MASTER

Healthy school environments

analysis of the factors influencing the travel mode to school of Dutch primary school children and its relation with parental safety perception and children's well-being and health

van de Craats, Iris

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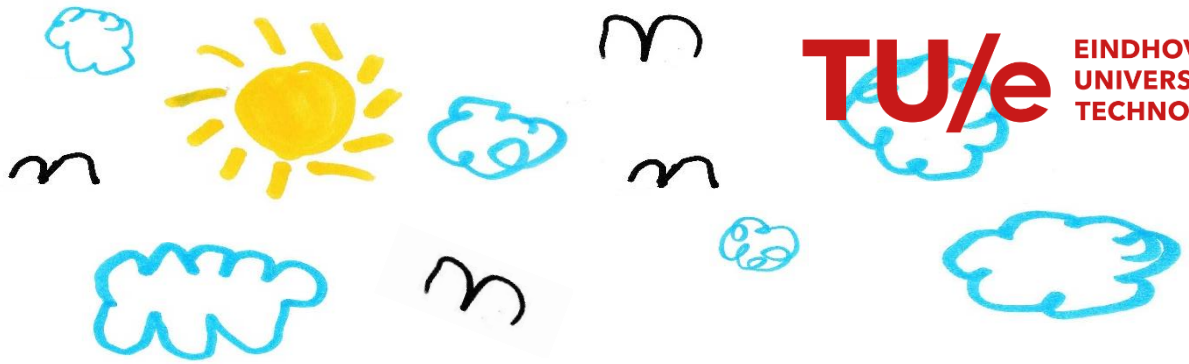

EINDHOVEN UNIVERSITY OF TECHNOLOGY

HEALTHY SCHOOL ENVIRONMENTS

Analysis of the factors influencing the travel mode to school of Dutch primary school children and its relation with parental safety perception and children's well-being and health

Graduation report
I. (Iris) van de Craats
January 2019

Drawing by Desiree & Amber van de Craats, 2018

COLOPHON

Master thesis

Healthy School Environments

Analysis of the factors influencing the travel mode to school of Dutch primary school children and its relation with parental safety perception and children's well-being and health

Eindhoven, January 2019

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PREFACE

Before you lies the final product of my graduation project on school environments that promote healthy travel behavior of children. This project was conducted to finalize the master Architecture, Building and Planning, specialization Urban Systems and Real Estate at Eindhoven University of Technology. I worked on the graduation project between April 2018 and January 2019. Throughout this project I have continued discovering what interests and motivates me most within the field of Urban Systems and Real Estate: the ability of the built environment to make people healthier and happier.

I started out with a very large piece of paper on which at least twenty possible graduation topics were written down. Together with my first supervisor Pauline van den Berg, I soon narrowed it down to healthy children in the built environment, a topic that intrigued us both. I started working out the details and meanwhile my graduation internship at HEVO *experts in huisvesting en vastgoed* commenced, under the supervision of Gerhard Jacobs and Wouter Houët. Gerhard, Wouter and Pauline helped me find and shape a research topic that was both interesting and practically relevant. Soon, Pauline and I asked my second supervisor, Astrid Kemperman, to participate. Also Astrid was a valuable addition to the team, both Pauline and Astrid have provided me with helpful feedback and a critical but realistic view on the literature, methodology, analysis and reporting stages of the project. To complete the team, we asked Owen Waygood from Polytechnique Montréal / Université Laval to fulfill the role of third supervisor. Owen helped me with his feedback and advice, based on his broad and international experience in researching child travel behavior.

I am grateful for the marvelous team that I was surrounded with during my graduation project. Everyone was at least as enthusiastic as I was about the research topic, which inspired me to make the best of the project. Moreover, Gerhard and Wouter helped me to obtain a large dataset and to make and understand the connection between research and practice. Pauline, Astrid and Owen provided me with valuable feedback throughout the different stages of the research that helped me take my graduation thesis to a higher level. Thank you very much!

I also want to thank my parents, family and friends for their genuine involvement and the necessary distractions. Special thanks to Robin, for listening to my enthusiasm as well as the occasional complaints and for fulfilling the important position of mediator between me and the various computer programs that I used.

Hereby, I proudly present my master thesis. This thesis does not only represent the finalization of my master specialization Urban Systems and Real Estate, but also the closure of a fantastic student life in Eindhoven. Therefore, my final thanks go to the fellow students in my study and student association that contributed to making the past 6,5 years unforgettable.

Eindhoven, January 2019

Iris van de Craats

SUMMARY

Abstract

Several studies have shown that children worldwide, including in the Netherlands, are not meeting physical activity requirements. Active travel among children is decreasing and more children commute to school on the backseat of the car. This is an unfavorable development, because active travel provides important health and well-being benefits and the increasing numbers of cars around schools cause safety issues. The current study used a socio-ecological approach to search for empirical evidence on the influencing factors of child travel behavior. Several layers of the child's environment have been considered, from the personal layer to the external layer. Additionally, the mediating role of the parental safety perception was studied, as well as the relationship between active travel and subjective well-being and health. A literature review was conducted, on the basis of which a conceptual model was made. Survey data were collected from 660 children (aged 7-12) and their parents, attending 14 primary schools. The data were analyzed by means of multilevel regression analyses and a path analysis for the dependent variables parental safety perception, active travel and satisfaction with travel. Results show, among other things, that the active travel participation is influenced by age, the parental safety perception, parental travel mode, social connections of the child and travel distance. Parental safety perception is influenced by age, social cohesion and connectivity. Children who travel actively are more satisfied with their trip and are more active overall. School boards and policy makers can use these insights to develop interventions which may increase active travel and, by extent, subjective well-being and health of children.

Keywords: children, well-being, safety perception, active transport, school trips, satisfaction

i. Introduction

The World Health Organization (WHO) recommends sixty minutes or more of moderate to vigorous physical activity daily for children, in order to experience the important health benefits of physical activity (WHO, 2010). Just approximately 10% of European children are currently meeting this recommendation (Verloigne et al., 2012). Active travel (cycling and walking) among children of the "backseat generation" (Karsten, 2005) is decreasing worldwide (Boarnet et al., 2005; Buliung, Mitra, & Faulkner, 2009; Fyhri et al., 2011; McDonald, 2007a), including in the Netherlands (NOS, 2015, 2018; Vos, 2018). This is an unfavorable development because inactivity as a child tracks into inactivity in adulthood (Telema, 2009) and children that miss out on active travel miss out on valuable health benefits and cognitive development benefits (e.g. Lubans et al., 2011; Martin, Goryakin, & Suhrcke, 2014; Brown et al., 2008). A child travels to and from school every day, which means that active travel to school can make a valuable contribution to everyday physical activity and to developing an active lifestyle in general (Cooper et al., 2003; Tudor-Locke, Ainsworth, & Popkin, 2001).

It is imperative to develop means and interventions that can stop or reverse the decrease in active travel among children. Although authors have been stressing the importance of considering the child in the urban environment, scientific attention remains limited. Likewise very few studies have been conducted which look into children's active travel, especially in the Netherlands. Country-specific research is important and called for (Aarts et al., 2013; Kemperman & Timmermans, 2014). The current study has looked into the influencing factors of active travel among Dutch children attending primary school. Additionally, the study considered the mediating effect of parental safety perception and the effects of active travel on subjective well-being and health. It is believed that approaching the problem of decreasing active travel from a socio-ecological approach is most successful, as this approach considers multi-level influences from someone's environment (Mitra, 2013). The current study has considered five layers of the child's environment in the following main research question:

> *Which personal-, household- and school factors and which characteristics of the social & physical- and external environment of primary school-going children have an influence on participation in bicycling, walking or motorized transport to primary school in the Netherlands? How is this relationship mediated by the parental safety perception about transport mode of their children? How is it related to children's subjective well-being and health?*

The aim was to learn about the relationships between factors in the different layers of the child's environment and active travel, parental safety perceptions and subjective well-being and health, and to understand and use these relationships to promote active school travel in the Netherlands. To this extent, an extensive literature review was conducted, followed by a quantitative research.

ii. Literature review

Brief history and current status of children's travel in The Netherlands

The suggestion that children are no longer independent in mobility which is threatening their quality of life was increasingly supported in the eighties and nineties (Berg & Medrich, 1980; Gaster, 1991; Van Vliet, 1983). Among other things, the need to create child-friendly environments, which facilitate the mobility and preferences of children, was expressed by David & Jones (1996). There are several trends that have been emerging in the past decades, which have changed Dutch school travel behavior to more car travel. One example is the increasing distance to primary school (CBS, 2017b) due to schools in small towns that have been closing down (Trouw, 2015) and parents who increasingly choose schools with specific educational visions, even if these schools are farther away from home (Van der Klis, 2013). Another trend is that almost a third of Dutch children are driven to school by car (NOS, 2013) as a result of increasing safety concerns that parents have (VVN, 2014). However, the problem is that this is part of a vicious circle: as more parents drive their children to school, there will be more cars, which results in more chaos and a more negative perception of traffic safety. VVN questioned one third of Dutch primary schools, of which 80% are having trouble concerning traffic outside the school and 58% claim that dangerous situations take place as a result of the bringing and taking of children by car (NOS, 2015).

Active travel and child well-being

Some studies have already looked into the associations between children's travel behavior and their subjective well-being and health. For example, active as opposed to passive travel was found to be associated with positive emotions such as feeling happy or relaxed (Ramanathan et al., 2014). Stark et al. (2018) suggest that this relation should be seen as a feedback loop: the travel mode elicits certain emotions which influence perception and affect of that mode, which in turn contribute to future travel mode decisions. The relation between travel behavior and subjective well-being can be expressed by considering the child's satisfaction with travel. According to Bergstad et al. (2011), daily travel likely has an influence on the mood and satisfaction of an individual. They found that travel satisfaction had a direct effect on cognitive and affective subjective well-being. Also Ettema et al. (2011) reported that satisfaction with travel had a high reliability in predicting subjective well-being as a result of the trip.

Although very few studies exist that particularly tested the direct relationship between active travel and health, several researchers found active travel to be significantly associated with overall higher physical activity levels (e.g. Faulkner et al., 2009; Roth, Millett & Mindell, 2012). Physical activity has many health benefits for children, such as lowered chances of obesity (Janssen & LeBlanc, 2010), improved skeletal health and cardiorespiratory fitness (Loprinzi et al., 2012). Active travel also has psychological benefits, such as the relation between physical activity and self-esteem (Loprinzi et al., 2012) and psychological well-being (Hamer et al., 2008; Martin, Goryakin, & Suhrcke, 2014). Another beneficial aspect of active travel among children is that it can lead to improvement of social connections in the neighborhood. Having social connections in the neighborhood is important for the social capital and social cohesion in the neighborhood (Waygood et al., 2017a), which in turn were found to be beneficial for both physical and subjective well-being (Helliwell & Putnam, 2004), for adults as well as children (Waygood et al., 2017a). Finally, active travel is also important for the development of children. An important skill that children can gain from physical activity is motor skill, the ability of knowing how to move. It is essential for children's development towards adult life that they learn motor skills involved in different physical activities (Loprinzi et al., 2012).

Socio-ecological approach of active travel

This section describes the influencing factors of children's active travel behavior from a socio-ecological approach. To this extent, five different layers of the child's environment which may influence their travel behavior have been considered.

In the personal layer, gender was found to be associated with active travel by some studies. Boys have been reported to more often be allowed to travel independently than girls (Carver, Timperio & Crawford, 2013; Trapp et al., 2012), which results in more active travel participation. However, other studies found no association between travel behavior and gender (e.g. Kemperman & Timmermans, 2014). In contrast, the age of children was often found to be of great influence on the relationship between active travel behavior and its many predicting factors (Carver, Timperio, & Crawford, 2013; Kann et al., 2015; Kemperman & Timmermans, 2014). An older age was often associated with more participation in active travel. Additionally, in relation to the child's enjoyment of a trip, Westman et al. (2017) found active travel mode as well as social interaction during travel to be positively associated with children's satisfaction of the trip.

In the household layer, also various aspects were found to play an important role. The number of cars in a household was found to be negatively associated with active travel to school (Aarts et al., 2013; Pont et al., 2009) and it was found to enable car travel (Grize et al., 2010; Sidharthan et al., 2011). Lower household income was found to be associated with more active travel participation (Sidhartan et al., 2011) but also with less active travel participation (Pont et al., 2009; van Goeverden & de Boer, 2013). Carver, Timperio, & Crawford (2013) found that children who had at least one parent that did not work were more likely to be driven home from school by car, while Davison et al. (2008) found evidence implying that children were less likely to participate in active travel when their parents worked and when the active travel would hinder the parents' work schedules. In contrast, children had higher odds of participating in active school travel when their parents used active travel modes to get to their work (Davison et al., 2008; Panter et al., 2010a). The importance of the parental safety perception in the transport mode decision making process has been found by so many researchers (e.g. Kerr et al., 2006; Carver, Timperio & Crawford, 2008a; Veitch et al., 2017) that it is given special attention in the current study. Another influence that parents have is referred to as parental support, the verbal encouragement of active travel participation. Parental support was found to have a significant influence on active travel of children (Mah et al., 2017; Leung, Chung & Kim, 2017).

Almost no research has been conducted on the relationship between factors in the school layer and children's participation in active travel. Some school factors that may influence travel behavior are the trends of changing school schedules to having lunch at school instead of at home (NOS, 2016) and the earlier mentioned larger school distances. Moreover, some Dutch schools and municipalities have started various health and active travel related initiatives, such as the possibility of obtaining a "healthy school" status (Rijksoverheid, n.d.).

More factors from the physical and social environmental layer have been found to significantly influence children's travel behavior. The most commonly found influencing factor of school travel behavior was, not surprisingly, distance to school. Living closer to school was found to enable active travel internationally (e.g. Chillón et al., 2015; McMillan, 2007; Merom et al., 2006; Nelson et al., 2008; Panter et al., 2010) as well as in the Netherlands (Aarts et al., 2013; Dessing et al., 2014; Helbich et al., 2016; Kemperman & Timmermans, 2014). Kemperman & Timmermans (2014) also found high urban density to be associated with more children walking, but fewer children cycling. Giles-Corti et al. (2011) found street connectivity to enable walking to school, as did D'Haese et al. (2011). However, there is also research that suggests connectivity to negatively influence active travel (Sirard & Slater, 2008; Timperio et al., 2006), possibly because connectivity also might enable motorized travel, which influences the (perceived) safety. Waygood & Susilo (2015) found in a study in Scotland that having

good local shops near the school is positively correlated with active travel, specifically with children walking to school. A higher percentage of recreation areas in the neighborhood was found to be associated with higher probabilities of walking and lower probabilities of cycling (Kemperman & Timmermans, 2014). De Vries et al. (2010), on the other hand, found that cycling to school and cycling for transportation were significantly associated with higher numbers of recreational facilities in the neighborhood. The presence of forest and natural areas lead to higher chances of children cycling (Kemperman & Timmermans, 2014) and to lower chances of walking to school (de Vries et al., 2010). The earlier mentioned parental safety perception was also found to be associated with several factors from the physical and social environment. Examples of this are living by a busy road and/or a road with insufficient crossings (Trapp et al., 2012) and traffic safety and social safety (Van Kann et al., 2015). In the social environment, especially social cohesion, social connections and social safety were found to be important. Aarts et al. (2013) found, especially for children attending primary school, significant relations between active school travel and the perceived social safety and social cohesion in the neighborhood. Kemperman & Timmermans (2014) found that children who live in neighborhoods that are perceived safe and have high social cohesion use the bicycle more often than children who live in perceived unsafe neighborhoods with lower social cohesion. Waygood et al. (2017a) also suggest that having neighborhood connections decreases parental concern which leads to more children traveling independently. Something similar was found by Bringolf-Isler et al. (2007), parents were less worried about children's safety when there would likely be social contacts during the trip.

Finally, in the external layer, especially policies and initiatives were found to be related to children's active travel participation. Carver, Timperio & Crawford (2013) argue that several policies aiming towards social trust and a more connected community as well as improved neighborhood safety could lead to more frequent participation in active school travel of children. Buliung et al. (2011) found modest increases of active travel and decreases of car travel at schools that participated in projects that encourage active travel. Law and regulations that consider the vulnerability of cyclists in traffic are, according to Puch & Buehler (2008), one of the reasons why cycling is popular in the Netherlands compared to other countries and especially compared to the USA. Finally, Buliung et al. (2011) found that one of the reasons for Canadian parents to drive their children to school by car was the weather.

iii. Data collection & description

After the literature review, the next step of the current study was to conduct a quantitative analysis using data derived from the national database CBS, from questionnaires distributed among primary school pupils and their parents and from interviews with principles of the participating schools. Using the insights from the literature review, a conceptual model was created on the basis of which the questionnaire and the research design were built-up. In the conceptual model it was hypothesized that factors from the five layers of the child's environment influence the safety perception of their parents, their own transport mode to school and their subjective well-being and health. Furthermore, the parental safety perception was hypothesized to influence the school transport mode, which in turn was hypothesized to influence the subjective well-being and health of the child.

Data measurement tool: questionnaire

Results from the Dutch National Travel Survey (OViN) concerning children's school travel were studied and, combined with the literature review and the conceptual model, used as the main input for the questionnaire of the current study. A combined questionnaire was made for Dutch primary school children (part 1) and their parents (part 2). The transport mode was measured by asking the children which mode they used. Children's travel behavior in general was measured by asking parents to report the weekly average frequency of using different school transport modes. To measure parental safety perception, parents were asked to reply to a set of statements concerning traffic safety, social safety and the traffic skills of their children. Children's subjective well-being and health were measured by means of statements indicating satisfaction with travel of the children, but also by questions for

parents about the health and physical activity of children. Additionally, parents were asked to report on household factors such as income and work status and physical and social environmental factors such as statements about the quality of cycling and walking paths, social cohesion, connectivity and social interaction of the child. The weather was measured by asking children to choose from a few images visualizing very sunny to very rainy weather conditions.

Questionnaires were distributed among 15 primary schools in and around the Dutch city Arnhem in the fall of 2018. The schools vary in number of pupils, education type, health attitude and they are located in areas with different urban density levels. All children in grades 5-8 (aged 7-12 years old) of the 15 participating schools received a questionnaire in class, which they were asked to immediately fill in. They were then asked to bring the questionnaire home to be completed by their parents. Meanwhile, the researcher conducted short interviews with the principals of the 15 schools to learn about car parking and traffic safety conditions around the schools and the health attitude of the schools. To ensure reliability and validity of the data, special attention was given to make the questionnaires and the interview questions clear and unambiguous, to avoid suggestive questions and to ask only questions about subjects that the respondent has sufficient knowledge on. Moreover, to decrease the risk of misinterpretation, the questionnaire was tested by several children and adults and the child-survey was especially designed to be appealing and comprehensible to children.

In the end, 676 completed questionnaires were collected from 14 primary schools. After removing some unsuitable responses, a final sample of 660 respondents remained. This is a response rate of 46%. The distributions among personal characteristics and household factors as well as the physical and social environmental factors were all quite balanced. In most cases, all of the categories were represented by a substantial amount of respondents. If this was not the case, categories were merged to improve distributions between categories. The 14 different schools that the children in the sample attend are of different sizes, have different education visions and schedules and they are located in different types of surroundings. Assuming that the current data form a representation of the Dutch primary school children in grades 5-8, it can be said that definitely most children still use active transport modes to go to school. However, also a substantial amount of children travel sometimes or often by car. A significant share of school principals and parents have their doubts concerning traffic safety around schools. Children mostly travel alone or with a parent and/or sibling. The sample consists mostly of Dutch households, but also a substantial share of households have other ethnic backgrounds, which is representative of the Dutch population.

iv. Data analysis & results

Data analysis steps

The analyses of the data from the questionnaires, the school interviews and the CBS database took place in three steps. The first step was to conduct bivariate analyses in SPSS between all independent variables and dependent variables. The aim was to eliminate relationships between independent variables and dependent variables that were not significant (p-value ≤ 0.05). The second step was to conduct regression analyses. In this step, the combined predictive power of the independent variables could be investigated for each dependent variable. The dependent variables that were investigated by means of regression analyses were: parental safety perception, satisfaction with travel (SWT), weekly physical activity, active vs. passive travel and transport mode on the day of the survey. Because the data might be dependent on the different schools that respondents attend, a multilevel data analysis approach was used. For the continuous dependent variables multilevel linear regression analyses were conducted in SPSS, for the binary dependent variable a multilevel binary logistic regression analysis was conducted in SPSS and for the multinomial dependent variable a multilevel multinomial regression analysis was conducted in HLM. After the regression analyses, relationships were eliminated if they were not significant at the 0.1 significance level. The third and final step of the data analysis was to conduct a path analysis in LISREL. In the path analysis, three dependent variables were included:

parental safety perception, SWT and percentage of active trips (derived from active vs. passive travel). The transport mode variable was not included because the path analysis method does not comply with categorical dependent variables and the weekly physical activity variable was not included because it was not significantly associated with any of the other dependent variables.

Final results regression analyses

For the variables percentage of active trips, parental safety perception and satisfaction with travel the results of the regression analyses were used as input for the path model. However, the variables weekly physical activity and transport mode on the day of the survey were not included in the path model. For these variables the results from the regression analyses are the final results.

The regression model for the transport mode considered the car transport mode as reference category, the odds of traveling by bicycle or by foot compared to traveling by car were investigated. Children that were older had higher odds of traveling by bicycle as well as by foot than by car. When a child had walking as their favorite transport mode, the child was more likely to walk than travel by car. Children in households with 2 parents and 1 child were less likely to walk to school than children in households with 2 parents and 2 children. Children who have parents that, combined, travel by car more than 8 days per week have decreased odds of traveling by bicycle as opposed to traveling by car. Higher levels of active travel participation of parents are associated with larger odds for children to walk as well as cycle to school. Small distances increase the odds of walking, larger distances decrease the odds of cycling as opposed to traveling by car. When there are 26-30% households with children in the neighborhood, as opposed to 25% or less, children are more likely to walk to school. It is not completely clear why this relationship occurs. Associated with higher odds of cycling compared to car travel are high levels of connectivity, which could be because many different routes make it possible to choose the safest or most convenient one. In contrast, also low connectivity was found to be associated with higher odds of cycling. In this case, the explanation could be that lower connected areas are less attractive for car travel and are therefore more quiet and safe for cyclists. When children know a lot of other children in the neighborhood, they are more likely to walk to school than travel by car. Rain is associated with lower odds of cycling to school and more positive parental safety concerns increase the odds of cycling as opposed to traveling by car.

The regression analysis for weekly physical activity revealed that children who travel more actively to school, are also more active overall. However, this relationship was only significant when the percentage of active trips was operationalized as an ordinal variable. Other predictors of weekly physical activity are gender (girls were less physically active), contact with children (knowing more children in the neighborhood is associated with more physical activity) and school size (children in smaller schools are less physically active). Especially the significant relationship with contact with children is interesting and logical: when children know more other children, they are likely to go outside to play with their friends more often.

Final results path analysis

The final step of the quantitative research was the path analysis which was conducted in LISREL. In the path analysis, the combined predictive power of independent variables on the parental safety perception, the percentage of active trips and the satisfaction with travel were investigated. The final path model can be seen in figure i.

First, the parental safety perception was found to be significantly and positively influenced by age. This is not surprising, older children become more independent and learn how to recognize dangers. Also the favorite mode of a child is associated with the safety perception of the parent. Children who prefer to travel by another mode than the car, bicycle or walking, have parents who are more concerned about the safety. This result is unexpected, but it may be caused by the fact that children who choose another mode, about half of the times choose the taxi-bus which they take to their special education school. Earlier analyses revealed that parents of children attending special education schools generally belong to the groups of parents that are more concerned about safety. In

the physical environmental factors, there is a positive relationship between higher connectivity and the parental safety perception. This may be because a larger choice of routes to take to school allows the selection of the safest route. Parents who are more positive about the quality of bicycle and walking paths are also more positive about overall safety concerning school travel. Lastly, when parents feel like there are higher levels of social cohesion in the neighborhood (e.g. they know and trust their neighbors), they are more positive about the safety of the trip to school.

Several significant relationships were found between independent variables and the percentage of active trips. Firstly, a more positive parental safety perception is associated with higher percentages of active travel. Also age is positively associated with the percentage of active trips, older children travel more actively. Children in households with one parent and more than one child and in households with two parents and one child experience a lower percentage of active trips than children in households with two parents and more than one child. Concerning travel behavior of parents, children who have parents that, together, use the car more than 8 days per week and parents that never travel actively experience lower percentages of active travel. Children who live closer than 1 km to school experience higher percentages of active trips than children who live between 1 and 2 km from school. Children who live over 2 km away from school experience lower levels of active travel. High urban density is also associated with lower levels of active travel, perhaps because the more dense areas are busier, a little chaotic and therefore are perceived as less safe. Children who have more contacts with other children in the neighborhood are more likely to travel more actively. This may be because parents are less worried when they know their children will run into other children on the way to school. Partly, the relationship could also be reversed: children that travel actively are likely to get to know other children. Children who travel with a parent, with a parent and a sibling and with other people were found to experience lower percentages of active trips than those who travel alone.

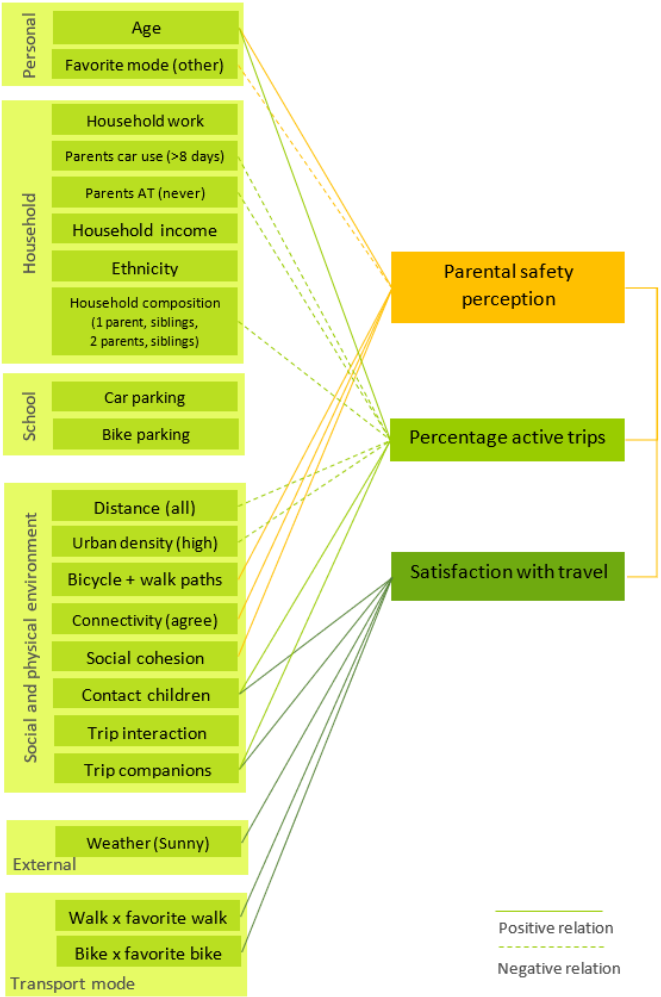

Figure i Final path model, significant relations

The subjective well-being approach of the current research is represented by the satisfaction with travel dependent variable in the path model. Children who traveled to school by bicycle and also have the bicycle as their favorite mode were more satisfied with their trip, as were children who came by foot and prefer to walk. This relationship is not visible for car travel. Moreover, without including the interaction factor of the preferred transport mode in the regression analysis, it became visible that cycling results in a higher satisfaction than car travel. A relationship that is reversed to what would be expected considering the literature is that children who know some other children are less likely to be satisfied with their trip than children who do not know other children. There is, however, a positive significant relationship between traveling with a friend and satisfaction, which is in line with the expectations. Children who traveled to school on a sunny day were, not surprisingly, more satisfied than for other weather conditions. Lastly, children whose parents are more positive about the safety were more satisfied about their trip. This may be because parents are more relaxed which increases

the child's satisfaction, or because the trip to school is (perceived) safer which is why parents are less concerned and at the same time why children are more satisfied.

v. Conclusion, discussion and recommendations

The aim of this study was to identify the factors in children's environment that contribute to children's participation in active school travel, to understand the role of parental safety concerns in the transport mode decision making process and to investigate the relationship between school transport mode and subjective well-being and health. Overall, it can be concluded that the influencing factors of active travel participation can be found in all the layers of the child's environment except for the school layer. Especially the travel behavior of parents, the distance to school, social contacts of children and trip companions, the weather and the parental safety perception are important predictors of children's travel behavior. The parental safety perception is influenced by factors from the personal layer, the household layer and the physical and social environmental layer. Especially age of the child, social cohesion in the neighborhood, connectivity of the neighborhood and the quality of cycling and walking paths are important. Lastly, both the weekly physical activity of a child and the satisfaction with travel of children are significantly higher when children travel more actively. The satisfaction with travel is also positively related to sunny weather. Children are more physically active when they know other children in the neighborhood and they are more satisfied with their trip when traveling with a friend.

There are some limitations and remarks to the current study. Firstly, the data were measured at one day in the year, while travel behavior may differ between seasons. Moreover, the weather conditions were not entirely representative to the season in the Netherlands. The school sample size was mediocre, possibly lowering the quality of the distribution of the school variables. An additional difficulty concerning the school sample is that the special education schools may have been slightly overrepresented. Many children from these schools traveled to school by taxi-bus, which was coded as "other". This lead to over half of the "other" travel modes and favorite modes to refer to the taxi-bus, which may have caused some misleading results. However, most of the possible bias due to the special education schools should have been eliminated by using a multilevel analysis approach. Finally, another difficulty concerns the marital status of parents and the consequences on the manner of answering questions if parents are divorced and children live in two homes. In some cases it may have happened that parents filled-in the questionnaire on behalf of two homes. The cases for which this was detected have been removed from the sample.

Despite of these limitations, the current study is one of the first and more complete studies looking simultaneously at children's travel behavior, safety concerns of their parents and the relation to their subjective well-being and health. This makes the study scientifically relevant because it adds new empirical evidence and relevant from a societal perspective because it draws attention to and increases the understanding of children's active travel participation in the Netherlands. During the course of the current research some new perspectives for future research surfaced. For example, it would be interesting to conduct a longitudinal research to investigate whether active travel rates increase after a certain intervention in the traffic safety, in the environment of the school or in active travel policies. Another interesting approach for future research is to dig deeper into the perception that children have of their school trip, the safety and the extent to which they enjoy it. Suggestions to improve the fact that the variables of the current study are based mainly on perceptions and not on facts, include using GPS trackers, a Fitbit or actual street maps. Lastly, several implications for practice can be derived from the results of the current study and applied by schools and municipalities aiming to increase children's active travel participation. These stakeholders are advised to focus mostly on social aspects such as the social network of children and the social cohesion of neighborhoods, on the safety perception and the travel behavior of parents, on the enjoyment that children get out of their active trips and on connectivity, urban density and bicycle and walking paths. Possible interventions include informing parents and children on the benefits of active travel, facilitating encounters between children in neighborhoods and improving the safety (perception) of walking and cycling infrastructure.

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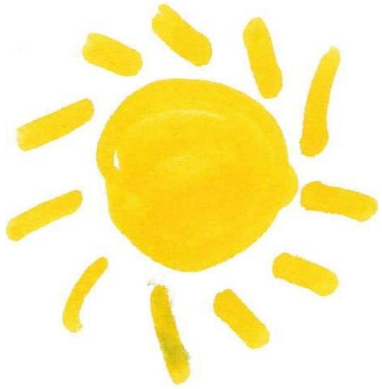
CHAPTER 1

INTRODUCTION



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1. INTRODUCTION

1.1 Background

The World Health Organization (WHO) recommends sixty minutes or more of moderate to vigorous physical activity daily for children, in order to benefit from the important health benefits of physical activity (WHO, 2010). Just approximately 10% of European children is currently meeting this recommendation (Verloigne et al., 2012). Also in the Netherlands, most children are not meeting the recommendation (Aarts et al., 2013), only 30 – 40 % of children experience sufficient physical activity (Kann et al., 2015). Furthermore, in the Netherlands 13,1% of children aged between 4 and 11 years old is overweight, 3,3% is obese (CBS, RIVM, & Trimbos-instituut, 2017). The WHO considers childhood obesity currently as one of the most serious issues in public health (WHO, 2017). Altogether, these developments have led to researchers investigating several health and physical activity issues, such as the decrease in active travel (by bicycle and by foot) among children. Several studies and articles indicate that the amount of active travel among children of the "backseat generation" (Karsten, 2005) is decreasing worldwide (Boarnet et al., 2005; Buliung, Mitra, & Faulkner, 2009; Fyhri et al., 2011; McDonald, 2007a), including in the Netherlands (NOS, 2015, 2018; Vos, 2018). Children more often spend their journeys to school being transported by car, which is an unfavorable development because inactivity as a child tracks into inactivity in the adult life (Telama, 2009). Moreover, active travel has several health benefits (e.g. Lubans et al., 2011; Martin, Goryakin, & Suhrcke, 2014; Roth, Millett, & Mindell, 2012; Schoeppe et al., 2012) and cognitive development benefits (Brown et al., 2008; Prezza et al., 2001) that many children of the current generation are missing out on. A child travels to and from school every day, which makes active school travel a potential regular source of physical activity. Active travel to school can make a valuable contribution to everyday physical activity and to developing an active lifestyle in general (Cooper et al., 2003; Tudor-Locke, Ainsworth, & Popkin, 2001).

The increasing car-usage for school trips does not only result in less physical activity, but also in decreased safety levels for traffic outside schools. In the Netherlands, the traffic situation at four out of five primary schools is unsafe (NOS, 2015). The Dutch travel safety organization *Veilig Verkeer Nederland* (VVN) states that too many parents bring their children to school by car. VVN calls the traffic situation outside primary schools a vicious circle; parents judge the area around school as too dangerous for their children to go by bicycle and therefore they bring the children by car. However, this adds to the unsafe traffic situation (NOS, 2018). Replacing short car trips with active transport to school would reduce unfavorable environmental issues around schools, such as emissions of greenhouse gasses and rush hour traffic congestion (Maibach, Steg, & Anable, 2009).

Children's active travel is decreasing and it is of importance to turn this trend around, which is why more insights in children's travel behavior are needed. Fyhri et al. (2011) have focused on active travel and independent mobility of children in various age groups (mostly aged between 6 and 14 years old) in four countries (Denmark, Great Britain, Norway and Finland) and found a decrease in independent mobility and active travel in all four countries over de past decades. The amount of transport by car had increased. Fyhri et al. (2011) indicate several trends that most likely have contributed to this change in children's transport modes over the past decades. Examples are increased parent employment and car ownership, and an increase in the amount of parents who share the perception that being outside is unsafe for children (Fyhri et al., 2011).

Several studies have looked into what might influence the school transport mode of children. They often consider different levels of influences, such as individual and family characteristics, school characteristics and community and environmental characteristics (Davison et al., 2008). Authors have used frameworks modified from Bronfenbrenner's (1979) socio-ecological theory while attempting to

explain the factors from these different levels that influence children's transportation mode (e.g. Curtis, Babb, & Olaru, 2015; Mitra, 2013b; Panter et al., 2010). Sallis, Owen & Fisher (2008) explain that these types of models propose that behavior is influenced by factors from different levels (e.g. the personal level, the household level, the community level) and that influences interact between the different levels. Mitra (2013) believes that the socio-ecological approach is useful when looking into the travel behavior of children going to school because it allows researchers to develop a model which shows the multi-level influences such as the built and social environments, relations between child and caretaker's transport and the attitude of the household towards school travel mode.

Factors of several environmental layers such as the built environment, the social environment, the household and personal factors have been found to influence transport mode and participation in active travel of children. Examples are the degree of urbanization (Kemperman & Timmermans, 2014), factors relating to land-use (de Vries et al., 2010; Waygood & Susilo, 2015), street connectivity (D'Haese et al., 2011; Kerr et al., 2006; Sirard & Slater, 2008) and trip characteristics such as distance (Chillón et al., 2015; Easton & Ferrari, 2015; Nelson et al., 2008) and purpose of the trip (Kemperman & Timmermans, 2014). Also social characteristics in the neighborhood are indicators of children's participation in active travel, such as the degree of social cohesion (Kemperman & Timmermans, 2014) and the safety perception concerning the neighborhood (Trapp et al., 2012). The parental concern, often related to safety, has been found to be very influential on whether or not a child participates in active travel (Kann, 2017; Kerr et al., 2006; Timperio et al., 2006). Finally, personal factors of the child have been found to influence travel behavior, mostly through what they are allowed to do by their parents, which is related to their gender (Shaw et al., 2015; Trapp et al., 2012) and age (Carver et al., 2013; Shaw et al., 2015).

1.2 Problem description

As described in the previous section, there is a decrease in active travel among children, which is an undesirable development. Furthermore, children who spend less time participating in active travel and more on the backseat of a car will miss out on essential social, psychological and cognitive developments. As it is imperative to develop means and interventions which could stop or reverse the decrease in active travel among children, a better understanding in the influencing factors of school travel mode is required. Authors have been stressing the importance of considering the needs of children in the urban environment for decades. However, scientific attention remains limited. Existing literature has tended to focus on travel behavior of adults, whereas children's travel behavior remains understudied (McMillan, 2007; Panter et al., 2010b; van Goeverden & de Boer, 2013). Children's travel behavior should be investigated on its own, instead of converting the influences on travel behavior of adults into that of children (Mitra, 2013). The influential factors may be different between adults and children (Panter et al., 2010b).

Furthermore, especially very few studies have been found to investigate children's travel in the Netherlands. The urge to improve children's health does appear to be gaining attention in the country. There are already several government-initiated initiatives to improve children's health, for example focused on raising awareness of children's health-related needs among municipalities (JOGG, n.d.) and giving out certificates to schools that are actively and effectively promoting health and physical activity (Rijksoverheid, n.d.). Also the Dutch press acknowledges the issue; several newspaper articles have been written about children using the bicycle less often (NOS, 2015, 2018) and De Volkskrant states that primary school children perform poorer than ten years ago in physical education (Vos, 2018). Also other newspapers occasionally write about similar issues concerning primary school children (AD, 2014; Telegraaf, 2018). Although the Dutch press as well as the government clearly recognize the importance of improving children's well-being and are mostly approaching this issue from the point of

view of education and schools, there is not yet a sound basis of empirical evidence on which kind of factors have a relation with children's physical activity and well-being in the urban environment in the Netherlands. Moreover, although there have been studies (internationally) reporting that active school travel is associated with higher levels of physical activity in general, and that physical activity in turn comes with several health benefits, the actual relation between active travel and (subjective) well-being and health remains especially understudied (Bergstad et al., 2011).

Country-specific research on children's travel behavior is important; the relation between active travel behavior and the environment may differ between countries. Therefore, in order to guide policy makers in the making of policies that support active travel for children, country-specific studies in the Netherlands are called for (Aarts et al., 2013; Kemperman & Timmermans, 2014). Furthermore, unlike the countries in which most existing studies are based, the Netherlands has a bicycle culture (van Goeverden & de Boer, 2013) and the land-use pattern is organized accordingly (de Vries et al., 2010). This different main mode of transport may influence the experience of travel and the relation between the environment and children's (active) travel behavior, hence the need for country-specific research.

An important indicator for active travel among children appears to be the attitude that parents have towards the transport modes of their children. Mah et al. (2017) refer to parents as the "gatekeepers" of the travel behavior of children. Parents have an influence on the transport mode of children (Carver et al., 2013; Panter, Jones, & van Sluijs, 2008; Pont et al., 2011), which is why only implementing changes in the physical environment of children might not be enough to promote active travel (Mah et al., 2017). However, not all of the existing literature gives attention to this subject, especially in the Netherlands. Furthermore, in the existing body of research describing the role of parental concerns, the factors that cause parents' perceptions are not well understood (Rothman et al., 2015).

The current study will search for empirical evidence on the determinants of children's active school travel specific to the Netherlands. Additionally, the manner in which the parental safety perception about transport mode of children relates to this will be looked into as well as the relation between school travel mode and children's well-being and health.

1.3 Research objective

Considering the importance of active travel among children, the fact that active travel to school can contribute to daily physical activity patterns and that roughly half of children's travel is education-related (Kemperman & Timmermans, 2014), the primary objective of the current study is to provide insights into the determinants of active travel to primary schools in the Netherlands. These insights can subsequently be used by policy makers in the development of interventions to increase active travel among primary school-going children, which may by extent improve their well-being and health. The second research objective is to gain insights in the motivation and influence of the parental safety perception about children's travel mode to school, which has been proven to be highly influential. Thirdly, this study aims to gather a larger understanding of how primary schools and policy makers could influence children's active travel through multi-layer interventions in the child's socio-ecological environment. Finally, the fourth aim of this study is to gain insights on the possible association between school travel mode and well-being and health of children.

1.4 Research questions

The build-up and approach of the research question will be illustrated through a socio-ecological model, modified from Curtis, Babb & Olaru (2015), see figure 1.1. It is assumed that the influences of children's travel mode to school are divided into different layers, which all have an effect on the transport mode of children, but also interact with each other. The proposed layers in which the

influences are categorized are the layer of the child's personal factors, household factors and school factors, the physical and social environment and external factors. It is believed that especially the parental safety perception about travel mode, which is part of the household factors layer and may be influenced from several layers, has a strong relationship with the child's school travel mode. This effect is therefore specifically addressed in the main research question. Moreover, the relationship between school travel mode and well-being and health of children is included in the research question. To represent well-being, specifically subjective well-being is measured, which leads to the component subjective well-being and health in the research question.

The main research question of the current study is as follows:

> *Which personal-, household- and school factors and which characteristics of the social & physical- and external environment of primary school-going children have an influence on participation in bicycling, walking or motorized transport to primary school in the Netherlands? How is this relationship mediated by the parental safety perception about transport mode of their children? How is it related to children's subjective well-being and health?*

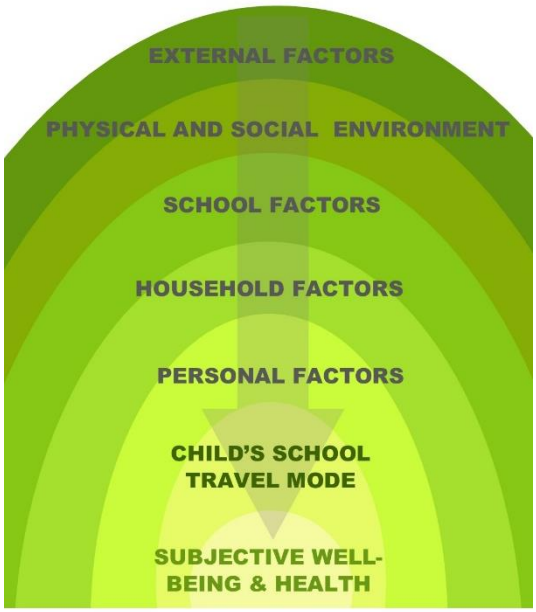


Figure 1.1 Socio-ecological model of children's active travel to school, modified from Curtis, Babb & Olaru (2015)

The model presented in figure 1.1 shows the five layers which are believed to influence a child's travel mode to school and their satisfaction with travel. The satisfaction with travel is seen as an indicator of subjective well-being resulting from school travel. The aim is to find out which relationships are significant and how to understand and use them to promote active school travel in the Netherlands. In order to answer the main research question, the following sub-questions will be answered.

a. Which factors influence the travel mode of children to school according to the literature?
b. What are the direct effects of personal-, household- and school factors and characteristics of the social-, physical- and external environment on the travel mode of children traveling to primary school in the Netherlands?
c. Which factors influence the parental safety perception about the travel mode of children and how does this influence the actual travel mode of children to school according to the literature?
d. What are the indirect relationships of personal-, household- and school factors and characteristics of the social-, physical- and external environment through the mediation of

parental safety perception about travel mode of children on the actual travel mode of children traveling to primary school in the Netherlands?

e. What is the relationship between children's travel mode to school and their health and subjective well-being according to the literature?
f. How does children's travel mode to primary school in the Netherlands influence their subjective well-being and health, while controlling for other characteristics in the child's environment?

1.5 Relevance

Societal relevance

Many children are not meeting physical activity recommendations, resulting in a series of health and child development issues. Specifically the trend of decreasing participation in active travel among children is highly unfavorable, which emphasizes the societal relevance of gaining insights on determinants of children's active travel to school. The overall decrease in physical activity and active travel among children, which has been pointed out by several authors the past years (e.g. Boarnet et al., 2005; Buliung, Mitra, & Faulkner, 2009; Fyhri et al., 2011; McDonald, 2007), leads to children missing out on proven health benefits of active travel. Therefore, the current study's aim of facilitating a better understanding of children's active travel to school which can be used by policy makers to develop effective interventions towards more participation in active travel, has strong societal relevance. By approaching the different socio-ecological domains that are believed to have an influence on children's travel behavior, insights can be gained on multi-level interventions that may influence active school travel of children.

Scientific relevance

There are several relevant findings in previous studies which prove the importance of active travel to school for overall physical activity, which by extent results in healthier children. However, the research base looking into active school travel and children's travel behavior is limited worldwide and especially in the Netherlands. Moreover, country-specific research is needed for the Netherlands due to the somewhat unique bicycle culture. Lastly, a better understanding of parental perceptions that influence children's travel behavior is called for.

This study will contribute to the existing body of literature by providing a better understanding of children's active travel behavior to school. The study will have a country-specific approach for the Netherlands, from which the insights will not only be interesting for researchers, policymakers and school boards in the Netherlands, but also for researchers from other countries in gaining understanding of the influence that the bicycle culture in the Netherlands may have on active travel of children. The additional analysis of the parental safety perception of their children's active travel expands the findings by also gaining understanding on how the parental safety perception is developed and influences actual active travel among children. Finally, investigating the relationship between school travel mode and subjective well-being and health is essentially a new approach. It is likely to add valuable insights to the existing research base. The current study provides relevant and new insights for future research and interventions on children's travel behavior to school in the Netherlands.

1.6 Research method

Different research methods will be used in this study to answer the main research question and the sub questions. In the first place a literature research will be conducted. A large part of the available literature on children's transport worldwide will be reviewed in order to answer sub questions a, c and e. The literature research will mainly result in a more comprehensive understanding of children's travel

behavior overall, the relation between transport and children's well-being and most importantly the socio-ecological factors that influence children's school travel modes. This will lead to an elaborate socio-ecological model which should illustrate the most important factors from a child's environment that influence their travel behavior and mode choice.

Moreover, a quantitative approach will be used to answer sub questions b, d and f and by extent answer the main research question. For this part of the research, existing as well as new databases will be used. Some descriptive analyses will be conducted with the OViN database, the Dutch National Travel Survey. Furthermore, data on urban density, land use and other environmental factors will be extracted from the Central Bureau of Statistics (CBS). Moreover, questionnaires will be made to suit the two target groups for the research: children in grades five to eight in Dutch primary schools and their parents. The questionnaires will be distributed among children (and their parents) attending a variety of schools in different types of (urban and rural) environments. The questionnaire for the children will focus on their satisfaction with the travel mode they used that day. The questionnaire for the parents is meant to surface insights about parental safety perception regarding their children's travel mode, the work situation of parents, but also information about the child's health and physical activity in general and factors concerning their physical and social environment. Lastly, the participating schools will be interviewed to derive some school-related data that may influence the school travel mode. The complete database with the existing data and the new data from the questionnaires will be combined and quantitively analyzed to learn which factors from mainly the different layers of the socio-ecological environment are associated with children's travel behavior, parental safety perception about travel behavior and the subjective well-being and health of children. Altogether, the data gathered through the various data collection methods will be used in bivariate and regression analyses and a path analysis to determine the answer to the research questions.

To illustrate the approach of answering the research questions, figure 1.2 presents the preliminary conceptual model, including all the environmental layers which are believed to influence children's school travel mode and the parental attitude as a mediating variable. The model also indicates how subjective well-being and health are believed to be influenced by travel mode to school as well as by factors from the several environmental layers.

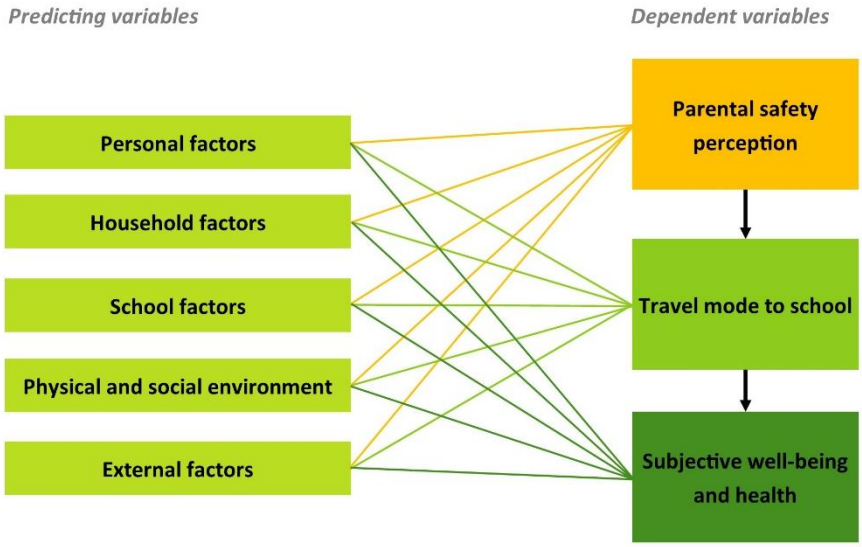


Figure 1.2 Preliminary conceptual model children's travel mode to school

1.7 Thesis structure

This thesis consists of 11 chapters, which in a logical way work towards answering the separate sub questions and eventually the main research question. The first chapter is the introduction of the thesis. The next three chapters, chapters 2, 3 and 4, constitute the theoretical framework. In chapter 2 the general history and current status of children's transport and their place in the built environment will be expanded upon. Chapter 3 focuses on the relationship between transport and children's well-being, first introducing how transport has had an effect on children's well-being and then highlighting the different benefits of active transportation for children. In chapter 4, the search for the influencing factors of children's school travel behavior truly takes off. In this chapter the literature research on the factors from five different socio-ecological layers of children's environment that may influence travel behavior are presented and explained. Chapter five presents some results from the national travel survey in the form of descriptive analyses highlighting different frequencies of travel modes on the basis of personal, household and physical environmental factors.

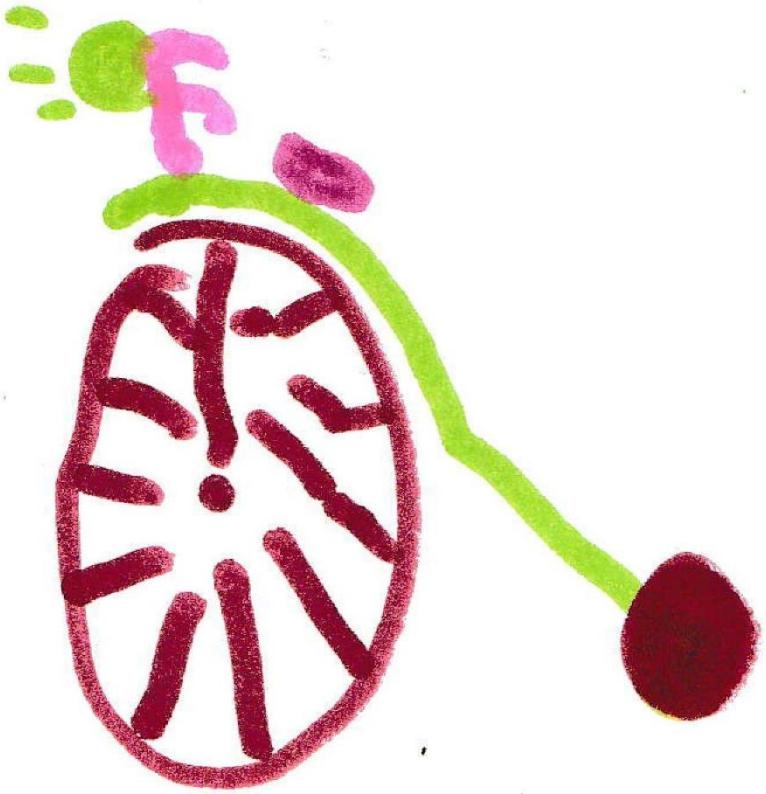
In the next chapters, chapters 6 – 10, the quantitative research is introduced and fully reported. Chapter 6 presents the research plan, which entails the methodology, the research design, the data collection and the description of the statistical data analysis methods that will be used. Chapter 7 describes the data from the CBS database and the child & parent surveys. Chapter 8, 9 and 10 present respectively the procedure and results of the bivariate, regression and path analyses.

Finally, chapter 11 makes up the conclusion, discussion and recommendations following from the contents and results of the theoretical framework and the quantitative research.

Figure 1.3 Thesis structure

CHAPTER 2

BRIEF HISTORY AND CURRENT STATUS OF CHILDREN'S TRAVEL IN THE NETHERLANDS



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2. BRIEF HISTORY AND CURRENT STATUS OF CHILDREN'S TRAVEL IN THE NETHERLANDS

This chapter gives a brief history of the developments concerning children in the built environment and of the role of the built environment for children. Also the current travel behavior of children in the Netherlands is described, including the exploration of some travel trends, in- and outside the Netherlands. These trends have led to a decrease in physical activity. This chapter concludes by introducing some noteworthy initiatives to improve children's health in the school context.

2.1 Children in the built environment

Already over twenty years ago, studies were pleading for an urban environment more suitable for children (Davis & Jones, 1996). The suggestion that children are no longer independent in mobility which is threatening their quality of life was increasingly supported in the eighties and nineties (Berg & Medrich, 1980; Gaster, 1991; Van Vliet, 1983). Concerns were about neighborhoods often not having been designed with children in mind (Berg & Medrich, 1980) and about the fact that both the degree to which neighborhoods supported the playing of children and the access for children had considerably declined since 1940 (Gaster, 1991). Children have different aspirations in the urban environment than adults. While adults might prefer environments that have low density and are therefore car-dependent, these kinds of environments might not at all be suitable for children. Children would be highly dependent on their parents in terms of transportation. According to Davis & Jones (1996), children wish for environments that stimulate them to explore and that allow them to meet other children. When these types of aspirations are not properly considered, children become increasingly dependent on adults (Davis & Jones, 1996). Davis & Jones (1996) describe healthy children as: *"those who are able to access and use city streets for work and play, move about their local area with a reasonable degree of independence and safety, play some part in local decision-making and have some sense of ownership or entitlement to be heard* (p. 108)". In other words, it is important to create environments that are accessible to children, facilitate their safe mobility and reflect their preferences. Davis and Jones (1996) found several researchers suggesting to consult children on potential interventions in their environment and stating that children may in fact be careful observers of their own environments. The same researchers suggested considering the ideas and experiences of children could be an effective way to gain understanding of the parts in the environments that should be changed. Although more recent research (i.e. Pont et al., 2011) has urged the importance of considering the child as decisionmaker in their choice of transport mode, Davis and Jones' (1996) view on consulting children about built environment interventions appears not to be backed-up anymore.

Nevertheless, the need for planning the built environment with children in mind continues to be relevant throughout the years, as can be seen in studies arguing that it is time to define some agenda or guidelines for the geography of children (Gilbert & O'Brien, 2005; Matthews & Limb, 1999). Gilbert & O'Brien (2005) ground this argument by stating that the transport needs of young people differ greatly from those of adults due to differences in travel destinations and travel modes. When looking at all local travel by all residents, about 20% consists of trips taken by young people. This is a large group which makes considering their needs separate of those of adults imperative (Gilbert & O'Brien, 2005). Gilbert & O'Brien additionally state that young people are especially vulnerable to negative effects of car travel such as poor air quality, both inside and outside of the car and in the neighborhood as a result of frequent car usage. This is an additional reason to strive for planning guidelines that take children into account. In a report published by the World Health Organization and Unicef in 2008, the following statement was made: *"It is normal for children to carry out activities in the road environment – such as cycling, walking, running, playing and other common group activities. It is also important for*

their healthy development that children, from an early age, undertake such activities. For this reason, it is important for the road environment to be safe so that these activities can be undertaken without the child's safety being put at risk" (p. 41). Overall, the need for including the perspective and needs of children in the planning of the built environment and infrastructure has been firmly established.

2.2 Active travel in general in the Netherlands and worldwide

Before expanding upon the travel behavior of Dutch children and households, the Dutch travel behavior in general will be compared to other Western countries. In order to gain some perspective into how The Netherlands are performing in terms of active travel behavior, observe figure 2.1. Especially the Netherlands, Denmark and Germany are performing well, but also other Western European countries have active travel rates more than twice as high as Australia, the USA and Canada. However, it should be noted that for all internationally based figures, 2.1, 2.2 and 2.3, the national survey data that was used differed per country, which limits the comparability between the countries. The figures do, however, present a general overview of the contrasts. In the Netherlands, of all trips, 25% are done by foot and 26% are done by bicycle. Just over half of all trips can be categorized as active transport. Especially compared to the non-European countries with active transport rates around 10%, the Dutch population can already be considered rather active.

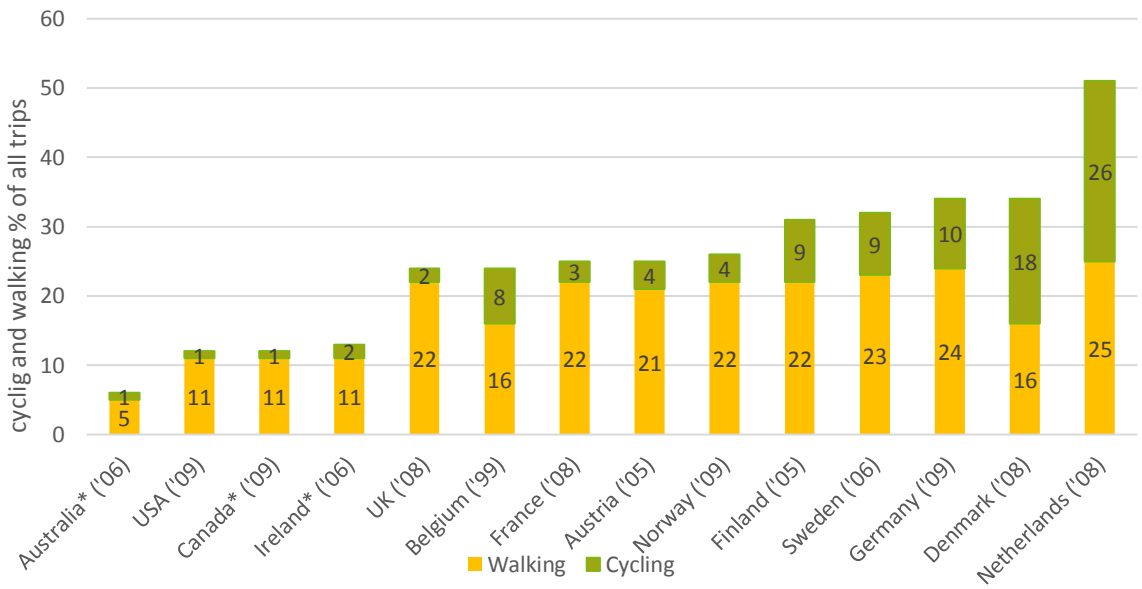


Figure 2.1 Percentage cycling and walking trips of all trips in Western Europe, Canada, Australia and the USA (Buehler & Pucher, 2012). The year when data was collected is marked in parentheses per country.
**For these countries only data about trips to work was available.*

Figure 2.2 shows the percentages of children's trips that were by an active travel mode of all children's trips in the USA and several European countries. When comparing this data to the data from figure 2.1, it becomes clear that in all countries, children make more active transport trips than the average inhabitant (Buehler & Pucher, 2012). However, as has been established earlier, children do not participate in sufficient physical activity and promoting more active travel is a promising strategy towards more physical activity.

In figure 2.3, some trends in active travel can be seen, these are about the trips made by residents of all ages from several countries. In most countries a decline especially in walking rates is visible. For example, in Germany in 1976, 34% of trips was done by foot, by 2008 this was only 24%. In the

Netherlands, however, active travel rates appear quite stable according to this source. Walking rates have remained the same throughout the decades and cycling only decreased by about three percentage points.

From figures 2.1, 2.2 and 2.3 the conclusion can be drawn that especially the Netherlands and also Germany and Denmark are already performing well in terms of active travel rates. Pucher & Buehler drew this same conclusion in 2008, when they wrote their article entitled "Making cycling irresistible: Lessons from the Netherlands, Denmark and Germany". These lessons can be interpreted as the aspects of travel planning that, from a foreign point of view, are already going well. Some of the lessons presented by Pucher & Buehler (2008) are:

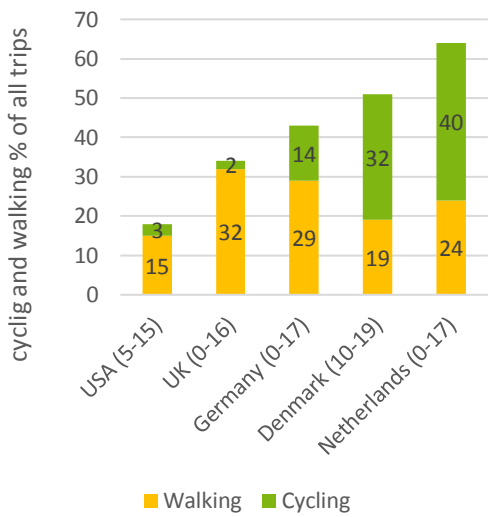


Figure 2.2 Children - percentage cycling and walking trips of all trips (Buehler & Pucher, 2012). Ages are marked in parentheses.

- Cycling policies and programs are organized at the local government level;
- National government provides overall goals, design guidelines, funding, etc.;
- Safety measures are implemented in a coordinated measure;
- Bicycle lanes have been widely expanded through countries;
- Intersections are modified especially for cyclists;
- Residential neighborhoods all have speed limits (30km/h) and there are several other traffic calming measures;
- All cities have a large amount of bicycle parking places, at convenient locations;
- Children receive proper traffic safety and bicycle education;
- There are sufficient laws protecting cyclists in case of accidents.

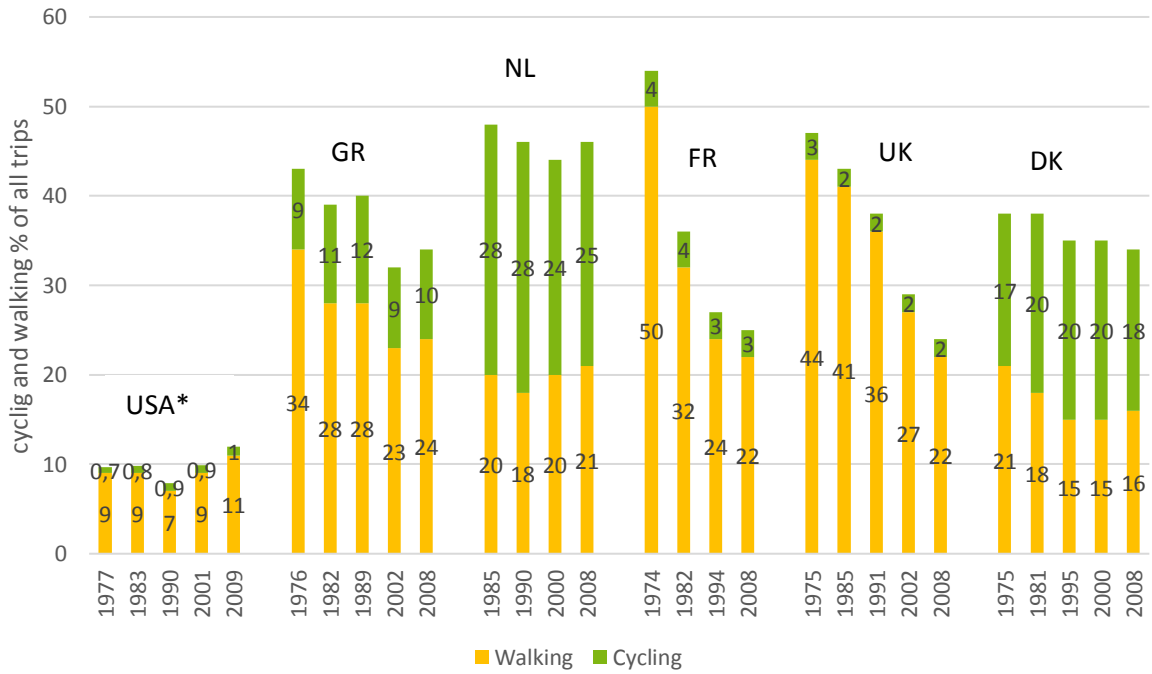


Figure 2.3 Trend - percentage cycling and walking trips of all trips (Buehler & Pucher, 2012).
**Change in walking rates between 2001 and 2009 most likely result of a change in data gathering methodology.*

Besides these factors that directly reinforce cycling, several laws, policies and taxes are believed to indirectly encourage Dutch, Danish and German people to use the bicycle instead of the private car (Pucher & Buehler, 2008). Pucher & Buehler (2008) mention taxes for using and owning a car, limitations to driving speed and parking in especially the inner cities and rather strict land use policies. These land-use policies restrict construction of real estate mostly to locations adjacent to already existing buildings, which ensures a relatively high urban density with as a result, on average, shorter travel distances. According to Pucher and Buehler (2008), the most important strength of Dutch, Danish and German travel planning is the existence of separate bicycle facilities. These result in relatively stress free cycling conditions, especially important for children and elderly.

2.3 Travel behavior of households with children in the Netherlands

This section will elaborate on the different dimensions of the travel behavior of Dutch households with children. Important aspects determining this travel behavior include travel planning and distance to school. Moreover, this section provides insights into children's transport modes throughout the years and into the determination of whether or not children are allowed to travel independently by their parents.

2.3.1 Travel planning of parents with children

In the Netherlands, the daily transport of families with children is mostly dependent on travel between work and home and to locations such as the children's school and after school care (Van der Klis, 2013). Parents usually have fixed working hours and schools have fixed beginning- and end times on weekdays. These times are normally not flexible, which occasionally makes it difficult for parents to combine their own work and the children's education. Nevertheless, parents report that they are satisfied with the school schedules (Cloïn et al., 2010). Similarly, Schaap, Jorritsma, & Olde Kalter (2013) argue that these fixed times result in daily planning for which the borders are already established. Furthermore, especially young children are usually brought to school and picked up by one of the parents. Most important reasons for not letting the children travel alone are safety-related (Van der Klis, 2013). Another characteristic of Dutch households that influences their travel behavior is the fact that they often have to travel far to work, which is a result of the mismatch between work- and residential locations. Households in which both parents work therefore often choose strategic residential locations, considering the workplaces of both partners (Van der Klis, 2013).

Schaap, Jorritsma & Olde Kalter (2013) compared the mobility of Dutch parents of young children with the mobility of the average Dutch person. Parents with children on average have more trips and higher daily distances than average Dutch inhabitants. However, the average daily travel duration for fathers is similar to the average Dutch male and for mothers it is lower than for the average Dutch female. Possibly, this difference is due to the fact that parents have more shorter, simple trips, while the average Dutch person has more trips commuting to and from work. These commuting trips may take more time due to traffic jams. This difference in mobility behavior is limited on days that parents do not have to bring children to school (Schaap, Jorritsma, & Olde Kalter, 2013).

On days when parents accompany their children to school or daycare as well as go to their work, they often divide tasks (one parent brings the child to school, the other picks up the child from school). For these days, the car is chosen for transport relatively often. This has to do with the fact that parents generally go straight to work afterwards, by car. Some parents do prefer to bring the children to school by bicycle, even if they go by car to their work place, because of parking issues and crowded traffic conditions around school. Personal preferences in these cases are more influential than differences in travel time (Schaap, Jorritsma, & Olde Kalter, 2013).

2.3.2 Children's transport modes to school

Throughout the years, cycling has always been the main transport mode to school among Dutch children (Houwen, Goossen, & Veling, 2003; Kemperman & Timmermans, 2014; OViN, 2016). Houwen, Goossen & Veling studied children's transport modes to school in 2003. They received responses to 1861 questionnaires which had been sent out to households with children aged between four and twelve years old, equally distributed among the twelve Dutch provinces. Back in 2003, most transport to school in the mornings occurred by bicycle (49%). Of these trips, a little over half are accompanied by parents. About 15% of trips to school in the morning occurred by car. Among the children who always used the same transport mode, transport by car is only 8%. The rest of the children walked alone (15%) or with parents (18%). In the afternoon, more children walked to school and less were driven by car. This can mainly be explained by the fact that fewer young children go to school in the afternoons and that many children (17%) stayed at school for lunch (Houwen, Goossen, & Veling, 2003). Currently, this share is probably higher, considering the increasing popularity of primary school schedules where all children have lunch in school (NOS, 2016). In general, the results of Houwen, Goossen & Veling (2003) are rather dated as the research took place fifteen years ago. However, considering the few available results on Dutch children's travel behavior, the study still provides added value to the understanding of developments around children's travel modes. Houwen, Goossen & Veling (2003) further mention that their results are mostly consistent with the data from the Dutch National Travel Survey in 2001 (Onderzoek Verplaatsingsgedrag, OVG). These results are presented in table 2.1.

Table 2.1 Travel modes and trip purposes - ages 0-11 (Houwen, Goossen, & Veling, 2003).
Data collected in 2001 by OVG.

Travel modes	Purposes						
	Education (%)	Shopping (%)	Social contacts (%)	Sport club activities (%)	Touring (%)	General leisure activities (%)	Total (%)
Car passenger	14.7	55.1	57.2	55.8	26.3	49.6	40.5
Public transport	1.0	2.3	1.3	0.8	1.2	0.6	1.1
Biking	42.5	27.8	27.3	31.0	27.1	23.0	34.5
Walking	38.2	14.2	19.3	12.9	40.0	36.1	28.9
Other	3.6	0.8	2.1	1.0	4.8	2.7	2.7
Total %	100	100	100	100	100	100	100
Total km (x1mln)	630.4	128.9	215.5	216.3	62.1	122.5	1375.8
% of total	45.8	9.4	15.7	15.7	4.5	8.9	100

Kemperman & Timmermans (2014) also studied children's travel modes in the Netherlands, roughly ten years later, although their data was collected earlier, in 2006. They used data from a more recent edition of the National Travel Survey (Mobility Research Netherlands, MON), collected by the Ministry of Transport in 2006. The study by Kemperman & Timmermans (2014) did not focus only on trips to school, but also on other trip purposes. Table 2.2 shows the percentage of travel modes used, divided between trip purposes. Of all the trips that children took, most were by bicycle (36%), but trips made as a car passenger were a close second (35%). 27% of the children's total of trips occurred by foot. Trips by foot are on average trips of 600 meters, whereas trips by bicycle are on average 1,720 meters. Together these trips make up for 63% of the child's travel, which indicates that more than half of the activities in which children participate are close to home. As can be seen in table 2.2, most of the children's trips, almost half, are education related. The bicycle is most used for school trips (45%) and for going to sport clubs (38.3%). After cycling, walking is the second most used transport mode for

education related trips. 18.8% of children go to school as a car passenger. The car is by far the most popular transport mode for shopping and services activities and for bringing and getting (Kemperman & Timmermans, 2014). Although it can be concluded from this that cycling as well as walking are relatively often used transport modes, another study conducted in ten Dutch neighborhoods found that only about 10% of children cycle or walk on a daily basis (de Vries et al., 2010).

Table 2.2 *Travel modes and trip purposes – ages 4-11 (N=4,293)* (Kemperman & Timmermans, 2014). *Data collected in 2006.*

Travel modes	**Purposes**						
	Education (%)	Shopping/ services (%)	Bringing, getting (%)	Social contacts (%)	Sport club activities (%)	General leisure activities (%)	Touring (%)
Car passenger	18.8	60.6	69.7	52.0	52.6	47.7	25.0
Public transport	0.8	1.2	0.4	0.5	0.4	1.6	1.6
Biking	45.0	25.5	24.1	24.2	38.3	25.0	23.7
Walking	33.7	12.4	5.5	22.4	7.1	23.6	47.8
Other	1.6	0.3	0.4	0.9	0.6	2.1	1.8
Total %	100	100	100	100	100	100	100
Number of trips	7,575	1,562	568	2,392	1,281	1,000	1,365
% of total	48.1	9.9	3.6	15.2	8.1	6.4	8.7

Over the years, the National Travel Survey has had several names (OVG, MON, OViN). The OViN database ("Onderzoek Verplaatsingsgedrag in Nederland") is the current name, most recent data was collected in 2016. Table 2.3 shows the results of the data collected in 2016 concerning children's travel behavior for different purposes. As can be seen in the table, cycling is still the most dominant transport mode for school travel, with walking on the second place. When looking at the other trip purposes, the division of travel modes have changed more for one purpose than for the other, relative to 2006. For example, shopping purposes are currently less often reached by car and more by public transport and walking. For the general leisure activities a similar development is visible. Overall, car travel increased for education purposes and walking decreased, the opposite effect is visible for most other trip purposes. However, this may partly be because of slight changes throughout the years in how the research is conducted. In the total percentages of all travel modes in all trips, it can be seen that children in 2016 travelled exactly the same percentage of the trips (35.3%) as a car passenger and as a cyclist. 24.3% of the trips was by foot.

The OVG data (table 2.1), the MON data (table 2.2) and the OViN data (table 2.3) are all part of the same research that has been repeated several times. The biggest difference which makes the data less suitable for comparison is that the data in table 2.1 include children aged 0-11 and the data in table 2.2 and 2.3 include children aged 4-11. This might result in percentages that are not entirely comparative. However, when comparing the travel behavior with education purposes this is less of a problem, as children younger than 4 years old generally do not make education related trips.

Table 2.3 Travel modes and trip purposes – ages 4-11 (N= 12,281 trip legs) (OViN, 2016). Data collected in 2016.

Travel modes	Purposes								
	Education (%)	Shopping/ Services (%)	Bringing /getting (%)	Social contacts (%)	Sports/ hobby (%)	General leisure activities (%)	Touring (%)	Other (%)	% of total
Car passenger	22	46.5	62.5	52.3	52.4	33.3	17.0	56.8	35.3
Public transport	1.6	5.5	1.9	2.8	0.7	4.0	0.5	9.5	2.4
Biking	43.6	27.1	22.9	26.5	36.4	29.3	28.0	16.2	35.3
Walking	29.6	18.8	11.1	17.0	9.0	30.3	50.4	17.6	24.3
Other	3,2	2.1	1.6	1.4	1.5	3.2	4.1	0.0	2.6
Total %	100	100	100	100	100	100	100	100	100
Number of trips	5157	1246	315	1659	1601	1833	393	74	12281
% of total	42.0	10.1	2.6	13.5	13.0	14.9	3.2	0.6	100

Figure 2.4 shows the differences between 2001, 2006 and 2016 in terms of transport modes to school. Between 2001 and 2016, there are some changes in travel mode to school visible. Overall, cycling rates have remained quite stable. The largest differences can be seen for walking and traveling to school as car passenger. While walking rates decreased with about 9 percentage points, car passenger rates increased by over seven percentage points.

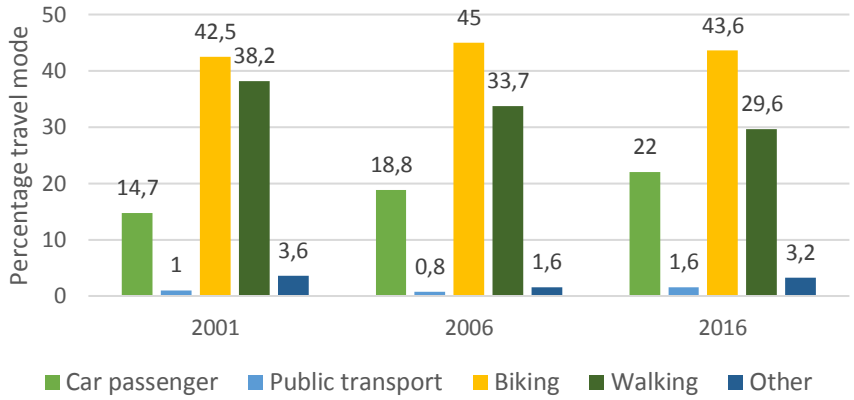


Figure 2.4 Percentages education related travel modes
Sources: OGV (2001)(0-11 years), MON (2006)(4-11 year), OViN (2016)(4-11 years)

2.3.3 Children's independent mobility in the Netherlands

Closely associated with active travel is children's independent mobility, which can be defined as their freedom to move around their neighborhood without supervision from the parents (Hillman, Adams, & Whitelegg, 1990). In a study conducted by CBS in 2010, results indicated that in the Netherlands, parents often accompanied children when traveling (Van Beuningen & Bouhuijs, 2011). Influencing factors on whether or not children were allowed to travel alone included age, distance and trip purpose. For distances below 500 meters, most children between 9 and 11 years old (almost 80 %) were allowed to travel alone. This was about 50% for children aged between 6 and 8 and 15% for those between 4 and 5 years old. When the distance increases to 2,5 km, only in the age group 9-11 year old children a substantial percentage is still traveling unaccompanied, nearly 60%. At a distance above 2,5 km, children of the highest age group may travel alone in about 20% of the cases (Van Beuningen & Bouhuijs, 2011). The influence of age on independent mobility in the Netherlands was also found by Houwen, Goossen & Veling in 2003. As previously stated, these results are rather dated. The

independent mobility starts rapidly increasing from the age of 7 and 8.6 is the average age at which half of children may travel independently to school (Houwen, Goossen, & Veling, 2003). This age is presumably higher nowadays, for instance due to the increased safety concerns of parents (Fyhri et al., 2011). When children travel alone, they are usually going to school, to visit friends or to visit a recreational association. One third of the trips with these purposes occur alone. For all other trip purposes, children only travel alone about 14% of the times. After 7 PM, the share of unaccompanied trips declines (Van Beuningen & Bouhuijs, 2011). Overall, girls are accompanied a little more often than boys (Houwen, Goossen, & Veling, 2003).

2.4 Children's travel trends explained

This section introduces some of the trends that are visible in children's (school) travel behavior. Most important are the increase in distance to primary schools, especially in the Netherlands, the change in frequency of parents driving children to school and the general decrease in active travel.

2.4.1 Larger distance primary school

Because the amount of school locations in the Netherlands has dropped, the average distance to primary schools has slightly risen. Until 2011 the average distance to the nearest school was 600 meters, between 2013 and 2016 this has been 700 meters (CBS, 2017b). This increase in distance can be explained by the fact that between 2008 and 2014 in 630 of the 2400 Dutch towns primary schools were closed, partly as a result of a drop in primary school pupils (Trouw, 2015). There are large differences in school distance on the local level. The shortest average distance between primary school and home on the municipality level is 0,4 km in Den Haag, the longest is 1,7 km in Baarle-Nassau (CBS, 2017a). However, in small villages that no longer have primary schools, some children have to travel up to 3,4 km to the nearest primary school (AVS, 2015).

Moreover, also the changing policy towards school choice may influence distances to school (Curtis, Babb, & Olaru, 2015). In the United States, the policy for school selection has been moving towards providing increasing freedom for parents to choose their children's school, as opposed to just choosing the nearest school to enroll the children (Wilson, Wilson, & Krizek, 2007). These increasing choice possibilities may result in more children attending schools outside active transportation distances (Wilson, Wilson, & Krizek, 2007). In the Netherlands people are also free to choose the primary school for their children, it does not necessarily have to be the nearest school to the home location. Therefore, schools compete with each other and there are different types of schools (van Goeverden & de Boer, 2013) which increasingly differentiate themselves from others and work on profiling to attract more pupils (Ministerie van Onderwijs, n.d.). More and more parents are choosing specific schools which for example have specific educational visions, even if these schools are farther away from home (Van der Klis, 2013). The result of the developments described above will for many children be that they live farther away from school, possibly making active travel less attractive. This may be why the average distance to the nearest primary school in the Netherlands is 700 meters (CBS, 2017, b), but the actual average distance that children travel to primary school is approximately 1,4 km (DUO, 2018).

2.4.2 Driving children to school

Almost one third of Dutch children is driven to school by car, as reported by NOS in 2013. NOS (2013) suggest the reason for this is that parents perceive the environment as unsafe for their children to walk or cycle, even if they live very close to school. The development is remarkable, because traffic accident statistics indicate that the number of young people being killed in traffic accidents has strongly decreased, while roads have become more crowded (NOS, 2013). VVN (2014) describe that parents reacting to safety concerns by driving their children to school is part of a vicious circle (figure 2.5). As more parents drive their children to school, there will be more cars, which results in more chaos and

an increased perception of the area being unsafe. The fact is that travel behavior and traffic safety are closely related, a relationship that VVN is investigating (VVN, 2014). It cannot be denied that participating in traffic can also have adverse effects on children's health, such as being in traffic accidents, being exposed to emission gasses and being stressed and annoyed due to noise (Waygood et al., 2017b). However, the "vicious circle" in figure 2.5 describes how these undesirable effects are only reinforced when more parents drive their children to school by car. VVN questioned one third of Dutch primary schools, of which 80% is having trouble concerning traffic outside the school and 58% percent claims that dangerous situations take place as a result of the bringing and taking of children (NOS, 2015).

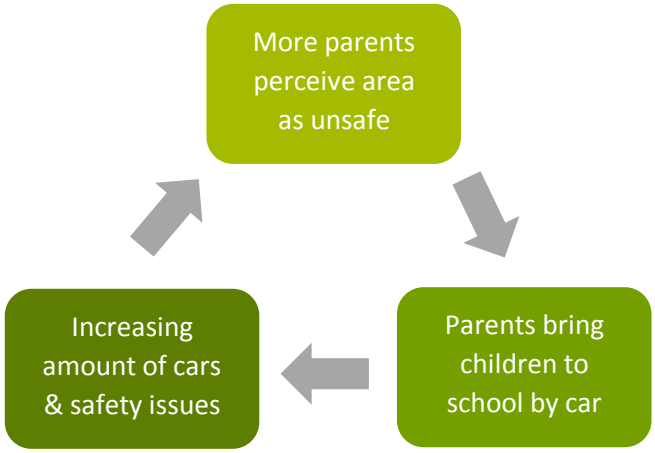


Figure 2.5 Vicious circle of safety perception around primary schools, adapted from VVN (2014)

In several countries the trend of increasing car-use for transport to school is visible. Fyhri et al. (2011) looked at the car use in four different countries over the past decades. They found that in Norway children's transportation by car was 4% in 1992 and it went to 11% in 2005. Similar increases were found for Danish children between 6 and 15 years old, the share of children of this age group being driven to school by car at least doubled in the period from 1978 to 2000. Also in the United Kingdom and Finland comparable developments were visible (Fyhri et al., 2011). From these four different countries, the reasons that parents mainly name for why they drive their children to school are unsafe traffic conditions and a fear for their children being assaulted. The one exception is Norway, where also the convenience of driving the children by car plays a role for many parents. Fyhri et al (2011) point out the "traffic danger paradox", which indicates the same effect as the vicious circle named by VVN (figure 2.5). Also independent mobility among children has declined strongly the past decades in several countries. More parents wish to accompany their children in the trip to school, partly because their perception of children being in danger outside has increased. This also results in more organized as opposed to spontaneous activities among children (Fyhri et al., 2011).

2.4.3 Trends towards less active travel

Fyhri et al. (2011) indicate several trends across the four countries that most likely have contributed to this change in children's transport modes over the past decades. Firstly, increased parent employment and mostly the increased employment among women has led to less available time in the family. This is accompanied by increasing numbers of children taking part in leisure activities resulting in also children to have more occupied lives. Secondly, increased car ownership results in better accessibility of a car, which inevitably leads to using it more. Also the larger distances that children live from school play a role and the increased availability of mobile phones leads to better accessibility of parents as "chauffeurs". Parents drive their children more often to leisure activities than in the past, the most commonly named reason for this is a time shortage (Fyhri et al., 2011).

Also in Switzerland, especially in the French-speaking part, participation in motorized transport to school increased. Bringolf-Isler et al. (2007) attempt to explain the underlying reasons for this change in habits of the parents driving children to school. They mention safety concerns, the availability of cars (two and more), parents' employment and the resulting attendance of the child to daycare and a cultural difference between the French-speaking and the German-speaking part of Switzerland (Bringolf-Isler et al., 2007).

Carver, Timperio & Crawford (2013) conducted a study in which they asked parents of Australian primary- and secondary school children about why the children are accompanied to school (by car). Among others, the parents acknowledged that when they were a child, they were granted more independent mobility than they allow their own children to have today. The most frequently named reasons for this change were, according to the parents, that nowadays the traffic danger is greater and so is the risk to be assaulted by strangers. The change also has to do with a change in lifestyle, about a quarter of the parents mentioned an increase in car ownership and almost a third stated that the free time of their children was more filled than their own free time was when they were children (Carver, Timperio, & Crawford, 2013). This is mostly in line with the findings of Fyhri et al. (2011).

2.5 Current initiatives promoting children's health

In the Netherlands, the topic of children's health is being tackled by various government-initiated initiatives, although these so far appear not to have focused on active travel. One example is the initiative called 'Youth with a healthy weight', *Jongeren op gezond gewicht* (JOGG). JOGG (n.d.) states that one in every seven Dutch children is overweight, and this problem must be countered through considering the entire environment of the child, namely the home, the school, the neighborhood, the recreation time, the work and the media (JOGG, n.d.). The initiative aims at participation of municipalities and has already convinced 136 municipalities to participate. These municipalities in turn participate in diverse health initiatives, among others to raise awareness for a healthy lifestyle. Other initiatives include one called healthy school canteen, *Gezonde schoolkantine*, stimulating schools to offer more healthy choices at the school canteen (Voedingscentrum, n.d.) and one called Healthy schools, *Gezonde scholen*, which gives out certificates to schools that effectively give attention to several health aspects at school. These aspects include education in health, an environment promoting health and tracking and noticing potential health issues (Rijksoverheid, n.d.). The green schoolyard, *groene schoolplein*, is another increasingly popular initiative among primary schools. The idea of the green schoolyard is that there is more nature in the schoolyard, such as plants, trees and insects, which promotes more kinds of playing than a simple paved schoolyard (Groeneschoolpleinen.nl, n.d.). The green schoolyard is also believed to challenge children to move more, which is important because possibilities for physical activity in the streets are decreasing. Several types of movement are possible in the green schoolyard, such as walking, climbing and playing hide and seek. Children learn to understand risk and they develop motor skills (Groeneschoolpleinen.nl, n.d.).

Internationally, there are more successful health initiatives, also towards increasing active travel. A good example is the walking school bus, which is an initiative in which parents take turns in walking a group of children to school (Smith et al., 2015). The walking school busses can be highly structured, literature has reported organizations with trained volunteers, previously set routes and timetables. The aims are to increase physical activity among children and reduce congestion around schools. Smith et al. (2015) found that the walking school buses were indeed associated with increasing amounts of children walking to school. These results were, however, derived from self-reports, which makes them susceptible to social-desirability bias. More objectively measured, using accelerometers, higher activity levels were visual (Smith et al., 2015). Some remaining barriers of the walking school bus are time constraints for volunteers, parental safety concerns and the recruitment of sufficient volunteers.

2.6 Conclusion

Throughout the past decades it has been established that children are not well enough considered in the development of the built environment. Children have different needs than adults, needs that are not always sufficiently considered. Children should be walking, cycling, running and playing in the built environment, which therefore needs to be made safe and accessible for them. Fortunately, compared to other European and North American countries, active travel rates in the Netherlands are relatively high. Not only adults, but also children are participating more in cycling and walking activities than in other Western European and North American countries. Only Germany and Denmark also report high cycling and walking rates. It is believed that the higher active travel rates are the result of urban planning, cycling facilities and policies and regulations all in favor of cyclists in these countries.

When looking more closely at how transport of Dutch children and their families is organized, it becomes clear that there are a few factors that have a strong influence. Travel planning is mostly dependent on school- and work times. Also the location of the home, school and workplace have an influence. Households with children report different travel behavior than those without children, such as a higher daily trip frequency. The most used transport mode to school for Dutch children is the bicycle, this has been the case for at least two decades. Between 2001 and 2016 notable changes in children's school travel mode are increases in motorized travel and decreases in travel by foot, cycling rates remained more or less the same. Whether or not children are allowed to travel independently is influenced by age and distance to school. The different sources that report Dutch children's travel mode to school are not always consistent in their results. Nevertheless, the general increase in car travel and the decrease in active travel modes is consistently reported.

There are some trends that have changed children's travel behavior to school. Firstly, there are the larger distances to primary schools, mostly in smaller villages that no longer have their own primary school. Secondly, more parents are driving their children to school, a development that has been linked to parents perceiving the road as unsafe and to convenience experienced from driving children to school on the way to work. The problem is, however, that a higher number of cars around the school decreases the safety in the school area, which in turn leads to more parents driving their children to school because of safety concerns. Increased parent employment and increased car ownership have most likely contributed to the changing travel patterns. Nevertheless, there are already several initiatives to increase active school travel and physical activity rates at school, such as certificates that can be given out to so called "healthy schools" and schoolyards that are designed in such a way that they encourage physical activity. The next chapter will describe what the benefits of active travel and physical activity are and how they have an influence on the well-being of children.

CHAPTER 3

ACTIVE TRAVEL AND CHILD WELL-BEING

Drawing by Desiree & Amber van de Craats, 2018

3. ACTIVE TRAVEL AND CHILD WELL-BEING

This chapter introduces the association between active travel and child well-being. First, a general definition of child well-being will be given. After that, the effects that transport has on the different domains of well-being will be looked into. In the last paragraphs of the chapter, the wide range of benefits that have in previous studies been found to be associated with active travel will be presented.

3.1 Definition of child well-being

As already introduced in the previous chapter, several authors claim that the current layout of the built environment is not suitable for the needs and by extent the well-being of children (Davis & Jones, 1996; Gilbert & O'Brien, 2005; Matthews & Limb, 1999). To further dive into the relation between children's well-being and built environmental and transport factors, the first step is to define well-being of children. According to Pollard & Lee (2003), the term well-being is frequently used but its definition is not consistent. They therefore call for a comprehensive definition of well-being, which considers various domains. Dodge et al. (2012) appear to have answered to this call by conducting an extensive literature review in pursuit of a new definition of well-being. They conclude by stating that well-being is a balance between resources and challenges from the physical, social and psychological domain. Stable well-being occurs when the necessary resources from the different domains are present to meet the challenges. If there would be no challenge, 'stagnation' would occur (Dodge et al., 2012). Pollard & Lee (2003) found several separate definitions from the points of view of different domains. These domains are, like Dodge et al. (2012) found, the physical, psychological and social domain and they add the cognitive and economic domain of well-being. Well-being can be defined as a multi-dimensional construct considering several domains (Pollard & Lee, 2003). In the current study, the balance definition of Dodge et al. will be used, supplemented with the two extra domains used by Pollard & Lee (2003). The advantages of this "see-saw" definition of well-being as presented in figure 3.1 are its simplicity, the universal application (it can be used for people of all ages, culture and gender) and the optimism that it can provide (It elicits the assumption that individuals have the power to increase their resources or challenges to remain in balance) (Dodge et al., 2012). Well-being is defined as the balance between resources and challenges in the physical, social, psychological, cognitive and economic domain.

Figure 3.1 Definition of well-being, adapted from Dodge et al. (2012) and Pollard & Lee (2003)

3.1.1 Subjective well-being and satisfaction with travel

Another way of defining well-being, especially related to travel, is the degree to which people, in this case children, are satisfied with their trip and travel mode and how this relates to their subjective well-being. Subjective well-being indicates to what extent a person is satisfied with their life in general, with an emphasis on cognitive and emotional well-being (Bergstad et al., 2011). The cognitive component

is about satisfaction of life in general and the emotional component is also referred to as the affective component; positive and negative affect of direct experiences. Subjective well-being is about emotion, happiness, fulfillment and satisfaction, but also about stress and positive as well as negative affect (Bergstad et al., 2011). According to Bergstad et al. (2011), daily travel likely has an influence on the mood and satisfaction of an individual. In their study on how subjective well-being of adults is impacted by daily travel, they found that travel satisfaction had a direct effect on cognitive as well as affective subjective well-being. Bergstad et al. (2011) argue that their results show the importance of daily travel satisfaction for subjective well-being. Ettema et al. (2011) tested the reliability of an individual's satisfaction with travel to predict their assessment of affective and cognitive subjective well-being. They asked participants to evaluate particular hypothetical days with different trip characteristics and reported that satisfaction with travel had a high reliability in predicting subjective well-being as a result of the trip. This is why it is believed that satisfaction with travel can be considered as an indicator of the (school) trip's contribution to subjective well-being of the traveler, which, conveniently, is more easily measured than well-being in general.

3.2 Transport in general and child well-being

Waygood et al. (2017) also considered the five domains as described by Pollard & Lee (2003) (physical, social, psychological, cognitive, economic) to look into the relation between transport and children's well-being. Waygood et al. (2017) conducted a thorough literature review on the effects that transport has on children's well-being in the different domains.

Waygood et al. (2017) found several consistent findings in their literature review of the associations between transport and the different domains of child well-being. In *the physical domain*, consistent findings are that active travel is positively associated with recreational activities, independent mobility among children and everyday physical activity. On the other hand, negative influences occur as a result of externalities of traffic such as emissions, traffic density and noise, crashes and numerous cancers and tumors. In *the psychological domain* consistent findings include positive effects of walking in the form of lowering stress levels and an increase in positive emotions. There are also negative effects as a result of traffic in the form of annoyance, travel avoidance, sleep difficulty, anxiety in traffic and restrictions of independent mobility imposed by parents after crashes. *The cognitive domain* is about intellectual and school-related indicators. Consistent findings indicate beneficial effects of exploring and growth through being in the outdoors when not traveling by car and an increase in spatial knowledge when walking with parents. Children were also found to be observing their surroundings more when walking and through independent mobility. In *the social domain*, consistent results were found on children's desire to meet their friends close to home and to have social interaction during travel, which is associated with walking and limited by traffic. Independent mobility and active travel are consistently found to be related to community connections. Furthermore, areas that were less walkable restricted the children's playing to events that were planned. Finally, *the economic domain* is mostly related to the household's economic situation with child support as a measure. In terms of transport it refers to how parents or caregivers limit and facilitate mobility and provide the child's opportunities and access to mobility. Consistent findings include an increase in transporting children by car when this was seen as convenient and socially acceptable to parents and a relation between smaller travel distances and more independent mobility. Additionally, there is a relation between parents who recognize the relevance of active travel and the social interaction that children experience. Furthermore, children's age, confidence that parents had in children's skills in travel safety, and overall concern about traffic are external influences of independent mobility (Waygood et al., 2017b).

3.3 Subjective well-being and active travel

Although scarce, there are some studies that have already looked into the association between children's subjective well-being and their travel mode to school. A Canadian study with a large sample (N=5423) found active travel as opposed to passive travel to school to be associated with positive emotions such as feeling happy or relaxed, for children as well as for parents (Ramanathan et al., 2014). Children and parents who travel with passive modes such as the car were found to be significantly more likely to feel negative emotions such as feeling tired or in a hurry. Moreover, they mention some results of previous studies which suggest factors that may have led to positive emotions as a result of travel. These include the possibility to interact with the parent when being accompanied on a trip and being able to experience the environment when traveling actively. Negative impact of traveling by car may be the fact that this experience can be tiring and rushed, for example if parents are stressed or frustrated with traffic (Stark et al., 2018). Stark et al. (2018) furthermore report, based on several previous studies (J. De Vos & Witlox, 2017; Kroesen, Handy, & Chorus, 2017; Parkany, Gallagher, & Viveiros, 2004) that the relation between travel mode and emotions related to the mode should be seen as a causal feedback loop. The travel mode elicits certain emotions which influence perception and affect of that mode, which in turn contribute to future travel mode decisions. As mentioned earlier, Waygood et al., (2017b) reported consistent findings of walking being related to positive emotions and to lowering stress. Westman et al. (2017) found travel mode to be associated with the degree of children's satisfaction with travel, active modes were associated with a higher rated quality of the trip than car travel. While several studies have addressed the relation between active travel and physical health, social contacts and children's overall development (see the next sections), research on how travel mode to school affects subjective well-being is scarce. Waygood et al., (2017b) call for more effort in researching the relation between transport and children's well-being.

3.4 Health benefits of active travel

Several studies have proven that active travel has crucial health benefits for children. Firstly, active travel is an important source of physical activity, Faulkner et al. (2009) have found that children participating in active travel also have significantly higher physical activity levels in general. However, because this concerns a cross-sectional study, it is difficult to determine causality in the relationship between active travel and overall physical activity. Nevertheless, eleven of the thirteen studies that Faulkner et al. (2009) reviewed reported higher overall physical activity among children that participated in active travel. Furthermore, four of these studies found a twenty minutes difference between daily moderate to vigorous activity of children who traveled actively to school and those who did not. Roth, Millett, & Mindell (2012) also studied the contribution of active travel to overall physical activity, they used data from the Health Survey for England. They found that children participating in active travel had similar or higher levels of participation in other physical activity types than children not traveling actively. Although in this study also the insecurity of causality plays a role, Roth, Millet & Mendell predict that encouraging active travel among children is likely to result in more physical activity in general. Physical activity has many health benefits such as lower cholesterol, healthy blood pressure, lowered chances of obesity (Janssen & LeBlanc, 2010), improved skeletal health and cardiorespiratory fitness (Loprinzi et al., 2012). Furthermore, increasing one's physical activity later on in life is more challenging than creating an active lifestyle during childhood (Loprinzi et al., 2012; Verrotti et al., 2014), which by extent emphasizes the importance of children's active travel.

Active travel also has psychological benefits, such as the relation between physical activity and self-esteem (Loprinzi et al., 2012) and psychological well-being (Hamer et al., 2008; Martin, Goryakin, & Suhrcke, 2014). Humphreys, Goodman, & Ogilvie (2013), however, found no association between physical activity and mental well-being. Lubans et al. (2011) found some evidence that active school

transportation is associated with a healthier body composition and with cardiorespiratory fitness. As independent mobility has been found to be associated with increasing active travel (Page et al., 2010) and physical activity (Schoeppe et al., 2013), also independent mobility likely provides children with health benefits.

3.5 Social benefits of active travel

From the literature it can be derived that the relation between social aspects and children's travel behavior may be working in two directions. On the one hand, children who travel actively experience more social interaction during their trip (Waygood et al., 2017a) and therefore enjoy their trip better (Westman et al., 2017). On the other hand, children living in neighborhoods with high social cohesion and a likeliness of meeting friends during travel are more likely to be allowed to travel unaccompanied by their parents (Aarts et al., 2013; Veitch et al., 2017). In this section, the first relation, about the benefits of social interaction during active travel, will be expanded upon. The second relation, about the social factors that influence active travel, will receive attention in chapter four.

Having social connections in the neighborhood is important for the social capital and social cohesion in the neighborhood (Waygood et al., 2017a), which in turn were found to be beneficial for both physical and subjective well-being (Helliwell & Putnam, 2004), for adults as well as children (Waygood et al., 2017a). Moreover, Helliwell & Putnam (2004) found a positive relation between social networks and the welfare of children. Children may experience numerous other benefits of social connections in the neighborhood, such as improved social skills, interaction and safety (Waygood et al., 2017a). Furthermore, the sense of safety that children and their parents experience can be influenced by community connections (Waygood et al., 2017a). When children traveled independently in their neighborhood, they were also more likely to know where to find social interaction. From all of the above, it can be assumed that community connections and social interaction during travel can provide an added value for children's well-being.

Walking trips of children were found to increase the chances of seeing a familiar person during the trip in Japan, Canada and Sweden (Waygood et al., 2017a). Seeing a familiar person often led to a form of interaction, mostly verbal communication. Also the independence of children in travel was found to be associated with the chances of them meeting a familiar person during a trip on foot or by bicycle (Waygood et al., 2017a). This is in line with a study by Waygood & Friman in 2015, who found that traveling by car decreased the odds of seeing someone familiar. Children in the car were less attentive of people than children walking or traveling unaccompanied by parents. Moreover, an Italian study found that children who had more autonomy to move around their neighborhood had higher chances of socializing and playing with other children (Prezza et al., 2001). Increasing independent mobility among children may result in a higher frequency of social interaction. This could facilitate improved community connections, which in turn increase the chances of parents allowing their children to travel independently (McDonald, Deakin, & Aalborg, 2010).

Social interaction during trips does not only have an influence on social connections in general, it may also increase the odds of children perceiving the trip as pleasant. Westman et al. (2017) found that children who had participated in social activities during their travel were more excited about the travel than those who had not. When they had engaged in activities by themselves during the travel, they worried more and experienced more stress. Having a social trip to school thus results in more enjoyment of that trip (Westman et al., 2017).

3.6 Active travel and children's development

Also children's development is believed to be influences by active travel participation. An important skill that children can gain from physical activity is motor skill, the ability of knowing how to move. It is essential for children's development towards adult life that they learn motor skills involved in different physical activities (Loprinzi et al., 2012). The travel to school has also been found to influence cognitive performance. Westman et al. (2017) looked into satisfaction, mood and cognitive performance in relation to children's travel mode in Sweden. They found that children who traveled for a longer time performed better on the cognitive test. Moreover, activities that children performed during the travel affected cognitive performance (Westman et al., 2017). Children who traveled actively to school were more satisfied about their trip than those who were driven by car and those who came by car were more frequently tired and felt dull during the day (Westman et al., 2013).

Aside from the increase in activity, children's independent mobility has more advantages. The implications for independence are important for the process of growing up. The recreational and social opportunities available for children increase when their independence from their parents increases. Independence puts them in the position of having to make certain decisions individually as well as having to handle with the responsibilities that come with these decisions (Brown et al., 2008). Furthermore, according to VVN cycling is part of the growing-up process of Dutch children (NOS, 2018). Knowing how to properly ride a bicycle enables children to take part in school trips, move independently and travel to sports activities or friends' houses. Dutch teachers notice that children's cycling skills are no longer sufficient, resulting in them bumping into each other on the bicycle. Children who cycle less are also missing out on valuable lessons on how to participate in traffic (NOS, 2018).

3.7 Conclusion

Well-being is defined as a construct where the physical, social, psychological, cognitive and economic domain are considered. The state in which resources and challenges from all domains are balanced, is considered to be the state of well-being. A systematic literature review has revealed several consistent findings on the relationship between transport and the five domains of child well-being. These include effects that can be considered beneficial, such as increased levels of active travel, lowering of stress through travel and more sociability, but also negative effects such as traffic crashes and exposure to emission gasses.

Several subjective well-being, health, social and cognitive benefits of active travel have been discussed. Active travel can elicit positive emotions and lower stress. Moreover, active travel was found to result in overall higher physical activity levels, which in turn has beneficial effects such as a healthy blood pressure and lowered chances of obesity. Children participating in active travel have also been found to experience more social interaction during their trip and they build up community connections. Social networks have in turn been found to positively influence children's welfare. Finally, children learn important skills from physical activity and active travel, such as motor skills, knowing how to ride a bike and how to participate in traffic. From traveling independently, they gain additional skills in terms of handling responsibilities and making choices.

The next chapter will look into factors that have been found to influence the travel mode of children to school and whether or not they travel independently.

CHAPTER 4

SOCIO-ECOLOGICAL APPROACH OF ACTIVE TRAVEL

Drawing by Desiree & Amber van de Craats, 2018

4. SOCIO-ECOLOGICAL APPROACH OF ACTIVE TRAVEL

Chapter four describes the influencing factors of active travel, as determined in previous studies, from a socio-ecological point of view. Factors from different layers of the child's development have an influence on the child's school travel behavior. The factors may also be related to each other between the different levels, thus having an indirect effect on children's travel behavior. First, the socio-ecological approach will be introduced, after which the findings from the literature review on the different layers of the child's environment will be discussed.

4.1 How to approach active travel predictors?

Pont et al. (2011) state that any model that is to represent active travel among children should at least include some aspects of the environment around children and the perceptions that parents have. Also the parents' decisions about active travel of their children and the perceptions of the children themselves, considered within the context of their family, should be included. When the objective is to promote active travel among children efficiently, it is important to not only point out the environmental factors that facilitate or impede active travel, but also investigate how decisions are made as to whether or not children participate in active travel (Pont et al., 2011). Therefore, several layers of influence will be considered in the following paragraphs.

As stated previously, the socio-ecological approach, first introduced by Bronfenbrenner (1979), has been widely used by authors attempting to increase the understanding of the multi-level influences from the child's environment on their travel behavior (e.g. Curtis, Babb, & Olaru, 2015; Mitra, 2013; Panter et al., 2010). As agued by Mitra (2013), applying the socio-ecological model when approaching children's travel behavior is useful as it allows for showing multi-level influences as displayed in the model in figure 4.1. Moreover, the complex interaction between the different levels of the environmental factors of the setting in which the transportation occurs can be studied to increase the understanding of children's physical activity behavior (Giles-Corti et al., 2005). The socio-economic models are made for a specific type of behavior, in this case school travel behavior, for which the most important of potential indicators per level are included. It is assumed that interventions to modify the behavior would be most successful when they make changes in more than one level (Sallis, Owen, & Fisher, 2008).

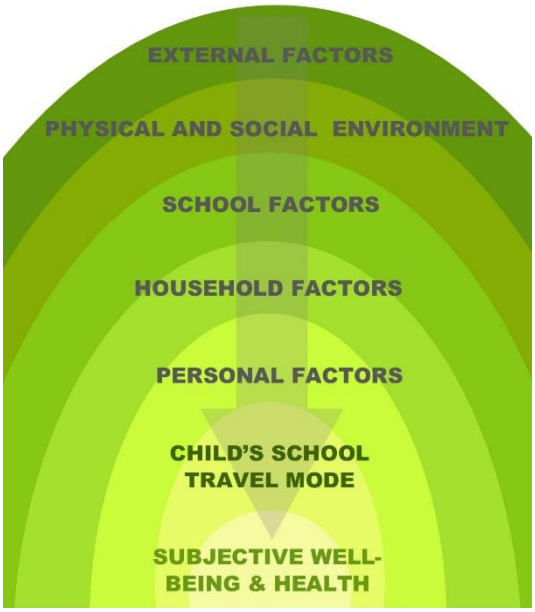


Figure 4.1 – Socio-ecological model of children's active travel to school, modified from Curtis, Babb & Olaru (2015)

In figure 4.1, the child's environment is divided into five layers, all surrounding the school travel mode. The personal factors include the characteristics of the child itself, such as age and gender but also compatibility in traffic and attitude towards travel modes and active transport in particular. The household factors are more related to the parents or caregivers: what is their attitude towards active travel, which licenses do they give out to their children? But also: are they employed and how do they travel to work? Does the household own one or more cars? School factors include the type of school and the extent to which the school stimulates certain travel modes and their attitude towards health and well-being. The physical and social environment are about the neighborhood in which the child and the school are situated. The physical environment includes factors such as infrastructure, traffic

calming measures and urban density, whereas in the social environment the social cohesion and social interaction during travel are considered. The last layer, the external factors, include all aspects that cannot be placed in any of the other layers as they are of a larger scale, but still could be related to the children's travel behavior. Examples can be found in the political and natural environment domain. The effect of the parental perception on whether or not the child should be allowed to travel alone and/or whether they will be participating in active travel is represented in all layers, as this is influenced by factors from all layers.

The following sections will expand on previous findings of the influence that the factors from the different layers in the socio-ecological model have on child travel behavior. Often, not only active travel is considered, but also independent mobility of children. When children travel without their parents, it can be assumed that this occurs through active transport modes. Parents give out so-called independent mobility licenses to their children. These licenses are given out based on the trust that parents may or may not have about letting their children travel without being accompanied (Curtis, Babb, & Olaru, 2015). Therefore, the factors that are found to increase the independent mobility licenses that children are granted, indirectly also increase the odds of active travel. It should be noted that some of the studies considered in the next section only consider walking as a means of active travel, whereas cycling is the more used active travel mode in the Netherlands. The results of the studies give valuable insights on how certain factors of the child's environment affect their travel behavior to school, but cannot completely be mirrored for the Dutch setting. Environments that promote walking do not always also promote cycling (de Vries et al., 2010).

4.2 Individual factors

This section highlights the factors from the individual layer, the personal factors, in the environment of children which are related to active school travel. These factors include gender, age (and the corresponding skill levels) and the child's attitude towards travel modes.

4.2.1 Gender

Some studies found gender to be related to active travel or independent mobility. In one study, boys were found to be more likely to be allowed higher levels of independent mobility in several countries. One exception was France, where the likelihood to be allowed to cross main roads alone was higher for girls than boys (Shaw et al., 2015). The research by Carver, Timperio & Crawford (2013) among parents of Australian children revealed that girls were more likely to be driven to school than boys, indicating lower granted independent mobility levels among girls. Furthermore, Trapp et al. (2012) found that when parents perceived the neighborhood as safe, only for boys the odds of walking to and from schools would be higher. On the other hand, Carver et al. (2013) found that there were no differences in independent mobility licenses granted to boys or girls in primary school in England and in Australia, and there was also no difference between English boys and girls in secondary school. The only significant difference they found was between Australian boys and girls in secondary school: boys were granted more mobility licenses by their parents (Carver et al., 2013). Curtis, Babb & Olaru (2015) found that boys had more freedom to travel unaccompanied by their parents than girls. Kemperman & Timmermans (2014) found that gender was not related to active travel among Dutch children.

4.2.2 Age

According to VVN (n.d.), children's abilities in traffic evolve with their age. Children do not have the same skills when participating in traffic as adults. For example, children have trouble recognizing danger and they cannot see from the corner of their eyes like adults can. They also take more time to respond to situations and have trouble determining from which direction the sounds they hear originate. Table 4.1 shows the traffic-related abilities of children, by age (VVN, n.d.).

Table 4.1 Traffic-related abilities of children by age (VVN, n.d.)

Age	Abilities
3 years old	Walking while also focusing attention on other factors
4 years old	Running becomes easier Children commence riding a bicycle. They still swerve when looking around and have trouble remaining the balance
5 years old	Children learn to ride the bike without thinking. They can now start learning to participate in traffic
6 years old	Traffic is still a game to children, they do not recognize the danger, they are not yet a proper participant in traffic
7 – 8 years old	Children start having a sense of wrong and right, parents can start teaching them to be careful and polite in traffic
8 – 9 years old	Rules remain important, children until this age might still not recognize danger
8 – 12 years old	Children of this age usually already participate quite often in traffic, their skills are improving but they are still easily distracted
9 years old	From this age, children can usually be trusted to travel without being accompanied, as long as they know the rules and the environment is safe
9 – 10 years old	At this age, children increasingly recognize danger, they still have trouble with more complicated situations and with combining rules
10 years old	Until this age children might over-estimate the speed of vehicles, for this reason they sometimes wait for vehicles that are far away
11 years old	From this age onwards children are able to properly focus on traffic
16 years old	Until this age, the information processing speed continues increasing

In line with this increase in skill-level as children mature, which results from cognitive and physical development, many studies have found age to be associated with travel behavior. The age of children was often found to be of great influence on the relationship between active travel behavior and its many predicting factors (Carver, Timperio, & Crawford, 2013; Kann et al., 2015; Kemperman & Timmermans, 2014). Kemperman & Timmermans (2014) found that as children in the Netherlands grow older, they are more likely to use the bicycle instead of being transported by car. Aarts et al. (2013) also confirmed for the Netherlands that age is related to active transportation of children. Furthermore, this relation was found to be associated with the ownership of a bicycle, which increased with age (Kemperman & Timmermans, 2014). Carver, Timperio and Crawford (2013) found increasing age to be related to lower odds for children being driven to school by parents, which may be related to fewer limitations of independent mobility with increasing age. Furthermore, significant restrictions are placed on the independent mobility of children across all the ages studied by Shaw et al. (2015) (7–15-year-olds). Children younger than eleven experience the most restrictions, but even the oldest children are restricted in what they are allowed to do (Shaw et al., 2015). Curtis, Babb & Olaru (2015) also found associations between age and more independent travel in the neighborhood.

Carver et al. (2013) emphasize that age and school grade *in combination* are important indicators of granted mobility licenses and by extension the independent mobility of children. They found that the amount of licenses granted increased with age among English and Australian children, but there were also large differences between primary and secondary school pupils (the age at which this switch took place was different between Australia and England). Although it was a long time ago, Valentine (1997) stated that the transition between primary and secondary school is accompanied with the most extensive changes in the autonomy of children. At this time all parents realize and accept that they should give their children more freedom to engage in the public space. It may be that this is still the case today.

4.2.3 Child's attitude and satisfaction

Sebire et al. (2013) looked into the motivation for 7 – 11 year old children's physical activity in the United Kingdom. They looked into different motivation types in relation to objectively measured physical activity. Intrinsic motivation, which is motivation based on the natural interest and satisfaction received from being active, was found to be the only type of motivation associated with physical activity among children (Sebire et al., 2013). Veitch et al. (2017) found similar results in Australia, the enjoyment that children experienced while walking or cycling was associated with independent mobility (their study was conducted in disadvantaged neighborhoods). Both Sebire et al. (2013) and Veitch et al. (2017) propose that when designing interventions which aim to increase children's physical activity, it may be effective to improve the degree of enjoyment that children experience during physical activity. It would be less fruitful to rely on extrinsic motivation, such as how someone values the benefits or broader goals of being active (Sebire et al., 2013). The intrinsic motivation of children was found to be primarily brought about by the extent to which the children's need for autonomy was sufficed. This highlights the importance of the role that parents and teachers have in fostering the children's perceptions of being able to choose and have a free will in physical activity. The perception of autonomy would in turn help children develop intrinsic motivation towards physical activity (Sebire et al., 2013).

Westman et al. (2017) conducted a study in Sweden among 258 children who were asked to fill in travel diaries. The aim of the study was to introduce affect as an important factor in the experience of children's travel. They found that the satisfaction that children had of their journey was affected by their travel mode. Traveling by school bus, bicycle or by foot resulted in higher satisfaction than traveling by car. Also the activities that they participated in during the travel were of influence. For example, when children engaged in social activities during their trip, this positively influenced their satisfaction. This was not the case when they engaged in solitary activities such as using the smartphone. Furthermore, engaging in solitary activities led to the children feeling more stressed and worried. Longer travel duration was found to be associated with lower satisfaction, but also with higher cognitive performance. Conducting activities during the trip to school was also associated with higher cognitive performance (Westman et al., 2017). Age was also found to be associated with the experience of the trip to school, older children experience the least excitement and quality of their trip (Westman et al., 2017). On a related note, Trapp et al. (2012) found that the likelihood of Australian children walking to school was associated with their perception of which transport mode was convenient to them. Specifically they found that children who believed walking to school was more convenient to them than being driven, were more likely to walk.

4.3 Household factors

Within the layer of household factors, especially the position that the parents have in determining the transport modes of their children appears important. Mah et al. (2017) have called parents the "gatekeepers" to the travel behavior of children. Several studies have highlighted the importance of the role that the parents have in children's travel behavior (Carver et al., 2013; Carver, Timperio, & Crawford, 2013; Panter, Jones, & van Sluijs, 2008; Pont et al., 2011), this role will be explained in the current section. Furthermore, the socio-economic status of the household has been found to be of influence on participation in active travel, this influence will be expanded upon first.

4.3.1 Households' socio-economic status

Some factors relating to the socio-economic status of the household have been found to influence travel behavior of children. These are related to whether or not households can afford certain luxuries (multiple cars, mobile phones) but also to the composition of the household. Aarts et al. (2013) found

for the Netherlands that the number of cars was negatively associated with walking and cycling to school. This was previously already reported by several studies in different countries, car ownership is assumed to enable school trips by car (Ewing, Schroeer, & Greene, 2004; Grize et al., 2010; Sidharthan et al., 2011) and decrease active travel rates among children (Pont et al., 2009). Shaw et al. looked specifically at independent mobility, the freedom of children to play and move around in their neighborhood in a total of sixteen different countries (ten European countries, Australia, Brazil, Israel, Japan, South Africa and Sri Lanka). They report that there are very few differences in the independent mobility of children dependent on car ownership of the households, in all countries. However, the only significant difference they found when comparing 11-year-old children in households with and without access to a private car, regardless of their country, was that fewer children were allowed to come home alone from school if their household owned a car (Shaw et al., 2015).

According to Sidharthan et al. (2011), the children that walked or used the school bus belonged to households with lower incomes, possibly because fewer households with low incomes own a car. This relationship was also measured in the opposite direction, households with higher incomes reported more car trips than walking and bus trips (Sidharthan et al., 2011). Ewing, Schroeer, & Greene (2004) found similar results, although they also reported that car ownership had a stronger relation with travel mode to school than household income. Pont et al. (2009) conducted a systematic literature review and found six publications reporting significant relations reporting decreasing active travel rates as a result of higher household income. In a Dutch and Belgian study, however, income was found to have little and inconclusive effects (van Goeverden & de Boer, 2013). Low household income was favorable as well as unfavorable for walking in Belgium. In the Netherlands low income was, in contrast to most previously stated studies, supportive for car use (van Goeverden & de Boer, 2013). Kann et al. (2015) explain this effect by arguing that children who live in neighborhoods with lower socio-economic status do not have a lot of opportunities to become physically active, as their surroundings do not support physical activity as much as neighborhoods with higher socio-economic status. Overall, the association between household income and children's travel behavior appears firmly established, yet it remains unclear whether it concerns a positive or a negative relation.

Some other socio-economic factors relating to children's travel behavior include mobile phone ownership, household composition and ethnicity. Fyhri et al. (2011) state that the mobile phone has had a strong influence on the changes in how people organize their lives. For instance, the mobile phone makes it easier to make plans on later notice than in the past and it makes it easier to call parents and ask for a ride, which by extension reinforces car use. A significant correlation was found between how long in advance an activity was planned, whether a mobile phone was used and whether the child (10-11 years old) traveled by car. However, in the study by Shaw et al. (2015) mobile phone ownership does not appear to have a strong influence on children's independent mobility. In only one of the cases they studied, owning a mobile phone in fact led to higher levels of traveling independently. Shaw et al. (2015) argue that this has to do with the fact that fears the parents may have are reduced by the knowledge that the child is reachable and capable of communicating changes in plans.

Aarts et al. (2013) found the number of siblings to be significantly associated with participation in active travel. They hypothesize that this may be because of the possibility that siblings can walk or cycle to school together. Previous literature studied by Pont et al. is, however, inconclusive about the effect of having siblings on active school travel (Pont et al., 2009). In a study among Pacific parents, Lin et al. (2017) found the variable "having older siblings" to be significantly associated with a higher frequency of independent trips among children. Carver et al. (2014) found similar results, children with more siblings were more likely to experience higher independence in travel. Also some studies reported the distinction between school travel by car or by active modes to be associated with

ethnicity (Easton & Ferrari, 2015). According to Yu & Zhu (2016), however, the effect of ethnicity on independent mobility has been reported inconsistently in previous studies. Pont et al. (2009) argue that ethnicity indeed influences parents' decision about their children's active travel. Bere et al. (2008) found specifically for Dutch adolescents that ethnicity strongly influenced transport mode to school. They did not study younger children. Mcdonald, Deakin, & Aalborg (2010), who studied the relation between the social environment and 10-14 year old children's school travel mode, found that parental perceptions of the social environment were more important for the travel behavior of non-Hispanic white children than children of other ethnicies. They suggest this may be because white families have several options for getting children to school, so if the children walk to school this is probably a deliberate choice. Because of that, the social environment may have a larger influence on the travel behavior (McDonald, Deakin, & Aalborg, 2010).

4.3.2 Parents' or caregivers' work commute and travel mode

Easton & Ferrari (2015) argue that several developments in the last decade have led to more concerns about road safety and less independence of children. Parents are believed to cope with these developments by driving their children to school on the way to work, which is most convenient (Easton & Ferrari, 2015). Several researchers have looked into this relationship. On the other hand, Carver, Timperio, & Crawford (2013) found that children who had at least one parent that did not work were more likely to be driven home from school by car, but there were no differences in the travel behavior of other trips in the neighborhood. This may be explained by the fact that parents who both work have no opportunity to pick up their children from school, but for other activities in the evening or weekend work does not restrict travel possibilities. Aarts et al. (2013) did not find an association between the number of working hours of parents and the transport mode to school of children. They do mention a limitation to their dataset in the fact that for some categories of working situations the number of respondents was low. However, in the same study a positive association was found between the number of days a child goes directly home after school and active travel mode to school. Aarts et al. (2013) imply that this could mean that the amount of hours parents work are less important than whether they have the possibility to accompany the child home from school. Bringolf-Isler et al. (2007) found similar results, the daycare attendance was found to be positively associated with the amount of regular car trips for children. Henne et al. (2014) found that more working hours of American parents led to their children participating less in active travel. In their literature review, Davison et al. (2008) found evidence implying that children were less likely to participate in active travel when their parents worked and when the active travel would hinder the parents' work schedules. Furthermore, children had higher odds of participating in active school travel when their parents used active travel modes to get to their work (Davison et al., 2008; Panter et al., 2010a).

4.3.3 Independent mobility licenses, safety perception

The concept of independent mobility licenses was first introduced by Hillman, Adams & Whitelegg (1990). They explain that just as how one can get a license to drive a car or a scooter at a certain age, also parents give out licenses to their children. As with the license to drive a car, the licenses given out by parents can be given out for a degree of maturity, safety judgment and physical competence. Therefore, the licenses are seen as a means to reflect the perception and judgments that parents have of their children being able to handle participating in traffic on their own (Hillman, Adams, & Whitelegg, 1990). For example, parents fear letting their children travel independently when they have the feeling that their children do not yet have the skill level and maturity to travel safely by themselves (Faulkner et al., 2010). Hillman et al. (1990) differentiate between four types of licenses: to cross the road, go to other destinations than school, come home from school and go outside after dark. As children age, they gain more independence; they possess an increasing number of licenses. Some

authors have used the concept of “licenses” to study independent mobility as a part of active travel (Carver et al., 2013; Curtis, Babb, & Olaru, 2015).

In McMillan's (2005) framework, the decision of the parents about their child’s travel mode is seen as the ultimate decision. Also in the study conducted by Faulkner et al. (2010) parents mostly characterized themselves as the final decisionmaker of the child’s school travel behavior. On the other hand, in the framework by Pont et al. (2011) the perceptions of the parents are not seen as more important than those of the child in the decision making process.

Carver et al. (2013) found that the increase in independent mobility licenses that children were granted was significantly associated with higher chances of participating in active travel to school independently. This effect was the largest for primary school children in England, they were two times more likely to walk or cycle to school with every additional independent mobility license they were granted. With secondary school children the relationship was no longer significant. Furthermore, Curtis, Babb & Olaru (2015) found that the active travel of children is influenced by a combination of the preferences of children and the licenses that are granted to the children by their parents. Children who travel actively prefer to be more autonomous and are given more freedom by their parents. On the other hand, children who prefer to be driven to school have parents who are scared of letting their children travel independently. Also levels of trust in the social aspects of the neighborhood were found to be important to influence the odds of a child being driven to school within walking distance (Carver, Timperio, & Crawford, 2013). This makes sense, as higher levels of social trust may result in a decrease in concerns about strangers, which in turn has been found to be an important reason for parents to limit independent mobility among children (Carver, Timperio, & Crawford, 2008a).

Kerr et al. (2006) also found parental concerns to be associated with active commuting. In fact, parental concern was the strongest of the explanatory variables. Children whose parents had little concerns were five times as likely to participate in active travel to school than those with concerned parents. The parental concerns were mostly safety-related. It appeared that some parents were overly concerned and preventing their children to cycle or walk, even though the neighborhoods were suitable for active travel (Kerr et al., 2006). Also Carver, Timperio, & Crawford (2008a) found that road safety and fear for strangers was related to parental concerns, which in turn had an effect on parents limiting their children’s active transport and playing outdoors. Veitch et al. (2017) found that children whose mothers were concerned about the child’s safety had decreased odds of being allowed to travel independently to school. Rothman et al. (2015) found similar associations with walking to school. Moreover in terms of safety, parents in Switzerland worried mostly about traffic danger (85% of the parents) and not so much about harassment or violence (23% of the parents) (Bringolf-Isler et al., 2007). Bringolf-Isler et al. (2007) additionally found that the perception of safety that parents had improved when the children would be likely to socialize during commuting.

Carver, Timperio & Crawford (2013) studied the motivation behind parental chauffeuring and searched for the correlates of parental travel behavior concerning their children. They found that many children were accompanied (43%) or partly accompanied (34%) on trips within walking distance. The largest part of these trips (91%) occurred by car, so it may be assumed that the increased accompaniment of children leads to a decrease in active travel. Parents have named several reasons for accompanying their children. Most named reasons in the study by Carver, Timperio & Crawford (2013) were concerns about traffic safety, the age of the child, the absence of help that a child may need and not having sufficient time to accompany the child. More specifically, about half of the parents was very or quite concerned about incidents that may occur when their child crosses a road. This concern was more common among parents of primary school children than secondary school children (Carver, Timperio, & Crawford, 2013). Almost half of the parents addressed in the study of Carver, Timperio & Crawford

(2013) reported that the distance to school was a reason for bringing the children by car. This is in line with previous research about the correlates of active travel, such as D'Haese et al. (2011) who state that distance is the most important determinant for participation in active travel to school. Also Curtis, Babb, & Olaru (2015) found distance to be strongly associated with whether or not children are allowed to travel to school independently. The effect that the child's age has is also highlighted by other studies, such as Leung, Chung, & Kim (2017), who state that the influence that parents have on the physical activity of their children is strongest when the child is aged ten or younger. Faulkner et al. (2010) found that parents were reluctant to let their children travel to school by themselves because the child's skills and maturity were insufficient for traveling alone. Carver, Timperio, & Crawford (2008a) suggest another possible reason for parents accompanying their children to school. They argue that parents may feel socially obliged to drive their children to school, caused by a fear of not being considered responsible parents by other parents who bring their children to school using the car.

4.3.4 Parental support

Mah et al. (2017) looked into parental support for active travel to school in Canada, by which they mean the verbal encouragement of participating in active travel to school. Parental support may play an important part in the school travel behavior of children (Mah et al., 2017) and it is influenced by factors such as concerns about traffic volume, safety of the children, safety of the routes around school and convenience for parents (Faulkner et al., 2010). In the study by Mah et al. (2017), 63% of the parents provided support for active travel to school on a daily basis, only 12% never provided support. Of the same respondents group, 57% of the children said they traveled actively to school every day, 14% said not to make any active school trips. Parental support was not found to be associated with distance to school or with factors of the school in general. Parental support was found to be related to perceptions of crime safety in the neighborhood, but not on pedestrian safety and traffic safety. Of the children that did not receive daily support, only 9% participated in daily active travel. Of the children receiving daily support only 15% did not travel actively every day. Receiving everyday support was significantly more likely for boys than girls, but both genders were equally likely to participate in active travel. Even after adjusting for gender, distance to school, and several safety perceptions, daily support remains a significant predictor of daily active travel to school among children (Mah et al., 2017). As the relationship between parental support and children's daily active travel was independent of built environmental factors such as perceptions of safety, Mah et al. argue that interventions towards more daily active travel should not be limited to the built environment, as this might reduce the actual changes in children's travel behavior. In aiming to increase active travel to school, the factors that influence parental support should be considered.

Leung, Chung, & Kim (2017) studied parental support of physical activity in general among children in Hong Kong. They also found a significant direct effect of parental support on the physical activity of children. Furthermore, they found that how the parents perceived the competence of their child and the benefit of exercise (the potential added value of physical activity) was significantly associated with parental support and therefore had an indirect effect on children's physical activity (Leung, Chung, & Kim, 2017). Surprisingly, the parental perception of neighborhood safety was not found to be significantly associated. However, this may be explained by the fact that Hong Kong in itself is one of the safest cities in the world, which could diminish the explanatory power of neighborhood safety on parental support and physical activity (Leung, Chung, & Kim, 2017). Panter et al. (2010a) also emphasize the importance of parental support in the encouragement of active travel.

4.3.5 Convenience, time constraints

Trapp et al. (2012) found a relation between walking to school and the parents' perception of convenience of the travel mode. The odds of walking to school were lower for children whose parents thought driving was more convenient. Furthermore, another study found that children are more likely to perceive active transport modes as convenient than their parents are (Lorenc et al., 2008). Parents, on the other hand, had higher odds of perceiving driving children to school as more convenient than walking or cycling. Moreover, walking was more frequently considered convenient in urban areas and cycling in rural areas (Lorenc et al., 2008). Also related to convenience are time constraints, which are believed to strongly impact decisions that parents make about their children's travel. Trapp et al. (2012) found that when girls had commitments before or after school, they were less likely to walk to school. Furthermore, the Australian Travel Survey that Trapp et al. (2012) consulted, revealed that 61% of the car trips to and from primary school were linked to other destinations before or after the school. The school travel behavior is not only dependent on the trip to school, but also on linked activities on the same day. The car can be seen as a means of lowering the difficulties for households with time-constraints (Trapp et al., 2012). Trapp et al. (2012) admit that it is hard to work towards urban planning policies to counter this development, but one possible solution can be to locate primary schools and after-school destinations in close proximity to each other. Several studies have described that parents reported (time related) convenience as motive for driving children to school by car (e.g. Faulkner et al., 2010; Fyhri et al., 2011; Mitra & Faulkner, 2012; Waygood & Susilo, 2015).

4.4 School factors

This section looks into the school related factors that may influence children's travel behavior. So far, little research has looked into school related factors, which makes pointing out consistent results challenging. Furthermore, school locations, policies and trends are likely to be strongly country dependent, possibly more so than travel behavior in general. Some factors discussed in this section include Dutch primary school schedules, different primary school policies and the school's overall attitude towards health and physical activity.

4.4.1 Primary school schedule

There is a trend of staying at school for lunch instead of having lunch at home (NOS, 2016). The concept of having lunch at school, with the supervision of parents rotating in a schedule, was originally initiated when households were increasingly made up from two working parents. Nowadays, this development has increased in such a way that it has become hard to find parents who can supervise the lunch breaks (Consultancy.nl, 2018). As a result, the traditional school schedule where children have a long lunch break and finish early on Wednesday afternoons, is becoming increasingly less popular among primary schools. Schools are switching from these traditional school schedules to a "continuous schedule" (a shorter lunch break at school, finishing earlier in the afternoon, still no school on Wednesday afternoon) or to an "equal days schedule" (No longer a free Wednesday afternoon, having a short lunch break at school and finishing daily around two p.m.). In 2012 more than 75% of primary schools still had a traditional schedule, towards 2016 this had decreased to 50% (NOS, 2016). In the current school year, 2017-2018, this has decreased to 41% (Consultancy.nl, 2018). Principals of the schools that have switched to other schedules name several advantages. Pupils are more focused, because everybody remains at school for lunch there is more structure and because children finish early in the afternoon they have more time for sports and hobbies (NOS, 2016). As the schedules of households are highly dependent on the times that school starts and finishes (Cloïn et al., 2010), these changing school schedules may influence household travel behavior and by extent travel behavior of children.

4.4.2 Larger school distance

As described previously, distances to school have been increasing in the Netherlands. This is not only because of the decreasing amount of schools, especially in smaller villages, but also because of the increasing competition. Parents are free to choose a primary school for their children, it does not have to be the nearest school. The next section, about the physical environment of children, will describe that living at closer proximity to the school leads to higher chances of traveling actively to school. Therefore, the location of the school is a factor that may influence children's travel behavior. Wilson et al. (2010) found for the United States that children who attend so called "magnet schools" walk less frequently than those who attend the school in their neighborhood. The reason for this is that the magnet schools are usually farther away from home. The fact that parents choose their children's school plays a role in determining the distance that children will have to commute, which influences their travel mode and may lead to decreases in active travel (Wilson et al., 2010). Policies that encourage enrolment to the nearest schools may lead to higher rates of active travel (Mandic et al., 2017). There are, however, difficulties in implementing these types of policies, as they would also influence several other planning factors, such as higher housing prices in school areas.

4.4.3 Primary school health initiatives

The health initiatives that some Dutch primary schools are participating in, sometimes aided by subsidies from the government, have previously already been described. These initiatives include the "healthy schools" (Rijksoverheid, n.d.) and the "green schoolyard" (Groeneschoolpleinen.nl, n.d.). It is assumed that these types of initiatives do not only promote health and physical activity while children are at school. The positive attitude that schools have towards health and physical activity possibly also influence actual travel behavior of children to school.

In terms of empirical research on health- and physical activity initiatives, Panter et al. (2010) did not find significant associations between children's travel behavior and whether or not a school promoted active commuting. Only for secondary schools some significant findings can be presented here. Hollein et al. (2017), who looked at active commuting behavior of adolescents in the Czech Republic, did find associations. Adolescents who attended schools that promoted students to walk and cycle participated more in active travel. This effect was even stronger among students that attended schools which were preparing the implementation of promoting health. The relation they found was stronger for boys than girls (Hollein et al., 2017).

4.4.4 Travel education

Teaching children about traffic would lead to the development of the necessary travel skills to travel safely to school. If parents have the perception that their children possess the skills to travel safely by themselves, children will be granted more freedom which by extent would increase the frequency of active school travel (Faulkner et al., 2010). Timperio et al. (2007) also highlighted the need to improve children's traffic skills, for instance by teaching them how to safely cross a road and recognize safe routes. Elaborate active travel initiatives called a "school travel plan" (STP) include some educational aspects, in which pupils are taught about, for instance, traffic safety (Hinckson, Garrett, & Duncan, 2011). These types of initiatives have been found modestly effective in increasing active school travel rates, parents emphasized the safe traffic education as one of the most successful aspects (Buliung et al., 2011). Some other authors conclude their study with a call for educating children on safe travel as a means to promote active travel and physical activity among children (Ghekiere et al., 2017; Kemperman & Timmermans, 2014; Salmon et al., 2007; Trapp et al., 2012). In the Netherlands, as well as in Germany and Denmark, children already receive rather elaborate training and education on cycling, including a test. According to Pucher & Buehler (2008), this is one of the lessons the USA can

learn from Germany, Denmark and the Netherlands to make cycling "more irresistible". Moreover, Verrotti et al. (2014) conducted a systematic review in search for the most effective and feasible strategies towards decreasing childhood obesity. They concluded that education at school aiming for healthy eating and physical activity may be most effective, also because encouraging adults to change their lifestyles as a way of treating obesity was found to be more challenging (Verrotti et al., 2014).

4.5 Physical and social environment

The following section describes factors from the physical and social environment that influence children's travel behavior. Some researchers have found physical and social environmental factors to be important in the determination of travel mode, while others believe that personal- and household factors are more important. For example, among the younger children attending primary school, Van Kann et al. (2015) found no associations with environmental factors of the school area in the Netherlands. It appears that age is an important factor influencing this relationship, which is in line with previous research (Carver, Timperio, & Crawford, 2008b). This might be because younger children are more dependent on the concerns of their parents (Panter, Jones, & van Sluijs, 2008). On the other hand, Kemperman & Timmermans (2014) found that the social and physical environment and sociodemographic factors are all related and have direct as well as indirect relations with walking and cycling. These interrelated effects occur because some physical environmental factors such as nature and recreation areas, which are influenced by safety and social environmental factors, provide opportunities to participate in active travel. The other way around, the physical environmental factors shape social cohesion and the perception of safety, which are reflected in the degree of urban density, which directly influences active travel behavior (Kemperman & Timmermans, 2014).

Physical environment

First, the contributing factors from the physical environment will be described. These include infrastructure and urban density, land use, aesthetics, travel distance and (traffic) safety perception.

4.5.1 Infrastructure and urban density

So far, not many studies have specifically considered the influence that the street design in the area around schools has on the mode choice of children traveling to and from school (Giles-Corti et al., 2011). It is, however, valuable to have a better understanding of the existence of these influencing factors in the physical environment, as these can provide insights for urban planning and transportation planning of school areas. Many studies looking at the built environmental influences on active travel consider only walking (e.g. Ewing, Schroeer, & Greene, 2004; Giles-Corti et al., 2005, 2011; Kerr et al., 2006), whereas others consider active travel behaviors as a whole (cycling and walking combined) (D'Haese et al., 2011; Panter et al., 2010b; Sirard & Slater, 2008). However, De Vries et al. (2010) argue that an area which is considered cyclable, is not necessarily also suitable for walking and vice versa. The built environmental correlates of cycling and walking have been found to differ between the two outcome behaviors (de Vries et al., 2010; Kemperman & Timmermans, 2014). The urgency to consider the different modes of travel separately was already introduced by Giles-Corti et al. in 2005, along with the necessity of considering behavior measures specific to the setting in which behaviors occur.

Kerr et al. (2006) define walkable neighborhoods as those that have several destinations near the residences of inhabitants, well-connected street networks and relatively high residential densities. Kerr et al. (2006) found walkability to have an influence on children participating in active commute to school in the United States. However, this was only the case in high-income neighborhoods, not in low-income neighborhoods. This suggests that the type of neighborhood might influence the relationship between walkability and active commuting (Kerr et al., 2006). Kerr et al. (2006) search for an

explanation of this difference in the importance of parental concerns. They found that within the low-income group, parents had more concerns about environmental factors, which could diminish the chances of the child participating in active travel.

Kemperman & Timmermans (2014) also found residential density to be an influential factor. In their study in The Netherlands the urbanization degree was found to predict active travel among children with a direct effect. Increasing urban density lead to more children walking, but it also lead to less children cycling. The probability that children participate in car travel was not found to be associated with urban density. Ewing, Schroeer & Greene (2004) on the other hand, who also studied children's school travel in the United States, found no relations with land-use factors such as density. They therefore assume that school trips are different from other trips in that the presence of other land-uses nearby is not important in the decision of travel mode. However, they did also include secondary schools in their study, which Kerr et al. (2006) did not. Ewing, Schroeer & Greene (2004) found that the presence of sidewalks on main roads was associated with likeliness of walking to school (Ewing, Schroeer, & Greene, 2004).

De Vries et al. (2010) studied the built environmental correlates of walking and cycling separately, specifically for Dutch urban children. They considered three different trip purposes: transportation, going to school and recreation. They found that the features of the built environment that were most consistently associated with walking and cycling for transportation and for going to school were the frequency of pedestrian crossings and parallel parking spaces. De Vries et al. (2010) suggested a few explanations for the association between active transport and parallel parking. It is likely that car drivers will decrease their speed in the more narrow streets, which is also suggested by Pucher & Dijkstra (2003). Moreover, many parallel parking spaces were located in 30 km/h zones, in areas with sports fields and areas where less trucks and buses were driving. Lastly, it could be that children feel safer on the sidewalk when cars are parked parallel to the road, forming a buffer between the child and other traffic (de Vries et al., 2010). Some more specific findings of De Vries et al. (2010) include that the number of pedestrian crossings and the frequency of parallel parking were both positively associated with cycling as well as walking. They found differences between the trip purposes. The presence of roundabouts and traffic lights in the neighborhood were found to be respectively negatively and positively associated with walking for transportation. Cycling for transportation was found to be positively associated with pedestrian crossing frequency. For walking to school, significant indicators were green space (negatively) and pedestrian crossing frequency (positively), as well as parallel parking spaces, parking lots and roundabouts (all positively).

Giles-Corti et al. (2011) hypothesize that children with the age of 10 – 12 are more likely to walk to primary school in neighborhoods that are walkable (i.e. neighborhoods that have high connectivity and low exposure to traffic). Their study was conducted among Australian parents and children, they considered the number of trips per week that children went to and from school using specific transport modes. The pedestrian network connectivity and the exposure to traffic on the route to school were found to influence the tendency to walk to school. In neighborhoods with high street connectivity and low traffic exposure, more children walked to school, and vice versa. D'Haese et al. (2011) found similar results in Belgium, the amount of destinations to walk to in the neighborhood and whether or not the walk to school is easy appeared positively associated with active travel to school. However, other research found the connectivity of streets to be negatively associated with active travel to school (Sirard & Slater, 2008; Timperio et al., 2006). This indicates that connectivity can either facilitate walking or cycling to school, related to the amount of other destinations that can be reached, but it can also facilitate motorized transport as it makes car travel more convenient. In a Dutch study, a higher percentage of land used for infrastructure lead to a decreased likelihood of children cycling as

neighborhoods are more likely perceived as unsafe (Kemperman & Timmermans, 2014). More land used for infrastructure could mean a higher degree of connectivity, to which decreased safety could be linked. Moreover, higher street connectivity is usually related to a greater frequency of street crossings. This, in turn, could be associated with traffic safety (Sirard & Slater, 2008). Panter et al. (2010b) found similar results in the UK, children were less likely to participate in active travel to school if they lived in neighborhoods that were highly connected, including short and direct routes to school and a busy road. Although the authors hypothesized that their results would be moderated by distance between home and school, no evidence for this relation was found. A counter-intuitive finding in this area was by Waygood & Susilo (2015), who found that in Scotland slow or safe traffic was negatively correlated with walking to school. In other words, in school neighborhoods characterized by safe and slow traffic, children were less likely to walk to school. This could be due to the fact that lower levels of traffic might make driving past the school more convenient. For parents whose children go to schools along streets filled with cars, walking could be the more convenient option.

It appears that street connectivity and slow traffic can have positive effects on the participation in active travel (it is safe and convenient this way), but it can also lead to more car use, which is faster and also more convenient in these types of neighborhoods. Therefore, a possible solution could be to focus on the connectivity and low traffic exposure of pedestrian and bicycle paths. In line with this, Kerr et al. (2006) found that walking- and bicycling facilities were significantly associated with active travel to school. In contrast to many other studies, Aarts et al. (2013) found no associations between active school travel and safety-related built environmental factors in the Netherlands. They did, however, find that children living in neighborhoods located in city centers were found more likely to actively travel to school than children living in green neighborhoods. It is possible that the classification of these neighborhoods already accounted for many differences in built environmental characteristics, such as city neighborhoods generally being more walkable and less suitable for parking cars (Aarts et al., 2013). Another proposed explanation is that the infrastructure in the Netherlands might already be properly facilitating cycling and walking to school more than in other countries (Aarts et al., 2013). This, however, would not explain why de Vries et al. (2010) did find associations between built environmental factors and active commuting among Dutch children.

Giles-Corti et al. (2011) argue for greater attention to the needs of child pedestrians in the areas around schools. They suggest that other efforts to increase active travel among children might be obstructed until attention is given to connectivity, minimizing distances and traffic exposure around schools. Panter et al. (2010) add to this by suggesting school environments with a high frequency of route choices, low connectivity and the resulting quieter streets. Additionally, they accentuate that implementations in the environment alone will not be enough, these should also result in increased support from parents towards active travel.

Cyclability and walkability

To summarize, the factors relating to infrastructure and density influencing children's travel behavior can to some extent be divided into cyclability and walkability. In short, a walkable neighborhood can be seen as an area that has a high urban density, has sidewalks along busy roads, has a large amount of pedestrian crossings, cars are parked parallel to the streets and the neighborhood has a high connectivity to many destinations for pedestrians, but not for motorized traffic. A cyclable neighborhood includes an area with not too much urban density, a large amount of pedestrian crossings and parallel parking along the road. Infrastructure should not take up a large percentage of land uses. Both cycling and walking appear to occur more in less deprived neighborhoods.

4.5.2 Land use

Gilbert & O'Brien (2005) argue that, in general, land-use is an important determinant of transport mode. The more land-use types are spread out, the higher the likelihood that people will travel by car. This is because a more spread-out town leads to larger distances and because transit modes are less financially feasible in towns like this. Furthermore, the relationship between car travel and land-use density is mutual. Low-density developments attract people that drive cars, which makes car driving more acceptable, which leads to more low-density developments. This will eventually make walking and cycling increasingly uncommon, as the area becomes less safe, accessible and enjoyable for active transport. This, in turn, causes car-use popularity to increase. Not only land-use density, but also land-use diversity is important. With more diverse uses such as schools, residential and retail close together, active transport becomes more realistic (Gilbert & O'Brien, 2005).

Waygood & Susilo (2015) found in a study in Scotland that having good local shops near the school is positively correlated with active travel, specifically with children walking to school. A possible explanation for this is that where there are good local shops, there may also be local walking which leads to increased perceived safety (Waygood & Susilo, 2015). Kerr et al (2006) found similar results in the association between perceived land use mix and number of stores within 20 minutes walking distance and active travel to school.

A higher percentage of recreation areas in the neighborhood was found to be associated with higher probabilities of walking and lower probabilities of cycling (Kemperman & Timmermans, 2014). De Vries et al. (2010), on the other hand, found that cycling to school as well as cycling for transportation were significantly associated with higher numbers of recreational facilities in the neighborhood. The presence of forest and natural areas lead to higher chances of children cycling (Kemperman & Timmermans, 2014) and to lower chances of walking to school (de Vries et al., 2010). Kemperman & Timmermans (2014) attempt to explain this different effect of natural areas and recreational areas by the fact that the first are usually more widely spread and connected by various bicycle paths, whereas the second in general are situated nearby other facilities, making the area more walkable. The difference between the findings of Kemperman & Timmermans (2014) and De Vries et al. (2010) concerning the effect of recreational areas might be explained by the fact that De Vries et al. only focused on urbanized neighborhoods, which could result in different attitudes to cycling and walking to recreational areas. Walking or cycling for recreation purposes was not found to be associated with the built environment features (de Vries et al., 2010)

4.5.3 Aesthetics

Kann et al. (2015) studied the physical environment associations of active school travel in mostly deprived neighborhoods where many children were not meeting physical activity recommendations. The children that participated in the study were aged between 5 and 12 and lived in Southern Limburg, The Netherlands. For older children the strongest environmental positive correlation with active travel to school that Van Kann et al. (2015) found was aesthetics in the school neighborhood. Specifically the presence of a park was found to be related to the likeliness of active travel, but also good maintenance of these places and the absence of litter. From this it could be extracted that a more attractive school neighborhood would indicate a higher likelihood of an active travel mode. Similar results concerning aesthetics have previously been found in other research (Kerr et al., 2006; Owen et al., 2004; Sirard & Slater, 2008). Aarts et al. (2013) on the other hand found a negative association between walking to school and the perceived presence of green in the Dutch neighborhood.

4.5.4 Distance between school and home address

Trapp et al. (2012) studied several environmental, social and individual factors associated with walking as a school transport mode, using a multi-level ecological approach. They looked at the school transport behavior of 617 children attending 25 different Australian primary schools. Distance to school, route safety and time constraints of the household were the factors consistently associated with walking to and from school (Trapp et al., 2012). The finding that higher proximity to school leads to more walking to school is in line with other research (e.g. Chillón et al., 2015; McMillan, 2007; Merom et al., 2006; Nelson et al., 2008; Panter et al., 2010). The relationship between proximity to school and active travel among children was also found specifically for the Netherlands (Aarts et al., 2013; Dessing et al., 2014; Helbich et al., 2016; Kemperman & Timmermans, 2014). According to Pont et al. (2009), who reviewed 38 studies on children's active travel behavior, distance to school was the most often examined and nearly always resulted in significant associations. D'Haese et al. (2011) even state that distance to school is the most important indicator of active travel to school. Findings in the United States enforce this statement, children living within one mile (1,6 km) of the school are more than three times more likely to participate in active travel to and from school than children living farther away (Davison et al., 2008). A British study found a threshold distance for walking to school among children and saw that this distance increased with age. The threshold distances were 1421 m for 10 year old children, 1627 m for 11 year old children and 2046 meters for 14 year old children (Chillón et al., 2015). In Belgium criterion distances of 1.5 km for walking and 3.0 km for cycling were found for 11-12 year old children (D'Haese et al., 2011).

The Netherlands traditionally has a strict land-use policy which limits residential development to locations close to existing settlements. This likely results in higher density within residential areas, as residential land use will be more concentrated. This could also influence the distance to schools (van Goeverden & de Boer, 2013). Moreover, with the closest primary school at a distance of 700 meters (CBS, 2017b), Dutch people live relatively close to primary schools. In comparison, the average distance to school for 5-10 year old British children was 2,6 km in 2008 (Fyhri et al., 2011), although Chillón et al. (2015) found a median distance of 1370 m to primary schools in the UK. In 2001, only about one quarter of American children aged 6-12 lived within one mile (1,6 km) of their primary school (NHTS, 2008). In Switzerland children live even closer to school than in the Netherlands, Bringolf-Isler et al. (2007) measured a median distance below 500 m between primary school and home.

With the importance of distance to school in mind, Trapp et al. (2012) suggest several implications for policy makers considering school site locations and housing densities around schools. They propose that urban planning strategies can aim towards more walkable distances by looking at housing density and connectivity of the streets with the focus of a larger amount of homes close to the schools. D'Haese et al. (2011) suggest using the criterion distance for walking in urban planning around schools by creating areas which are located about 1.5 km from school where parents can drop off their children on the way to work. From these areas, teachers or volunteers could accompany the children on the walk to school. This accompanying would be similar to the previously mentioned walking school busses (Smith et al., 2015).

4.5.5 Safety perception

Parental concerns have already been named as very important predictors of children's active travel. The concerns of parents are often related to safety, as found by several studies (e.g. Kann, 2017; Kerr et al., 2006; Timperio et al., 2006; Trapp et al., 2012). For that reason also the indicators for the parents' and the child's safety perceptions as a part of a multi-level influence on child travel behavior are investigated.

Trapp et al. (2012) found that when parents and children perceive that there is a busy road to cross on the way to school or that there are insufficient safe crossings, the chances that the child walks to school are reduced. Only for boys the odds of walking to and from school increase with the parents' perception of living in a safe neighborhood. Van Kann et al. (2015) also found associations between local safety and active travel among older Dutch primary school children. Specifically, they found that traffic safety, social safety and vandalism were important indicators. Previously, also traffic calming measures such as speed humps and traffic lights and pedestrian lights were found to influence physical activity (Carver et al., 2010). Also special walking tracks were effective in increasing active travel among girls, young and adolescent (Carver et al., 2010). Timperio et al. (2006) identified having to cross busy road and insufficient access to traffic lights and crossings to be negatively associated with active travel to school, which was confirmed in the study by Rothman et al. (2015). Timperio et al. (2006) also argue that children should be properly educated in traffic safety, such as how to safely cross a road, recognize danger and select safe routes (Timperio et al., 2006). Other safety concerns that parents had were about the presence of qualitatively good walking and cycling facilities and traffic danger (Kerr et al., 2006). Trapp et al. (2012) propose that increasing route safety and presence of qualitative sidewalks and reducing the crowdedness of cars on the road will likely reduce the safety concerns of children and parents. Rothman et al. (2015) add to this by arguing that routes to schools should be located along roads where traffic speed is low, there should be more traffic lights and a lower frequency of crossings. These measures were related to parental safety perception in research and associated with decreasing the frequency of accidents (Rothman et al., 2015).

Rothman et al. (2015), like many other authors, found a significant negative association between parental perceptions of danger along the school route and the frequency of children walking to school. However, they did not find this association with the parents' perceived danger at the school site. Objective measures of the traffic at school sites have revealed that the risk of danger in traffic is equally high and possibly higher in the direct surroundings of schools (Rothman et al., 2015). This makes the parents' focus on the route rather than the school site itself undesirable. Aarts et al. (2013) found that the perception of proper safety around school as judged by the school boards was positively related to children cycling to school, but the parents' perception of a safe traffic situation led to decreased odds of children cycling or walking to school. This seems like a remarkable finding, but Aarts et al. (2013) attempt to clarify it by stating that causality in this relationship cannot be pointed out, so it might be that parents who do not usually participate in active travel with their children have a less realistic perception of the traffic safety situation. Only 23,8 % of the school boards reported that they thought the school surrounding was safe, so the parents who more often walk or cycle with their children to school may have more experience with the (un)safety of the area.

4.5.6 Context-specific approach

Giles-Corti et al. (2005) argue for a context-specific approach when measuring built environmental correlates of physical activity. In other words, the measurements of behaviors should be specific to the behavior of interest, such as walking. Furthermore, they suggest the importance of the setting in which the behavior takes place. In their review of previous literature, they found that the capability of predicting behaviors appeared improved in models that considered environmental measures that were more compatible with the specific behavior and the setting in which it occurred. This predictive capability could be further enhanced when considering behavior measures specific to the context (Giles-Corti et al., 2005). Also considering the purpose of the trip is important, as several researchers have found differences between influences of overall active travel with different purposes, such as cycling or walking for recreational activities or for commuting (Carver et al., 2005; de Vries et al., 2010; Giles-Corti et al., 2005; Owen et al., 2004; Wendel-Vos et al., 2004). In this sense, an example of context-specific behavior could be recreational bicycling in the neighborhood.

Social environment

Second, the social environmental factors influencing children's travel mode to school are discussed. The social characteristics of the neighborhood where a child lives can have an influence on their odds of active school travel in various ways. The social environmental factors include socio-economic status of the neighborhood, social cohesion, social connections and social safety.

4.5.7 Socio-economic status neighborhood

Children who lived in neighborhoods with a lower socio-economic status were less likely to participate in active transportation modes to school in the Netherlands (Aarts et al., 2013). This phenomenon was already found by another study for Britain (Panter et al., 2010b). The finding that children in deprived neighborhoods were less likely to cycle or walk could be considered counter-intuitive, because financially less fortunate households are likely to have fewer cars than the more financially fortunate. Panter et al. (2010b) suggest that this finding may be caused by the parental perceptions on active travel which influence the child's travel behavior, and that perceptions of parents living in more affluent neighborhoods are more encouraging towards active travel (Panter et al., 2010b). Rothman et al. (2014) found no significant associations between walking to school and socio-economic status in their Canadian study. Contrary to the above, there are also studies suggesting that socio-economic status of the neighborhood is related to higher rates of active school travel among children (Mcdonald, 2008; Mitra, Buliung, & Faulkner, 2010).

4.5.8 Social cohesion and social connections

Social cohesion and social connections have been found to be associated with children's travel behavior. Aarts et al. (2013) emphasize the importance of perceived social neighborhood characteristics concerning active school travel. They found significant relations between active school travel and the perceived social safety and social cohesion in the neighborhood. This relation was in particular important for children attending primary school (Aarts et al., 2013). Kemperman & Timmermans (2014) found that children who live in neighborhoods that are perceived safe and have high social cohesion use the bicycle more often than children who live in perceived unsafe neighborhoods with lower social cohesion. This was also visible for walking, but the differences were very small. Similarly, Lin et al. (2017) found that parents of children aged 8-13 years old in the Pacific who perceived their neighborhood as having high social cohesion and many social network ties would more frequently allow their children to take independent trips. Moreover, Faulkner et al. (2010) found that although parents sometimes felt uncomfortable letting their children travel alone because of insufficient maturity and skills, this feeling was mitigated when parents perceived the social trust and social cohesion in the neighborhood as good. The importance of social cohesion in relation to active commuting behavior indicates that not only parental support, as mentioned previously, is relevant. Also social support on the neighborhood level is important, independent of the distance traveled to school (Panter et al., 2010a).

According to McDonald (2017b), however, distance might have a mediating effect on the association between social cohesion and children's travel behavior. McDonald (2007b) found the social environment to be most influential on school travel mode on shorter distances, below 1,6 km. Neighborhood social control and social cohesion were associated significantly with mode choice only on trips up to 1,6 km. This implies that parents are more inclined to let their children walk to school when they know the neighbors in their own neighborhood, which makes sense (McDonald, 2007b). The results of McDonald (2007b) suggest that the perception of social trust in the neighborhood as well as short proximity to school are needed for parents to allow their children to walk to school.

More in terms of social connections, knowing other children who also cycled or walked to school was found to be associated with walking or cycling without accompaniment to destinations in the neighborhood. This could indicate that social interaction during the school trip has a predictive effect on independent mobility and active travel by extent (Veitch et al., 2017). Waygood et al. (2017a) also suggest that having neighborhood connections decreases parental concern which leads to more children traveling independently. Something similar was found by Bringolf-Isler et al. (2007), parents were less worried about safety when children were likely to have social contacts during the trip. Having social contacts in the neighborhood can result in more often traveling with peers (Aarts et al., 2013). In line with this, Salmon et al. (2007) found in an American study that many parents reported not letting their children walk to school because there were no other children to walk with. This may indicate that parents assume their child is safer when traveling with other children. However, Salmon et al. (2007) also found that half of the parents who participated in the study feared that their child would take risks during the trip to school with friends.

Not only the perception that parents have of the environment is important for travel mode choice of children, but also the perception of the children themselves. Hume et al. (2009) conducted a study among 9-12 year old Australian children, investigating the relation between the children's perceptions of the social environment and their participation in walking and physical activity. They found the children's perception of neighborhood social capital to be positively associated with the amount of walking and physical activity, this was independent of gender. A remarkable result was that also access to social networks was found to be positively associated with physical activity, but not with walking behavior. Hume, Salmon, & Ball (2007) had previously also found this association. Hume et al. (2009) attempt to explain it by suggesting that having friends within the neighborhood is likely to result in children participating in physical activities with their friends. Having friends within the neighborhood is less likely to result in children walking around the neighborhood alone or with parents. Aarts et al. (2013) argue that it is important to not only consider improving physical characteristics when hoping to increase active travel, but to also focus on social initiatives.

4.5.9 Social safety

Mcdonald, Deakin, & Aalborg (2010), who surveyed American parents of 10-14 year old children, found that children would cycle and walk to school more often when their parents perceived the presence of social control centered around the children. This meant that the parents had the idea that neighbors would intervene if children behaved inappropriately. Safety concerns that parents may have regarding their children's independent travel, such as "people danger" and dangerous traffic situations were found to be the most common concern that parents had (Lin et al., 2017). Also studies conducted in the Netherlands found social safety or perceived neighborhood safety to be related to higher active travel rates (Aarts et al., 2013; Kemperman & Timmermans, 2014).

4.6 External environment

The last layer from the child's socio-ecological environment to influence their school travel behavior is the external environment. Within this layer, factors are included which are mostly out of reach from the children and their parents, but may still influence their travel behavior. These are government initiated policies and initiatives, traffic related laws and regulations and factors from the natural environment, mostly represented by the weather.

4.6.1 Policies and initiatives

As already mentioned before, there is a variety of policies and initiatives that promote and sometimes indeed increase active school travel. Carver, Timperio & Crawford (2013) argue that several policies aiming towards social trust and a more connected community as well as improved neighborhood

safety could lead to more frequent participation in active school travel of children. These include initiatives such as the aforementioned walking school busses, parents acting as road crossing agents and special walking- and cycling days. These type of initiatives could increase the self-efficacy of children considering active travel (Curtis, Babb, & Olaru, 2015).

School travel planning

School travel planning (STP) is a project in which multiple stakeholders from different disciplines such as safety, municipal planning, education and transportation collaborate to make plans for the increase of active school travel (Mammen et al., 2015). The stakeholders together start up an STP committee which is led by the STP facilitator. The eventual product of STP is a plan for traveling to school, based on the assessment and proposed interventions specific to a certain school (Mammen et al., 2015).

Buliung et al. (2011) looked into how school policy interventions in the form of STP had an influence on self-reported travel modes to school. STP's have as their main goal to promote and facilitate active transport modes. Buliung et al. (2011) conducted a pilot study in twelve schools in four different regions in Canada between 2007 and 2009. Within the modern, car-oriented neighborhoods where the pilot schools were located, several active school travel interventions were identified, executed and evaluated. Different types of interventions were applied in the different schools. Most widely used were education interventions, such as workshops about planning travel and improving cycling and pedestrian skills. Other interventions included special events such as walking or cycling days, (minor) capital improvement projects such as creating or repainting road crossing lines and improving sidewalk accessibility and law enforcement interventions in the form of ensuring speed limits are adhered to (Buliung et al., 2011). The findings of modest increases of active travel and decreases in car travel indicate the moderate effectiveness of STP, which contrasts some previous studies. Parents reported safety education, special events and infrastructure adjustments as being most effective. However, those families who in fact underwent a decrease in car usage indicated the identification of routes and the introduction of walking buddies were the best interventions (Buliung et al., 2011). Parents who did not adjust their driving patterns named weather, convenience and combining different trips (trip chaining) as most important reasons to continue driving (Buliung et al., 2011). Mammen et al. (2014) looked into the effects of nationally spread STP interventions in primary schools in Canada. Over the one year period after the interventions, they found no increases in active travel to school on the national scale. However, when they looked at schools individually, there was an increase in almost half of the schools. Furthermore, while not significant, the increase in active school travel was greater in larger schools of over 328 pupils. Hinckson, Garrett, & Duncan (2011) had already stated in their STP study among primary schools in New Zealand that changes considering active school travel related to STP interventions only became visible three years after the implementation. They name two reasons for this, the first being that it took about two years to implement all the changes and the second that a change in travel behavior requires about three years to turn into a rooted habit (Hinckson, Garrett, & Duncan, 2011).

Mammen et al. (2015) conducted a qualitative research on STP, they questioned STP facilitators of different schools on their opinions about the intervention method. All facilitators considered STP as a successful method, though they had diverse motivations for this. The primary indicator for its success was the manner in which STP could be used to start the conversation about active school travel. Also the multi-disciplinary approach towards active school travel promotion was seen as positive (Mammen et al., 2015). However, Mammen et al. (2015) further mention some evidence that suggest STP is just a quick solution on the short term, they compare it to a band-aid. They therefore argue for greater investments to support the interventions and to implement them in all government levels. A limitation to this study is that all participants were STP facilitators, who are naturally involved with STP.

Other initiatives

Chillón et al. (2011) conducted a systematic review on the literature available that researched interventions to promote active travel among children. The intervention studies they have found were highly heterogeneous and the quality of the studies was rather low, which made drawing conclusions difficult. One of the reasons why the studies are considered of rather poor quality is because hardly any of the studies account for distance, even though distance is a crucial indicator of active travel behavior, as mentioned earlier. However, half of the interventions that have been studied offered a slight increase in active travel to school resulting from the intervention. It was visible here that the interventions which Chillón et al. (2011) characterized as of higher quality also resulted in higher effect size. The interventions, especially when performed well, offer a promising effectiveness towards increased active travel rates, despite their small effect sizes (Chillón et al., 2011). Moreover, Chillón et al. (2011) mention some characteristics of active travel interventions in general which may result in higher effectiveness of the intervention. Especially the importance of determining and describing the objective of the intervention and motivating different stakeholder groups to get involved are pressed on. Two common components of the most effective interventions (studied by Merom et al. (2005) and Zaccari & Dirkis, (2003)) were the strong and active participation of school employees and the distribution of materials and encouragement to walk. The involvement and interaction between the parents, schools and the community may lead to more successful interventions of active school transport (Chillón et al., 2011). Moreover, as described earlier, interventions must address various factors spread out among the different layers of the child's environment (Sallis, Owen, & Fisher, 2008).

There are other examples of active travel intervention initiatives that have been studied. In Scotland, two schools participated in an intervention project called "traveling green"(McKee et al., 2007). This project consisted of curriculum materials guiding teachers in delivering projects of active travel and resources for children and their families to engage them. They then received, among others, a map illustrating walking path networks and activities to engage in setting goals towards changing to more active travel behaviors. In the end, also this intervention lead to an increase in walking distances travelled and a decrease in motorized travel. Furthermore, children recognized the benefits of active travel and realized that the largest barrier towards participating in walking activities was the fact that their parents drove them to school by car (McKee et al., 2007).

Another intervention in the United Kingdom used some similar methods as described in the previous examples, but they incorporated gamification aspects (Coombes & Jones, 2016). The intervention is called "Beat the Street" and it is about giving out rewards for participation in active travel trips. This way, children can compete with other pupils in their school in who makes the most active travel trips and they are hereby encouraged to participate in active school travel. "Beat the Street" was developed to encourage residents towards more active travel by the use of several strategies common for gamification (e.g. performance feedback, setting goals and monitoring improvement). Coombes & Jones (2016) looked into the effect of the implementation of "Beat the Street" among 8 – 10 year old children in the United Kingdom. As this was a pilot study, no significant effects of the interventions were found. However, the results do indicate that the intervention was effective, as self-reported active travel increased at the interventions school compared to the control school. However, overall engagement with the 'game' was low, so it can be concluded that the intervention is promising but engagement needs to be improved in order to reach higher effectiveness (Coombes & Jones, 2016).

In the United States there is a program called Safe Routes To School (SRTS), which aims at encouraging and enabling children to participate in active school travel in a safer and more appealing way. SRTS interventions are comparable to STP interventions, they focus on improvements of infrastructure, education on active travel, increasing the awareness of walking and cycling and funding safety

measures and law enforcement in the school area (Mcdonald et al., 2013). The study by McDonald et al. (2013) focused on the actual impacts that an SRTS implementation in Oregon, United States, had on the walking and cycling behavior of elementary- and middle school children. Differing between schools and number of interventions implemented, the amount of walking and cycling to school increased 5-20 percentage points. McDonald et al. (2013) consider this strong evidence for the effectiveness of SRTS programs. Although the results cannot be generalized for the entire country, several valuable lessons can be learned from this study in Oregon. Examples are the importance of short distances and the availability of sidewalks on the route to school, the availability of a substantial budget for a full-time coordinator and the creation of excitement and awareness (Mcdonald et al., 2013).

To conclude, there is a wide range of government- and school initiated policies and initiatives aimed at increasing active travel behavior. Although the effectiveness has not proven to be very high, the studies and marginal evidence altogether suggest that more research and implementation of school travel interventions is called for and would be promising of travel behavior changes.

4.6.2 Law and regulation

According to Pucher & Buehler (2008), one of the reasons why cycling is so popular in the Netherlands compared to other countries and especially compared to the USA, is the fact that the Netherlands have traffic laws that especially consider the vulnerability of cyclists compared to motorized vehicles. The laws are meant to protect cyclists and pedestrians and they are generally very strictly enforced by the police, more so than in the USA. For example, there is a law that motorists are generally assumed to be the guilty party in any accident with a “vulnerable traffic participant”, even if the cyclist was not obeying traffic rules. This law is meant to make car drivers increasingly aware of the cyclists and pedestrians (Pucher & Buehler, 2008).

Chriqui et al. (2011) looked into the relation between state laws in the USA, policies and implementations applied to promote active school travel and actual travel behaviors. Some states had laws requiring crossing guards to be present around schools, these laws were found to increase the likelihood of children participating in active school travel. State laws that required speed zones in school surroundings were only found to significantly lower the odds of zero children walking to school, but not to increase the odds of children participating in active travel. State laws that required sidewalks to be present near schools surprisingly did not affect walking or cycling policies. Safety was the greatest barrier to walking or cycling to school, only laws that required traffic control measures were found to reduce the effect of this barrier (Chriqui et al., 2011). Grundy et al. (2009) found a reduction in speed limit from 30 miles per hour to 20 miles per hour in the United Kingdom to result in fewer road accidents between motorized traffic and walking children.

On a more general note, many of the factors from the physical environment that may influence children’s traffic behavior could be enforced by law. For example, as Kann et al. (2015) suggest, the maintenance of local parks (which they found to be positively related to active travel) may be reinforced by regulations set by municipalities. This is true for many more factors, such as other aspects of aesthetics, but also neighborhood connectedness, land use and urban density.

4.6.3 Natural environment

Within the category natural environment, the weather is the only factor that has already been considered in a few studies. Some have found the weather to have an influence on active travel behavior of children. Buliung et al. (2011) found that one of the reasons for Canadian parents to drive their children to school by car was the weather. In the study by Helbich et al. (2016), weather conditions were not found to be associated with active school travel in the Netherlands. However,

Helbich et al. (2016) only included children who live in the same neighborhood as their school, which makes the average distance children live from school unrealistically small. This could also mitigate the effect that the weather has on travel behavior. Ahern et al. (2017), who conducted a qualitative research on the motivation behind parents' school travel behavior, found that weather played a minor role in the decision making. For some parents the weather significantly influenced travel mode, bad weather could lead to motorized transport and good weather could have the reversed effect (Ahern et al., 2017). This relationship was found to be closely related to the available resources (car, bicycle) to change the transport mode. Some other studies also found weather to be one of the motives for parents to drive their children to school (Bringolf-Isler et al., 2007; Buliung et al., 2011; Faulkner et al., 2010; Salmon et al., 2007), thus lowering the probability of traveling with active travel modes (van Goeverden & de Boer, 2013). On the other hand, some quantitative studies did not find associations between weather and children's participation in active travel (Mitra & Faulkner, 2012; Robertson-Wilson, Leatherdale, & Wong, 2008).

As there is little evidence available for the association between weather conditions and children's travel behavior, also a study by Helbich, Böcker, & Dijst (2014) on cycling behavior of adults under diverse weather conditions was reviewed. Temperature was found to influence cycling in a supporting way, wind speed and rain are barriers for cycling behavior. Generally, these effects are stronger on trips with a leisure purpose than a commuting purpose. It may be that work-trips are standard and habitual and therefore less influenced by the weather (Helbich, Böcker, & Dijst, 2014). Furthermore, all three weather conditions have stronger effects in the more remote areas than in city centers. This may be because the remote areas are more exposed to the weather conditions and are usually related to larger travel distances than trips within city centers (Helbich, Böcker, & Dijst, 2014). Of the different weather effects, temperature was found to have the strongest influence (Helbich, Böcker, & Dijst, 2014; van Goeverden & de Boer, 2013). Although there are some consistent findings of parents or children reporting weather to be an indicator of the school travel mode, in terms of significant evidence this factor is still understudied.

4.7 Concluding model

Drawing on the existing literature that has been studied this section will summarize the factors within each separate layer of the child's socio-ecological environment that have substantially been found to influence travel behavior of children. According to the studied literature there is a large group of factors, divided over several layers of the environment, which increase or decrease the odds of participating in active travel to school.

Socio-ecological model of children's active travel to school

The results can be seen in figure 4.2, the final socio-ecological model. All of the factors within the different layers of the child's environment that have been found to influence their travel mode to school have been included in the model. The most consistently found results have been marked with an asterisk. These are the factors that were found by a large amount of studies and occasionally they were also found to have a very strong influence.

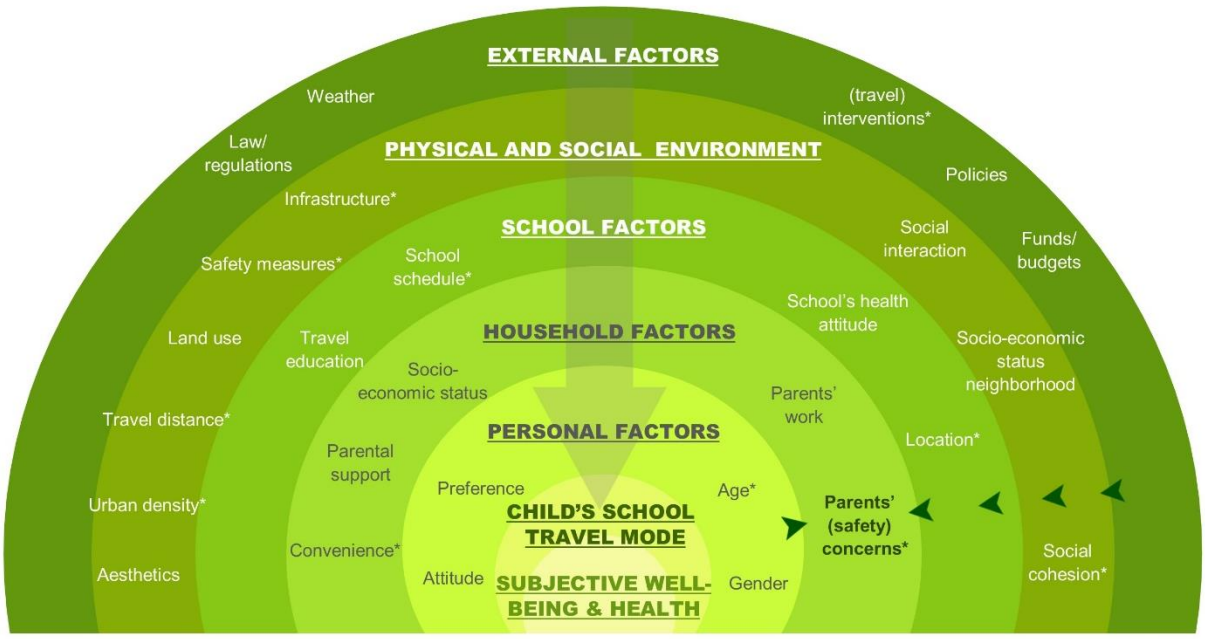


Figure 4.2 – Final socio-ecological model of children's active travel to school, modified from Curtis, Babb & Olaru (2015)

To answer sub question a, the model in figure 4.2 shows the most important factors that, according to the literature, may influence whether or not a child will participate in active travel to school. In the *domain of personal factors*, especially the child's age is important, for example because as age increases, so does independent mobility granted by parents. Also the gender has been found to be associated with travel behavior and the child's own attitude towards and preference of travel modes plays a role. In the *household domain*, especially the parental concerns as mentioned earlier are important. Also the socio-economic status plays a role, as this determines, for instance, car-ownership. Furthermore in this domain, time-related convenience of travel, parental support towards active travel and the parents' work are associated with travel mode. In the *school domain*, the schedule of the school may be important, for example whether or not children have lunch at school. Also the availability of travel education plays a role and the location of the school. Finally, the attitude that the school has towards health and whether or not they participate in certain health-promoting initiatives may influence children's travel behavior. In terms of *physical and social environmental factors*, the literature reports quite a lot of effects. In the physical environment aesthetics, urban density, travel distance, land use, traffic safety measures and infrastructure have been found to influence children's school travel behavior. In the social environment social cohesion, social interaction and the socio-

economic status of the neighborhood are of importance. Finally, the *external domain* contains the natural environment in terms of weather, traffic related law and regulations, travel related interventions, initiatives and policies that promote active travel and budgets available for these types of policies. Factors associated with children's travel mode to school have been found in all the domains of the socio-ecological model and it appears that each domain consists of at least one factor that has been found significantly associated with travel behavior by several past studies.

Parents' (safety) concerns

To answer sub question c, the factors influencing the parental safety perception with regard to their children's school transport mode and the effects of this perception on actual travel behavior have been searched for in the literature. Many studies have highlighted the importance of the parental (safety) concerns in the travel behavior of children. Especially for younger children parents can be considered gatekeepers of their children. This factor of influence has been placed in the household layer, while the parental safety perception is influenced by factors from all other layers. For instance, the parental concern is influenced by the age and sometimes gender of the child, by the distance that needs to be traveled to school, the safety perception of the neighborhood but also by social interaction in the neighborhood. Some of these factors, such as safety perception of the neighborhood, are in turn influenced by factors such as land uses and social cohesion. This illustrates the complexity and the importance of the parental safety perception as an indicator of children's travel behavior to school. If parents are concerned about their child's safety or about their ability to participate properly in traffic, the effect often is that the child is not allowed to travel independently, which in many occasions leads to the child being transported on the backseat of the car.

Relation to health and subjective well-being

Concerning the health and well-being aspect of the current study, sub-question e, the literature consistently indicates that participation in active travel is associated with more physical activity in general, which in turn has several health benefits. Moreover, although limited, some research suggests a relationship between satisfaction with travel and subjective well-being. Active travel has been found to be associated with less stress and more positive emotions. Especially the relationship between active travel and subjective well-being needs to be investigated more thoroughly, which will be done in the current research.

The next chapters will take a quantitative approach to investigate whether the results from this literature review are also true for the country-specific situation in the Netherlands. The quantitative research is conducted to provide more evidence concerning children's travel behavior, especially on the association between school travel mode, subjective well-being and parental safety perception.

CHAPTER 5

DATA DESCRIPTION NATIONAL TRAVEL SURVEY

Drawing by Iris van de Craats, 2018

5. DATA DESCRIPTION NATIONAL TRAVEL SURVEY

In this chapter the data resulting from the National Travel Survey of the Netherlands, called OViN, are described. The aim of this description is mainly to give insights into how Dutch children's travel behavior, as measured by OViN, is different for a range of personal-, household- and physical environment characteristics. The data description includes the data sample description and the associations between children's transport mode to school and various personal- household and physical environment characteristics. Because the OViN database consists of data for all trip purposes as opposed to only school trips, the other trip purposes will also be considered in this chapter. In some cases the data description for just school trips will be shown, in order to facilitate comparison.

5.1 Data sample description

The OViN database is derived from a national travel survey, which was filled in by a large sample of the Dutch population. The total number of respondents of the 2016 OViN survey is 37 229. The main objective of OViN is to supply adequate information to be used in the development and research on Dutch transportation and traffic policies (CBS, 2017c). Respondents are asked to fill in a traffic diary, reporting all of their trips during one particular day of the year, which differs between respondents. They are asked to report where they traveled, which transport mode they used, what the purpose of their trip was and how much time the trip took. Additionally, they are asked to fill in some personal information about themselves and their household (CBS, 2017c).

As the current study will focus on children attending primary school in grades five through eight, the respondents of the corresponding age group (8 – 11 years old) were selected from the OViN database. This resulted in a sample of 2034 respondents who together reported 6522 trips (referred to as trip legs). The characteristics of this sample are presented in table 5.1. The ages of the respondents are evenly distributed, there are a little more boys (51.3%) than girls (48.7%). Most children live in a four-person household (49.3%), the second largest group of children lives in a five-person household (25.1%). In terms of ethnicity, the largest group of respondents has a Dutch background (78.3%), and there are more respondents from a non-Western country (15.2%) than from a Western country other than the Netherlands (6.5%).

In terms of income, about half of the respondents have a household income of over 50,000 euros and the percentage of respondents with lower incomes gradually decreases to only a very small share of households with an income below 20,000 euros (2.4%) and below 10,000 euros (0.7%). Only 7.2% of the respondents live in a household that does not own any cars, about an equal amount of households have one (45.6%) or two cars (43.6%). Almost all respondents own a bicycle (97.6%).

As the respondents were asked to report every trip they made on the day they filled in the questionnaire, there are more trips in the datafile than there are respondents. In total, the 2034 respondents aged 8-11 years old made 6522 trips. Of these trips, the highest percentage was by bicycle (41.8%). Also quite a large share of trips was made by car (31.3%) and 22.2% were walking trips. See table 5.2 and figure 5.1 for these distributions.

Table 5.1: OViN sample characteristics (N=2034)

Variables	# Respondents	% of sample
Age	*N*	*%*
8	511	25.1
9	509	25.0
10	508	25.0
11	506	24.9
Gender	*N*	*%*
Boy	1044	51.3
Girl	990	48.7
Household size	*N*	*%*
2 person	74	3.6
3 person	239	11.8
4 person	1002	49.3
5 person	511	25.1
6 person	146	7.2
7+ person	62	3.0
Ethnicity	*N*	*%*
Dutch	1592	78.3
Western immigrant	133	6.5
Non-Western immigrant	309	15.2
Household income	*N*	*%*
Up to €10,000	15	0.7
€10,000 - € 20,000	48	2.4
€20,000 - €30,000	239	11.8
€30,000 - €40,000	327	16.1
€40,000 - €50,000	404	19.9
€50,000 or more	989	48.6
Unknown	12	0.6
Number of cars	*N*	*%*
zero	147	7.2
one	927	45.6
two	887	43.6
three or more	73	2.8
Child owns a bicycle	*N*	*%*
No	48	2.4
Yes	1986	97.6

Table 5.2: OViN trip travel modes distributions (6522 trip legs)

Travel mode	Number of trips	% of sample
All trips	*6522*	*100*
Car passenger	2046	31,4
Public transport	132	2,0
Bicycle	2729	41,8
Walking	1446	22,2
Other	169	2,6

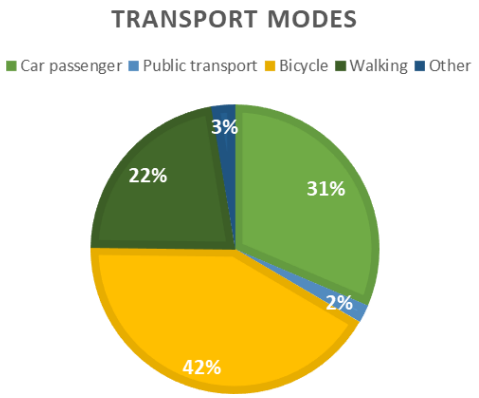


Figure 5.1 Transport modes (N=6522 trip legs) (OViN, 2016)

5.2 Trip purposes

All of the trips that respondents were asked to report in their travel diary were ordered into a set of trip purposes. This section describes the percentages of trips belonging to different trip purposes and how this may differ with age (see figure 5.2). Furthermore, the divisions of the trip purposes per transport mode are presented in figure 5.3. As can be seen in figure 5.2, by far most of the trips that children make are education related, over 40%. Sports and hobbies, general leisure activities and social contacts are the trip purposes that are also relatively common among children. There appears to be little effect of age on the percentage of trips per purpose.

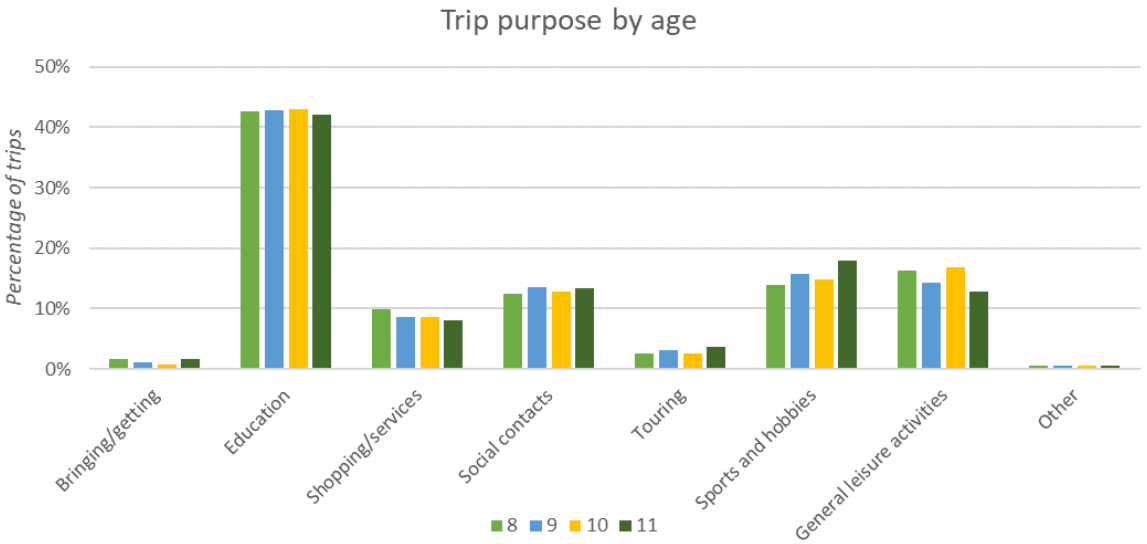


Figure 5.2 Trip purpose by age (N=6520 trip legs)(OViN, 2016)

For the different trip purposes, the dominant transport mode is not always the same (See figure 5.3). For bringing and getting as well as 'other', the car is by far the most used transport mode. For education trips, however, the bicycle is much more often used and also walking is a relatively more often used transport mode. For service and shopping trips, social contacts and sports and hobbies the car is more often used, but also the bicycle is quite common. Among the general leisure activity trips, the car, bicycle and going by foot are all similarly common. Touring trips is the only trip for which walking is most common, followed by the bicycle and the car is not very common. This may be because touring is a recreational activity, which is more attractive by active modes. Public transport appears uncommon in children's travel, only in trips with 'other purposes' around 15% is by public transport.

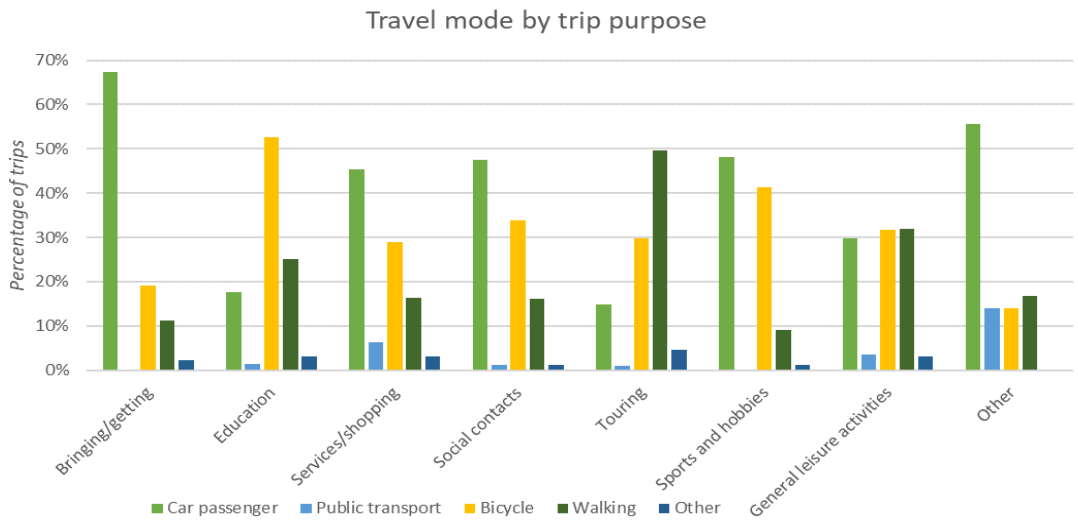


Figure 5.3 Travel mode by trip purpose (N=6520 trip legs)(OViN, 2016)

5.3 Transport mode by personal factors

As described in the literature review, several personal factors are believed to influence travel behavior. Using the OViN sample the effect of age and gender on transport modes can be visualized. Figure 5.4 shows how the transport modes of children aged 8-11 in the OViN sample differ by age. As age increases, so does bicycle usage. Meanwhile, traveling as a car passenger decreases when children grow older. This is in line with findings from the literature review that increasing age is associated with increasing active travel modes. This may have to do with more independence that older children are granted by their parents. Participation in traffic by means of public transport, walking and other appear not affected by age. Small differences are visible between females and males, as shown in figure 5.5. Boys cycle more than girls and girls travel more by car and walk more than boys. It is possible that this has to do with the increased independence that boys have while traveling, as found by some studies.

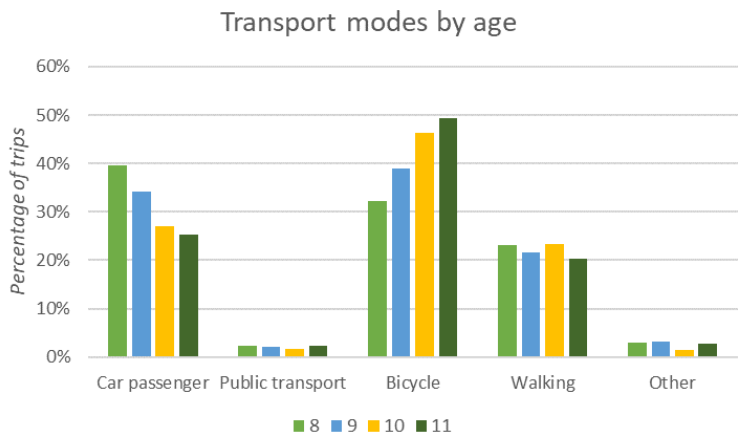


Figure 5.4 Transport modes by age (N=6522 trip legs)(OViN, 2016)

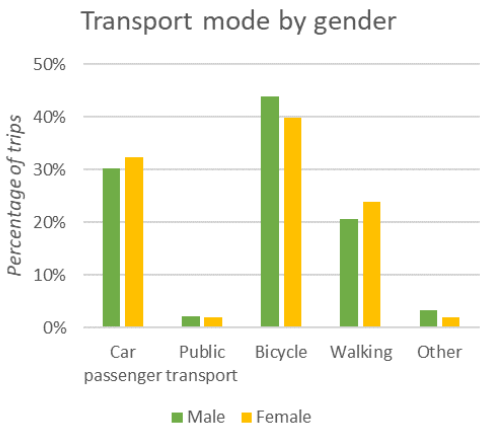


Figure 5.5 Transport modes by gender (N=6522 trip legs)(OViN, 2016)

5.4 Transport mode by household factors

Also a wide range of household factors has been found to be associated with travel behavior of children in previous studies. Using the OViN sample, the effects of household income, car ownership, ethnicity and household size on the travel mode choice of children in the Netherlands can be visualized.

Household income

Figure 5.6 shows how transport modes of children aged 8-11 in the OViN sample differ with the income of their households. As can be seen, children cycle more when the income of their household increases. This observation is partly in line with the literature, where higher neighborhood socio-economic status was found to be associated with higher active travel rates. In this sample, however, walking rates do decrease with increasing household income. Furthermore, car travel becomes more frequent when household income increases. The high rate of public transport among the households with the lowest income stands out. This participation in public transport may be caused by the fact that households with very low incomes do not always own a car. When these households live rather far from school, public transport could be the only remaining feasible mode of transport (see also figure 5.8 about car ownership). Figure 5.7 shows the relation between transport mode and household income, but focusses only on education related trips. Even though in this case respondents travel more frequently overall by bicycle and less by car when they travel to and from school, the same development with an increase of household income is visible.

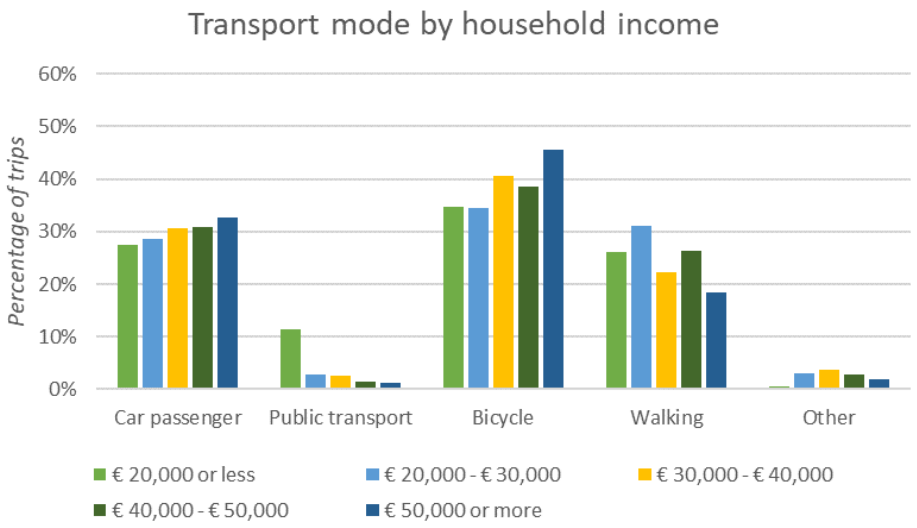


Figure 5.6 Transport modes by household income (N=6502 trip legs)(OViN, 2016)

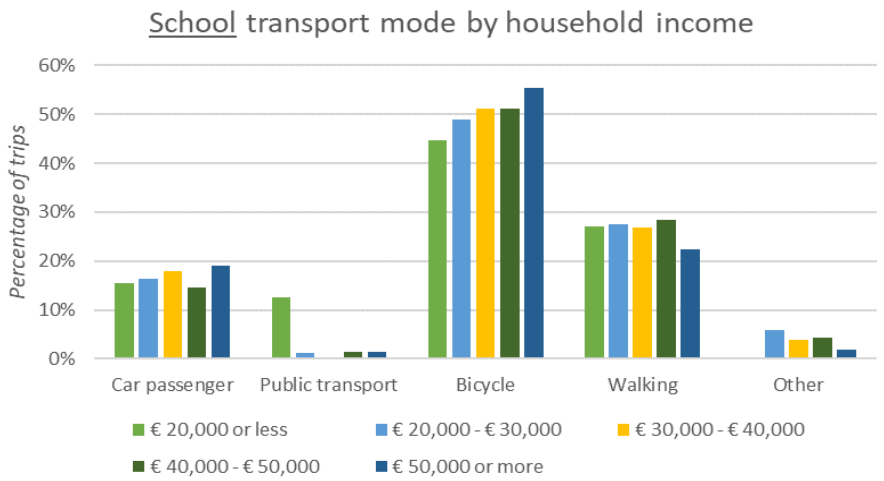


Figure 5.7 School transport modes by household income (N=2773 trip legs)(OViN, 2016)

Car ownership

Likely related to household income is car ownership. In figure 5.8 the relation between the amount of cars that a household owns and the travel modes that children use on their overall transport is presented. This figure shows that in households that do not own a car, public transport, walking and 'other' rates are substantially higher. Bicycle use increases with the increase of car ownership. It may be that in this case the relation between cycling and household income as presented in figures 5.6 and 5.7 is also visible in 5.8 as increased car ownership is likely to be associated with increased household income.

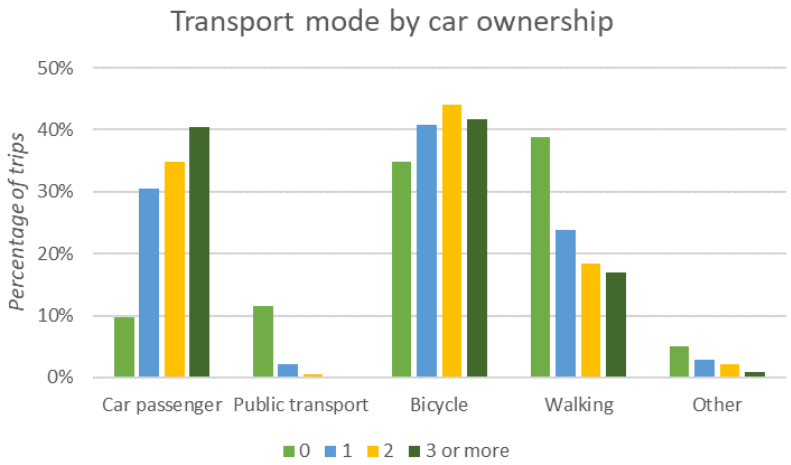


Figure 5.8 Transport modes by car ownership (N=6522 trip legs)(OViN, 2016)

Ethnicity

Several researchers have found associations between travel mode and ethnicity. Figure 5.9 shows that school transport modes indeed are very different between respondent groups from different backgrounds. Differences between Dutch respondents and Western immigrant respondents are small, the Dutch have a slightly higher tendency towards bicycle travel and the Western immigrants walk and drive a little more. When looking at non-Western immigrants however, bicycle rates are much lower and walking rates much higher than for Dutch respondents. Car travel percentages are fairly similar between Dutch residents and those of non-Western background.

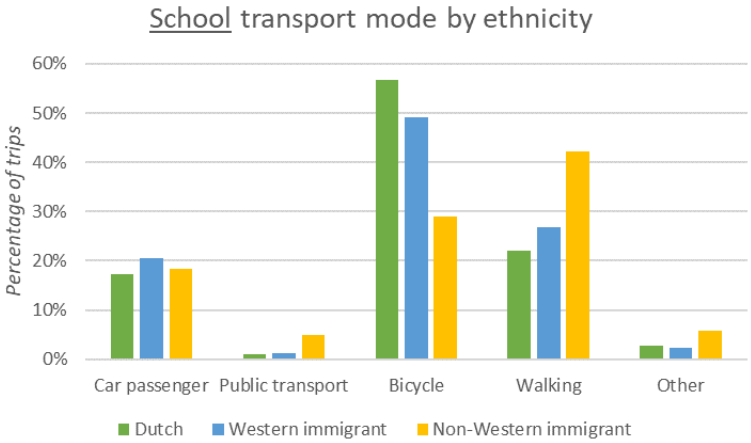


Figure 5.9 Transport modes by car ownership (N=6522 trip legs)(OViN, 2016)

School transport mode by household size

Household size was found to be associated with travel behavior of children. Some researchers hypothesized that children with siblings were more likely to be allowed to walk or cycle together to school. The school travel mode frequencies distributed by household size as found in the OViN database are presented in figure 5.10. Car travel appears to become less common as household size increases. It is also uncommon for 2-person households, maybe because single parents will likely have a lower household income. Bicycle use, on the other hand, increases with increasing household size, in line with the above mentioned hypothesis. Walking rates are higher for 2-person households, which is possibly again associated with lower household income. In most travel mode categories, there is an exception for 6-person households, which is quite unclear. Children from households of six persons travel relatively more by car, less by bicycle and more by foot.

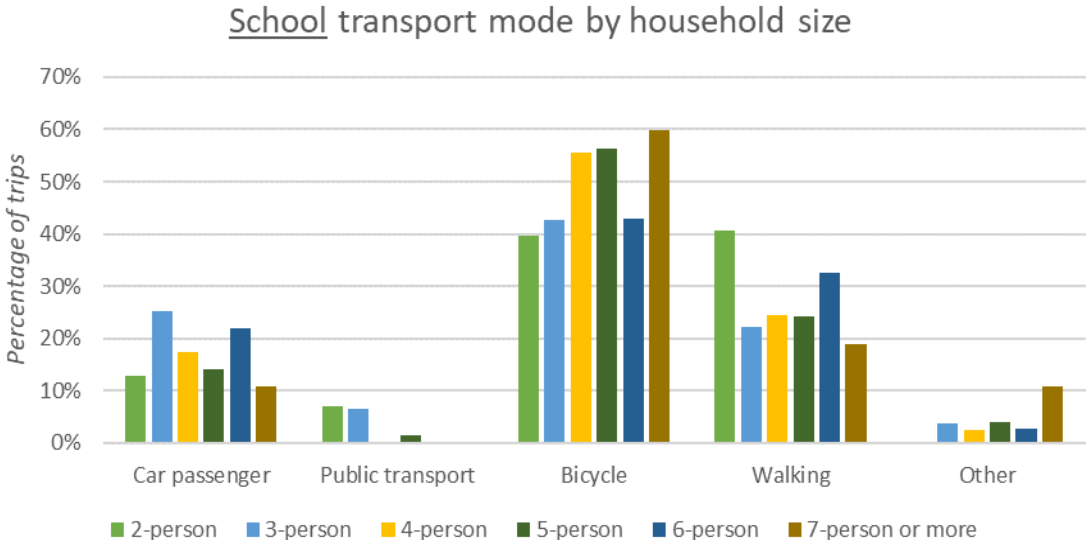


Figure 5.10 Transport modes by car ownership (N=6522 trip legs)(OViN, 2016)

5.4.1 Transport mode by physical environmental factors

The last category of factors from the socio-ecological environment that can be visualized using the OViN data is the category of physical environmental factors. In this section, the effects of urban density and travel distance are visualized.

Transport mode and urban density

According to the literature review, urban density is likely to have an influence on the travel mode of children. Proposed reasons for this can be because higher urban density leads to more locations to reach within smaller distances, which make active modes more attractive. However, areas with high urban density may also be associated with more traffic safety issues. Figure 5.11 shows the relationship between urban density and transport modes from the OViN sample.

Car travel among children appears to be not strongly influenced by urban density, only in the second density level a peak is visible. The reason for this peak is unclear. In very strongly urbanized areas, a higher percentage of trips is conducted by public transport. This may be explained by the effect that public transport is usually more easily accessible in highly urbanized areas. Bicycle use increases with the decrease of urban density. Meanwhile as urban density decreases, walking rates decrease. Lower urban density is likely to be associated with higher overall travel distances, which could explain this relationship. The only exception to this apparent relationship is the situation in not urbanized areas, where cycling rates drop and walking rates increase relative to the situation in little urbanized areas. It is unclear why exactly this would be, a possible explanation may be that this concerns very small towns which have a small primary school nearby the homes of residents.

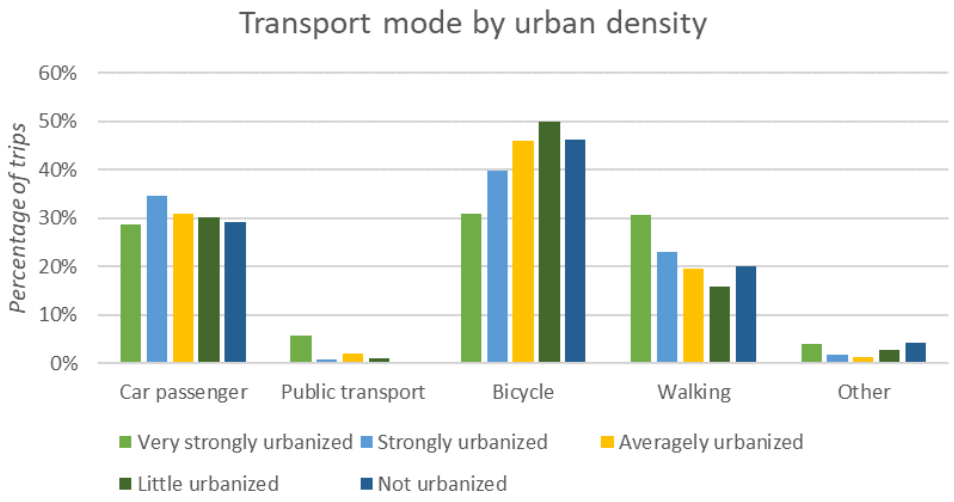


Figure 5.11 Transport modes by urban density (N=6522 trip legs)(OViN, 2016)

Travel distance

The literature has consistently found an association between travel distance and transport mode. In fact, many researchers have stated that distance may be the most important determining factor when it comes to the transport mode of children to school. Figure 5.12 shows the relation between travel distance and travel mode of trips in general. The same relation, but only for education related trips, is presented in figure 5.13. In terms of all trips made by children aged 8-11, for the lowest travel distances especially walking rates are high, approximately 70% of trips occurs by foot. As distance increases. The walking rates decrease quickly to only 10% for 1.0-2.5 km and close to zero at 2.5-5.0 km. Bicycle rates, on the other hand, start increasing and are highest at distances between 1.0 and 2.5 km (around 60% of trips). This is also the distance at which car travel starts rapidly increasing, from 5.0-10 km and higher nearly 70% of trips occur by car.

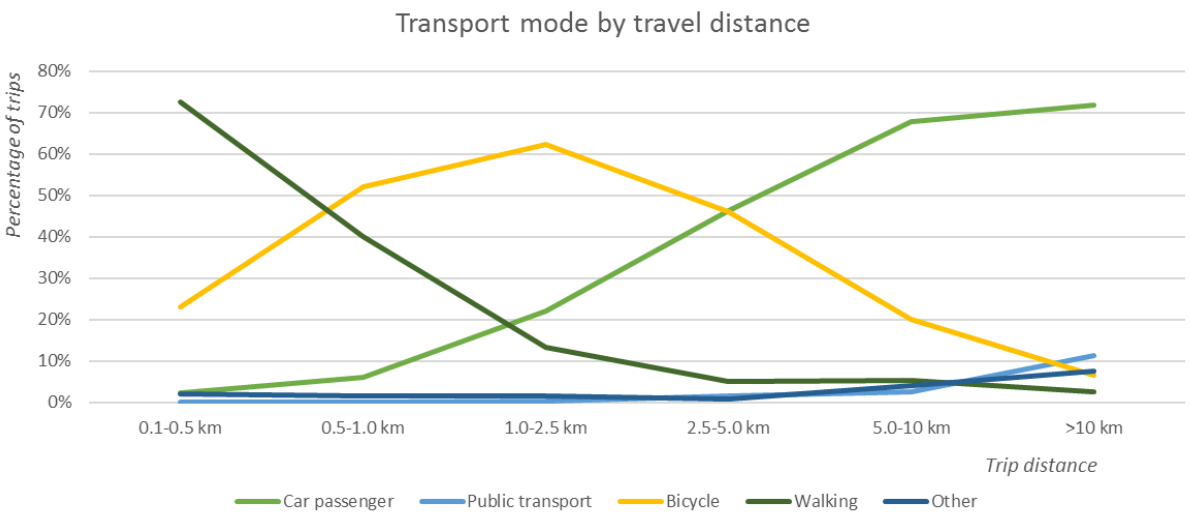


Figure 5.12 Transport modes by travel distance (N=6516 trip legs)(OViN, 2016)

For specifically the school travel trips (figure 5.13), the travel mode distribution is mostly the same until the point of 5.0-10 km. School trips with a larger distance than 10km are very uncommon (5% of education-related trips in this sample). However, among these long distance school trips, the travel modes are distributed differently than for the sample with all trip purposes as shown in figure 5.12. Suddenly, public transport and other travel modes become much more common and car travel drops. One possible explanation is that this concerns special schools which have arranged a transport service for children living farther away from school.

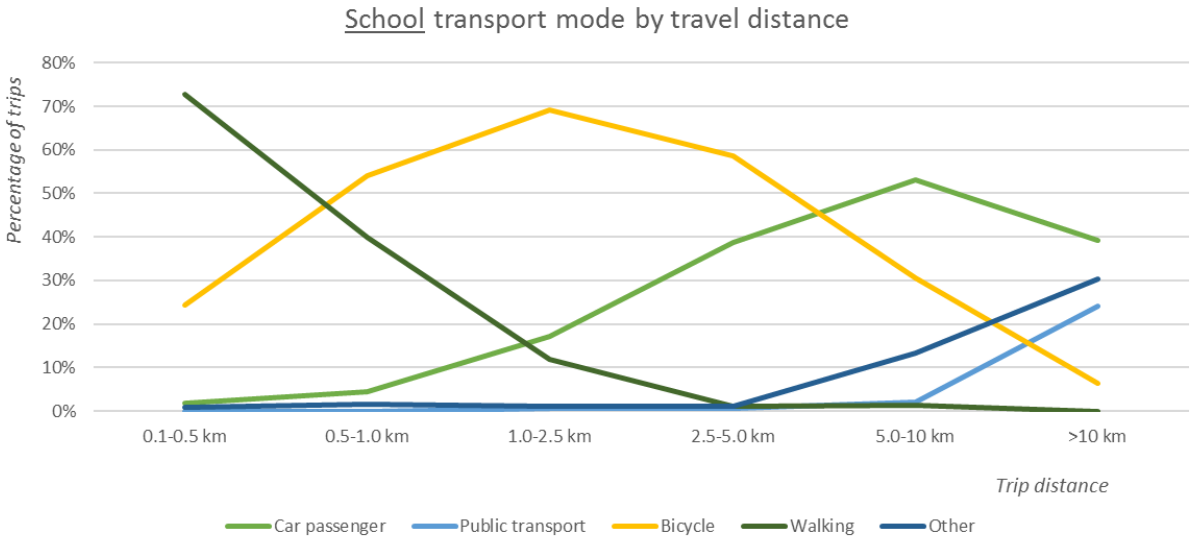


Figure 5.13 Transport modes by travel distance (N=2777 trip legs)(OViN, 2016)

5.5 Conclusion

It can be concluded that many of the personal, household and physical environmental factors that were found to be associated with children's school travel mode in the literature, also appear to have some relation in the OViN data sample. Examples are the effects of age, gender, household income and travel distance on (school) travel mode. Some unexpected results have become visible, such as the effect of larger distances to school on the usage of public transport and other modes than the bicycle, car and walking and the effect of larger household sizes on the school transport mode. It is possible that these results are caused by the fact that the groups of respondents belonging to the larger households and living abnormally far from school form a relatively small part of the total sample. Moreover, the quantitative research which will be explained in the following chapters, including the questionnaires based specifically on the previously presented literature review, is likely to clarify some of the unexpected results from the OViN survey.

CHAPTER 6

METHODOLOGY

Drawing by Desiree & Amber van de Craats, 2018

6. METHODOLOGY

This chapter will describe the complete methodology in preparation of conducting the quantitative research to answer the research question of this study. The chapter commences with a general description of the methodology to be used. After that, the research design is elaborated upon. The conceptual model is presented and described and the operationalization of all included variables is explained. Also the child-parent survey conducted especially for the current research and the resulting data sample are elaborated upon. Finally, the proposed statistical data analysis methods will be discussed.

6.1 Introduction methodology

The main objective of the current study is to gain insights on the determinants of children's travel mode to primary school, how this is impacted by the concerns of their parents and how the travel mode to school may influence health and well-being of children. As described in the problem statement, the available scientific evidence on this topic is limited. Therefore, it can be said that the most appropriate research strategy in this case would be descriptive and explorative research. A literature review has already been conducted, with a focus on children's travel trends, factors relating to their health and well-being in the travel context and a large selection of factors from different socio-ecological layers which are believed to influence children's travel behavior. With the results from this literature review in mind, a conceptual model was constructed which serves as the basis for the next part of the research: the quantitative analyses. Quantitative research is a suitable method for descriptive and explorative research, as it gives insights into which factors are important and it improves the understanding of which kind of relationships there are in the predicted model.

A cross-sectional approach using data from a questionnaire will be applied. This means that the data from the surveys is collected at one point in time (Baarda et al., 2012). A cross-sectional approach is an excellent, not too time-consuming approach to collect data and insights on the unit of analysis, in this case the Dutch primary school children and their travel mode, health and well-being. Distributing and collecting cross-sectional surveys is, compared to other types of surveys, relatively easy and quick, while quite large data samples can be achieved. The largest limitation of the cross-sectional approach is the fact that causality in relationships cannot be demonstrated, let alone proven (Baarda et al., 2012). The target group for the current research will be children attending grades five, six, seven and eight in primary school (8-12 year-old children) in the Netherlands, and their parents. Therefore, the questionnaire will consist of two parts: one for the children and one for the parents. Using the results of the questionnaires, combined with neighborhood characteristics collected from a national database and school characteristics derived from conversations with the schools, several statistical analyses will be conducted, as will be described in paragraph 6.4.

6.2 Research Design

This section will describe the design of the research, including the conceptual model and the description of the operationalization of all the independent (predicting) and dependent variables.

6.2.1 Conceptual model

The final conceptual model (figure 6.1 on the next page) visualizes the factors from the previously described five different layers of the child's environment which are believed to influence the travel mode of children to school, according to the literature research. All independent variables are expected to also influence the concerns that parents may have about their children's travel, mainly regarding safety. Furthermore, the assumption in this model that travel mode to school has an impact

on children's health and well-being was backed up by some literature and will be tested more thoroughly in the current research. Finally, as visualized in the model, all factors from the layers of the child's environment are also hypothesized to influence children's health and well-being.

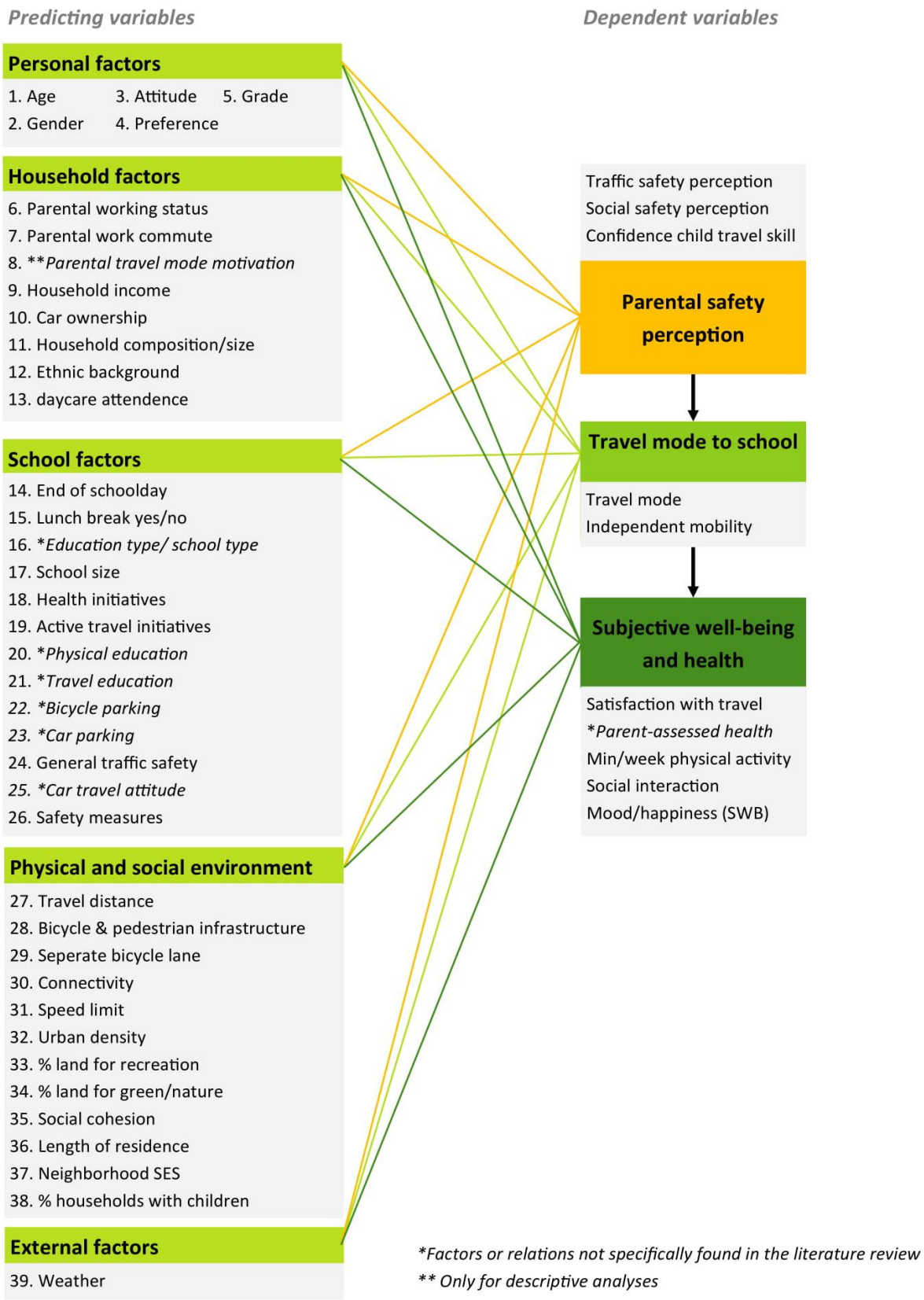


Figure 6.1: Final conceptual model of children's active travel

Predicting variables

The predicting variables are divided into five layers of children's environment. The first layer consists of personal factors, the individual characteristics of children which have been found in previous research to influence the parental concern about school travel and the actual travel mode of children. Logically, personal characteristics of children also influence their subjective well-being and health. Furthermore, especially the age and to some extent the gender of children have been found to be associated with the parental attitude towards travel modes for their children. The layer of household factors includes all influencing factors related to the households of children. Most of these are caused by socio-economic characteristics and the parents' work and travel behavior. The layer of school factors includes all school related factors which are believed to be important in this research design. Most of these have barely or not at all been investigated by previous research, partly because some of these factors such as the different types of school schedules are quite country-specific. The next layer of predicting variables in the model is the layer of the physical and social environment. Many researchers have consistently found that characteristics of the built environment and the social environment have a relationship with travel mode of children and the parental safety perception about school travel. The layer of external factors considers political initiatives, funding and the weather. Although the literature review did indicate that several significant associations existed between these factors and children's travel behavior to school, the decision was made to only include weather from the external environment variables in the quantitative research. This decision was made from a practical point of view; collecting data on political and funding related factors and their implications would be challenging. The weather, however, is much easier to measure and operationalize and likely has a large effect on the decision of parents and children concerning travel mode.

Dependent variables

The model has three dependent variables, two of which are in fact also intervening variables which allow indirect relationships. The variable referred to as parental safety perception is made up from three components: the parents' perception of the social safety, traffic safety and their confidence in their child's travel skills. Parental safety perception is believed to be influenced by factors from the child's environment. The influence of these factors results in a certain attitude towards travel modes and concerns about (traffic) safety and the travel skills of the child. The parental safety perception operates as intervening variable as it is believed to have a relationship with the actual travel mode to school of the child. The travel mode, in turn, is also influenced by the factors from the different environmental layers. Finally, the children's travel mode acts as an intervening variable as it, together with the child's environmental factors, is believed to be associated with subjective well-being and health. The measurement and operationalization of these dependent and intervening variables are discussed in the following sections.

6.2.2 Operationalization variables

The operationalization of variables is about determining how variables are built-up and how they can be measured. All of the factors included in this research have to be translated into tangible and measurable variables (Baarda et al., 2012). This action is needed in order to be able to correctly analyze the data later on. The operationalization is described for all variables that will be included in the child-parent questionnaire and in conversations with the schools. The current section will describe how variables are defined and, if applicable, how they are measured using the survey. Some variables are only measured in the CBS national database.

Some of the more qualitative variables such as safety perception or satisfaction make operationalization more complicated. For these variables, the so called constructs, it is important to include a set of clear statements or questions which, combined, represent the construct (Baarda et al.,

2012). This way, all respondents will understand how to respond to the simple questions and statements, while the researcher can derive a more complicated assessment for the entire construct. For a complete visual of how variables are measured in the survey, appendix 1 shows the child-parent survey in Dutch and appendix 2 shows the translation to English. Appendix 3 shows the questions that were asked in the school interviews.

Child's travel mode

The dependent variable child's travel mode is fairly uncomplicated: it only states which travel mode children have used on the day of the survey (child survey) and approximately how many times per week children use different transport modes to get to school (parent survey). For the purpose of this research, the distinction between five categories of travel modes is sufficient, namely: (1) by foot, skeelers or similar, (2) by bicycle, kickbike or similar, (3) seated on the back of the bicycle, (4) by car and (5) by public transport. Additionally, the option 'other' will be distinguished. These categories provide enough insights to distinguish active and passive modes and to understand the implications that the different predicting variables have for travel mode to school. Parents are asked how many trips their child approximately makes to and from school per week and to divide these trips over the five transport categories. For the children, however, the answer options need to be a little more elaborate. To a child, the kickbike is something not at all similar to a bicycle. A space scooter, which to adults looks exactly like a kickbike, is also very different to a child. Therefore, children have been given various transport modes to choose from when reporting on their school trip (see figure 6.2), which will later be recoded into the five options described earlier in this paragraph. The different versions of the travel mode variables will be applied in different models. Also measured in the variable travel mode is independent mobility, whether or not the child usually travels independently to school (parent survey). Parents are asked to report how often, on an average week, their child travels to school completely alone, with a parent, with an older sibling, with a younger sibling and with a classmate or friend. The answer options range from (almost) never to (almost) always.

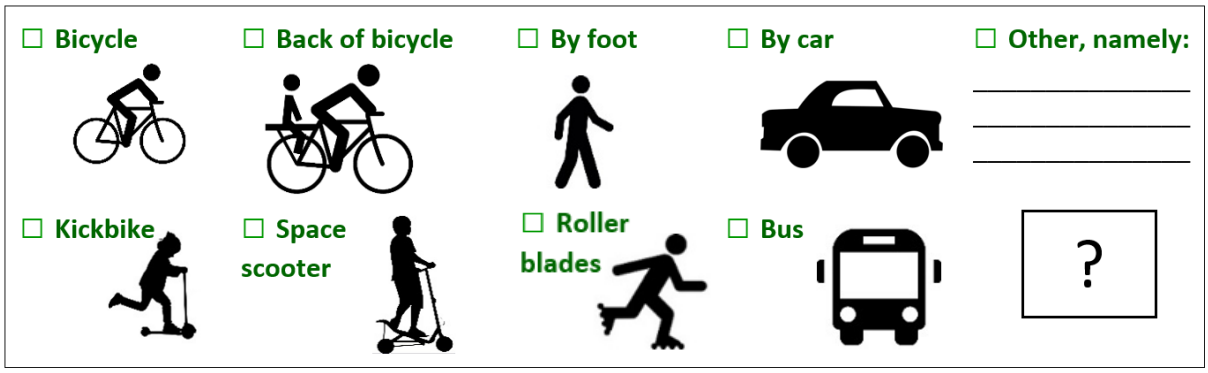


Figure 6.2: Transport mode options child questionnaire

Parental safety perception

The parental safety perception variable considers the concern that parents have about the safety of their child during travel. This safety concern is built-up from three factors. The first is the confidence that parents have in the travel skills of their children. This confidence is measured by a set of statements for which parents have to indicate to what extent they agree or disagree:

- *My child is good at riding a bicycle*
- *If my child walks to a destination, he or she pays good attention to other users of the road*
- *If my child cycles to a destination, he or she pays good attention to other users of the road*
- *My child is good at estimating potential danger in relation to traffic safety*

Next, the traffic safety perception that parents have of the route between home and school is a part of the concerns of parents. The safety perception of the route to school is measured by the following statements, for which parents are also asked to report to what extent they agree:

- *There are sufficient crossings and traffic lights to help pedestrians and cyclists to safely cross busy roads*
- *Normally, cars on the route to school do not drive too fast, in my opinion*
- *There is so much traffic on the route to school that I find it unsafe to walk or cycle to school with my child*
- *There is so much traffic on the route to school that I find it unsafe to let my child walk or cycle alone to school*
- *I have the feeling that drivers of cars pay good attention for pedestrians and cyclists*

The concerns that parents may have on the social safety in the neighborhood are measured through two statements about social safety in the neighborhood. Parents are asked to report to what extent they agree with the statements.

- *If my child is alone outside, I fear that they run into the wrong kind of people (people that are dangerous to my child)*
- *I find my neighborhood safe enough to allow my child to be outside by themselves*

The scores for these statements of safety concerns will be combined into one general parental safety perception variable.

Children's well-being

The third dependent variable is children's well-being, made up from their subjective well-being and health. Although both can have elaborate definitions, in the current research these are summarized in a limited number of indicators. Firstly, the health of children is measured simply by asking their parents to assess on a five point scale how healthy the child is (very poor health – very good health). This defines the variable parent-assessed indication of health, which is believed to be a simple but reliable indicator of the child's health. Secondly, the minutes of physical activity that a child experiences per week is measured, this is a summation of several questions. Parents are asked to report how many hours the child experiences physical activity in their free time by writing down the approximate hours per week that a child is at sport clubs, plays outside, sports and actively plays at daycare and walks or cycles to other locations than school. They are also free to specify hours of other types of free time activity. Additionally, parents are asked how many minutes it takes to cycle and/or walk to school. Also physical education classes and playing outside during the breaks at school are part of physical activity, which is why schools are asked to specify how many hours children in grades 5-8 are usually active at school per week. In the end, the physical activity variable can be calculated by the summation of the time spent on physical activity at school, in the free time (including daycare) and while actively commuting.

Furthermore, the literature review indicated that social interaction and a social network are beneficial for children's well-being. Therefore, the parents are asked to indicate how much they agree with the following statements:

- My child often meets other children during the trip to school (trip interaction)
- My child has contact with a lot of children in the neighborhood (social contacts)

Parents are also asked to report how often their child travels to school with a friend or a sibling. Furthermore, in order to be able to see how social interaction may affect the child's satisfaction with

their trip (described in next section), one further question is added in the child survey. Children are asked whether, on that particular day, they traveled to school alone, with a parent, sibling, friend or someone else (trip companions).

To measure a part of children's subjective well-being, the children are simply asked to indicate how their mood is on the moment of filling in the questionnaire. To make the questions more appealing to the children, emoticons are used to visualize the emotions that are being described. This technique was also applied by Stark et al. (2018), who looked into children's active travel and their attitudes and subjective well-being. See figure 6.3 for an example taken from the current study.

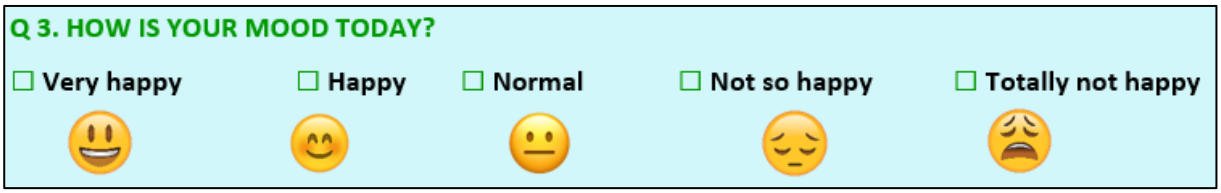


Figure 6.3: Child-survey: Question about current mood, emoticons used

The last measure of the variable subjective well-being and health is specifically about subjective well-being. It is a variable called Satisfaction with Travel (SWT), which is a specific measure that has been used by some previous studies (Bergstad et al., 2011; Ettema et al., 2011; Stark et al., 2018; Westman et al., 2017). From the literature review it became clear that the extent to which someone is satisfied with their daily travel is associated with their subjective well-being. Therefore, by measuring the satisfaction with travel, the contribution that travel has to subjective well-being can be measured. The satisfaction with travel scale measures both affective and cognitive satisfaction (Ettema et al., 2011). The cognitive evaluation can be understood as a measure of enjoyment, difficulty and usefulness of the trip. The affective evaluation measures to what extent the trip elicits valance and activation. This is measured by six scales that distinguish positive activation versus negative deactivation and negative activation versus positive deactivation. The six affective scales and three questions about cognitive evaluation were derived from the scales used by Ettema et al. (2011) and Westman et al. (2017). They were translated to Dutch and described in words that are understandable to young children. The nine questions used to measure satisfaction with travel are described in table 6.1.

Table 6.1: Measurement of Satisfaction with Travel used in child-survey

Cognitive evaluation	
What did you think of the trip to school this morning?	
Very much fun	Very lame
Very easy	Very difficult
I learnt very much	I learnt nothing
Affective evaluation	
How did you feel during your trip to school this morning?	
Negative deactivation	*Positive activation*
Very bored	Very much fun
Very indifferent	Very much looking forward to the day
Very tired	Very well rested
Positive deactivation	*Negative activation*
Very at ease	Very tense
I had a lot of time	I was in a big hurry
I was carefree	I was worried

Instead of asking the children to report on a scale to what extent they are, for example, tired or well rested, they were asked to choose between "very tired", "a little tired", "none of both", "well rested", "very well rested". It is assumed that this will make the question easier to answer for children. The answers to the three sets of questions are measured on a five point scale, with values 1 to 5. For each set separately and for the nine statements combined, an average score between 1 and 5 will be computed. This will result in one complete SWT variable and three separate, the SWT cognitive (SWT-C), the SWT negative deactivation and positive activation (SWT-NDPA) and the SWT positive deactivation and negative activation (SWT-PDNA).

To conclude, for the dependent variables this has led to the following components per variable:

Table 6.2 Components of dependent variables

Travel mode	Parental safety perception	Subjective well-being & health
Travel mode on day of survey Frequency different travel modes Independent mobility	Traffic safety perception Social safety perception Child 's travel skills perception	Parent-assessed health General physical activity Social interaction Current mood Satisfaction with Travel o Cognitive evaluation o Affective evaluation

Personal factors

The first layer of the child's environment that acts as predicting variable is that of the personal factors. There are some personal characteristics which are simple and not open for interpretation, namely age and gender. Both are included in the parent part of the survey, parents are asked to fill in the gender and age of the child. Travel mode preference and attitude towards travel mode are both measured in the child survey. The preference is asked simply by asking children which travel mode they would prefer to use if they had the choice. The same choice possibilities are provided as shown in figure 6.2. From this question, also a certain attitude can be derived, namely whether the children choose active or passive travel modes. Furthermore, the combination of the actual travel mode and the children's cognitive evaluation of their trip to some extent also indicates their attitude towards travel mode. This cannot be operationalized and measured as a variable, but after the analysis it could be interesting to see if children who chose an active travel mode as favorite mode, in fact also enjoy active trips more than children who chose a passive mode as favorite. Finally, the child is also asked to write on the questionnaire in which grade they are, this can be used as an extra variable to measure the effect of age and maturity.

Household factors

The second layer of the child's environment that is believed to be important in this model is the layer of the household factors. The household layer includes a rather wide range of factors, starting with the household composition: parents are asked to report how many siblings the child has, as well as how many parents or caretakers of the child live in the same house. Also factors relating to socio-economic status are included, namely the household income, which is measured by asking parents to report whether their household income is higher, similar or lower than the average Dutch household gross yearly income of €60,000 (CBS Statline, 2014; gemiddeld-inkomen.nl, 2015). Possibly related to household income is the number of cars that the household has (zero, one, or two or more cars). The parents are also asked to report to which ethnical group they consider their household to belong, the answer possibilities include the seven most common ethnicities in the Netherlands and an option to fill in another ethnicity or to specify two ethnicities. Furthermore, factors relating to the (possible) job that parents have and their work commute are included as household factors. Parents are asked about

their household work status, which includes the answer options two wage earner household, one wage earner household, household looking for employment and other. They are also asked to answer a question about the mode of transport they use in their possible work commute. For some different modes (by foot, bicycle, car, public transport, other) they report the average weekly frequency of use for both parents. Related to the effect that parental working hours have on travel behavior of children is the frequency of attending daycare. In some cases, this variable is a more reliable way to measure the relationship between parents' work situation and their child's transport mode to school (Aarts et al., 2013). Some parents might work a lot of irregular or flexible hours, making it possible for them to accompany their child to and from school while also working 'full time'. Therefore, the weekly frequency of attending the pre-, in between- and after school care are measured.

Lastly in this category, the parental travel mode motivation consists of possible reasons that parents may have for choosing a certain travel mode for their child. This variable is included in the household factors, but is most likely influenced by many variables from the different socio-environmental layers. The current variable is only used in descriptive analyses in order to find out which reasons are important. The parental travel mode motivation is measured in the survey by asking for the parents' motivation for the child's travel mode on days that the child goes to school by car, and on days that the child goes by an active mode. For both situations, the parents are presented with a list of possible reasons for the choice of transport mode. They are asked to respond to what extent they agree with the motivation to choose a certain travel mode concerning days the child goes to school by car and days the child goes to school walking or cycling. The motivation statements are:

- *This is usually most convenient for me/us as parents/caretakers*
- *I find this the best way for my child to travel to school*
- *I find this the safest option considering traffic safety*
- *This transport mode suits my child's age the best*
- *My child prefers to travel by this mode*
- *My child is stimulated by the school to come to school by this mode*
- *This transport mode is most suitable considering the distance to school*
- *The choice of transport mode is strongly dependent on the weather*
- *Most parents in my surroundings bring their child to school by this mode*
- *No specific reason*
- *Other, namely: _____*

School factors

It is believed that also the school environment, an environment in which the child spends a large amount of their time, can influence travel behavior of children. Not many consistent findings have been reported in the literature review, this is because not a lot of studies have addressed this relationship. For the current research, most of the school factors will be measured in an interview with the participating schools.

First, the type of school schedule is believed to be of importance, as this schedule in combination with the parents' work situation determines daily planning for households. Dutch primary schools can have different types of schedules which vary in duration of days (indicated by the time that children leave school every day) and inclusion or exclusion of a lunch break during which children go home. The schools will be asked to share their school schedule, from which the necessary information can be extracted. Dutch schools also apply many different forms of education, which is why the type of school will be included in the predicting school factors. The answer possibilities will include the most common types and the 'other, namely' option. Some studies found that school size was a mediating factor in

associations with travel mode. Therefore, the amount of pupils that a school has, in a categorical classification, will be included as a variable. The entire school size and the amount of pupils in grades 5 – 8 will be considered separately. The categories will be defined after all the answers have been gathered. One other consistent finding in the literature is about the attitude that a school has towards health, which influences physical activity of children. This includes participation in certain health-related initiatives (that stimulate a healthy lifestyle) and active travel initiatives (such as "bike to school days"). Both will be measured by asking what the school may do in terms of these initiatives. The most suitable category scales will be defined after the interviews, depending on the answers. Moreover, the time that a school spends on physical education is included as a variable. Most Dutch primary schools spend two classes of 45 minutes on physical education every week. There are also schools with more or less classes and schools that work with classes of 60 minutes (Inspectie van het Onderwijs, 2017). For this variable, the answers will be measured in terms of average minutes of physical education per week, which will further on be used to calculate overall weekly physical activity.

There are also some traffic-related school factors which will be included as variables in the current study. Firstly, the school will be asked to judge their bicycle storing facilities in terms of capacity and quality. The answer possibilities range from insufficient to very good on a five point scale. On the same scale, schools are asked to judge the overall traffic safety in the area around the school and the capacity and safety of the car parking facilities around the school. Furthermore, schools are asked about their overall attitude towards car travel. Do they direct attention towards decreasing car travel around the school? Answer possibilities are 'yes', 'no' and in case the school is located in a place where they have never experienced traffic-related issues, the answer will be 'not applicable '. Finally, the school is asked about safety measures they take during bringing and getting times, such as having crossing guards present at the street. The answer possibilities will be the same as for the previous question ('yes', 'no' and 'not applicable').

Physical and social environment

It is believed that several factors belonging to the physical and social environment are important predictors in the model. While a lot of these factors are measured through the perception that parents are asked to report in the survey, also a few are observed at the school sites or taken from databases of the Dutch Central Bureau of Statistics (CBS). For the measures of traffic safety, social cohesion and social safety the questionnaire by Aarts et al. (2013) was used for inspiration. They also studied the associations between environmental characteristics and active travel among children and distributed a questionnaire among parents. Not all questions used by Aarts et al. (2013) were also implemented in the current questionnaire. This decision was made because it is believed that the physical and social environment can also be adequately measured with fewer questions. A second reason is the belief that the total amount of questions should be limited in the hope of achieving a high response rate.

First, the variables of the physical environment that are measured in the parent survey are discussed. A very important variable according to the literature research is the travel distance from home to school, parents are asked to point out within which distance category they live from the school.

Furthermore parents are asked specifically to judge, on the same five point scale, the quality and safety of pedestrian paths and bicycle lanes on the route from home to school by means of the following statements:

- *Most pedestrian paths are separated from the road by parked cars, bushes or grass, or another form of separation*
- *Most streets have safe bicycle lanes or are safe to cycle on*
- *Most bicycle lanes and pedestrian paths are well maintained*

Additionally, in the observation of the school area, the presence of a bicycle lane separate from the road will be noted. This variable will be included as a dichotomous variable indicating that there is or is not a separate bicycle lane. Finally, to represent the variable connectivity, parents are asked whether or not there is a variety of safe routes that a child can take to get to school.

In terms of the social environment, parents are asked to judge the social cohesion in their neighborhood. They are asked to respond to what extent they agree with the following statements.

- *People in this neighborhood are prepared to help each other*
- *This neighborhood is a tight community*
- *I trust the people that live in this neighborhood*
- *Normally, the people in this neighborhood get along well*
- *My child has a lot of contact with other children in the neighborhood*

The operationalization of the variables that are taken from the database of CBS will now be explained. The variables that are taken from the CBS data (CBS, 2012, 2015, 2017d) can be added to the dataset of the current study using the postal code that each respondent is asked to fill in for the questionnaire. The data from CBS were measured on the scale of the neighborhood. From the postal code it can be determined in which neighborhood a household lives. The CBS data were gathered for the municipality of Arnhem, Renkum, Oosterbeek, Huissen and a few others where small amounts of respondents live. For the neighborhoods in these municipalities, the number of residents varies between below one hundred to around five thousand. The average number of inhabitants in a neighborhood is approximately 2.100. The average number of households is around 1.100. One of the variables constructed from CBS data is urban density. CBS measures urban density on a scale of five density levels, ranging from not urbanized; fewer than 500 addresses on a squared kilometer, to strongly urbanized; more than 2500 addresses on a squared kilometer. Furthermore, in terms of land use, the percentage of land used for recreation purposes and the percentage of land used for forest- and nature purposes are included as independent variable. Also for the social environment some variables can be measured in the CBS database. The socio-economic status (SES) of the neighborhood is measured by the percentage of households in the neighborhood which have a low income. This is indicated by looking at the amount of households that belong to the group of 40% of Dutch households with the lowest income nationally. The percentage of households belonging to this group, is the percentage used for the operationalization of the variable Neighborhood SES. Also the percentage of households with children in the neighborhood will be included in the social environment variables layer. Finally, the speed limit in the neighborhood of the school will be included as a variable in the physical environment, the answer possibilities consist of 15km/h, 30 km/h, 50 km/h and higher than 50 km/h. This variable will be measured through observation at the school sites.

External factors

Of the external factors found in the literature review, only the weather is included in the quantitative analysis. The weather variable is measured in both the child survey and the parent survey. Children are simply asked to report what the weather is like on that trip to school, they can choose from a set of images representing various weather conditions on a five point scale, ranging from very sunny to very rainy (See figure 6.4). In the parent survey, the weather variable is included in the measurement of the

Figure 6.4: Child-survey: Question weather during school travel

parental attitude. Parents are presented the following statement: "*The choice of transport mode is strongly dependent on the weather*". Parents are asked to what extent this statement is correct for their child's situation on a five point scale ranging from very true to very untrue. They are asked to fill in their answer separately concerning days the child goes to school by car and days the child goes to school by an active mode.

To conclude, the following predicting variables are included in the four layers of the child's environment:

Table 6.3 Predicting variables from five layers of child's environment

Personal factors	Household factors	School factors	Physical and social environment	External factors
Age Gender Attitude Preference Grade	Household work status Parental work commute Household income Car ownership Household composition Ethnic background Daycare attendance Parental travel mode motivation	Duration of days Lunch break School type School size Health initiatives Active travel initiatives Physical education Travel education Bike parking quality Car parking quality Traffic safety Car travel attitude Safety measures	Travel distance Bicycle & pedestrian infrastructure Separate bicycle lane Connectivity Land use diversity Urban density Social cohesion % household with children Neighborhood SES Speed limit	Weather

6.3 Data collection

This section describes the manner in which the data collection took place. This includes a description of the targeted population of the study, the distribution of the questionnaire, the definite respondents sample this resulted in and which measures were taken to ensure reliability and validity of the data.

6.3.1 Population & sample description

The population of the current study consists of children attending primary school in the Netherlands in grades 5 – 8 (children aged 7 – 12 years old). Specifically, a selection of 15 primary schools in and around the city Arnhem was made. Arnhem is a moderately large and steadily growing city of 155,000 inhabitants. The growth of the number of inhabitants between 2013 and 2017 was around 6,000 inhabitants (AlleCijfers.nl, 2018). It is important that the sample for which the questionnaires are distributed represents the entire population sufficiently (Baarda et al., 2012). Therefore, the participants should be selected in different kinds of schools and different types of environments. To ensure variability between the types of schools and the types of school environments, the following criteria were taken into consideration in the selection of the primary schools:

- Type of school schedule (do children have lunch at school or not)
- Type of education (education vision of a school)
- Size of the school (low, average or high number of pupils)
- Being active in pursuing health or physical activity goals
- Urban density neighborhood (city center, suburbs, little village, etc.)

The participating schools will be approached via their school boards. A school board in the Netherlands usually manages several schools, up to a few dozen. For the current research, school board De Basis

Fluvius in Arnhem (35 schools) was approached. From their schools, which are located in the city as well as the surrounding villages, 12 schools agreed to participate in the study. As these included no schools in the lowest and highest urban density levels, approximately 10 additional schools were approached individually. Of these, 3 agreed to participate in the study, which leads to a total of 15.

Table 6.4: overview of participating schools

School	Postal code	City/village	Pupils	Pupils grades 5-8
OBS Da Vinci Arnhem	6835 CD	Arnhem	180	100
Daltonschool Confetti	6846 XA	Arnhem	300	140
ASV	6813 GE	Arnhem	60	35
SBO Piramide	6835 HZ	Arnhem	142	80
IKC De Klimboom	6843 JM	Arnhem	228	140
Lea Dasbergschool	6836 TV	Arnhem	310	176
Heijenoordschool (partly)*	6813 GE	Arnhem	332	40
De Zyp	6815 GT	Arnhem	280	145
Mariënbornschool	6862 ZM	Oosterbeek	200	110
Bernulpusschool	6861 GR	Oosterbeek	265	120
SBO De Klaproos	6815 EC	Arnhem	155	110
De Doornick	6686 AE	Doornenburg	160	90
Prinses Beatrixschool	6874 AJ	Wolfheze	73	50
Basisschool Kunstrijk	6822 ET	Arnhem	140	70
Basisschool de Witte Vlinder	6824 RC	Arnhem	165	70

** Only the classes of the Heijenoordschool which are located in the same building as the ASV participated in the research. This is just a small part of the school.*

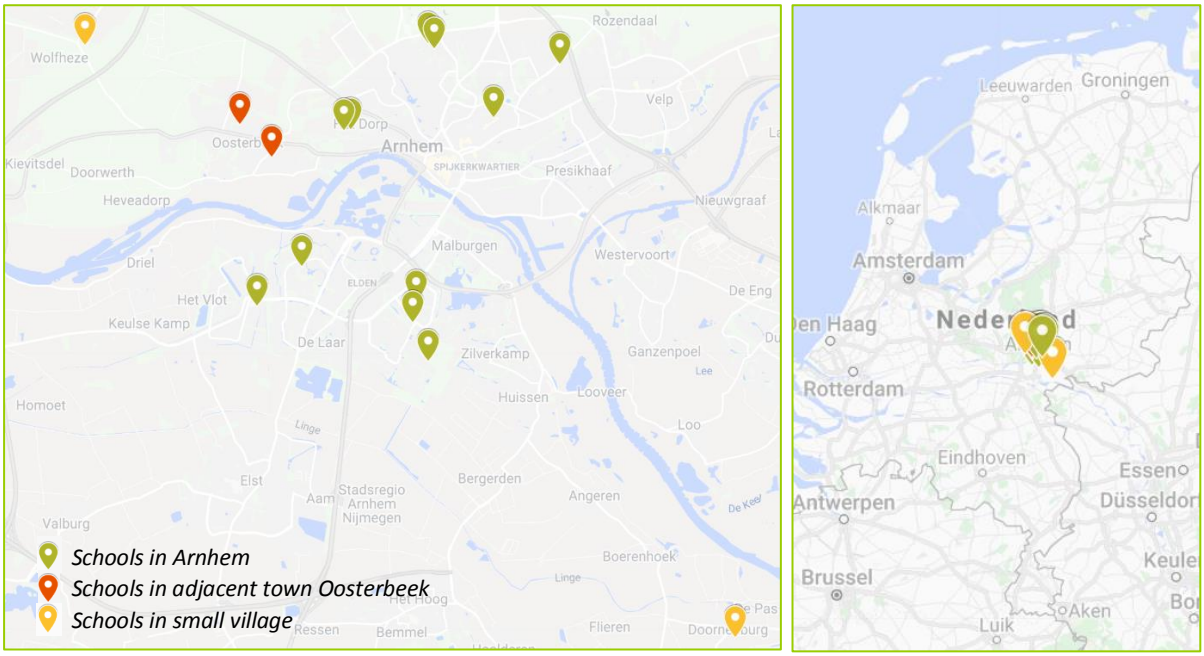


Figure 6.5: location of participating schools

As can be seen in table 6.4 and figure 6.5, the schools vary in location and in size. Most schools are located in Arnhem, although some can be found closer to the city center than others. Two schools, visualized in orange in figure 6.5, are located in Oosterbeek. This is located very close to Arnhem, the two are only separated by a small stretch of nature and agriculture land. It has around 11.300 inhabitants, which makes it the largest village in the municipality of Renkum (Gemeente Renkum, 2018). The two schools presented in yellow are located in smaller villages, Wolfheze and Doornenburg. Wolfheze is another village in the municipality of Renkum, it has around 1700 inhabitants (Gemeente

Renkum, 2018). Doornenburg is a village that has a similar amount of inhabitants, namely 2080 (Allecijfers.nl, n.d.). It is a part of the municipality of Lingewaard.

6.3.2 Questionnaire distribution & definite sample

From the schools listed in table 6.2, all children in grades five through eight are asked to fill in the questionnaire. This way, all children in the sample have equal chances of participating in the research, which is good for the external validity (described in the next section).

Distribution and procedure

With each participating school, an appointment is made between the researcher and the principal of the school to talk about the procedure of the data collection and about the characteristics of the school. During this meeting, the questionnaires are handed over to the principal and the school interview is conducted (as described in the next section). The researcher also hands over a note with clear instructions about the distribution of the questionnaires and the collection of completed questionnaires. Additionally, a note with a brief instruction for teachers is made, including the answers to some questions and confusions that children may have when filling in the questionnaires. The teachers of all classes in grades 5-8 are asked to distribute the questionnaires, preferably in the morning and to have the children fill them in. After this, the children bring them home to have their parents fill in the parent part. Within approximately one and a half week the teachers or the principal collect the completed questionnaires that the children brought back to school and the researcher picks them up from each school. To improve the chances of a sufficient response rate, the principal is asked to send a description of the research, including an explanation of the relevance (written by the researcher), to all parents via e-mail or another digital platform. Principals are also asked to send out a reminder e-mail just before the deadline for submission of the questionnaires. One exception to this procedure is for school De Doornick. The principal of this school indicated that he was interested in participating in the research, but it was not possible to fill in the questionnaires during class. Therefore, the pupils of De Doornick are given the questionnaire to complete it, together with their parents, at home. They then bring the completed questionnaires to hand in at school.

Procedure school interviews

The school variables are derived separate from the child- and parent surveys, namely during interviews with the participating schools. Each of the 15 schools presented in table 6.2 will be approached at school or by telephone to ask them a couple of questions. A short conversation with the principal followed. The decision was made to conduct a structured interview, which is an interview in which all questions are prepared beforehand and are presented in the same order for all schools (Business Dictionary, n.d.). The answer possibilities are pre-determined. This way, the precision and reliability of filling in the results for the school variables are maximized. To allow for some nuances, the questions are presented as open questions, to which the respondent may take some time to formulate an answer. The interviewer and respondent then together choose one of the answer possibilities, based on the answer that has been provided. During the data preparation phase, all school variables per school can be linked to the respondents' data sets. The complete set of questions and answer possibilities can be seen in appendix 3.

Definite sample

All pupils in grades 5-8 in the 15 participating schools receive a questionnaire. As some of the schools indicated that they asked for a few more questionnaires than needed, 3% of the total number of questionnaires will be distracted. This results in a sample of 1431 children that were asked to participate in the research. In the end, 676 questionnaires were collected. Of these respondents, some

were removed due to being unsuitable for several reasons, which resulted in a final sample of 660 respondent. This is a response rate of 46%.

6.3.3 Data reliability & validity

When constructing and distributing the questionnaire, it is important to consider the reliability and validity of the data that will be provided by respondents. This section will discuss the reliability, the internal validity and the external validity of the current study.

Data reliability is about ensuring that the data is as little as possible dependent on coincidence and random errors. The measuring instrument (in this case the survey) should be capable of measuring consistently the factors that it was designed to test (Baarda et al., 2012). It should be possible to interpret the survey results consistently in different situations (Field, Miles, & Field, 2013). Circumstances such as the mood of the respondent, their being confused or distractions should not influence the manner in which respondents answer the questions. To that extent, some provisions have been taken. The children are asked to fill in the questionnaire in the beginning of their day. This way, they are the least likely of being tired or distracted and they probably have not yet forgotten about their trip to school that morning. Furthermore, the teacher is asked to help the children in being concentrated by keeping order. Finally, for the child- as well as the parent survey the questions are formulated as clearly and simple as possible. If respondents can easily understand the questions, they are the least likely to be insecure about their answers or leave questions open. In the formulation of the questions, the following aspects were considered (Baarda et al., 2012):

- Clear and unambiguous language that matches the respondents level of thinking
- Avoid suggestive questions
- Avoid double questions (questions within questions)
- Ask only questions about subjects of which the respondent has sufficient knowledge
- Avoid controversial questions
- The answer possibilities:
    - Exclude each other
    - Are complete

Internal validity is about measuring exactly the aspects that are meant to be measured (Field, Miles, & Field, 2013). An example of poor validity would be if respondents misinterpreted a certain question and provided incorrect answers. This is called a systematic error (Baarda et al., 2012). In the operationalization of the variables for the questionnaire, a big step towards proper internal validity was already made in terms of creating questions and answer possibilities that respondents understand and that are also easy to measure. Although the above mentioned reliability is a condition to achieve validity, it is not a given that the one leads to the other. In other words, special care has to be taken to ensure the best validity. In the operationalization of the variables for the questionnaire, a big step towards proper internal validity was already made. The questions and answer possibilities that were constructed were made understandable for respondents and easy to measure. In the current questionnaire, the two main risks in terms of internal validity are that children or parents misinterpret a question or that they fill in the most socially desirable option. This second problem could occur if, for example, parents always drive their children to school while realizing that they live near school and walking would be healthier, so they dishonestly fill in “walking” as main transport mode.

The risk of misinterpretation was handled by carefully formulating the questions in a way that would not be too complicated for the target group. Furthermore, two pre-tests were done for the child questionnaire and one for the parent questionnaire. In the first pre-test, children and adults were asked to carefully read the questionnaire and point out any unclear parts. In the second pre-test, the

improved questionnaire was given to the test-respondents and they were asked to fill it in as if it was the final version. After completing the questionnaires, they were asked some specific questions to test whether or not they had fully understood the questionnaire. Additionally, thorough care was put into the development of the child questionnaire, which was designed to be understandable and appealing for children. The second risk, the risk of social desirable answers is more difficult to minimize. Two measures were taken. The first was that not only the parents, but also the children were asked to report their transport mode. Children may be less likely to be dishonest about it. The second measure was that parents could fill in the questionnaires at home and, later on, handed them in in enclosed envelopes. This maximizes the anonymity which hopefully leads to parents filling in the questionnaires honestly.

Another important issue to discuss is external validity, or ecological validity as Field, Miles, & Field (2013) call it. They describe ecological validity as the extent to which the results of the research can be considered generalizable and applied to conditions of real situations (Field, Miles, & Field, 2013). The aim, therefore, is to conduct a research of which the results are somewhat generalizable for the travel behavior of children in the entire country. Especially in the current research, which is scientifically relevant due to the added value of having more country specific evidence for the Netherlands, it would be ideal to be able to say the results are applicable for the rest of the country. In the selection of schools that were asked to participate in the study, several criteria were taken into account to stimulate a diversity of environments where respondents live and go to school. These criteria have been discussed in paragraph 6.3.1. By means of a selection of participating schools based on these criteria, to the best effort, the sample is generalizable for the rest of the country. Surveys were distributed among all children in grades five through eight. The children filled in the survey in class, brought it home to their parents and their participation to the study was dependent on whether or not the parents filled in their part of the survey and brought it back to school. This way, all children in the target group had equal chances of participating, their participation was only dependent on the willingness of their parents (and some random factors such as losing or forgetting the survey).

6.4 Statistical data analysis method

The current section will describe the statistical data analysis methods to be used in order to answer the research questions of this study. The statistical data analysis will consist of three steps: 1) bivariate analyses, 2) regression analyses and 3) path analysis.

Step one: Bivariate analyses

In the first step the relationships between all independent variables and the three dependent variables will be investigated. The aim of this step is to test whether there are significant relationships between the dependent variables parental safety perception, travel mode and child subjective well-being and health and the independent variables of the socio-ecological environment. The type of test to be used depends on which measurement level the variables have. The measurement levels of the independent variables are nominal, ordinal and ratio and of the dependent variables the measurement levels are interval and nominal. Depending on the variables, a choice will be made between the following bivariate analysis tests: Cross table with Chi Square, One-way ANOVA, Independent t-test and Pearson or Spearman correlation. After these analyses it will be clear which relationships are significant. Only the independent variables which are significantly associated with one or more of the dependent variables will be included in step two: the linear and logistic regression analyses.

Step two: Linear and logistic regression analyses

In linear and logistic regression analyses, the combined predicting power of the multiple variables can be analyzed (Field, Miles, & Field, 2013). The aim of step two is to find structural relationships and give

insights into the predicted multi-variate relationships between the different layers of the child's environment (personal, household, school, physical-social environment and external) and the dependent variables: concerns of their parents, their school transport mode and their well-being.

For the dependent variables with the measurement level interval, linear regression analysis will be used. Linear regression analysis is a method in which an outcome (in this case for instance the parental attitude towards travel mode) is predicted using a linear combination of several predicting variables. If the strength of the relationship between a certain predicter and the dependent variable that the linear regression analysis measures is significant, then it can be said that this predicter significantly predicts the outcome. This method allows multiple predicting variables to be added in a model and it continually evaluates whether variables in the model still contribute significantly to the outcome prediction relative to other variables' contribution (Field, Miles, & Field, 2013). As the relationships between the independent variables and the nominal dependent variable travel mode are not linear, linear regression analysis is not an option in this case. Therefore, a multinomial logistic regression model will be applied to study the predicting power of the independent variables for travel mode. This type of model is a version of multiple regression in which the dependent variable is categorical (nominal) (Field, Miles, & Field, 2013). As the data are most likely partly dependent on the different schools, a multilevel analysis approach will be used, which will be further explained in chapter nine.

Step three: Path analysis

In step three, the last step, a path analysis will be conducted. As described by Ho (2014), path analysis is often used in combination with a certain theory of causality and has as an aim "describing the entire structure of linkages between independent and dependent variables posited from that theory" (Ho, 2014, p.317). Only the variables that have been found to have significant predictive power in the linear regression and multinomial logistic regression models will be included in the path model. The path analysis makes it possible to measure the independent variables, while also looking at the relationship between the dependent variables. This way, direct as well as indirect relationships are looked into. The path analysis removes the relations that are not significant considering the construction of the entire model. Using the path analysis the main research question can be answered.

6.5 Conclusion

This chapter has described the methodology for the current research. The goal of the research is to gain understanding on the relationships between factors of children's socio-ecological environment and their school travel mode, the concern of their parents about travel modes and their well-being. Additionally, the mediating relationships of the dependent variables will be analyzed.

To this extent, the current chapter has described the conceptual model and operationalization of all variables. The model consists of 39 independent variables and the 3 dependent variables are built-up of several sub-variables, from which a selection will be made after having conducted bivariate analyses. In the operationalization, the variables were translated into clear and measurable questions and answer categories to be used in the questionnaire. The questionnaire included a separate section to be filled in by children and by their parents. The questionnaire has been distributed among children attending grades five, six, seven and eight (aged 7-12) of primary school in the Netherlands at 15 carefully selected schools. In the end, 676 children and their parents have handed in their completed surveys, of which 660 were usable for the research. In preparation for the survey distribution, several measures have been taken to maximize reliability and validity. The responses to the survey will be analyzed using bivariate analyses, regression analyses and in the end a path analysis will be constructed and analyzed. The following chapters will describe the collected data (chapter seven) and the results of the data analyses (chapters eight, nine and ten).

CHAPTER 7

DATA DESCRIPTION

Drawing by Desiree & Amber van de Craats, 2018

7. DATA DESCRIPTION

In this chapter, the data derived from the child- and parent surveys, from the school interviews and from the CBS database are described. The characteristics of the sample in terms of the four socio-ecological factors are described. The total sample, the group of respondents that have adequately completed and handed-in both surveys, consists of 676 children. 17 completed surveys were removed from the sample due to a large amount of missing answers, a confusing manner of filling in the answers or an overall incorrect manner of answering the survey (appendix 4). The data gathered from the school interviews with the principals were linked to the respondents attending that particular school. Furthermore, the data derived from the CBS database were linked to the respondents via their postal code. This resulted in a complete profile for every respondent. The current chapter will describe the data for all independent variables and the dependent variables. An overall description of how the data was prepared for the research (replacing missing values and recoding) can be found in appendix 5.

7.1 Personal factors

This section will describe the characteristics of the respondents in the category personal factors. In table 7.1 the personal factors of the respondents are presented. These are the variables in the personal layer of the socio-ecological environment.

Table 7.1 Description sample - personal factors

Personal factors	N in Sample	% of Sample	Measurement level
Age			
7	27	4.1	Ratio
8	140	21.2	
9	180	27.3	
10	155	23.5	
11	132	20.0	
12	26	3.9	
Grade			
5	160	24.2	Ordinal (4 groups)
6	169	25.6	
7	170	25.8	
8	161	24.4	
Gender (N=656)			
Boy	315	48	Nominal (2 groups)
Girl	341	52	
Travel mode preference			
Bicycle (including kick-bike & space scooter)	331	51.2	Nominal (4 groups)
Walking (including skeelers)	117	17.7	
Car	119	18	
Other (including back of bike and PT)	86	13.0	
Preference for active/passive			
Active travel (Bicycle and walking)	455	68.9	Nominal (2 groups)
Passive travel (Car and other)	205	31.1	
Actual vs. preferred mode			
Match	268	40.6	Nominal (2 groups)
No match	392	59.4	

Age, grade and gender are quite equally distributed. Only the seven-year-olds and the twelve-year-olds are less common. It may be that these children skipped or repeated a school year or just have their birthdays a little earlier or later than most children. As can be seen in table 7.1, there are four missing values for gender. This is the case because it would not be logical to simply replace these by the most common gender and there was no way to assume which gender would be most likely. A little over half of the children prefer the bicycle or kick-bike over all other modes, only 18% of the children see the car as their favorite mode. The category 'other' contains almost only passive modes, except for the eight children that filled in 'skate board'. Overall, active travel is preferred over passive travel by nearly 69% of the respondents. These categories were created by combining walking and cycling as active mode preferences and car and other as passive mode preferences. A little over 40% of the children used their preferred mode of transport on the day of the questionnaire. Some fun facts concerning the favorite transport modes and the category "other": nine children would want to go flying to school (either by airplane, jetpack, parachute or privet jet) and eight children preferred the skateboard. Two children would want to go by horse if they could choose and one child was particularly creative, wanting to walk on top of his or her dogs.

7.2 Household factors

This section will describe the characteristics of the respondents and their households in the category household factors. In terms of work status, most household reported to be a two wage-earner household (69.2%). Only 8% reported that they were seeking employment or were in another situation such as retirement or unpaid work. The largest share of respondents report their household as having a yearly income similar to the average Dutch household (43.3%). A little less respondents (38.2%) have a higher income than average and only 18.5% report to have a lower income than average. Almost 80% of the sample is of Dutch ethnicity, the second largest group is of both Dutch and non-European ethnicity (9.2%%). Only 7.9% of the sample does not own a car, almost half (44.2%) has one car and a little more (47.9%) has two or more cars.

Table 7.2 Description sample – parental work, household income, household ethnicity, car ownership

Work, income, ethnicity, cars	N in Sample	% of Sample	Measurement level
Household work status			
Two wage earner household	457	69.2	Nominal (3 groups)
One wage earner household	150	22.7	
Seeking employment or other	53	8.0	
Household income			
More than average Dutch income	252	38.2	Ordinal (3 groups)
Equal to average Dutch income	286	43.3	
Lower than average Dutch income	122	18.5	
Household ethnicity			
Dutch	522	79.1	Nominal (5 groups)
Dutch-European	18	2.7	
Dutch-non-European	61	9.2	
European	8	1.2	
Non-European	50	7.6	
Car ownership			
No car	52	7.9	Ordinal (3 groups)
One car	292	44.2	
Two or more cars	319	47.9	

Table 7.3 shows the household composition distribution of the sample. The largest group consists of households with two parents and at least two children (75.6%). After that, the single parent household with several children is the largest group (11.4%). This is fairly in line with the division in household sizes, the largest group is the group of four person households, exactly 50%. After that are the five person households (22.1%) and the three person households (16.4%). There are about twice as many six person households as there are two person households.

Table 7.3 Description sample – Household composition

Household composition	N in Sample	% of Sample	Measurement level
Household composition			
One parent – only child	25	3.8	Nominal (4 groups)
One parent – sibling(s)	75	11.4	
Two parents – only child	61	9.2	
Two parents – sibling(s)	499	75.6	
Household size			
2	25	3.8	Ordinal (5 groups)
3	108	16.4	
4	330	50.0	
5	146	22.1	
6+	51	7.7	

Table 7.4 shows that about half of the children in the sample never goes to daycare. This variable measures the frequency of attending before school care and after school care summed. About 31% of the children goes to daycare once per week and 19.2% goes more than once per week.

Table 7.4 Description sample – Daycare attendance

Daycare attendance	N in Sample	% of Sample	Measurement level
Never	327	49.5	Ordinal (3 groups)
Once per week	206	31.2	
More than once per week	127	19.2	

The next variable is the parental work commute. For this variable, two different items were computed in SPSS. One is the frequency that parents use the car, divided in different categories, and the other is the frequency that parents use an active transport mode. For households with two parents, the frequencies of using the transport modes were summed for both parents. For example, both parents using the car twice means 4 days of car use. Table 7.5 shows that about half of the parents uses the car 4-5 or 6-8 times weekly. Also about half of parents never travels with an active transport mode.

Table 7.5 Parental work commute

Work commute	N in Sample	% of Sample	Measurement level
Car use frequency			
Never	113	17.1	Ordinal (3 groups)
1-3 days	112	17.0	
4-5 days	214	32.4	
6-8 days	156	23.6	
More than 8 days	65	9.8	
Active travel frequency			
Never	327	49.5	Ordinal (3 groups)
1-4 days	206	31.2	
More than 4 days	127	19.2	

In the questionnaire parents were presented with a list of ten possible motivations to choose car travel or active travel as transport mode to school for their children. The parents were asked to report to what extent the different motivations were important for them to choose either the car or active travel for their children. Strongly disagreeing indicates a motivation is not important for that travel mode. Many parents also left open some motivations, usually indicating that the motivation is not applicable (for example when the child never travels by car, the car motivation statements were left open). Figures 7.1 and 7.2 show the distributions of the answers filled in by the parents. At first sight, looking at figure 7.1, it is noticeable that more parents have filled in the motivations for active transport than for car travel. This is in line with the fact that more children overall travel by active transport modes (which will be presented further on). Both transport modes are often chosen by parents due to being the most convenient. Active travel is by almost all parents seen as the best way to travel. Next, proportionally about the same share of parents agree that car and active travel are the safest way to travel. Active transport is more often seen as the most suitable transport mode considering the age of the child and it is also most often preferred by children. However, also a large share of parents indicate that they bring their children to school by car because this mode is preferred by the child.

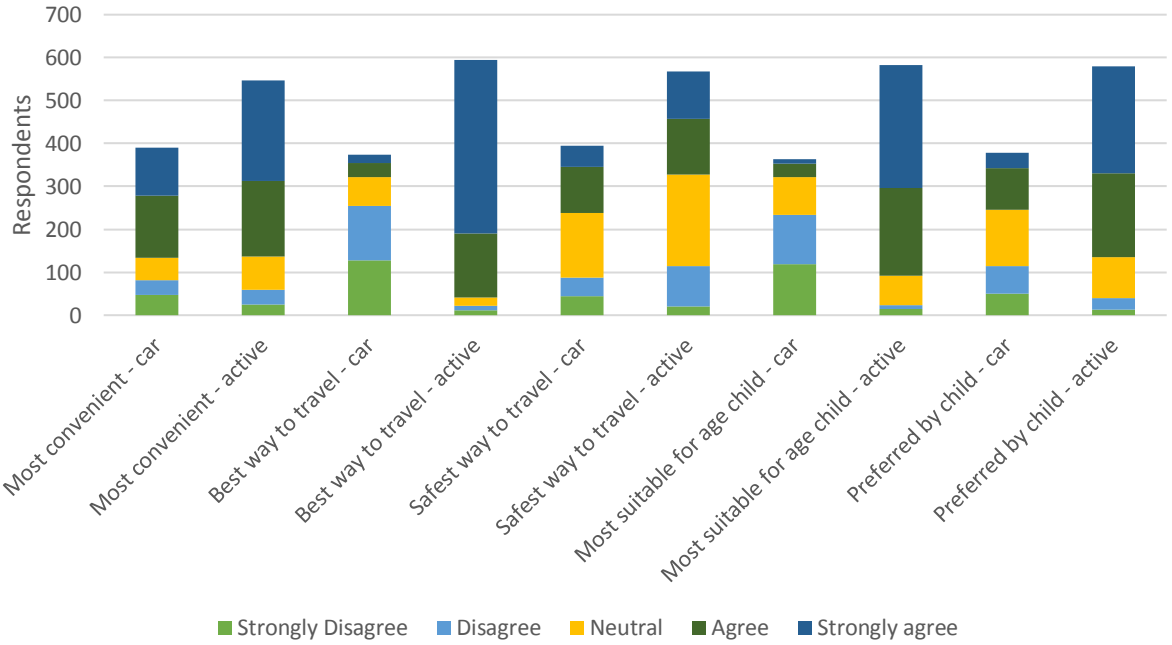


Figure 7.1 Parental school travel mode motivation – 1

Moving on to figure 7.2. Stimulation of the school for a certain travel mode is only relevant in some cases for choosing the bicycle, it does not seem to have an effect on the decision to travel by car. Active transport is much more often seen as most suitable considering the distance to school, probably because many children live close to school. The weather is equally important for choosing the car and the bicycle, which makes sense because good weather makes active transport more attractive and vice versa. If most other parents choose active travel as school transport mode, this is a motivation for quite a lot of parents in the current study to also use active transport modes for their children. This motivation is less important for the car; not so many parents take their children to school by car because other parents do so. Nevertheless, this difference probably also has to do with more parents choosing active travel as transport mode overall. Finally, not many parents agree with the fact that there is no specific reason to choose a transport mode, which indicates that most parents have certain motivations for choosing a transport mode.

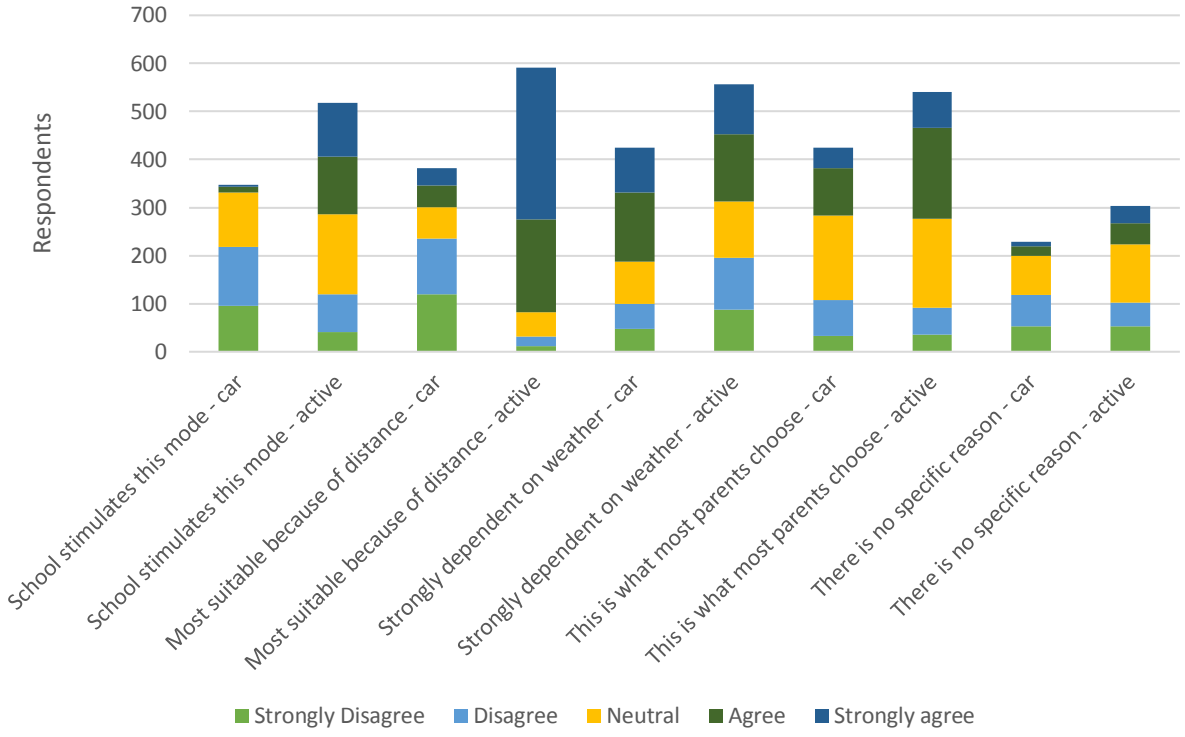


Figure 7.2 Parental school travel mode motivation- 2

7.3 School factors

This section will describe the data in terms of the school factor variables. Although 15 schools agreed to participate in the current study and distributed questionnaires among their students, one of the schools (De Witte Vlinder) did not receive any completed questionnaires from the parents in their school. Therefore, the respondents in this study attend 14 different schools.

Table 7.6 Distribution of respondents over the 14 participating schools

Participating schools	# in sample	% of sample	Measurement level
Enrollment to school			
OBS Da Vinci Arnhem	63	9.5	Nominal (14 groups)
Daltonschool Confetti	69	10.5	
ASV	21	3.2	
SBO De Piramide	31	4.7	
IKC De Klimboom	37	5.6	
Lea Dasbergschool	100	15.2	
Heijenoordschool	22	3.3	
De Zyp	70	10.6	
Mariënbornschool	53	8.0	
Bernulphusschool	66	10.0	
SBO De Klaproos	47	7.1	
De Doornick	47	7.1	
Prinses Beatrixschool	20	3.0	
Basisschool Kunstrijk	12	1.8	

As can be seen in table 7.6, some schools received a very large amount of questionnaires, the largest group of respondents attends the Lea Dasbergschool and also many respondents attend De Zyp, Daltonschool Confetti and the Bernulphusschool. This high response is partly due to these schools simply being larger: Lea Dasbergschool is the largest school in the sample. However, when looking at

the response rate per school, which takes their size into consideration, OBS Da Vinci Arnhem (67%), Bernulphusschool (58%), Lea Dasbergschool (58%) and Heijenoordschool (61%) have the highest response rate. This most likely has to do with the extent to which parents are involved and participate in the school and the extent to which parents see and experience the relevance of the problems considering health and traffic safety for children.

Table 7.7 describes the different school factor variables and how the respondents are distributed among the categories of these variables. The table also shows how many schools fall within each category of the variables. Most children in the sample attend a public school (44.4%) or a school with a religious background (22%), which is in practice quite similar to a public school. Interestingly, also a fair share of children attend a school with a Dalton education vision (18.5%) and a special education school (11.8%). Special education schools are for children that need special attention because they face extra challenges in learning and developing. Most respondents have lunch at school daily (92%). This is because 13 of the 14 schools have a continuous school schedule (lunch at school three or four days, one or two afternoons free from school) or a five equal days schedule (lunch at school five days, finish at 14:00 daily). Of the respondents, 12.7% attend a school that falls under the category 'small'. This is quite a low percentage, but it makes sense that smaller schools provide smaller numbers of respondents. Most respondents (58.3%) attend a school that is considered of average size. 28.9% of the respondents attend a large school. This division is rather similar when looking only at the amount of pupils in grades 5-8 that a school has. Due to the different types of school schedules and the fact that even within these types the school times may differ, the respondents finish school at five different times in the afternoon. The most common is at 14:45, which counts for 36.5% of the respondents. 15:00 is the least common, only 4.7% of the children finish school at that time. The different school schedules come with one, two or no afternoons per week that the child is free from school. About half of the children participating in the current study have one afternoon free, more or less a quarter has two afternoons free and another quarter has school daily including (part of) the afternoon.

Table 7.7 Description variables several general school factors

General school factors	N respondents	N schools	% of sample	Measurement level
School type				
Public school	293	5	44.4	Nominal (7 groups)
School religious background	145	4	22.0	
Dalton school	122	2	18.5	
Jenaplan school	22	1	3.3	
Special education	78	2	11.8	
Lunch at school				
Yes	607	13	92	Nominal (2 groups)
No	53	1	8	
Amount of pupils school				
Small school (<150)	84	4	12.7	Ordinal (4 groups)
Average school (150-300)	385	7	58.3	
Large school (>300)	191	3	28.9	

General school factors	N respondents	N Schools	% of sample	Measurement level
Amount of pupils grades 5-8				
Small (<90 pupils)	109	5	16.1	Ordinal (4 groups)
Average (90-130)	298	5	42.1	
Large (>130)	275	4	48.1	
End of school day - time				
14:00	176	3	26.7	Nominal (5 groups)
14:30	159	3	24.1	
14:45	241	6	36.5	
15:00	31	1	4.7	
15:15	53	1	8.0	
Number of free afternoons				Measurement level
No free afternoons	176	3	26.7	Ordinal (3 groups)
One free afternoon	315	9	47.7	
Two free afternoons	169	2	25.6	

Table 7.8 shows the amount of time spent on physical activity (PA) for the respondents. This amount is built up from the minutes per week spent on physical education lessons and the minutes per week spent on playing (outside) during breaks. Most respondents (42,7%) attend a school that ensures the highest category of minutes spent on PA weekly. The others receive the more average amount of minutes PA (29.4%) and the smaller amount of minutes PA (27.9%). The categories in this table are only to describe the data concerning physical activity in school, the exact number of minutes will be used in the calculation of overall physical activity, which will be described further on.

Table 7.8 Physical education and traffic education

Physical activity	N Respondents	N Schools	% of sample	Measurement level
Amount of physical activity				
Fewest minutes PA (<225 minutes)	184	3	27.9	Ordinal (3 groups)
Average minutes PA (225-275 minutes)	194	4	29.4	
Most minutes PA (>275 minutes)	282	7	42.7	

Table 7.9 is about whether or not and to what extent schools spend time on health- and active travel-related initiatives. Roughly the same amount of children attend a school that has only a few health-related initiatives a year, a school that has a substantial amount of initiatives per year and a school that also has a year-round special focus on health. This last category of schools does not necessarily have more activities than the second category, but they have an additional health focus which is rooted in their education vision. For example, they change classrooms after every lesson or they go outside during lessons as much as possible, to keep the children moving. The health-focus of schools was also measured in a different way, namely by looking at the absolute amount of initiatives and activities yearly. The largest share of children (42%) attend a school with 4-5 yearly health related activities. A little less children attend a school with 2-3 (32.4%) or 6-7 (25.6%) activities. Not many schools actively promote active travel to school, only 10.5% of the respondents attend a school where active travel is actively promoted. In some schools, promotion of active travel took place by asking parents in the weekly school newsletter to bring their children by foot or by bicycle to school. Another example is a school that tracked active travel participation for every class and visualized this in the form of a board or poster in the classrooms with stickers of 'green feet' for every child that came to school by an active travel mode.

Table 7.9 Health and active travel initiatives

Health and active travel initiatives	N Respondents	N Schools	% in sample	Measurement level
Health-related initiatives (attitude)				
Few initiatives (2-3)	214	4	32.4	Ordinal (3 groups)
Substantial amount of initiatives (5-6)	255	5	38.6	
Special focus on health (5-7)	191	5	28.9	
Health-related number of activities				
2-3	214	4	32.4	Ordinal (3 groups)
4-5	277	8	42.0	
6-7	169	2	25.6	
Active travel-related initiatives				
Yes	69	3	10.5	Nominal (2 groups)
No	591	11	89.5	

Principals of the participating schools were asked to give their opinion on the traffic safety and the quality and capacity of car parking quality and bicycle parking at their schools. Figure 7.3 shows that around 30% of the respondents attend a school for which the traffic safety was rated insufficient. Furthermore, only about 10% of the respondents attends a school where traffic safety was rated as good by the principal. Car parking quality for the respondents' schools was rated mostly as mediocre (about 40%) and as sufficient (about 35%). Bicycle parking was mostly rated as sufficient (nearly 50%), for about 25% of respondents bicycle parking was rated good.

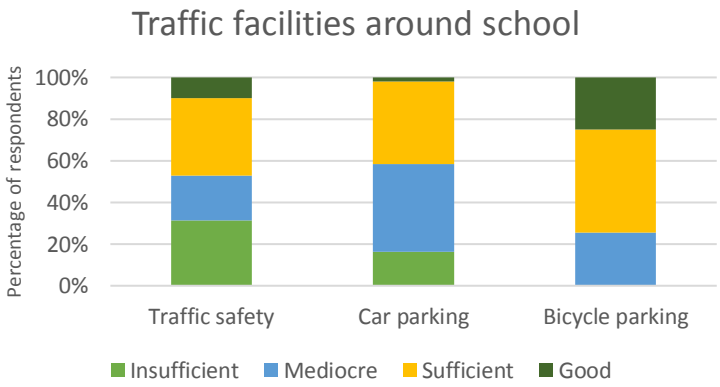


Figure 7.3 Traffic-related safety and quality around school (bike facilities, car facilities, overall safety)

In table 7.10 it can be seen that about half of the respondents attends a school that actively aims to decrease (problems resulting from) car travel around their school. Only 7.1% attends a school that uses traffic safety measures such as crossing guards during bringing and/or getting times.

Table 7.10 Traffic safety measures

Traffic safety measures	N Respondents	N Schools	% in sample	Measurement level
Actions to decrease car travel				
Yes	327	8	49.5	Nominal (2 groups)
No	333	6	50.5	
Use of traffic safety measures				
Yes	47	1	7.1	Nominal (2 groups)
No	613	13	92.9	

7.4 Physical and social environment

This section describes the data for the physical and social environment. These data are partly collected from the questionnaires and partly from CBS. Table 7.11 shows that the respondents are quite evenly distributed over the different distances they live from school. Only the category 5 km and more is not as well represented (8%). This makes sense, as the distance to primary school in the Netherlands is generally not so large. Only 20.3% of the children attend a school which has a separate bicycle lane connection. Almost all children attend a school which is located in a 30km/h zone. The urban density levels of the neighborhoods where respondents live are, as can be seen in the table, quite normally distributed. However, density level 5 will be merged with 4 and 1 will be merged with 2 for the analyses, for a more equal distribution. Most respondents (42.9%) live in a neighborhood with a density of 1000-1500 addresses/km^2. Almost half of the parents (47.4%) agree that there are several routes for their child to travel to school, indicating good connectivity. Finally, the length of residence in the current home is fairly well distributed among respondents, although quite a large group already lives in the same house for 10-15 years (33.6%).

Table 7.11 Description sample – general physical environment factors

General physical environment factors	N in sample	% of sample	Measurement level
Travel distance			
< 500 m	145	22.0	Ordinal (5 groups)
500 – 1000 m	190	28.8	
1 – 2 km	172	26.1	
2 – 5 km	100	15.2	
> 5 km	53	8.0	
Separate bicycle lane			
Yes	134	20.3	Nominal (2 groups)
No	526	79.7	
Speed limit			
30 km/h	629	95.3	Ordinal (2 groups)
50 km/h	31	4.7	
Urban density			
1 (> 2500 addresses/km^2)	31	4.7	Ordinal (5 groups)
2 (1500 - 2500 addresses/km^2)	170	25.8	
3 (1000 – 1500 addresses/km^2)	283	42.9	
4 (500 – 1000 addresses/km^2)	105	15.9	
5 (< 500 addresses/km^2)	71	10.8	
Connectivity	N in sample	% of sample	Measurement level
"There are different routes in our neighborhood that my child can take to come to school"			Ordinal (3 groups)
(strongly) Disagree	173	26.2	
Neutral	174	26.4	
(strongly) Agree	313	47.4	
Length of residence			
<2 years	84	12.7	Ordinal (5 groups)
2-5 years	112	17.0	
5-10 years	141	21.4	
10-15 years	222	33.6	
>15 years	101	15.3	

Table 7.12 Description sample – general physical environment factors

Land-use properties	N in sample	% of Sample	Measurement level
% land used for recreation			
0-2.5%	158	23.9	Ordinal (5 groups)
2.6-5%	133	20.2	
6-10%	192	29.1	
11-20%	125	18.9	
21+%	52	7.9	
% land used for green/nature			
0%	277	42.0	Ordinal (3 groups)
1-10%	220	33.3	
11+%	163	24.7	

In terms of land-use properties, the distributions are quite fairly spread, see table 7.12. 23.9% of the respondents live in an area with very little land used for recreation. The share of respondents living in areas which are more densely filled with recreation purposes are about the same size per category. Only for the largest share of recreation, which is over 20% of land used for recreation, the group becomes smaller (7.9%). Overall, there is less land used for green and nature purposes than for recreation in Arnhem and surroundings. For this reason, the categories are defined in a different way. In fact, 42% of the respondents live in an area with no land used for green or nature purposes in the neighborhood. One third of the respondents live in a neighborhood with 1 – 10% of the land used for green and the rest (24.7%) live in a neighborhood with more than 10% green and natural land-uses.

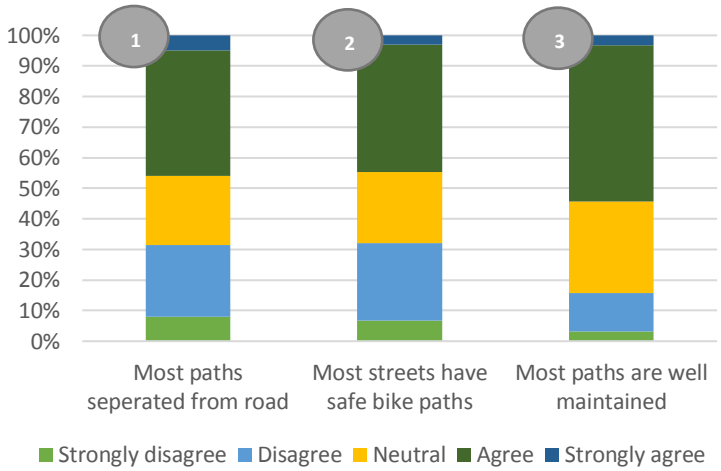


Figure 7.4 Bicycle and pedestrian infrastructure perception (based on three statements)

In figure 7.4 the opinion of respondents about bicycle paths and pedestrian paths is visualized. This was measured by presenting the respondents with three statements which can be read in the figure, below the bars. Respondents are fairly positive about the paths, they are most positive about how well the paths are maintained. About 30% of the respondents is unsatisfied about the safety of the paths and indicates that they are not separated from the main road. Using SPSS, one variable was computed which is the mean of the second and the third statement about the paths. A Cronbach's Alpha Reliability analysis was conducted, which indicated that the first statement is less correlated with the second and third statement. It would be better to only combine the second and third statement, which resulted in a Cronbach's Alpha of 0.655 and an inter-item correlation of 0.494, indicating moderate to good internal consistency and correlation. The combination of statement 2 and 3 leads to an overall bike and walking infrastructure variable, which is an indicator of the parents' perception of the safety and maintenance of the infrastructure.

Table 7.13 Description sample – general social environment factors

General social environment factors	N in sample	% of Sample	Measurement level
Neighborhood SES (% hh low income)			
0-20%	130	19.7	Ordinal (5 groups)
21-30%	140	21.2	
31-40%	183	27.7	
41-60%	135	20.5	
61+%	72	10.9	
% households with children			
0-25%	83	12.6	Ordinal (4 groups)
26-30%	193	29.2	
31-45%	276	41.8	
46+%	108	16.4	
Contact with children in neighborhood			
"My child has a lot of contact with other children in the neighborhood"			
(strongly) Disagree	92	13.9	
Neutral	159	24.1	
Agree	307	46.5	
Strongly agree	102	15.5	

Table 7.13 shows the largest group of respondents (27.7%) lives in a neighborhood with 31-40% households with a low income and the groups of respondents living in more and less wealthy neighborhoods are of about the same size. Over a third (41.8%) of the respondents live in a neighborhood with 31-45% households with children. Only 12.6% live in a neighborhood with 25% or less households with children. Partly in line with this is the fact that over half of the respondents indicate that their children have a lot of contact with other children in the neighborhood.

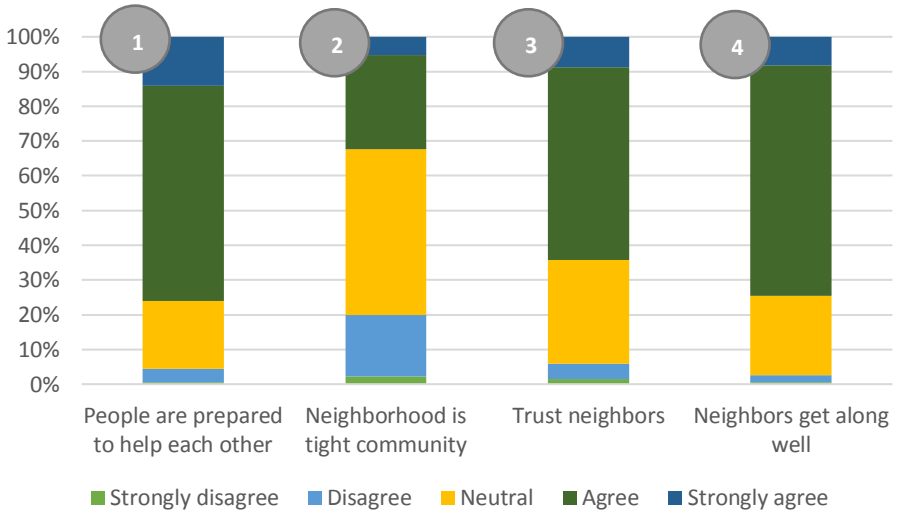


Figure 7.5 Perception of social cohesion (based on four statements)

Figure 7.5 visualizes the answers that people gave to the questions about social cohesion in the neighborhood, based on the four statements presented in the figure, below the bars. Almost all respondents indicate that they live in a neighborhood where neighbors are prepared to help each other. Furthermore, over half of the respondents trust their neighbors and indicate that they get along well. The second statement, about the neighborhood functioning as a tight community, is answered somewhat differently. Most respondents (about 50%) indicate that they are neutral about this, it

appears that they are not quite sure. However, about 30% indicates that they do feel like the neighborhood is a tight community. The four social cohesion statements were tested for internal consistency, the reliability analysis in SPSS resulted in a Cronbach's Alpha of 0.827. This value indicates that the four variables can be merged into one social cohesion variable. This final social cohesion variable represents the mean of the responses given to the four social cohesion statements. The variable social cohesion is an indication of the perception that respondents have of the social cohesion in their neighborhood, in terms of helping, being a community, trust and getting along.

7.5 External factors

This section will describe the data concerning the external factor. There is only one external factor which will be considered in the current research: the weather. Originally, the weather was to be measured in two different questions of the questionnaire. However, the question in which parents were asked to indicate to what extent the weather is an important factor in deciding whether or not to let their child go to school by an active transport mode or by car, had a very large amount of missing values. For this reason, it was decided not to use this as a measurement for the importance of the weather as independent variable. The question answered by the children, where they had to describe the weather of that particular day by choosing from five different options, will be used to represent the variable weather. As can be seen in table 7.14, most children went to school on a sunny but cloudy day (42.7%) or a completely cloudy day (37.4%).

Table 7.14 Description sample – weather

Weather	N in Sample	% of Sample	Measurement level
Weather today			
Sunny	57	8.6	Ordinal (4 groups)
Sun and clouds	282	42.7	
Clouded	247	37.4	
Raining	72	10.9	

7.6 Dependent variables

In this section, the data used to represent the dependent variables will be described. The dependent variables are parental safety perception, transport mode and subjective well-being and health. All dependent variables consist of several sub-variables. The reason for this is to increase the possibilities in the search for how all independent and dependent variables are interrelated. Eventually, a selection will be made for which sub-variables will be representing the three dependent variables. The distribution of the data for all the different sub-variables will be described in the following sections.

7.6.1 School transport mode

This section will elaborate upon and describe the data on the school travel mode of the children in the sample. The school travel mode has been operationalized in a couple of different ways to form several sub-variables. The first is visible in the pie chart of figure 7.6, which represents the distribution of travel modes that children used on the day they completed the questionnaire. Almost half of the children used the bicycle to get to school. Around 20% used the car and about the same percentage of children walked to school. Only a small amount of children came to school by public transport or on the back of a bicycle. 6% came by another mode. Most of these can be assigned to the transport mode taxibus. The taxibus is a transport mode organized by the municipality, especially for children attending special education schools. These children generally live further away from school, not within cycling distance. For the analyses, the decision was made to create fewer categories, as some categories are very small. Therefore, both public transport and the back of the bicycle were recoded to belong to 'other'.

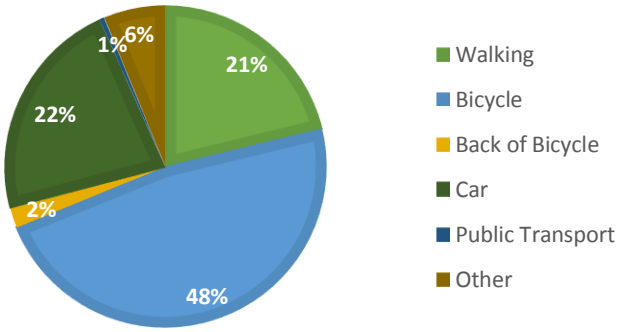


Figure 7.6 Travel mode on day of survey

The child's school transport mode was measured in one other question. Parents were asked to indicate how many trips per week their child made to and from school by the different possible transport modes. From this data, five different variables were computed in SPSS, making it possible to investigate which type of operationalization suits the analyses best. The data distribution for all five variables is presented in table 7.15. The sub-variables are about frequency of using the bicycle, going by foot and going by car and the balance between active and passive transport participation. 28.2% of the children in the sample always go to school by bicycle and do not use any other transport modes. 24.5% of the children go to or from school at least four times per week by foot. Almost the same percentage of children (25%) go to or from school at least four times per week by car. When looking at the division between active school travel and passive school travel, it becomes visible that half of the children go to school (almost) always by an active transport mode. Children for which the parents indicated that they go to school, for instance, once per week by car were considered to (almost) always go to school by an active mode. 16.8% of the children go more often to school by active modes than by passive modes, but they do go some days by passive modes. 12.9% of the children go to school by a passive transport mode (almost) daily. When only considering whether more active trips or more passive trips occur per week, it becomes visible that 24% of the children have more passive trips weekly and 76% have more active trips. This last variable has 13 missing values because there are 13 children that make exactly as many active trips as passive trips to school per week.

Table 7.15 School transport mode frequencies

School transport mode frequencies	# in sample	% of sample	Measurement level
Always cycle to school			
Yes	186	28.2	Nominal (2 groups)
No	474	71.8	
Go by car 4+ times			
Yes	165	25.0	Nominal (2 groups)
No	495	75.0	
Go walking 4+ times			
Yes	162	24.5	Nominal (2 groups)
No	498	75.5	
Active vs. passive five categories			
(almost) Always passive	85	12.9	Ordinal (5 groups)
More passive	43	6.5	
(almost) Equal	86	13.0	
More active	111	16.8	
(almost) always active	335	50.8	
Active vs. passive (N=647)			
More passive	155	24.0	Nominal (2 groups)
More active	492	74.5	

7.6.2 Subjective well-being and health

In this section the data concerning the subjective well-being and health of the children in the sample will be described.

Mood/happiness & health

Figure 7.7 shows the division of how parents judge their children's health. As can be seen, only a small share of parents (4%) judge their children's health as average. Less than 1% judge their child's health as below average. All others chose good (49%) to very good (47%) health. Figure 7.8 shows the mood or happiness level of the children on the day of the questionnaire. Almost half of the children report being happy, about a quarter report being very happy. 30% of the children were average to unhappy on the day of the questionnaire. Less than 1% was very unhappy.

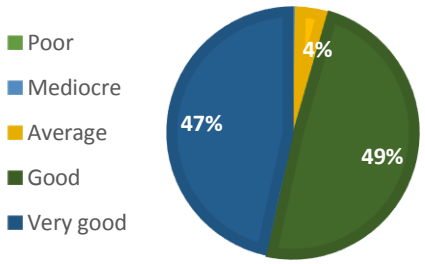


Figure 7.7 Parent assessed health

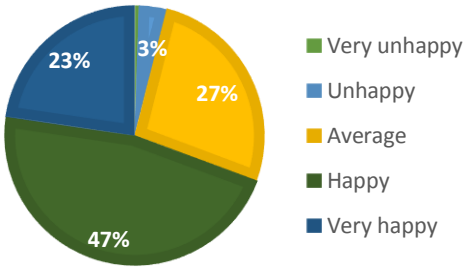


Figure 7.8 Mood/happiness of child

Social contacts

The social contacts that children have on the way to school have been operationalized in several ways, all of which are presented and visualized in this section. Table 7.16 shows that the largest share of children traveled either alone to school (23.5%) or with a parent and sibling(s) (26.7%) on the day of the questionnaire. Furthermore, in the variable trip interaction, over half of the parents indicate that children often meet other children on the way to school. For further analyses, the decision was made to combine the groups strongly disagree and disagree to create more equal groups. Figure 7.9 visualizes the frequencies that children travel with different relations to school.

Table 7.16 Social contacts on trip

Social contacts on trip	# in sample	% of sample	Measurement level
Trip companions			
Alone	155	23.5	Nominal (5 groups)
With sibling	48	7.3	
With friend/classmate	79	12	
With parent	161	24.4	
With parent and sibling(s)	176	26.7	
With other combination of people	41	6.2	
Trip interaction			
"On the way to school, my child often runs into other children"			Ordinal (5 groups)
Strongly disagree	20	3.0	
Disagree	75	11.4	
Neutral	122	18.5	
Agree	369	55.9	
Strongly agree	74	11.2	

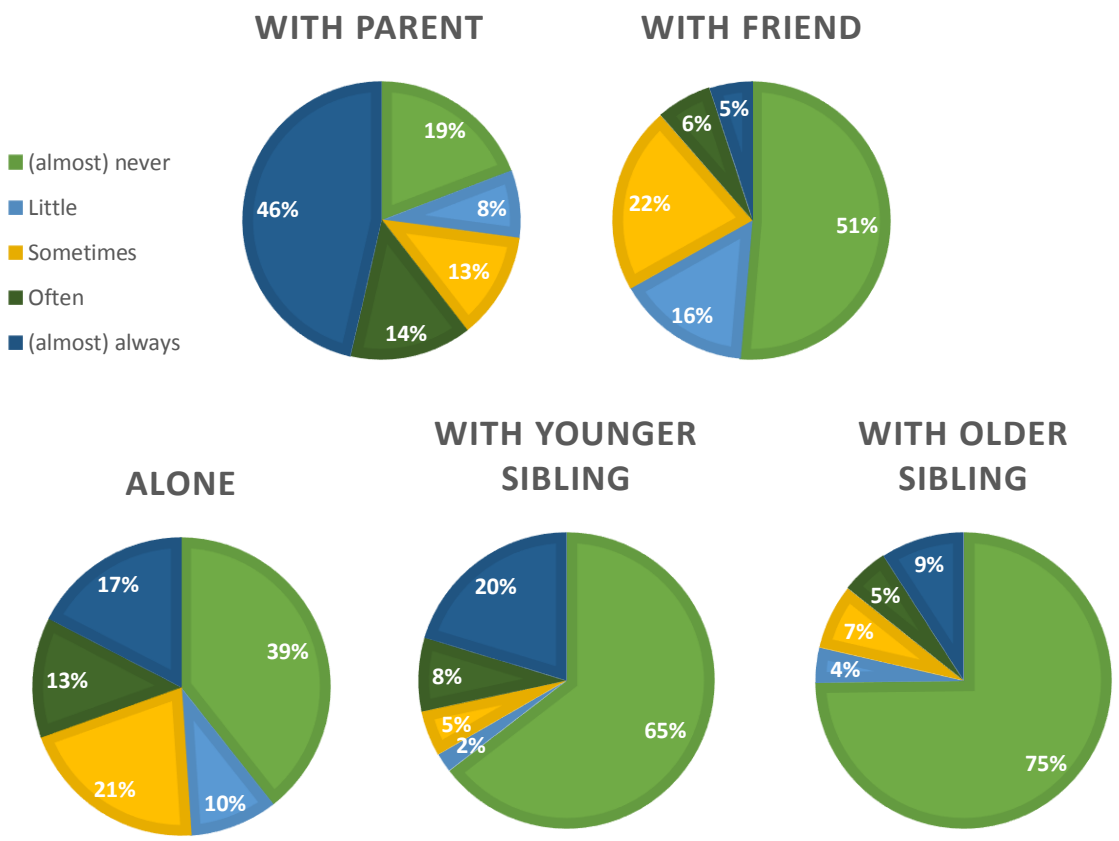


Figure 7.9 Companions on trip to school

As can be seen in the pie charts of figure 7.9, in an average week almost half of the children travels to school with a parent daily. Only 19% almost never travels with a parent. Traveling with an older sibling happens the least: 75% almost never travels with an older sibling. While also 65% almost never travels with a younger sibling, 20% does almost always travel with a younger sibling. About half of the children travels alone at least sometimes, 17% nearly always. Only about 10% travels often or nearly always with a friend, half almost never travels with a friend. This sub-variable will not be included in the bivariate analyses.

Weekly physical activity

Also the number of hours that a child experiences physical activity is a part of the health of children. This variable is calculated by summing the time children spend cycling and walking to school, the time they are physically active in school and the time they are physically active in their free time. Although the variable will be used as an interval/ratio variable in further analyses, table 7.17 gives an insight into roughly how many hours of physical activity children get in their free time. Most children experience 5-10 or 10-15 hours of physical activity in the free time. This is experienced through playing outside, going to sport's clubs, cycling and walking to other destinations than school, etc. A little over 10% of the children even gets more than 20 hours of physical activity in their free time per week.

Table 7.17 Average weekly physical activity in free time

Physical activity in the free time	# in sample	% of sample	Measurement level
0-5 hours	108	16.4	Ordinal (5 groups)
5-10 hours	208	31.5	
10-15 hours	189	28.6	
15-20 hours	88	13.3	
>20 hours	67	10.2	

The ratio/interval variable weekly physical activity overall can now be calculated from the different input variables. The mean of this variable is 969 minutes, which is roughly 16 hours per week. The World Health Organization recommends at least sixty minutes of moderate to vigorous physical activity, which is equal to 7 hours per week. In the current study, only 2.7% does not meet this recommendation.

Satisfaction with travel

The next variable to measure subjective well-being and health is the Satisfaction With Travel (SWT) scale, which consists of nine statements, scoring a value between one and five. The mean of the values of these statements would normally results in four variables; one complete SWT variable and three separate, the SWT cognitive (SWT-C), the SWT negative deactivation and positive activation (SWT-NDPA) and the SWT positive deactivation and negative activation (SWT-PDNA). However, Cronbach's Alpha analyses revealed that by far the complete combination of statements would be the most reliable variable. When looking at the subsets of statements the internal consistency is not good.

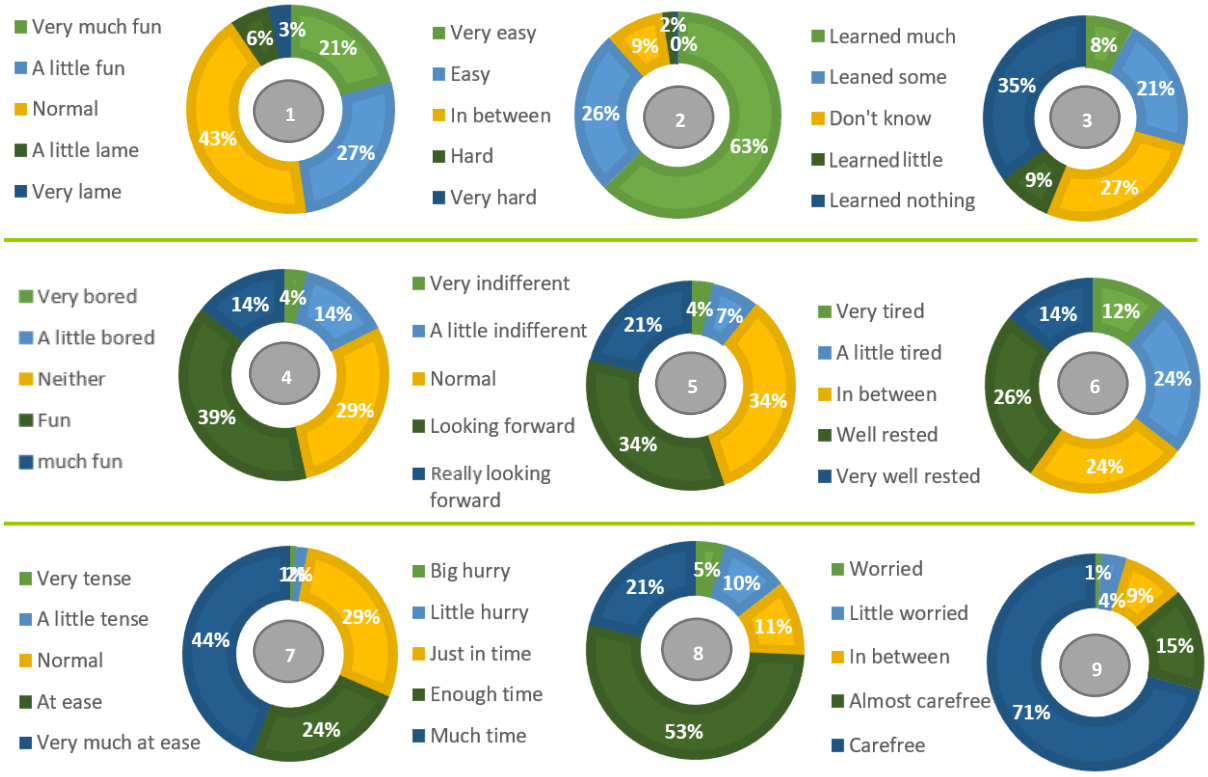


Figure 7.10 Satisfaction with travel – children

Figure 7.10 visualizes the answers that children have given to the nine Satisfaction With Travel questions. Note that for every chart the legend shows from which words the children could choose per question. Every time they were asked to choose which best descri bed how they felt during their trip to school that morning. Very few children (only 9%) said that their trip was lame or very lame, most were neutral about the trip (43%). More than half of the children (63%) said that their trip was very easy, only 2% indicated the trip was hard. About 20% of the children thinks that they learned something on the trip to school, 35% indicates not having learnt anything. A large share of the children found their trip to school fun (39%) or neutral (29%). The rest are mostly equally divided between being a little bored and finding the trip very much fun. One third was looking forward to the day, one third was neutral and one third was either very much looking forward or (a little) indifferent. About a quarter was a little tired, a quarter was well rested and a quarter was something in between. The rest were either very tired or very well rested. Nearly half of the children was very much at ease during the

trip, nearly nobody was worried. Around three quarters of the children had enough time or much time on their way to school. The rest were mostly just in time or a little in a hurry. 71% of the children was completely carefree, 15% was almost carefree. Only 5% was (a little) worried.

In the analyses for the current study, one overall SWT variable will be used. A Cronbach's Alpha Reliability analysis was conducted to check for the internal consistency between the 9 questions. The results of the analysis indicated that it would be best to *not* include the second and third question (about difficulty level and learning). The combination of the remaining seven questions resulted in a Cronbach's Alpha of 0.673, indicating moderate to good internal consistency. The final SWT variable will therefore represent the mean of question 1 and questions 4-9 in figure 7.10.

7.6.3 Parental safety perception

The parental safety perception is built-up from three factors: the way parents experience the social safety in their neighborhood, the way they experience the traffic safety on the route to school and the trust they have in their children's traffic skills. Figure 7.11 shows the distribution of answers that parents gave to the questions about social safety. As can be seen, almost all parents disagree with the first statement, indicating that they experience very little 'stranger danger' in their neighborhood. Furthermore, most parents agree that their neighborhood is a safe place for their children to be outside alone. The inter-item correlation was calculated for the combination of these two statements, which resulted in a value of 0.481. This indicates the two statements are correlated, but not too strongly, which allows the combination of two statements into a final social safety variable. This variable indicates the perception that parents have of the social safety.

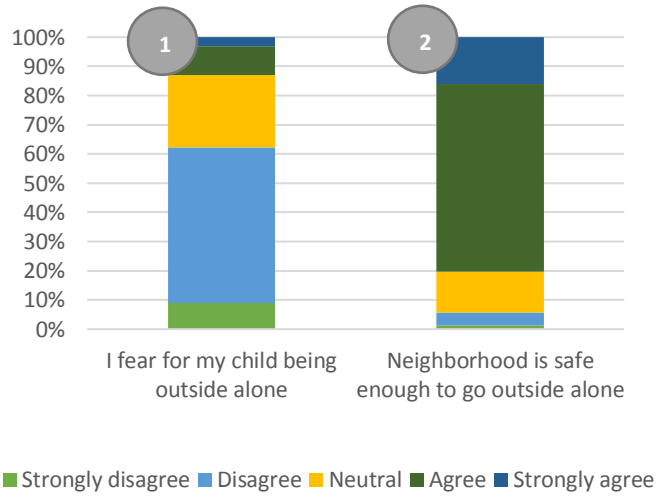


Figure 7.11 Perception of social safety

Figure 7.12 presents the responses that parents gave concerning the five traffic safety statements, as presented below the bars. The statements are all about the route between the respondent's home and the child's school. Although more parents indicate that there are sufficient safe road crossings, there is also a group of about 30% which disagrees with this statement. Over half of the respondents (strongly) disagrees with the statement that cars usually do not speed, indicating that they in fact do speed. About 20% agrees with the statement that cars do not usually speed. 60% of the respondents report that traffic intensity causing unsafe travel conditions for active travel, accompanied or as a child alone, is *not* the case. Lastly, the largest group of respondents (nearly half) is neutral about whether or not car drivers pay proper attention to cyclists and pedestrians. Roughly 25% agrees that car drivers pay proper attention and around a third disagrees. A Cronbach's Alpha reliability analysis was conducted to check for the internal consistency of the traffic safety statements. The outcome was that

it would be best to remove statement 1, resulting in a Cronbach's Alpha value of 0.688: moderate to good internal consistency for the combination of statements 2-5. This results in the final traffic safety variable, which measures the perceptions that parents have of the traffic safety in terms of intensity, attitude of car drivers and speeding.

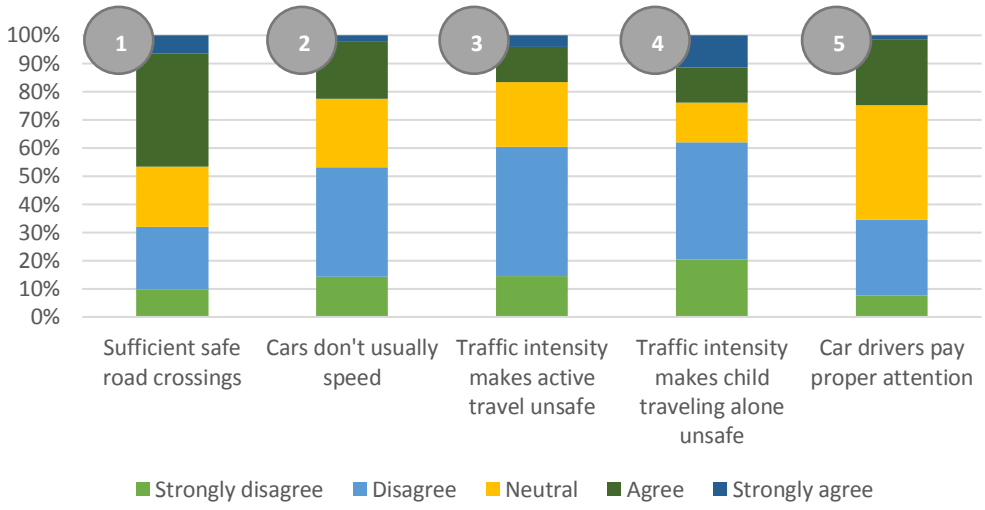


Figure 7.12 Traffic safety perception

Figure 7.13 shows the answers to the questions about the trust that parents have or do not have in their children's traffic skills. As can be seen, the answers to the first three questions are roughly the same: respondents mostly agree with the statements, although the largest share of respondents agrees with the statement that the child cycles well and slightly fewer agree with the fact that the child pays attention when cycling and walking. A bigger share of parents is unsure about whether or not the child can estimate danger.

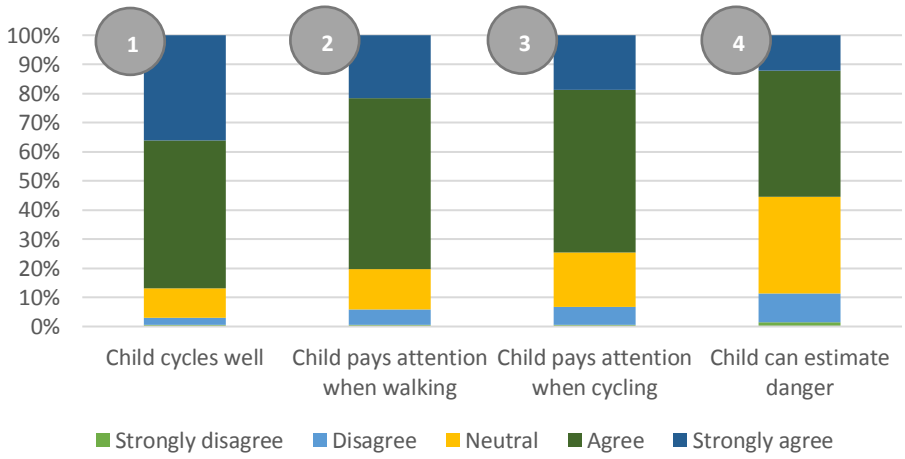


Figure 7.13 Perception of child's traffic skills

Also for the child's traffic skills statements, a Cronbach's Alpha reliability analysis was conducted. After removing the first statement, which turned out to be less consistent with the set of statements, the Cronbach's Alpha was 0.876. This value indicates strong internal consistency, so a final child's traffic skills variable was made to represent the mean of the responses to the last three statements. This traffic skills variable is a measurement of the trust that parents have in the safe traffic skills of their children.

Finally, a Cronbach's Alpha analysis was conducted to investigate the possibility of combining all statements in the category parental safety perception (i.e. all social safety, traffic safety and traffic

skills statements) into one overall variable. The analysis showed that, after removing traffic safety statements 1 and 2, the overall set of statements was properly internally consistent with a Cronbach's Alpha value of 0.779. Therefore, the final and complete parental safety perception variable was computed in SPSS. This variable represents the mean response of parents to (nearly) all statements in the category of parental safety perception. Therefore, the parental safety perception variable is an indication of how parents perceive the overall safety concerning the school trip of their children. Although the dependent variable parental safety perception will only be represented by this total, combined variable, also the three sub-variables will be used in the bivariate analyses, just to get better insights into the relationships.

7.7 Conclusion

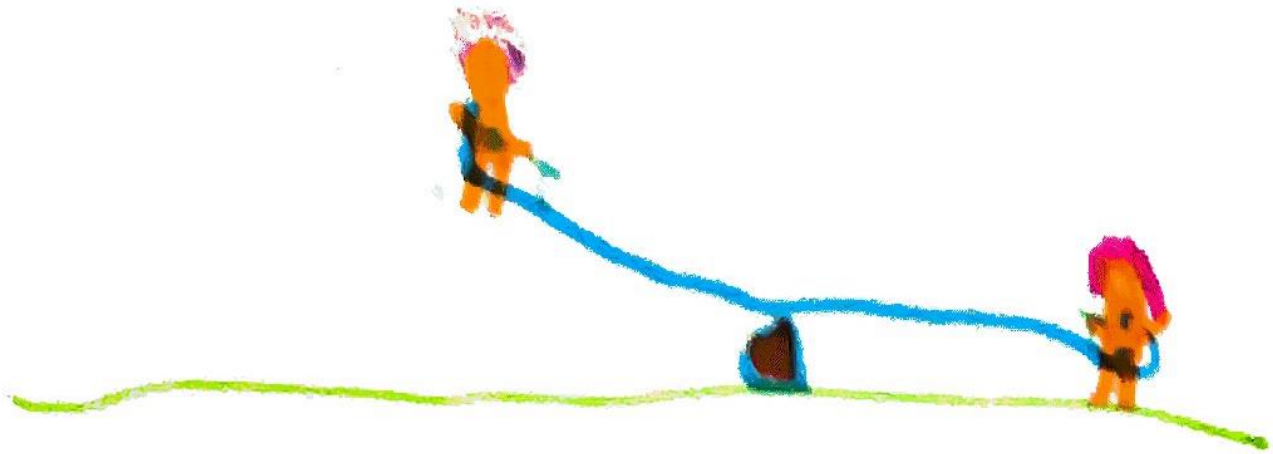
This chapter has described the data that were collected from 660 respondents in the fall of 2018. The data were collected through combined questionnaires for children and their parents. Nearly all missing values have been removed and the data have been recoded to suit the analyses of the current study (see appendix 5). Overall, it can be concluded that the distribution of the data concerning the different types of variables is quite balanced. The data are quite evenly distributed among personal characteristics and for the different household factors and physical and social environmental factors, mostly all the categories are represented by a substantial amount of respondents. The fourteen different schools that the children in the sample attend are of different sizes, have different education visions and schedules and they are located in different types of surroundings.

Assuming that the current data form a representation of the Dutch primary school children in grades 5-8, it can be said that definitely most children still use active transport modes to go to school. However, also a substantial amount of children travel sometimes or often by car. A significant share of school principals and parents have their doubts concerning traffic safety around schools. Children mostly travel alone or with a parent and/or sibling. The sample consists mostly of Dutch households, but also a substantial share of households have other ethnic backgrounds, which is representative to the Dutch population.

The following chapters will use the data to investigate which independent variables are significantly related to which dependent variables, and in what way.

CHAPTER 8

BIVARIATE ANALYSES



Drawing by Desiree & Amber van de Craats, 2018

8. BIVARIATE ANALYSES

In this chapter the results of the bivariate analyses are presented. The bivariate analyses have been conducted to test the relationship between all independent variables and dependent variables. The results of the bivariate analyses indicate which of the variables are relevant to add in the regression analyses described in chapter 9. Variables are considered relevant if they are significantly associated (p-value is 0.05 or lower) to one or more of the dependent variables.

8.1 Explanation of bivariate analysis

Bivariate analyses are conducted to provide insights into the relevance of the different independent variables for the regression analyses. For every independent variable in the five different layers of the child's environment, the relationship with all dependent variables is checked for significance. Because the independent variables differ in measurement scale between nominal, ordinal and interval/ratio and the dependent variables are of a nominal and interval/ratio measurement scale, several different bivariate analyses techniques will be applied. These are Chi-Square, Independent t-test, One-way ANOVA, Spearman's correlation and Pearson's correlation. The following sections will elaborate on the basic principles of the different tests.

8.1.1 Chi-Square

The chi-square test can be used to investigate the relationship between two categorical variables (Field, Miles, & Field, 2013). What the test does is compare the observed frequencies in the different combinations of the two categorical variable options with the frequencies that can be expected to occur by chance. This test will also be used to investigate the relationship between the ordinal independent variables and the nominal dependent variable. The chi-square test has two important assumptions. Firstly, the data has to be independent. In other words, each respondent should be contributing to only one of the categories in the nominal variables. This assumption is relevant for almost all tests in statistical analysis. Secondly, the frequencies that are expected must be larger than five, otherwise the test loses its statistical power (Field, Miles, & Field, 2013).

8.1.2 Independent t-test

The independent t-test can be used to test the relationship between an independent variable which has only two levels (is dichotomous) and a dependent variable on interval/ratio scale (Field, Miles, & Field, 2013; Ho, 2014). The independent t-test can be used to test the difference between the means of the two independent groups (the two categories of the independent variable). Important assumptions of the independent t-test are threefold. Firstly, the two groups need to be independent of each other. Secondly, the distribution of the dependent variable must be normal. Thirdly, both groups being compared in the test must have roughly the same distribution of variance (Field, Miles, & Field, 2013; Ho, 2014). To check the third assumption, Levene's test can be used in SPSS. The null-hypothesis of this test is that the difference between the variances of the two groups is zero. If there is insufficient evidence (when Levene's test is non-significant) to reject the null-hypothesis, the assumption is justifiable (Field, Miles, & Field, 2013).

8.1.3 One-way ANOVA

The one-way ANOVA test is similar to the independent t-test, except for the fact that it can measure whether the differences of means of more than two groups differ (Ho, 2014). The one-way ANOVA will therefore be used to investigate the relationship between the independent variables of nominal level with more than two variables and the interval/ratio dependent variables. The test will also be used to investigate the relationship between interval/ratio independent variables and the nominal dependent variable. Assumptions for the one-way ANOVA test are that the different groups are independent from

one another, the dependent variable is normally distributed and the groups have roughly the same variance (Ho, 2014). As stated in the previous chapter, the difference in variances can be tested using Levene's test.

8.1.4 Spearman & Pearson correlation

The correlation test can also be used to statistically analyze whether a relationship exists between two variables. The two types of correlation, Spearman rank order correlation and Pearson product moment correlation, will be applied depending on the measurement levels of the variables. The Spearman's correlation will be used to determine whether a relationship exists between the independent variables with an ordinal measurement scale and the dependent variables with an interval/ratio scale. The Pearson's correlation is used to statistically investigate whether there is a relationship between only interval/ratio variables. Assumptions for both a Pearson's correlation and a Spearman's correlation to be taken into account are that the variables have a linear relationship and that there is homoscedasticity. This means that the variability of the scores for the dependent variable are constant for all values of the independent variable (Ho, 2014). Furthermore, for a Pearson's correlation, the data must be normally distributed, while this is not required for a Spearman's correlation (Field, Miles, & Field, 2013). To visually assure that the data meet the linearity and homoscedasticity assumptions, scatterplots will be made in SPSS.

Table 8.1 Bivariate analyses per measurement level

<table>
<tr><th></th><th colspan="4">Dependent variables</th></tr>
<tr><th>Independent variables</th><td>Nominal (2 categories)</td><td>Nominal (>2 categories)</td><td>Ordinal</td><td>Interval/ratio</td></tr>
<tr><td>Nominal (2 categories)</td><td colspan="3" rowspan="3">Chi-Square</td><td>Independent t-test</td></tr>
<tr><td>Nominal (>2 categories)</td><td>One-way ANOVA</td></tr>
<tr><td>Ordinal</td><td>Spearman's correlation</td></tr>
<tr><td>Interval/ratio</td><td>Independent t-test</td><td colspan="2">One-way ANOVA</td><td>Pearson's correlation</td></tr>
</table>

Table 8.2 Measurement levels dependent variables

Dependent variable	Category	Measurement level
TM day	Travel mode	Nominal (4 groups)
Always bike		Nominal (2 groups)
Car 4+		Nominal (2 groups)
Walk 4+		Nominal (2 groups)
Active vs. Passive		Nominal (2 groups)
Parental safety perception	Parental safety perception	Interval/ratio
Health	Subjective well-being & health	Nominal (2 groups)
Mood/happiness		Ordinal (3 groups)
PA weekly		Interval/ratio
SWT		Interval/ratio
Trip companions		Ordinal (5 groups)
Trip interaction		Ordinal (3 groups)

8.2 Results personal factors

The bivariate analyses that were conducted in SPSS to investigate the relationships between the personal independent variables and the various dependent variables are discussed in this section. Most analyses include a Chi Square test, some relationships were investigated by independent t-test, one-way ANOVA or Spearman's correlation. In the bivariate analyses, age is seen as an ordinal variable. In the next step, the regression analyses, age will be considered as an interval/ratio variable.

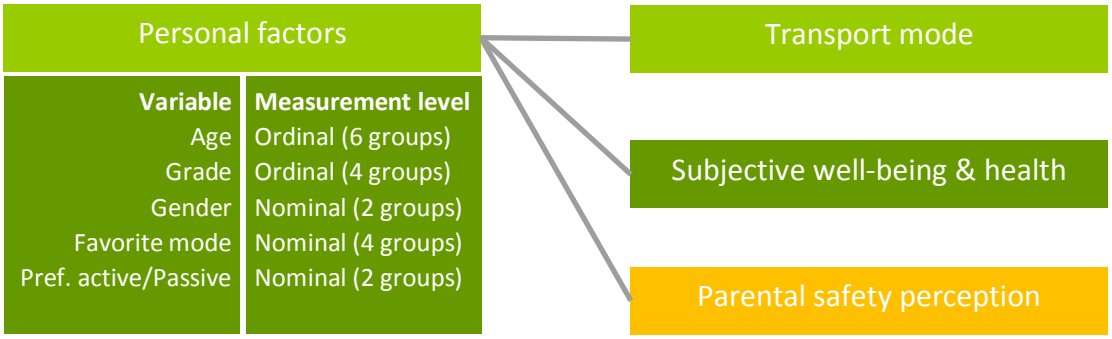


Figure 8.1 Visualization bivariate analyses personal factors – dependent variables

8.2.1 Transport mode

Table 8.3 shows the results of the bivariate analyses that were conducted to investigate whether or not there is a significant association between the personal factors and the different variables that indicate child transport mode. The first variable indicates the transport mode that the child used on the day of the survey (TM day). Gender is the only variable that does not have a significant relationship with TM day. Although some international studies have found gender to influence travel mode, the finding of the current study is in line with a previous Dutch study by Kemperman & Timmermans (2014). Age, whether the child prefers active or passive transport modes, the specific transport mode the child prefers and the grade that they are in all are significantly associated with transport mode, all at the 0.01 significance level. As children age, they generally cycle more, walk less and go less by car. Furthermore, they more often use their favorite transport mode than another mode. The association with age is in line with several previous studies (e.g. Kemperman & Timmermans, 2014 and Aarts et al., 2013). The four other transport mode variables presented in table 8.3 are based on the frequencies of using different transport modes in an average week, as reported by parents in proxy of their children. The second transport mode variable is whether or not the child always goes to school by bicycle (always bike). Age, the favorite mode of the child and the grade this child is in are significantly associated with the variable always bike. The percentage of children that always cycles increases with age. Children that always cycle to school are much more likely to identify the bicycle as their favorite transport mode (of this group, 66,7% has the bicycle as favorite mode, 18.3% the car). No significant relationship was found between gender and a preference for active or passive. The next two variables are whether the child goes to school by car or by foot at least four times per week (car 4+ and walk 4+). Age, the favorite transport mode of the child, the preference for active or passive and the grade are all significantly associated with walking or going by car at least 4 times per week. However, the associations between age and the preference for active/passive with walking 4+ times are only significant at the 0.05 level. The percentage of children going by car four or more times per week decreases with age, the percentage of children walking at least four times per week has a somewhat normal relationship with age. Finally, all variables except for gender have a significant association with whether a child travels more by active modes or more by passive modes in an average week. Active travel increases with age and the children that travel more actively also more often have an active mode as favorite mode.

Table 8.3 Chi Square test results personal factors – transport mode

Variables	TM day		Always bike		Car 4+		Walk 4+		Active/passive (N=647)	
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Age	39.132**	0.000	51.896**	0.000	31.025**	0.000	13.065*	0.023	22.712**	0.000
Gender (N=656)	6.961	0.073	2.011	0.156	0.580	0.446	0.057	0.812	3.793	0.051
Pref. active or passive	42.171**	0.000	2.112	0.146	11.890**	0.001	9.187*	0.027	20.193**	0.000
Favorite mode	112.627**	0.000	34.560**	0.000	13.996**	0.003	78.912**	0.000	23.841**	0.000
Grade	44.042**	0.000	53.599**	0.000	34.599**	0.000	11.458**	0.001	27.537**	0.000

**significant at the 0.05 level*
***significant at the 0.01 level*

8.2.2 Subjective well-being and health

Table 8.4 presents the results of the bivariate analyses between different subjective well-being and health variables. The first is the mood of the child, as indicated on the child questionnaire. Both gender and the favorite mode of the child have a significant relationship with the mood of the child. Parents were asked to indicate how healthy they thought their child was, resulting in the health variable. Gender is the only personal factor that was found to be significantly associated with the parent-assessed health. The third variable in the table is the trip companions that the child had on the day of the survey. Age, a preference for active or passive, the favorite mode of the child and the grade were all found to be significantly associated with the trip companions. The relationship with the preference for active/passive was only significant at the 0.05 level. Traveling alone, with a friend or with a sibling happens more often among older children, while traveling with a parent or a parent and a sibling happens less often among older children. The turning point seems to be at the age of 10. Trip interaction, whether children usually run into other children on the way to school, is not significantly associated to any of the personal variables. Age and grade were the only two independent variables in the personal factors to be significantly associated with the frequency of traveling to school alone, on an average week. When children are older, they more often travel alone. This relationship between age and whether or not a child is allowed to travel independent of the parent was found in earlier studies (e.g. Shaw et al., 2015 and Curtis, Babb & Olaru, 2015).

Table 8.4 Chi Square test results personal factors – mood, health and social contacts

Variables	Mood		Health		Trip companions day		Trip interaction		Travel alone frequency	
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Age	10.793	0.374	3.836	0.573	121.723**	0.000	10.578	0.102	169.783**	0.000
Gender (N=656)	7.691*	0.021	9.503**	0.002	2.930	0.711	3.420	0.181	3.053	0.217
Pref. active or passive	5.923	0.052	1.210	0.271	14.468*	0.013	3.713	0.156	4.147	0.126
Favorite mode	17.424**	0.008	1.560	0.668	30.685**	0.010	9.805	0.133	10.351	0.111
Grade	2.926	0.818	4.862	0.182	135.229**	0.000	4.354	0.629	192.780**	0.000

**significant at the 0.05 level **significant at the 0.01 level*

The last two dependent variables concerning subjective well-being and health are Satisfaction with Travel (SWT) and the weekly physical activity (see table 8.5 and 8.6). Gender has a significant relationship with weekly physical activity, not with SWT. Boys have more minutes of physical activity

in an average week than girls. The preference for active or passive travel has a significant association with both variables: children that prefer active travel are generally more satisfied with their trip to school and they also experience more weekly physical activity. The favorite transport mode is only significantly associated with SWT; children that prefer to walk are generally most satisfied with their trip, followed by children that prefer to bike. The age of a child only has a significant relationship with their weekly physical activity; the amount of hours of weekly physical activity deceases with age.

Table 8.5 Independent t-test, one-way ANOVA and Spearman's correlation test results personal factors - Satisfaction with travel and weekly PA

Variables	Satisfaction with Travel		Weekly physical activity	
	Independent t-test (2-tailed)			
	t	*Sig.*	*t*	*Sig.*
Gender (N=656)	0.265	0.791	2.500*	0.013
Preference active or passive	4.114**	0.000	2.582**	0.010
	One-way ANOVA			
	F	*Sig.*	*F*	*Sig.*
Favorite mode	6.203**	0.000	3.315*	0.020
	Spearman's correlation			
	r	*Sig.*	*r*	*Sig.*
Age	-0.39	0.313	-0.095*	0.015
Grade	-0.021	0.597	-0.069	0.076

**significant at the 0.05 level **significant at the 0.01 level*

Table 8.6 Bivariate analyses – descriptive statistics of relationship between personal factors and satisfaction with travel and weekly physical activity (means in green boxes differ significantly).

	Satisfaction with travel				Weekly physical activity			
Variable	*N*	*Mean*	*St. dev.*	*St. error*	*N*	*Mean*	*St. dev.*	*St. error*
Age								
7	27	3.69	0.556	0.107	27	1003.9	283.2	54.50
8	140	3.73	0.579	0.049	140	985.0	321.7	27.19
9	180	3.74	0.602	0.045	180	985.4	338.0	25.20
10	155	3.75	0.579	0.046	155	993.4	353.6	28.40
11	132	3.71	0.595	0.052	132	924.5	346.9	29.93
12	26	3.42	0.697	0.137	26	818.6	315.1	61.79
Gender								
Boy	315	3.73	0.608	0.034	315	1004.0	341.9	19.26
Girl	341	3.71	0.580	0.031	341	938.1	333.1	18.04
Preference								
Active	455	3.79	0.577	0.027	455	991.9	338.9	15.89
Passive	205	3.58	0.606	0.042	205	918.8	330.7	23.10
Favorite mode								
Walking	117	3.81	0.514	0.047	117	980.6	371.2	34.32
Cycling	338	3.78	0.598	0.033	338	995.8	327.5	17.82
Car	119	3.54	0.642	0.059	119	883.8	312.8	28.67
Other	86	3.64	0.550	0.059	86	967.3	350.1	37.75
Grade								
5	160	3.72	0.575	0.045	160	993.9	333.0	26.32
6	169	3.73	0.578	0.044	169	980.3	334.4	25.73
7	170	3.77	0.607	0.047	170	965.8	354.4	27.18
8	161	3.66	0.613	0.048	161	936.5	328.7	25.91

8.2.3 Parental safety perception

The last dependent variable is about the concerns that parents have in terms of traffic safety, traffic skills of their child and social safety (see tables 8.7 and 8.8). The variable parental safety perception is an indication of how parents perceive the safety on the route between home and school, a higher value indicates a more positive perception of the safety. All personal factors except for gender are significantly associated with the parental safety perception. As children age, the parents generally have a more positive perception of the safety. The same effect is visible between grade and parental safety perception. Parents of children that prefer to travel actively have fewer concerns and parents of children that prefer walking to school have the fewest concerns, followed by children that prefer to cycle. This result is similar to previous findings of Curtis, Babb & Olaru (2015). They found that children who prefer to travel by car, generally have parents that fear letting their children travel independently.

When looking at the subcomponents of parental safety perception, it becomes clear that gender in fact does have a significant relationship with parents' perception of traffic safety and their social safety concerns. Of the subcomponents, the preference for active or passive travel and for specific transport modes only have a significant relationship with parental trust in traffic skills. Finally, age and grade are significantly associated with all subcomponents of parental safety perception. These findings are quite logical. If a child, for instance, prefers to cycle, this would likely influence their cycling skills and by extent influence whether parents trust these cycle skills. Gender and especially age may influence the fear that parents have concerning traffic safety, because older children are generally better at paying attention to complicated traffic situations.

Table 8.7 Independent t-test, one-way ANOVA and Spearman's correlation results personal factors – Parental safety perception

Variables	**Parental safety perception total**		**Traffic safety**		**Traffic skills**		**Social safety**	
	Independent t-test							
	t	*Sig.*	*t*	*Sig.*	*t*	*Sig.*	*t*	*Sig.*
Gender(N=656)	1.847	0.065	3.206**	0.001	-0.632	0.528	2.374*	0.018
Preference active or passive	3.888**	0.000	1.783	0.075	3.825**	0.000	1.279	0.201
	One-way ANOVA							
	F	*Sig.*	*F*	*Sig.*	*F*	*Sig.*	*F*	*Sig.*
Favorite mode	5.574**	0.001	1.151	0.328	5.435**	0.001	0.608	0.610
	Spearman's correlation							
	r	*Sig.*	*r*	*Sig.*	*r*	*Sig.*	*r*	*Sig.*
Age	0.271**	0.000	0.185**	0.000	0.221**	0.000	0.108**	0.005
Grade	0.306**	0.000	0.211**	0.000	0.240**	0.000	0.128**	0.001

**significant at the 0.05 level*
***significant at the 0.01 level*

Table 8.8 *Bivariate analyses – descriptive statistics of relationship between personal factors and parental safety perception (means in green boxes differ significantly).*

	Parental safety perception			
Variable	*N*	*Mean*	*St. dev.*	*St. error*
Age				
7	27	3.23	0.485	0.093
8	140	3.52	0.539	0.046
9	180	3.54	0.510	0.038
10	155	3.77	0.562	0.045
11	132	3.82	0.497	0.043
12	26	3.75	0.622	0.122
Gender				
Boy	315	3.69	0.550	0.031
Girl	341	3.60	0.547	0.030
Preference				
Active	455	3.70	0.516	0.024
Passive	205	3.52	0.602	0.042
Favorite mode				
Walking	117	3.72	0.468	0.043
Cycling	338	3.69	0.532	0.029
Car	119	3.56	0.632	0.058
Other	86	3.47	0.557	0.060
Grade				
5	160	3.44	0.545	0.043
6	169	3.53	0.525	0.040
7	170	3.76	0.523	0.040
8	161	3.84	0.513	0.040

8.3 Results household factors

This section presents the results to the bivariate analyses that were conducted in SPSS to investigate the relationships between the household independent variables and the various dependent variables. Most analyses include a Chi Square test, some relationships were investigated by independent t-test, one-way ANOVA or Spearman's correlation.

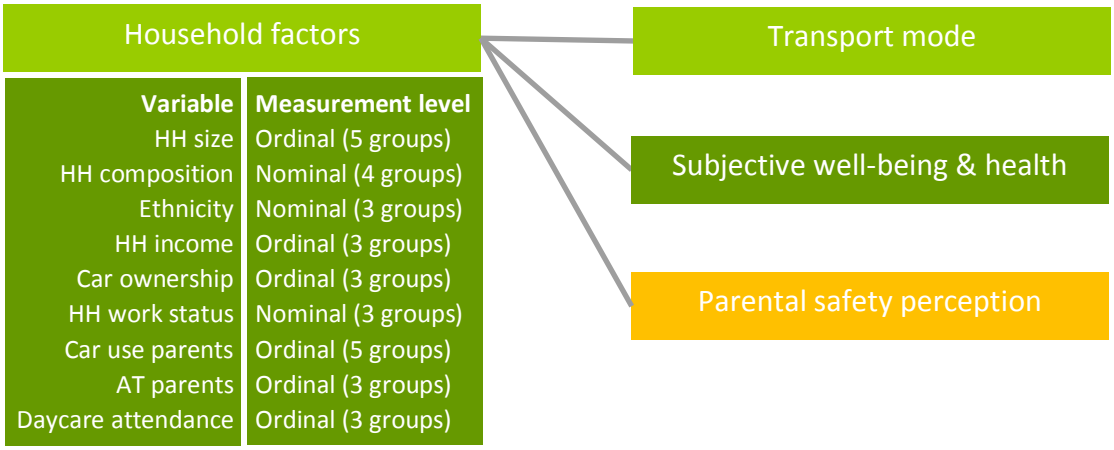


Figure 8.2 *Visualization bivariate analyses household factors – dependent variables*

8.3.1 Transport mode

Table 8.9 shows the results of the bivariate analyses between the household factors and the various variables representing transport mode. Ethnicity is the only household factor that is not significantly associated with the transport mode the child used on the day of the survey. This is not in line with some studies that found significant associations between school transport mode and ethnicity (Easton & Ferrari, 2015). Household size and composition, household income, car ownership, household work status, parents' frequency of using the car and active transport and daycare attendance all have a significant association with the transport mode the child used. The active transport frequency of parents is only significant at the 0.05 level, the rest are significant at the 0.01 level. Overall, the share of children using active modes is higher in the higher income categories. The percentage of children coming to school by bicycle increases with an increase in car ownership, as does the percentage of children coming to school by car. The biggest difference is seen within the percentage of children using another transport mode than walking, cycling or the car, which is a lot lower for households with two or more cars than the other two groups. Children who came to school by car were more likely to attend daycare than for any other mode. The percentage of children walking is highest for five person households and the percentage of children cycling is highest in four person households. Both of these relationships are quite normally distributed. The percentage of children coming by car is higher in two and three person households.

The literature review has revealed previous findings which enforce most of these associations, as described in chapter 4, section 4.3, Household factors. For example, Aarts et al. (2013) found associations between car ownership and frequency of active travel participation and Pont et al. (2009) found six publications reporting associations between active travel participation and household income. However, the increase of active travel participation with an increase in car ownership is not in line with previous findings. Although Pont et al. (2009) found higher incomes to be associated with lower active travel rates, van Goeverden & de Boer (2013) found, just as in the current study, that children belonging to households with higher incomes more often belonged to the group who used active modes. Aarts et al. (2013) as well as Carver et al. (2014) also found evidence that the number of siblings is associated with participation in active travel.

Table 8.9 Chi Square test results household factors – transport mode

Variables	**TM day**		**Always bike**		**Car 4+**		**Walk 4+**		**Active/passive** (N=647)	
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Household size	56.563**	0.000	0.774	0.942	20.364**	0.000	10.303*	0.036	23.492**	0.000
Household composition	43.841**	0.000	2.903	0.407	19.664**	0.000	6.272	0.099	31.792**	0.000
Ethnicity	8.165	0.226	0.170	0.918	0.911	0.634	1.252	0.535	1.808	0.000
Income	40.422**	0.000	0.915	0.633	1.514	0.469	2.029	0.358	10.983**	0.004
Car ownership	92.350**	0.000	1.502	0.472	7.352*	0.025	2.028	0.363	7.701*	0.021
Work status	37.593**	0.000	0.996	0.608	2.631	0.268	1.012	0.603	25.719**	0.000
Car – parents	47.360**	0.000	4.758	0.313	29.339**	0.000	11.235*	0.024	25.147**	0.000
AT - parents	16.252*	0.012	4.710	0.095	31.286**	0.000	0.957	0.620	23.187**	0.000
Daycare	16.393*	0.012	19.392**	0.000	13.755**	0.001	0.553	0.758	8.528*	0.014

**significant at the 0.05 level*
***significant at the 0.01 level*

When looking more into the details, it becomes visible that the only household variable that is significantly associated with whether or not the child cycles daily is the daycare attendance. The percentage of children that always cycles decreases with daycare attendance. This is possibly in line with the suggestion of Aarts et al. (2013) that daycare attendance in fact is a better indicator of associations between the parents' work and transport mode than their work status itself is. Household size and composition, as well as car ownership, car use by parents, active transport frequency of parents and daycare attendance are significantly associated with whether or not the child travels by car to get to school at least four times per week. The percentage of children using the car more than four times per week increases with the increase of parental car use and with daycare attendance. It decreases with parental active transport use and household size. Only household size and car usage of parents are significantly associated with a child walking to school four times or more per week. Both associations are significant at the 0.05 level. The percentage of children walking to school four or more times per week is highest for four and five person households and for children whose parents use the car 6 to 8 times per week. Just like for the overall transport mode variable, all household factors except for ethnicity are significantly associated with whether the child usually travels more actively or more passively. The associations with daycare attendance and car ownership are only significant at the 0.05 level. Directions are mostly the same as described for transport mode.

8.3.2 Subjective well-being and health

The results of the bivariate analyses between mood, health, trip companions, trip interaction and the travel alone frequency and the household factors are presented in table 8.10. As can be seen, ethnicity is the only household factor to have a significant relationship with mood of the child on the day of the survey. Household income and daycare attendance were both found to be significantly associated with parent-assessed health, daycare attendance was significant at the 0.05 significance level. Parent-assessed health is higher in the higher income categories. All household factors except for ethnicity and work status were found to be significantly associated with which trip companions a child had on the day of the survey. About half of these associations are at the 0.01 significance level. Whether or not the child usually runs into other children on the way to school (trip interaction) is only significantly associated with ethnicity and income at the 0.05 level and car ownership at the 0.01 level. The frequency by which a child, in an average week, travels alone to school is only significantly associated with the active travel use of parents and the daycare attendance.

Table 8.10 Chi Square test results household factors – mood, health and social contacts

Variables	Mood		Health		Trip companions		Trip interaction		Travel alone frequency	
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Household size	9.879	0.274	0.608	0.926	65.339**	0.000	4.089	0.849	12.185	0.143
Household comp.	5.407	0.493	0.647	0.886	63.710**	0.000	7.464	0.113	11.030	0.087
Ethnicity	11.180*	0.025	3.887	0.143	3.058	0.691	7.271*	0.026	5.183	0.269
Income	5.541	0.236	9.925**	0.007	22.230*	0.014	11.938*	0.018	7.147	0.128
Car ownership	4.086	0.394	4.627	0.099	20.810**	0.002	15.028**	0.005	7.501	0.112
Work status	7.404	0.116	5.564	0.062	5.458	0.487	7.383	0.117	5.389	0.250
Car – parents	6.304	0.613	5.499	0.240	22.330*	0.034	7.171	0.518	13.237	0.104
AT - parents	1.582	0.812	1.397	0.497	22.279*	0.014	4.519	0.340	10.015*	0.040
Daycare	2.131	0.712	9.000*	0.011	37.971**	0.000	8.314	0.081	27.874**	0.000

**significant at the 0.05 level*
***significant at the 0.01 level*

The last two variables in the category of subjective well-being and health are satisfaction with travel (SWT) and weekly physical activity. See the results of the bivariate analyses in tables 8.11 and 8.12. Household size (positive) and household income (negative) are the only two household factors to be significantly correlated with the satisfaction that the child had with their trip to school. As there are only two fairly week correlations with SWT, the descriptive statistics for SWT were not included here.

Table 8.11 One-way ANOVA and Spearman's correlation results household factors – SWT & Weekly PA

Variables	**Satisfaction with travel**		**Weekly physical activity**	
	One-way ANOVA			
	F	*Sig.*	*F*	*Sig.*
Household composition	2.018	0.110	0.476	0.699
Ethnicity	0.495	0.610	1.891	0.152
Work status	0.657	0.519	5.556**	0.004
	Spearman's correlation			
	r	*Sig.*	*r*	*Sig.*
Household size	0.082*	0.035	0.029	0.461
Income	-0.081*	0.037	-0.120**	0.002
Car ownership	0.038	0.328	0.082*	0.036
Car parents	-0.003	0.946	0.079*	0.041
AT parents	-0.004	0.911	0.036	0.359
Daycare	0.031	0.429	0.123**	0.002

**significant at the 0.05 level*
***significant at the 0.01 level*

Work status was found to be significantly associated with weekly physical activity, children in two wage earner households experience the most physical activity, children in households which are unemployed or 'other' experience the least weekly physical activity. Income is negatively correlated with weekly physical activity: children in households with an income below average experience less physical activity than those in households with an income equal to or above average. This is partly in line with the theory that the children who live in neighborhoods with lower socio-economic status have fewer opportunities to be physically active (Kann et al., 2015). Also car ownership and the frequency that parents use the car are significantly associated with weekly physical activity. Children in households that have one or more cars are more physically active than those in households that do not own a car. The increase of PA is also visible with the increase of parental car use. Although this may seem counter-intuitive, the explanation is most likely that car ownership is correlated with income. This result therefore might reflect the relationship between household income and car ownership. Finally, weekly daycare attendance is significantly associated with weekly PA: children who never attend daycare are less physically active than those who attend daycare once or more per week. Perhaps children are more physically active at daycare than at home.

Table 8.12 *Bivariate analyses – descriptive statistics of relationship between household factors and weekly physical activity and parental safety perception (means in green boxes differ significantly).*

	Weekly physical activity				Parental safety perception			
Variable	*N*	*Mean*	*St. dev.*	*St. error*	*N*	*Mean*	*St. dev.*	*St. error*
Household composition								
Single parent, 1 child	25	941.1	351.3	70.26	25	3.42	0.675	0.135
Single parent, 2+ child	75	930.5	357.8	41.32	75	3.52	0.644	0.074
2 parents, 1 child	61	964.7	334.8	42.87	61	3.45	0.507	0.065
2 parents, 2+ child	499	977.0	335.0	15.00	499	3.69	0.523	0.023
Household size								
2 person household	25	941.1	351.3	70.26	25	3.42	0.675	0.135
3 person household	108	938.9	339.3	32.65	108	3.48	0.551	0.053
4 person household	330	997.6	332.8	18.32	330	3.71	0.518	0.028
5 person household	146	976.1	336.5	27.85	146	3.69	0.507	0.042
6 person household	51	843.5	342.9	48.01	51	3.50	0.677	0.095
Household ethnicity								
Dutch	523	979.9	326.4	14.27	523	3.68	0.537	0.024
European	26	994.6	345.9	67.84	26	3.49	0.554	0.109
Non-European	111	912.7	383.5	36.40	111	3.52	0.588	0.056
Household income								
Above average	252	1007.6	309.6	19.51	252	3.75	0.541	0.034
Equal to average	286	960.7	343.6	20.31	286	3.62	0.508	0.030
Below average	122	909.8	371.3	33.62	122	3.46	0.609	0.055
Car ownership								
No car	52	844.4	339.2	47.04	52	3.38	0.649	0.090
One car	292	972.1	355.2	20.78	292	3.64	0.552	0.032
Two or more cars	316	987.0	317.4	17.85	316	3.69	0.519	0.029
Household work status								
Two wage earners	457	997.9	332.8	15.57	457	3.69	0.507	0.024
One wage earner	150	991.9	343.1	28.01	150	3.61	0.619	0.051
unemployed or other	53	883.9	337.6	46.38	53	3.34	0.607	0.083
Car use both parents								
Never	113	893.3	367.7	34.59	113	3.53	0.632	0.059
1-3 days	112	988.5	326.2	30.81	112	3.71	0.512	0.048
4-5 days	214	975.7	334.2	22.85	214	3.61	0.582	0.040
6-8 days	156	994.7	335.5	26.86	156	3.74	0.437	0.035
More than 8 days	65	985.0	311.6	38.65	65	3.57	0.561	0.070
Active transport both parents								
Never	327	962.7	338.9	18.74	327	3.61	0.556	0.031
1-4 days	206	959.2	311.4	21.69	206	3.66	0.561	0.039
More than 4 days	127	1002.0	375.1	33.28	127	3.71	0.510	0.045
Daycare attendance								
Never	473	946.8	342.7	15.76	473	3.66	0.557	0.026
Once a week	82	1002.3	312.0	34.45	82	3.64	0.581	0.064
More than once a week	105	1044.1	325.3	31.74	105	3.55	0.482	0.047

8.3.3 Parental safety perception

Table 8.13 shows the results of the one-way ANOVA and the Spearman's correlation analyses between the household factors and the parental safety perception variables. The descriptive statistics were already presented in table 8.12. Household composition was found to be significantly associated with parental safety perception, households with two parents and two children have the least concerns. There is no significant association between parental safety perception and household size. Ethnicity has a significant association with parental safety perception, parents in households of Dutch ethnicity have fewer concerns. Furthermore, work status as well as household income have a significant relationship with parental safety perception. Parents of unemployed or 'other' households have more concerns, as do households with an income below average. The last household factor to be significantly associated with parental safety perception is daycare attendance: parents with children who go to daycare more than once a week are more concerned. In terms of the sub components, the highest number of household factors is significantly associated with traffic safety, namely: household composition on the 0.01 scale and work status, household size, income, car ownership and daycare on the 0.05 scale. The only two household factors associated with parents' confidence in their children's traffic skills are work status and daycare attendance. The parental concern for social safety is significantly associated with household composition, ethnicity, work status, income and car ownership.

Table 8.13 One-way ANOVA and Spearman's correlation test results household factors – Parental safety perception

Variables	**Parental safety perception total**		**Traffic safety**		**Traffic skills**		**Social safety**	
	One-way ANOVA							
	F	*Sig.*	*F*	*Sig.*	*F*	*Sig.*	*F*	*Sig.*
Household composition	6.642**	0.000	5.697**	0.001	1.109	0.345	4.677**	0.003
Ethnicity	4.597**	0.010	0.687	0.503	0.647	0.524	28.482**	0.000
Work status	9.719**	0.000	3.757*	0.024	3.338*	0.036	5.603**	0.004
	Spearman's correlation							
	r	*Sig.*	*r*	*Sig.*	*r*	*Sig.*	*r*	*Sig.*
Household size	0.073	0.062	0.082*	0.035	0.001	0.974	0.061	0.120
Income	-0.187**	0.000	-0.096*	0.014	-0.050	0.198	-0.260**	0.000
Car ownership	0.096*	0.014	0.077*	0.045	0.013	0.734	0.129**	0.001
Car parents	0.029	0.452	0.025	0.527	0.005	0.907	0.053	0.174
AT parents	0.074	0.059	0.043	0.271	0.032	0.405	0.036	0.350
Daycare	-0.079*	0.043	-0.099*	0.011	-0.082*	0.036	0.030	0.439

**significant at the 0.05 level*
***significant at the 0.01 level*

8.4 Results school factors

The results of the bivariate analyses that were conducted in SPSS to investigate the relationships between the school factor independent variables and the various dependent variables are presented in this section. Most analyses include a Chi Square test, some relationships were investigated by independent t-test, one-way ANOVA or Spearman's correlation.

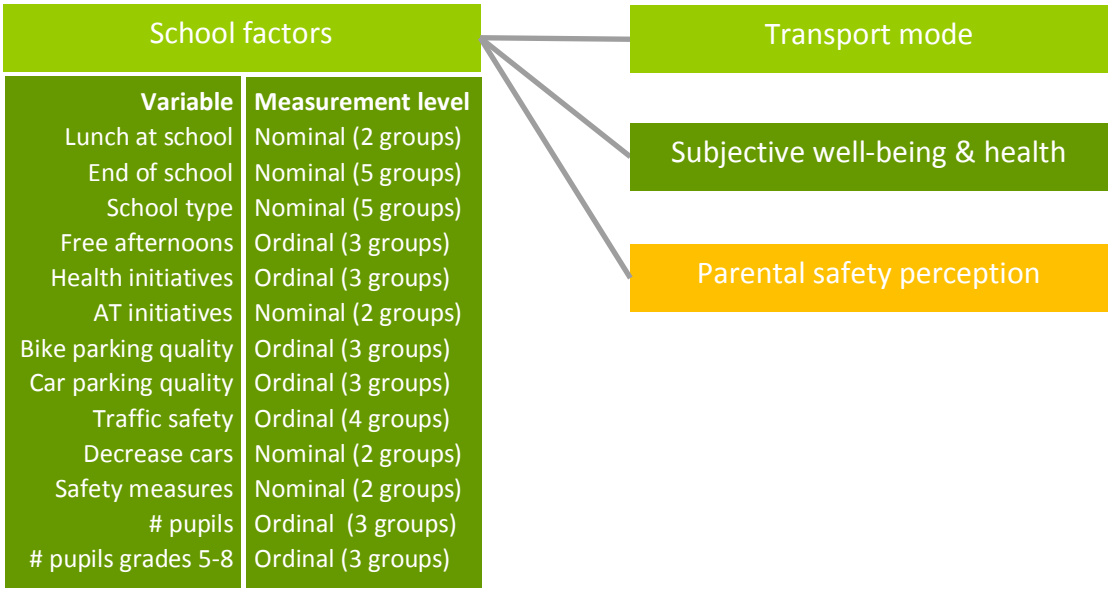


Figure 8.3 Visualization bivariate analyses school factors – dependent variables

8.4.1 Transport mode

As can be seen in table 8.14, all school variables except for whether or not the school takes initiatives to stimulate active travel are significantly associated with the transport mode on the day of the survey. The highest percentage of car users occurs when car parking quality is rated as mediocre, the highest percentage of bike users occurs when car parking quality is rated as sufficient to good. This seems counter-intuitive, but it may be explained by the fact that better parking conditions lead to better safety as well. This theory is, however, not completely supported by the results for traffic safety. Car usage is highest in good traffic safety conditions and bicycle usage is highest in sufficient traffic safety conditions. In larger schools active travel rates appear to be higher and bicycle usage increases with the number of free afternoons. Perhaps the probability of living near school is higher for larger schools, enabling more active travel. It is assumed, however, that many of the school variables mutually correlate strongly. They will probably not all be included in the regression models in the next chapter, but this will be discussed in the preparation for the regression analysis. The fact that variables such as traffic safety, car parking quality, effort taken to decrease the amount of cars around school and safety measures are associated with transport mode is not surprising. All of these variables have something to do with safety around the school, which is likely to influence transport mode. These results are mostly in line with the small share of literature that was found on the effects of school factors. An example of literature that supports the results of the bivariate analyses is related to the schedules of households being dependent on school schedules (Cloïn et al., 2010) which may influence transport modes. Furthermore, as in the current study, Panter et al. (2010) did not find significant associations between travel mode and the school's promotion of active travel. On the other hand, Hollein et al. (2017) found that adolescents who attended a school that promoted active travel in fact did participate more in active travel. Perhaps, in the current study, this effect can be seen in the significant association between health initiatives that a school participates in and the school transport mode.

When looking more specifically at the different transport mode variables, eight out of the thirteen variables are significantly associated with whether or not a child always bikes to school. Only five variables are significantly associated with car travel: the school type, the health initiatives of the school, the quality and capacity of car parking facilities, the traffic safety and whether or not traffic safety measures are taken. Additional to these five, four more variables are significantly associated with walking to school, namely the time school is out, the number of pupils in the whole school and in grades 5-8 and whether or not the school takes initiatives to stimulate active travel. Finally, all school variables except for the efforts to decrease the amount of cars around school and to stimulate active travel are significantly associated with more active or more passive travel in an average week.

Table 8.14 Chi Square test results school factors – transport mode

Variables	TM day		Always bike		Car 4+		Walk 4+		Active/passive (N=647)	
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Lunch at school	16.882**	0.001	6.591**	0.010	0.171	0.679	4.000*	0.046	8.211**	0.004
End of day	156.357**	0.000	15.186**	0.004	5.463	0.243	24.626**	0.000	70.605**	0.000
School type	275.456**	0.000	23.598**	0.000	13.385**	0.010	59.755**	0.000	119.110**	0.000
Free afternoons	50.396**	0.000	2.177	0.337	6.184*	0.045	4.557	0.102	27.169**	0.000
Health initiatives	58.186**	0.000	8.657*	0.013	6.631*	0.036	42.425**	0.000	18.922**	0.000
Bike parking	42.282**	0.000	0.062	0.969	2.849	0.241	5.292	0.071	10.882**	0.004
Car parking	118.067**	0.000	17.129**	0.000	14.000**	0.001	43.079**	0.000	55.332**	0.000
Traffic safety	146.012**	0.000	17.444**	0.001	8.682*	0.034	13.403**	0.004	67.973**	0.000
Decrease cars	34.694**	0.000	1.134	0.287	0.729	0.393	0.245	0.621	3.628	0.057
Safety measures	139.827**	0.000	7.695**	0.006	10.454**	0.001	13.731**	0.000	83.444**	0.000
# pupils	38.846**	0.000	3.663	0.160	2.907	0.234	8.589*	0.014	13.348**	0.001
# pupils 5-8	61.545**	0.000	13.323**	0.001	0.756	0.685	21.509**	0.000	17.703**	0.000
AT initiative	7.659	0.054	3.322	0.068	0.135	0.713	8.850**	0.003	2.144	0.143

**significant at the 0.05 level*
***significant at the 0.01 level*

8.4.2 Subjective well-being and health

For the dependent variables category subjective well-being and health, the results of the bivariate analyses between the school factors and mood, health and trip companions, trip interaction and the travel alone frequency are presented in table 8.15. The school type, the time school ends and the number of free afternoons are all significantly associated with the mood of the child on the day of the survey. Also the health initiatives that the school undertakes, the quality of bike parking and whether or not safety measures are undertaken, have a significant relationship with mood. The time school ends and the school type, as well as the traffic safety and whether or not the school makes an effort to decrease the amount of cars and increase the safety, are all significantly associated with health of the child, as assessed by parents. Except for whether or not children have lunch at school, all school variables are significantly associated with the type of company the child had on the day of the survey. Whether or not the school makes an effort to promote active travel is the only variable for which this relationship is at the 0.05 level of significance instead of 0.01. Also almost all school variables are associated with the trip interaction variable, expect for lunch at school, decrease cars and active travel initiatives. The frequency of traveling alone is significantly associated with all but the lunch at school, decrease cars and number of pupils.

Table 8.15 Chi Square test results school factors – mood, health and social contacts

Variables	Mood		Health		Trip companions		Trip interaction		Travel alone frequency	
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Lunch at school	2.745	0.290	0.004	0.951	3.240	0.356	1.576	0.455	2.971	0.226
End of day	29.663**	0.000	10.542*	0.032	51.486**	0.000	35.980**	0.000	48.936**	0.000
School type	25.457**	0.001	22.204**	0.000	59.175**	0.000	44.308**	0.000	34.093**	0.000
Free afternoons	22.998**	0.000	0.237	0.888	39.142**	0.000	26.144**	0.000	28.145**	0.000
Health initiatives	15.090**	0.005	2.114	0.347	41.976**	0.000	9.171*	0.045	27.321**	0.000
Bike parking	16.423**	0.003	5.103	0.078	41.631**	0.000	28.482**	0.000	14.686**	0.005
Car parking	8.122	0.087	2.712	0.156	46.516**	0.000	17.539**	0.002	39.331**	0.000
Traffic safety	7.336	0.291	10.896*	0.012	48.200**	0.000	26.897**	0.000	30.052**	0.000
Decrease cars	2.622	0.270	5.893*	0.015	16.735**	0.005	3.148	0.207	1.664	0.435
Safety measures	16.533**	0.000	11.854**	0.001	36.847**	0.000	25.766*	0.000	34.123**	0.000
# pupils	7.845	0.097	5.430	0.066	29.910**	0.001	10.891*	0.028	5.903	0.207
# pupils 5-8	9.412	0.052	3.208	0.201	38.322**	0.000	21.125**	0.000	21.179**	0.000
AT initiative	2.630	0.269	0.519	0.471	11.103*	0.011	0.773	0.680	7.988*	0.018

**significant at the 0.05 level*
***significant at the 0.01 level*

Table 8.16 shows the result of the bivariate analyses between the school factors and the satisfaction with travel and weekly physical activity and table 8.17 shows the descriptive statistics. Children that have lunch at school are generally more satisfied with their trip to school, this is a significant association. Also the time that school is out has a significant relationship with the satisfaction with travel: children that finish school at 14:00 are generally the least satisfied with their trip and those that finish at 15:15 are the most satisfied. However, the second highest mean for SWT belongs to the next to earliest finish time. This leads to believe that there is another reason why children that go to these specific schools are generally more satisfied, but that is not linked to the time school finished. This may in fact be the case for the association between several school factors and satisfaction with travel. Children that have no free afternoons are slightly less satisfied with their travel than those who have one or two free afternoons, which is a significant relation. Also a significant relation is the quality of the bicycle storage: the better the bicycle storage, the lower the travel satisfaction. Finally, children that attend a school that makes an effort in decreasing the amount of cars are significantly more satisfied with their travel. In terms of weekly physical activity, the school size is significantly associated. Children in average sized schools have the most weekly physical activity, but when only looking at grades 5-8, children in the largest category have the most physical activity. Also whether or not lunch is had at school is significantly associated to weekly physical activity; children at the only school that does not include lunch in the schedule experience significantly less physical activity during the week. This may be because when children have lunch at school, they generally also play outside for 15-30 minutes. This may not be the case for children who have lunch at home. Also the time school finishes is significantly associated with weekly physical activity as well as the school type. Children at public schools and the Jenaplan school experience significantly more weekly physical activity. Finally, weekly physical activity significantly decreases with increasing quality and capacity of bicycle storage and car

parking facilities. It is not clear why this relationship is occurs, it could be partly because, coincidentally the schools that have higher bike parking quality and car parking quality provide more physical education lessons or longer playing breaks.

Table 8.16 Independent t-test, one-way ANOVA and Spearman's correlation test results school factors – Satisfaction with travel and weekly physical activity

Variables	Satisfaction with travel		Weekly physical activity	
	Independent t-test			
	t	*Sig.*	*t*	*Sig.*
Lunch at school	-2.083*	0.038	2.019*	0.044
Decrease cars	-2.248*	0.025	-1.88	0.851
Safety measures	-0.265	0.791	0.908	0.364
AT initiative	-0.368	0.713	0.834	0.404
	One-way ANOVA			
	F	*Sig.*	*F*	*Sig.*
End of day	3.389**	0.004	6.309**	0.000
School type	0.609	0.565	4.651**	0.001
# pupils	1.028	0.358	8.512**	0.000
# pupils 5-8	1.026	0.359	5.618**	0.004
	Spearman's correlation			
	r	*Sig.*	*r*	*Sig.*
Free afternoons	0.117**	0.003	-0.038	0.328
Health initiatives	0.072	0.066	0.007	0.857
Bike parking quality	-0.128**	0.001	-0.101**	0.010
Car parking quality	0.023	0.550	-0.095*	0.014
Traffic safety	-0.074	0.057	0.052	0.185

**significant at the 0.05 level*
***significant at the 0.01 level*

Table 8.17 Descriptive statistics household factors with SWT and Weekly PA (means in green boxes differ significantly)

	Satisfaction with Travel				Weekly physical activity			
Variable	*N*	*Mean*	*St. dev.*	*St. error*	*N*	*Mean*	*St. dev.*	*St. error*
Total pupils in school								
Small (<150)	84	3.68	0.624	0.068	84	832.9	310.5	33.29
Average (150-280)	385	3.71	0.592	0.030	385	998.9	334.4	19.17
Large (>280)	191	3.77	0.580	0.042	191	969.9	343.1	21.18
Total pupils in grades 5-8								
Small (<90)	106	3.71	0.591	0.057	106	881.3	332.4	32.29
Average (90-130)	278	3.69	0.610	0.037	278	963.2	319.6	19.17
Large (>130)	276	3.76	0.576	0.035	276	1008.9	351.9	21.18
Lunch at school								
Yes	607	3.71	0.595	0.024	607	977.0	344.5	13.98
No	53	3.89	0.551	0.076	53	879.5	233.2	32.03
Time day ends								
14:00	176	3.60	0.636	0.048	176	989.7	342.4	25.81
14:30	159	3.81	0.565	0.045	159	989.1	335.3	26.59
14:45	241	3.72	0.562	0.036	241	994.0	335.2	21.59
15:00	31	3.67	0.671	0.120	31	710.2	380.7	68.38
15:15	53	3.88	0.551	0.076	53	879.5	233.2	32.03

	Satisfaction with Travel				Weekly physical activity			
Variable	*N*	*Mean*	*St. dev.*	*St. error*	*N*	*Mean*	*St. dev.*	*St. error*
School type								
Public	293	3.74	0.596	0.035	293	1007.0	352.8	20.61
Religious	145	3.67	0.584	0.049	145	993.4	315.3	26.19
Dalton school	122	3.74	0.593	0.054	122	882.5	263.4	23.85
Jenaplan school	22	3.82	0.439	0.094	22	1066.0	355.4	75.77
Special school	78	3.69	0.637	0.072	78	892.3	385.2	43.62
Health initiatives								
Some initiatives	214	3.70	0.572	0.039	214	998.9	364.1	24.89
Several initiatives	255	3.68	0.620	0.038	255	912.7	296.2	18.55
Strong health attitude	191	3.80	0.575	0.042	191	1011.3	350.6	25.37
Active Travel initiatives								
Yes	69	3.70	0.604	0.072	69	1001.3	327.9	39.47
No	591	3.73	0.592	0.024	591	965.4	339.1	13.95
Number of free afternoons								
Zero	176	3.60	0.636	0.048	176	989.8	342.4	25.8
One	315	3.77	0.557	0.031	315	964.4	334.4	18.8
Two	169	3.77	0.597	0.046	169	956.6	340.5	26.2
Bicycle parking								
Mediocre	168	3.81	0.530	0.041	168	1000.7	323.2	24.9
Sufficient	328	3.74	0.597	0.033	328	989.0	362.0	20.0
Good	164	3.59	0.626	0.049	164	897.3	290.8	22.7
Car parking quality								
Insufficient	107	3.75	0.544	0.053	107	1091.5	355.3	34.35
Mediocre	278	3.67	0.605	0.036	278	943.7	342.4	20.54
Sufficient to good	275	3.76	0.598	0.036	275	947.3	316.5	19.09
Decrease cars								
Yes	327	3.78	0.577	0.032	327	966.7	352.1	19.47
No	333	3.67	0.605	0.033	333	971.6	323.7	17.74
Traffic safety								
Insufficient	206	3.76	0.596	0.042	206	977.1	345.9	24.24
Mediocre	143	3.73	0.595	0.050	143	918.2	352.0	29.43
Sufficient	245	3.72	0.580	0.037	245	967.7	312.3	19.95
Good	66	3.61	0.625	0.077	66	1061	352.6	43.41
Safety measures								
Yes	47	3.70	0.622	0.091	47	1012	341.8	49.85
No	613	3.72	0.591	0.024	613	965.9	337.6	13.64

8.4.3 Parental safety perception

The only two school variables that are not significantly associated with parental safety perception are the amount of health initiatives that a school participates in and the quality and capacity of the bicycle storage. Table 8.18 shows the results of the bivariate analyses and table 8.19 shows the descriptive statistics. Parents of children in bigger schools have significantly fewer concerns. The parents of the children that attend the school that does not include lunch in their schedule also have fewer concerns. This may be because this specific school is located in a village, not in the city. The time school ends is also significantly associated with the parental safety perception, but there is no pattern visible. Parents of children who attend a school that finishes at 15:00 have the most concerns. Parents of children attending a special school have the most concerns, which is a significant association. These children generally live farther to school are likely to be driven to school by car or taxi-bus. Parental safety perception significantly decreases with an increasing amount of free afternoons. Parents of children that attend a school which takes active transport initiatives are more concerned. Possibly, these initiatives were launched as a result of safety issues. Roughly the same significant relationships exist between parental safety perception and car parking quality and traffic safety: when these aspects are judged sufficient to good, the parents are the least concerned. When the school makes an effort to decrease the amount of cars and take safety measures, parents are significantly more concerned about safety. This may relate to the fact that the traffic situations around these schools are more dangerous.

Table 8.18 Ind. t-test, one-way ANOVA and Spearman's correlation results school factors – par. safety perception

Variables	Parental safety perception total		Traffic safety		Traffic skills		Social safety	
	Independent t-test							
	t	*Sig.*	*t*	*Sig.*	*t*	*Sig.*	*t*	*Sig.*
Lunch at school	-2.925**	0.004	-3.091**	0.002	-1.178	0.239	-2.782**	0.006
Decrease cars	-4.087**	0.000	-4.974**	0.000	0.265	0.265	-3.552**	0.000
Safety measures	-7.229**	0.000	-5.635**	0.000	-4.500**	0.000	-2.453*	0.014
AT initiative	-2.264*	0.024	-2.797**	0.005	-0.080	0.937	-1.951	0.055
	One-way ANOVA							
	F	*Sig.*	*F*	*Sig.*	*F*	*Sig.*	*F*	*Sig.*
End of day	6.600**	0.000	3.152*	0.014	2.853*	0.023	4.644**	0.001
School type	16.400**	0.000	9.223**	0.000	9.046**	0.000	5.175**	0.000
# pupils	6.487**	0.002	4.425*	0.012	0.437	0.646	8.664**	0.000
# pupils 5-8	8.247**	0.000	6.415**	0.002	1.437	0.238	6.325**	0.002
	Spearman's correlation							
	r	*Sig.*	*r*	*Sig.*	*r*	*Sig.*	*r*	*Sig.*
Free afternoons	0.097*	0.013	0.031	0.426	0.052	0.180	0.033	0.398
Health initiatives	-0.054	0.162	-0.074	0.057	0.021	0.582	-0.164**	0.000
Bike parking quality	-0.054	0.163	0.011	0.768	0.037	0.346	-0.154**	0.000
Car parking quality	0.119*	0.002	0.146**	0.000	0.093*	0.017	-0.099*	0.011
Traffic safety	0.090*	0.020	0.111**	0.004	0.033	0.393	0.121**	0.002

**significant at the 0.05 level **significant at the 0.01 level*

Table 8.19 Descriptive statistics household factors with parental concerns (means in green boxes differ significantly)

	Parental safety perception			
Variable	*N*	*Mean*	*St. dev.*	*St. error*
Total pupils in school				
Small (<150)	84	3.44	0.64	0.070
Average (150-280)	385	3.67	0.55	0.028
Large (>280)	191	3.68	0.49	0.036

	Parental safety perception			
Variable	*N*	*Mean*	*St. dev.*	*St. error*
Total pupils in grades 5-8				
Small (<90)	106	3.45	0.609	0.059
Average (90-130)	278	3.66	0.555	0.033
Large (>130)	276	3.70	0.505	0.030
Lunch at school				
Yes	607	3.62	0.549	0.022
No	53	3.85	0.522	0.072
Time day ends				
14:00	176	3.56	0.560	0.042
14:30	159	3.74	0.480	0.038
14:45	241	3.63	0.543	0.035
15:00	31	3.36	0.716	0.129
15:15	53	3.85	0.522	0.072
School type				
Public	293	3.71	0.509	0.030
Religious	145	3.69	0.496	0.041
Dalton school	122	3.73	0.552	0.050
Jenaplan school	22	3.49	0.480	0.102
Special school	78	3.20	0.604	0.068
Number of free afternoons				
Zero	176	3.56	0.560	0.042
One	315	3.66	0.571	0.032
Two	169	3.70	0.489	0.038
Active transport initiatives				
Yes	69	3.50	0.588	0.071
No	591	3.66	0.543	0.022
Car parking quality				
Insufficient	107	3.70	0.531	0.051
Mediocre	278	3.50	0.572	0.034
Sufficient to good	275	3.76	0.500	0.030
Traffic safety				
Insufficient	206	3.67	0.518	0.036
Mediocre	143	3.34	0.590	0.049
Sufficient	245	3.78	0.513	0.033
Good	66	3.69	0.440	0.054
Decrease cars				
Yes	327	3.55	0.570	0.032
No	333	3.73	0.516	0.028
Safety measures				
Yes	47	3.10	0.500	0.073
No	613	3.68	0.532	0.021
Health initiatives				
Some initiatives	214	3.71	0.522	0.036
Several initiatives	255	3.60	0.595	0.037
Strong health attitude	191	3.63	0.511	0.037
Bicycle parking				
Mediocre	168	3.74	0.523	0.040
Sufficient	328	3.59	0.556	0.031
Good	164	3.65	0.554	0.043

8.5 Results physical and social environment

This section presents the results of the bivariate analyses that were conducted to test the relationships between the physical and social environmental factors and the various dependent variables. Chi square analyses, independent t-tests, one-way ANOVA analyses, Spearman's correlations and Pearson's correlations were applied in SPSS.

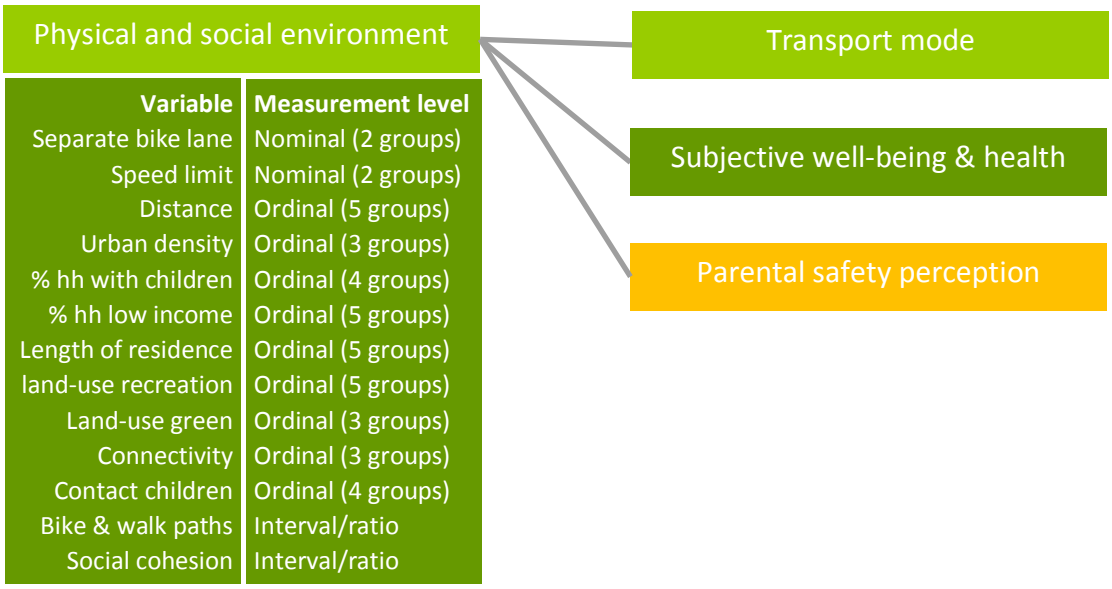


Figure 8.4 Visualization bivariate analyses physical and social environmental factors – dependent variables

8.5.1 Transport mode

As can be seen in table 8.20, all physical and social environmental variables except for the length of residence were found to be significantly associated with the transport mode a child used on the day of the survey. This means that the presence of a separate bicycle lane, the speed limit around the school site, the distance to school, the urban density level, the percentage of households with children in the neighborhood, the percentage of households with a low income, the percentage of land used for recreation purposes, the percentage of land used for green purposes, the connectivity, whether or not children often meet other children in the neighborhood, the quality of bike and walking infrastructure and social cohesion are all significantly associated with transport mode. Previous studies found significant associations with most of these aspects, e.g. green land-use (De Vries et al., 2010), connectivity (Panter et al., 2010b) and the presence of good local shops (Waygood & Susilo, 2015).

The relationship with distance is as expected, walking rates decrease with distance, car rates increase. The bicycle rates first increase with distance and after the turning point of 1-2 km they once again decrease. In the group of respondents living more than 5 km away, the 'other' transport mode is most used. This is the result of the two special education schools that have arranged for taxi-busses to pick-up the children who live far away. The importance of the distance to school as a determinant for transportation mode is the most commonly named variable in previous literature (e.g. Chillón et al., 2015; McMillan, 2007; Merom et al., 2006; Nelson et al., 2008; Panter et al., 2010). Cycling and walking rates are highest in the medium urban density areas, whereas car travel is highest in the areas with higher urban density. Kemperman & Timmermans (2014) also found associations between transport mode and urban density, although they found active travel to go up with urban density, which is not completely the case in the current study. Active travel rates are higher when parents strongly agree that there are different safe routes to take to school (connectivity). Children that walked to school live in the neighborhoods with highest rated social cohesion.

Table 8.20 Chi Square, one-way ANOVA and independent t-test results physical and social environmental factors – transport mode

Variables	TM day		Always bike		Car 4+		Walk 4+		Active/passive (N=647)	
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Separate bike lane	15.575**	0.001	1.050	0.306	0.112	0.737	0.062	0.803	3.048	0.081
Speed limit	78.670**	0.000	0.504	0.478	0.011	0.915	10.581**	0.001	29.402**	0.000
Distance	408.181**	0.000	31.500**	0.000	58.224**	0.000	218.484*	0.000	209.148**	0.000
Urban density	65.344**	0.000	4.328	0.115	10.674**	0.005	4.723	0.094	48.825**	0.000
% hh with children	82.743**	0.000	7.419	0.060	21.211**	0.000	32.664**	0.000	26.693**	0.000
% hh low income	79.917**	0.000	4.460	0.347	5.158	0.271	10.423*	0.034	45.527**	0.000
Length residence	20.295	0.062	5.520	0.238	2.406	0.661	13.389**	0.010	6.510	0.164
% land-use recreation	58.274**	0.000	5.667	0.225	1.937	0.747	23.366**	0.000	6.551	0.162
% land-use green	45.282**	0.000	5.259	0.072	17.626**	0.000	3.357	0.187	46.532**	0.000
Connectivity	50.510**	0.000	1.896	0.388	10.906**	0.004	4.197	0.123	34.375**	0.000
Contact children	30.943**	0.000	14.793**	0.002	0.794	0.851	21.084**	0.000	10.465*	0.015
	One-way ANOVA		**Independent t-test**							
	F	*Sig.*	*t*	*Sig.*	*t*	*Sig.*	*t*	*Sig.*	*t*	*Sig.*
Bike, walk paths	3.330*	0.019	0.212	0.832	0.938	0.349	-2.992**	0.003	0.686	0.493
Social cohesion	5.243**	0.001	0.497	0.619	-0.772	0.440	0.851	0.395	-3.243**	0.001

**significant at the 0.05 level* ***significant at the 0.01 level*

It may be that when people walk they run into more neighbors and their social cohesion perception could improve, resulting in their children to be allowed to travel more independently. Only the distance to school and the contact with children in the neighborhood have a significant relationship with whether or not a child always uses the bicycle to get to school. The percentage of children using the bicycle daily is highest in the 500-1000 m distance category and second highest in the 1-2 km category. Urban density, the percentage of households with children, the percentage of land used for green and connectivity are significantly associated with car travel, but they do not play a significant role for walking to school. On the other hand, variables that have a significant relationship with walking to school are the speed limit around school, the percentage of households with low income, the length of residence, the land used for recreation, the contact with other children in the neighborhood and the quality of bicycle and pedestrian infrastructure. Surprising, better walking and cycling paths are associated with lower walking rates. Perhaps parents that walk a lot with their children are less positive about paths. Finally, distance and percentage of households with children play a significant role for both walking and traveling by car. The share of children using the car four or more times is lowest in the <500m distance category, but it is roughly the same between 500 m and 5 km. The car travel decreases with a decrease in urban density and also decreases when connectivity is rated better. When looking at the children that travel at least four days per week by foot, distance has a negative relationship with walking. When recreation land-use is higher, so is the percentage of children walking at least four times per week. Concerning the variable whether children travel more passively or actively on an average week, the same independent variables are associated significantly as for the overall transport mode variable, except for percentage of land used for recreation and the quality of bicycle and pedestrian infrastructure. A larger distance to school is associated with a smaller percentage of

children traveling more actively, higher urban density with more passive travel. Apparently, parents in more densely populated areas more often drive their children to school. Higher connectivity as well as social cohesion are associated with more active travel.

8.5.2 Subjective well-being and health

Tables 8.21 shows the results of the bivariate analyses between mood, health, trip companions, trip interaction and travel alone frequency and the various social and physical environmental variables. The variables in this section that are significantly associated with the mood of the child on the day of the survey are the distance to school, the urban density, the percentage of households with a low income in the neighborhood, whether or not the child has contact with other children in the neighborhood, the quality of bike and walking infrastructure and social cohesion. The mood of children increases with a decrease in travel distance. Although the difference is small, children with a good or very good mood live in neighborhoods with higher social cohesion than children with an average to bad mood. Variables that are significantly associated with parent-assessed health are the speed limit, the distance to school, the urban density and whether or not the child has contact with other children in the neighborhood. Children that have a very good parent-assessed health more often have contacts with children in the neighborhood. The association of contact with children in the neighborhood with mood and health may be in line with the finding that having connections in the neighborhood is beneficial for both physical and subjective well-being (Helliwell & Putnam, 2004), for adults as well as children (Waygood et al., 2017a). Most social and physical environmental variables had a significant relationship with the trip companions on the day of the survey. Only the presence of a separate bicycle lane and the percentage of recreation land-use are not significantly associated with trip companions.

Table 8.21 Chi Square test results physical and social environment – mood, health and social contacts

Variables	**Mood**		**Health**		**Trip companions**		**Trip interaction**		**Travel alone frequency**	
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Sep. bike lane	1.174	0.556	0.284	0.594	9.785	0.082	7.669*	0.022	1.299	0.522
Speed limit	3.956	0.138	8.148**	0.004	22.127**	0.000	12.264**	0.002	10.999**	0.004
Distance	16.842*	0.032	15.094**	0.005	61.426**	0.000	87.308**	0.000	60.635**	0.000
Urban density	19.757**	0.001	10.230**	0.006	20.468*	0.025	29.071**	0.000	29.343**	0.000
% hh with children	1.726	0.943	2.045	0.563	47.275**	0.000	14.199*	0.027	12.523	0.051
% hh low income	18.576*	0.017	7.050	0.133	33.156**	0.001	39.902**	0.000	28.972**	0.000
Length residence	3.425	0.905	6.313	0.177	57.179**	0.000	15.660*	0.048	8.977	0.344
% land-use recr.	4.317	0.827	2.800	0.592	14.554	0.267	18.813*	0.016	14.380	0.072
% land-use green	9.252	0.055	2.703	0.259	35.283**	0.000	15.902**	0.003	29.868**	0.000
Connectivity	5.366	0.252	1.442	0.486	19.686*	0.032	24.106**	0.000	26.092**	0.000
Contact children	16.709**	0.010	11.749**	0.008	28.118*	0.021	248.730**	0.000	2.938	0.817
	One-way ANOVA		**Indep. t-test**		**One-way ANOVA**					
	F	*Sig.*	*t*	*Sig.*	*F*	*Sig.*	*F*	*Sig.*	*F*	*Sig.*
Bike & walk paths	4.175*	0.016	-0.481	0.631	3.954**	0.002	1.230	0.293	3.966*	0.019
Social cohesion	3.480*	0.031	-4.740**	0.000	2.741*	0.018	47.095**	0.000	7.133**	0.001

**significant at the 0.05 level **significant at the 0.01 level*

The only independent variable not significantly associated with trip interaction, whether or not the child usually runs into other children on the way to school, is bicycle and walking paths. When the distance to school is smaller, children are more likely to run into other children. They are also more likely to run into other children when the percentage of children in the neighborhood is one of the higher categories. When they have contacts with children in the neighborhood, they are more likely to run into children on the way to school. For traveling alone, the distance, urban density, the speed limit, the percentage of households with a low income, the percentage of green land-use, the connectivity, the bike and walking infrastructure and the social cohesion are significantly associated. The association between traveling alone and social cohesion is supported by the previous theory that children living in neighborhoods with high social cohesion and a likeliness of meeting friends during travel are more likely to be allowed to travel unaccompanied by their parents (Aarts et al., 2013; Veitch et al., 2017). The direction of this relationship in the current study is, however, not entirely the same. Children that almost never travel alone do live in areas with the lowest social cohesion, but children that travel alone little to sometimes live in areas with the highest social cohesion.

Table 8.22 shows the results of the bivariate analyses between the physical and social environmental factors and the satisfaction with travel and weekly physical activity of children. For the satisfaction with travel only whether or not the child had contact with other children in the neighborhood, the quality of walking and bicycle infrastructure and the social cohesion were found to be significantly associated. Children of which the parents strongly agree with the statement that their children have a lot of contact with other children in the neighborhood generally have a higher value for satisfaction with travel, indicating that they are more satisfied. The infrastructure variable is positively correlated with travel satisfaction, indicating that children whose parents are more satisfied with the infrastructure for biking and walking, are themselves more satisfied with the trip. Likewise, social cohesion is positively correlated with travel satisfaction, indicating that children living in a neighborhood that is rated higher on social cohesion are more satisfied with their trip to school.

Table 8.22 Independent t-test, Spearman's correlation and Pearson's correlation results social and physical environment – satisfaction with travel and weekly physical activity

Variables	**Satisfaction with travel**		**Weekly physical activity**	
	Independent t-test			
	t	*Sig.*	*t*	*Sig.*
Separate bike lane	-1.329	0.184	0.449	0.654
	Spearman's correlation			
	r	*Sig.*	*r*	*Sig.*
Speed limit	-0.028	0.468	-0.177**	0.000
Distance	-0.017	0.669	-0.075	0.054
Urban density	0.068	0.081	0.036	0.355
% hh with children	-0.005	0.900	-0.030	0.442
% hh low income	-0.072	0.065	-0.023	0.558
Length residence	-0.071	0.069	0.005	0.902
% land-use recreation	-0.050	0.200	0.085*	0.029
% land-use green	0.075	0.054	0.077*	0.047
Connectivity	-0.012	0.754	-0.037	0.338
Contact children	0.082*	0.036	0.230**	0.000
	Pearson's correlation			
	r	*Sig.*	*r*	*Sig.*
Bike + walk paths	0.087*	0.026	-0.072	0.065
Social cohesion	0.113**	0.004	0.092*	0.018

**significant at the 0.05 level*
***significant at the 0.01 level*

Westman et al. (2017) found that when children engaged in social activities during their trip to school, they were more satisfied with the trip, which is in line with the current study's findings so far. However, Westman et al. (2017) also found duration of trip to be significantly associated with travel satisfaction, which is an association not found in the results of the current bivariate analyses. Nevertheless, a significant association was found where a longer distance was associated with a less positive mood (table 8.21), which may also reflect satisfaction.

There are also some significant correlations for weekly physical activity. Firstly speed limit is negatively correlated with weekly physical activity; children that attend a school in an area with a speed limit of 50km/h are less physically active in an average week. As mentioned earlier, this effect most likely occurs because only one school is situated in a 50 km/h area, so there are probably other school factors at play. The percentage of land used for recreation and for green both significantly and positively correlate with weekly physical activity; the weekly physical activity roughly increases with the percentage of land used for recreation and for green purposes. Whether or not the child has a lot of contact with other children in the neighborhood also positively correlates with weekly physical activity; the mean hours of physical activity is a lot higher for children who are said to have a lot of contact with other children in the neighborhood than for those who are said to not have so much contact.

Table 8.23 Descriptive statistics physical and social environment factors – satisfaction with travel and weekly physical activity (means in green boxes differ significantly).

	Satisfaction with Travel				Weekly physical activity			
Variable	*N*	*Mean*	*St. dev.*	*St. error*	*N*	*Mean*	*St. dev.*	*St. error*
Separate bike lane								
Yes	134	3.662	0.627	0.054	134	982.7	391.1	33.79
No	526	3.74	0.584	0.025	526	965.8	323.2	14.09
Speed limit								
30 km/h	629	3.73	0.589	0.024	629	981.9	330.7	13.19
50 km/h	31	3.67	0.671	0.120	31	710.2	380.7	68.4
Distance to school								
<500 m	145	3.73	0.530	0.044	145	1004.1	352.7	29.29
500-1000 m	190	3.71	0.579	0.042	190	980.1	328.7	23.84
1 – 2 km	172	3.77	0.593	0.045	172	964.5	334.0	25.47
2 – 5 km	100	3.67	0.665	0.067	100	936.6	334.4	33.44
>5 km	53	3.71	0.669	0.092	53	909.3	346.5	47.59
Urban density								
1 – 2 (>1500 addr. per km²)	201	3.64	0.635	0.045	201	949.0	348.2	24.56
3 1000-1500 addr. per km²)	283	3.75	0.601	0.036	283	978.9	344.1	20.46
4 – 5 (<1000 addr. per km²)	176	3.77	0.520	0.039	176	976.1	315.9	23.81
% households with children								
0-25%	83	3.71	0.65	0.072	83	962.5	294.7	32.35
26-30%	193	3.73	0.580	0.042	193	989.2	360.3	25.93
31-45%	276	3.72	0.590	0.036	276	964.1	335.0	20.16
>45%	108	3.73	0.582	0.056	108	951.4	337.6	32.48
% households with low income								
0-20%	130	3.76	0.580	0.051	130	966.8	332.9	29.19
21-30%	140	3.77	0.579	0.049	140	994.1	319.3	26.99
31-40%	183	3.76	0.546	0.040	183	969.3	324.6	23.99
41-60%	135	3.66	0.575	0.049	135	937.3	346.4	29.81
>60%	72	3.61	0.760	0.090	72	984.5	398.2	46.92

	Satisfaction with Travel				Weekly physical activity			
Variable	*N*	*Mean*	*St. dev.*	*St. error*	*N*	*Mean*	*St. dev.*	*St. error*
Length of residence								
<2 years	84	3.68	0.553	0.060	84	927.8	296.7	32.38
2 – 5 years	112	3.70	0.696	0.066	112	965.9	332.4	31.41
5 – 10 years	141	3.71	0.619	0.052	141	991.8	328.9	32.82
10 – 15 years	222	3.71	0.555	0.037	222	978.4	365.0	24.50
>15 years	101	3.85	0.537	0.053	101	955.5	329.9	32.82
% land-use recreation								
0-2.5%	158	3.78	0.577	0.046	158	950.4	327.2	26.03
2.6-5%	133	3.72	0.592	0.051	133	918.2	305.0	26.44
6-10%	192	3.69	0.635	0.046	192	958.4	318.3	22.97
11-20%	125	3.77	0.492	0.044	125	1041.4	381.4	34.11
21+ %	52	3.56	0.681	0.095	52	1022.8	384.0	53.25
% land-use green								
0%	277	3.66	0.635	0.038	277	946.2	359.4	21.59
1-10%	220	3.75	0.519	0.035	220	974.2	305.2	20.58
>10%	163	3.79	0.606	0.047	163	1001.3	341.2	26.72
Connectivity "There are different routes in our neighborhood that my child can take to come to school"								
(strongly) Disagree	173	3.76	0.563	0.043	173	994.6	355.0	26.99
Neutral	174	3.69	0.645	0.049	174	961.4	349.3	26.48
(strongly) Agree	313	3.72	0.579	0.033	313	959.5	321.7	18.18
Contact children "My child has a lot of contact with other children in the neighborhood"								
(strongly) Disagree	92	3.74	0.505	0.053	92	822.2	290.8	30.31
Neutral	159	3.62	0.648	0.051	159	899.0	325.4	25.80
Agree	307	3.74	0.574	0.033	307	1021.1	329.5	18.81
Strongly agree	102	3.83	0.620	0.061	102	1054.8	361.8	35.83

8.5.3 Parental safety perception

The last dependent variable is about the parental safety perception, consisting of perceived traffic safety, traffic skills of children and neighborhood social safety. The results of the bivariate analyses that were conducted for these variables can be seen in table 8.24, the descriptive statistics are presented in table 8.25. Parents of children of the school in the 50km/h zone are significantly more concerned. Furthermore, parental safety perception significantly decreases with the increase in distance to school and it significantly improves with decreasing urban density. Parents in neighborhoods with 26-30, 31-45 or over 45% households with children are mostly equally concerned, but parents in neighborhoods with 25% or less are significantly more concerned. Parental safety perception also significantly decreases with an increase in the percentage of households with a low income. Finally, parental safety perception is significantly higher in areas with more green and with better connectivity. When looking specifically at the three components of parental safety perception, it becomes visible that the highest number of variables is significantly associated with social safety, followed by traffic safety. Only two have a significant relationship with traffic skills. Variables that were associated significantly with parental safety perception overall, but not with only traffic safety, are the speed limit and urban density. The only two variables associated significantly with traffic skills are the connectivity and the bicycle and walking infrastructure. Speed limit and the percentage of households with children are no longer significant when only looking at social safety. Additional significant relationships for social safety occur with the percentage of land used for recreation and with the contact with children in the neighborhood. There is a positive correlation between land used for recreation and social safety: higher percentages of recreation land-use correlate with a higher (more positive) parental safety perception. The correlation with the contact with other children in the neighborhood is also positive, parents who believe their children have many contacts in the neighborhood are less concerned.

Table 8.24 *Independent t-test, Spearman's correlation and Pearson's correlation results social and physical environment – Parental safety perception*

Variables	Parental safety perception total		Traffic safety		Traffic skills		Social safety	
	Independent t-test							
	t	*Sig.*	*t*	*Sig.*	*t*	*Sig.*	*t*	*Sig.*
Separate bike lane	-1.780	0.075	-0.896	0.371	-1.236	0.218	-0.232	0.816
	Spearman's correlation							
	r	*Sig.*	*r*	*Sig.*	*r*	*Sig.*	*r*	*Sig.*
Speed limit	-0.092*	0.018	-0.034	0.377	-0.045	0.249	-0.072	0.066
Distance	-0.229**	0.018	-0.170**	0.000	-0.063	0.103	-0.140**	0.000
Urban density	0.155**	0.007	0.063	0.107	0.049	0.206	0.270**	0.000
% hh with children	0.105**	0.007	0.107**	0.006	0.009	0.822	0.074	0.058
% hh low income	-0.188**	0.000	0.141**	0.000	-0.019	0.627	-0.266**	0.000
Length residence	-0.006	0.878	-0.043	0.269	0.027	0.488	-0.024	0.538
% land-use recreation	0.047	0.224	0.002	0.925	0.062	0.112	0.144**	0.000
% land-use green	0.127**	0.001	0.077*	0.047	0.042	0.277	0.133**	0.001
Connectivity	0.334**	0.000	0.414**	0.000	0.179**	0.000	0.171**	0.000
Contact children	0.063	0.105	0.050	0.202	0.005	0.892	0.130**	0.001
	Pearson's correlation							
	r	*Sig.*	*r*	*Sig.*	*r*	*Sig.*	*r*	*Sig.*
Bike + walk paths	0.272**	0.000	0.367**	0.000	0.141**	0.000	0.163**	0.000
Social cohesion	0.234**	0.000	0.177**	0.000	0.062	0.113	0.340**	0.000

**significant at the 0.05 level*
***significant at the 0.01 level*

Table 8.25 *Descriptive statistics social and physical environmental factors and parental safety perception (means in green boxes differ significantly)*

Variable	Parental safety perception			
	N	*Mean*	*St. dev.*	*St. error*
Separate bike lane				
Yes	134	3.57	0.577	0.050
No	526	3.66	0.542	0.024
Speed limit				
30 km/h	629	3.66	0.537	0.021
50 km/h	31	3.36	0.716	0.129
Distance to school				
<500 m	145	3.74	0.480	0.040
500-1000 m	190	3.74	0.511	0.037
1 – 2 km	172	3.67	0.529	0.040
2 – 5 km	100	3.49	0.624	0.062
>5 km	53	3.20	0.518	0.071
Urban density				
1 – 2 (>1500 addr. per km²)	201	3.49	0.601	0.042
3 1000-1500 addr. per km²)	283	3.69	0.518	0.031
4 – 5 (<1000 addr. per km²)	176	3.74	0.502	0.038
% households with children				
0-25%	83	3.39	0.552	0.061
26-30%	193	3.68	0.550	0.040
31-45%	276	3.67	0.548	0.033
>45%	108	3.69	0.505	0.049

Variable	Parental safety perception			
	N	*Mean*	*St. dev.*	*St. error*
% households with low income				
0-20%	130	3.70	0.520	0.046
21-30%	140	3.74	0.505	0.043
31-40%	183	3.72	0.478	0.035
41-60%	135	3.54	0.622	0.054
>60%	72	3.31	0.567	0.067
Length of residence				
<2 years	84	3.64	0.536	0.059
2 – 5 years	112	3.60	0.598	0.057
5 – 10 years	141	3.68	0.562	0.047
10 – 15 years	222	3.64	0.532	0.036
>15 years	101	3.62	0.532	0.053
% land-use recreation				
0-2.5%	158	3.56	0.558	0.044
2.6-5%	133	3.64	0.549	0.048
6-10%	192	3.71	0.502	0.036
11-20%	125	3.76	0.507	0.045
21+ %	52	3.39	0.681	0.094
% land-use green				
0%	277	3.52	0.617	0.037
1-10%	220	3.75	0.485	0.033
>10%	163	3.70	0.468	0.037
Connectivity "There are different routes … - … to come to school"				
(strongly) Disagree	173	3.41	0.574	0.044
Neutral	174	3.53	0.571	0.043
(strongly) Agree	313	3.83	0.448	0.025
Contact children "My child has a lot of contact with other children…"				
(strongly) Disagree	92	3.60	0.617	0.064
Neutral	159	3.58	0.577	0.046
Agree	307	3.66	0.513	0.029
Strongly agree	102	3.72	0.544	0.054

8.6 Results external factors

The results of the bivariate analyses that were conducted to investigate the relationship between the one external factor, weather, and four dependent variables are presented in tables 8.26 & 8.27. The analyses were only conducted between the weather variable and the dependent variables that relate to the day of the survey. After all, it would not make sense to search for associations between the weather on one particular day and, for instance, the average weekly physical activity.

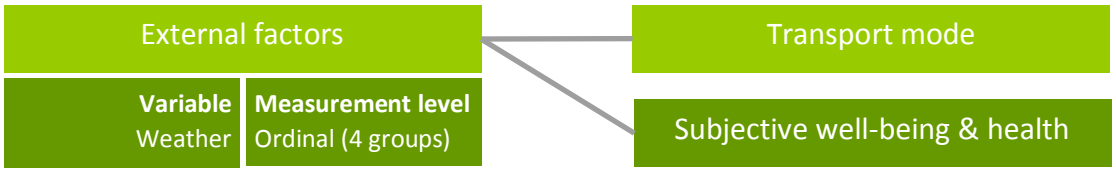


Figure 8.5 Visualization of bivariate analyses external factor and dependent variables

The weather on the day of the survey has a significant relationship with the transport mode that the child used that day. This is supported by previous research, several researchers found the weather to be a motive of parents by which they decide what transport mode their children would use to get to school (Bringolf-Isler et al., 2007; Buliung et al., 2011; Faulkner et al., 2010; Salmon et al., 2007). On the other hand, some quantitative studies did not find associations between weather and children's participation in active travel (Mitra & Faulkner, 2012; Robertson-Wilson, Leatherdale, & Wong, 2008). The weather was also significantly associated with the mood of the child. This is a matter of common sense, generally people's moods are influenced by the weather, especially by very sunny or very rainy weather. In line with this belief, weather also was found to have a significant relationship with satisfaction with travel. SWT was highest on days that it was very sunny. No significant association was found between the weather and the trip companions on the day of the questionnaire.

Table 8.26 Chi Square and Spearman's correlation test results external factors – transport mode and social contacts

Variables	**TM day**		**Trip companions day**		**Mood**	
	Chi Square analysis					
	Chi Sq.	*Sig.*	*Chi Sq.*	*Sig.*	*Chi Sq.*	*Sig.*
Weather	32.374*	0.000	14.402	0.109	21.814**	0.001
	Satisfaction with travel					
	Spearman's correlation					
	r	*Sig.*				
Weather	0.102**	0.009				

**significant at the 0.05 level*
***significant at the 0.01 level*

Table 8.27 Descriptive statistics weather – satisfaction with travel

	Satisfaction with travel			
Variable	*N*	*Mean*	*St. dev.*	*St. error*
Sunny	57	3.91	0.602	0.080
Partly clouded	282	3.76	0.610	0.036
Very clouded	249	3.65	0.562	0.036
Raining	72	3.71	0.589	0.069

8.7 Results dependent variables analyses

In this section, the results of the bivariate analyses to test the associations between the dependent variables are presented. Not all components of the variables that have been investigated in the analyses above are included in this section, only the main dependent variables are included: transport mode on the day of the survey, active vs. passive transport in an average week, mood, health, trip companions on the day of the survey, frequency of traveling alone, satisfaction with travel, weekly physical activity and parental safety perception. Table 8.28 shows the results of the bivariate analyses between the dependent variables. Table 8.29 shows some descriptive statistics. Note that the active vs. passive variable is coded as active = 1 and passive = 2. This means that a positive relationship with this variable indicates a positive relationship with more passive travel.

As can be seen in table 8.28, transport mode on the day of the survey is significantly associated with all other dependent variables except for mood. Naturally, children that came by car almost always traveled with a parent or a parent and a sibling. The bicycle is most often used by children that traveled alone, and also the highest percentage of children that walked, walked alone. However, traveling with a parent and sibling is a close second in the category walking. Children in the category 'very good health' more often traveled by foot or bicycle. The highest percentage of children that often run into

other children on the way to school come by foot, the second highest by bicycle. Children that came to school by car were the least satisfied, children that came by an 'other' mode were most satisfied. A close second and third are cycling and walking. The association between active vs. passive travel and satisfaction is in line with findings of Stark et al. (2018). The result for the 'other' mode resulting in the most satisfied children is quite surprising, although it might be (partly) caused by the fact that these children mostly came by taxi-bus, they travel together with other children. Possibly, this traveling together is a lot of fun, which would be in line with the finding of Westman et al. (2017) that traveling by school bus resulted in higher satisfaction with travel than traveling by car. The mean weekly physical activity is by far highest for children that walked to school. Parents of children that cycle have the most positive safety perception, second place is for parents of children that walk. Several researchers found parental safety perception to influence travel mode and independent travel of children (e.g. Carver, Timperio & Crawford, 2008a; Veitch et al., 2017; Rothman et al., 2015). The variable that indicates active or passive travel is significantly associated with all dependent variables except for the satisfaction with travel. This is not completely surprising, as active/passive is an overall indicator, whereas satisfaction with travel is an indicator for that particular day. Children that travel more actively have a higher parent-assessed health, have more overall weekly physical activity and less concerned parents. Some researchers also found that children who travel more actively, also experience more physical activity in general (Roth, Millet & Mindell, 2012; Faulkner et al., 2009).

Table 8.28 Results bivariate analyses of the dependent variables

Variables	Transport mode day		Active vs. Passive		Travel alone frequency		Trip companions		Mood		Health	
	Chi Square											
	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.
Act vs. Pass	355.9**	.000										
Alone	129.8**	.000	109.4**	.000								
Trip comp.	183.0**	.000	81.47**	.000	291.5**	.000						
Mood	7.181	.304	7.304*	.026	12.32*	.015	15.39	.118				
Health	18.17**	.000	8.477**	.004	0.222	.895	14.14*	.015	.416	.812		
Trip int.	50.42**	.000	23.873**	.000	16.79**	.002	11.76	.068	10.29*	.036	10.31**	.006

Variables	SWT		PA weekly		Parent safety perception	
	Independent t-test					
	t	Sig.	t	Sig.	t	Sig.
Active vs. passive	-1.503	0.133	-2.325*	0.020	-9.190**	0.000
Health	-2.534*	0.011	-2.543**	0.000	-4.840**	0.000
	One-way ANOVA					
	F	Sig.	F	Sig.	F	Sig.
Transport mode day	2.730*	0.043	3.629*	0.013	38.80**	0.000
Trip companions	3.553**	0.004	1.344	0.244	18.49**	0.000
	Spearman's correlation					
	r	Sig.	r	Sig.	r	Sig.
Mood	-0.466**	0.000	-0.052	0.185	-0.058	0.135
Travel alone frequency	0.014	0.716	0.016	0.687	0.435**	0.000
Trip interaction	0.098*	0.012	0.187**	0.000	0.155**	0.000
	Pearson's correlation					
	r	Sig.	r	Sig.	r	Sig.
SWT						
PA weekly	0.083*	0.033				
Parent safety perception	0.119**	0.002	0.073	0.060		

**significant at the 0.05 level*
***significant at the 0.01 level*

The frequency of traveling alone is significantly associated with transport mode, active/passive, the social companions of the trip, the mood and parental safety perception. There is no significant association with PA weekly, satisfaction with travel and health. Children that travel alone more often have less concerned parents. The trip companions variable has a significant relationship with all dependent variables except for mood and PA weekly. Children that traveled with a friend or with a parent and sibling were the most happy. Children that traveled alone were the most satisfied, second and third place are children that traveled with a sibling and with a friend. The mood of the child on the day of the survey is only significantly associated with active/passive travel, travel alone frequency and satisfaction with travel. As expected, when children are more happy, they are also more satisfied. The parent-assessed health of the child is associated with all other dependent variables except for travel alone frequency and mood. Healthier children also have more weekly physical activity and their parents have a more positive safety perception. The variable trip interaction, whether the child usually meets other children on the way to school, is significantly associated with all dependent variables except for the social trip companions. Children that usually run into other children on the way to school are more satisfied, have more overall weekly physical activity and less concerned parents.

The satisfaction with travel is significantly associated with all dependent variables except for active vs. passive and the travel lone frequency. Higher satisfaction with travel is associated with more weekly physical activity and a better parental safety perception. The weekly physical activity that children get is significantly associated with active/passive travel, health, the transport mode of the day and satisfaction with travel. The association with active vs. passive travel mode is not surprising, because active travel can be a regular source of physical activity. Finally, parental safety perception is significantly associated with all dependent variables except for mood and weekly PA. When children travel alone more often and when they are (according to parents) more likely to run into other children on the way to school, parents have fewer concerns.

Table 8.29 Descriptive statistics dependent variables satisfaction with travel, weekly physical activity and parental safety perception (means in green boxes differ significantly)

Variable	Satisfaction with travel				Weekly physical activity				Parent safety perception			
	N	*Mean*	*St. Dev.*	*St. error*	*N*	*Mean*	*St. Dev.*	*St. error*	*N*	*Mean*	*St. Dev.*	*St. error*
Transport mode												
Walking	140	3.75	0.533	0.045	140	1047.7	365.5	30.89	140	3.70	0.495	0.042
Bicycle	315	3.76	0.600	0.034	315	954.7	317.0	17.86	315	3.80	0.467	0.026
Car	148	3.60	0.624	0.051	148	951.2	319.1	26.23	148	3.46	0.586	0.048
Other	57	3.79	0.579	0.077	57	902.9	398.4	52.77	57	3.10	0.537	0.071
Active/passive												
More passive	155	3.66	0.625	0.050	155	914.6	337.6	27.11	155	3.28	0.602	0.048
More active	492	3.75	0.578	0.026	492	986.6	335.5	15.13	492	3.76	0.473	0.021
Travel alone												
(almost) never	260	3.71	0.591	0.037	260	946.9	331.1	20.53	260	3.33	0.562	0.035
Little-sometimes	199	3.72	0.584	0.041	199	1005.0	323.7	22.94	199	3.79	0.437	0.031
Often-always	201	3.74	0.607	0.043	201	962.5	358.4	25.28	201	3.90	0.432	0.030
Health												
Average - good	346	3.67	0.604	0.032	346	903.8	323.6	17.40	346	3.55	0.546	0.029
Very good	314	3.78	0.576	0.032	314	1041.2	339.0	19.13	314	3.75	0.535	0.030
Mood												
Very happy	150	4.11	0.606	0.050	150	989.8	330.1	26.95	150	3.66	0.552	0.045
Happy	311	3.77	0.473	0.027	311	972.4	329.3	18.67	311	3.67	0.531	0.030
Average-unhappy	199	3.36	0.543	0.038	199	948.6	356.8	25.29	199	3.58	0.574	0.041

Variable	Satisfaction with travel				Weekly physical activity				Parent safety perception			
	N	*Mean*	*St. Dev.*	*St. error*	*N*	*Mean*	*St. Dev.*	*St. error*	*N*	*Mean*	*St. Dev.*	*St. error*
Trip companions												
Alone	155	3.69	0.609	0.049	155	983.5	364.7	29.29	155	3.91	0.438	0.035
Sibling	48	3.62	0.627	0.091	48	944.3	267.1	38.55	48	3.76	0.493	0.071
Friend	79	3.96	0.537	0.060	79	975.0	369.7	41.59	79	3.74	0.501	0.056
Parent	161	3.64	0.566	0.045	161	924.5	324.5	25.58	161	3.41	0.547	0.043
Parent + sibling	176	3.75	0.606	0.046	176	1011.2	325.2	24.51	176	3.61	0.542	0.041
Other	41	3.75	0.541	0.085	41	928.1	339.2	52.98	41	3.33	0.605	0.095
Trip interaction												
Disagree-neutral	217	3.65	0.610	0.041	217	883.0	340.9	23.14	217	3.53	0.602	0.041
Agree	369	3.75	0.592	0.031	369	1006.0	319.8	16.65	369	3.67	0.514	0.027
Strongly agree	74	3.80	0.527	0.061	74	1038.5	370.3	43.04	74	3.83	0.503	0.058

8.8 Conclusion

In this chapter hundreds of bivariate analyses have been conducted in order to gain a better understanding of the associations between all independent and dependent variables. The aim was to test which associations are significant and to use this knowledge in preparation of the regression analyses, described in the next chapter. A large amount of significant associations has been found, all independent variables were significantly associated with at least one of the dependent variables. However, also some independent variables were not well distributed because they were measured on the school level and apply only to one of the schools. These variables (lunch at school, safety measures at school and speed limit) will not be included in the regression analyses. Figures 8.6 and 8.7 visualize the associations between all independent variables and dependent variables. A distinction is made between the relationships at the 0.01 significance level and the 0.05 significance level. Table 8.7 shows that especially transport mode, active/passive travel and trip companions have a significant association with almost all independent variables. The figures also indicate for the relationships with dependent variables of ratio/interval scale whether the association is positive (+) or negative (-).

In total, 38 independent variables will be taken to the next step: regression analysis. In the next chapter the variables will first be checked for mutual correlations. If independent variables are too strongly associated with each other, they cannot both be included in the regression analyses. Moreover, a decision will be made for some similar variables such as household size and household composition, which of the two will be removed. After that, regression analyses will be conducted and described.

	Transport mode	*Active vs. passive*	*Travel alone*	*Trip comp.*	*Trip int.*	*Mood*	*Health*	*SWT*	*PA weekly*	*Safety perception*
Transport mode										
Active vs. Passive										
Travel alone										
Trip companions										
Trip interaction										
Mood										
Health										
SWT				+	+	-	-			
PA weekly		-			+		-	+		
Safety perception		-	+	+	+		-	+		

	Sig. 0.01 level		Sig 0.05 level		Not significant

Figure 8.6 Overview results bivariate analyses dependent variables

	Transport mode	*Always bike*	*Car 4+ times*	*Walk 4+ times*	***Active vs. passive***	***Safety perception***	*Traffic safety*	*Traffic skills*	*Social safety*	***Health***	***Mood/ happiness***	***PA weekly***	***SWT***	***Trip companions***	*Travel alone frequency*	*Trip interaction*
Personal factors																
Age						+	+	+	+			-				
Grade						+	+	+	+							
Gender																
Favorite mode																
Active/passive pr.																
Household factors																
HH size							+						+			
HH composition																
Ethnicity																
HH income						-	-		-			-	-			
Car ownership							+		+			+				
HH work status												+				
Car use parents												+				
AT parents																
Daycare						-	-	-				+				
School factors																
Lunch at school																
End of school																
School type																
Free afternoons						-							+			
Health initiatives									-							
AT initiatives																
Bike parking quality									-			-	-			
Car parking quality						+	+	+	-			-				
Traffic safety						+	+		+							
Decrease cars																
Safety measures																
# pupils																
# pupils 5 – 8																
Physical and social environment																
Sep. bike lane																
Speed limit																
Distance						-	-		-							
Urban density						+			+							
% hh children						+	+									
% hh low income						-	+		-							
Length residence																
Rec. land-use									+			+				
Green land-use						+	+		+			+				
Connectivity						+	+	+	+							
Contact children									+			+	+			
Bike, walk paths						+	+	+	+				+			
Social cohesion						+	+		+				+			
External factors																
Weather													+			

	Sig. 0.01 level		*Sig 0.05 level*		*Not significant*		*Not suitable/remove*

Figure 8.7 Overview results bivariate analyses independent variables

CHAPTER 9

REGRESSION ANALYSES

Drawing by Desiree & Amber van de Craats, 2018

9. REGRESSION ANALYSES

In this chapter, the results of the regression analyses, approached as multilevel models, will be discussed. Depending on the measurement scale of the dependent variables, either multilevel linear regression analyses or multilevel logistic regression analyses were conducted. A multilevel approach was used due to the fact that respondents are nested in different schools. The aim of the regression analyses is to determine the combined predicting power of the independent variables, while controlling for the effect of the respondents being clustered into different schools. The first section of the chapter will explain the basic principles and assumptions for the multilevel regression analyses, the remainder of the chapter will describe and analyze the results of the analyses. Multilevel linear regression analyses were conducted to investigate the relationships between the dependent variables parental safety perception, satisfaction with travel and weekly physical activity with the independent variables that were found to be significantly associated in the bivariate analyses in chapter 8. Multilevel logistic regression analyses were conducted to investigate the relationships between the active vs. passive travel dependent variable and the transport mode dependent variable with the independent variables that were found to be significantly associated in the bivariate analyses.

9.1 Explanation of multilevel regression analysis

As explained by Field, Miles, & Field (2013), *"regression analysis is a way of predicting an outcome variable from one predicter variable (simple regression) or several predicter variables (multiple regression)"* (Field, Miles, & Field, 2013. p. 198). Using regression, the relationship between an outcome variable and a set of predictor variables can be analyzed (Ho, 2014). For the regression analysis of the nominal outcome variables transport mode and active vs. passive travel, logistic regression will be used (multinomial and binary). For the analyses of the interval/ratio outcome variables parental safety perception, weekly physical activity and satisfaction with travel, linear regression will be used. Furthermore, because the data are nested into different clusters, namely the fourteen different schools, it is not possible to run regular regression analyses. There is a risk that because groups of respondents share the same school context, the results of the regression models may be influenced by this context and therefore be biased (O'Dwyer & Parker, 2014). Alternatively, multilevel regression models will be made, which will be explained in the next sections. Multilevel modeling takes a similar statistical approach as regular regression analysis. The big difference is that a multilevel model takes into account the fact that the data are clustered into two levels, in this case the individual-level and the school-level. In the following paragraphs, first the basics of linear regression will be explained. Next, the adaptions that are made to create a multilevel linear model are elaborated upon. Finally, the main characteristics of regular and multilevel logistic regression will be explained.

Figure 9.1-I and 9.1-II visualize the regression analyses that will be conducted and reported in the current chapter. In the figure it is visible which independent variables will be added in the regression models with the different dependent variables. Some of the variables have shortened names that will be used in the remainder of the chapter, what these variables entail is visible in figure 9.1. Also the regression method is given and the order in which the variables are added into the regression analyses. This order is the same for all five regression analyses. First, the personal factors are added, then the household factors, then the physical and social environmental factors as well as the weather variables. Next, the school-level variables are added and finally, optionally, some dependent variables acting as predictors are added. Each regression analysis is concluded with a final model that only includes the variables that were significant in the preceding model. Finally, figure 9.1 gives an indication of how the variables with more than two categories were coded as dummy variables (which is elaborated upon in section 9.2.2.).

			Transport mode day	Multilvel multi-nomial logistic regression	Active vs. Passive	Multilevel binary logistic regression	Parental safety perception	Multilevel linear regression	Satisfaction with travel	Multilevel linear regression	Weekly physical activity	Multilevel linear regression
Variable name		Dummy coding *reference category										
Personal factors Model 1	Age	-	X		X		X				X	
	Gender	Girl									X	
		Boy*										
	Favorite mode	Bicycle*	X		X		X		X			
		Walking										
		Car										
		Other										
Household factors Model 2	Household composition	1 parent, 1 child	X		X		X					
		1 parent, siblings										
		2 parents, 1 child										
		2 parents, siblings*										
	Ethnicity	Dutch					X					
		Non-Dutch*										
	Household income	Low	X		X		X		X		X	
		Average *										
		High										
	Work household	2 wage earners	X		X		X				X	
		1 wage earner*										
		Other										
	Car use parents	Never	X		X						X	
		1-3 days										
		4-5 days *										
		6-8 days										
		More than 8 days										
	Active travel parents	Never	X		X							
		1-4 days*										
		More than 4 days										
	Daycare	Never	X		X		X				X	
		Once per week*										
		Twice or more										
School factors Model 4	Total pupils	Small	X		X		X				X	
		Average*										
		Large										
	Initiative active travel	Yes					X					
		No*										
	Bicycle parking quality	Mediocre	X		X				X		X	
		Sufficient*										
		Good										
	Car parking quality	Insufficient	X		X		X				X	
		Mediocre*										
		Sufficient to good										
Social and physical env. Model 3	Distance	<500 m	X		X		X					
		5000-1000 m										
		1-2 km*										
		2-5 km										
		>5 km										
	Urban density	High	X		X		X					
		Average *										
		Low										
	% households with children	0-25% *	X		X		X					
		26-30%										
		31-45%										
		>45%										

Figure 9.1- I Overview of regression analyses

			Transport mode day	Multilvel multi-nomial logistic regression	Active vs. Passive	Multilevel binary logistic regression	Parental safety perception	Multilevel linear regression	Satisfaction with travel	Multilevel linear regression	Weekly physical activity	Multilevel linear regression
Variable name		Dummy coding *reference category										
Social and physical env. Model 3	% land-use recreation	0-2.5% *	X								X	
		6-10%										
		11-20%										
		>20%										
	Connectivity *"Many different routes to school"*	Agree	X		X		X					
		Neutral*										
		Disagree										
	Contact children *"child knows other children in neighborhood"*	Disagree	X		X				X		X	
		Neutral*										
		Agree										
	Bicycle walk paths *quality perception*	-	X				X		X			
	Social cohesion	-	X		X		X		X			
	Trip interaction *"child usually runs into children on way to school"*	Disagree to neutral	X		X		X		X			
		Agree *										
		Strongly agree										
	Social companions *(trip to school companions)*	Alone*	X		X				X			
		Sibling										
		Friend										
		Parent										
		Parent + sibling										
		Other										
External Model 3	Weather	Sunny*	X						X			
		Partly clouded										
		Clouded										
		Rainy										
Dependent variables Model 5	Transport mode	Walking					X		X			
		Cycling*										
		Car										
		Other										
	Active vs. Passive	-					X				X	
	Parental safety perception	-	X		X				X		X	
	Satisfaction with travel	-	X									
	Weekly physical activity	-	X		X							

Figure9.1-II Overview of regression analyses

9.1.1 Multilevel modeling – linear regression

This section will explain the basis of a linear regression analysis and multilevel regression analysis. Usually, the main objectives of a linear regression analysis are to find the best predicting equation of a set of predicter variables for an outcome variable, to control for confounding factors in order to identify independent relationships. Another objective is to find structural relationships in order to explain multivariate relationships that appear complicated (Ho, 2014). This will be done in the path analysis explained in the next chapter. Specifically for the current research, the main objective of the regression analyses is to identify which predictors have the best combined predictive power in the different models and which predictors are better to be removed before conducting the path analysis, in order to reduce the complexity of the path model.

Assumptions

Although a multilevel modeling approach is used instead of a regular regression analysis, the main assumptions that count for a regular regression analysis still stand, except for the assumption of independent error terms. This section elaborates upon the assumptions for linear regression.

- Independent observations – It is assumed that the observations all derive from different entities or respondents (Ho, 2014). For instance, the research design cannot be longitudinal.
- Measurement level – Variables must be of either a dichotomous or continuous measurement scale. Furthermore, the outcome variable must be quantitative (interval), continuous and unbounded (no constraints on variability of outcome) (Field, Miles, & Field, 2013). For categorical variables with more than two categories to meet this assumption, dummy variables have to be computed. This will be explained in section 9.2.2.
- Linearity – The relationship between dependent and independent variables must be linear. This is the case when the mean values of the dependent variable and the increasing values of the predicter variable lie along a straight line (Field, Miles, & Field, 2013). Linearity can be observed in residual plots in SPSS.
- Homoscedasticity – At each level of the predictor variables, the variance of the residuals should be equal. In other words, the residuals for each value of the predicting variables must have the same variance (Field, Miles, & Field, 2013). When the variances are very unequal, this assumption is not met. Homoscedasticity can also be detected in a plot of the residuals.
- Independence of error terms – The predicted value must be unrelated to any other prediction, every predicted value must be independent. Because of the fact that respondents attend a set of different schools, it cannot be assumed that the error terms are uncorrelated with each other (O'Dwyer & Parker, 2014), they are likely to be influenced by the schools. That is why this assumption might not be complied with and why a multilevel approach is required.
- Normality of errors – The errors of prediction, the differences between obtained and predicted values for the dependent variable, should be normally distributed (Ho, 2014). This can be examined using the residual plots.
- Multicollinearity – Multicollinearity occurs when the predictor variables are highly correlated with each other. In this case the predictors share predictive power (Ho, 2014). The assumption is that the predictor variables should not correlate too highly (Field, Miles, & Field, 2013). The problem with multicollinearity is that the predictors may, together, explain a large part of the dependent variable, but they do not contribute significantly on their own. Before starting the regression analysis, it is important to check the mutual associations between all independent variables by means of a correlation analysis or a Chi Square analysis, depending on the measurement scale. This is expanded upon in section 9.2.1.

Explanation and characteristics multilevel linear model

The respondents in the current sample attend fourteen different schools, which means that they all experience a different school context. This might lead to observations that are correlated, which means that there is a so-called statistical dependency among the data, also referred to as 'nested data' (O'Dwyer & Parker, 2014). This possible statistical dependency can lead to biased results in the form of Type I errors and Type II errors. Type I errors are so-called false-positive errors, resulting in the conclusion that a certain predictor variable is significantly associated with the outcome variable, while in reality it is not. Type II errors result in the opposite effect: a false-negative error, not noticing a significant relationship. Both error types can cause misguided decision-making, which is undesirable. In a multilevel regression analysis, these issues are resolved because the coefficients refer to different levels in the nested data (O'Dwyer & Parker, 2014).

To explain the main difference between regular linear regression and multilevel linear regression, the difference in regression equations will be considered. An example will be used in which the outcome variable is parental safety perception and the predictor variables are the age of the child (individual-level variable) and whether or not the parking facilities of the school are rated insufficient (school-level variable). Equation (1) shows the equation for a regular regression model, where Y_i represents the parental safety concern for individual *i*. β_0 represents the intercept, β_1 the regression coefficient for age and β_2 the regression coefficient for car parking quality. ε_i is the prediction error (Peugh, 2010).

Regression equation $$Y_i = \beta_0 + \beta_1 Age_i + \beta_2 Carpark_i + \varepsilon_i \quad (1)$$

The problem of equation (1) for the current dataset is that it does not take into account that the data are clustered and that there may be a difference in the variance between schools, which would affect the error term. Equations (2), (3) and (4) illustrate how a mixed model is built up. Equation (2) represents the individual level, level 1. Y_{ij} represents the parental safety perception for individual *i* at school *j*. β_{0j} is the school-level intercept, the mean parental safety concern score for school *j*. β_{1j} is the school-level slope (regression coefficient) for age and ε_{ij} is the error term for individual *i* at school *j*. This error term represents the differences of the individual student around the mean of the school, the variance in parental safety perception scores within schools (Peugh, 2010). Equation (3) defines β_{0j}, the school-level intercept. γ_{00} is the grand mean, the average of the intercepts across schools. γ_{01} is a regression coefficient for school-level car parking quality. μ_{oj} is the prediction error, the school-specific deviation from the grand mean. This school-specific deviation represents the variance in parental safety perception scores between schools. Equation (4) defines the school-level slope for age, β_{1j}, as γ_{10}. This indicates that the slope is fixed across schools. This slope is fixed because the aim in the current study is only to predict variation in the intercepts across schools, not between schools.

Level 1 $$Y_{ij} = \beta_{0j} + \beta_{1j} Age_{ij} + \varepsilon_{ij} \quad (2)$$

Level 2 $$\beta_{0j} = \gamma_{00} + \gamma_{01} Carpark_j + \mu_{oj} \quad (3)$$

$$\beta_{1j} = \gamma_{10} \quad (4)$$

When equations (3) and (4) are substituted into equation (2), the combined mixed model equation (5) is created. In this step of the analysis for the current research, the research question is only to discover which predictor variables significantly predict the parental safety perception, considering the combined power of predictors. The interaction between a certain predictor variable and the effect of the school, or between two predictor variables, is not under investigation. Therefore, all coefficients (marked as γ) are considered as fixed effects across schools. The only components that are not fixed across schools are the variation between schools (μ_{oj}) and the variation within schools (ε_{ij}) (Peugh, 2010).

Mixed model $$Y_{ij} = \gamma_{00} + \gamma_{01} Carpark_j + \mu_{oj} + \gamma_{10} Age_{ij} + \varepsilon_{ij} \quad (5)$$

This mixed model can be calculated in SPSS. Because the mixed model acknowledges that the data are clustered in schools and because it includes two error terms, one for the variance within schools and one for the variance between schools, the multilevel regression approach is a suitable and reliable approach to investigate the combined predictive power of the independent variables on the continuous dependent variables. However, there are also categorical dependent variables in the conceptual model of the current research. Normally, logistic regression analysis would be used to investigate the predictors of these dependent variables. However, due to the nested data, multilevel logistic regression will be applied. This data analysis technique will be explained in the next section.

9.1.2 Multilevel logistic regression

This section will explain the basis for a logistic regression analysis and a multilevel logistic regression analysis. Because the analysis of the dependent variable travel mode and active vs. passive are categorical, not continuous, they violates several assumptions for linear regression, such as the measurement level and linearity. This is why another type of regression must be applied. To find out the best combined predictive power for the travel mode outcome variable, multilevel binary logistic regression will be conducted in SPSS and a multilevel multinomial logistic regression in HLM. With logistic regression it is possible to use a set of variables that are continuous, discrete or dichotomous to predict a discrete outcome (Ho, 2014), such as the category of school travel mode. The main goal of the logistic regression analysis is to identify which independent variables increase or decrease the probability of certain categories in the discrete outcome variable.

Assumptions

Unlike linear regression, logistic regression does not have a lot of assumptions that need to be met. However, logistic regression does share some of the assumptions with linear regression:

- Linearity – a linear relationship between the predictor variables and the outcome variable, as is assumed for linear regression, is not possible for logistic regression because the outcome variable is categorical. However, the assumption for linearity is defined differently for logistic regression analysis. In logistic regression, the log of the data is used because the outcome variable is categorical. It is assumed that there is a linear relationship between any continuous predictor and the log of the outcome variable. To test this assumption, interaction terms of each predictor with the log of itself need to be computed and added in the same logistic regression. If the interaction terms are significantly related to the outcome variable, this violates the assumption of linearity of the log (Field, Miles, & Field, 2013).
- Independence of error terms – this is the same assumption as for linear regression: every predicted value must be independent and the plot of the residuals should appear random (Field, Miles, & Field, 2013). Once again, this assumption is not met, which is why a multilevel model will be used.
- Multicollinearity – although multicollinearity is not a strict assumption as for linear regression, it is still a problem. The main idea for logistic regression is that predictors should not be too correlated with each other. Multicollinearity can be tested using the tolerance value in SPSS (Field, Miles, & Field, 2013).
- Measurement scale – The dependent variable must be categorical and predicting variables may be continuous, discrete and dichotomous (Ho, 2014).

Explanation and characteristics multilevel logistic model

The general background of how multilevel logistic modeling works is rather similar to multilevel linear modeling, with three main exceptions. The first exception concerns the measurement level of the outcome variable and the corresponding implications in modeling. In linear regression, outcome variables are continuous and the regression model aims to predict the variance in the means, for example between schools. In the case of a categorical outcome variable, for example a binary outcome variable, the mean actually represents a proportion of respondents per school belonging to one of the two categories. In generalized linear models, the method in SPSS that is used for multilevel logistic regression, a so-called link function is used that transforms the categorical outcome variable in such a way that it can be modeled as a linear function of a set of predictors (Heck, Scott, & Tabata, 2012).

The second and third exceptions concern the (multilevel) regression equations introduced in section 9.1.1. In multilevel linear regression, the outcome variable is referred to as Y_{ij}, which is simply the

outcome value of the variable (e.g. the value for parental safety perception). The second exception is that in multilevel logistic regression the outcome value is referred to as η_{ij}, which is the log odds predicted as a result from the regression equation. η_{ij} represents the odds of the outcome variable (e.g. traveling actively) happening or not happening (Heck, Scott, & Tabata, 2012). The third exception is that there are no level-1 (individual-level) residual variances when the outcome variable is categorical. For multilevel models with a categorical outcome, it is usually not possible to add a level-1 error term, because the sampling distribution of the level-1 outcome is different from normal. In this case the level-1 residual can generally only take on a limited set of values and will not be normally distributed. For example, in the case of a binary outcome variable, the residual can only take on two values: either the respondent was incorrectly predicted to travel actively when they actually traveled passively, or the other way around (Heck, Scott, & Tabata, 2012).

With these three exceptions, the multilevel logistic regression equation, considering one individual-level variable (age) and one school-level variable (school size), is constructed as in equation (6).

Mixed model
$$\eta_{ij} = \gamma_{00} + \gamma_{01} SchoolSize_j + \mu_{oj} + \gamma_{10} Age_{ij} \quad (6)$$

In equation (6), η_{ij} is the predicted log odds from the logistic regression, γ_{00} is the grand mean for all schools, μ_{oj} the variation from the grand mean *across* schools, γ_{01} is the regression coefficient for school size and γ_{10} the regression coefficient for age (which is fixed across schools, as in section 9.1.1) (Heck, Scott, & Tabata, 2012).

9.2 Preparation independent and dependent variables

This section describes the steps that were taken to prepare the dataset for the regression analyses. These steps include removing or recoding variables to create an overall better dataset, computing dummy variables to meet one of the regression assumptions, and checking for the other assumptions in linear and logistic regression.

9.2.1 Removing or changing variables

In the selection of which independent variables will be used in the various regression models, not only significance is used as a motivation. There are two other reasons for which variables may be removed from the dataset. One is correlation: if independent variables are too strongly correlated/associated with each other, the decision has to be made to either combine them, or remove one of them. The other reason is about the variables that were measured on the school level: variables are removed if a certain category of a variable is only true for one school. Appendix 6 explains for each socio-ecological layer of the child's environment which variables are to be removed and why. To summarize, the following variables will no longer be included in the regression analyses:

Table 9.1 Variables excluded from regression analyses

Independent variables		
Grade	*Preference active/passive*	*Household size*
Car ownership	*Lunch at school*	*Safety measures school*
End of school-day	*Education type*	*Health initiatives*
School traffic safety	*Decrease cars around school*	*Separate bicycle lane*
Speed limit	*% green land-use*	*Length of residence*
Neighborhood SES		
Dependent variables		
Health	*Mood*	*Social variables*

The ethnicity variable was operationalized as a variable with three groups (Dutch, European and non-European). In some of the Chi Square analyses, the binary version of the ethnicity was already used to avoid expected counts that are too low. The same was done when checking for associations with other independent variables. From this moment onwards, this binary version (Dutch and non-Dutch) will be used, because the "European" category is not big enough to be representative.

Removing dependent variables

As can be seen in the overview in table 9.1, also some dependent variables are to be removed. There are too many dependent variables for the scope of the research. Some dependent variables have to be removed in order to be left with a feasible number of variables for the regression analyses. Furthermore, when looking at the matrix of significant associations between variables presented in figures 8.6 and 8.7 of the previous chapter, it becomes clear that some dependent variables have more significant associations than others. In order to answer the main research question, it is important to include some measure of the transport mode, subjective well-being & health and parental safety perception in the coming analyses. Firstly, to represent child transport mode, the transport mode of the day and whether or not a child on average travels more actively or passively will be included. There will no longer be a measure of independent travel among the dependent variables; the focus will be on travel mode. Secondly, to represent subjective well-being and health, the satisfaction with travel and the weekly physical activity will be included. Parent-assessed health and the mood on the day of the survey were not associated with a large amount of independent variables and also fall more outside the scope of the research. The variables social trip companions and trip interaction will be included as independent variables, to still be able to measure their effect on transport mode and satisfaction with travel. Thirdly, the overall parental safety perception variable will be included in the regression analyses. This means that the dependent variables are: transport mode, active vs. passive travel, satisfaction with travel, weekly physical activity and parental safety perception.

9.2.2 Computing dummy variables

In order to comply with the assumptions for measurement level and linearity, some adaptions have to be made to the data. As quite a large part of the predictors in the current study are categorical variables of nominal or ordinal scale with more than two categories, they have to be transformed into a different form in order to be compatible in the multiple linear regression analyses. By applying dummy codes, different categories can be represented as though they were dichotomous variables, using only ones and zeros (Field, Miles, & Field, 2013). The number of new dummy variables that have to be created to represent a categorical variable is one less than the amount of categories that the variable has. For every variable that is being recoded, one category has to be chosen as the baseline group, which is the group against which the other groups will be compared. The baseline group is usually a control group or the group that represents the largest part of the people (Field, Miles, & Field, 2013). To see how variables were dummy coded, see figures 9.1-I and 9.1-II in the beginning of the current chapter.

9.2.3 Checking assumptions for linear regression

As described earlier in this chapter, there are seven assumptions that have to be checked for, before it can be certain that the results of the regression analyses are reliable. The first is the assumption of independent observations. Because this concerns a cross sectional study and not a longitudinal study, the observations are independent. The assumption of measurement scale was met when all nominal and ordinal variables with more than two categories were recoded into dummy variables. The assumptions of linearity, normality of errors of prediction, and homoscedasticity were checked visually by observing the scatter plots and the normal P-P plot of the standardized residuals for the three linear regression models. The results of these plots can be seen in appendix 7. The residuals appear randomly distributed and the observed residuals for parental safety perception, satisfaction with travel and

weekly physical activity match the expected pattern. These figures indicate that the assumptions of linearity, normality of errors and homoscedasticity are met. The multicollinearity was checked for by looking into the mutual associations between the independent variables. First, as described in section 9.2, all associations with a Cramer's V value above 0.5 or a correlation above 0.7 were further looked into. In each case of too strong associations, one of the associated variables was removed. The only assumption that is not met is the independence of error terms, which is why a multilevel model is used.

9.2.4 Checking assumptions for logistic regression

Although most of the assumptions that are important for linear regression do not count for logistic regression, there are still some aspects concerning the data to look at before conducting the analysis. One of the assumptions is the independence of errors which, as previously stated, is not met. This problem is solved by conducting multilevel analyses. Another assumptions is that of multicollinearity. As described for the linear regression models, the multicollinearity has been checked for by inspecting Cramer's V values and correlation matrices. In logistic regression, the measurement scale of the dependent variable must be categorical and predicting variables can be continues, discrete and dichotomous. As in the regression analyses, only continuous and dichotomous (dummy) variables will be used. Finally, there must be a linear relationship between the continuous predictors and the log of the outcome variables for the binary logistic regression analysis. This assumption was violated for the predictor variables age, social cohesion and parental safety perception in the logistic regression analysis for active vs. passive travel. Therefore, these three variables were recoded into ordinal variables and then into dummy variables for the analysis.

9.3 Multilevel regression analysis for parental safety perception

To analyze the power of the predictors on the parental safety perception using multiple linear regression, five different models will be used. The first model will only include the predicting variables belonging to the personal factors in the model. In the second model, also the variables from the household factors will be added in a similar manner. The third model will additionally consider school factor variables. The fourth model will search for the physical- and social environmental variables that have an added value for the perception of safety that parents have and finally, in the fifth model, only the variables that were significant in the fourth model will be included. A high level for parental safety perception indicates a positive safety perception concerning school travel. After having checked the model for generalizability and the assumptions mentioned in the previous paragraphs, the model can provide information about which predicting variables are significantly related to parental safety perception and in which way. This information can be used in the next chapter: the path analysis.

9.3.1 Results multilevel linear regression – parental safety perception

The results of the multilevel linear regression models for parental safety perception are presented in table 9.2. After the bivariate analyses and after removing correlating variables, eighteen variables remained to be investigated in regression models with parental safety perception. For a variable to be included in the path model in chapter 10 (step 3), it has to be significant at least at the 0.1 level. In the path model, a more strict cut-off significance level will be considered. Four predicting variables were not found to be significantly associated with parental safety perception in any of the models: daycare attendance, trip interaction (usually running into children on the way to school), the total amount of pupils in school and the AT initiatives.

For model 1, the 2Log likelihood value is 966.1. This model includes 7 parameters. The intercept, the between-group variance in this model has a value of 0.036 and a significance of 0.025. This indicates that the variance accounted for by the difference between schools has a significant impact. In this model, only the personal factors age and favorite transport mode were added. Age was found to be

significantly associated with parental safety perception, the safety perception generally becomes more positive when children are older. Also the 'other' transport mode preference was found to be significantly associated with parental safety concern. This association may be explained by the fact that about half of the children that filled in an 'other' favorite mode choose the bus or taxi-bus. These are generally the children that attend the special education schools, live far away and have parents with lower incomes. These parents were generally found to have more safety concerns. Moreover, the other half of the children that chose an 'other' favorite mode choose modes such as a skateboard, a jetpack or a limousine. Possibly, these are children that are more adventurous and in that sense their parents may have more to worry about concerning (independent) active travel.

In model 2, the 2Log likelihood has decreased to 936.1 and the parameters have increased to 17. From the decrease in 2Log likelihood and the increase in parameters, a likelihood ratio chi square test can be conducted in SPSS. This test can indicate whether the new, larger model is a significant better fitting model than the smaller model. The result of this test is significant (0.001) which means that model 2 fits the data significantly better than model 1. The intercept between schools is smaller than in the previous model (0.025), but is still statistically significant. In model 2, some household factors were added. A significant association was found between household composition and parental safety perception. As opposed to households with two parents and two or more children, households with two parents and one child have more safety concerns. Also ethnicity was found to be significantly associated, Dutch parents have a more positive perception of safety than non-Dutch parents. Households with a high income are more positive about the safety than households with an average income. This is not surprising, as households with a higher income generally live in more wealthy and safer neighborhoods. The earlier named association with a preference for an 'other' transport mode is no longer significant in model 2.

In model 3, which also includes social and physical environmental factors, the 2Log likelihood has decreased to 814.2 and the model has 32 parameters. The likelihood ratio chi square test for this decrease in 2Log likelihood is significant, indicating that model 3 is a significantly better fit with the data than model 2. In this model, the variance between schools, the intercept, has become very small (0.006) and it is no longer significant. This indicates that the school the child attends no longer has a significant effect on the variance in parental safety perception. As opposed to living 1-2 km from school, living over 5 km away from school is associated with a significantly more negative perception of safety. As opposed to having not a lot of households with children in the neighborhood (<25%), living in a neighborhood with 31-45% households with children, the second highest category, is significantly associated with a more positive parental safety perception. Also living in well-connected neighborhoods, neighborhoods that have several routes to take to school, is associated with significantly higher values for parental safety perception. The quality of bicycle and walking paths and the perception of social cohesion are both positively associated with safety perception. Children who usually run into other children on the way to school (trip interaction) have parents that are significantly more positive about the safety. In model three, the association between the favorite 'other' travel mode is once again significant, as opposed to in the previous model. The association with household composition is no longer significant in model 3.

In model 4, also the level 2 variables have been added: the school variables. This model has a 2Log likelihood value of 801.6 and 37 parameters. The improvement of the model was found significant in the log likelihood chi square test (sig. 0.030). The variance between schools in this model was found to be redundant. This indicates that the variance accounted for by the difference between schools has gotten too small to detect in the analysis. Of the school variables, the only significant association is seen for sufficient to good car parking quality as opposed to mediocre car parking quality. Parents of children attending schools that have sufficient to good car parking facilities are more positive about the safety. A new significant association at the 0.1 significance level in model 4 is visible for low urban density as opposed to average urban density: parents in less densely populated areas are more positive about the safety. There is also a new significant association with the work status of the household. Parents in households that have an 'other' work status as opposed to one wage earner households are more concerned about safety. The association with the percentage of households with children is no

longer significant. There is one other new significant association with the distance category 500-1000 meters, which is associated with a significantly higher value for safety perception.

Model 5, the final model, only includes the twelve variables that were significant in the previous model. These variables are in turn the only variables that will be included in the path model in chapter 10, to be associated with parental safety perception. These variables are: age, favorite mode (other), ethnicity, income (high), work household (other), distance (500-1000m and >5 km), urban density (low), connectivity (agree), bicycle and walking paths, social cohesion and car parking quality (sufficient to good). In the final model, all variables are significantly associated (two only at the 0.1 level). Not surprisingly, the 2Log likelihood is larger in this model (810.1) than in the previous model, because a lot of predicting variables have been removed from the model. While not significant, these variables do have some predicting power. The variance between schools is redundant in model 5.

The literature study revealed that as children get older, they generally gain more independence in travel (Carver et al., 2013; Curtis, Babb, & Olaru, 2015). This indicates that parents have fewer safety concerns when their children are older, which is in line with the findings in the current research. The relationship with usually running into other children on the way to school is in line with previous research on independent mobility and parental concerns. Waygood et al. (2017) suggest that having connections in the neighborhood decreases parental concern, which in turn leads to more independent mobility. Several similar results have been reported (e.g. Bringolf-Isler et al., 2007; Aarts et al., 2013; Salmon et al., 2007). This may also explain the significant positive association with social cohesion. The positive correlation between parental safety perception and bicycle and walking paths quality was also found by Kerr et al. (2006). The association with car parking quality around school was not found in previous literature. However, at most schools poorer car parking conditions led to unclear and therefore unsafe traffic situations. The association with car parking quality can effectively also be seen as an association with traffic safety, which is in line with previous findings on parental concerns (e.g. Kerr et al., 2016; Trapp et al., 2012). The associations of distance, urban density and connectivity with parental safety perceptions were not found in the literature review. However, Curtis, Babb & Olaru (2015) did find distance to influence whether or not children were allowed to travel independently. This might be an indirect effect of parental safety perception.

Table 9.2 Multilevel linear regression modeling – results for parental safety perception

Parental safety perception	Model 1		Model 2		Model 3		Model 4		Model 5	
	Est.	Sig.	Est.	Sig.	Est.	Sig.	Est.	Sig.	Est.	Sig.
Intercept (between schools)	*0.036**	*0.025*	*0.025**	*0.034*	*0.006*	*.241*	*Redundant*		*Redundant*	
Intercept (within schools)	*2.44***	*.000*	*2.36***	*.000*	*1.489***	*.000*	*1.551***	*.000*	*1.530***	*.000*
Level 1 – individual level variables										
Personal factors										
Age	*0.124***	*.000*	*0.123***	*.000*	*0.105***	*.000*	*0.102***	*.000*	*0.107***	*.000*
Favorite mode – bicycle										
Walking	*0.036*	*.515*	*0.017*	*.751*	*0.008*	*.869*	*0.019*	*.713*	*0.017*	*.730*
Bicycle	-	-	-	-	-	-	-	-	-	-
Car	*-0.063*	*.244*	*-0.040*	*.469*	*-0.042*	*.402*	*-0.040*	*.423*	*-0.052*	*.299*
Other	*-0.106~*	*.085*	*-0.094*	*.123*	*-0.119**	*.035*	*-0.120**	*.035*	*-0.124**	*.028*
Household factors										
Household composition – 2 parents, siblings										
1 parent, 1 child			*-0.109*	*.308*	*-0.060*	*.550*	*-0.049*	*.622*		
1 parent, siblings			*-0.016*	*.821*	*0.028*	*.674*	*0.031*	*.642*		
2 parents, 1 child			*-.170**	*.012*	*-0.095*	*.131*	*-0.099*	*.116*		
2 parents, siblings	-	-	-	-	-	-	-	-	-	-

*~ significant at 0.1 level * significant at 0.05 level ** significant at 0.01 level*

Parental safety perception	Model 1		Model 2		Model 3		Model 4		Model 5	
	Est.	Sig.	Est.	Sig.	Est.	Sig.	Est.	Sig.	Est.	Sig.
Ethnicity – Dutch			0.123*	.015	0.085~	.070	0.086~	.065	0.084~	.068
Income – average										
Low			-0.063	.303	-0.049	.391	-0.049	.385	-0.050	.371
Average	-	-	-	-	-	-	-	-	-	-
High			0.089*	.043	0.073~	.072	0.078~	.051	0.078*	.050
Work household – 1 wage earner										
2 wage earners			0.004	.937	-0.030	.548	-0.033	.512	-0.044	.336
1 wage earner	-	-	-	-	-	-	-	-	-	-
Other			-0.123	.150	-0.127	.106	-0.148~	.059	-0.154*	.048
Daycare – once per week										
Never			0.018	.764	0.025	.662	0.020	.719		
Once per week	-	-	-	-	-	-	-	-	-	-
Twice or more			0.002	.977	-0.010	.888	-0.012	.862		
Physical and social environment										
Distance – 1-2 km										
< 500 m					0.045	.414	0.045	.405	0.058	.282
500 – 1000 m					0.077	.114	0.080~	.099	0.085~	.080
1 – 2 km	-	-	-	-	-	-	-	-	-	-
2 – 5 km					-0.077	.200	-0.084	.166	-0.085	.152
>5 km					-0.184*	.027	-0.227**	.005	-0.197*	.012
Urban density – average										
High					0.043	.447	0.019	.715	-0.002	.966
Average	-	-	-	-	-	-	-	-	-	-
Low					0.091	.113	0.096~	.054	0.095*	.042
% Children – 0-25%										
0-25%	-	-	-	-	-	-	-	-	-	-
26-30%					0.108	.105	0.098	.148		
31-45%					0.116~	.071	0.099	.123		
>45%					0.119	.186	0.106	.248		
Connectivity - Neutral										
Disagree					-0.041	.426	-0.044	.391	-0.043	.396
Neutral	-	-	-	-	-	-	-	-	-	-
Agree					0.172**	.000	0.170**	.000	0.180**	.000
Bicycle, walk path					0.137**	.000	0.135**	.000	0.134**	.000
Social cohesion					0.121**	.000	0.118**	.000	0.125**	.000
Trip interaction – Agree										
Disagree to neutral					0.007	.878	0.005	.897	0.018	.674
Agree	-	-	-	-	-	-	-	-	-	-
Strongly agree					0.105~	.086	0.106~	.083	0.103~	.089
Level 2 – school level variables										
School factors										
Total pupils - average										
Small							-0.042	.541		
Average	-	-	-	-	-	-	-	-	-	-
Large							-0.061	.296		
Initiative AT - Yes							-0.029	.698		
Car parking quality – mediocre										
Insufficient							-0.032	.657	0.006	.923
Mediocre	-	-	-	-	-	-	-	-	-	-
Sufficient to good							0.135**	.002	0.159**	.000

~ significant at 0.1 level ** significant at 0.05 level* *** significant at 0.01 level*

9.4 Multilevel linear regression analysis for satisfaction with travel

To analyze the power of the predictors on the satisfaction with travel using multiple linear regression, five different models will be made. The first model will only include the predicting variables belonging to the household factors, as there are no personal factors in the model for satisfaction with travel. The second model will additionally consider the social and physical environmental variables, as well as the weather. The third model will include the school factor bike parking quality, which was found to be significant in the bivariate analyses. In the fourth model also the dependent variable travel mode on the day of the survey will be added, as well as an interaction factor with the favorite travel mode of children. In this model, also the parental safety perception is added to act as predicting variable. In the final model, only the variables that were significant in the fourth model will be included. After having checked the regression model for generalizability and the assumptions mentioned in the previous paragraphs, the model can provide information about which predicting variables are significantly related to satisfaction with travel and in which way. This information can be used in the next chapter: making the path analysis.

9.4.1 Results multilevel linear regression – satisfaction with travel

The results of the multilevel linear regression models for satisfaction with travel (SWT) are presented in table 9.3. The satisfaction with travel was measured by means of cognitive and affective satisfaction questions that were answered on a five point scale. The mean of these questions represents the satisfaction with travel, in which a higher level indicates higher satisfaction. After the bivariate analyses and after removing correlating variables, eleven variables remained to be investigated in regression models with satisfaction with travel. For a variable to be included in the path model in chapter 10 (step 3), it has to be significant at least at the 0.1 level. In the path model, a more strict cut-off significance level will be considered. Three predicting variables were not found to be significantly associated in any of the regression models: income, trip interaction (running into other children on the way to school) and transport mode. Also parental safety perception was not found to be significantly associated, but this is a relation that will be tested one more time in the path model including all significant variables.

In model 1, the household factor income is the only variable, as no other household factors were found to be significantly associated with SWT in the bivariate analyses. The 2Log likelihood of this model is 1173.4, the model has 5 parameters. The variance between schools is not significant and has a value of 0.0047. The variable income does not have a significant relationship with SWT in this model.

In model 2, several social and physical environmental variables have been added. The 2Log likelihood decreased to a value of 1131.6, model 2 has 20 parameters. The likelihood ratio chi square test indicated that the improvement of the fit of the model is significant (sig. 0.000). The variance between schools has decreased to 0.0001 and is still not significant. Children whose parents reply neutral as opposed to disagree to the question about having contact with other children in the neighborhood were significantly less satisfied with their trip. This finding is rather strange, nothing similar was found in previous studies. When the perceived quality of cycling paths and the perceived social cohesion are higher, the satisfaction with travel is also significantly higher. Children that traveled to school with a friend as opposed to alone are significantly more satisfied with their trip. Clouded, very clouded and rainy weather conditions as opposed to sunny weather conditions are significantly associated with lower travel satisfaction.

In model 3, the only school-level variable that was found to be significantly associated with SWT in the bivariate analyses was added. This lead to a slightly smaller 2Log likelihood of 1126.6 and 22 parameters. The likelihood ratio chi square test pointed out that this increase in model fit is not significant. The intercept of variance between schools has become so small, that SPSS reports it as being redundant. In model 3, the negative relationship between the dummy variable good bicycle parking quality and SWT is significant. It sounds counter-intuitive that good bicycle facilities decrease satisfaction. However, it could be that at schools where many children enjoy cycling (and are more

satisfied with their trip), the supply of bicycle storage does not meet the demand because so many children cycle and therefore the bicycle storage is rated as sufficient or mediocre instead of good.

In model 4, the dependent variable transport mode on the day of the survey is added, as well as an interaction factor with favorite transport mode for all four modes. The interaction variable bicycle x favorite bicycle has a value of 1 if a child travelled by bike and had the bike as their favorite transport mode. This works the same for the interaction variables for walking, car travel and an "other" mode. Also the dependent variable parental safety perception was added in model 4. The inclusion of dependent variables as predictors in the model lead to a decrease in the 2Log likelihood to 1093.5 and the model has 30 parameters. The decrease in 2Log likelihood was significant according to the likelihood ratio chi square test. The variance between schools is still redundant. The parental safety perception is not significantly associated with satisfaction with travel in this model. However, as mentioned earlier, this relationship will be tested once more in the complete path model in chapter 10. Also the transport mode is not significantly associated with the satisfaction in this model. The interaction factors for bicycle and walking are significantly associated with a higher travel satisfaction. This indicates that children who came by an active mode and also preferred active modes, were more satisfied with their trip. This cannot be said for car travel and traveling by an "other" mode, as the interaction factors for car travel and the "other" mode are not significant. When, instead of the interaction variables, only the dummy variables indicating actual travel mode were added, there was also a significant association with SWT: children traveling by bicycle were significantly more satisfied than children traveling by car. However, this model resulted in a poorer fit with the data, which became visible when inspecting the likelihood ratio chi square test. As the main goal in the regression analysis is to find the predictors that have the best combined predictive power for the outcome variable, the decision was made to include the two interaction variables for walking and cycling and to exclude the actual transport mode variable. This way, the significant predictive power of transport mode is represented, which is strengthened by the child's preference. A new significant association in model 4 is between traveling with a parent and higher satisfaction. The associations with social cohesion and the quality of cycling and walking paths are no longer significant in this model.

In model 5, only the variables with a significant association in model 5 were added. This model led to a slightly increased 2Log likelihood of 1108.5, which is not surprising. The model has 18 parameters and the between group variance is redundant. All relationships that were significant in the previous model, are significant in model 5. Therefore, all six predicting variables that are significant and the parental safety perception will be included in the path analysis of chapter 10 to see how they perform in the complete model.

The significant association between traveling with a friend and satisfaction with travel is in line with the findings of Westman et al. (2017). They found children that engaged in social activities during their trip to be more satisfied. Moreover, they found higher satisfaction to be associated with an active travel mode. Similar results can be seen for the current study. The only result that is very curious and not in line with the previous findings is that children who know some children are less satisfied than those who do not know any children in the neighborhood. There are some associations with travel satisfaction in the literature that are not present in the current study, such as the associations with age and with trip duration (Westman et al., 2017).

Table 9.3 Multilevel linear regression modeling – results for satisfaction with travel

Satisfaction with travel	Model 1		Model 2		Model 3		Model 4		Model 5	
	Est.	*Sig.*	*Est.*	*Sig.*	*Est.*	*Est.*	*Sig.*	*Sig.*	*Est.*	*Sig.*
Intercept within	*3.719***	*0.000*	*3.483*	*0.000*	*3.510***	*0.000*	*3.223***	*0.000*	*3.802***	*0.000*
Intercept between	*0.0047*	*.242*	*0.0001*	*0.710*	*Redundant*		*Redundant*		*Redundant*	
Level 1 – individual level variables										
Household factors										
Income – average										
Low	*-0.088*	*0.173*	*-0.071*	*0.259*	*-0.074*	*0.238*	*-0.066*	*0.295*		
Average	-	-	-	-	-	-	-	-	-	-
High	*0.051*	*0.324*	*0.049*	*0.324*	*0.039*	*0.439*	*0.020*	*0.680*		
Social and physical environment + weather										
Contact children (child has social network) – Disagree										
Disagree	-	-	-	-	-	-	-	-	-	-
Neutral			*-0.133~*	*0.082*	*-0.128~*	*0.093*	*-0.143~*	*0.057*	*-0.148**	*0.046*
Agree			*-0.046*	*0.536*	*-0.036*	*0.623*	*-0.038*	*0.596*	*-0.010*	*0.880*
Strongly agree			*0.001*	*0.991*	*0.015*	*0.876*	*0.034*	*0.721*	*0.073*	*0.378*
Bicycle + walk paths			*0.047~*	*0.098*	*0.053~*	*0.058*	*0.044*	*0.124*		
Social cohesion			*0.087**	*0.042*	*0.075~*	*0.082*	*0.054*	*0.203*		
Trip interaction – Agree										
Disagree to neutral			*-0.057*	*0.291*	*-0.054*	*0.311*	*-0.052*	*0.329*		
Agree	-	-	-	-	-	-	-	-	-	-
Strongly agree			*-0.087*	*0.295*	*-0.091*	*0.278*	*-0.080*	*0.329*		
Trip companions – alone										
Alone	-	-	-	-	-	-	-	-	-	-
Sibling			*-0.050*	*0.597*	*-0.038*	*0.686*	*-0.063*	*0.499*	*-0.067*	*0.472*
Friend			*0.268***	*0.001*	*0.243***	*0.003*	*0.224***	*0.006*	*0.250***	*0.002*
Parent			*-0.002*	*0.981*	*0.000*	*0.995*	*0.090*	*0.207*	*0.050*	*0.447*
Parent + sibling			*0.053*	*0.402*	*0.051*	*0.424*	*0.121~*	*0.072*	*0.112~*	*0.076*
Other			*0.088*	*0.386*	*0.082*	*0.420*	*0.121*	*0.253*	*0.134*	*0.181*
Weather – Sunny										
Sunny	-	-	-	-	-	-	-	-	-	-
Partly clouded			*-0.167**	*0.047*	*-0.161~*	*0.056*	*-0.172**	*0.036*	*-0.178**	*0.031*
Clouded			*-0.267***	*0.002*	*-0.249***	*0.004*	*-0.268***	*0.002*	*-0.269***	*0.001*
Rainy			*-0.228**	*0.028*	*-0.234**	*0.023*	*-0.228**	*0.025*	*-0.236**	*0.019*
Level 2 – School level variables										
School factors										
Bicycle parking – Sufficient										
Mediocre					*0.044*	*0.453*	*0.027*	*0.642*	*0.028*	*0.613*
Sufficient	-	-	-	-	-	-	-	-	-	-
Good					*-0.102~*	*0.073*	*-0.112*	*0.048*	*-0.122**	*0.031*
Dependent variables as predictors										
Transport mode - bicycle										
Bicycle	-	-	-	-	-	-	-	-	-	-
Walking							*0.024*	*0.775*		
Car							*0.021*	*0.789*		
Other							*0.176*	*0.126*		
Bicycle x fav bicycle							*0.281***	*0.000*	*0.279***	*0.000*
Walking x fav walking							*0.213**	*0.028*	*0.229***	*0.004*
Car x fav car							*-0.024*	*0.829*		
Other x fav other							*0.050*	*0.750*		
Parental safety perc.							*0.068*	*0.152*		

~ significant at 0.1 level ** significant at 0.05 level* *** significant at 0.01 level*

9.5 Multilevel linear regression analysis for weekly physical activity

To analyze the power of the predictors on the weekly physical activity using multiple linear regression, six different models will be made. The first model will only include the predicting variables belonging to the personal factors. In the second model, also the variables from the household factors will be added in a similar manner. The third model will additionally consider school factor variables. The fourth model will also include physical- and social environmental variables and in the fifth model also some dependent travel mode variables will be added as predictors. In the final model, only the variables that were significant in the fifth model will be included. After having checked the regression model for generalizability and the assumptions mentioned in the previous paragraphs, the model can provide information about which predicting variables are significantly related to weekly physical activity and in which way. This information can be used in the construction of the path model in chapter 10.

9.5.1 Results multilevel linear regression – weekly physical activity

The result of the six multilevel linear regression models that were analyzed are presented in table 9.4. In total, fourteen predicting variables were added in the regression analyses, based on the results of the bivariate analyses. Eight of these were not found to be significantly associated with weekly PA in any of the models: age, income, parents' car use, daycare attendance, % recreation land-use, car parking quality, bike parking quality and transport mode. The weekly physical activity is measured in minutes, a higher value in weekly PA indicates a higher amount of minutes being active. The dependent variable active vs. passive travel was recoded to an ordinal scale indicating a percentage of trips that a child travels actively in an average week.

In model 1, the two personal factors (age and gender) that were significantly associated with weekly physical activity (PA) were included. The 2Log likelihood of model 1 is 9468.7 and the model has 5 parameters. The variance between schools has a value of 7576.21 and a significance of 0.52. Gender has a significant relationship with weekly PA in the regression model, the gender girl was associated with significantly fewer minutes of weekly physical activity than the gender boy.

In model 2, also the significant household factors, as concluded from the bivariate analyses, were included. The 2Log likelihood decreased to 9453.5 and the model now has 15 parameters. The increased fit is not significant according to the likelihood ratio chi square test. The variance between schools in this model has a value of 6825.05 and a significance of 0.58. The only household factor to have a significant association with weekly PA in the regression model was the household work-status. Children in two wage earner households, as opposed to children in one wage earner households, were likely to experience more weekly PA.

In model 3, several physical and social environmental factors were added. The 2Log likelihood deceased to 9410.4, the model has 24 parameters. According to the likelihood ratio chi square test, this is a significant improvement of the model fit. The variance between schools dropped to a value of 5509.97 with a significance of 0.085. The two significantly associated variables in the physical and social environment were contact with children and trip interaction; two social variables. Children whose parents agreed or strongly agreed that the child knew a lot of other children in the neighborhood experience a lot more weekly PA than children whose parents disagree that the child has contacts in the neighborhood. Children whose parents are neutral about or disagree with the statement that the child usually runs into other children on the way to school are likely to experience less physical activity per week than children whose parents agree with the statement. These two findings indicate that knowing and meeting children in the neighborhood is significantly associated with higher levels of weekly physical activity. This is not surprising, if children know more other children they are likely to be playing outside more often as there are more children to play with. In model 3, the significant association between work status and weekly PA that was visible in the previous model is no longer present.

In model 4, also the school-level variables that turned out to be significantly associated with weekly PA in the bivariate analyses were included. The 2Log likelihood of model 4 is 9403.8, the model has 30 parameters. The improvement of this model fit is not significant. The between-school variance now has a value of 1878.2 and a significance of 0.346. The only school level variable that turned out to be significantly associated in the regression model was school size. Specifically, children that attend small schools appear to experience significantly less weekly PA (at the 0.1 significance level).

In model 5, also the transport mode and the percentage of active trips variables were added. This lead to the 2Log likelihood to decrease to 9394.4 with 36 parameters, which is not a significant increase in model fit. The intercept between schools now has a value of 1847.5 and a significance of 0.362. The travel mode is not associated significantly with PA weekly, but the percentage of active trips per week is. This indicates that children who make more active trips per week are likely to experience more physical activity overall per week. In model five the association with trip interaction is no longer significant.

Finally, model 6 includes all predictor variables that were significant in the previous model. The 2Log likelihood increased to 9415.0, the model has 12 parameters. All four included variables remained significant in the final model. These variables are: gender, school size (small), contact children (agree and strongly agree) and percentage of active trips. The intent was to include all of these predictor variables and the dependent variable PA weekly in the path model in chapter 10. However, as PA weekly is only significantly associated with the percentage of active trips as an ordinal variable and not as a continuous variable, there may not be a significant association between PA weekly and percentage of active trips in the path model. This is because the dependent variable percentage of active trips can only be added into the path model as a continuous variable, not as an ordinal variable or dummy variables. This will be further investigated in chapter 10.

The literature review revealed several studies that found significant associations between (active) transport mode and overall physical activity. Faulkner et al. (2010) reviewed several papers that reported higher levels of overall physical activity among children that traveled actively to school and Roth, Millet & Mindell found similar results. This relationship is also visible in the current regression analysis. Schoeppe et al. (2013) found independent mobility to influence physical activity, which might be why children who know more children in the neighborhood experience more active travel. Having more social contacts might lead to being allowed to travel more independently. This is in line with the theory of Hume et al. (2009), that having friends within the neighborhood will probably result in more participation in physical activities with these friends. Finally, concerning the significant association with gender, no previous research was found in which this association was tested. However, many researchers did look into the relationship between gender and active travel and independent mobility, which are likely to be associated with physical activity. Although some found no significant associations with gender (e.g. Kemperman & Timmermans, 2014; Carver et al., 2013), researchers that did find significant associations only indicated that boys were more likely to travel actively (Carver, Timperio & Crawford, 2013) or independently (Curtis, Babb & Olaru, 2015). This could explain why boys in the current study were found to experience more weekly physical activity.

Table 9.4 Multilevel linear regression analyses for weekly physical activity

Weekly PA	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Est.	*Sig.*	*Est.*	*Sig.*	*Est.*	*Sig.*	*Est.*	*Sig.*	*Est.*	*Sig.*	*Est.*	*Sig.*
Intercept *(within)*	*1171.3***	*.000*	*1020.5***	*.000*	*847.8***	*.000*	*917.3***	*.000*	*843.9***	*.000*	*787.0***	*.000*
Intercept *(between)*	*7576.2~*	*.052*	*6826.1~*	*.058*	*5510.0~*	*.085*	*1878.2*	*.346*	*1847.5*	*.362*	*4835.4~*	*.080*
Level 1 – individual level variables												
Personal factors												
Age	*-18.39~*	*.079*	*-9.901*	*.361*	*1.390*	*.897*	*0.692*	*.949*	*1.131*	*0.919*		
Gender - Girl	*-69.87***	*.006*	*-67.42***	*.009*	*-69.81***	*.005*	*-69.23***	*.005*	*-68.42***	*0.006*	*-65.23***	*.009*
Household factors												
Income - average												
Low			*-3.539*	*.930*	*-0.020*	*1.00*	*6.71*	*.865*	*6.310*	*0.873*		
Average	-	-	-	-	-	-	-	-	-	-	-	-
High			*22.65*	*.435*	*22.00*	*.436*	*24.01*	*.396*	*22.75*	*0.422*		
Work household – 1 wage earner												
2 wage earners			*68.07**	*.050*	*51.45*	*.131*	*45.15*	*.187*	*39.35*	*0.255*		
1 wage earner	-	-	-	-	-	-	-	-	-	-	-	-
Other			*-3.358*	*.955*	*-26.91*	*.643*	*-23.50*	*.685*	*-22.81*	*0.693*		
Car use parents – 4-5 days												
Never			*-44.75*	*.277*	*-37.95*	*.345*	*-40.41*	*.316*	*-36.45*	*0.366*		
1-3 days			*0.145*	*.997*	*-11.28*	*.763*	*-17.55*	*.640*	*-15.35*	*0.682*		
4-5 days	-	-	-	-	-	-	-	-	-	-	-	-
6-8 days			*-13.47*	*.712*	*-16.33*	*.648*	*-19.63*	*.583*	*-21.23*	*0.552*		
More than 8 days			*-23.17*	*.625*	*-36.52*	*.429*	*-31.03*	*.502*	*-8.12*	*0.864*		
Daycare – once per week												
Never			*-27.43*	*.494*	*-40.61*	*.300*	*-40.24*	*.305*	*-40.53*	*0.301*		
Once per week	-	-	-	-	-	-	-	-	-	-	-	-
Twice or more			*37.63*	*.438*	*36.25*	*.442*	*30.01*	*.524*	*15.31*	*0.747*		
Social and physical environment + weather												
% land-use recreation – 0-2.5%												
0-2.5%	-	-	-	-	-	-	-	-	-	-	-	-
2.6-5%					*-29.69*	*.445*	*-27.79*	*.476*	*-34.42*	*0.379*		
6-10%					*1.26*	*.977*	*-14.03*	*.747*	*-19.55*	*0.651*		
11-20%					*38.68*	*.401*	*18.67*	*.700*	*17.07*	*0.723*		
>20%					*51.24*	*.383*	*29.86*	*.621*	*31.47*	*0.602*		
Contact children (child has social network) – Disagree												
Disagree	-	-	-	-	-	-	-	-	-	-	-	-
Neutral					*65.69*	*.117*	*68.99*	*.101*	*69.57~*	*0.098*	*76.57~*	*.065*
Agree					*156.1***	*.000*	*158.9***	*.000*	*161.58***	*0.000*	*186.3***	*.000*
Strongly agree					*211.3***	*.000*	*214.3***	*.000*	*219.08***	*0.000*	*232.8***	*.000*
Trip interaction – Agree												
Disagree to neutral					*-65.84**	*.028*	*-63.11**	*.035*	*-44.92*	*0.142*		
Agree	-	-	-	-	-	-	-	-	-	-	-	-
Strongly agree					*-38.29*	*.406*	*-37.57*	*.417*	*-37.99*	*0.410*		

~ significant at 0.1 level ** significant at 0.05 level* *** significant at 0.01 level*

Weekly PA	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Est.	*Sig.*	*Est.*	*Sig.*	*Est.*	*Sig.*	*Est.*	*Sig.*	*Est.*	*Sig.*	*Est.*	*Sig.*
Level 2 – School level variables												
School factors												
Total pupils – average												
Small							*-116.8~*	*.055*	*-120.3**	*0.049*	*-144.2**	*.021*
Average	-	-	-	-	-	-	-	-	-	-	-	-
Large							*-34.65*	*.505*	*-48.01*	*0.364*	*-55.93*	*.346*
Bicycle parking – Sufficient												
Mediocre							*-11.90*	*.803*	*-19.16*	*0.690*		
Sufficient	-	-	-	-	-	-	-	-	-	-	-	-
Good							*-46.72*	*.337*	*-56.96*	*0.254*		
Car parking quality – mediocre												
Insufficient									*13.17*	*0.854*		
Mediocre	-	-	-	-	-	-	-	-	-	-	-	-
Sufficient to good									*-49.82*	*0.270*		
Dependent variables as predictors												
Transport mode – bicycle												
Walking									*16.05*	*0.649*		
Bicycle	-	-	-	-	-	-	-	-	-	-	-	-
Car									*5.60*	*0.898*		
Other									*59.99*	*0.356*		
% Weekly active school trips – 0%												
0% active	-	-	-	-	-	-	-	-	-	-	-	-
1-50% active									*157.6***	*0.005*	*171.7***	*.001*
51-99% active									*143.3**	*0.012*	*146.4***	*.002*
100% active									*120.7**	*0.043*	*116.3***	*.008*

~ significant at 0.1 level ** significant at 0.05 level* *** significant at 0.01 level*

9.6 Multilevel logistic regression analysis for active vs. passive travel

For the multilevel logistic regression analysis in which the power of predictors on children's school travel mode is analyzed, a similar approach will be used as for the previous models described in section 9.2. Naturally, the large difference is that the measurement level of the dependent variable is categorical instead of continuous, which means regular linear regression analysis is not applicable. Therefore, the previously described multilevel logistic regression will be applied. The dependent variable for this regression is active vs. passive travel, here to be interpreted as traveling more weekly trips by an active mode than a passive mode. This variable has a value of one for children that have more active than passive school trips per week and a value of zero for children who have more passive than active school trips per week. The logistic regression analysis predicts the odds of a child having more active than passive trips per week. The results of the analyses are presented in tables 9.5 (model 1 – 3) and 9.6 (model 4-6). For each variable the coefficient (log odds) and the Exp. coefficient (odds ratio) are presented. The odds ratio can be seen as a ratio of probabilities, i.e. the probability of falling into the more active group as opposed to falling into the more passive group. If the odds ratio is greater than one, that is an indication that the probability of falling into the more active traveling group is greater than falling into the more passive traveling group and vice versa if it is less than one. With an odds ratio of one, the probabilities for both groups are equal. If the coefficient, the log odds, is above zero, that indicates that the individual is more likely to fall into the more active category. A coefficient value below zero indicates a higher likelihood of falling into the more passive category.

9.6.1 Results multilevel logistic regression

For the results of the regression analyses presented in tables 9.5 and 9.6, the reference dependent variable category is passive travel. This means that all coefficient values are indicators of the likelihood that an individual travels more actively as opposed to passively. 13 respondents traveled exactly the same amount of trips passively as actively, which is why the sample for the current regression analysis is 647 instead of the usual 660. For the multilevel logistic regression analysis of active vs. passive travel, a total of six models will be analyzed. In the first model, only the effects of the personal factor variables on the school travel mode will be considered. In models 2, 3 and 4, respectively the household factors, school factors, physical- and social environmental factors (including the weather) will be added. In the fifth model, also the dependent variable parental safety perception will be included as predictor. In the sixth and final model, only the variables with a significant association in model 5 will be included. As in the previous paragraph, the information obtained from the multiple logistic regression analyses can be used to determine which variables to add in the path analysis.

In model 1, the personal factors that were found to be significantly associated with whether or not a child travels more actively or passively in an average week were added in the logistic regression. The overall percentage of outcomes that the model predicts correctly is 83.2%. The value for the intercept, the variance between schools, is 1.669 with a significance of 0.029. In model 1, only age is significantly associated with active travel. Children who are older are significantly more likely to travel actively.

In model 2 also the relevant household factors were added. This model predicts 84.5% correctly overall, which indicates an improvement as opposed to model 1. The value for the intercept between schools is 1.973 and the significance for this value is 0.031. Several household factors were found to be significantly associated with a larger frequency of active travel. Children in households with 2 parents and 1 child were significantly less likely to belong to the more actively traveling category than children in households with 2 parents and 2 or more children. Children in two wage earner households as opposed to one wage earner households were significantly more likely to fall into the active traveling category. Children who have parents that, combined, travel more than 8 days per week by car or never travel by active transport modes were less likely travel more actively than passively.

In model 3 the social and physical environmental factors that were found to be significantly associated with active vs. passive travel in the bivariate analyses were added. Model 3 overall predicts 89.0% correctly and the intercept between schools has a value of 0.253 and is no longer significant (sig. 0.389). Also a large part of the social and physical environmental variables was found to be significantly associated with the odds of falling into the more active traveling group. All of the distance categories have a significant relationship with active travel. If children live under 1 km from school, they are more likely to travel more actively and if they live over 2 km from school, they are more likely to travel more passively, which is not a surprising relationship. The odds ratios indicate that children living closer than 500 meters to school are almost 5 times as likely to fall in to the more active traveling group than children living 1-2 km from school. Moreover, the children that live over 5 km's from school are very unlikely to travel more actively than passively to school. Children who live in a densely populated area are significantly less likely to travel more actively to school than children who live in average urban density conditions. If there are several routes to take to school (connectivity), children are significantly about two times as likely to travel more actively to school. Having contacts with other children in the neighborhood also has a positive relationship with traveling more actively. Finally, all companions on the trip to school are significantly associated with traveling more actively. Compared to traveling alone, traveling with any of the other relations is associated with decreased odds of traveling more actively to school. The odds of traveling more actively to school are lower for children who traveled with a parent, parent and sibling or with other combinations of people than for children that traveled with a friend or a sibling. In model 3, the previously mentioned significant relationship with household work status is no longer visible, nor is the relationship between being 10 years old and active travel participation. Furthermore, there is a new significant relationship with active travel for parents; children whose parents travel actively more than four times per week are more likely to

belong to the more actively traveling group. There is another new negative relation with the category 1 parent households with 2 or more children and traveling more actively.

Model 4 also includes the school-level variables that are expected to have a significant contribution in the prediction of active vs. passive travel. This model predicts 90.0% of the outcomes correctly. The intercept between schools has a value of 0.839 and a significance of 0.337. None of the school-level variables in model 4 turned out to be significantly associated with the frequency of traveling actively.

Model 5 includes not only the regular predictor variables, but also the dependent variable parental safety perception. This model predicts 89.8% of the outcomes correctly. The intercept for the variance between schools has a value of 1.016 and a significance of 0.289. The dependent variable parental safety perception is significantly associated with active travel. If parents have a more positive perception of safety, children are more likely to fall into the more active traveling group. With the inclusion of parental safety perception in the model, the significant association with connectivity is no longer visible.

Model 6, the final model, includes only the variables that were found to be significantly associated with active vs. passive travel in the previous model. This model predicts 88.1% correctly and the value for the intercept between schools is 0.411 with a significance of 0.201. All of the significant relationships in model 5 are still significant in model 6. All nine variables that were significantly associated with traveling more actively will be included in the path model. These are: age, household composition, car use of parents, active travel parents, distance, urban density, contact with children, trip companions and parental safety perception.

Most of the associations with active travel in the current study were also previously found in other studies. Aarts et al. (2013) found the number of siblings to be associated with participation in active travel and Lin et al. (2017) found having older siblings to be associated with a higher independence of traveling (which in turn may lead to more active travel). Concerning the transport mode frequencies of parents, there are several similar associations in previous studies in line with the current study's findings. For example, Henne et al. (2014) found more working hours to be associated with less active travel among children and Davison et al. (2008) found evidence implying that children were less likely to participate in active travel when their parents worked and when the active travel would hinder the parents' work schedules. Although the current study only found associations with parental car use (more than 8 days per week for both parents), the measured effect is probably similar: it concerns parents' work. Furthermore, children had higher odds of participating in active school travel when their parents used active travel modes to get to their work (Davison et al., 2008; Panter et al., 2010a), as in the current study. The distance has been mentioned several times so far to be an important indicator of travel mode according to many studies (e.g. Chillón et al., 2015; McMillan, 2007; Merom et al., 2006; Nelson et al., 2008; Panter et al., 2010). The association between knowing other children in the neighborhood and active travel was also found similarly in other studies, such as Waygood et al. (2017a) who suggest that social connections decrease parental concern which increases independent travel and Hume et al. (2009) who found the child's perception of neighborhood social capital to be positively associated with walking and physical activity. The association between social cohesion and active travel that some researchers found (e.g. Kemperman & Timmermans, 2014; Aarts et al., 2013) was not significant in the current study. Perhaps this effect was replaced by the effect of social contacts with other children. The importance of parental safety perception in the odds of traveling more actively or passively was previously proven by many researchers (e.g. Carver, Timperio & Crawford, 2008a; Veitch et al., 2017; Rothman et al., 2015). Furthermore, the social cohesion was found to be a significant predictor for parental safety concerns in the current study, which may indicate an indirect effect on active travel.

Table 9.5 Multilevel logistic regression modeling – model 1-3 for active vs. passive, more active travel (N=647)

Active vs. Passive	Model 1			Model 2			Model 3		
	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)
Intercept (within)	0.378	0.364	1.460	0.292	0.659	1.338	2.464*	0.032	11.751
Intercept (between)	1.669*	0.029	-	1.973*	0.031		0.253	0.358	-
Level 1: individual level variables									
Personal factors									
Age – 7-8 years									
7 – 8 years	-	-	-	-	-	-	-	-	-
9 years	0.908**	0.002	2.479	0.798*	0.012	2.221	0.719~	0.064	2.052
10 years	0.882**	0.003	2.416	0.831*	0.014	2.296	0.380	0.364	1.462
11-12 years	2.087**	0.000	8.064	2.219**	0.000	9.200	1.631**	0.003	5.110
Favorite mode (bicycle)									
Bicycle	-	-	-	-	-	-	-	-	-
Walking	0.543	0.108	1.720	0.400	0.268	1.492	0.302	0.504	1.352
Car	-0.143	0.622	0.867	0.223	0.484	1.250	0.234	0.559	1.263
Other	-0.295	0.343	0.745	-0.119	0.733	0.888	-0.522	0.218	0.594
Household factors									
Household composition – 2 parents, siblings									
1 parent, 1 child				0.095	0.874	1.100	0.173	0.838	1.189
1 parent, siblings				-0.612	0.127	0.542	-0.996~	0.065	0.369
2 parents, 1 child				-1.033**	0.005	0.356	-0.964*	0.046	0.381
2 parents, 2 sibl.	-	-	-	-	-	-	-	-	-
Income - average									
Low				-0.010	0.979	0.991	-0.010	0.983	0.990
Average	-	-	-	-	-	-	-	-	-
High				-0.190	0.497	0.827	-0.307	0.354	0.736
Work household – 1 wage earner									
2 wage earners				0.797*	0.020	2.218	0.413	0.348	1.512
1 wage earner	-	-	-	-	-	-	-	-	-
Other				-0.384	0.477	0.681	-0.026	0.970	0.975
Car use parents – 4-5 days									
Never				0.592	0.170	1.808	0.551	0.270	1.736
1-3 days				0.315	0.403	1.371	0.169	0.721	1.184
4-5 days	-	-	-	-	-	-	-	-	-
6-8 days				0.043	0.901	1.044	-0.075	0.859	0.928
> 8 days				-1.335**	0.001	0.263	-1.011*	0.040	0.364
Active travel parents – 1-4 days									
Never				-0.582*	0.044	0.559	-0.644~	0.058	0.525
1-4 days	-	-	-	-	-	-	-	-	-
> 4 days				0.657	0.117	1.929	0.925~	0.067	2.522
Daycare – once per week									
Never				0.147	0.698	1.158	0.101	0.831	1.106
Once per week	-	-	-	-	-	-	-	-	-
Twice or more				-0.129	0.760	0.879	-0.404	0.424	0.668

*~ significant at 0.1 level * significant at 0.05 level ** significant at 0.01 level*

Active vs. Passive	Model 1			Model 2			Model 3		
	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)
Physical and social environmental factors									
Distance – 1-2 km									
< 500 m							*1.631***	*0.003*	*5.111*
500 – 1000 m							*0.911**	*0.018*	*2.487*
1-2 km	-	-	-	-	-	-	-	-	-
2 – 5 km							*-0.944**	*0.022*	*0.389*
>5 km							*-3.785***	*0.000*	*0.023*
Urban density - average									
High							*-1.104**	*0.016*	*0.331*
Average	-	-	-	-	-	-	-	-	-
Low							*-0.058*	*0.897*	*0.944*
% households children - 0-25%									
0-25%	-	-	-	-	-	-	-	-	-
26-30%							*0.370*	*0.440*	*1.447*
31-45%							*-0.064*	*0.889*	*0.938*
>45%							*-0.804*	*0.223*	*0.448*
Connectivity – Neutral									
Disagree							*0.286*	*0.469*	*1.331*
Neutral	-	-	-	-	-	-	-	-	-
Agree							*0.717**	*0.049*	*2.047*
Contact children (child has social network) – Disagree									
Disagree	-	-	-	-	-	-	-	-	-
Neutral							*0.990**	*0.039*	*2.691*
Agree							*1.145**	*0.016*	*3.143*
Strongly agree							*0.703*	*0.249*	*2.019*
Social cohesion - average									
Low							*-0.197*	*0.597*	*0.822*
Average	-	-	-	-	-	-	-	-	-
High							*-0.107*	*0.772*	*0.898*
Trip interaction – Agree									
Disagree-neutral							*0.049*	*0.886*	*1.051*
Agree	-	-	-	-	-	-	-	-	-
Strongly agree							*0.540*	*0.341*	*1.717*
Trip companions – alone									
Alone	-	-	-	-	-	-	-	-	-
Sibling							*-1.512~*	*0.066*	*0.221*
Friend							*-1.592**	*0.043*	*0.204*
Parent							*-2.60***	*0.000*	*0.074*
Parent + sibling							*-2.74***	*0.000*	*0.065*
Other							*-2.73***	*0.000*	*0.065*

~ significant at 0.1 level ** significant at 0.05 level* *** significant at 0.01 level*

Table 9.6 Multilevel logistic regression modeling – model 4-6 for active vs. passive, more active travel (N=647)

Active vs. Passive	Model 4			Model 5			Model 6		
	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)
Intercept (within)	2.282	0.089	9.796	1.706	0.242	5.506	1.828*	0.033	6.220
Intercept (between)	0.839	0.316		1.016	0.289		0.411	0.201	
Level 1: individual level variables									
Personal factors									
Age – 7-8 years									
7 – 8 years	-	-	-	-	-	-	-	-	-
9 years	0.724~	0.070	2.062	0.676~	0.096	1.966	0.686~	0.062	1.987
10 years	0.422	0.329	1.525	0.065	0.887	1.067	0.108	0.791	1.114
11-12 years	1.800**	0.002	6.048	1.503**	0.010	4.494	1.454**	0.005	4.279
Favorite mode (Bicycle)									
Bicycle	-	-	-	-	-	-	-	-	-
Walking	0.272	0.553	1.312	0.282	0.547	1.326			
Car	0.292	0.479	1.339	0.382	0.369	1.466			
Other	-0.490	0.263	0.612	-0.411	0.361	0.663			
Household factors									
Household composition – 2 parents, siblings									
1 parent, 1 child	0.135	0.875	1.144	0.256	0.771	1.292	0.298	0.708	1.348
1 parent, siblings	-0.919~	0.098	0.399	-1.154*	0.046	0.315	-1.156**	0.009	0.315
2 parents, 1 child	-0.996*	0.048	0.369	-1.050*	0.045	0.350	-1.106*	0.021	0.331
2 parents, siblings	-	-	-	-	-	-	-	-	-
Income - average									
Low	-0.093	0.843	0.911	0.013	0.978	1.013			
Average	-	-	-	-	-	-	-	-	-
High	-0.372	0.277	0.689	-0.490	0.171	0.613			
Work household – 1 wage earner									
2 wage earners	0.345	0.443	1.412	0.368	0.427	1.444			
1 wage earner	-	-	-	-	-	-	-	-	-
Other	-0.079	0.911	0.924	0.037	0.960	1.037			
Car use parents – 4-5 days									
Never	0.673	0.198	1.960	0.789	0.151	2.202	0.595	0.189	1.813
1-3 days	0.204	0.673	1.226	0.292	0.559	1.339	0.396	0.394	1.486
4-5 days	-	-	-	-	-	-	-	-	-
6-8 days	-0.045	0.917	0.956	0.003	0.995	1.003	0.079	0.847	1.082
> 8 days	-1.045*	0.038	0.352	-0.938~	0.075	0.391	-0.916~	0.058	0.400
Active travel parents – 1-4 days									
Never	-0.682~	0.051	0.505	-0.706~	0.051	0.493	-0.629~	0.060	0.533
1-4 days	-	-	-	-	-	-	-	-	-
> 4 days	0.944~	0.070	2.570	0.924~	0.083	2.520	0.851~	0.078	2.341
Daycare – once per week									
Never	0.053	0.913	1.054	0.015	0.976	1.015			
Once per week	-	-	-	-	-	-	-	-	-
Twice or more	-0.358	0.489	0.699	-0.425	0.427	0.654			

*~ significant at 0.1 level * significant at 0.05 level ** significant at 0.01 level*

Active vs. Passive	Model 4			Model 5			Model 6		
	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)
Physical and social environmental factors									
Distance – 1-2 km									
< 500 m	*1.612***	*0.004*	*5.014*	*1.727***	*0.003*	*5.622*	*1.801***	*0.001*	*6.053*
500 – 1000 m	*0.960**	*0.016*	*2.612*	*0.910**	*0.025*	*2.486*	*1.146***	*0.002*	*3.145*
1 – 2 km	-	-	-	-	-	-	-	-	-
2 – 5 km	*-0.786~*	*0.067*	*0.455*	*-0.761~*	*0.080*	*0.467*	*-0.810**	*0.039*	*0.445*
>5 km	*-3.53***	*0.000*	*0.029*	*-3.605***	*0.000*	*0.027*	*-3.702***	*0.000*	*0.025*
Urban density - average									
High	*-1.013**	*0.047*	*0.363*	*-1.047**	*0.047*	*0.351*	*-0.745~*	*0.056*	*0.475*
Average	-	-	-	-	-	-	-	-	-
Low	*-0.012*	*0.980*	*0.988*	*-0.093*	*0.852*	*0.911*	*0.033*	*0.938*	*1.033*
% households children - 0-25%									
0-25%	-	-	-	-	-	-	-	-	-
26-30%	*0.409*	*0.420*	*1.506*	*0.240*	*0.654*	*1.272*			
31-45%	*-0.141*	*0.777*	*0.869*	*-0.285*	*0.586*	*0.752*			
>45%	*-0.746*	*0.353*	*0.474*	*-0.834*	*0.314*	*0.434*			
Connectivity – Neutral									
Disagree	*0.288*	*0.484*	*1.333*	*0.361*	*0.394*	*1.434*			
Neutral	-	-	-	-	-	-	-	-	-
Agree	*0.714~*	*0.057*	*2.043*	*0.505*	*0.192*	*1.657*			
Contact children (child has social network) – Disagree									
Disagree	-	-	-	-	-	-	-	-	-
Neutral	*0.995**	*0.041*	*2.704*	*1.063**	*0.035*	*2.896*	*0.799~*	*0.081*	*2.222*
Agree	*1.231**	*0.011*	*3.426*	*1.285***	*0.010*	*3.613*	*0.974**	*0.022*	*2.648*
Strongly agree	*0.886*	*0.157*	*2.426*	*0.983*	*0.127*	*2.672*	*0.691*	*0.191*	*1.996*
Social cohesion - average									
Low	*-0.174*	*0.653*	*0.840*	*-0.082*	*0.839*	*0.921*			
Average	-	-	-	-	-	-	-	-	-
High	*-0.097*	*0.795*	*0.907*	*-0.232*	*0.550*	*0.793*			
Trip interaction – Agree									
Disagree-neutral	*0.117*	*0.740*	*1.124*	*0.248*	*0.501*	*1.281*			
Agree	-	-	-	-	-	-	-	-	-
Strongly agree	*0.498*	*0.391*	*1.645*	*0.307*	*0.607*	*1.359*			
Trip companions – alone									
Sibling	*-1.709**	*0.044*	*0.181*	*-1.778**	*0.040*	*0.169*	*-1.551~*	*0.053*	*0.212*
Friend	*-1.589**	*0.050*	*0.204*	*-1.295*	*0.119*	*0.274*	*-0.960*	*0.204*	*0.383*
Parent	*-2.674***	*0.000*	*0.069*	*-2.544***	*0.000*	*0.079*	*-2.119***	*0.001*	*0.120*
Parent + sibling	*-2.863***	*0.000*	*0.057*	*-2.769***	*0.000*	*0.063*	*-2.559***	*0.000*	*0.077*
Other	*-2.703***	*0.001*	*0.067*	*-2.676***	*0.001*	*0.069*	*-2.791***	*0.000*	*0.061*
Level 2 – School level variables									
School factors									
Total pupils - average									
Small	*-0.543*	*0.501*	*0.581*	*-0.627*	*0.471*	*0.534*			
Average	-	-	-	-	-	-	-	-	-
Large	*0.162*	*0.848*	*1.176*	*0.074*	*0.936*	*1.076*			
Bicycle parking – Sufficient									
Mediocre	*0.343*	*0.648*	*1.409*	*0.453*	*0.574*	*1.573*			
Sufficient	-	-	-	-	-	-	-	-	-
Good	*-0.157*	*0.841*	*0.855*	*-0.019*	*0.982*	*0.981*			

~ significant at 0.1 level ** significant at 0.05 level* *** significant at 0.01 level*

Active vs. Passive	Model 4			Model 5			Model 6		
	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)	Coeff.	Sig.	Exp (coeff.)
Car parking quality – mediocre									
Insufficient	*0.078*	*0.940*	*1.081*	*0.111*	*0.920*	*1.118*			
Mediocre	-	-	-	-	-	-	-	-	-
Sufficient - good	*0.524*	*0.458*	*1.689*	*0.414*	*0.586*	*1.513*			
Dependent variables as predictors									
Parental safety perception - low									
Low	-	-	-	-	-	-	-	-	-
Semi-low				*0.511*	*0.271*	*1.666*	*0.454*	*0.283*	*1.574*
Semi-high				*1.020**	*0.021*	*2.772*	*1.019***	*0.010*	*2.772*
High				*1.729***	*0.003*	*5.635*	*1.597***	*0.002*	*4.939*

~ significant at 0.1 level ** significant at 0.05 level* *** significant at 0.01 level*

9.7 Multilevel logistic regression analysis for transport mode

In this section, the results of the regression analyses for transport mode on the day of the survey are presented. The reference dependent variable category is car travel, all coefficient values are indicators of the likelihood that an individual travels by bicycle or by foot as opposed to by car. For this regression analysis, the transport mode 'other' has been recoded to also belong to the category car, which becomes a category representing motorized travel. For the multilevel logistic regression analysis of transport mode, a total of six models will be analyzed. Model 6 is presented in table 9.7, models 1 – 5 can be seen in appendix 8. In the first model, only the effects of the personal factor variables on the school travel mode will be considered. In models 2, 3 and 4, respectively the household factors, school factors, physical- and social environmental factors (including the weather) will be added. In the fifth model, also the parental safety perception will be included. In the sixth and final model, only the variables with a significant association in model 5 will be included. Because this dependent variable is a nominal variable, and it cannot be recoded into a continuous variable, it is not possible to add the dependent variable into the path model in chapter 10. Therefore, the results of the predictors in the sixth model of the current analysis will be considered the final results concerning the variable transport mode. In the six multinomial logistic regression models, 8 variables were not significant in any of the models and, for the bicycle and walking category. These are: income, daycare attendance, recreation land-use, bicycle and walking paths, social cohesion, school size, bicycle parking quality at school and car parking quality at school. Some variables are only significant for one of the two transport mode categories that are compared to car travel in this analysis.

In model 1, only the personal factors that were found to be significantly associated with travel mode on the day of the survey are added: age and the favorite mode. The variance between schools for the comparison between car travel and bike travel has a chi square value of 2304.3 and it is significant, which indicates that there is still unexplained variance between schools. For the comparison between traveling by car and by foot the variance between school has a chi square value of 1164.9, which is also significant. Age is significantly associated with travel mode, when children are older they are more likely to travel to school by bicycle than the reference variable, traveling by car and also more likely to travel by foot than by car. Moreover, not surprisingly, children who have walking as their favorite transport mode are also more likely to walk to school. It could be that this relationship is significant not because children who prefer to walk are more likely to walk, but because children who usually walk are more likely to prefer walking. However, Pont et al. (2011) did make a framework in which the perceptions of the parents on the transport mode choice are seen as equally important as the perceptions of the child in the decision making process.

In model 2, also the household factors that had a significant association with transport mode in the bivariate analyses are added. For the bicycle category, the between schools intercept has a value of 2635.0 and it is still significant. For the walking category, the value is 1226.8 and also significant. The

only two variables significantly associated with traveling by bicycle are household work status and car use of parents. Children in households that have 2 wage earners are more likely to travel by bicycle than by the reference category, car, and children who have parents that together use the car more than 8 days per week are less likely to travel to school by bike than by car. For the likelihood that children walk to school as opposed to going by car, there are three significant associations: household composition, car use of parents and active transport use of parents. Children in households with fewer parents and children are less likely to travel to school by foot than children in households with two parents and more than one child. Children whose parents combined travel more than eight days per week by car are less likely to walk than travel by car. Children whose parents use active transport modes more than four times per week are more likely to walk than be transported by car.

In model 3 several factors from the physical and social environment are added, as well as the variable weather. For the category bicycle as well as the category walking, the variance between schools is no longer significant. For the category bicycle, six new variables are significantly associated. Children that live further away are less likely to travel to school by bicycle than by car, the reference category. The same relationship is visible with children that live in neighborhoods with a high urban density. Children in neighborhoods with 26-30% children are significantly more likely to travel to school by bike than by car, compared to neighborhoods with less than 25% children. This is a remarkable association, because there is no significant association with the higher percentages of children. When children live in neighborhood with many different routes to school (high connectivity) and when they live in a neighborhood with not many different routes (low connectivity), they are more likely to travel to school by bicycle. Perhaps, this result is caused by the attractiveness of highly connected neighborhoods for cycling and at the same time the relationship between living closer to school and therefore not having many different routes available. Finally, when it rains, children are less likely to use the bicycle than the car, which is common sense. Furthermore, there is now also a significant association with active transport use of parents and the odds for cycling. Children whose parents use active transport modes more than four days per week are more likely to travel by bike than by car.

For the category walking, there are five new significant associations in this model. Not surprisingly, children who live within 1 km from school are significantly more likely to walk to school than be driven by car. For walking, the same, somewhat strange, association with percentage of households with children is visible as for cycling. When children live in areas that have 6-10% recreation land-uses, they are more likely to travel to school by foot than by car. They are also more likely to walk to school than go by car if they know many children in the neighborhood and less likely to walk when the chance that they run into other children on the way is low. This makes sense: children that travel to school by car are not likely to run into children on the way. Moreover, when children run into other children while walking to school, this could mean that walking is the “normal” travel mode and parents are likely to perceive it as safer. There is no significant association between walking to school and the weather. There is, however, a new association with household work status. Children whose parents belong to the ‘other’ category in terms of work status are more likely to walk to school. Perhaps this is because many of these households are unemployed or similar and might not own a car or parents have the time to walk to school with their children.

In model 4 also the school level variables that were significantly associated with transport mode in the bivariate analyses were added to the model. For both the cycling and the walking category, the between school variance is still not significant. None of the school factors are significantly associated with either transport mode in the regression analysis. However, in this model, the association between recreation land-use and walking is no longer significant. Also the association between contact with children and traveling by bicycle is no longer significant.

In model 5 the dependent variable parental safety perception is added. The variation between schools is still not significant for either transport mode. When parents have a more positive perception of safety, their children are significantly more likely to travel to school by bicycle than by car. Parental safety perception is not significantly associated with walking. In this model, the association between contact with children and cycling to school is once again significant. No other changes occur in model 5 as opposed to the previous model.

Finally, model 6 only includes the variables that were significantly associated with transport mode in the previous model. Because this dependent variable cannot be added into the path model in chapter 10, the current regression analysis is the final analysis for this variable. Therefore, in model 6, only variables that are significant at the 0.05 or the 0.01 significance level are marked with a green box. For traveling by bicycle as opposed to traveling by car, the final significant predictors are age, car use of parents (more than 8 days per week), active travel of parents (more than 4 days per week), distance (2-5 and >5 km), connectivity, weather (rainy) and parental safety perception. The final significant predictors for walking as opposed to traveling by car are age, favorite mode (walking), household composition (2 parents, 1 child), work household (other), active travel parents (more than 4 days per week), distance (<500m and 500-1000m), percentage children in the neighborhood (26-30%) and contact with children in the neighborhood (strongly agree).

It is interesting to see that there is a difference in variables that are significantly associated with traveling by bike and with traveling by foot to school. Differences between the correlates of these two modes have also been found in previous studies (e.g. de Vries et al., 2010; Kemperman & Timmermans, 2014). In the current study the household composition is significantly associated with walking to school, but not with going by bicycle. Perhaps this is an indirect effect of distance. McDonald (2017b) suggested that distance might have a mediating effect on the association between social cohesion and children's travel behavior. They found that the social environment was most influential for school travel mode on short distances. Connectivity only is a significant predictor of cycling, which may be because children who are likely to walk probably live close to school and therefore do not have many different route possibilities. Having contacts with children only has a significant relation with walking. This might be because children are likely to walk together with other children (and perhaps their parents) if they know other children. Cycling together with other children is also possible, but cycling usually covers a larger distance which in turn reinforces the effect of parental safety perception.

Most of the results of the multinomial logit model for transport mode are in line with previous research. For instance, the importance of parental safety perception was found in other Dutch studies (Kemperman & Timmermans, 2014; Aarts et al., 2013). Aarts et al. (2013) also found an association between the number of siblings and active travel participation. The association with work status and car travel (indirectly related to work status) is also not new. In the study of Carver, Timperio & Crawford (2013), children who had at least one parent that worked were more likely to be picked up from school by car. Furthermore, Henne et al. found that increasing working hours of parents were associated with less participation in active travel. Interesting about the current study is that children whose parents belong to the 'other' work category are more likely to walk to school, but children whose parents belong to the '2 wage earner' category are more likely to cycle to school. This could be in line with the finding that in the Netherlands low income was associated with more car use (van Goeverden & de Boer, 2013) but that walking trips are not replaced by car trips. In previous studies there have been many associations between active travel and income, both positive and negative (e.g. Goeverden & de Boer, 2013; Pont et al., 2009; Sidhartan et al., 2011), but the current study found no significant association between cycling or walking and income. The association between higher odds of using active modes when the distance to school is smaller is in line with international research (e.g. Chillón et al., 2015; McMillan, 2007; Merom et al., 2006) as well as Dutch research (Aarts et al., 2013; Dessing et al., 2014; Helbich et al., 2016). The results for connectivity in the current study are twofold: more connectivity leads to more cycling and less connectivity also leads to more cycling. These seemingly inconclusive results are in line with previous research. Panter et al. (2010b) found lower active travel rates in highly connected neighborhoods, whereas Giles-Corti et al. (2011) had opposite results. In the current study, it may be that highly connected neighborhoods facilitate the opportunity to choose the safest or most comfortable routes, whereas poorly connected neighborhoods may be safer overall because they are less attractive for cars. It could also be that children who have fewer connections to school simply live closer to school, facilitating active travel. The relationship with weather was also found by Builiung et al. (2011).

Table 9.7 Results multilevel multinomial logistic regression analysis for transport mode (reference category is motorized transport mode)

Transport mode – Model 6	Bicycle		Walking	
	Chi Sq.	Sig.	Chi Sq.	Sig.
Intercept (between schools)	5777.7**	0.000	3538.4**	0.000
	Coeff.	Sig.	Coeff.	Sig.
Intercept (within schools)	-8.453**	0.000	-9.682**	0.001
Level 1 – individual level variables				
Personal factors				
Age	0.483**	0.000	0.376*	0.016
Walking	-0.463	0.204	0.900*	0.036
Bicycle	-	-	-	-
Car	-0.229	0.486	-0.424	0.428
Other	-0.462	0.211	0.156	0.783
Household factors				
Household composition – 2 parents, siblings				
1 parent 1 child	-0.503	0.440	-0.935	0.331
1 parent sibl.	-0.324	0.461	-0.343	0.622
2 parents 1 child	-0.141	0.727	-1.511*	0.028
2 parents sibl.	-	-	-	-
Work household – 1 wage earner				
2 wage earners	0.699~	0.054	0.635	0.199
1 wage earner	-	-	-	-
Other	0.209	0.712	1.838*	0.039
Car use parents – 4-5 days				
Never	0.538	0.195	-0.342	0.570
1-3 days	0.079	0.838	-0.328	0.542
4-5 days	-	-	-	-
6-8 days	-0.644~	0.075	-0.160	0.744
>8 days	-0.939*	0.035	-0.282	0.668
Active travel parents – 1-4 days				
Never	0.148	0.607	0.370	0.359
1-4 days	-	-	-	-
>4 days	1.022**	0.010	1.801**	0.001
Physical and social environment + weather				
Distance – 1-2 km				
<500 m	-0.314	0.477	4.027**	0.000
500-1000 m	-0.208	0.507	2.049**	0.001
1-2 km	-	-	-	-
2-5 km	-0.901*	0.016	-1.855	0.130
>5 km	-3.095**	0.000	-0.874	0.509
Urban density - average				
High	-0.781~	0.056	0.365	0.526
Average	-	-	-	-
Low	0.079	0.850	1.031	0.115
% Children – 0-25%				
0-25%	-	-	-	-
26-30%	0.762~	0.086	2.041**	0.007
31-45%	0.371	0.379	1.163	0.128
>45%	0.645	0.312	1.931~	0.053

Transport mode – Model 6	Bicycle		Walking	
	Chi Sq.	Sig.	Chi Sq.	Sig.
Connectivity - Neutral				
Disagree	1.047**	0.003	0.508	0.281
Neutral	-	-	-	-
Agree	1.061**	0.001	0.198	0.641
Contact children (child has social network) - Disagree				
Disagree	-	-	-	-
Neutral	0.525	0.203	1.366	0.061
Agree	0.173	0.656	0.726	0.279
Strongly agree	-0.025	0.962	1.849*	0.022
Trip interaction – Agree				
Disagree-neutral	0.086	0.774	-0.852~	0.075
Agree	-	-	-	-
Strongly agree	0.095	0.838	-0.626	0.285
Weather – Sunny				
Sunny	-	-	-	-
Partly clouded	0.078	0.855	0.616	0.317
Very clouded	0.564	0.219	0.591	0.361
Rainy	-1.487*	0.027	-0.608	0.474
Dependent variable as predictor				
Parental safety perception	0.897**	0.001	-0.043	0.906

~ significant at 0.1 level ** significant at 0.05 level* *** significant at 0.01 level*

9.8 Conclusion regression analyses

In this chapter, five elaborate regression analyses have been conducted to investigate the combined predictive power of the independent variables on the five dependent variables. For the continuous dependent variables parental safety perception, satisfaction with travel and weekly physical activity, multilevel linear regression analyses were conducted in SPSS. For the binary dependent variable, active vs. passive travel, multilevel binary logistic regression in SPSS was applied. For the nominal dependent variable transport mode, a multilevel multinomial logit model was made in HLM. Figure 9.2, shown on the next page, represents the revised conceptual model for the current research, based on the results of the five regression analyses. This revised conceptual model presents the conclusion of the chapter regression analyses, as it shows all significant relationships between the predictor variables in the different layers and the five dependent variables. There are a few predictor variables in each socio ecological layer that have a significant relationship with at least one of the dependent variables. As described previously, not all relationships were in line with the literature review.

From the regression analyses it can be concluded that in total twelve independent variables are significantly associated with parental safety perception. These are: age, favorite mode of child, household work status, household income, ethnicity, car parking quality at school, distance, urban density, quality of walk and bicycle paths, connectivity, social cohesion and trip interaction (running into children on the way to school). Eleven independent variables have a significant association with transport mode: age, favorite mode, household work status, parental car use, parental active travel, household composition, distance, connectivity, trip interaction, % households with children and the weather. Furthermore, parental safety perception is a significant predictor of transport mode. Eight independent variables are significantly associated with active vs. passive travel. These are: age, parental car travel, parental active travel, household composition, distance, urban density, contact with children in the neighborhood and trip companions. Also parental safety perception is a significant predictor of active vs. passive travel. Four variables are significantly associated with satisfaction with travel. These are bicycle parking quality at school, contact with children in the neighborhood, trip companions and the weather. From the dependent variables there is a significant association with transport mode, which is stronger when an interaction between actual transport mode and preferred transport mode is used. Finally, there are three significant associations between independent variables and weekly physical activity. These are gender, school size and contact with children in the neighborhood. Furthermore, traveling more actively is also significantly associated with transport mode, but only when measured as an ordinal variable for the percentage of active trips.

The relationships between 19 predictor variables and 3 of the 5 dependent variables will be investigated in the path analysis in chapter 10, the last step of the statistical analyses of the current research. Transport mode will not be included because it does not have the measurement scale required for a path analysis and weekly PA will not be included because it is only significantly associated with percentage active at an ordinal scale.

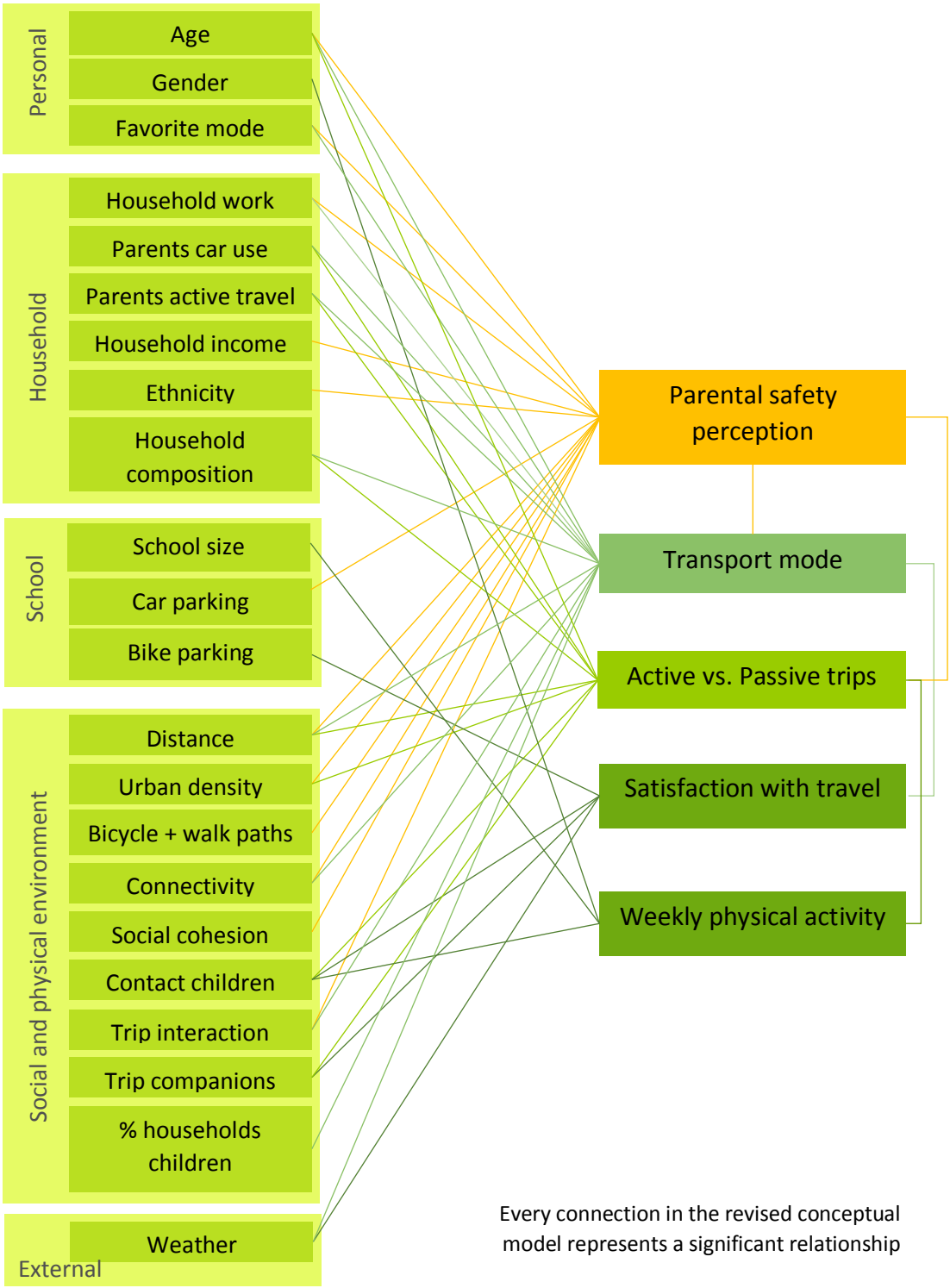


Figure 9.2 *Revised conceptual model – active school travel of primary school children*

CHAPTER 10

PATH ANALYSIS

Drawing by Desiree & Amber van de Craats, 2018

10. PATH ANALYSIS

In this chapter the results of the path analysis will be discussed. Path analysis is a technique which can define more meaningful and complicated models, which in the current study can help answer the main research question. The path analysis will be conducted to discover which factors from the different layers of the child's environment influence their travel mode, how this relationship is mediated by the parental safety perception and how it is related to their subjective well-being and health (in this model represented by satisfaction with travel). In the first sections of the chapter the analysis technique is introduced and the conceptual model is transformed into the path model. The remaining sections of the chapter describe the results and implications of the path analysis.

10.1 Explanation of path analysis

Path analysis is an analysis technique that "goes beyond regression" as it is possible to analyze more complicated models and compare different models to find out which best fits the data (Streiner, 2005). What path analysis can do and regression cannot, is analyze models with more than just independent variables and one dependent variable. For instance, it is possible to analyze the relationships in a model with mediating variables (Streiner, 2005) and several dependent variables, as visible in the conceptual model of the current research. Path analysis makes it possible to deal with several relationships at the same time (Ho, 2014), such as direct- as well as indirect relationships. Furthermore, the method is theory driven. This means that the path model can be used to test a theory consisting of certain relationships. It is not sensical to have the program structure the model, then it will be based on chance and most likely it will not be logical (Ho, 2014). To test whether the model fits the data, several goodness-of-fit measures are used. The value of the goodness-of-fit indicates to what extent the observed data match the prediction of the hypothesized model (Ho, 2014). By means of the path analysis, sub questions b, d and f of the current research will be answered, as the analysis will provide final results concerning the predictors of active travel, parental safety perception and satisfaction with travel (which can be seen as a component of subjective well-being).

10.2 Conversion conceptual model to path model

The conceptual model that was constructed based on the literature review has already become smaller and less complicated after implementing the results of the different statistical analyses so far. Moreover, the quality of the model has improved as it can be backed-up by the results of the bivariate analyses, multilevel linear regression analyses and multilevel logistic regression analyses. The final version of the conceptual model was presented in the conclusion of chapter 9, the conclusion of the regression analyses. This model serves as the basis for the path analysis in the current chapter, except for two changes. First, the nominal variable transport mode cannot be tested in the path analysis because the analysis only accepts continuous dependent variables. Second, the weekly physical activity variable was removed from the path model because it is not significantly associated with the other dependent variables. The binomial variable active vs. passive was recoded to represent a percentage of weekly active school trips in order to comply with the assumptions of the path analysis. This new variable was checked for the assumptions of regression analysis, see appendix 7.

From the multilevel linear regression analysis for parental safety perception, the conclusion was that eleven independent variables had a significant association with parental safety perception. These variables are age and favorite mode in the personal factors, household work status, household income and ethnicity in the household factors, distance, urban density, bicycle and walk paths, connectivity, social cohesion and trip interaction in the physical and social environment and car parking quality in the school factors. The number of significant associations with percentage of active trips is eight. Age

is the only personal factor significantly associated with the percentage of active trips. The significant predictors of active travel in the household layer are parental car use, parental active travel and household composition. There are no significant associations with the school factors and the significant predictors from the social and physical environment are distance to school, urban density, having contacts with children in the neighborhood and the trip companions on the day of the survey. Finally, also the dependent variable parental safety perception was found to be a significant predictor for the percentage of active trips. For the third dependent variable, satisfaction with travel, there are six significant associations with independent variables. None of these associations are in the personal layer or the household layer. In the school factors, there is a significant association between bike parking quality and satisfaction with travel. There are two significant physical and social environmental predictors, namely having contacts with children in the neighborhood and traveling with a friend (part of the variable trip companions). Satisfaction with travel is also significantly predicted by the weather and there is a significant association with travel mode. This association is greater when an interaction term of travel mode and preferred travel mode is used. The interaction term of cycling and having the bicycle as a favorite mode and the interaction term of walking and having walking as a favorite mode were found to be significant predictors of satisfaction with travel. Finally, parental safety perception was found to be a significant predictor of satisfaction with travel. In figure 10.1 all of the above mentioned associations are presented in the conceptual path model. Using this knowledge, a path model is constructed in which all of the above mentioned relationships can be investigated simultaneously by means of a path analysis, also known as structural equation modeling.

10.3 Results path analysis

The path analysis was conducted in the statistical program LISREL. First, all variables that were expected to have a significant association with the different dependent variables were added into the model at the same time. Moreover, the expected relationships between the dependent variables were included. The path analysis provided the relationships and whether or not they were significant. Step by step the non-significant relationships were removed from the model, which resulted in a final path model with only significant associations between at least one of the dummy categories per independent variable and at least one dependent variable. Figure 10.1 shows the conceptual path model and figure 10.2 shows the final path model. In table 10.1 the goodness of fit statistics for the final path model are provided. There are some guidelines as to the values for the Chi Square divided by the degrees of freedom, and for the Root Mean Square Error of Approximation (RMSEA) which indicate that the model has a good fit. Dividing the Chi Square of the current model by the degrees of freedom results in a value of 2.27, which is very close to the rule of thumb that states a value below 2 is optimal (Golob, 2001). The value for the RMSEA of the final path model is 0.064, which is once again close to the guideline which states that RMSEA values should ideally be below 0.05 (Golob, 2001). These values indicate that the path model presented in figure 10.2 is a good fit for the data. Table 10.2 provides the coefficients and significance of the different relationships in the model. The path model includes significant relations with variables in all layers of the socio-ecological environment of the child except for the school layer. School factor relationships were no longer significant in the path model.

Table 10.1 Goodness of fit of the path model

Degrees of freedom	*178*
Full information ML chi Square	*404.50*
Chi Square / Degrees of freedom	*2.27*
Root Mean Square Error of Approximation (RMSEA)	*0.064*
90 Percent Confidence Interval for RMSEA	*0.055;0.072*
P-Value for Test of Close Fit (RMSEA <0.05)	*0.0000*

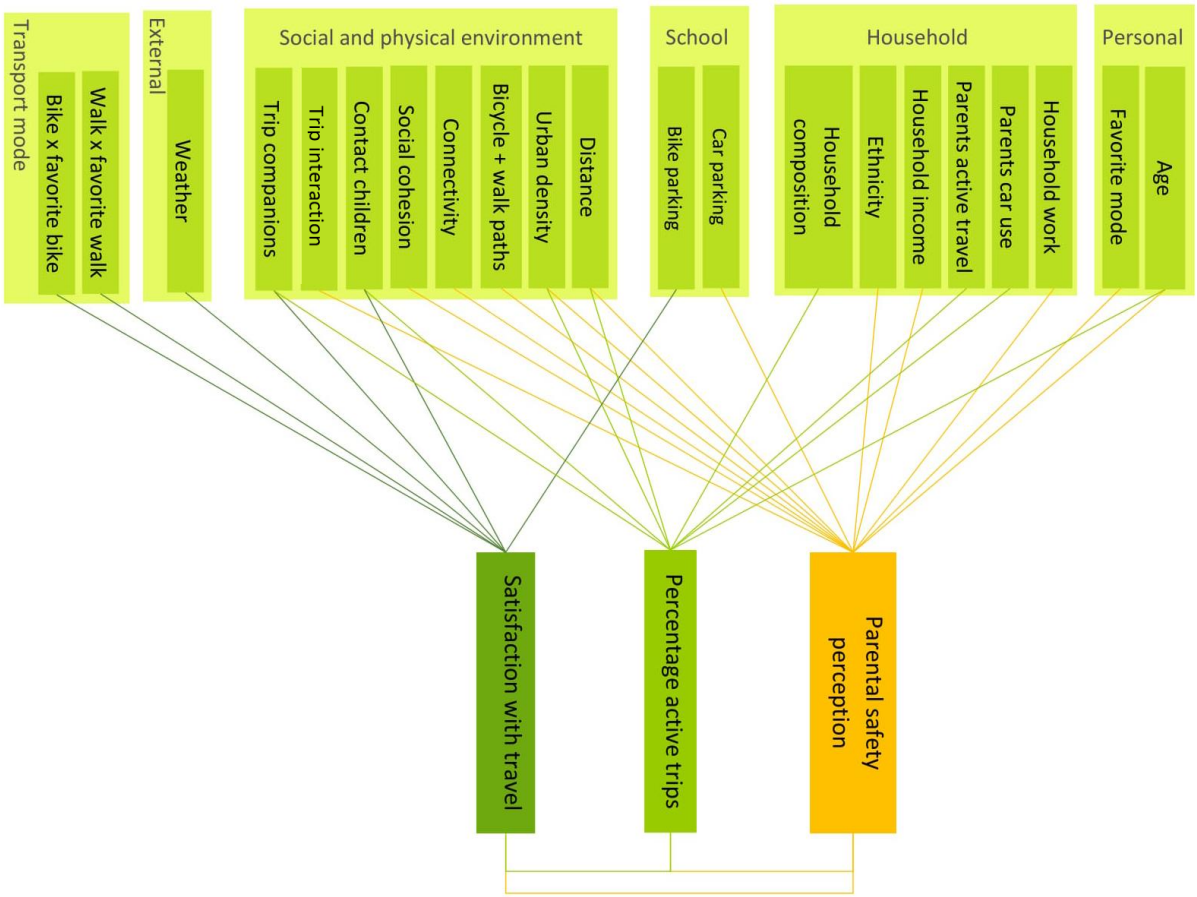


Figure 10.1 Conceptual path model

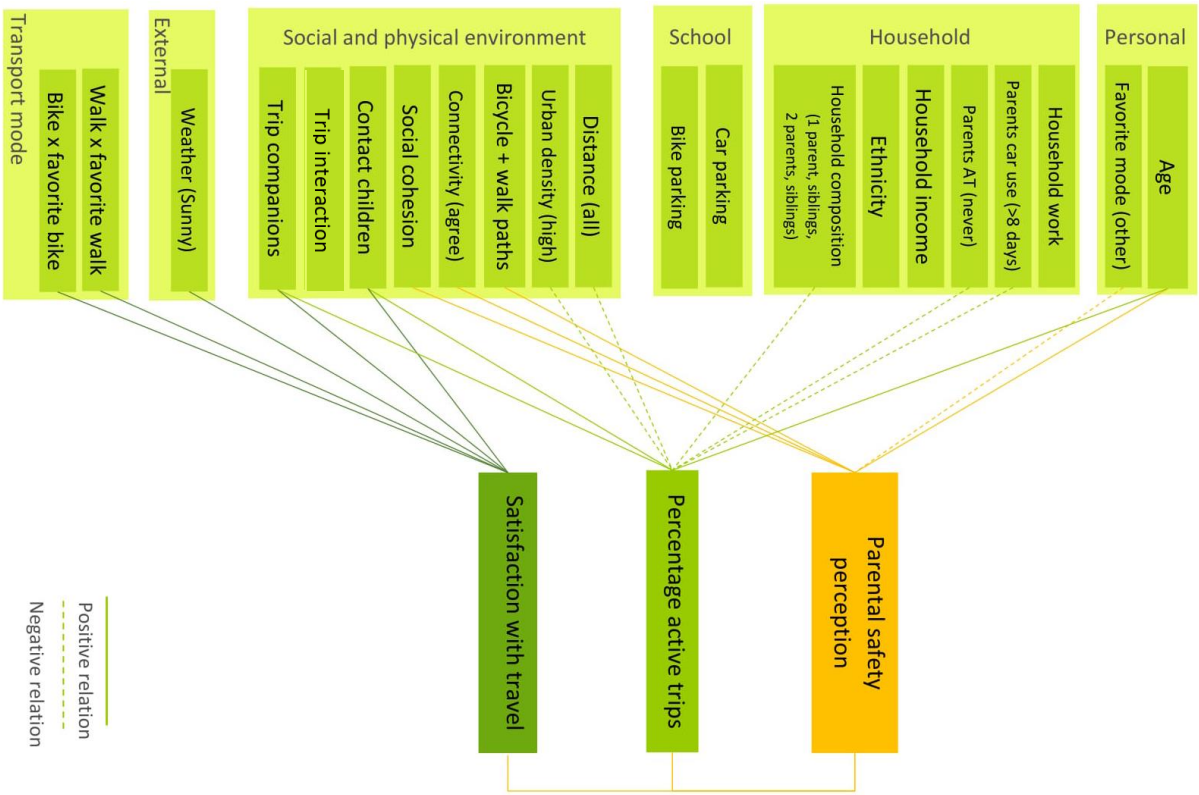


Figure 10.2 Final path model – active school travel of primary school children

10.3.1 Relationships parental safety perception

In this section the significant relationships with parental safety perception in the path model of children's active travel to school are discussed. First of all, and not surprisingly, age is a predictor for parental safety perception. When children are older, their parents are likely to be more positive about the safety concerning the trip to school. No specific results have been found in the literature review for this association, but several researchers found that children generally were granted more independence by their parents when they were older (Carver et al., 2013; Curtis, Babb, & Olaru, 2015), which is an indication of positive safety perceptions.

There is also a significant association between favorite mode and the safety perception of children. Children who prefer an 'other' transport mode have parents that are more concerned about the safety. It is not very clear why this relationship occurs. One theory is that quite a lot of children that have an 'other' mode as preferred mode are children that travel to school by taxi-bus every day. These children also prefer the taxi-bus. In the regression analysis for parental safety concerns it became clear that also larger distance and 'other' work status are associated with lower parental safety perceptions. The parents of children that travel by taxi-bus are generally less wealthy and live far away from school. Therefore, the relationship with an 'other' favorite mode could be an indirect effect from preferring another mode to traveling by taxi-bus to having more concerned parents.

A better connectivity between the home and school, having more possible routes to take to school, is associated with a more positive parental safety perception. This could be because having more routes to choose from makes it possible to choose a safe route the child can take to school.

When the parents' perception of social cohesion is higher, they are also more positive about the safety. This is in line with the previously stated finding by Waygood et al. (2017a) that having connections in the neighborhood decreases parental concern.

Also when parents perceive bicycle and walking paths to be better, they are significantly more positive about the safety. This may be because the perception of bicycle and walking paths can be influenced by traffic safety, which is likely to influence parental safety perception. Moreover, Kerr et al. (2006) also found a positive association between parental concerns and the quality of walking paths.

10.3.2 Relationships percentage of active trips

In this section the significant relationships with the dependent variable percentage of active trips in the path model will be discussed. First, a commonly found predictor for active travel is parental safety perception (e.g. Carver, Timperio & Crawford, 2008a; Veitch et al., 2017; Rothman et al., 2015). Also in the current path model, a positive parental safety perception is associated with a higher percentage of active trips to school. This means that the direct effects on the parental safety perception described in the previous section can also be considered indirect effects on active travel participation.

There is also a significant positive association with age, as children are older they are likely to travel more actively. This is not a surprising result and it can be backed-up by an extensive share of literature. Age was found to be an important influencer between active travel behavior of children and the predicting factors of this behavior (Carver, Timperio, & Crawford, 2013; Kann et al., 2015; Kemperman & Timmermans, 2014).

The household composition was also found to be significantly associated with the percentage of active trips. More specifically, when children belonged to a 1 parent household and had a sibling or they belonged to a 2 parent household and they did not have a sibling, their percentage of active trips was lower than for 2 parent households with 2 children. This is similar to previous findings that indicate having (more) siblings is associated with more active travel (Aarts et al., 2013) or more travel independence (Lin et al., 2017). Other studies remain inconclusive on the effect of having siblings (Pont et al., 2009) and the effect living with one or two parents has not been previously investigated. The decreasing active travel rate in 1 parent households with siblings may be explained by the fact that the single parent has trouble coordinating the family schedule and finds it more convenient to drive the children by car.

Also the travel behavior of parents is an important predictor of the percentage of active school trips of children. When parents together travel more than 8 days per week by car, their children are likely to have a lower percentage of weekly active trips than children of parents who travel 4-5 days by car. Moreover, children whose parents never use active travel modes experience lower percentages of active trips than children whose parents travel 1-4 days per week by an active mode. These results are mostly in line with previous studies, although there is at least one study that found results implying the contrary. When parents together use the car more than 8 days per week, this usually means that both parents work. Carver, Timperio and Crawford (2013) found that children with at least one parent that did not work experienced less active travel. They suggest that his may be because when both parents work, their busy schedules do not allow bringing and getting the children from schools, resulting in more independent, active travel. In contrast, Easton and Ferrari (2015) suggest that parents with busy schedules drive their children to school on the way to work. Other studies found that children had higher odds of active school travel if their parents also used active modes to get to work (Davison et al., 2008; Panter et al., 2010a), which is in line with the findings in the current research.

Also the distance to school is an important predictor of the percentage of active travel participation in the current study. The distance is the most commonly found predictor of active travel participation in previous literature (e.g. Chillón et al., 2015; McMillan, 2007; Merom et al., 2006; Nelson et al., 2008; Panter et al., 2010).

The remaining independent variables that were found to be significantly associated with the percentage of active trips in the path model are social factors: knowing children in the neighborhood and travel companions. When children knew some or a lot of other children in the neighborhood as opposed to when they did not, they were likely to experience a higher percentage of active trips. Researchers emphasize the importance of having neighborhood connections to increase independent mobility and active travel by extent (Veitch et al., 2017) and to decrease parental concerns which leads to more independent travel (Waygood et al., 2017a). Moreover, some researchers also found that a more positive perception of social cohesion was associated with higher active travel rates (e.g. Kemperman & Timmermans, 2014; Aarts et al., 2013). As perceived social cohesion and having social contacts in the neighborhood are likely to be related, these results are similar to the findings in the current research. The associations between traveling with a parent or parent and sibling and lower percentages of active trips compared to traveling alone is not surprising, as traveling alone is almost always active. Traveling with 'other' travel companions often means traveling with the other children in the taxi-bus. This is not an active mode, which explains the negative relationship with active travel.

10.3.3 Relationships satisfaction with travel

In this section, the significant associations with satisfaction with travel (SWT) that were found in the path analysis will be discussed. In the regression analysis for satisfaction with travel it already became clear that traveling by bicycle as opposed to by car lead to a significantly higher satisfaction. Moreover, this effect became more important when the variable transport mode was added as an interaction of actual transport mode and favorite transport mode. Also in the path analysis, the interaction variable between traveling by bicycle and preferring the bicycle and the interaction variable between traveling by foot and preferring to travel by foot are significant predictors of travel satisfaction. Westman et al. (2017) also found active travel modes to be associated with higher satisfaction than car travel.

Parental safety perception was also found to have a significant positive relationship with satisfaction with travel. This indicates that parents who are more positive about the safety have children who are more satisfied about their trip. This relationship has not been investigated in previous studies. There are some possible explanations for this relationship. Firstly, it could be that parental safety is a mediating variable between active travel participation and satisfaction with travel, i.e. parents that are less concerned let their children travel actively, which the children enjoy. Another possibility is that the route is simply safer, which the children enjoy. The associations between SWT and parental safety perception as well as the percentage of active trips also result in several indirect effects on SWT, through the mediation of the other two dependent variables.

Table 10.2 Results of final path analysis

	Variables	Categories	Percentage active trips	Parental safety perception	Satisfaction with travel
			Coefficients		
Personal	Age		3.20*	0.11*	
	Favorite mode	*Walking*		0.05	
		Bicycle	-	-	-
		Car		-0.05	
		Other		-0.12*	
Household	Household composition	*1 parent, 1 child*	2.70		
		1 parent, siblings	-11.98*		
		2 parents, 1 child	-8.14*		
		2 parents, siblings	-	-	-
	Car travel parents	*Never*	3.72		
		1-3 days per week	-2.69		
		4-5 days per week	-	-	-
		6-8 days per week	-1.84		
		> 8 days per week	-14.98*		
	Active travel parents	*Never*	-5.12*		
		1-4 days per week	-	-	-
		>4 days per week	5.00		
Social & physical environment and weather	Distance to school	*<500 m*	13.17*		
		500-1000 m	9.49*		
		1-2 km	-	-	-
		2-5 km	-11.90*		
		>5 km	-40.23*		
	Urban density	*High*	-8.07*		
		Average	-	-	-
		Low	0.25		
	Connectivity	*Disagree*		-0.05	
		Neutral	-	-	-
		Agree		0.20*	
	Contact children (child has social network)	*Disagree*	-	-	-
		Neutral	7.30*		-0.17*
		Agree	7.75*		-0.01
		Strongly agree	5.46		0.04
	Social cohesion			0.14*	
	Bicycle and walk paths			0.13*	
	Trip companions	*Alone*	-	-	-
		Sibling	-3.87		-0.08
		Friend	-2.24		0.24*
		Parent	-17.70*		0.05
		Parent + sibling	-17.75*		0.13
		Other	-17.37*		0.15
	Weather	*Sunny*	-	-	-
		Partly clouded			-0.22*
		Very clouded			-0.30*
		Rainy			-0.28*
	Dependent variables				
	Parental safety perception		8.54*		0.09*
	Bike x favorite bike				0.28*
	Walk x favorite walk				0.23*

** significant relationship at the 0.05 significance level*

Satisfaction with travel was found to be significantly associated with having contacts with other children in the neighborhood. The curious thing is that children who are believed to have some contacts are less satisfied about the trip than children that do not have any contacts. There is no way of understanding this relationship, especially because it particularly applies to the group of children whose parents replied 'neutral' to the statement about knowing a lot of children, and not to the groups of children whose parents replied 'agree' or 'strongly agree'. Westman et al. (2017) actually found that children who engaged in social activities on the way to school would be likely to be more satisfied. What is in line with this finding is the fact that children who traveled together with a friend were significantly more satisfied than children who traveled alone. Also children traveling with a parent, parent and sibling or another combination of companions were more satisfied, but this relationship was not significant. The weather was also found to be associated with travel satisfaction. When it was partly clouded, very clouded or raining, children were less satisfied with their trip than when it was sunny. Although no literature was found to verify this finding, it is not surprising.

10.4 Conclusion

In the path analysis, which has been described in this chapter, the complete model with three dependent variables and all the relations they have with the independent variables from the personal, household and school factors and the physical and social environment and the weather have been investigated. By means of the path analysis, in combination with the results of the regression analyses for transport mode and weekly physical activity, research questions b, d and f can be answered. This means that in the next chapter, the conclusion, the answer to the main research question can be given.

From the path analysis it became clear that percentage of active trips has a significant relationship with eight independent variables and one dependent variable: age, parental car travel, parental active travel, distance to school, urban density, contact with children in the neighborhood and trip companions. The significant dependent variable is parental safety perception. The variable parental safety perception, in turn, has five significant predictors: Age, favorite mode of the child, quality of bike and walking paths, social cohesion and connectivity. Finally, the satisfaction with travel is significantly associated with five independent variables and one dependent variable: contact with children, trip companions, weather, walking x preferring to walk, cycling x preferring to cycle and parental safety perception.

CHAPTER 11

CONCLUSION, DISCUSSION & RECOMMENDATIONS

Drawing by Desiree & Amber van de Craats, 2018

11. CONCLUSION, DISCUSSION & RECOMMENDATIONS

In this final chapter, the conclusion of the research on the influencing factors of Dutch children's active travel behavior is presented. Moreover, this chapter includes the discussion of limitations of the current research. Finally, recommendations for practice and for future research are provided.

Conclusion

The aim of this study was to identify the factors in children's environment that contribute to their participation in active school travel. Furthermore, there was the aim to understand the role of parental safety concerns in the transport mode decision making process and to investigate the relationship between school transport mode and subjective well-being and health. The main problems are the decrease in active travel rates among children and the increase in parental safety concerns and unsafe traffic situations outside Dutch primary schools. Participation in active school travel can be an important, regular source of physical activity for children. Moreover, increasing active travel participation among children goes hand-in-hand with decreasing the intensity of cars around primary schools, which is likely to improve the safety. In the current study, a socio-ecological approach was used to develop a conceptual model of children's travel behavior. This means that different layers in the child's environment were considered in the model, allowing multilevel influences. The research question specifically addresses these different layers, as well as the parental safety perception and the subjective well-being of children. The main research question is as follows:

> *Which personal-, household- and school factors and which characteristics of the social & physical- and external environment of primary school-going children have an influence on participation in bicycling, walking or motorized transport to primary school in the Netherlands? How is this relationship mediated by the parental safety perception about transport mode of their children? How is it related to children's subjective well-being and health?*

In pursuing the answer to this question and identifying the influencing factors of child travel behavior, first an extensive literature research was conducted. From the results of previous studies, three sub-questions of the current research could be answered. The first was the question "which factors influence the travel mode of children according to the literature?" The literature revealed that there are important factors in every layer of the child's environment, from the personal to the external layer. Age and preferences of the child were found to be important, as well as household composition and socio-economic status. The perception that parents have of the safety was named in many studies, as well as the distance to school. Also factors such as urban density, connectivity, social cohesion and weather were believed to be of importance, as well as school factors such as health initiatives and safety around school. The second sub-question addressed in the literature review was: "which factors influence the parental safety perception about the travel mode of children and how does this influence the actual travel mode of children to school according to the literature?" As mentioned, the parental safety perception was studied by many researchers, and many see parental concerns as a key factor in the transport mode decision making process. The parental safety perception, in turn, was found to be influenced by age and several physical and social environmental factors, such as social cohesion, social connections and traffic safety conditions. The third question to be answered by the literature review was: "what is the relationship between children's travel mode to school and their health and subjective well-being according to the literature?" Of the three questions, this question had been studied the least by other researchers, especially in the Netherlands. There are some studies that report a significant relationship between active travel participation and overall higher physical activity levels, which is the only direct relationship with child well-being that was studied. Some researchers indicated that satisfaction with travel, which was found to be associated with active travel participation, is also beneficial for subjective well-being.

From the answers to these first three sub-questions and from some descriptive analyses that were conducted on the data from the Dutch National travel survey (OViN), a conceptual model and a data measurement tool in the form of a questionnaire for Dutch primary school children and their parents were constructed. This marked the second part of the current research: the quantitative analysis. 660 useful questionnaires were collected from primary school children (and their parents) attending 14 different primary schools in and around the Dutch city Arnhem. The data were analyzed in three steps. In step one, bivariate analyses were conducted to eliminate relationships that were not significant. In step two, multilevel regression analyses were conducted, to investigate the combined predictive power of the independent variables on child travel behavior, parental safety perception, weekly physical activity and satisfaction with travel. In step three, a path analysis was conducted to investigate the predictors of active travel, while simultaneously looking at the mediating effect of parental safety perception and the relationship with satisfaction with travel. Three remaining sub questions were answered from the results of these analyses, completing the answer to the main research question. See the final path model in figure 11.1. The remaining sub-questions are similar to the questions addressed in the literature review, but these questions are addressed in the quantitative research.

The first sub question answered in the quantitative research is: "What are the direct effects of personal-, household- and school factors and characteristics of the social-, physical- and external environment on the travel mode of children traveling to primary school in the Netherlands?" This question was answered in two ways. The determinants of transport by walking and cycling as opposed to the reference category car travel on the day of the survey were investigated in a multilevel multinomial logistic regression model. The factors that influence the percentage of weekly school trips that a child makes by an active mode were studied in the path analysis. In the regression model for the transport mode, three variables were found to be significantly associated with traveling by bicycle as well as traveling by foot as opposed to traveling by car: age, active travel behavior of parents and distance. Four variables were only associated with the odds of walking as opposed to traveling by car: favorite mode (walking), household composition, % of households with children in the neighborhood and knowing children in the neighborhood. Four variables were only significantly associated with cycling: car travel behavior of parents, connectivity, the weather and the safety perception of parents. The results for the percentage of active school trips that children make are quite similar. In the path model, the significant direct effects with the percentage of travel are age, household composition, parental car use and active travel behavior, distance, urban density, travel companions and the parental safety perception.

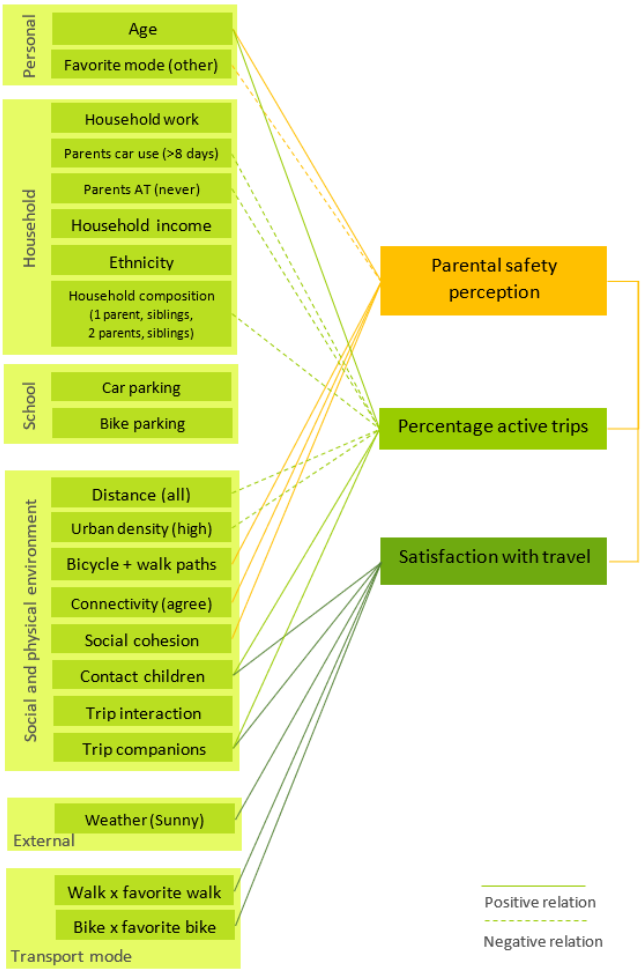


Figure 11.1 *Final path model – active school travel of children*

The next sub-question answered by the quantitative research is: "What are the (in)direct relationships of personal-, household- and school factors and characteristics of the social-, physical- and external environment through the mediation of parental safety perception about the travel mode of children on the actual travel mode of children traveling to primary school in the Netherlands?" Because the parental safety perception was found to be positively related

with the percentage of active trips, factors that have a direct effect on the parental safety perception have an indirect effect on the travel mode of children to primary school. In the path model, there are significant direct effects on parental safety perception by five variables: age, the favorite mode of the child, connectivity between the home and the school, social cohesion and the quality of cycling and walking paths. It can be concluded that factors from the personal layer, the household layer and the physical and social environmental layer have significant direct relationships with the parental safety perception and therefore have indirect relationships with the active travel participation of children.

The third sub-question that can be answered by looking at the results of the path analysis and the regression analysis is: "How does children's travel mode to primary school in the Netherlands influence their subjective well-being and health, while controlling for other characteristics in the child's environment?" First, the results of the regression analysis of weekly physical activity are inspected, which reveal that children who traveled more actively to school, were also more active overall. However, this relationship was only significant when the percentage of active trips was operationalized as an ordinal variable. Other significant predictors of weekly physical activity are gender, contact with children and school size. This makes weekly physical activity the only dependent variable associated with a school-level variable. Another aspect of subjective well-being and health that was extensively studied is satisfaction with travel. Children who came to school by bicycle and had the bicycle as their favorite mode as well as children who came to school walking and preferred to walk, were significantly more satisfied with their trip to school. The other three significant predictors for satisfaction with travel in the path model are knowing other children in the neighborhood, the companions of the trip to school and the weather. Overall, it can be concluded that children enjoy active travel more than passive travel and children that participate in a higher percentage of active trips are likely to experience more physical activity overall.

These results support the theory that the travel behavior of children is influenced by factors from the different layers of the child's environment. Moreover, the expectations that parental safety perception would play a mediating role for the participation in active travel and that there would be a relationship with subjective well-being and health have been proven. The current research is an important contribution to the existing scientific literature on children's travel behavior. Firstly, because scientific attention to children's travel behavior overall has remained limited, additional evidence for factors influencing children's participation in active travel is valuable. Moreover, no previous studies were found which looked into children's travel behavior, as well as their satisfaction with travel and the parental perception of safety, making this one of the more complete studies on child travel behavior. Finally, because the Netherlands is unique compared to other countries in terms of cycling behavior and infrastructure, country-specific research is a relevant contribution to the existing literature. The current study and the results also deliver important contributions on the societal level. Considering the decreasing active travel and physical activity rates of (Dutch) children, the increase in car travel and the resulting safety issues around primary schools, insights on the influencing factors of children's travel behavior is valuable. Especially school principals, school boards and municipality policy makers can use these insights in developing areas around schools and social environments where more children travel actively to school. Specific practical implications are discussed further on.

Discussion and limitations

This section elaborates upon the limitations and remarks that surfaced during and after the completion of the research. Firstly, because the questionnaires were all distributed in the fall, differences in travel behavior between seasons were not accounted for. Furthermore, the weather in September and October of 2018 was quite unusual for the season the Netherlands, with high temperatures and little rain. However, significant relations concerning the weather were still measured. Another limitation may be that two of the fourteen participating schools were special education schools, the share of children in the sample attending these schools may be a little larger than it is in general in the Netherlands. An additional difficulty concerning the special education schools concerns the fact that

many children traveled to school by taxi-bus, which was coded as “other”. This lead to over half of the “other” actual modes and favorite modes to refer to the taxi-bus, which may have caused some misleading results. However, most of the possible bias due to the special education schools should have been eliminated by using a multilevel analysis approach.

There are also some limitations relating to the participating schools and the school variables, none of which remained significant in the final path model. This could partly be because the differences between school environments and education types are simply not as large in the Netherlands as they may be in other countries, such as the USA. However, there are some limitations to the variables relating to the schools. Firstly, although it is sufficient, fourteen participating schools is not a very large number. Moreover, a few schools only provided around twenty respondents. This may have caused that not all school characteristics such as school size or school surroundings were sufficiently represented. Partly because of the moderate amount of schools, many of the school variables correlated and could not be included in the regression analyses. Furthermore, in multilevel regression analyses it is recommended to have at least 25 groups (schools)(O’Dwyer & Parker, 2014), the multilevel regression analyses may therefore not have performed optimally.

Despite the great amount of effort put into creating a questionnaire that would be reliable and have high validity, some improvements can be noted afterwards. Firstly, the answers to the question about children’s hours of physical activity in the free time indicated that parents experienced it as a difficult question. Some parents wrote this down as a comment, some left the question open and some provided quite unrealistic answers (which were treated as outliers). Perhaps this question was too difficult for some parents, which could influence the validity of the answers. Another difficulty concerns the marital status of parents and the consequences on the manner of answering questions if parents are divorced and children live in two homes. Although the questionnaire did include the question “how many parents live in the same home as your child”, some parents seemed to have included step-parents in their answers, some excluded step-parents but included the other parent they divorced because the child lives in two homes, etc. Although this problem only surfaced in a few questionnaires, which were deleted, it is something that could have better been accounted for. Furthermore, there may have been more undetected cases where questionnaires were filled in on behalf of two homes. One other issue related to one-parent households occurred in the operationalization of the variables representing travel modes of parents. In the operationalization of parental car travel and parental active travel, the number of days that parents use these modes are summed for both parents. However, this does not take into consideration the fact that households might have only one parent. It would have been better to divide the days both travel modes were used by the number of parents, which solves the problem that the parental transport modes are not entirely representative and the problem that saying “parents who used the car more than 8 days” can confuse readers. Finally, parents who lived farther away from school were generally less positive about the safety. On the one hand this makes sense, on a longer route to school there are more dangers that a child could encounter. However, these children generally came to school by car or taxi-bus, which could mean that parents actually do not really know how the safety situation around school is.

Recommendations

In this section, recommendations and implications for practice as a result of the current research are provided, as well as recommendations for future research.

Implications for practice

The results of this study have a wide range of implications for stakeholders such as school principals, school boards and municipality policy makers. A better understanding of the influencing factors of children’s travel behavior, their parents’ safety perception and the relation with subjective well-being and health can guide these stakeholders in directing their focus.

Although it is not surprising, it is good to have verified that also in the Netherlands the parental safety perception plays an important role in the choice of transport mode and that this relationship is mediated by age. As children age, their parents are more positive about their safety concerning the trip to school. This tells schools and municipalities that focusing on the perception that parents have of the safety is important. The last paragraph of this section gives some insights as to how the safety perception could be improved. Furthermore, also the transport mode that parents most frequently use is related to the children's participation in active travel. When parents travel mostly by car, their children are likely to do so also, whereas children whose parents travel more actively, are also more often traveling by an active mode. This means that when the aim is to get children to travel more actively, a possible strategy is to also focus on the travel behavior of parents. This can be referred to as travel socialization: children learn their travel behavior from their surroundings such as the neighborhood and the parents. Possible interventions include informing parents on the benefits of active travel, not only for their children but also for themselves. The school could also provide parents with advice concerning the logistics of active school travel, such as letting children travel together with other children in the neighborhood (and their parents).

Also the preference of the child plays a role and children are more satisfied with their trip to school if it was an active trip. This tells us that it could be useful to work on improving the extent to which children experience an active trip as enjoyable. For example, schools could encourage children to travel actively by handing out stickers or other rewards for each active school trip. These rewards could also be organized in such a way that the whole class benefits.

There is also a social aspect to school travel: meeting friends on the way to school or even traveling together. The results of the current study showed that children who know many other children in the neighborhood have higher odds of walking to school and overall travel a higher percentage of their trips by an active mode. Moreover, knowing other children in the neighborhood was found to be associated with more hours of being physically active. Perhaps because then, children play more outside with friends. Of course, the relationship with knowing children works in both directions: when children can travel together and know others in the neighborhood, parents are more likely to allow them to travel actively to school and to play outside, but children who travel actively and play outside are also more likely to get to know other children. Either way, active travel participation, physical activity and having social connections have all been found to be positively associated with children's overall well-being. Additionally, children who traveled with a friend were more satisfied with their trip. Therefore, a focus on the social network of a child in his or her neighborhood is always beneficial and something schools and municipalities are encouraged to work on. Examples of interventions would be to create playgrounds or other social facilities where children can meet each other and play together. Another possibility is to team-up children in class for whom the school knows they live close together. These children and their parents could be encouraged to travel together. These types of interventions can increase the odds that children travel together to school, which may result in more active travel and more travel satisfaction.

Finally, there are some factors in the physical environment that play a role in active travel behavior of children. High levels of connectivity as well as low levels of connectivity were found to be positively associated with higher odds of taking the bicycle to school. This indicates that when there are a lot of routes to take to school, parents are more likely to let their children cycle, perhaps because they can choose the safest route. Also when there are not many or just one route, children have higher odds of taking the bicycle than the car. This could be because areas that are not very well connected are not attractive for car drivers, resulting in fewer cars and more safety. Especially when selecting locations for new schools, this relationship can be considered in searching for either very well connected areas, or more poorly and indirectly more quiet areas. The last finding concerning travel behavior that may have implications for practice is the finding that children living in areas with high urban density experience a lower percentage of active trips. This may be because in more dense areas children automatically encounter more cars and perhaps these areas are a little more chaotic. In terms of the physical environment around schools, it seems that either poorly connected or highly connected

areas with medium density levels are most encouraging for active travel, specifically for cycling. Walking is more influenced by the social factors such as knowing children.

Also from the associations that were found between factors in the child's environment and the safety perception that parents have, some lessons can be learned by schools and municipalities. Firstly, as mentioned, age plays a role. As children get older, parents have fewer concerns. Perhaps this means that the focus should be more on the safety perception of parents who have children below the age of 10 or 11, children that are now not always very independent in travel yet. Connectivity, which played a role in travel behavior, also plays a role in the concerns that parents have. When areas are highly connected, parents have fewer concerns, which once again may be because parents and children have the freedom to choose the safest route. Also social cohesion is associated with parental safety perception, when social cohesion is higher, so is the perception that parents have of the safety. This means that investing in the social connections and, for instance, the opportunities to get to know neighbors may help when aiming to increase active travel among children, because it improves the safety perception of parents. Possible actions include supporting neighborhood gatherings such as a barbecue, creating community centers where activities are organized or facilitating that parents of children in the same area are introduced to each other (at school). Another interesting influencing factor of the parental safety perception is the quality of bicycle and walking paths. When parents perceive the quality of paths as more positive, also their safety perception is more positive. More specifically, parents were asked about the extent to which the bicycle paths were safe to cycle on and the extent to which the walking and bicycle paths were well maintained. This relationship means that working on the quality of walking paths and bicycle paths could result in an improved safety perception of parents, which in turn could result in more active travel participation among children. Lastly, children whose parents are more positive about the safety of the trip, are themselves more satisfied with their trip. This could mean that when the parental safety perception is improved, a side-effect is that children enjoy their trips more. Perhaps this is because they will travel more actively or because the traffic situations are more safe and relaxed for children.

To conclude, it is advised that schools and municipalities focus mostly on social aspects such as the social network of children and the social cohesion of neighborhoods, on the safety perception and the travel behavior of parents, on the enjoyment that children get out of their active trips and on connectivity, urban density and bicycle and walking paths in terms of the built environment.

Recommendations for future research

Apart from the shortcomings and limitations discussed earlier, which should be considered in future research on children's travel behavior, there are some more recommendations for future research in terms of different approaches that could be considered. Because the topic of children's travel behavior has so many facets and has not yet been widely studied, coming up with other interesting perspectives for future research is no challenge. For example, the current and many previous studies have proven the importance of the parents in the choice of a child's transport mode. The current study mostly focused on the safety perception and to some extent the travel behavior of the parents, but there are so many other factors that could play a role, such as convenience in the time schedule, the background and upbringing of parents, the social norm in the neighborhood, etc. A study that would mainly focus on the role that the parents have and how it is shaped could help surface many new perspectives.

Another interesting perspective to consider is the effect on children's travel behavior of improvements in traffic safety conditions, active travel policies of a school or the relocation of a school to a safer, more quiet or better connected area. In this case, a longitudinal approach would have to be applied to actually investigate the effects of these kinds of improvements. Some similar studies have been conducted in Canada, such as the study by Buliung et al. (2011), who looked at the effects of an active travel initiative called school travel planning (STP). The main goal of an STP is to promote and facilitate active transport modes. Buliung et al. (2011) found modest increases of active travel and

parents reported safety education, special events and infrastructure adjustments as being most effective. It would be interesting to investigate whether these kinds of interventions could be successful in the Netherlands. On a related note, it could also be interesting to look into the effects on the amount of parents driving their children to school and the safety perception after an improvement of parking conditions. The current study looked at the perception of car parking quality and capacity, but it cannot be certain how this perception was derived. For example, consider two schools with the same amount of pupils and parking spaces, located in two different environments. It could be that in an environment where not many parents drive, the perception of the car parking is good, whereas it is insufficient in an environment where many parents drive. It would be interesting to investigate, by means of a longitudinal approach, the changes in travel behavior and safety perception after an intervention in car parking quality and capacity, or after the adding of a kiss and ride lane.

The current study showed that the satisfaction that children have of their trip is associated with their travel mode and that their preference may play a role in the transport mode decision making process. An interesting approach for future research could be to dig deeper into the perception that children have of their school trip, the safety and the extent to which they enjoy it. Moreover, especially when the aim is to develop interventions to increase active travel, it can be valuable to have a better understanding of the role of children and how important their opinion is in the decision of parents to select their school transport mode.

Lastly, in the current study many variables are the product of the perception of parents and children, such as the social cohesion, safety perception, quality of bicycle and walking paths, satisfaction with travel and even, to some extent, the number of hours per week that children are physically active. Although there is nothing wrong with this approach, a more factual content is something that is missing from the current research. Suggestions to improve this in future research are to use GPS trackers or a Fitbit to gather more data concerning the activities of children. Moreover, when using GPS trackers, also the travel behavior outside of school travel can be measured, which could lead to new perspectives, especially because Trapp et al. (2012) indicated that the school travel mode is partly dependent on activities conducted before and after school. Finally, GPS trackers make it possible to see which routes were taken by children, which gives some insights into the preferences for certain aspects of routes. Another possibility is to include actual street maps, measures of traffic speeds, measures of car parking availability, etc. in the research design, by means of GIS or similar software, to learn much more about the relationship between children's travel behavior and their built environmental surroundings.

This study is one of the first to conduct an integrated quantitative research of children's travel behavior in relation to many factors in their environment and especially to the safety perception of their parents and their own subjective well-being and health. The results have shown that personal factors, household factors and factors from the physical and social environment and the weather are all important in the active travel participation of children attending primary school in the Netherlands. Moreover, children that travel more actively were found to be more physically active overall and active travel was associated with higher satisfaction with travel. Important aspects to focus on when aiming to increase active travel rates among children include the parental safety perception, travel behavior of parents, social contacts of children and social cohesion in neighborhoods, connectivity and the quality of cycling and walking paths. Although more country-specific research is needed to truly understand the travel behavior of children and how to influence this behavior, the current study has provided many useful, scientifically as well as practically relevant insights.

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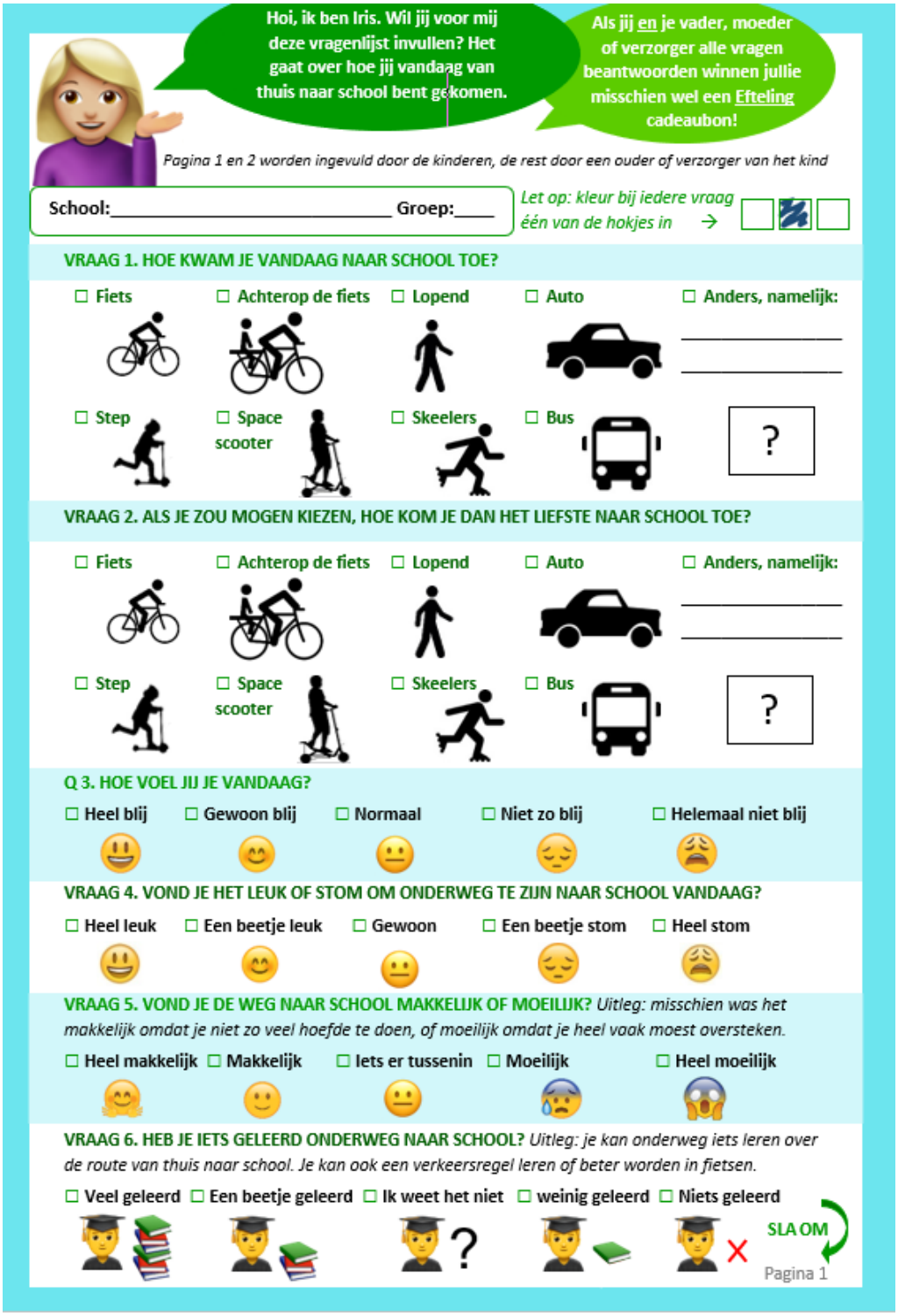
APPENDIX

This section is where all appendices are gathered.

Appendix 1: Complete child-parent questionnaire

In this appendix, the child-parent survey that was made especially for the current study is presented. The survey was designed in such a way that it would be understandable for the target groups (children and parents of all education levels). Additionally, the layout of the survey was made to be appealing to the children.



Hoi, ik ben Iris. Wil jij voor mij deze vragenlijst invullen? Het gaat over hoe jij vandaag van thuis naar school bent gekomen.

Als jij en je vader, moeder of verzorger alle vragen beantwoorden winnen jullie misschien wel een Efteling cadeaubon!

Pagina 1 en 2 worden ingevuld door de kinderen, de rest door een ouder of verzorger van het kind

School:_____ Groep:____

Let op: kleur bij iedere vraag één van de hokjes in →

VRAAG 1. HOE KWAM JE VANDAAG NAAR SCHOOL TOE?

☐ Fiets ☐ Achterop de fiets ☐ Lopend ☐ Auto ☐ Anders, namelijk: _____ _____

☐ Step ☐ Space scooter ☐ Skeelers ☐ Bus ?

VRAAG 2. ALS JE ZOU MOGEN KIEZEN, HOE KOM JE DAN HET LIEFSTE NAAR SCHOOL TOE?

☐ Fiets ☐ Achterop de fiets ☐ Lopend ☐ Auto ☐ Anders, namelijk: _____ _____

☐ Step ☐ Space scooter ☐ Skeelers ☐ Bus ?

Q 3. HOE VOEL JIJ JE VANDAAG?

☐ Heel blij ☐ Gewoon blij ☐ Normaal ☐ Niet zo blij ☐ Helemaal niet blij

VRAAG 4. VOND JE HET LEUK OF STOM OM ONDERWEG TE ZIJN NAAR SCHOOL VANDAAG?

☐ Heel leuk ☐ Een beetje leuk ☐ Gewoon ☐ Een beetje stom ☐ Heel stom

VRAAG 5. VOND JE DE WEG NAAR SCHOOL MAKKELIJK OF MOEILIJK? *Uitleg: misschien was het makkelijk omdat je niet zo veel hoefde te doen, of moeilijk omdat je heel vaak moest oversteken.*

☐ Heel makkelijk ☐ Makkelijk ☐ Iets er tussenin ☐ Moeilijk ☐ Heel moeilijk

VRAAG 6. HEB JE IETS GELEERD ONDERWEG NAAR SCHOOL? *Uitleg: je kan onderweg iets leren over de route van thuis naar school. Je kan ook een verkeersregel leren of beter worden in fietsen.*

☐ Veel geleerd ☐ Een beetje geleerd ☐ Ik weet het niet ☐ weinig geleerd ☐ Niets geleerd

SLA OM

Pagina 1

VRAAG 7. VERVEELDE JIJ JE ONDERWEG NAAR SCHOOL, OF VOND JE HET LEUK?

- ☐ Ik verveelde mij heel erg
- ☐ Ik verveelde mij een beetje
- ☐ Geen van beide
- ☐ Ik vond het wel leuk
- ☐ Ik vond het heel leuk

VRAAG 8. HAD JE HELEMAAL NERGENS ZIN IN, OF HAD JE WEL ZIN IN DE DAG?

- ☐ Ik had helemaal nergens zin in
- ☐ Ik had bijna nergens zin in
- ☐ Ik voelde mij normaal
- ☐ Ik had zin in de dag
- ☐ Ik had heel veel zin in de dag

VRAAG 9. WAS JE MOE OF WAS JE UITGERUST TOEN JE ONDERWEG WAS NAAR SCHOOL?

- ☐ Ik was heel moe
- ☐ Ik was een beetje moe
- ☐ Iets er tussenin
- ☐ Ik was uitgerust
- ☐ Ik was heel uitgerust

VRAAG 10. TOEN JE ONDERWEG WAS NAAR SCHOOL, VOND JE DE WEG SPANNEND OF VOELDE JIJ JE OP JE GEMAK?

- ☐ Ik vond het heel spannend
- ☐ Ik vond het een beetje spannend
- ☐ Ik voelde mij normaal
- ☐ Ik voelde mij op mijn gemak
- ☐ Ik voelde mij heel erg op mijn gemak

VRAAG 11. HAD JE VEEL HAAST OF HAD JE VEEL TIJD ONDERWEG NAAR SCHOOL?

- ☐ Ik had veel haast
- ☐ Ik had een beetje haast
- ☐ Ik was net op tijd
- ☐ Ik had genoeg tijd
- ☐ Ik had veel tijd

VRAAG 12. WAS JE ONDERWEG BEZORGD, OF HAD JE GEEN ZORGEN?

- ☐ Ik was heel bezorgd
- ☐ Ik was een beetje bezorgd
- ☐ Iets er tussenin
- ☐ Ik had bijna geen zorgen
- ☐ Ik had helemaal geen zorgen

VRAAG 13. WAT VOOR WEER WAS HET TOEN JE ONDERWEG NAAR SCHOOL WAS?

VRAAG 14: MET WIE WAS JIJ ONDERWEG NAAR SCHOOL?

Als er meerdere mensen bij waren, dan mag je meer dan één hokje aankruisen.

- ☐ Met niemand, want ik was alleen
- ☐ Broer, broertje of zus, zusje
- ☐ Vriendje, vriendinnetje of klasgenootje
- ☐ Vader of moeder
- ☐ Iemand anders: _____

DANKJEWEL!

De rest van de vragen mogen jouw ouders of verzorgers thuis invullen. Neem je de vragenlijst daarna weer mee naar school? Misschien win je dan wel de Efteling cadeaubon!

Pagina 2

VRAGENLIJST REISGEDRAG KINDEREN - in te vullen door ouder/verzorger

Introductie

Onderzoek: **beweegvriendelijke en gezonde omgeving van scholen**

Doel: aanbevelingen doen voor een omgeving van de school waar kinderen veilig te voet en op de fiets naar school kunnen, veel bewegen, stapsgewijs om leren gaan met het verkeer en waar de wegen rustig zijn. Om dit doel te bereiken is een groot aantal ingevulde vragenlijsten nodig.

Details:

- Vragenlijst gaat over het kind dat de eerste twee pagina's reeds heeft ingevuld
- Invullen duurt ongeveer tien minuten
- Verloting Efteling cadeaukaart, zie laatste pagina

Ingevulde vragenlijsten kunnen bij de leerkracht van uw kind worden ingeleverd tot en met XX september 2018

Verklaring toestemming

Uw antwoorden en de antwoorden van uw kind worden volledig anoniem verwerkt en er wordt vertrouwelijk met de antwoorden omgegaan. Om uw persoonlijke informatie nog verder te beschermen kunt u of uw kind de ingevulde vragenlijst in de bijgevoegde gesloten envelop inleveren.

Wij vragen u om uw toestemming voor het gebruiken van de antwoorden die u en uw kind hebben ingevuld op deze vragenlijst. Indien u de onderstaande verklaring niet ondertekent, dan zullen wij geen gebruik maken van de door u en uw kind ingevulde antwoorden.

TOESTEMMINGSVERKLARING DEELNAME ONDERZOEK

Ik geef toestemming voor het afnemen van deze vragenlijst over het reisgedrag van kinderen. De antwoorden die mijn kind en ik hebben ingevuld mogen anoniem verwerkt worden in het onderzoek.

Handtekening: _____ **Datum:** _____

.

Deze vragenlijst is onderdeel van de afstudeerscriptie van student Iris aan de Technische Universiteit Eindhoven (TU/e). Iris voert dit onderzoek uit namens de TU/e in samenwerking met HEVO, een huisvestingsadvies- en bouwmanagementbureau met als specialisatie onder andere schoolgebouwen.

Technische Universiteit Eindhoven University of Technology

Tenzij anders aangegeven, kunt u per vraag slechts één hokje aankruisen.

Deel 1: Kenmerken kind

Deze vragen gaan over de algemene kenmerken van uw kind.

Vraag 1.1: Wat is de leeftijd van uw kind? _____ jaar

Vraag 1.2: Wat is het geslacht van uw kind?
□ Jongen
□ Meisje

Vraag 1.3: Hoe lang is uw kind? _____ cm

Vraag 1.4: Wat is het gewicht van uw kind? _____ kg

Vraag 1.5: Hoeveel kinderen heeft u in totaal?

□ Eén
□ Twee
□ Drie
□ Vier of meer

Vraag 1.6: Hoeveel ouders of verzorgers van uw kind wonen in hetzelfde huis als uw kind?

□ Eén □ Twee □ Anders:_____

Deel 2: Kenmerken huishouden

Deze vragen gaan over de kenmerken van uw huishouden. Onder uw huishouden worden de personen gerekend met wie u samenwoont. Het doel van deze vragen is om te onderzoeken of algemene kenmerken van het huishouden een relatie hebben met het reisgedrag van kinderen.

Vraag 2.1: Wat is uw postcode? *(bijv. 1234 AB)* _____

Vraag 2.2: Hoe lang woont u al op uw huidige adres? _____ jaar

Vraag 2.3: Tot welke etnische groepering rekent u uw huishouden?

□ Nederlands
□ Turks
□ Marokkaans
□ Surinaams
□ Indonesisch
□ Duits
□ Pools
□ Anders, namelijk: _____

Vraag 2.4: Wat is de beste omschrijving van het jaarinkomen van uw huishouden?
Het gemiddelde bruto jaarinkomen van een Nederlands huishouden is 60.000 euro.

□ Het inkomen van mijn huishouden is hoger dan dat van de meeste Nederlanders
□ Het inkomen van mijn huishouden is ongeveer gelijk aan dat van de meeste Nederlanders
□ Het inkomen van mijn huishouden is lager dan dat van de meeste Nederlanders

Vraag 2.5: Hoeveel auto's bezit uw huishouden? *Ook een lease auto kan hier meegeteld worden.*

□ Geen auto
□ Eén auto
□ Twee of meer auto's

Deel 3: Kenmerken ouder(s)/ verzorger(s)

De volgende vragen gaan over uw werkstatus en reisgedag.

Vraag 3.1: Wat is de beste omschrijving van uw huishouden met betrekking tot werk?

- ☐ Tweeverdiener huishouden
- ☐ Eenverdiener huishouden
- ☐ Werkzoekend huishouden
- ☐ Anders (bijvoorbeeld gepensioneerd of onbetaald werk)

Vraag 3.2: Indien u werkt, hoe vaak maakt u gemiddeld per week gebruik van onderstaande vervoersmiddelen om naar uw werk te gaan? En uw (eventuele) partner?

		1 X	2 X	3 X	4 X	5 X	Nooit of n.v.t.
Te voet of met de fiets	Ik zelf	☐	☐	☐	☐	☐	☐
	Partner	☐	☐	☐	☐	☐	☐
Met de auto	Ik zelf	☐	☐	☐	☐	☐	☐
	Partner	☐	☐	☐	☐	☐	☐
Met het openbaar vervoer	Ik zelf	☐	☐	☐	☐	☐	☐
	Partner	☐	☐	☐	☐	☐	☐
Anders, namelijk: _____ _____	Ik zelf	☐	☐	☐	☐	☐	☐
	Partner	☐	☐	☐	☐	☐	☐

Deel 4: Reisgedrag kind

De volgende vragen gaan over het reisgedrag van uw kind, tussen thuis en school.

Vraag 4.1: Hoeveel ritjes maakt uw kind gemiddeld per week tussen thuis en school?

Dat is dus een ritje in de ochtend naar school, in de middag naar huis en eventueel op en neer voor de lunch.

_____ ritjes

Vraag 4.2: Verdeel deze ritjes over de onderstaande vervoersmiddelen, voor een gemiddelde week.

Indien een vervoersmiddel nooit wordt gebruikt, dan vult u bij dat vervoersmiddel niets in.

	Ritjes naar/van school per week
Te voet, met skeelers of vergelijkbaar	_____ ritjes
Met de fiets, step of vergelijkbaar	_____ ritjes
Achterop de fiets	_____ ritjes
Als passagier in de auto	_____ ritjes
Met het openbaar vervoer	_____ ritjes
Anders, namelijk:_____	_____ ritjes

Vraag 4.3: Wat is de afstand tussen uw woning en de school van uw kind?

- ☐ Minder dan 100 meter
- ☐ 100 – 500 meter
- ☐ 500 – 1000 meter
- ☐ 1 – 2 km
- ☐ 2 – 5 km
- ☐ Meer dan 5 km

Vraag 4.4: Indien uw kind loopt en/of fietst naar school, hoe lang duurt deze reis?

_____ minuten fietsen ☐ n.v.t.
_____ minuten lopen ☐ n.v.t.

Vraag 4.5: Deze vraag gaat over de reden(en) waarom u de auto of wandelen/fietsen als vervoersmiddel voor uw kind kiest

*Onderstaand overzicht geeft een lijst van mogelijke redenen. Ik vraag u om per reden aan te geven in hoeverre u het met de reden eens bent. Maak hierbij onderscheid tussen dagen waarop u uw kind **met de auto** naar school brengt, en dagen waarop uw kind **wandelt of fietst**. Als u een reden helemaal niet belangrijk vindt, kiest u dus "zeer oneens". Indien uw kind nooit met de auto gaat, of nooit wandelt of fietst, vul dan "n.v.t." in*

Redenen keuze voor vervoersmiddel			Zeer oneens	Oneens	Neutraal	Eens	Zeer eens	n.v.t.
a.	Dit komt meestal het beste uit voor mij/ons als ouder(s)/verzorger(s)	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
b.	Ik vind dit de beste manier voor mijn kind om naar school te reizen	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
c.	Ik vind dit de veiligste optie op het gebied van verkeersveiligheid	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
d.	Dit vervoersmiddel past het beste bij de leeftijd van mijn kind	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
e.	Mijn kind gaat het liefste met dit vervoersmiddel	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
f.	De school stimuleert dat mijn kind met dit vervoersmiddel gaat	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
g.	Dit vervoersmiddel is het meest geschikt gezien de afstand naar school	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
h.	De keuze voor het vervoersmiddel is sterk afhankelijk van het weer	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
i.	De meeste ouders in mijn omgeving brengen hun kinderen zo naar school	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
j.	Er is geen specifieke reden	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐
k.	Andere reden:_____ _____	Met de auto	☐	☐	☐	☐	☐	☐
		Wandelen/fietsen	☐	☐	☐	☐	☐	☐

Vraag 4.6: Deze vraag gaat over de persoon of personen met wie uw kind eventueel naar school reist.

Hoe vaak reist uw kind naar school…		(Bijna) nooit	Weinig	Soms	Vaak	(Bijna) altijd
a.	…begeleid door een ouder of verzorger	☐	☐	☐	☐	☐
b.	…samen met een oudere broer en/of zus	☐	☐	☐	☐	☐
c.	…samen met een jongere broer en/of zus	☐	☐	☐	☐	☐
d.	…samen met vriend(en) of klasgenoot(jes)	☐	☐	☐	☐	☐
e.	…zonder begeleiding, alleen	☐	☐	☐	☐	☐

Vraag 4.7: De volgende stellingen gaan over hoe u de vaardigheden van uw kind m.b.t. het verkeer inschat. Geef aan in welke mate u het eens of oneens bent met de stellingen.

Vaardigheden van kind in verkeer:		Zeer Oneens	Oneens	Neutraal	Eens	Zeer eens
a.	Mijn kind kan goed fietsen.	☐	☐	☐	☐	☐
b.	Als mijn kind buiten ergens naartoe loopt, dan let hij/zij goed op andere weggebruikers.	☐	☐	☐	☐	☐
c.	Als mijn kind buiten ergens naartoe fietst, dan let hij/zij goed op andere weggebruikers.	☐	☐	☐	☐	☐
d.	Mijn kind is goed in het inschatten van eventueel gevaar m.b.t. verkeersveiligheid.	☐	☐	☐	☐	☐

Vraag 4.8: Hoeveel dagen per week gaat uw kind normaal gesproken naar buitenschoolse opvang?

	1 X	2 X	3 X	4 X	5 X	Nooit of n.v.t.
Voorschoolse opvang	☐	☐	☐	☐	☐	☐
Tussenschoolse opvang	☐	☐	☐	☐	☐	☐
Naschoolse opvang	☐	☐	☐	☐	☐	☐

Deel 5: Levensstijl kind

De volgende vragen gaan over gezondheid en lichamelijke beweging van uw kind

Vraag 5.1: Hoe beoordeelt u de algemene gezondheid van uw kind?

☐ Slecht ☐ Matig ☐ Redelijk ☐ Goed ☐ Zeer goed

Vraag 5.2: Hoeveel uren in de week is uw kind normaal gesproken in beweging tijdens de vrije tijd?
Let op, sporten en beweging op en onderweg naar school worden hier niet meegeteld

Sporten bij sportclubs en vergelijkbaar: _____ uren
Buitenspelen en vergelijkbaar: _____ uren
Actief spelen en sporten bij de buitenschoolse opvang: _____ uren
Lopen of fietsen naar/van andere plekken dan school: _____ uren
Anders: _____
_____ _____ uren

Deel 6: Eigenschappen route naar school

De volgende vragen gaan over de veiligheid en kwaliteit van de route van uw huis naar de school van uw kind.

Vraag 6.1: Onderstaande stellingen gaan over veiligheid van de route van uw huis naar de school van uw kind. Geef aan in welke mate u het eens of oneens bent met de stellingen.

Veiligheid op de route van huis naar school:		Zeer Oneens	Oneens	Neutraal	Eens	Zeer eens
a.	Er zijn voldoende oversteekplaatsen en stoplichten om voetgangers en fietsers te helpen op een veilige manier drukke wegen over te steken.	☐	☐	☐	☐	☐
b.	Normaal gesproken rijden auto's op de route naar school niet te snel naar mijn mening.	☐	☐	☐	☐	☐
c.	Er is op de route naar school zo veel verkeer dat ik het onveilig vind om met mijn kind naar school te lopen of fietsen.	☐	☐	☐	☐	☐
d.	Er is op de route naar school zo veel verkeer dat mijn kind niet alleen naar school mag lopen of fietsen.	☐	☐	☐	☐	☐
e.	Ik heb het gevoel dat bestuurders van auto's goed uitkijken voor voetgangers en fietsers.	☐	☐	☐	☐	☐

Vraag 6.2: Onderstaande stellingen gaan over de voetgangerspaden en fietspaden op de route van uw huis naar de school. Geef aan in welke mate u het eens of oneens bent met de stellingen.

Voetgangerspaden en fietspaden:		Zeer Oneens	Oneens	Neutraal	Eens	Zeer eens
a.	De meeste voetgangerspaden zijn van de weg gescheiden door parkeervakken, struiken of gras of een andere afscheiding.	☐	☐	☐	☐	☐
b.	De meeste straten hebben veilige fietspaden of zijn veilig om in te fietsen.	☐	☐	☐	☐	☐
c.	De meeste fietspaden en voetgangerspaden worden goed onderhouden.	☐	☐	☐	☐	☐
d.	Er zijn verschillende wegen in onze buurt die mijn kind kan nemen om veilig op school te komen.	☐	☐	☐	☐	☐

Deel 7: Sociale eigenschappen buurt

De volgende vragen gaan over de sociale eigenschappen en sociale veiligheid van de buurt waar u woont.

Vraag 7.1: Onderstaande stellingen gaan over de sociale cohesie in uw buurt. Geef aan in welke mate u het eens of oneens bent met de stellingen.

Sociale cohesie in uw buurt:		Zeer Oneens	Oneens	Neutraal	Eens	Zeer eens
a.	Mensen in onze buurt zijn bereid om elkaar ergens mee te helpen.	☐	☐	☐	☐	☐
b.	Onze buurt is een hechte gemeenschap.	☐	☐	☐	☐	☐
c.	Ik vertrouw de mensen die bij ons in de buurt wonen.	☐	☐	☐	☐	☐
d.	Over het algemeen kunnen mensen in onze buurt het goed met elkaar vinden.	☐	☐	☐	☐	☐
e.	Mijn kind heeft veel contact met andere kinderen bij ons in de buurt.	☐	☐	☐	☐	☐
f.	Onderweg naar school komt mijn kind vaak andere kinderen tegen.	☐	☐	☐	☐	☐

Vraag 7.2: Onderstaande stellingen gaan over de sociale veiligheid in uw buurt. Geef aan in welke mate u het eens of oneens bent met de stellingen.

Sociale veiligheid in uw buurt:		Zeer Oneens	Oneens	Neutraal	Eens	Zeer eens
a.	Als mijn kind alleen buiten is, dan ben ik bang dat hij/zij mensen met verkeerde bedoelingen tegen zou komen *(Angst voor vreemden).*	☐	☐	☐	☐	☐
b.	Ik vind het in onze buurt veilig genoeg om mijn kind onbegeleid buiten te laten zijn.	☐	☐	☐	☐	☐

Einde vragenlijst

<u>Hartelijk bedankt voor het invullen!</u>

Controleer a.u.b. of u niets over het hoofd heeft gezien.

Als dank voor het invullen verloot ik onder alle deelnemers van dit onderzoek één Efteling cadeaukaart t.w.v. €50,-. Als u mee wilt loten, dan kunt u dat hier aangeven. Het is belangrijk dat u dan ook uw e-mailadres invult, zo kan ik de winnaar contacteren. Als u nieuwsgierig bent naar de uitslag van het onderzoek, dan kunt hieronder aanvinken dat u de resultaten wilt ontvangen.
Uiteraard wordt uw e-mailadres niet voor andere doeleinden dan de verloting en het doorsturen van de resultaten van het onderzoek gebruikt en niet meegenomen in het onderzoek, zodat alle antwoorden anoniem blijven. Na afloop van de verloting wordt uw e-mailadres verwijderd.

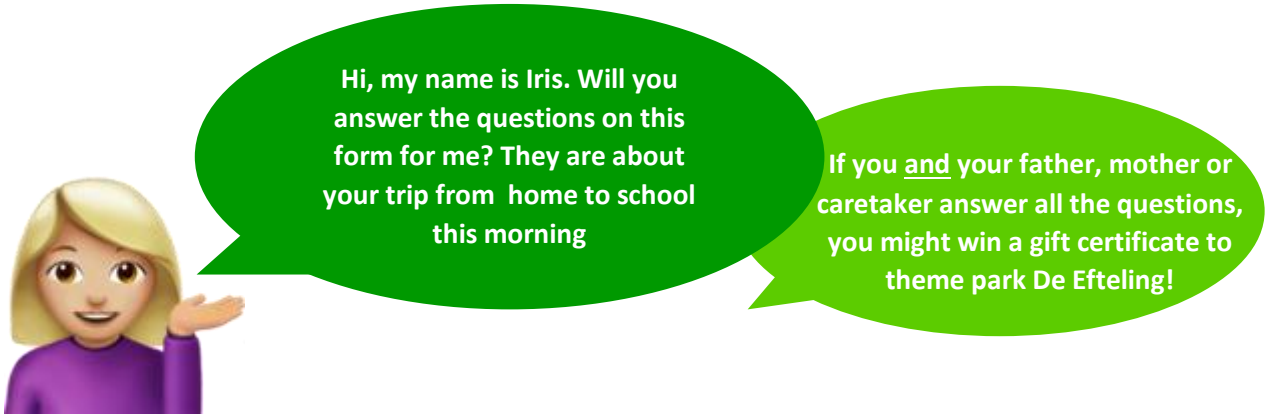
- ☐ Ja, ik wil graag mee-loten voor de Efteling cadeaukaart
- ☐ Ja, ik wil graag de resultaten van het onderzoek ontvangen

E-mailadres: _____

De winnaar van de Efteling cadeaukaart zal in oktober 2018 bericht krijgen. De onderzoeksresultaten zullen, indien gewenst, rond de jaarwisseling met u worden gedeeld.

Appendix 2: Questionnaire English translation

This appendix holds the English translation of the child-parent survey belonging to the current study.



Note: Sometimes this English version of the questionnaire contains some words that would be difficult to young children. This is the result of the translation; in Dutch easier words are used.

School:_____ Grade:_____

Q.1: HOW DID YOU COME TO SCHOOL TODAY?

- ☐ By bicycle
- ☐ On the back of a bicycle
- ☐ Walking
- ☐ By car
- ☐ By kick-bike
- ☐ By space scooter
- ☐ By skates
- ☐ By bus
- ☐ Other, namely:_____

Q.2: IF YOU COULD CHOOSE, HOW WOULD YOU WANT TO COME TO SCHOOL?

- ☐ By bicycle
- ☐ On the back of a bicycle
- ☐ Walking
- ☐ By car
- ☐ By kick-bike
- ☐ By space scooter
- ☐ By skates
- ☐ By bus
- ☐ Other, namely:_____

Q.3: HOW ARE YOU FEELING TODAY?

- ☐ Very happy
- ☐ Happy
- ☐ Normal
- ☐ Not so happy
- ☐ Totally not happy

Q.4: DID YOU FIND IT FUN OR LAME TO BE ON YOUR WAY TO SCHOOL THIS MORNING?

- ☐ Very much fun
- ☐ A little fun
- ☐ Normal
- ☐ A little lame
- ☐ Very lame

Q. 5: HOW DIFFICULT OR EASY WAS THE ROAD TO SCHOOL? *Explanation: maybe it was easy because you did not have to do very much or difficult because you had to cross many roads.*

- ☐ Very easy
- ☐ Easy
- ☐ Something in between
- ☐ Difficult
- ☐ Very difficult

Q.6: DID YOU LEARN SOMETHING ON YOUR TRIP TO SCHOOL? Explanation: *On your trip to school, you could learn something about the route to school. You could also learn a traffic rule or improve your bicycle skills.*

- ☐ Learnt very much
- ☐ Learnt a little
- ☐ I don't know
- ☐ Learnt not much
- ☐ Learnt nothing

Q. 7: WERE YOU BORED DURING YOUR TRIP TO SCHOOL OR DID YOU FIND IT FUN?

- ☐ I was very bored
- ☐ I was a little bored
- ☐ None of both
- ☐ I found it fun
- ☐ I found it very much fun

Q. 8: WERE YOU INDIFFERENT OR WERE YOU LOOKING FORWARD TO THE DAY?

- ☐ I was very indifferent
- ☐ I was a little indifferent
- ☐ I felt normal
- ☐ I was looking forward to the day
- ☐ I was very much looking forward to the day

Q. 9: WERE YOU TIRED OR WERE YOU WELL-RESTED?

- ☐ I was very tired
- ☐ I was a little tired
- ☐ Something in between
- ☐ I was well rested
- ☐ I was very well rested

Q. 10: WHEN YOU WERE ON YOUR WAY TO SCHOOL, WERE YOU TENSE BECAUSE OF THE ROAD OR WERE YOU AT EASE?

- ☐ I was very tense
- ☐ I was a little tense
- ☐ I felt normal
- ☐ I was at ease
- ☐ I was very much at ease

Q. 11: WERE YOU IN A HURRY OR DID YOU HAVE ENOUGH TIME ON YOUR WAY TO SCHOOL?

- ☐ I was in a big hurry
- ☐ I was in a little hurry
- ☐ I was just in time
- ☐ I had enough time
- ☐ I had a lot of time

Q. 12: WERE YOU WORRIED ON THE WAY TO SCHOOL OR WERE YOU CAREFREE?

- ☐ I was worried
- ☐ I was a little worried
- ☐ Something in between
- ☐ I was almost carefree
- ☐ I was carefree

Q. 13: HOW WAS THE WEATHER WHEN YOU WERE ON YOUR WAY TO SCHOOL?

Q. 14.: WITH WHOM WERE YOU ON YOUR WAY TO SCHOOL?

If there were more people with you, then you may select more than one answer.

☐ With no one because I was alone ☐ Big brother, little brother, big sister or little sister

☐ friend or classmate ☐ Father or mother

☐ Someone else: _____

The remaining questions may be answered by your parents or caretakers at home. Will you bring the form back to school after that? Then you might win the gift certificate for the theme park!

QUESTIONNAIRE CHILDREN'S TRAVEL BEHAVIOR

To be filled in by parent/caretaker

Introduction

Research: **environments of schools that are healthy and reinforce physical activity**.

Aim: make recommendations for an area around schools where children can walk and cycle safely, they are put in motion, they gradually learn to participate in traffic and where the roads are not crowded. To reach this aim, a large amount of filled in questionnaires is needed.

Details:

- Questionnaire is about the child that has already filled in the first two pages
- Filling in the questionnaire takes about ten minutes
- Possibility to win Efteling gift card, see final page

Filled-in questionnaires can be handed in with your child's teacher up to and including xx September 2018

Permission declaration

All information will be processed anonymously and handled with care. To protect your personal information, you can hand-in the filled-in questionnaire in the enclosed envelope.

We want to ask your permission for using the answers that you and your child have provided in this questionnaire. In case you do not sign the declaration below, we will not use your and your child's answers.

Permission declaration

I give permission for the participation of my child and myself in this research on children's travel behavior. The answers that my child and I have written down may be processed anonymously in the research.

Signature: _____ Date: _____

This questionnaire is a part of the master thesis of student Iris at the Eindhoven University of Technology (TU/e). Iris is conducting this research on behalf of the TU/e in collaboration with HEVO, a real estate consultant and management company specializing, among others, in education real estate.

Unless specified differently, you may only check one box per question.

Part 1: Characteristics of child

These questions are about the personal characteristics of your child.

Q. 1.1: How old is your child? _____ years

Q. 1.2: What is your child's gender?
- ☐ Boy
- ☐ Girl

Q. 1.3: How tall is your child? _____ cm

Q. 1.4: What is the weight of your child? _____ kg

Q. 1.5: How many children do you have in total?

- ☐ One
- ☐ Two
- ☐ Three
- ☐ Four or more

Q. 1.6: How many parents or caretakers of your child live in the same house as your child?

☐ One ☐ Two ☐ Different:_____

Part 2. Characteristics of household

These questions are about the characteristics of your household. Your household consists of the people that you live with. The aim of these questions is to investigate whether general household characteristics are related to the travel behavior of children.

Q. 2.1: What is your postal code? *(e.g. 1234AB)* _____

Q. 2.2: How long have you lived on your current address? _____ years

Q. 2.3: To which ethnical group do you consider your household to belong? *In case, for example, you consider yourself and your parent to belong to different ethnical groups, it is possible to fill in multiple answers.*

- ☐ Dutch
- ☐ Turkish
- ☐ Moroccan
- ☐ Surinam
- ☐ Indonesian
- ☐ German
- ☐ Polish
- ☐ Other, namely: _____

Q. 2.4: What is the best description of your household income?
The average yearly gross household income of Dutch households is 60.000 euros

- ☐ The yearly income of my household is <u>higher than</u> that of the average Dutch household
- ☐ The yearly income of my household is <u>similar to</u> that of the average Dutch household
- ☐ The yearly income of my household is <u>lower than</u> that of the average Dutch household

Q. 2.5: How many cars does your household have? *Also lease cars can be included.*

- ☐ No car
- ☐ One car
- ☐ Two or more cars

Part 3: Characteristics of the parent(s)/caretaker(s)

The next questions are about your work status and travel behavior.

Q. 3.1: How can your household best be described, concerning employment?

- ☐ Two wage-earner household
- ☐ One wage-earner household
- ☐ Household looking for employment
- ☐ Other (such as retired or unpaid work)

Q. 3.2: In case you have a job, how many times per week, on average, do you use the modes of transport listed below? And your (possible) partner?

		1 X	2 X	3 X	4 X	5 X	n.a.
Walking or cycling	Me	☐	☐	☐	☐	☐	☐
	My partner	☐	☐	☐	☐	☐	☐
By car	Me	☐	☐	☐	☐	☐	☐
	My partner	☐	☐	☐	☐	☐	☐
By public transport	Me	☐	☐	☐	☐	☐	☐
	My partner	☐	☐	☐	☐	☐	☐
Other, namely: _____	Me	☐	☐	☐	☐	☐	☐
	My partner	☐	☐	☐	☐	☐	☐

Part 4: Travel behavior child

The next questions are about your child's travel behavior between school and home

Q. 4.1: How many trips per week, on average, does your child make between home and school?
This includes one trip in the morning to school, one in the afternoon to come home and possibly more for lunch.
_____ trips

Q. 4.2: Divide these trips between the transport modes below, for an average week.
In case a transport mode is never used, leave this transport mode blank.

	Trips to/from school per week
By foot or similar	_____ trips
Bicycle or similar	_____ trips
On the back of the bicycle	_____ trips
As car passenger	_____ trips
By public transport	_____ trips
Other, namely:_____	_____ trips

Q. 4.3: What is the distance between your home and your child's school?

- ☐ Less than 100 meters
- ☐ 100 – 500 meters
- ☐ 500 – 1000 meters
- ☐ 1 – 2 km
- ☐ 2 – 5 km
- ☐ More than 5 km

Q. 4.4: In case your child walks and/or cycles to school, how long does this trip take?

_____ minutes cycling ☐ Not applicable
_____ minutes walking ☐ Not applicable

Q. 4.5: This question is about the reason(s) why you choose the car or walking/cycling for your child to go to school.

The table below lists a number of possible reasons. I ask you to indicate per reason to what extent you agree with this reason. Indicate this separately considering days that your child goes to school by car and days that your child cycles or walks. If you find a reason not important at all, you write down "Strongly disagree". If your child never goes to school by car or never goes to school walking or cycling, you can fill in "n.a.".

			Strongly disagree	Disagree	Neutral	Agree	Strongly agree	n.a.
a.	This mode is usually most convenient for me/ us as parent(s)/caretaker(s)	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
b.	I find this the best way for my child to travel to school	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
c.	In my opinion, this is the safest mode in terms of traffic safety	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
d.	This travel mode matches my child's age the best	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
e.	My child prefers to go to school by this mode	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
f.	My child is stimulated by the school to go by this mode	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
g.	This mode is most appropriate considering the distance to school	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
h.	The choice of transport mode is strongly dependent on the weather	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
i.	Most parents in my surrounding bring their children to school this way	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
j.	There is no specific reason	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐
k.	Other reason:_____ _____	By car	☐	☐	☐	☐	☐	☐
		Walking/cycling	☐	☐	☐	☐	☐	☐

Q. 4.6: This question is about the people with whom your child possibly travels to school.

How often does your child travel to school…	(almost) never	Not often	Sometimes	Often	(almost) always
a. … accompanied by parent or caretaker	☐	☐	☐	☐	☐
b. …together with an older sibling	☐	☐	☐	☐	☐
c. …together with a younger sibling	☐	☐	☐	☐	☐
d. …together with friend(s) or classmate(s)	☐	☐	☐	☐	☐
e. …without being accompanied, alone	☐	☐	☐	☐	☐

Q. 4.7: The next statements are about how you judge your child's skills to participate in traffic. Please indicate to what extent you agree or disagree with the statements.

Child's traffic skills:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a. My child is good at riding a bicycle.	☐	☐	☐	☐	☐
b. If my child walks to a certain destination, they pay good attention to other users of the road.	☐	☐	☐	☐	☐
c. If my child cycles to a certain destination, they pay good attention to other users of the road.	☐	☐	☐	☐	☐
d. My child is good at estimating potential danger in relation to traffic safety.	☐	☐	☐	☐	☐

Q. 4.8: How many days per week does your child normally go to daycare outside school hours?

	1 X	2 X	3 X	4 X	5 X	Never or n.a.
Pre-school care	☐	☐	☐	☐	☐	☐
In-between-school care	☐	☐	☐	☐	☐	☐
After-school care	☐	☐	☐	☐	☐	☐

Part 5: Child's lifestyle

The next questions are about your child's lifestyle, such as their health and leisure activities

Q. 5.1: How do you judge your child's health?

☐ Poor ☐ Mediocre ☐ Sufficient ☐ Good ☐ Very good

Q. 5.2: How many hours per week is your child normally active during the free time?
Sports and other active behavior at school and on the way to/from school should not be included here

Sports at sports club and similar: _____ hours
Playing outside and similar: _____ hours
Actively playing and sports at daycare _____ hours
Walking or cycling to/from other places than school: _____ hours
Other: _____ _____ hours

Part 6: Characteristics of the route to school

The next questions are about the quality and safety of the route between your home and your child's school.

Q. 6.1: These statements are about the safety of the route between your home and your child's school. Please indicate to what extent you agree or disagree with the statements.

Safety on the route from home to school:		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a.	There are sufficient crossings and traffic lights to help pedestrians and cyclists to safely cross busy roads.	☐	☐	☐	☐	☐
b.	Normally, cars on the route to school do not drive too fast, to my opinion.	☐	☐	☐	☐	☐
c.	There is so much traffic on the route to school that I find it unsafe to walk or cycle to school with my child.	☐	☐	☐	☐	☐
d.	There is so much traffic on the route to school that my child is not allowed to walk or cycle alone to school.	☐	☐	☐	☐	☐
e.	I feel that drivers of cars pay good attention for pedestrians and cyclists on the road.	☐	☐	☐	☐	☐

Q. 6.2: The next statements are about the pedestrian paths and bicycle lanes on the route between your home and the school. Please indicate to what extent you agree or disagree with the statements.

Pedestrian paths and bicycle lanes:		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a.	Most pedestrian paths are separated from the road by parked cars, bushes or grass, or another form of separation.	☐	☐	☐	☐	☐
b.	Most streets have safe bicycle lanes or are safe to cycle in.	☐	☐	☐	☐	☐
c.	Most bicycle lanes and pedestrian paths are well maintained.	☐	☐	☐	☐	☐
d.	There are different roads in our neighborhood that my child can take to get to school.	☐	☐	☐	☐	☐

Part 7: Social characteristics of your neighborhood

The next questions are about the social characteristics and social safety of the neighborhood where you live.

Q. 7.1: The next questions are about the social cohesion in your neighborhood. Please indicate to what extent you agree or disagree with the statements.

Social cohesion in your neighborhood:		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a.	People in this neighborhood are prepared to help each other	☐	☐	☐	☐	☐
b.	This neighborhood is a tight community.	☐	☐	☐	☐	☐
c.	I trust the people that live in this neighborhood.	☐	☐	☐	☐	☐
d.	Normally, the people in this neighborhood get along well.	☐	☐	☐	☐	☐
e.	My child has a lot of contact with other children in the neighborhood.	☐	☐	☐	☐	☐
f.	My child often meets other children during the trip to school.	☐	☐	☐	☐	☐

Q. 7.2: The next statements are about the social safety in your neighborhood. Please indicate to what extent you agree or disagree with the statements.

Social safety in your neighborhood:		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a.	If my child is alone outside, I fear that they run into the wrong kind of people *(People that are dangerous to my child).*	☐	☐	☐	☐	☐
b.	I find my neighborhood safe enough to allow my child to be outside by themselves.	☐	☐	☐	☐	☐

End of questionnaire

Thank you very much for completing the questionnaire!

Please check if you have filled in all questions.

To thank all participants of this research, one participant will win a gift certificate for amusement park De Efteling, worth €50,-. If you want to make a chance of winning the gift certificate, you can check the box below and fill in your e-mail address (needed to contact the winner). If you are curious about the results of the research, you can check the box below. Of course your e-mail address will not be be used for any other purposes and will not be included in the research, to make sure that your answers remain anonymous. Furthermore, your e-mail address will be deleted after announcing the winner and distributing the results.

- ☐ Yes, I would like to make a chance to win the Efteling gift certificate
- ☐ Yes, I would like to receive the results of the research

E-mail address: _____

The winner of the gift certificate will be contacted in November 2018. The results of the research will be distributed among those who are interested just before or after the December holidays.

Appendix 3: School interviews

All the 15 schools that participated in the current research were asked to answer a set of questions. The answers to these questions shape the input for the school variables and complete the profiles of the respondents, as the characteristics of the schools are linked to the children attending these schools. The questions were presented in a structured interview, in which the answers were divided into different categories, in consultation with the interviewee, which was in most cases the principal of the school.

GENERAL

1. **How many pupils does your school have in total? And how many in grades 5-8?**
   _____ pupils, _____ in grades 5-8
2. **What is the schedule of the school?**
   To define lunch break and end of schoolday
3. **Which type of education does the school have?**
   a. Public school
   b. School with certain religious belief
   c. Montessori school
   d. Jenaplan school
   e. Dalton school
   f. Free school
   g. Other, namely: _____

HEALTH AND PHYSICAL ACTIVITY

4. **How many minutes per week do the children in grades 5-8 get physical activity, on average?**
   During gym class _____minutes
   During breaks _____minutes
   Other _____minutes
5. **Does your school participate in activities or initiatives which stimulate a healthy lifestyle. If yes, which activities?**
   To be sorted on the basis of frequency of activities
6. **Does your school participate in activities or initiatives that specifically stimulate active travel to school? Such as?**
   To be sorted on the basis of frequency of activities

TRAFFIC & SAFETY

7. **How much attention is spent on traffic education, how many hours is that, more or less, in total for children in grades 5-8?**
   To be sorted on the basis of amount of hours
8. **How do you judge the bicycle storage facilities in terms of quality and capacity (combined)?**
   a. Insufficient
   b. Mediocre
   c. Sufficient
   d. Good
   e. Very good

9. **How do you judge the car parking facilities and possibilities in the surrounding of you school, in terms of quality and capacity?**
    a. Insufficient
    b. Mediocre
    c. Sufficient
    d. Good
    e. Very good
10. **How do you judge the overall traffic safety around your school?**
    a. Insufficient
    b. Mediocre
    c. Sufficient
    d. Good
    e. Very good

11. **Does your school direct attention towards decreasing car traffic around the school?**
    a. Yes
    b. No
    c. Not applicable or not necessary
12. **Does your school use crossing guards or other types of traffic safety measures?**
    a. Yes
    b. No

Appendix 4: Explanation deleted cases

After having received 676 completed questionnaires from 14 different schools, some questionnaires revealed signs that they might not be trustworthy for the study. After inspecting the complete dataset, 17 cases were removed. This appendix will explain the motivation for deleting these cases.

The most common reason for deleting a case was that the respondent had left large parts of the questionnaire open. This was an indication that the respondent had not understood the questionnaire, or did not take the time to fill it in carefully. For this reason, 12 cases were removed. 2 Cases were removed because the parent indicated that the child lives at two addresses (with divorced parents), but it was unclear for which residence the answers were filled in. 3 cases were removed because several questions were answered in a confusing manner, which made it unclear whether the replies from these respondents were trustworthy.

Appendix 5: Data preparation

This appendix describes the several stages of the data preparation for the current study. The appendix is divided into six sections, one for every socio-ecological category of independent variables and one for the dependent variables. For each variable, the handling of missing values is described, as well as the recoding of the variable, if applicable.

1. Personal factors

The variable **gender** had 4 missing values, but these were not replaced because it does not make sense to replace them by the average or the most common value. For the variable **age** there were three missing values. Two of these were replaced by the most common age in the school grade that they belonged to. Because for the other also the school grade was missing, the age was replaced by the average age over the whole sample. For **grade** there was a fairly large number of missing values, namely 56 (8.5% of the sample). The original variable for grade was kept and a new variable was created where the missing values were replaced by the grade in which most children of the corresponding age were. For the variables **preference** and **attitude,** the answers to the question considering the favourite travel mode had to be recoded. First, the missing values were replaced by the most common favourite travel mode (bicycle). The variable was then recoded into six categories: walking (including skeelers), cycling (including kick-bike and space scooter), back of bicycle, car, public transport and other. This results in the variable **preference.** Next, the variable **attitude** reduces the amount of categories to active (walking and cycling) and passive (all others). Finally, an extra variable was made which indicates whether or not the child used their favourite mode on the day of the questionnaire.

2. Household factors

The variable **household income** had quite a few missing values, namely 39 which is 5.9% of the total sample. Also for this variable, the original record was kept an a new variable was made in which the missing values were replaced. In case respondent had reported to be seeking for employment or 'other, such as retired or unpaid work' or they reported that the owned no car (6 cases in total), the missing value for income was replaced by 'lower income than average Dutch people'. All other missing values were replaced by the mean of the sample, which was 'income equal to average Dutch people'.

The variable **car-ownership** had four missing values, all of which were replaced by the mean (which was owning one car). The **frequency of attending before school care and after school care** counted four missing values, which were replace by the mean of the sample (zero times per week). For the statements which indicate the **parental motivation for their children's transport mode**, the missing values (around 15 per statement) were replaced by the mean of the sample. Only for the statement concerning the weather the original record was kept, as this is the only variable that will be used in the statistical analyses.

The variable **household composition** is built up from two variables in the questionnaire; namely the amount of siblings that the child has and the amount of parents that the child lives in the same house with. The missing values for both of these variables (3 for siblings and 10 for parents) were replaced by the most common value in the sample. Furthermore, 8 respondents had checked the box 'other, namely' for the question about the number of parents. They wrote down things such as grandparents, divorced parents or co-parenting. These could be sorted into one (such as divorced parents) or 2 (such as grandparents). The variable household composition was then built-up in two different ways. One was simply the household size, the summation of the number of parents and the number of children. The other consisted of some categories indicating different types of household compositions: one

parent and only child, one parent with sibling(s), two parents and only child, two parents with sibling(s).

The missing values for the variable **ethnicity** (15) were replaced by the most common: Dutch. Then, from the question to which ethnicity the parent would assign their household, the following categories were made: Dutch, Dutch-European, Dutch-non-European, European, non-European. This was coded as follow: a Dutch household is one that only checked the box Dutch. Dutch-European and Dutch-non-European households are households that checked the Dutch box and a European or non-European ethnicity. European and non-European households are those that only checked a European or non-European ethnicity.

For the variable **parental working hours** the missing values (8) were replaced by the most common (two wage earner's household) and then recoded to merge 'seeking for employment' and 'other' as one category.

For the variable **daycare attendence**: first the sub-variable in-between care was removed. This was not applicable as 13 of the 14 schools had a schedule indicating that children always have lunch at school. Then, the missing values for before-school care and after-school care (2) were replaced by the average value of 0. Finally, the variable daycare attendance was recoded to three categories: never going to daycare, going to daycare once per week, going to daycare more than once per week. Before school care and after school care are both included in the calculation of daycare attendance frequency (i.e. attending before school care once per week indicates the second category, attending both before-school and after-school daycare once per week indicates the third category).

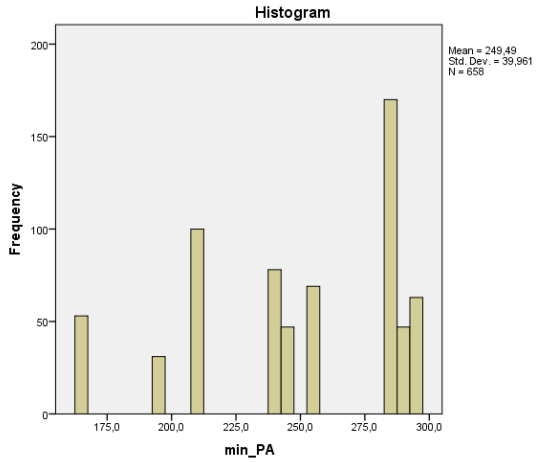
For the variable **parental transport mode**, the missing values were replaced by the mean frequencies per transport modes (once per week by active mode and once per week by passive mode per parent). Then, the data were recoded into two different versions of the variable to be used in further analyses, namely the frequency of both parents using active transportation weekly and the added frequency of both parents using the car weekly. The trips per transport mode of both parents were summed. The categories for active transportation are: never, 1-4 times, 5 or more times per week. For the car as transport mode there are more categories because the frequencies varied more: never, 1-3 times weekly, 4-5 times weekly, 6-8 times weekly and 9 or more times weekly.

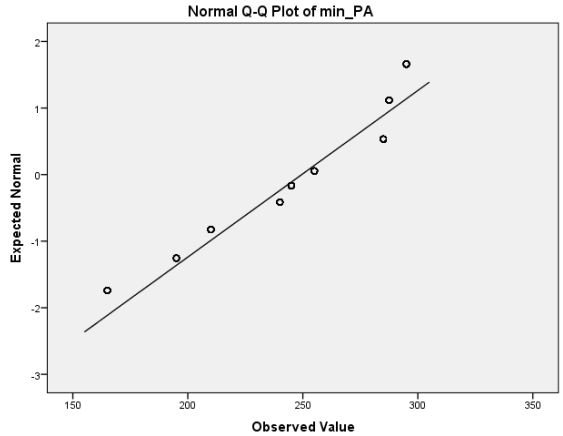
3. School factors

There were several school factor variables that did not need recoding or replacement of missing values. These were: **lunch at school**, **end of school day**, **number of afternoons free**, **active travel initiatives** of school, **quality of bike storage**, judgment of **traffic safety**, effort to **decrease cars** around school and **traffic safety measures**.

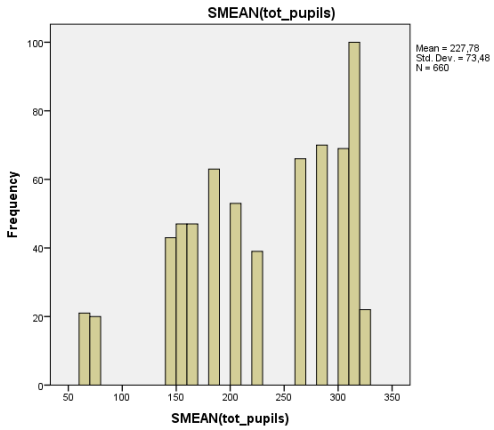
The variable **car parking quality** did not have missing values, but needed some recoding. Because only a very small share of respondents attended a school where the car parking was judged as 'good', this category was recoded to be merged with the category 'sufficient'.

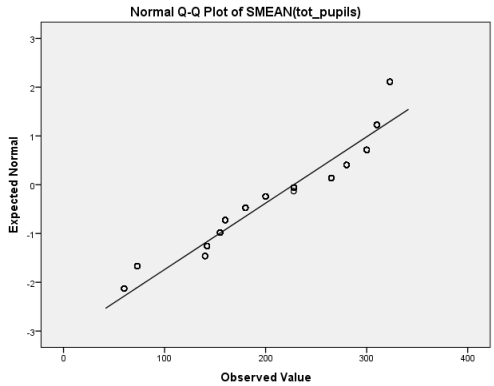
The variable **minutes of physical activity at school** did not have any missing values, but it did have to be recoded into an ordinal variable with three categories, as it was not at all normally distributed and had very unequal groups, as can be seen in the figures below. The three categories that the variable was recoded to were: fewer than 225 minutes, 225-275 minutes and 275 or more minutes.

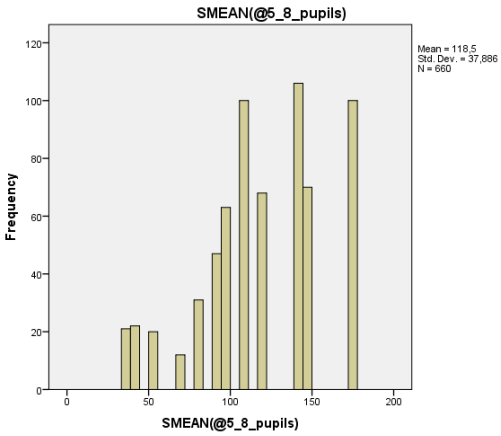


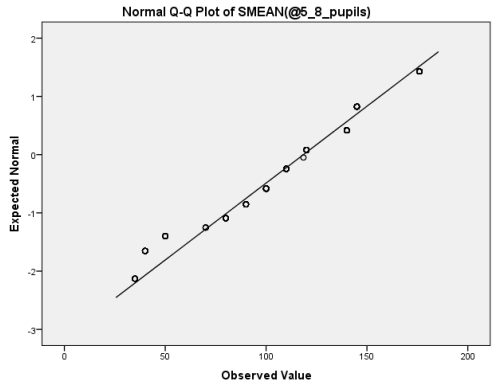


Also the variables total number of **pupils in school** and total number of **pupils in grades 5-8** were recoded into categories as an ordinal variable, as they were not normally distributed, see the figures below. For the total number of pupils in school, the new categories were as follows: <150, 150-280 and >280 for the total number of pupils and <90, 90-130 and >130 for the amount of pupils in grades 5-8.









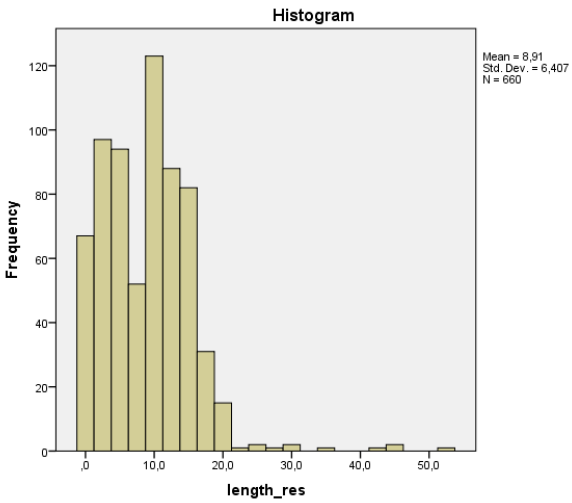
The variable **health initiatives** of a school was operationalized in two different ways. In the school interviews, principals were asked to report what kind of yearly initiatives and activities the school participates in that promote health. The answers to these questions were recoded to an absolute amount of the activities/initiatives the principal named and to a value indicating both quantity of initiatives and rootedness of health in the school. For the number of initiatives there were two missing values, which were replaced by the mean of the sample. The variable was then recoded into the

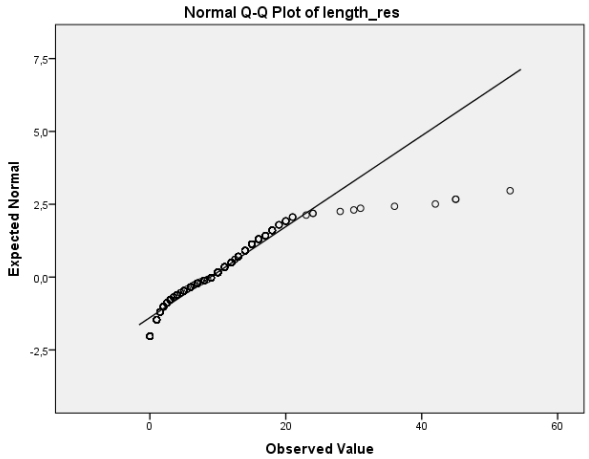
following categories: 2-3, 4-5 and 6-7 initiatives/activities yearly. The value (between one and three) was also missing for two of the respondents, this value was replaced by the mean.

4. Physical and social environmental factors

The variables **speed limit** and **presence of bicycle lane** did not have missing values and did not need recoding. For the variable **Connectivity,** the 7 missing values were replaced by the mean of the sample.

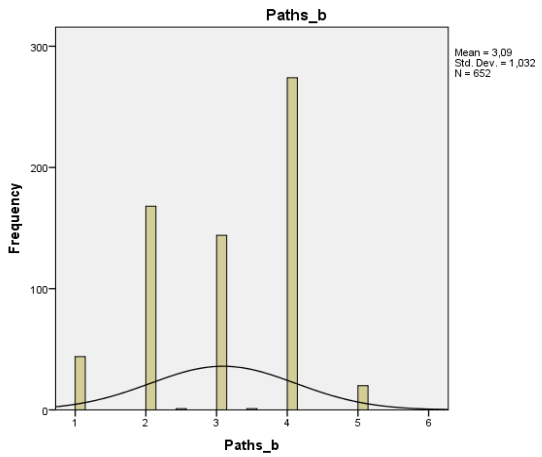
The variable **length of residence** missed only three values, these were replaced by the average value of the sample. As the variable was not quite normally distributed, see the figure below, it was recoded into 5 groups. These groups are: <2 years, 2 – 5 years, 5 – 10 years, 10 – 15 years and > 15 years.

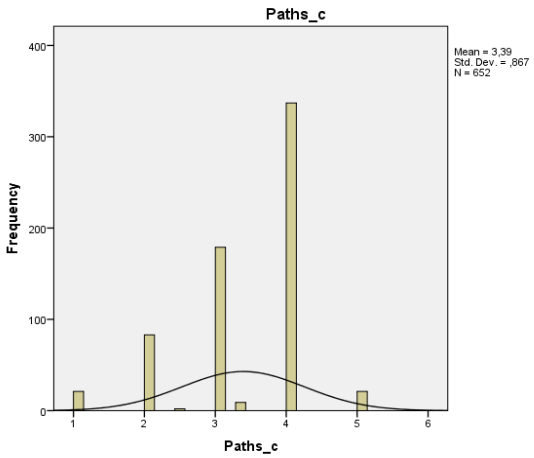




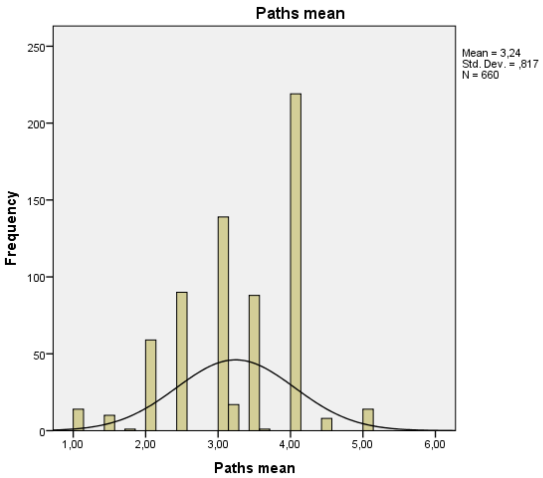
The variables **quality of bicycle and pedestrian paths** and **social cohesion** are both to be built up from two or more statements from the questionnaire. All the missing values for the statements were replaced by the mean of the sample. Some of the respondents did not fill in the statements concerning bicycle paths on purpose, as they never used the paths (children in these cases went by taxibus daily). In the original variables, the regular missing values were replaced, the filled in 'not applicable' values were not. These original variables will be used in the bivariate analyses, but the variables in which all values were replaced will be used in the regression and path analyses. To test whether or not the answers to the predetermined statements can be combined to construct the final variables, several Cronbach's Alpha Reliability tests were conducted in SPSS.

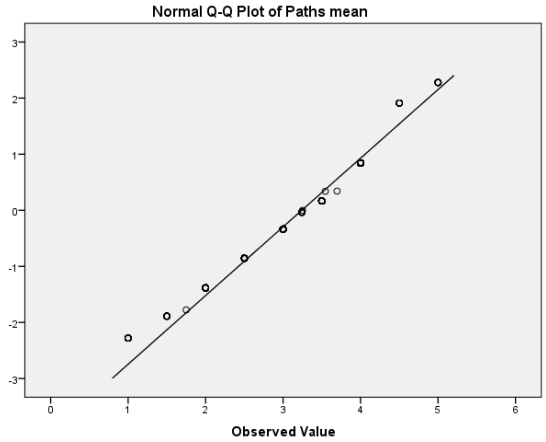
For the combination of the three bicycle and pedestrian path statements, the Cronbach's Alpha was 0.637. The analysis indicated that the removal of statement a, concerning whether or not the paths



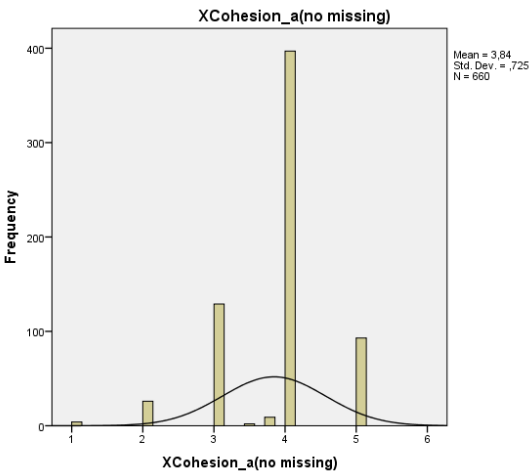


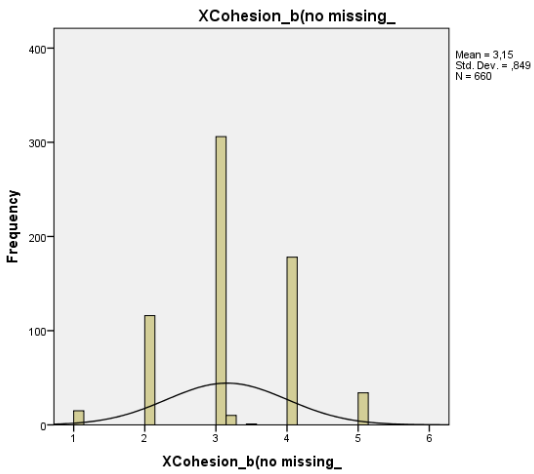
are separated from road, would result in a higher Cronbach's Alpha. Therefore, the mean of paths statement a and b was calculated to compute the variable **quality of bicycle and pedestrian paths**. The resulting Cronbach's Alpha was 0.655, which indicates fairly internally consistent values. A separate mean is calculated for the version of paths which include the missing values resulting from some of the parents filling in N.A., this variable is to be used in the bivariate analyses and it has the same value for Cronbach's Alpha. The figures below show the histogram for both path statements and for the calculated mean variable which will be used in further analyses. As can be seen, it is not perfectly normally distributed. However, the normal distribution is well enough to use in in planned analyses.

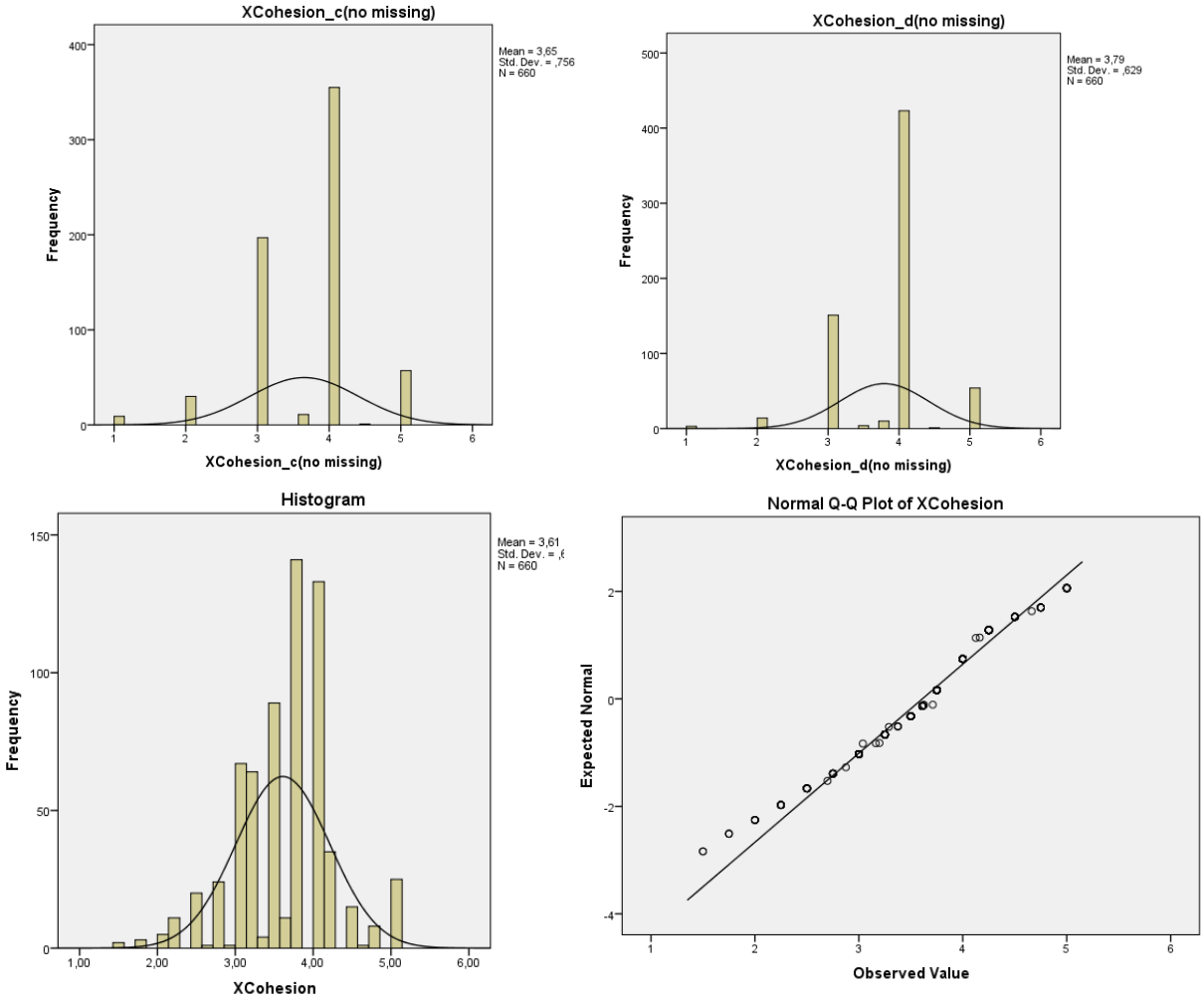




To compute the variable **social cohesion**, 5 statements were answered by the respondents in the questionnaires. The Cronbach's Alpha analysis indicated a score of 0.799 for internal consistency. Furthermore, the removal of statement e resulted in a Cronbach's Alpha of 0.827, which indicates high internal consistency. The decision was made to not include social cohesions statement e in computing the social cohesion variable, but to keep it in the analysis as an independent variable, as it is an indication of the social network that the child has with other children in the neighborhood. The figures below show the histogram for each social cohesion statement included in the final variable and the it gives an indication for the normality of the final variable for the mean social cohesion. The normality is not perfect, but good enough for the planned analyses.



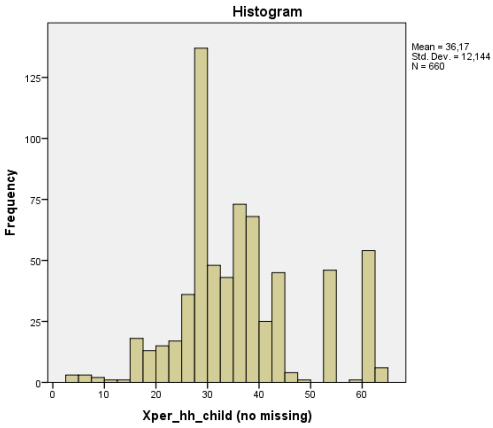


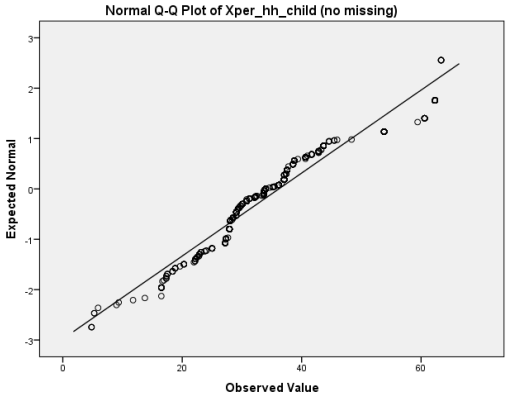


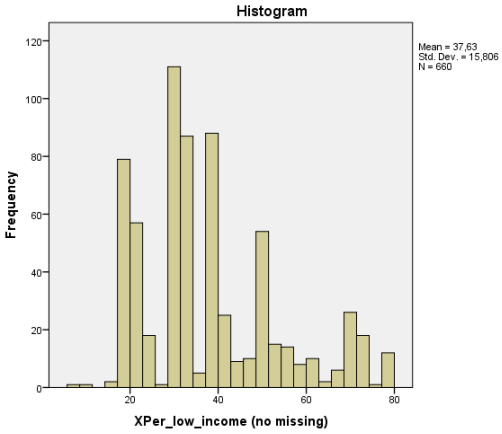
The remaining social and environmental factors came from the link from the postal code to the neighborhood and from the neighborhood to the CBS database. For all variables, there were 15 missing values due to unknown postal codes. The variable percentage of low income has two additional missing values due to a neighborhood for which the data was unavailable. The missing values for the variable **urban density** were replaced by the mean value. Furthermore, the variable was recoded to include only three categories, urban density levels 1-2, urban density level 3 and urban density levels 4-5. All other environmental factor variables had their missing values replaced by the mean of the sample. They were then each recoded into an ordinal variable with several categories, as they were all not quite normally distributed (see the original distributions on the next page. The new distributions are:

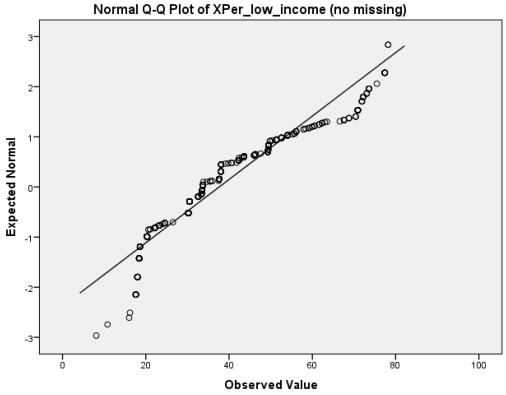
Percentage households with children:	0-25%, 26-30%, 31-45%, 46-100%
Percentage households with low income:	0-20%, 21-30%, 31-40%, 41-60%, 61-100%
Percentage land used for recreation:	0-2,5%, 2,6-5%, 6-10%, 11-20%, 21-100%
Percentage land used for green:	0%, 1-10%, 11-100%

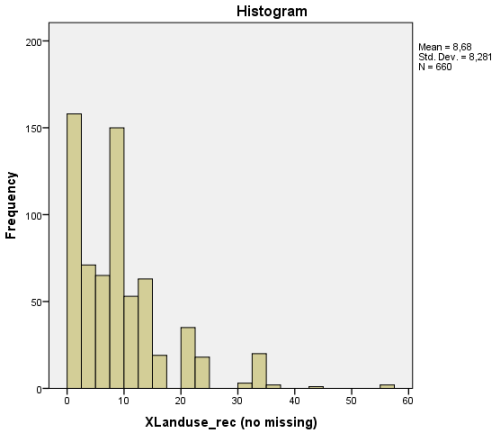
Below, histograms of the original four variables are presented, along with their Q-Q plots.

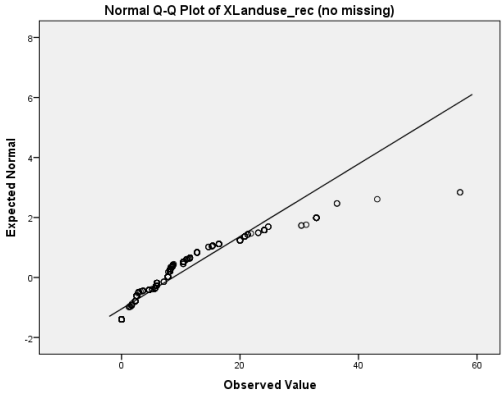

Histogram
Mean = 36,17
Std. Dev. = 12,144
N = 660
Frequency
Xper_hh_child (no missing)

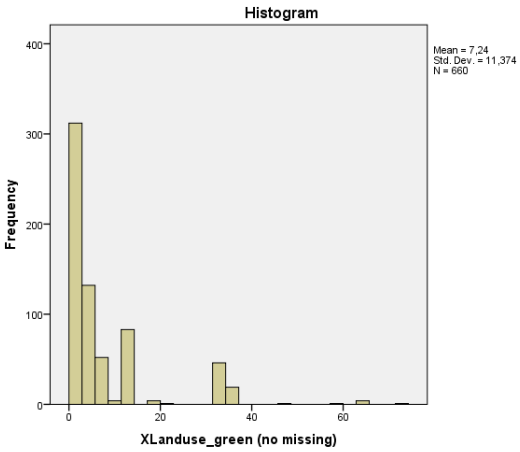

Normal Q-Q Plot of Xper_hh_child (no missing)
Expected Normal
Observed Value

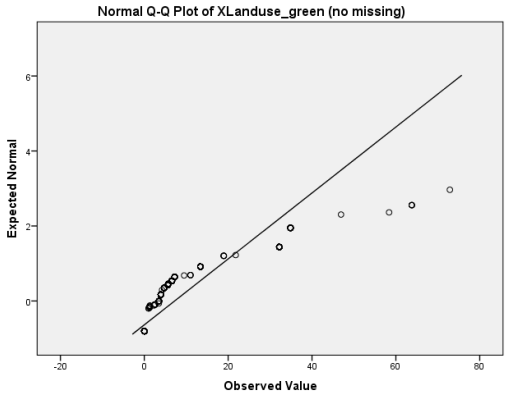

Histogram
Mean = 37,63
Std. Dev. = 15,806
N = 660
Frequency
XPer_low_income (no missing)


Normal Q-Q Plot of XPer_low_income (no missing)
Expected Normal
Observed Value


Histogram
Mean = 8,68
Std. Dev. = 8,281
N = 660
Frequency
XLanduse_rec (no missing)


Normal Q-Q Plot of XLanduse_rec (no missing)
Expected Normal
Observed Value


Histogram
Mean = 7,24
Std. Dev. = 11,374
N = 660
Frequency
XLanduse_green (no missing)


Normal Q-Q Plot of XLanduse_green (no missing)
Expected Normal
Observed Value

5. External factors

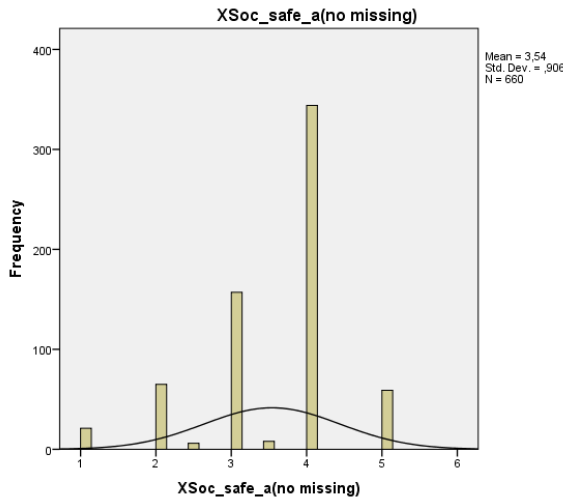
The variable **weather** was measured in two different places. The first was in the child questionnaire, where children were asked to report the weather of that particular day. This variable had 2 missing values, which were replaced by the most common. Furthermore, the variable was recoded from five to four categories: sunny, partly clouded, very clouded and rain. Very rainy and rainy were recoded into one category. The oth er place where the influence of the weather was measured, was in the statement on how important the weather is in deciding to travel by car or by an active mode to school. This had 18 missing values, which were replaced by the mean of the sample. Due to the fact that many parents checked 'not applicable', the variable still has over one hundred missing values which cannot be replaced, which makes it a less suitable variable to represent the weather in further analyses.

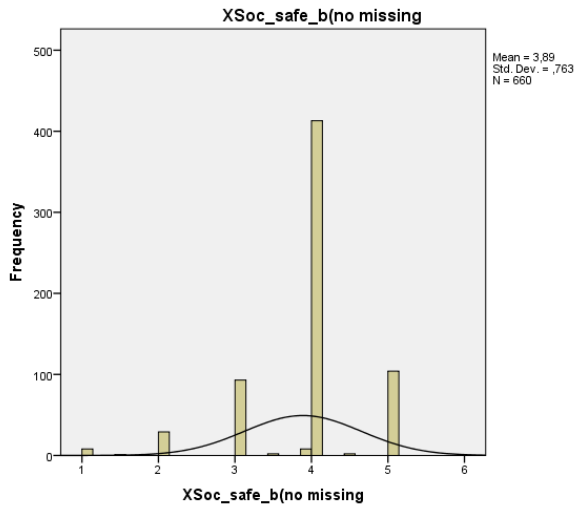
6. Dependent variables

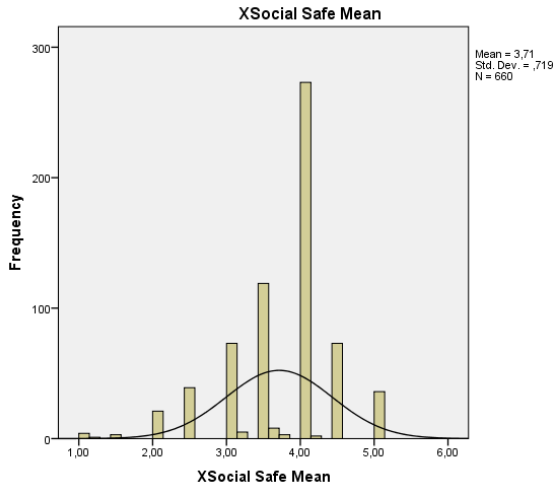
Parental safety perception

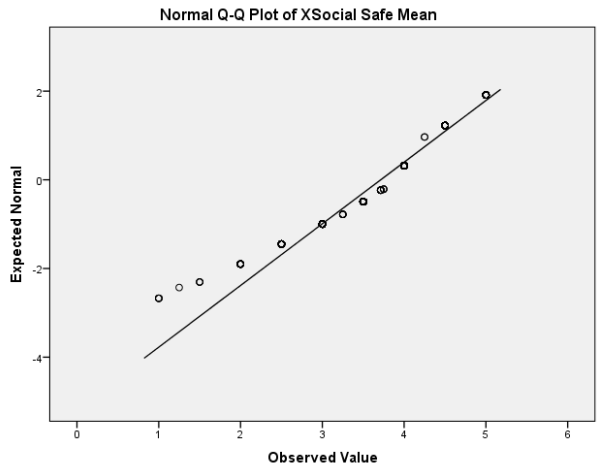
The dependent variable **parental safety perception** consists of the variables **social safety, traffic skills** and **traffic safety**. These were all built-up from a set of statements, for each statement the missing values (8-10) were replaced by the mean. Some statements were also recoded because they were formulated negatively and others positively (i.e. 5 was recoded to 1 and 4 was recoded to 2).

The combination of the two social safety statements has a Cronbach's Alpha value of 0.643. This indicates that they are fairly correlated and internally consistent. Below, the histograms for the two statements can be seen, as well as the normality plots for the final variable for social safety.

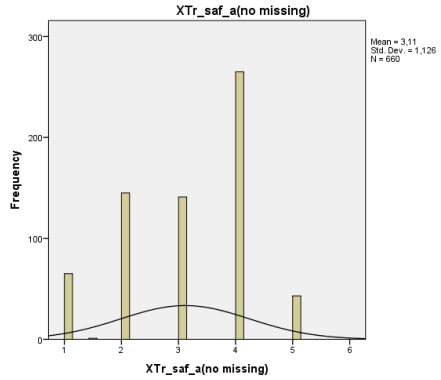


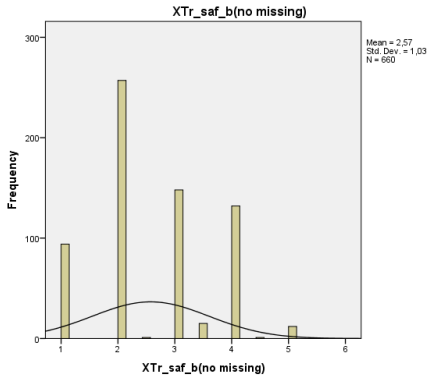


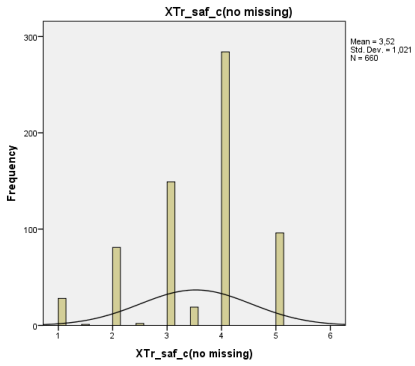


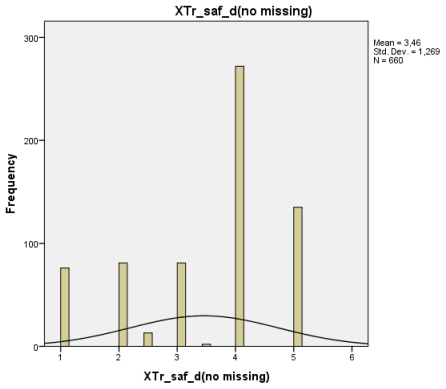


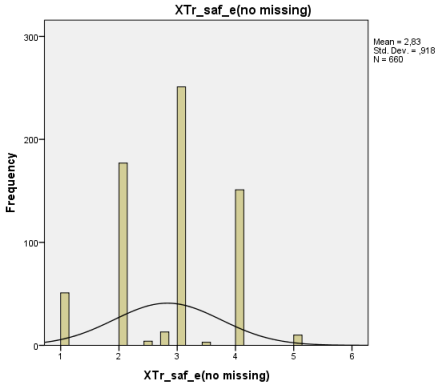
Combining the five traffic safety statements results in a Cronbach's Alpha value of 0.688, which again indicates fairly internally consistent variables which can be combined into one. All of the statements are relevant, removing one statement always lowers the Cronbach's Alpha value. See the histograms for the five statements and the final traffic safety variable.

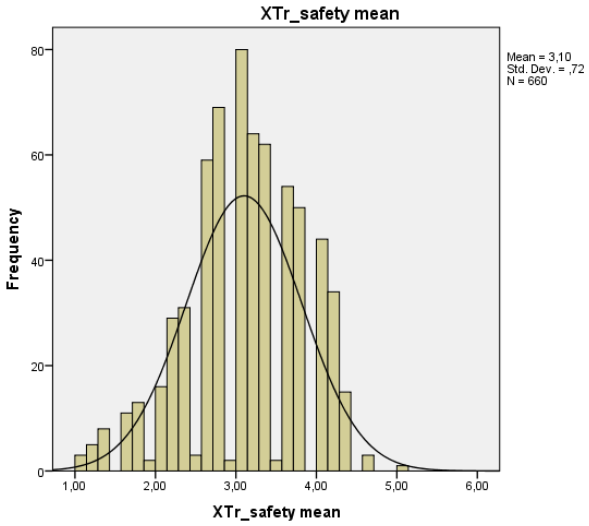


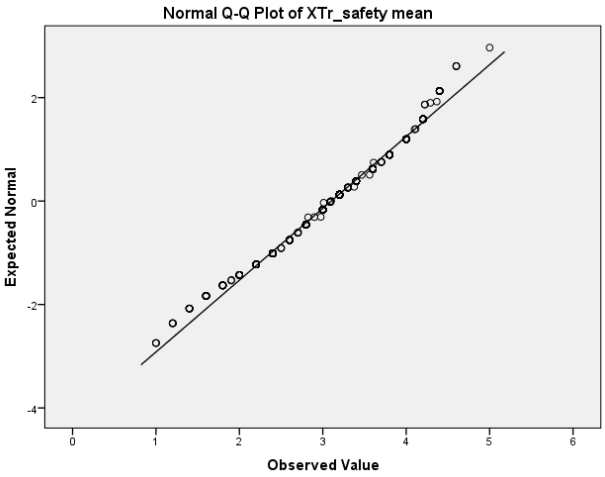




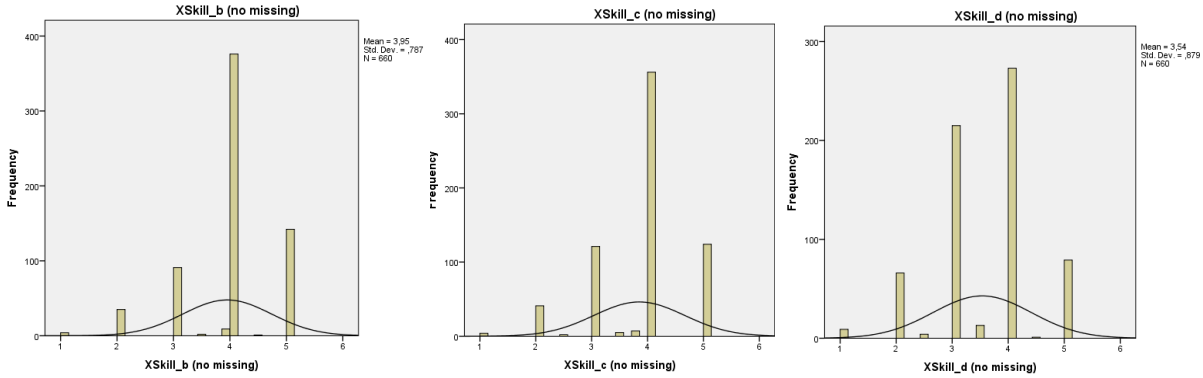


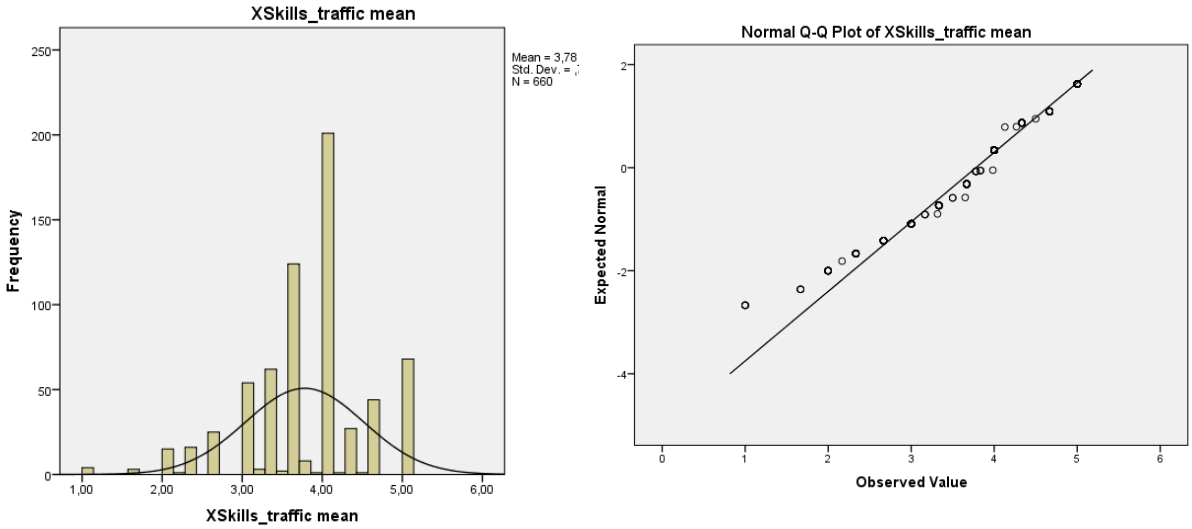






Combining the four traffic skills statements has a Cronbach's Alpha of 0.871. Furthermore, removing traffic skills statement a makes the Cronbach's Alpha slightly higher: 0,876, which indicates the variables are strongly internally consistent. The decision was made to remove statement a and combine statements b, c and d to the final traffic skills variable. The histograms below show the data for the three statements and the final traffic skills variable.



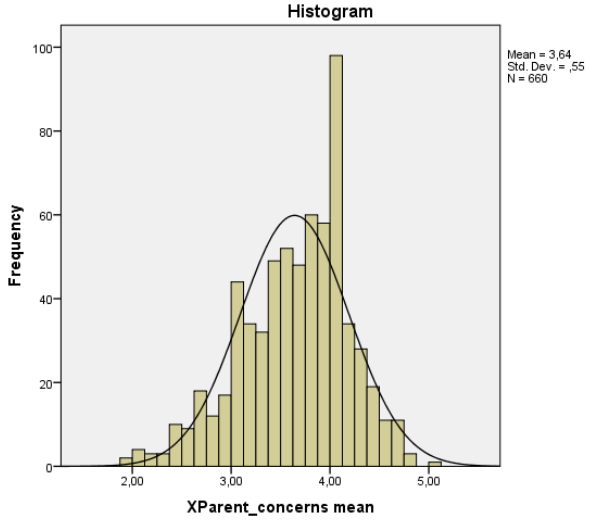


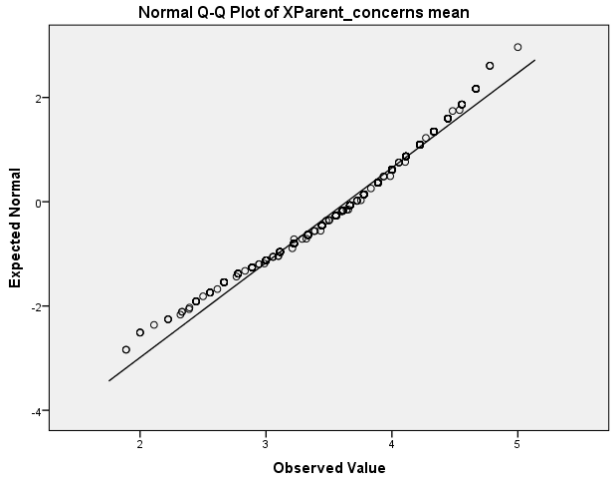
Finally, to construct the final **parental safety perception** dependent variable, it was investigated whether combining the statements from the traffic safety, social safety and traffic skills could all be averaged as one variable. Two traffic safety statements were removed from the set, as they were found to be less correlated with the rest of the variables. These were the statement about the availability of places to cross the street and about speeding of cars. This resulted in a set of four traffic skills statements, three traffic safety statements and two social safety statements with a Cronbach's Alpha of 0.779: well internally consistent. See the table below for the correlation matrix:

Inter-Item Correlation Matrix

	XSkill_a (no missing)	XSkill_b (no missing)	XSkill_c (no missing)	XSkill_d (no missing)	XTr_saf_c(no missing)	XTr_saf_d(no missing)	XTr_saf_e(no missing)	XSoc_safe_a (no missing)	XSoc_safe_b (no missing
XSkill_a (no missing)	1,000	,478	,623	,548	,212	,269	,077	,139	,217
XSkill_b (no missing)	,478	1,000	,763	,632	,180	,246	,126	,112	,129
XSkill_c (no missing)	,623	,763	1,000	,724	,222	,312	,143	,097	,180
XSkill_d (no missing)	,548	,632	,724	1,000	,182	,329	,143	,132	,134
XTr_saf_c(no missing)	,212	,180	,222	,182	1,000	,541	,303	,261	,272
XTr_saf_d(no missing)	,269	,246	,312	,329	,541	1,000	,277	,312	,315
XTr_saf_e(no missing)	,077	,126	,143	,143	,303	,277	1,000	,184	,149
XSoc_safe_a(no missing)	,139	,112	,097	,132	,261	,312	,184	1,000	,481
XSoc_safe_b(no missing	,217	,129	,180	,134	,272	,315	,149	,481	1,000

Removing traffic safety statement e would result in a slightly higher Cronbach's Alpha of 0.782, but the decision was made to still include this variable, as it is about the attitude of car drivers towards pedestrians and cyclists, an aspect not covered in other statements. Furthermore, the Cronbach's Alpha of 0.799 is already more than good enough. The final variable for parental safety perception, the mean of traffic safety, traffic skills and social safety, looks as follows:





Child transport mode variables

The next variable, **transport mode child**, has some different approaches. The first is the question in the child questionnaire, where children were asked to report their mode of that particular day. This question had 6 missing values, which were replace based on the indication of the parents on how often different transport modes are usually used and on the most used transport mode overall (i.e. for one child the parents indicated the child used the car 5 times per week and the bike 5 times per week. In this case the bike was filled in to replace the missing value as this is the most common transport mode overall). The transport mode variable was then recoded to the following six categories: By foot, by bicycle, on the back of the bicycle, by car, by public transport and other. The space scooter and kick-bike were added to the bicycle category, the skeelers were added the walking category. For the bivariate analyses, the variable was recoded some more. The least common transport modes (back of bicycle, public transport and other) were merged together to one overall 'other' category.
The variable transport mode as filled in by the children need some additional recoding for children attending special education schools (SBO). The principals of both SBO schools reported that many children of these so called special education schools often live far away. Therefore, the municipality provides transport for these children by taxibus. This also became visible in the responses of the children, almost twenty children reported the taxibus as their transport mode. However, also a large amount of children attending these schools checked the box of bus as transport mode. As it is likely that these children actually also traveled by municipality taxibus and not by public transport, the record of respondents from SBO schools were recoded from PT to taxibus. This prevents an unrealistic and most likely incorrect amount of respondents traveling by PT to school.

The other version of the variable is the **frequency of child transport mode** in the parent questionnaire, there were 14 missing values which needed to be replaced. It would be too unrealistic to simply replace these missing values by the most common mode, as this could result in children living very far away from school to supposedly travel daily by bicycle. To create transport mode frequency profiles that are to some extent realistic as replacement for the missing values, the frequencies of the three most common modes (walking, cycling and as car passenger) were studied for the different distances. From

these differing frequencies, a most likely profile was made for each travel distance to be used as a replacement for the missing values. The resulting values can be seen in the table below. The total amount of trips of 10 was used, as this was the most common and also the most logical in terms of school schedules. Furthermore, also in this variable the respondents that attended a special education school and filled in PT as transport mode were recoded to taxibus, for the same reason as described in the child transport mode section.

Distance	Frequencies		
	By foot	By bike	By car
<100 m	9	1	0
100-500 m	5	4	1
500-1000 m	2	6	2
1-2 km	1	7	2
2-5 km	0	6	4
>5 km	0	3	7

Some final recoding took place concerning the 'other mode, namely:…' frequency. From the trips that were assigned to this mode, there were only two transport modes specified. These were the taxibus and the scooter. Therefore, two additional variables were created to indicate the frequency of taxibus and scooter as transport mode for school trips.

Then, from the frequencies of the different transport modes (foot, bike, back of bike, car, PT, taxibus & scooter), different variables were constructed to be used in further analyses. By means of recoding the data, the following five variables concerning average weekly school transport modes were constructed:

1. Transport mode = always bicycle (yes/no)
   Coded yes if child never uses another mode than the bicycle
2. Car is used four times or more per week (yes/no)
   Coded yes if child uses car to school at least four times per week
3. Child walks to/from school four times or more per week (yes/no)
   Coded yes if child walks to school at least four times per week
4. Active transport vs. passive transport (more active/more passive)
   Coded 'active' if child has more school trips by an active mode than by a passive mode
   Foot and bicycle are coded as active, car, back of bicycle, PT, taxibus and scooter are coded as passive.
5. Active transport vs. passive transport – 5 categories
   (almost) always passive, mostly passive, about equal, mostly active, (almost) always active

Subjective well-being variables

The **mood/happiness** variable had 2 missing values, replaced by the mean and then recoded to three categories: Very happy (1), happy (2) and normal to unhappy (3-5). This recoding took place because not many children filled in 3, 4 or 5.

The **social interaction** during travel variable can be approached in three different ways. The first is by whom the child traveled to school that day (filled in by the children themselves). This question had 6 missing values, which were replaced by the most common: parent. From the answers to the question, a new variable with the following categories was made: Alone, with parent, with sibling, with friend, with parent and sibling, with mixture of people. This variable was called *trip* companions. There were also two questions in the parent questionnaire about social interaction. For one parents were asked to indicate the frequency of their child traveling with different people to school (e.g. parent, sibling,

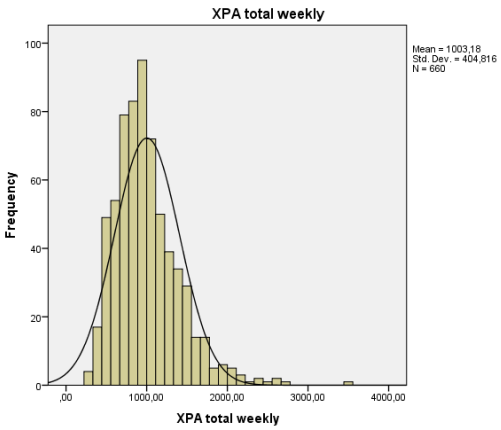
etc.) and the other was a statement concerning how often children meet other children on the way to school. For the answers to both questions the missing values were replaced by the mean. Furthermore, for the statement on meeting other children on the way to school, the variable was recoded to the following categories: 0-3 (strongly disagree-neutral), 4 (agree) and 5 (strongly agree) and it was called *trip interaction*. The frequencies of traveling to school with the different types of contacts were also recoded, to the following categories:

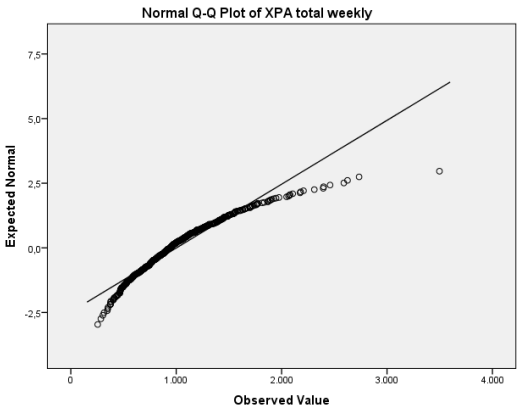
- With parent: 1-2 (never – little), 3-4 (sometimes – often), 5 (almost always)
- With older sibling: 1 (almost never), 2-5 (little - always)
- With younger sibling 1 (almost never), 2-4 (little to often), 5 (almost always)
- With friend 1 (almost never), 2-5 (little – always)
- Alone 1 (almost never), 2-3 (little – sometimes), 4-5 (often – always)

The missing values for the variable **parent-assessed health** were replaced by the replaced by the mean of the sample. To create equal category groups within the variable, it was then recoded into three groups: 0-3.9, 4 and 4.1-5 and into two groups: 0-4 and 4.1-5. Initially, 1 indicated very poor health and 5 indicated very good health. Now the three categories indicated very poor to sufficient health, good health and very good health. In the analyses, it became clear that it was better to only use the health variable with only two categories.

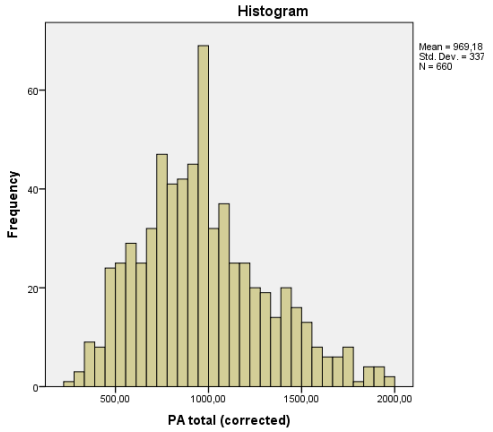
The physical activity that children normally experience in their free time serves as input value in calculating the **overall weekly physical activity** of children. The question in the questionnaire about the PA during free time has 20 missing values. Most occurred because parents filled in things such as 'a lot', which was unclear. The missing values are replaced by the mean number of hours per week of PA in the free time (11,7 hours). After that, the PA in free time variable was recoded into five categories: 0-5 hours, 5-10 hours, 10-15 hours, 15-20 hours and >20 hours. Also the hours of PA in school (which did not have missing values) are a part of the calculation of overall weekly physical activity. Lastly, the minutes spent on the bicycle or while walking to school are part of the calculation. The travel time to school by foot or by bicycle had some missing values, these were replaced by the walking and cycling time calculated by Google Maps using the postal code of the respondent. Always a few minutes were added, proportionally to the total duration, because children usually cycle and walk slower than adults (whom Google Maps is based on).

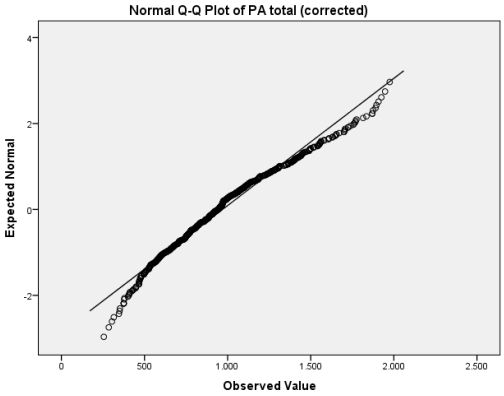
The final calculation for overall weekly physical activity was as follows: minutes spent being physically active in the free time + minutes spent being physically active in school + minutes spent actively commuting to and from school. In the final variable, there are a few outliers, as can be seen in the upper two figures on this page. These are probably the result of parents' incorrect guesswork





concerning playing outside. These outliers (16) were replaced by the mean of the sample. This leads to the corrected normality plots on the next page.





The last dependent variable is the **Satisfaction With Travel** that children have, concerning the day of the questionnaire. In total, this variable is built-up from 9 statements, 3 measuring cognitive aspects and 6 measuring affective aspects. Combining the three cognitive variables results in a Cronbach's Alpha of only 0.206, indicating the variables are not internally consistent. The table below shows that they are also barely correlated, and some are even negatively correlated.

Inter-Item Correlation Matrix			
	SWT_C_funlame_1	SWT_C_easyhard_1	SWT_C_learn_1
SWT_C_funlame_1	1,000	,098	,199
SWT_C_easyhard_1	,098	1,000	-,066
SWT_C_learn_1	,199	-,066	1,000

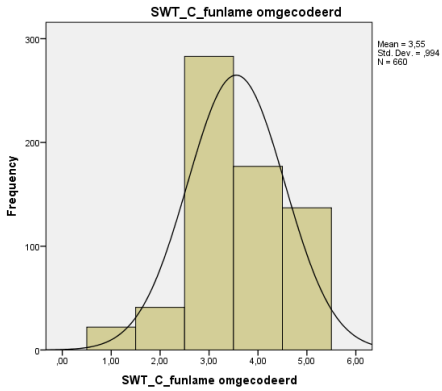
When looking at the Negative Deactivation – Positive Activation statements, the Cronbach's Alpha is better, but still not implying strong consistency: .583.

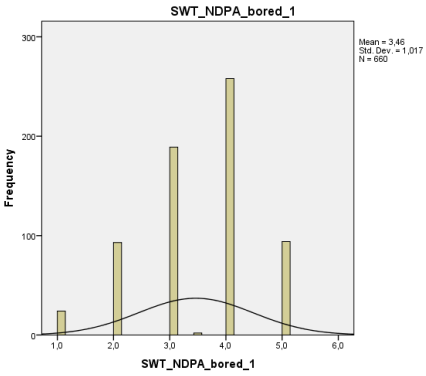
Inter-Item Correlation Matrix			
	SWT_NDPA_bored_1	SWT_NDPA_excited_1	SWT_NDPA_tired_1
SWT_NDPA_bored_1	1,000	,349	,294
SWT_NDPA_excited_1	,349	1,000	,330
SWT_NDPA_tired_1	,294	,330	1,000

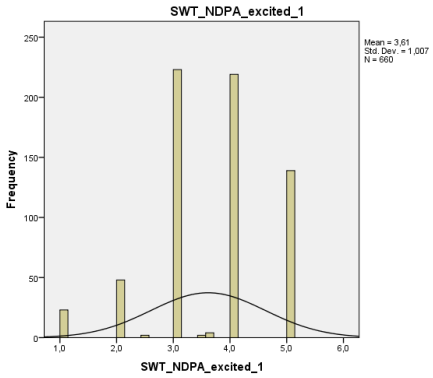
When looking the Positive Deactivation – Negative Deactivation statement, the Cronbach's Alpha becomes .469, which is definitely too low.

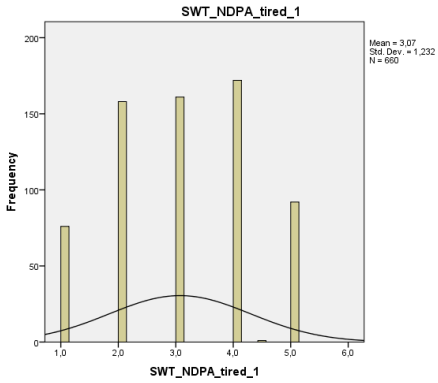
Inter-Item Correlation Matrix			
	SWT_PDNA_tense_1	SWT_PDNA_time_1	SWT_PDNA_worry_1
SWT_PDNA_tense_1	1,000	,192	,210
SWT_PDNA_time_1	,192	1,000	,285
SWT_PDNA_worry_1	,210	,285	1,000

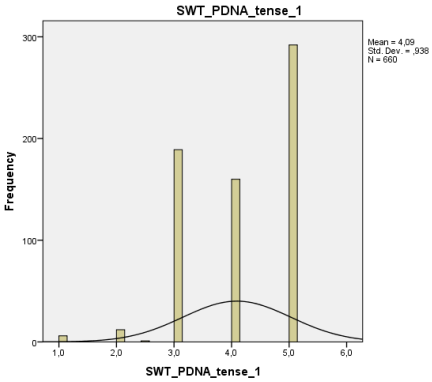
Finally, the best option appears to be adding all affective statements into one variable, and including only the first cognitive statement (whether the trip was fun or lame). This option shows the best Cronbach's Alpha of .673. This shows a moderate to good consistency between the variables. See the figures, which show the distributions for the seven statements and the normality plots for the final SWT variable.

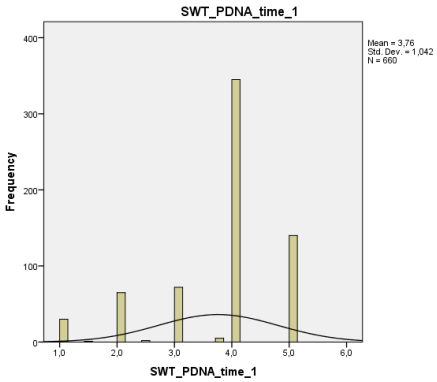


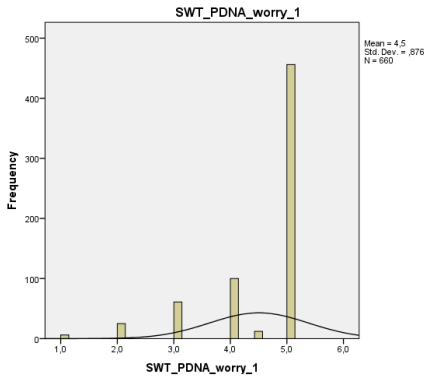


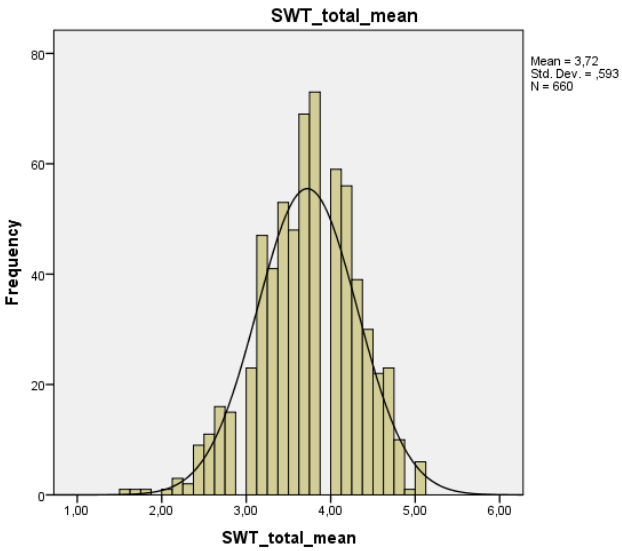


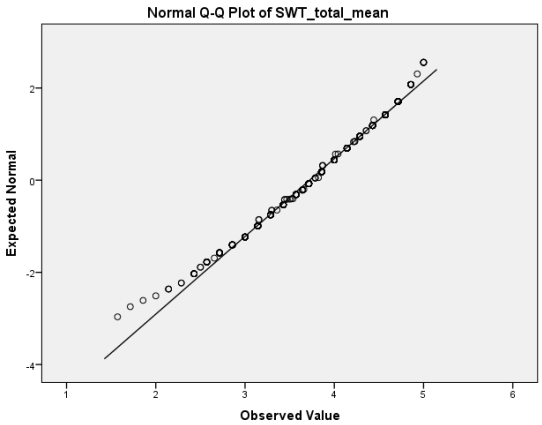












7. Recoding for Chi Square analyses

One of the assumptions of the Chi Square analysis is that the 'expected values' in the output of the analysis are not lower than five. However, due to some variables consisting of small groups, this assumption was sometimes violated when using the originally operationalized variables. Therefore, some variables were recoded to have fewer variables, especially for some Chi Square analyses. This was the case for the following analyses (the manner of recoding is including between parentheses):

- Age (7&8 were combined, 11&12 were combined) with:
    - Transport mode day of survey
    - Trip companions day of survey
- Trip companions day of survey (sibling & friend were grouped with 'other' category) with:
    - Car ownership
    - Car use both parents
    - Household work status
    - Safety measures school
    - Traffic safety around school
    - Active travel initiatives
    - Land used for recreation
    - Percentage of low income households
    - Distance to school
    - Speed limit around school
    - Weather on day of survey
- Ethnicity (European and non-European grouped together) with:
    - Trip companions day of survey
    - Trip interaction (meeting children on the way to school)
- Household composition (single parent with one child and with more than one child grouped together) with:
    - Trip companions day of survey (recoded versions described above)
    - Trip interaction (meeting children on the way to school)
- Household size (2 and 3 person households grouped together) with:
    - Trip companions day of survey (recoded versions described above)
    - Trip interaction

Appendix 6: Removal of predictor variables

1. Personal factors

For the personal factors, the independence of the variables were tested using the Cramer's V in SPSS. The Cramer's V measures the strength of the association between two categorical variables (Field, Miles & Field, 2013), a Cramer's V of over 0.5 is considered a too strong association in the current study. Not surprisingly, the association between age and grade is too strong, which is why the decision has to be made to remove one of these variables. Because age is significantly associated with one more independent variable than grade, the decision was made to remove the variable grade. Furthermore, the favorite mode (four categories) and the preference for active or passive travel are too strongly associated, as they describe the same effect in a different way. The decision was made to keep the favorite mode variable, because it is associated significantly with one more dependent variable and because it entails more information, such as the difference between bike and walking as a preference. All other personal factors will be included in the regression models.

2. Household factors

In the household factors, two variables for household composition were used, in order to find out which would be the most suitable for further analyses. After seeing the results of the bivariate analyses, the decision was made to remove household size and keep household composition. Household composition has one more significant association with the (most important) dependent variables, and all of the associations with household composition are at the 0.01 significance level, whereas household size has some associations at the 0.05 level. Furthermore, car use and car ownership were also found to be too strongly associated with each other. As car ownership is also quite strongly associated with income and with work status of the household, the decision was made to remove car ownership. The two are significantly associated with approximately the same amount of dependent variables. There are no other complications concerning the household factors and they all have a significant relationship with at least one of the dependent variables, so all other variables in the household factors layer will be used in the regression analyses.

3. School factors

There are two variables in the school factors layer that are unreliable because one of the categories turned out to only be applicable to one school. These variables are whether or not children have lunch at school and whether or not the school takes safety measures concerning traffic. Therefore, these two variables have been removed from the dataset. Furthermore, it became visible after doing some chi square analyses with Cramer's V, that a large amount of the school factors are strongly associated with each other. This is not entirely surprising, as all variables are measured on the school level and then assigned to the respondents, resulting in only fourteen identical 'school profiles'. Nevertheless, some school variables did not exceed the critical 0.5 level for Cramer's V, which is why they will be used in the regression analyses. These variables are the total number of pupils, the quality + capacity of bike storage, the quality + capacity of car parking and whether or not the school participates in active travel initiatives. The car parking quality variable is, indirectly, also a measure of traffic safety. Most principles that were unhappy about their parking situations, indicated that this automatically resulted in unclear traffic situations. The variable total number of pupils did exceed the appointed critical Cramer's V value of 0.5 in its association with the percentage of children living in the neighborhood. The Cramer's V for these two variables was 0.509. Because it exceeds the critical value so little, the decision was made to keep the variable.

4. Physical and social environment

Within the group of variables in the physical and social environment the variable speed limit was measured on the school level and there was only one school in a 50 km/h zone, all other are located in a 30 km/h zone. Because of this, the variable was removed from the data set. The variable urban density was found to be too strongly associated with the variable green land-use. Both variables are significantly associated with the same dependent variables. The decision was made to keep urban density, because this variable was most frequently named in previous research. Also the urban density and the percentage of households with a low income in the neighborhood are too strongly associated. Because the variable household income and percentage of households with low income were already found to also be quite strongly associated, the decision was made to remove the variable percentage of households with low income from the dataset. The variable separate bicycle lane is only significantly associated with two of the dependent variables (transport mode and trip interaction). Furthermore, this variable was measured on the school level and only three schools had a separate bicycle lane, eleven did not. All in all, it is not a very reliable and influential variable. For this reason, the decision was made to remove the variable from the dataset. Finally, length of residence was only found to be significantly associated with one of the main dependent variables, trip companions. However, as will be explained in the section dependent variables, the decision was made to not include this dependent variable. Therefore, also length of residence will be removed from the dataset. The rest of the physical and social environment do not have any conflicts and are all significantly associated with at least one of the dependent variables, which is why they will be included in the regression analyses.

5. External factors

There were no conflicts with the weather variable in terms of too strong correlations. The variable also has significant associations with several dependent variables and will be included in the regression analyses.

Appendix 7: scatterplots and normal P-P plots

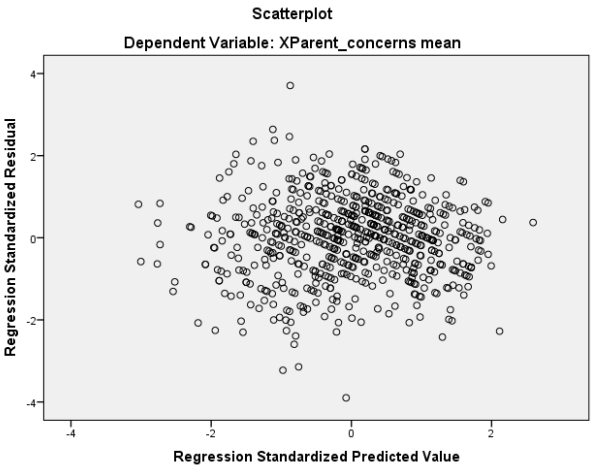


Figure A7.1 Scatterplot of residuals parental safety perception

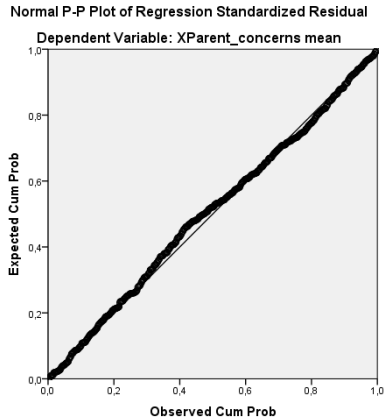


Figure A7.2 Normal P-P plot of standardized residuals parental safety perception

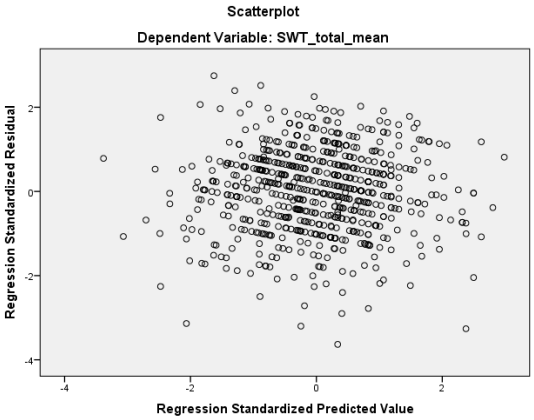


Figure A7.3 Scatterplot of residuals SWT

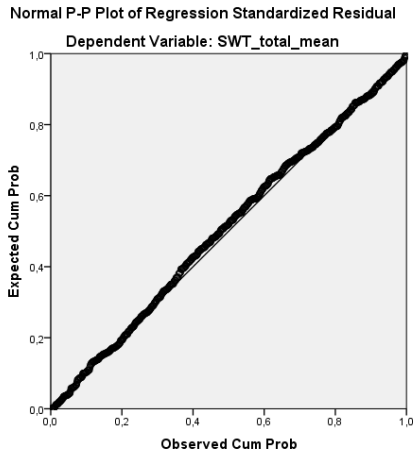


Figure A7.4 Normal P-P plot standardized residuals SWT

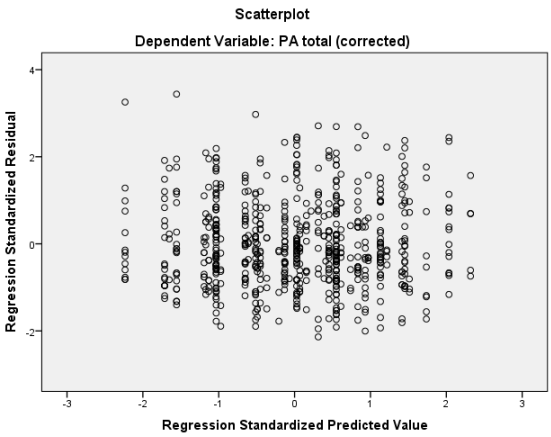


Figure A7.5 Scatterplot of residuals Weekly PA

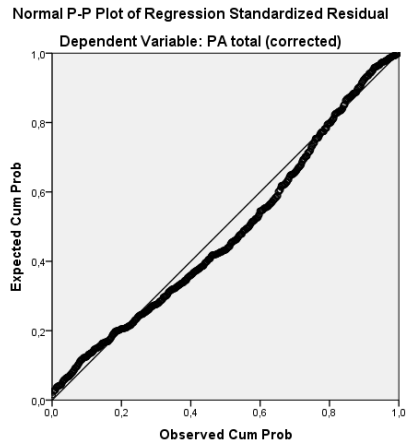


Figure A7.6 Normal P-P plot standardized residuals Weekly PA

Checking assumptions for the percentage of active trips

The percentage of active trips variable is only used in the path analysis, but it is important to see whether it also complies with the assumptions of regression. Figure A7.7 and A7.8 below show the scatterplot of the residuals and the normal P-P plot of the standardized residuals.

The observations are, as for the other variables, independent because the study is cross sectional. Because dummy variables are used, also the assumption of measurement scale is met. By observing the scatterplot and the P-P plot no alarming patterns are visible, indicating that the assumptions of linearity, normality of errors and homoscedasticity are met. The assumption of multicollinearity was already met when all correlating variables were removed from the models for the regression chapter. The only assumption that is not met is the independence of error terms, which is why a multilevel model is used.

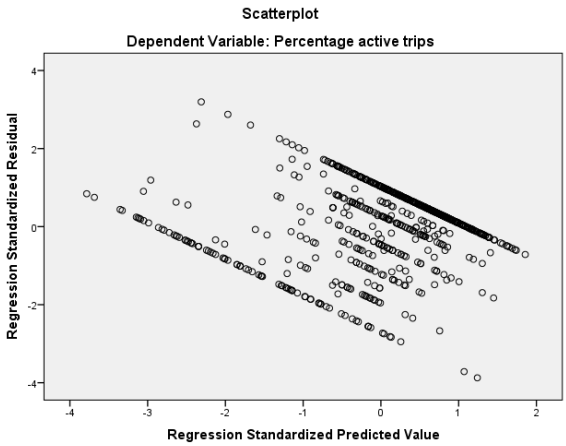


Figure A7.7 Scatterplot of residuals percentage active trips

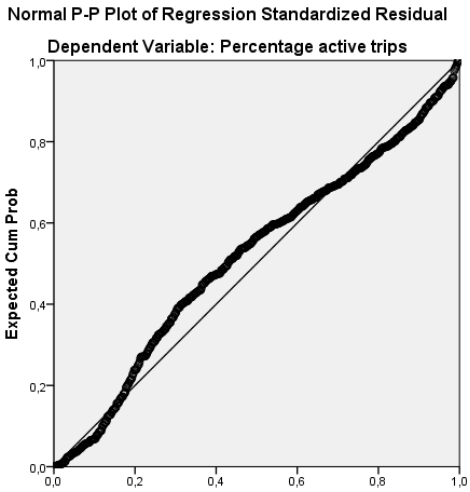


Figure A7.8 Normal P-P plot standardized residuals percentage active trips

Appendix 8: Results multilevel multinomial logit model transport mode

Table A8.1 Results multilevel multinomial logistic regression analysis for travel mode – bicycle

Transport mode - Bicycle	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.
Intercept (between schools)	2304.3**	0.000	2635.0**	0.000	2850.3	>.500	3056.2	>.500	4178.0	>.500	5777.7**	0.000
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Intercept (within schools)	-4.405**	0.000	-5.042**	0.000	-5.806**	0.008	-6.677*	0.016	-7.903**	0.009	-8.453**	0.000
Level 1 – individual level variables												
Personal factors												
Age	0.532**	0.000	0.586**	0.000	0.551**	0.000	0.583**	0.000	0.480**	0.000	0.483**	0.000
Favorite mode - bicycle												
Walking	-0.418	0.191	-0.516	0.123	-0.452	0.227	-0.422	0.266	-0.439	0.252	-0.463	0.204
Bicycle	-	-	-	-	-	-	-	-	-	-	-	-
Car	-0.393	0.151	-0.118	0.686	-0.429	0.204	-0.381	0.268	-0.360	0.296	-0.229	0.486
Other	-0.473	0.125	-0.387	0.245	-0.561	0.125	-0.465	0.216	-0.403	0.291	-0.462	0.211
Household factors												
Household composition – 2 parents, siblings												
1 parent 1 child			-0.442	0.442	-0.316	0.641	-0.261	0.704	-0.280	0.680	-0.503	0.440
1 parent sibl.			-0.100	0.796	-0.178	0.692	-0.147	0.748	-0.205	0.656	-0.324	0.461
2 parents 1 child			-0.368	0.290	-0.253	0.541	-0.271	0.520	-0.217	0.612	-0.141	0.727
2 parents sibl.	-	-	-	-	-	-	-	-	-	-	-	-
Income - average												
Low			-0.458	0.180	-0.496	0.202	-0.555	0.163	-0.498	0.217		
Average	-	-	-	-	-	-	-	-	-	-	-	-
High			0.398	0.120	0.165	0.564	0.188	0.521	0.143	0.630		
Work household – 1 wage earner												
2 wage earners			0.694*	0.029	0.632~	0.088	0.641~	0.088	0.736~	0.055	0.699~	0.054
1 wage earner	-	-	-	-	-	-	-	-	-	-	-	-
Other			-0.231	0.648	0.489	0.404	0.484	0.419	0.604	0.320	0.209	0.712
Car use parents – 4-5 days												
Never			0.574	0.125	0.332	0.433	0.359	0.409	0.452	0.305	0.538	0.195
1-3 days			0.362	0.289	0.049	0.901	0.055	0.890	0.076	0.850	0.079	0.838
4-5 days	-	-	-	-	-	-	-	-	-	-	-	-
6-8 days			-0.372	0.244	-0.659~	0.075	-0.662~	0.079	-0.721~	0.059	-0.644~	0.075
>8 days			-0.964*	0.014	-0.971*	0.033	-1.018~	0.028	-0.982*	0.035	-0.939*	0.035
Active travel parents – 1-4 days												
Never			-0.180	0.495	0.078	0.790	0.065	0.826	0.069	0.818	0.148	0.607
1-4 days	-	-	-	-	-	-	-	-	-	-	-	-
>4 days			0.556	0.117	1.102**	0.006	1.091**	0.008	1.022*	0.013	1.022**	0.010
Daycare – once per week												
Never			-0.273	0.431	-0.013	0.975	-0.051	0.901	-0.036	0.932		
Once per week	-	-	-	-	-	-	-	-	-	-	-	-
More than once			-0.469	0.244	-0.648	0.147	-0.630	0.167	-0.667	0.150		

Transport mode bicycle	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Chi Sq.	Sig.	Chi Sq.	Sig	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.
Physical and social environment and weather												
Distance – 1-2 km												
<500 m					-0.327	0.465	-0.352	0.442	-0.457	0.325	-0.314	0.477
500-1000 m					-0.144	0.649	-0.158	0.624	-0.289	0.382	-0.208	0.507
1-2 km	-	-	-	-	-	-	-	-	-	-	-	-
2-5 km					-0.906**	0.017	-0.830**	0.033	-0.902*	0.023	-0.901*	0.016
>5 km					-3.215**	0.000	-3.044**	0.000	-3.08**	0.000	-3.095**	0.000
Urban density - average												
High					-1.216*	0.018	-1.226*	0.031	-1.201*	0.035	-0.781~	0.056
Average	-	-	-	-	-	-	-	-	-	-	-	-
Low					-0.200	0.648	-0.284	0.543	-0.332	0.484	0.079	0.850
% Children – 0-25%												
0-25%	-	-	-	-	-	-	-	-	-	-	-	-
26-30%					0.944*	0.049	0.916~	0.064	0.901~	0.072	0.762~	0.086
31-45%					0.525	0.258	0.411	0.404	0.416	0.403	0.371	0.379
>45%					0.368	0.578	0.427	0.562	0.329	0.657	0.645	0.312
% Recreation land-use – 0-2.5%												
0-2.5%	-	-	-	-	-	-	-	-	-	-	-	-
2.6-5%					0.122	0.777	0.153	0.741	0.095	0.840		
6-10%					-0.762	0.159	-0.678	0.249	-0.861	0.145		
11-20%					0.293	0.586	0.302	0.603	0.090	0.878		
>20%					-1.092	0.101	-1.106	0.122	-0.991	0.163		
Connectivity - Neutral												
Disagree					1.175**	0.002	1.197**	0.002	1.255**	0.001	1.047**	0.003
Neutral	-	-	-	-	-	-	-	-	-	-	-	-
Agree					1.206**	0.000	1.192**	0.000	1.041**	0.002	1.061**	0.001
Contact children (child has social network) - Disagree												
Disagree	-	-	-	-	-	-	-	-	-	-	-	-
Neutral					0.704~	0.099	0.689	0.112	0.738~	0.096	0.525	0.203
Agree					0.300	0.458	0.271	0.511	0.245	0.561	0.173	0.656
Strongly agree					0.240	0.666	0.244	0.667	0.152	0.792	-0.025	0.962
Bike, walk paths					0.161	0.336	0.171	0.316	0.021	0.909		
Social cohesion					0.008	0.974	0.019	0.941	-0.080	0.753		
Trip interaction – Agree												
Disagree-neutral					0.068	0.824	0.095	0.761	0.052	0.870	0.086	0.774
Agree	-	-	-	-	-	-	-	-	-	-	-	-
Strongly agree					0.236	0.622	0.232	0.631	0.120	0.807	0.095	0.838
Weather - Sunny												
Sunny	-	-	-	-	-	-	-	-	-	-	-	-
Partly clouded					-0.116	0.793	-0.130	0.773	-0.143	0.751	0.078	0.855
Very clouded					0.424	0.365	0.405	0.405	0.369	0.449	0.564	0.219
Rainy					-1.964**	0.005	-2.136**	0.005	-2.16**	0.005	-1.487*	0.027
Level 2 – School level variables												
School factors												
Total pupils - average												
Small							0.345	0.741	0.344	0.721		
Average	-	-	-	-	-	-	-	-	-	-	-	-
Large							-0.115	0.914	-0.141	0.885		

Transport mode Walking	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.
Bicycle parking – Sufficient												
Mediocre							*-0.125*	*0.890*	*-0.025*	*0.977*		
Sufficient	-	-	-	-	-	-	-	-	-	-	-	-
Good							*0.041*	*0.967*	*0.193*	*0.830*		
Car parking quality - mediocre												
Insufficient							*0.808*	*0.544*	*0.848*	*0.492*		
Mediocre	-	-	-	-	-	-	-	-	-	-	-	-
Sufficient - good							*1.134*	*0.212*	*0.980*	*0.236*		
Dependent variables as predictors												
Parent saf. perc.									*0.900***	*0.001*	*0.897***	*0.001*

~ significant at 0.1 level * significant at 0.05 level ** significant at 0.01 level

Table 9.8 Results multilevel multinomial logistic regression analysis for travel mode – walking

Transport mode Walking	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.
Intercept (between schools)	*1164.9***	*0.000*	*1226.8***	*0.000*	*2064.9*	*>.500*	*2744.0*	*>.500*	*2807.6*	*>.500*	*3538.4***	*0.000*
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Intercept (within schools)	*-4.483***	*0.002*	*-4.812***	*0.003*	*-7.320**	*0.015*	*-9.294*	*0.018*	*-9.494**	*0.018*	*-9.682***	*0.001*
Level 1 – individual level variables												
Personal factors												
Age	*0.385***	*0.001*	*0.366***	*0.003*	*0.305~*	*0.061*	*0.349**	*0.037*	*0.315~*	*0.065*	*0.376**	*0.016*
Favorite mode - bicycle												
Walking	*1.284***	*0.000*	*1.221***	*0.001*	*0.992**	*0.026*	*1.029**	*0.024*	*1.018**	*0.026*	*0.900**	*0.036*
Bicycle	-	-	-	-	-	-	-	-	-	-	-	-
Car	*-0.615*	*0.134*	*-0.450*	*0.302*	*-0.488*	*0.376*	*-0.428*	*0.446*	*-0.448*	*0.425*	*-0.424*	*0.428*
Other	*0.136*	*0.734*	*0.313*	*0.470*	*0.232*	*0.687*	*0.366*	*0.542*	*0.373*	*0.538*	*0.156*	*0.783*
Household factors												
Household composition – 2 parents, siblings												
1 parent 1 child			*-0.560*	*0.448*	*-0.982*	*0.315*	*-0.845*	*0.402*	*-0.811*	*0.417*	*-0.935*	*0.331*
1 parent sibl.			*-0.920~*	*0.095*	*-0.566*	*0.424*	*-0.516*	*0.473*	*-0.479*	*0.508*	*-0.343*	*0.622*
2 parents 1 child			*-1.339**	*0.012*	*-1.53**	*0.028*	*-1.710**	*0.018*	*-1.735**	*0.017*	*-1.511**	*0.028*
2 parents sibl.	-	-	-	-	-	-	-	-	-	-	-	-
Income - average												
Low			*-0.199*	*0.647*	*0.042*	*0.938*	*0.042*	*0.941*	*0.002*	*0.997*		
Average	-	-	-	-	-	-	-	-	-	-	-	-
High			*-0.066*	*0.832*	*-0.408*	*0.312*	*-0.447*	*0.280*	*-0.433*	*0.298*		
Work household – 1 wage earner												
2 wage earners			*0.579*	*0.146*	*0.775*	*0.133*	*0.851*	*0.107*	*0.910~*	*0.086*	*0.635*	*0.199*
1 wage earner	-	-	-	-	-	-	-	-	-	-	-	-
Other			*0.411*	*0.517*	*1.836**	*0.034*	*1.857**	*0.037*	*1.916**	*0.031*	*1.838**	*0.039*
Car use parents – 4-5 days												
Never			*0.138*	*0.770*	*-0.596*	*0.330*	*-0.568*	*0.364*	*-0.490*	*0.439*	*-0.342*	*0.570*
1-3 days			*0.063*	*0.881*	*-0.363*	*0.510*	*-0.416*	*0.463*	*-0.346*	*0.545*	*-0.328*	*0.542*
4-5 days	-	-	-	-	-	-	-	-	-	-	-	-
6-8 days			*-0.005*	*0.990*	*-0.156*	*0.757*	*-0.155*	*0.764*	*-0.173*	*0.739*	*-0.160*	*0.744*
>8 days			*-1.004**	*0.049*	*-0.340*	*0.622*	*-0.394*	*0.579*	*-0.349*	*0.623*	*-0.282*	*0.668*

Transport mode Walking	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.	Chi Sq.	Sig.
Active travel parents – 1-4 days												
Never			-0.044	0.894	0.383	0.352	0.384	0.362	0.343	0.417	0.370	0.359
1-4 days	-	-	-	-	-	-	-	-	-	-	-	-
>4 days			0.807*	0.052	1.91**	0.001	1.90**	0.001	1.883**	0.002	1.801**	0.001
Daycare – once per week												
Never			0.440	0.320	0.683	0.229	0.724	0.211	0.721	0.217		
Once per week	-	-	-	-	-	-	-	-	-	-	-	-
More than once			0.036	0.944	-0.032	0.962	0.058	0.932	0.005	0.994		
Physical and social environment and weather												
Distance – 1-2 km												
<500 m					4.01**	0.000	4.19**	0.000	4.117**	0.000	4.027**	0.000
500-1000 m					2.09**	0.001	2.23**	0.001	2.142**	0.001	2.049**	0.001
1-2 km	-	-	-	-	-	-	-	-	-	-	-	-
2-5 km					-2.100	0.101	-1.923	0.136	-2.005	0.119	-1.855	0.130
>5 km					-1.050	0.419	-0.724	0.617	-0.767	0.596	-0.874	0.509
Urban density - average												
High					-0.494	0.474	0.352	0.704	0.321	0.727	0.365	0.526
Average	-	-	-	-	-	-	-	-	-	-	-	-
Low					0.605	0.387	1.002	0.209	0.954	0.234	1.031	0.115
% Children – 0-25%												
0-25%	-	-	-	-	-	-	-	-	-	-	-	-
26-30%					1.880*	0.016	1.966*	0.016	1.957*	0.017	2.041**	0.007
31-45%					0.824	0.300	1.067	0.250	1.120	0.193	1.163	0.128
>45%					0.754	0.477	1.388	0.306	1.345	0.286	1.931~	0.053
% Recreation land-use – 0-2.5%												
0-2.5%	-	-	-	-	-	-	-	-	-	-	-	-
2.6-5%					-0.970	0.167	-0.574	0.500	-0.623	0.467		
6-10%					-1.50~	0.059	-1.162	0.272	-1.248	0.243		
11-20%					0.410	0.585	-0.583	0.553	-0.613	0.534		
>20%					0.193	0.849	-0.304	0.808	-0.363	0.774		
Connectivity - Neutral												
Disagree					0.728	0.135	0.795	0.156	0.790	0.162	0.508	0.281
Neutral	-	-	-	-	-	-	-	-	-	-	-	-
Agree					0.425	0.330	0.368	0.413	0.267	0.574	0.198	0.641
Contact children (child has social network) - Disagree												
Disagree	-	-	-	-	-	-	-	-	-	-	-	-
Neutral					1.675*	0.031	1.680*	0.038	1.722~	0.072	1.366	0.061
Agree					0.958	0.178	0.958	0.199	0.921	0.218	0.726	0.279
Strongly agree					2.082*	0.018	2.155*	0.018	2.125*	0.020	1.849*	0.022
Bike, walk paths					-0.207	0.365	-0.194	0.410	-0.263	0.283		
Social cohesion					-0.185	0.614	-0.146	0.701	-0.160	0.679		
Trip interaction – Agree												
Disagree-neutral					-1.057*	0.035	-0.997~	0.052	-1.017*	0.049	-0.852~	0.075
Agree	-	-	-	-	-	-	-	-	-	-	-	-
Strongly agree					-0.313	0.607	-0.409	0.510	-0.503	0.421	-0.626	0.285

Weather – Sunny												
Sunny	-	-	-	-	-	-	-	-	-	-	-	-
Partly clouded					*0.572*	*0.367*	*0.578*	*0.368*	*0.569*	*0.376*	*0.616*	*0.317*
Very clouded					*0.582*	*0.380*	*0.620*	*0.372*	*0.574*	*0.409*	*0.591*	*0.361*
Rainy					*-1.071*	*0.221*	*-1.084*	*0.245*	*-1.095*	*0.243*	*-0.608*	*0.474*
Level 2 – School level variables												
School factors												
Total pupils - average												
Small							*0.528*	*0.691*	*0.579*	*0.665*		
Average	-	-	-	-	-	-	-	-	-	-	-	-
Large							*0.659*	*0.588*	*0.662*	*0.587*		
Bicycle parking – Sufficient												
Mediocre							*0.499*	*0.621*	*0.511*	*0.615*		
Sufficient	-	-	-	-	-	-	-	-	-	-	-	-
Good							*-0.807*	*0.491*	*-0.638*	*0.585*		
Car parking quality - mediocre												
Insufficient							*1.703*	*0.307*	*1.832*	*0.277*		
Mediocre	-	-	-	-	-	-	-	-	-	-	-	-
Sufficient - good							*0.190*	*0.839*	*0.130*	*0.890*		
Dependent variables as predictors												
Parent saf. perc.									*0.256*	*0.530*	*-0.043*	*0.906*

~ significant at 0.1 level * significant at 0.05 level ** significant at 0.01 level