Master thesis
Urban Geography

Travelling to school: walking, cycling or on the backseat of the car?

A cross-sectional analysis on the influences on the decision to walk, cycle or travel passively to primary schools in the Netherlands.

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Supervisor: Marco Helbich

April 25, 2016

Picture: Natuur en milieu federatie Utrecht (2015).

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Master thesis GEO4-3313
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April 2016

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Preface

Dear reader,

It took some time, but finally, here it is: my master thesis. The result of hard work, stress and some incidental frustration. Writing a master thesis proved to be a challenge on its own, and writing in English, especially about the statistical tests and results, gave me an extra challenge. It also gave me a result that I'm proud of, and a lot of satisfaction. It created happy moments, especially when people asked about the subject of my thesis and they responded with great interest. I started very passionate about the subject and I still am. Active travelling to school makes children not only physical active and thus healthier, it also makes them mobile and independent. When I was growing up, it was out of question to travel to school any other way than cycling, and to this day I still go everywhere by bike. I hope my thesis will help passing on this attitude to future generations of Dutch children.

This thesis, however, would not have been here without the help of a number of people that supported me during the challenge of writing this Master's thesis. First of all, my supervisor Marco Helbich who, with his scribbles, patience and down-to-earth advises, always knew how I could keep my research on track. Furthermore, my colleagues who didn't mind being flexible so I could finish my thesis. A special thanks to Thijs, who had to deal with my spelling mistakes, worries and excitement. No one could have handled it better than you. Also a lot of thanks to my dear friends and families for waiting patiently until I had time and energy to spend with you. From now one, you'll be stuck with me again. Without your inspiration, pep talks, encouragements and the incidental non-thesis related activities this road would have been a lot harder. I can't express how grateful I am to have you all in my life.

Finishing this thesis means completing the master urban geography, a program I followed with great pleasure. It also means the end of my time as a student and a new chapter in my life. Although I don't know where the road will lead me yet, I'm looking forward to start this next phase. I hope it stays filled with mobility, active travelling and other urban geography related subjects.

Hester Hellinga
Utrecht, April 2016

Abstract

Childhood obesity is increasing, partly caused by a lack of physical activity. Active transport to school (ATS) is a way to counteract this, but international ATS rates are dropping and children are becoming backseat children. Little is known about the Dutch ATS situation and the different influences on walking and cycling. In this research the influence of the characteristics of the individual, household, trip, built environment and weather on the transport mode decision of Dutch primary school children is examined. With the use of the national Movement research in the Netherlands 2012 (Onderzoek Verplaatsing in Nederland) 7,464 home-to-school trips were analyzed with binary logistic regression analysis, of which 5,817 children travelled actively (78%). The decision between active and passive transport was mostly influenced by distance, age of the child, the transport modes in a household and the weather. Of all active travelers two-third cycled. This was also mostly decided by distance, and further by the level of urbanization and ethnicity. To increase ATS and cycling rates, solutions are to build drop-off zones further from school, organizing walking and cycling school busses and increasing traffic and cycling skills, with a special focus on non-native children and their parents.

Keywords: active school transport, passive transport, primary school children, cycling, walking, the Netherlands

Table of contents

Table of figures

Table of tables

1. Introduction

1.1 Childhood obesity and overweight

All over the world the prevalence of childhood obesity has increased significantly over the last decades (Schönbeck, et al., 2011) and this has far reaching consequences. There are of course the health problems caused by childhood obesity. Obese children are at more risk to develop diseases as diabetes type 2 (Lobstein, et al., 2004; Schönbeck, et al., 2011; Wabitsch, 2000), asthma (Lobstein, et al., 2004; Reilly, et al., 2003), liver issues (Lobstein, et al., 2004) and sleeping disorders (Lobstein, et al., 2004) than non-obese children. They are also at risk to develop cardiovascular diseases such as high blood pressure (Reilly, et al., 2003; Schönbeck, et al., 2011; Wabitsch, 2000). According to Freedman et al. (1999) 58 percent of obese 5-10 year olds in the U.S. had at least one of five cardiovascular risk factors, and a quarter had two or more (as stated in Reilly, et al., 2003).

Also the psychological health of obese children is at risk, as stigmatization and discrimination of overweight children among peers starts at young ages (Dietz, 1998). Young children already show a preference for thinness, and "overweight children are ranked lowest as those with whom [10 to 11-year old children] would like to be friends" (Dietz, 1998, p. 519), compared with children with other 'handicaps' as crutches or facial disfigurement (Dietz, 1998). This discrimination leads to social isolation, with all kinds of psychological problems as a consequence (Lobstein, et al., 2004; Reilly, et al., 2003; Wabitsch, 2000).

These health issues have also economic consequences, as more hospital treatments are necessary for both physical as psychological issues (Lobstein, et al., 2004). According to the World Health Organization already six percent of all health care expenditure in 2011 in the European Region was caused by overweight and obesity (as stated in Schönbeck, et al., 2011). If you take into consideration that obese children are likely to become obese adolescents and obese adults (Reilly, et al., 2003; Schönbeck, et al., 2011; Van der Horst-Nachtegaal, 2009; Wabitsch, 2000), these costs will only rise in the coming decades.

Obesity develops when there is "a discrepancy between energy intake and energy output" (Wabitsch, 2000, p. s.9). Over the last decades the food supply has changed extremely, with the availability of fast-food and ready-made dinners everywhere, and with a simultaneous increase of sugars, salt and grease in food. This way, the energy intake of children increased (Kennisplatform CROW, 2013).

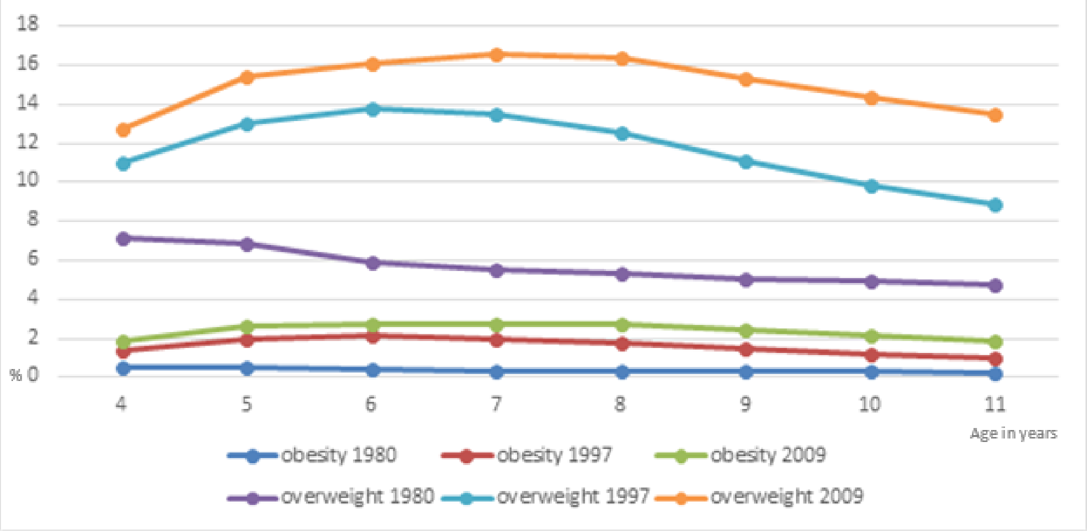
At the same time the amount of physical activity (PA) that children engage in is decreasing (Eyler, et al., 2008). Children increasingly have sedentary lifestyles (Faulkner, et al., 2010; Su, et al., 2013), whereby activities as video games and watching television often substitute the more physically active playing (Ahlport, et al., 2008). There are also less possibilities during school hours to be physically active, as many schools have reduced the physical education programs (Eyler, et al., 2008). Not only does it contribute to the weight of children, it also increases the risks of developing chronic diseases (Hume, et al., 2009; Cooper, et al., 2003; Leslie, et al., 2010).

The increase of children with overweight and obesity is also happening in The Netherlands. The amount of overweight children has increased to fourteen percent (Rijksinstituut voor Volksgezondheid en Milieu, 2014), a two to three fold increase compared to 1980 (Schönbeck, et al., 2011). Two percent of all Dutch children is even classified as obese (Rijksinstituut voor Volksgezondheid en Milieu, 2014), four times as many as in 1980 (Schönbeck, et al., 2011) (see Figure

1-1 for a distribution by age). Besides, not only more children are overweight, but the children who are overweight are also more overweight than before (Lobstein, et al., 2004).

At the same time Dutch children are not physical active enough: not even half of all the children aged four till eleven met the standard recommended minimum amount of physical activity[1] in 2011 (42.3%). This rate has decreased with more than ten percentage points compared to 2006-2007 (53.3%), only five years earlier (TNO, 2013).

Figure 1-1: Overweight and obesity in Dutch children, distributed by age (1980, 1997 & 2009).



Source: Derived from Schönbeck et al. (2011).

1.2 Active transport to school

It is important to counteract the increasing childhood overweight and obesity and get Dutch children more physical active again. One way to promote physical activity among children is to promote active travelling to school. Active transport to school (ATS) can contribute to higher overall PA levels (Bere, et al., 2011; Chillón, et al., 2014; Davison, et al., 2008; Moodie, et al., 2011; Trapp, et al., 2012). ATS consists of walking, cycling or the use of other active transport modes to get to school[2]. This type of physical activity can be engaged into the daily routine (Chillón, et al., 2014; Larouche, et al., 2014; Bere, et al., 2008; Panter, et al., 2008). It is a reliable (Su, et al., 2013) and affordable form of travelling (Shokoohi, et al., 2012; Larouche, et al., 2014) and can reach almost every child, as all children have to go to school and most of them travel to school on a daily basis (Trapp, et al., 2012).

Furthermore, using active transport modes to school also increases the amount of active transport used to travel to other destinations, just like it increases the chances that a child keeps using active transport modes throughout the rest of its life (Faulkner, et al., 2009). Besides, not only ATS itself contributes to physical activity, some studies even found evidence that children commuting actively to school are also more active during the rest of the day than children that commute passively. ATS

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[1] The standard for children means meeting at least one of the following standards:

- De Nederlandse Norm Gezond Bewegen (Dutch standard healthy exercising): At least one hour per day moderate intensive physical activity, and at least twice a week physical activity focusing on improving or maintaining physical fitness.
- Fitnorm (Fit standard): performing heavy intensive activity for a minimum of twenty minutes, for at least three times a week (TNO, 2013).

[2] The focus in this research will be on walking and cycling to school.

has an influence on a better cardio-respiratory fitness (Chillón, et al., 2014; Davison, et al., 2008; Henne, et al., 2014) and is also associated with better weight (Chillón, et al., 2014; Henne, et al., 2014) and thus a way to counteract obesity.

Travelling actively to school can also have an influence on making the overall traffic safer (Panter, et al., 2010). Chauffeuring children to school creates traffic congestion (Wendel & Dannenberg, 2009; McMillan T. E., 2007), but ATS on the other hand causes less car traffic and therefore the traffic volume decreases (Wendel & Dannenberg, 2009), lowering the risk of traffic injuries and increasing road safety (McMillan T. E., 2007). The congestion around schools also causes air pollution (McMillan T. E., 2007), noise pollution (Stewart, 2011) and an increase of greenhouse gases (Larouche, et al., 2014; Wendel & Dannenberg, 2009). Walking and cycling on the other hand are sustainable travel modes (Panter, et al., 2010; Trapp, et al., 2012; Mitra, 2013; Black, et al., 2001), that can decrease our dependency on fossil fuels (Carver, et al., 2013).

Furthermore, children will get familiar with active transport and dealing with traffic (Hume, et al., 2009), get to learn their neighborhood and get experienced in way-finding tasks (Fyhri & Hjorthol, 2009). This way they learn to be independent in traffic, what helps children in making contact with other children and developing emotional bonds (Fyhri, et al., 2011). Children that travel actively also require less household trips than escorted children, as the independent travelers don’t require caregivers that have to make an extra trip to drop off their children (Shokoohi, et al., 2012), that way contributing to traffic congestion, air pollution and busy time schedules. Besides, children will get used to travel actively and become active travelers in adolescents and adulthood, instead of becoming ‘backseat children’ that are accustomed to using the car for every trip (Black, et al., 2001; Carver, et al., 2013). As stated by Roberts (1996, p. 1229), “it may be unrealistic to expect the chauffeured children of today to become the ambulant adults of tomorrow”.

Though the benefits of ATS are clear, international declines in rates of ATS by primary school children are visible (inter alia Davison, Werder, & Lawson, 2008; Timperio, et al., 2006; Mitra & Buliung, 2014). This trend isn’t happening everywhere with the same speed. Differences between continents and countries are visible, and even within countries there are notable differences.

According to the National Household Travel Survey only fifteen percent of all American children aged between five and fifteen used ATS to commute to school in 2001; a substantially decline compared to 1969 when 48 percent commuted actively (McDonald, 2007a). Even children living close to school for U.S. standards (within one mile) did not use ATS much. Most of the active transport has been replaced by private vehicles and the rates went up from seventeen percent in 1969 to 55 percent in 2001, a number that is probably even higher today (McDonald, 2007a). The same thing is happening in Canada, where the use of inactive modes of transportation by 5-17 year olds increased from 51 percent to 62 percent between 2000 and 2010 (Mammen, et al., 2014). In Australia it went from 44 percent in 1971 to 22 percent in 2008 (Buliung, et al., 2009).

Compared to countries as the U.S., Canada and Australia, countries in Europe have a different urban form and, on average, distances are smaller. Furthermore, cycling is more common in some European countries as Denmark, Germany and the Netherlands (Dessing, et al., 2014). Therefore, rates are not as low as outside of Europe, but also here are trends of decline visible (Fyhri & Hjorthol, 2009). In the UK rates declined from 75 percent of the 5-10 year olds using ATS in 1975 to 53 percent in 2002 (Buliung, et al., 2009; McMillan T. E., 2007). In Switzerland it decreased from 79 percent in 1994 to 71 percent in 2005, mainly due to less biking to school (Grize, et al., 2010). In Norway, the number of children who go to school by car increased by more than sixty percent in the 1990s (Fyhri & Hjorthol, 2009) and active transportation decreased with 22 percentage points since the 1970s (Buliung, et al., 2009). In Denmark the rates of cycling declined only slightly, but walking to school rates dropped by forty percent between 1978 and 2000 (Jensen, 2008). Other Scandinavian countries are showing the same trends (Fyhri, et al., 2011).

This trend is also visible in the Netherlands. In 1994 a quarter of the primary school children was driven to school by car; in 2012 this number had increased to thirty percent. The majority of the Dutch children still uses ATS (59%), but these numbers are also declining (Kennisplatform CROW, 2013).

1.3 Relevance

It is important to counteract the increasing obesity and the decreasing ATS rates as soon as possible and get children more physical active again by using ATS. Therefore effective policies should be formulated or existing ones should be revised to stimulate the use of ATS. However, to do so sufficient knowledge about ATS is necessary. This includes not only information about who is using ATS and who isn't, but also about which variables are having the biggest influence on the decision whether to use ATS or to use other transport modes to travel to school.

Already a lot of research has been done about predictors of children's ATS (Davison, et al., 2008), but the vast majority is based on data found outside the Netherlands. Most studies are based on the North-American or Australian context (Panter, et al., 2010; Van Goeverden & De Boer, 2013). These contexts are different from European contexts, and more specifically the Dutch context, with typical urban layouts that are not commonly found in Europe (Panter, et al., 2010) and different school systems. Furthermore, the data is often quite country specific, and although foreign researches can give indicating variables, they can't always be generalized to the Dutch situation (Dessing, et al., 2014). The Netherlands has a unique ATS situation. Because of the cycling culture, cycling is very popular and the ATS rates are higher than in most countries. "The Netherlands has the highest level of bicycle use within the industrialized world" (Martens, 2007, p. 327): 84 percent of the Dutch people owns at least one bike (Fietsersbond, 2015). There is also relatively a lot of infrastructure for bicycles and the distances are small (Dessing, et al., 2014). Furthermore, Dutch primary school children are different than school children in other countries, because they learn how to ride a bike at quite a young age (Fietsersbond, 2015). Most learn around the age of four (J/M Ouders, 2015) and therefore even some of the youngest children will be able to use the bicycle to travel to school. This is different in most countries, where young children only walk or use passive modes to commute to school.

That means specific research is necessary to investigate the Dutch situation. So far, there haven't been a lot of Dutch studies. Most studies focused on adolescents (Bere, et al., 2011; Bere, et al., 2008), who are following secondary education, to where travel behavior will differ (Van Goeverden & De Boer, 2013). Other studies zoomed in on small geographical areas, like a few neighborhoods (De Vries, et al., 2010) or schools (Dessing, et al., 2014). Most studies only had a couple of hundred respondents (Dessing, et al., 2014; De Vries, et al., 2010). This research is different because it has a nationwide focus and therefore can find general results for the country as a whole, but at the same time determine differences between geographical areas or between rural and urban areas (Dessing, et al., 2014). That way policies can be written for the whole country, or, if necessary, adapted to specific geographical regions. This research makes use of a database that contains, among others, information about seven and a half thousand trips to school, made by children in the age four till eleven, the average age for Dutch primary school. The only two studies with nationwide focuses so far, used databases that were way smaller (n = 3,363 (Van Goeverden & De Boer, 2013); n = 5,963 (Aarts, et al., 2013)).

Another important aspect of this study is that it splits ATS into cycling and walking. Most ATS studies don't make the distinction between walking and cycling (Bere, et al., 2011; Panter, et al., 2010), and if they do, the main focus is on walking. This is logical if you look at the fact that walking takes the main part of ATS in most countries. For instance, McDonald (2007a) found that walking accounts for ninety percent of the ATS in the U.S.; a big difference compared to the Netherlands, where cycling accounts for approximately half of all the ATS (Kennisplatform CROW, 2013). The differences between various forms of ATS are also important, because walking and cycling can have different effects on children's health (Wendel & Dannenberg, 2009). A European study found that children cycling to school were almost "five times as likely to be in the top quartile for fitness, than school children that walked or used motorized forms of transport" (Cooper et al., 2006, as cited in Davison, Werder, & Lawson, 2008, pp. 2-3). The distinction is also of importance as factors influencing cycling and walking probably differ (De Vries, et al., 2010; Trapp, et al., 2012) and cycling can cover longer distances (Trapp, et al., 2012), therefore enabling more children to travel actively to school. Also the infrastructure and the resources necessary to perform the different ways of travelling differ (Wendel & Dannenberg, 2009). Therefore, the focus of this research is not only on the differences between active or passive transport modes, but also on making a distinction between walking and cycling to school. A specific selection was made on walkers and cyclers, creating a sample of almost six thousand walking and cycling trips.

1.4 Research questions

The purpose of this research is to find out which factors have the strongest influences on the decision for Dutch primary school children to use ATS. By knowing more about the influencing factors, it becomes possible to write new policies or change existing policies to stimulate ATS and especially cycling among Dutch primary school children. Obesity rates among school children can also be reduced if efficient policies are written. To investigate this, information is necessary about the transport mode, the children and the influencing factors, to find out how these trends can be counteracted.

To examine this, the following research questions are central in this study:

1. To what extent is the decision for active or passive transport to school by Dutch primary school children influenced by individual's, household's and other characteristics?
2. To what extent are differences between walking and cycling to school by Dutch primary school children influenced by individual's, household's and other characteristics?

1.5 Reading guide

This thesis will start with a review of the studies that have been done about ATS in the last decades, to find out what already is known about ATS. This will give an overview of the factors that can have an influence on the transport mode decision. After that, the third chapter will continue with the research design, to explain the choices that are made in this research. The results of the research will follow. The research questions will be answered in the conclusion and recommendations for stimulating ATS will be given.

2. Review of literature

Although the advantages are clear, the ATS rates are dropping. Therefore, over the past decades the research into ATS has taken a flight. The choice for an active or passive transport mode is a complex one and is influenced by a lot of factors. The most influencing factor is home-to-school distance, but also the characteristics of the individual child and his/her family are of importance, just as other trip characteristics, the built environment, the social environment, the season and the weather of that day will influence the decision for the transport mode. This chapter will give an overview of the researches conducted so far and the factors that are of influence whether a child travels actively or passively to school and whether he walks or cycles.

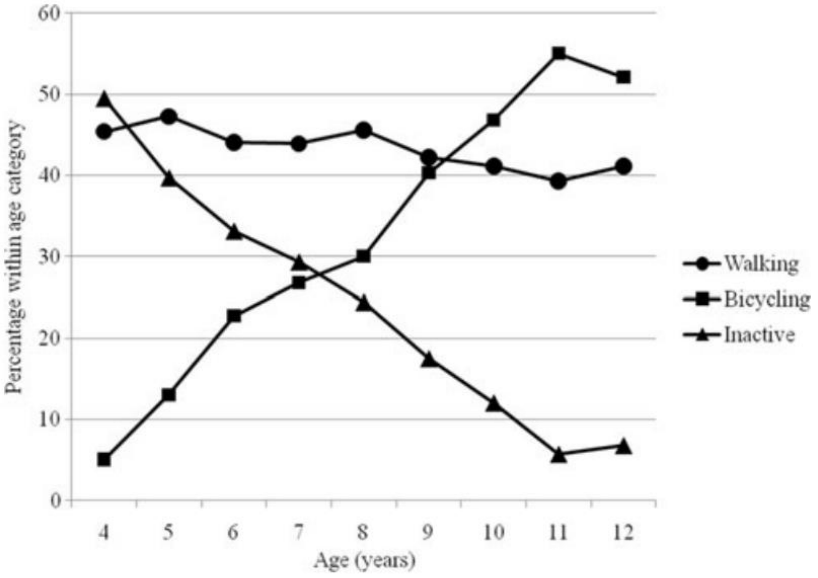
2.1 Individual characteristics and household characteristics

2.1.1 Age

One of the children's characteristics that has been reported to have a strong association with using ATS is the age of the child (Mitra, 2013; McDonald, 2008b; McDonald, 2012; Yarlagadda & Srinivasan, 2008; Van Goeverden & De Boer, 2013; Mitra, et al., 2014a). Older children are more likely to use ATS than younger children (Yarlagadda & Srinivasan, 2008). This is also confirmed by the research of Aarts et al. (2013) among 6,000 Dutch primary school children. In the chart in Figure 2-1 it is visible that ATS rates increase with higher ages: of the four year olds fifty percent travels inactively to primary school, compared to seven percent of the eleven year olds.

The explanation for higher ATS rates among older children can be found in the skills of a child, as they are closely linked to age. The younger a child is, the less the physical, cognitive and psychosocial abilities are yet developed (Stewart, et al., 2012). Therefore walking or cycling the distance to school can be more difficult or tiring than for older children or adults. Besides, they are less capable of coping with traffic in the streets (Mitra, et al., 2014a), making them especially vulnerable in traffic and en route (Stewart, et al., 2012). Parents can therefore decide the child isn't ready to walk or bike to school yet. These physical, cognitive and psychosocial skills develop when a child gets older and gains more experience. Parents' confidence about skills of their child turned out to increase the probability of walking to school in multiple researches in amongst others the review of Mitra (2013), and to cycling to school (Trapp, et al., 2012).

Figure 2-1: Usual mode of transportation to school of 6,000 Dutch primary school children, distributed by age.



Source: Aarts, Mathijssen, van Oers & Schuit, 2013.

However, lacking skills are not only influencing the safety and exhaustion of children, it also influences the decision whether a child can travel independently to school or not. If parents don’t have confidence in their skills, children are not allowed to travel independently (Mitra, 2013). This is of importance as travelling independently for young children almost immediately means travelling actively, as they aren’t able to take the car.

With a higher age, independent mobility increases (Lang, et al., 2011; Yarlagadda & Srinivasan, 2008). What age a child is ‘ready’ to travel independently depends on a number of facets. On the one side the child itself needs to be mature enough. However, even more important is the fact that a parent needs to think the child is mature enough. In the research of Faulkner et al. (2010) Canadian parents often cited age twelve as the age to travel independently to school. Stewart et al. (2012) compare this to the advice given by the U.S. National Center for Safe Routes to School. They state that most children are ready to begin walking alone at age ten (cited in Stewart, Vernez Moudon, & Claybrooke, 2012); two years earlier than most parents allow their child[3]. This indicates an inconsistency. Parents have mentioned various reasons why their children aren´t allowed to travel independently yet, as “not ready” or not responsible enough to cross the street”: all reasons due to lacking skills (Faulkner, et al., 2010) (more on parents’ perceptions in paragraph 2.5).

Although the age to travel independently in the Netherlands, with different urban forms and home-to-school-distances, is probably lower than in the U.S., the same principal accounts to the Netherlands (Dessing, et al., 2014). If a child is not allowed to travel unaccompanied to school, this brings along limitations as schedule constraints (see paragraph 2.1), but also possibilities to use a passive travel mode as a car. Therefore the chance accompanied children travel by car to school increases. This is also confirmed when looking at the fact that, with a higher age, the amount of car use decreases (Fyhri, et al., 2011), as children get more independent. The same was found in a Dutch and Flemish study. Hereby not only the amount of car use decreased, but also the amount of walking. Both were in favor of more cycling to school (Van Goeverden & De Boer, 2013). This probably has to do with the fact that more skills are necessary for cycling than for walking, and, as said before, with higher age come improved skills. Therefore older kids are more often allowed to cycle to school, either accompanied or unaccompanied.

2.1.2 Gender

Another often cited child characteristic is the gender of the child (McDonald, 2008b; McDonald, 2012; Mitra, et al., 2014a). The overall assumption is that boys are more likely to use ATS than girls (Davison, et al., 2008; Stewart, 2011). Significant results were found in Melbourne, Australia, where boys cycled to school significantly more than girls, although no differences were found for walking to school (Timperio, et al., 2006). Another Australian study however cited that girls walked to school more often than boys, but because of the higher cycling rates for boys, the overall ATS was lower for girls than boys (Leslie, et al., 2010). Similar results are cited in studies from the U.S. (McMillan, et al., 2006), New Zealand (Yelavich, et al., 2008), the UK (Panter, et al., 2010), Belgium (Van Goeverden & De Boer, 2013) and Ireland (Nelson, et al., 2008).

Explanations for this pattern are sought in parental fears (Stewart, et al., 2012; Van Goeverden & De Boer, 2013), whereby parents are more worried about girls than about boys. These fears result in a more protective attitude towards girls, less independent mobility (Davison, et al., 2008; McDonald, 2012; Mitra, et al., 2014a), more supervision in the public urban setting and therefore, a more restricted home range (Stewart, 2011; Stewart, et al., 2012).

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[3] Although these differences could be cause by coming from different countries, it doesn’t seem likely as the traffic and school systems are comparable.

However, not all studies found significant correlations between the child's sex and active school travel modes (Black, et al., 2001; Grize, et al., 2010; McDonald, 2012). This was also the case in the Netherlands (Van Goeverden & De Boer, 2013).

2.1.3 Ethnicity

Some studies found significant correlations for the family characteristic ethnicity and active transport, but the results are not always directing the same way (Stewart, et al., 2012). In the U.S., a national study found that minority students are twice as likely to walk to school as white students (McDonald, 2007a), what was confirmed in the review of Pont et al. (2009), that concluded that white ethnics are less likely to walk and the review by Davison et al. (2008), that stated that Hispanic and African American children are more likely to use ATS. McDonald, Deakin and Aalborg (2010) explain this by looking at differences in vehicle access and income, whereby "lower-income minority households may have fewer options for getting their children to school" (McDonald, et al., 2010, p. S67). Fewer options mean no choice between transportation options, resulting in ATS because they have to.

However, Chillón et al. (2014) came to the conclusion that, since Davison's review, other studies have found contradicting results, whereby ethnicity is associated with less ATS. This was also the case in England, where black students had more chance of being driven to school by car compared to white ethnics (Sirard & Slater, 2008). McDonald, Deakin and Aalborg (2010) also give an explanation for this phenomenon, stating that white students are "more likely to be 'choice walkers'"; making a conscious choice for ATS because of the values in their social environment (McDonald, et al., 2010, p. S67) (more about social environment in paragraph 2.5).

Although no research among primary school children has been done so far, this seems to be the case among Dutch adolescents. However, they are not 'choice walkers', but 'choice cyclers'. Both Bere et al. (2011) and De Bruin et al. (2005) found in their researches among Dutch adolescents that native Dutch students were more likely to cycle than non-native students. They ascribe it to the Dutch cycling culture, since cycling is very common in the Netherlands (De Bruijn, et al., 2005). This is also reflected by the amount of bicycles the adolescents stated to have at home: 83 percent of the native Dutch reported to have at least one bicycle, compared to 67 of the Western adolescents and 47 percent of the non-Western adolescents (Bere, et al., 2008). According to Olde Kalter (2008), social-cultural characteristics can explain these differences in mobility behavior. She found out that there is no cycling culture among the non-natives as there is among the natives. A lot of non-natives don't want to be associated with cycling, as the bicycle has a low status. This in contrast to the status of the car, that is used to show you have achieved something, especially among men. Besides, a lot of non-native adults, especially women, miss cycling skills and think cycling is unsafe, dangerous and not suited for bad weather situations. Therefore, they make more use of public transport, or they walk (Olde Kalter, 2008). To what extent these socio-cultural characteristics influence the active school travel of non-native school children is not known yet.

2.1.4 Household composition

The household composition can have an influence on which travel mode will be chosen to commute to school with, as it brings along options for ATS as well as limitations. Some studies found positive associations whereby a child is more likely to use active transport to school if the child has siblings, than if the child is an only child (McMillan T. E., 2007; Copperman & Bhat, 2007; Mitra & Buliung, 2014b). A possible explanation can be that siblings, especially older siblings, act as a person to accompany the child to school if they attend the same school or if the schools are on the same route (Stewart, et al., 2012; Mitra & Buliung, 2014b; Ahlport, et al., 2008). As most siblings won't be able to use the car or other motorized vehicles to bring the child to school cause they are too young to drive, this escort will most likely be an active one. In a nationwide U.S. study McDonald (2008b) found that siblings accounted for an eight of all escorted trips to schools.

Having siblings can also have another influence on the travel mode, cause the chance will be higher that at least one of them is not capable or allowed to travel independently or with just a sibling, and therefore all siblings will get transported by car (Stewart, et al., 2012). ATS also gets challenged if different children are going to different schools and therefore multiple school trips have to be made (Ahlport, et al., 2008; Faulkner, et al., 2010). Furthermore, although no significant outcomes in this direction have been found so far, an American study found that children are more likely to be driven to school by car in bigger households, instead of riding the school bus (Yarlagadda & Srinivasan, 2008). This doesn't have an immediate impact on choosing active travel modes, but it reduces the chances for children to travel independently, and therefore the chance to use ATS.

Also the marital status of the parents has been examined, but with several outcomes. In the review by Pont et al. (2009) three studies were noted whereby children in single parent families have lower rates of overall active transportation than children with two parents in the household. With only one parent available, there are more time constraints and therefore it could be that there is no time left to escort the child to school in an active way. It can be quicker to drive them to school by car or, as there one study is American and one is Australian, let the child take the school bus. However, another reviewed American study found an outcome in the other direction, with children in single parent families more likely to travel actively (Pont, et al., 2009), an outcome also found by Copperman & Bhat (2007). A possible explanation here fore can also be found in time constraints, as a single parent may not be able to escort the child, reducing the possible travel modes, leaving only active travel modes for the child to use.

2.1.5 Economic environment

Another factor of influence is what Pont et al. (2009) call the 'economic environment'. This consists of the social economic status, the work situation of the parents, the household income and the ownership of transport modes (Pont, et al., 2009). Stewart et al (2012) added education of parents to this list.

Car ownership is the most frequently cited factor of the economic environment and most often negatively associated with ATS (Pont, et al., 2009). This seems logical, as it is impossible to drive a child to school without a car. Black et al. (2001) point out that it is not only necessary to own a car, it also has to be available at time of travel and the parent that brings the child should also have a driving license. In their research among four thousand parents of elementary school children in England, only fourteen percent didn't own a car, but 21 percent didn't had a driving license and even 24 percent had no car available to take the child to school (Black, et al., 2001). This also accounts for cycling to school: the household has to have bicycles available to give the child the possibility to cycle to school.

The review by Pont et al. (2009) concludes that convincing negative associations were found between increasing car ownership and ATS as nine papers found significant lower ATS-rates if the household owns more cars. The other seven studies didn't found significant results (Pont, et al., 2009). This was similar in other reviews (Mitra, 2013; Sirard & Slater, 2008; Ewing, et al., 2004). In a study among primary students in New Zealand it turned out that households without a car were even ten times as likely to walk compared to households that had at least as many cars as adults (Yelavich, et al., 2008). As bicycle ownership is positively associated with using ATS (Copperman & Bhat, 2007) and the Dutch have a high percentage of bicycle ownership (Fietsersbond, 2015) it is likely that most Dutch children will switch to cycling instead of walking if no car is available.

Closely connected to transport mode ownership is household income, as the household income decides for a big part the options a household has for paying for the transport modes. However, Ewing et al. (2004) emphasize that a higher income also has an effect on travel mode, independent of the availability of cars. Pont et al. (2009) also found a convincing relationship between increasing household income and lower ATS rates, as all six reviewed studies found a significant negative association. This is confirmed by the review of Stewart et al. (2012) and a nationwide U.S. research whereby a “ten percent increase in household income led to a 2.6 percent decline in walking and a two percent increase in being driven to school” (McDonald, 2008a). A possible explanation, besides the availability of transport modes, could be that households with higher incomes have more schedule constraints, and therefore less time available to accompany the child to school in an active way (Stewart, et al., 2012).

This is depending on the employment status of the child’s parents, an factor that also can be of importance in the decision of an transport mode to school (Davison, et al., 2008; Stewart, et al., 2012). If both parents are working, children are less likely to use ATS (Davison, et al., 2008), possibly because children will be dropped off at school on the way to work (Stewart, 2011). This is supported by McDonald (2008a), who found a relation between parents travelling to work in the morning and less walking to school. This makes the transport mode parents use to commute to work a contributing factor to the decision of transport mode.

The influence of parent employment on ATS has become bigger over the last decades, as the rates of women working outside of the home have increased rapidly (Moodie, et al., 2011; Trapp, et al., 2012; Fyhri, et al., 2011). Parent education showed in multiple studies associations in the same direction, with higher education of the parents indicating lower ATS rates (Stewart, et al., 2012).

The results about parent employment and education are consistent with associations between ATS and the Social Economic Status (SES), whereby a higher SES results in less ATS (Stewart, 2011; Davison, et al., 2008). However, in the study by Faulkner et al. (2010) parents living in a higher-SES neighborhood did report that ATS was part of their healthy lifestyle, contrary to parents in lower-SES neighborhoods that had less time to accompany the child on the walk to school. This seems consistent with the findings of a Dutch study among six thousand primary school children (Aarts, et al., 2013). They found children living in lower SES neighborhoods were less likely to travel actively to school. They also didn’t find significant results between working (nearly) full time and more car driving to school (Aarts, et al., 2013), contradicting the results of other studies. The same accounts for parental education. It could be possible that this association is different in the Netherlands, as travelling actively is part of the Dutch culture and the distances are smaller (Van Goeverden & De Boer, 2013).

2.2 Trip characteristics

2.2.1 Distance

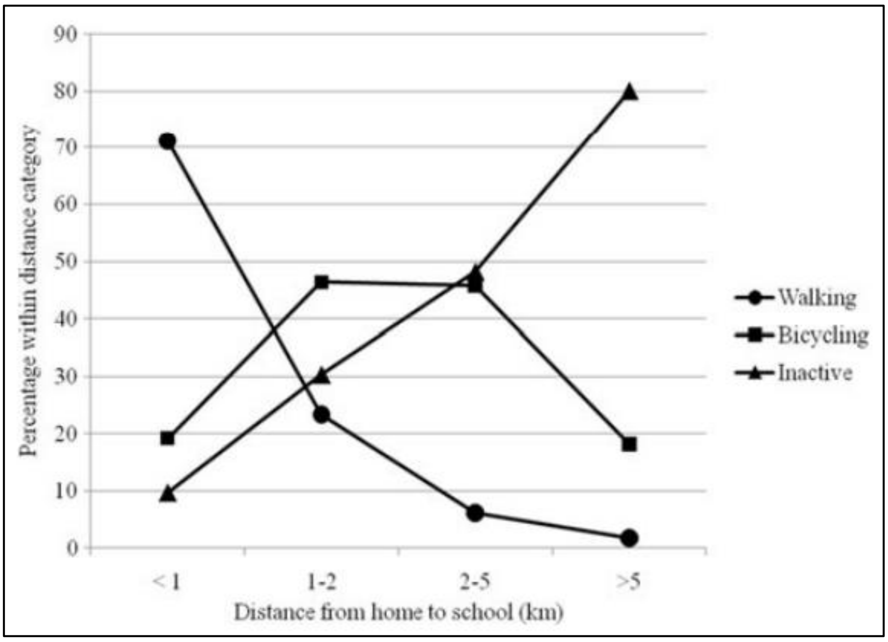
The barrier that is most often cited and the factor with the clearest and biggest significant correlation with ATS is distance, according to amongst others the reviews by Davison et al. (2008), Mitra (2013), Stewart et al. (2012), Panter et al. (2008), Stewart (2011), Wong et al. (2011) and Pont et al. (2009). With increasing distance, children are less likely to walk or cycle to school. Children are more likely to travel independently to school if the distance is short (Mitra, 2013). If distance increases, the parents will have to accompany the child, claiming time of the parent. At the same time, the travel time increases with bigger distances, claiming even more time of the parents.

Although time is not the only influencing factor on the mode parents choose to accompany their child, as it also depends on the built environment (see paragraph 2.3), features of the weather (see paragraph 2.4) and their values (see paragraph 2.5), it is an important factor. Faulkner et al. (2010) even found that parents often choose the mode of the shortest duration. In the research among Norwegian 6-12 year olds, fifteen percent of the parents stated that driving children to school by car saves time for the parents (Fyhri, et al., 2011).

As the social and natural environment differ per person and per region or country, the average threshold distance to switch from walking or cycling to using passive transport modes also differs. 5-6 year old children in Australia were five times more likely to use ATS at least once a week, when they lived within 800 meter of their school, compared to children living further away (Timperio, et al., 2006). As older children are more allowed to travel independently, the effect was even bigger for the 10-12 year olds, being 10 times more likely to use ATS (Timperio, et al., 2006). McMillan (2007) found comparing results in the U.S. where children living within one mile of school were three times more likely to use ATS as children living further away. McDonald found that a one-minute increase in walking to school decreased the chance to walk to school with 0.2 percent (McDonald, 2008a), though this doesn’t have to apply to cycling in the same way, as Schlossberg et al. (2006) stated that the effect of distance has more influence on walking than on cycling. Also in the Netherlands increasing distance leads to lower ATS-rates, with different influences on walking and cycling. In the research of Aarts et al. (2013) among 6,000 Dutch primary school children distance turned out to be of great importance. Of all children living less than one kilometer from school ninety percent was usually travelling in an active way, but this number saw a rapid decrease with increasing distance (see Figure 2-2). Of the children living between one and two kilometers from school already thirty percent travelled inactively, going up to eighty percent for children travelling five or more kilometers. Especially walking decreased by increasing distance. Cycling on the other hand saw an increase if the distance went from less than one, to between one and two kilometer, and decreased again after more than five kilometers.

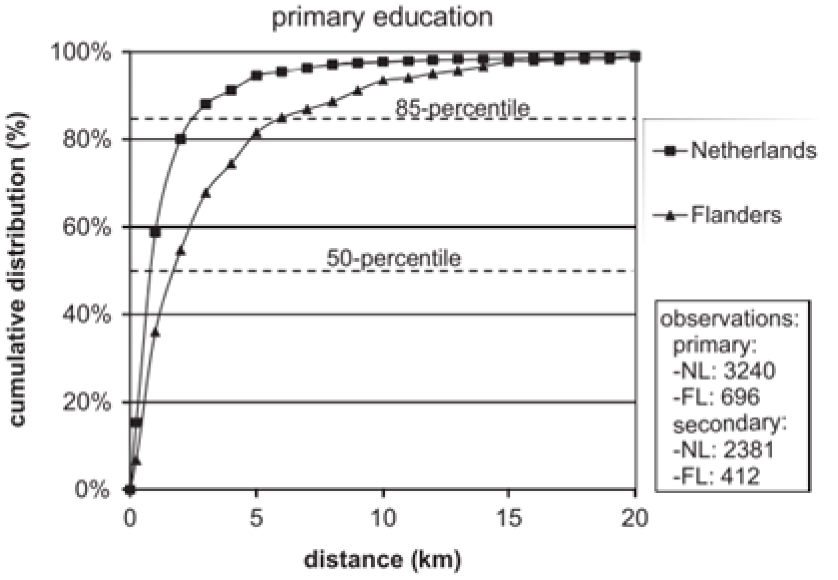
The distance between house and school is determined by the location of the residence and the location of the school (Wong, et al., 2011). Both are outcomes of personal preferences and characteristics and the options a household has (Ahlport, et al., 2008). In the Netherlands, primary schools are widespread and home-to-school distances are generally short (Van Goeverden & De Boer, 2013), but schools aren’t only chosen for their distance. According to Kennisplatform CROW 89.7 percent of all Dutch primary school children lives within walking

Figure 2-2: Usual mode of transportation to school from home to school, among 6,000 Dutch primary school children, by distance.



Source: Aarts, Mathijssen, van Oers & Schuit, 2013.

Figure 2-3: Cumulative frequency distributions of home-to-school distances for Dutch and Flemish pupils in the primary school age.



Source: Van Goeverden & de Boer, 2013.

distance (1 km), 97 percent lives within cycling distance (2 km) of a primary school (Kennisplatform CROW, 2013). However, this doesn't match with the figures of Van Goeverden & De Boer (2013), based on the Dutch national travel survey, whereby respondents reported the distances themselves. They found that only sixteen percent lives within a one kilometer zone around their school, and sixty percent lives within two kilometers (see Figure 2-3), contradicting the figures provided by the Kennisplatform CROW. Though it could be possible that one or both researches are not representative of the whole Dutch population, it could also be that a big part of Dutch primary school children doesn't visit the closest school, but visit a school further away because of special preferences.

The factor distance however is not sufficient to explain whether children travel actively or passively to school (Panter, et al., 2008). Only 47 percent of the reduction of ATS between 1969 and 2001 could be explained by greater distances between home and school (McDonald N., 2007b). This is logical, as some children simply don't have other options than to walk or cycle to school, even over long distances (Stewart, et al., 2012). It's also a good thing that distance is not the only factor, as home-to-school-distances have been increasing over the last decades in most Western countries (Great Britain and Norway (Fyhri, et al., 2011)), as it has in the Netherlands. In 2006 the average distance over the road to the closest primary school was 0.6 kilometer in the Netherlands, but this increased to 0.7 kilometer in 2013 (CBS Statline, 2015a). This is caused by decreasing birth rates, leading to less primary school children. Less school children means schools have to centralize, causing lower numbers of primary schools (Rijksoverheid, 2015a). If distance was the only explanatory factor, increasing home-to-school distances would mean an immediate decrease of ATS.

2.2.2 Other trip characteristics

Besides distance, other characteristics of the trip are also of influence. The total travel time, although closely linked to distance, can be an important and independent factor. The total travel time can differ per person or transport mode, for instance because a child of four won't walk as fast as an eleven-year old, therefore increasing the total travel time. ATS can be also facilitated because of longer travel time if, for instance, it takes too much time to find a parking spot near the school or that shortcuts available for cycling or walking can't be taken by cars (Stewart, 2011). Also the time of departure is of importance, especially in winter, when it is still dark in the morning. This darkness has a negative impact on active travel (Hume, et al., 2009).

Another often cited factor is the amount and weight of stuff children have to bring to school (Schlossberg, et al., 2006; Fyhri, et al., 2011; Pont, et al., 2009). Because it can be hard for children to take heavy or big bags with them while walking or cycling, they are driven to school by car.

Also characteristics of the destination, the school, are of influence. As already mentioned in paragraph 2.2.1, the type of school is of importance, as special types schools are not as widespread as public schools are (Pont, et al., 2009; Davison, et al., 2008). Also the policies a school applies can both act as facilitators as well as barriers (Stewart, et al., 2012). The difficulties people perceive parking near schools can acts as facilitator for ATS (Stewart, 2011; Ahlport, et al., 2008), just like offering, for instance, a walking school bus program (Mitra, 2013). Barriers could be a limited storage for jackets (Ahlport, et al., 2008), bike helmets (Stewart, et al., 2012) and bicycle racks (Mitra, 2013). This last one is a common thing in the Netherlands, where children are not always allowed to bike to school if they live within a certain distance, because there are not enough places to stall the bike (Nationale onderwijsgids, 2013). Start times of schools can also act as barriers, as early start times could mean travelling in the dark in some seasons (see paragraph 2.4) (Sirard & Slater, 2008; Wong, et al., 2011; Stewart, et al., 2012). Schools in the research of Ahlport et al. (2008) had rules about grade/age minimums for walking and cycling and against riding push scooters, acting as barriers for active school travelling.

A last trip characteristic is one that doesn't has to do specifically with the home-to-school trip, but to other trips later that day. Activities performed before or after the trip (by the child, siblings or by the accompanying parent) are of importance and can influence the decision whether children commute to school actively (Trapp, et al., 2012). Especially when taking into consideration that children nowadays have more organized after-school activities than a few decades ago, and that these can be far away to reach, the car can seem an easy solution (Fyhri, et al., 2011). As siblings also have more organized activities and it is more common for both parents to be working, more constraints are put on the family schedule, leaving less time to escort children in an active way to school and other activities (Mitra & Buliung, 2014b).

2.3 Built environment

A third set of characteristics that are of influence on the choice of a transport mode are the built environmental characteristics. Panter et al. (2008) have indicated that three environmental components should be considered: the built environment around the home, around the destination (the school) and en route. However, the environment around the home is believed to be of biggest importance (Stone, et al., 2012), as a child and his/her parents come into daily contact with it (De Vries, et al., 2010). These built environmental characteristics decide what the route from home to school is like and whether a neighborhood is walkable (and cycle-able) or not. Children are more likely to use ATS in a more walkable neighborhood: results found in both the U.S. (Ewing, et al., 2004) and the UK (Panter, et al., 2010). Walkability is "an aggregate of measures of residential density, retail floor area ratio, intersection density and land use mix" (Stewart, et al., 2012, p. 243). Other built environmental characteristics that have been found or hypothesized to be of influence are the level of urbanization, the infrastructure, the aesthetics and the traffic in a neighborhood.

Important to keep in mind is that the actual environment is of importance, but the perception about the environment is of even bigger importance. Mitra et al. (2014a) found that parents who had been living in the same home for a longer time, allowed their children more independent travel. Besides, not all studies have used the same measurements of the built environment and the route that was travelled (Mitra & Buliung, 2014b). Some have used GIS to measure the route, others asked the respondents or their parents to fill it in themselves. This makes results sometimes hard to compare. Furthermore, as a lot of studies have been done in North-America or Australia, it is not always possible to generalize the results to the Dutch context as the Netherlands have a different and unique land-use pattern, that is in a lot of places designed for active travelers (Aarts, et al., 2013; De

Vries, et al., 2010).

2.3.1 Residential density, land use mix and urbanization

A lot of studies have focused on residential density. There are probably a lot of children in neighborhoods with dense populations, of who at least a part lives within easy walking or cycling distance of schools (Stewart, 2011). With more children there are likely more schools and the chance increases that there is a school close enough for ATS to be used (Stone, et al., 2012; Van Goeverden & De Boer, 2013; Davison, et al., 2008). Besides, there are other children travelling to school so children can travel together and thus independent from their parents at a younger age. However, mixed results have been found. Positive associations have been found in studies reviewed reviews by Stewart (2011) and Mitra & Buliung (2014b), but the last also reviewed studies with no associations or negative associations. A decrease of the likelihood of cycling, and of walking to a lesser extent, was also found by Broberg & Sarjala (2015) in their research among eleven and fourteen year olds in Helsinki, Finland. However, these children most often switched to public transport instead of to car driving, something that is also better arranged in more dense areas (Van Goeverden & De Boer, 2013). Non-significant results were found in Toronto (Stone, et al., 2012), but also in the Netherlands (De Vries, et al., 2010).

Mixed results have also been found for land use mix (see reviews by Mitra & Buliung (2014b), Stone et al. (2012), Stewart (2011)), something that might be explained by the fact that it is difficult to interpret. An association is often found in studies about adults (Stone, et al., 2012), as a high land use mix generally means a high amount of potential destinations in the proximity of the home. However, the relationship for children is different, as only home and school are really necessary for the home-to-school trip (Stewart, 2011). It is possible though that children who are living in a neighborhood with a high land use are used to walking to different destinations and they and their parents are therefore more comfortable with using ATS. Another explanation can be that the amount of ‘eyes on the street’ is higher in an area with a high land use mix, or that parents can travel to their work in the same area and therefore trip chains are possible (Wong, et al., 2011). Mitra (2013) found that a neighborhood with a mix of residential blocks and small retail shops had the best combination to use ATS. Larger retail centers or employment districts however could lower ATS rates, though in the Netherlands, schools are not often placed in these kind of settings. The same accounts for the urban form and land-use patterns in the Netherlands that are quite different from other countries, especially from the countries outside of Europe. The results are therefore not always easy to generalize to the Dutch context (De Vries, et al., 2010).

Both a high residential density as a high land use mix are often found in urban areas. The level of urbanization is also found to be of influence on walking and cycling to school, whereby a higher level of urbanization means an increase in ATS (see reviews by Stewart (2011), Mitra (2013), Davison et al. (2008)). This was also the case in the research by Aarts et al. (2013) among 6,000 primary school children. They found that living in a city center type of neighborhood had a positive association with ATS.

2.3.2 Infrastructure and traffic

Another reason why less active transport is done in more rural areas, is because there is less infrastructure for walking or cycling (Davison, et al., 2008). The infrastructure for walkers and cyclists influences the transport mode (Chillón, et al., 2014; Eyler, et al., 2008; Henne, et al., 2014; Moodie, et al., 2011; Rothman, et al., 2014).

All different kind of infrastructure facilities together make a safe or unsafe neighborhood for a child to travel in to school. Overall, the presence of walk and bike paths, preferably of good quality, increases the chance of using ATS (Aarts, et al., 2013; De Vries, et al., 2010; Mitra, 2013). Further, diversity of routes (Aarts, et al., 2013) that have a good pedestrian/cycling connection with low traffic (Mitra, 2013) and a minimum of road crossings (Bringolf-Isler, et al., 2008) increase the use of ATS, as this gives children the possibility to travel on quiet streets to school. Direct routes (Schlossberg, et al., 2006; Stewart, 2011), major roads crossings (Mitra, 2013), steep inclines (De Vries, et al., 2010), busy traffic (Mitra, 2013) and barriers as railways or major roads (Stewart, et al., 2012) decrease the amount of ATS.

2.3.3 Green and recreational areas in neighborhood

Some researchers have suggested that also the aesthetics of the neighborhood are of influence, as they can increase the attractiveness of travelling actively in a neighborhood (Wong, et al., 2011). “The presence of open space/parks, tree-lined streets, smaller neighbourhood blocks and pedestrian-oriented buildings/houses, for example, may enhance the enjoyment of walking/cycling, or make it comfortable to navigate the built environment between the home and school locations” (Mitra, 2013, p. 35). A few studies have found associations between neighborhood aesthetics and active travelling (De Vries, et al., 2010) and in the review by Pont et al. (2009), five out of seven researches found higher ATS rates in areas where parks play areas and recreational facilities were present. However, the review by Mitra (2013) found only one out of five associations between ATS and trees along the road positive, the rest showed no association. Also in Helsinki it turned out that the proportion of forests was not associated with ATS and that a higher amount of recreation areas even meant lower rates of walking and cycling (Broberg & Sarjala, 2015). A similar result was found in the Netherlands, whereby living in a green type of neighborhood had a negative association with both walking and cycling (Aarts, et al., 2013).

2.4 Weather and seasonal characteristics

2.4.1 Weather

Weather is likely to have an influence on the transport mode, as it is often stated that it can act as a main barrier (Chillón, et al., 2014; Mitra & Faulkner, 2012; Lorenc, et al., 2008), for instance in (Faulkner, et al., 2010; Mitra, 2013; Ahlport, et al., 2008; Schlossberg, et al., 2006; Eyler, et al., 2008; Chillón, et al., 2014; Oliver, et al., 2014; Bringolf-Isler, et al., 2008; Panter, et al., 2008). Weather is both stated as a possible positive influencer on ATS as a negative influencer, depending on the actual weather, but also on the perspective. As stated by Stewart et al., (2012, p. 242): “Travel mode habits were sometimes interrupted by weather. Children who usually walked were sometimes driven in bad weather, while children who regularly drove sometimes walked in pleasant weather.” A mother in the research of Faulkner et al. (2010) said she rather walks the children to school if there is snow, as it is more work clearing out the driveway than walking through the snow to school.

Though it influences the ATS decision in multiple ways, so not a lot of research has been conducted to examine the influence of weather and seasonality so far (Mitra & Faulkner, 2012; Van Goeverden & De Boer, 2013). This might be caused by the fact that these are non-modifiable factors (Børrestad, et al., 2011; Mitra & Faulkner, 2012). Therefore, it is not possible to change them to settings that can have a positive influence on active commuting to school (Davison, et al., 2008). However, if weather turns out to have a big influence on the use of ATS, it can be used to explain why other policies or adaptations are not working. And though it is not possible to change the weather, it is possible to adapt to the weather (Oliver, et al., 2014; Mitra & Faulkner, 2012). Because of the lack of research, the influence of the weather differences on ATS remains unclear (Robertson-Wilson, et al., 2008; Oliver, et al., 2014).

The researches that were conducted often didn't find a significant association. Robertson-Wilson et al. (2008) found that in Ontario, Canada, indicators of weather didn't predict ATS; the same results that were found by Mitra & Faulkner (2012) in the city of Toronto. A similar trend is visible in the U.S., where different weather conditions had little influence on the rates of ATS (Stewart, et al., 2012). Sirard et al. (2005) also didn't find a significant influence of weather conditions with their research in a southeastern city in the U.S.. The same was visible in four New Zealand cities, where no relationship between daily weather patterns and ATS was found (Oliver, et al., 2014).

However, most authors still named a possible influence of weather and blamed the limitations of their research for not finding an association the influence weather has on ATS. One of the mentioned reasons is about the way the weather was measured. Robertson-Wilson et al. stated that the used weather data wasn't always accurate, as the weather stations were up to 25 kilometers away (Robertson-Wilson, et al., 2008); a reason also put forward by Oliver et al. (2014). Mitra & Faulkner (2012) gave as explanation that their weather variables were based on weekly averages, instead of on the weather on the day of the trip, sorting out the possibility to examine the influence of extreme weather situations. This was also an outcome of the review by Lorenc et al. (2008), whereby three studies were reviewed that examined weather as factor. Only one study found significant outcomes, being also the only study that examined weather conditions at the time of travel (Mitra, 2013). As extreme weather can create circumstances whereby walking or cycling becomes dangerous or difficult, it can change a decision for a travel mode on the short term (Zwerts, et al., 2010; Mitra & Faulkner, 2012). Sirard et al. (2005) gave a similar explanation for not finding any differences, as their research was conducted during the milder months of the year, without a lot of fluctuations. A bigger role is expected for colder climates (Sirard, et al., 2005).

Other reasons why the weather only has a little influence can be found in the fact that people are creatures of habit, who rather "stick to habitual patterns of travel than respond to variable factors such as the weather" (Black, et al., 2001, p. 1129). Because the decision of the travel mode is a daily one, it will be a routine and not one that is evaluated every time the trip will be made, therefore choosing the usual transport mode unless there are extreme conditions (Mitra & Faulkner, 2012). Furthermore, it should be taken in account again that perceptions of the weather may be of bigger influence than the actual weather (Robertson-Wilson, et al., 2008; Oliver, et al., 2014). Therefore you would not only need to use objective weather data from weather stations, but also the perceptions of parents and children. Besides, not only data about the weather of time of travel is necessary, but also of the rest of the day as it also influences travel plans for later periods (Oliver, et al., 2014). The fact that weather can influence ATS both ways around, as well stimulating as limiting, can also contribute to the fact that the influence of weather on ATS is unclear.

A Dutch study among adults did find significant outcomes, whereby temperature had the most influence and the bicycle turned out to be the most sensitive mode to weather conditions (Sabir, 2011). This is in line with a German study among secondary school students, that found that weather didn't influence walking much, as it is used mostly for short distances, but it did influence cycling. The association was the strongest for students that were able to switch from bike to car (and as some are old enough to drive themselves, there are more possibilities for secondary school students than for primary school students). The weather had a smaller influence on the transport mode of students that had to switch from bike to public transport (Müller, et al., 2008).

2.4.2 Seasonal differences

Closely connected to weather is the influence of the different seasons, as the weather is for a large part dependent on what season it is. Seasonality also can have an influence on the decision for a transport mode, as it not only influences the weather, but also the amount of daylight (Hume, et al., 2009). This is an important aspect (Ahlport, et al., 2008), as traffic and stranger danger is often assumed to be safer in daylight than in darkness (Stewart, et al., 2012; Dessing, et al., 2014), therefore allowing children more independent travel and increasing the chance children will use ATS. A lot of countries have responded to the limited daylight in winter by changing the clocks (daylight savings) (Goodman, et al., 2012).

Though seasonality also hasn't got a lot of attention so far (Børrestad, et al., 2011), there are some studies focusing on seasonality. Børrestad et al. (2011) examined the associations between seasonality and ATS of 10-12 year olds in Norway, a country where the seasons differ highly from one another in terms of temperature, precipitations and daylight. They found that ATS varies largely between the seasons, also mostly the cycling. Where in fall and spring more than half of all students used the bike to travel to school, in the winter this was only three percent. However, most children switched from cycling to walking to school and therefore were still using ATS (Børrestad, et al., 2011). Similar results were found for 6-12 year olds Norwegian children, although the seasonal differences were a bit smaller. Also here, the children mostly shifted from cycling to walking in winter months (Fyhri & Hjorthol, 2009). Lower ATS-rates were also found by Mammen et al. (2014) in their research among 106 Canadian schools. They saw that the schools that collected the data in winter had a lower average of ATS than the schools that collected during other seasons (Mammen, et al., 2014). The differences were especially high for travelling to school in the morning, higher than the travelling from school. This could be explained by the differences in daylight, whereby it's still dark in the morning before school, but there is daylight after school.

Another Canadian research however didn't found an association for the different seasons. The research among elementary school children took place in Southern Ontario, Canada, a place that also knows large variations in season, with high temperature differences and long days in the summer, and short days in winter (Mitra & Buliung, 2014b). A possible explanation for this could be that cycling only contributes for a very small amount to the school travelling, and most children already walk to school or are being driven by car of bus.

However, the differences between the seasons are not varying everywhere in the same way, so it won't have the same influence in every place. What the influences of the seasons in the Netherlands will be, still has to be investigated (Van Goeverden & De Boer, 2013).

2.5 Attitudes, values and concerns

According to some researchers the most important factors for influencing the decision for the transport mode to school are the attitudes, beliefs and the social environment. Although the values and opinions of the child itself are also of importance, the ones of the parent are more important (Sirard & Slater, 2008). They decide most often what transport mode the child will use to travel to school (Mitra, 2013) are the ultimate decision makers (Faulkner, et al., 2009): "the gatekeepers to the ATS behaviors of their child" (Oliver et al., 2014), especially for the children in primary school.

2.5.1 Safety concerns

A lot of parents are concerned about the safety of their children, also while travelling to school. According to Ahlport et al. (2008) this has been a long known phenomenon. They report about multiple researches from the seventies and eighties, that already reviewed the effect of safety concerns on independent travelling for children and found significant associations. These safety concerns influence whether a child can travel independently, and therefore use more ATS than children travelling dependently. According to Henne et al. (2014, p. 645): "Generally, parents who are more concerned about the safety of their neighborhood have children who engage in less physical activity, including active transport".

A lot of parents are concerned about the danger traffic causes for children (Ahlport, et al., 2008). The risk that a child gets into an accident while travelling to school is always present and therefore parental fear of traffic is often mentioned. Safety often correlates with ATS (see reviews (Stewart, et al., 2012; Trapp, et al., 2012)). Safety issues can include dangerous street crossings (Chillón, et al., 2014; Napier, et al., 2011), poor walking and cycling facilities (Trapp, et al., 2012; Lorenc, et al., 2008), for example missing or incomplete sidewalks or bicycle paths (Chillón, et al., 2014; Napier, et al., 2011) or heavy traffic (Napier, et al., 2011; Trapp, et al., 2012; Lorenc, et al., 2008). However, also parents themselves contribute to traffic unsafety. As mentioned by Carver et al. (2013, p. 75), it is "ironic that 45 percent of parents who drove their child home from school by car did so because of concerns about traffic", thereby contributing to the congestion around the school area. In their research among primary school children´s parents in New Zealand Lang et al. (2011) heard similar statements, whereby parents claimed to be forced to drive their kids to school, because of other parents dangerous behavior. This statement is also often heard in the Netherlands (Kennisplatform CROW, 2013), although the traffic situation in the Netherlands differs from most countries, as the road safety is better guaranteed because of the special infrastructure for cyclists and because road users are more used to walkers and cyclers (Dessing, et al., 2014). However, also in the Netherlands are the concerns about traffic danger influencing the use of ATS. These concerns are the biggest when the child is young and reduce when the child ages (Mitra, et al., 2014a). Children are still developing physical cognitive and psychosocial abilities: skills they need to cope with traffic (Stewart, et al., 2012). Therefore, they are especially vulnerable to traffic, and most parents don't put trust in the road safety skills of their child. Confidence about road safety skills of the child turned out to increase the probability of walking to school in multiple researches (amongst others the review of Mitra (2013)), and to cycling to school (Trapp, et al., 2012). In the research of Faulkner et al. (2010), parents mentioned multiple reasons why their child wasn't allowed to travel independently, like "not ready" or not responsible enough to cross the street": all reasons due to lacking skills. When a child is 'ready' depends on a number of facets. On the one side the child itself needs to be mature enough, but maybe even more important is the fact that a parent need to think the child is mature enough. In the research of Faulkner et al. (2010) Canadian parents often cited age 12 as the age to travel independently to school. Stewart et al. (2012) compared this to the advice given by the U.S. National Center for Safe Routes to School and found an inconsistent pattern. They state that most children are ready to begin walking alone at age 10; two years earlier than most parents allow their child[4]. The age is probably lower in the Netherlands with the different ATS-situation and school pattern, but the same idea applies to Dutch children: they need to be ready according to their parents. To accelerate this, investments should be made in the skills of children (Hume, et al., 2009; Trapp, et al., 2012), such as teaching safe crossing practices, appropriate and safe routes and areas of high danger (Timperio, et al., 2006). However, as a big part of the concerns aren't based on the actual situation but on the perceptions of parents (and for a smaller part of children), there should also be attention for the perceptions about the children's' skills (Stewart, et al., 2012; Trapp, et al., 2012). That is also visible from the number of road deaths among children in the Netherlands that are steadily decreasing over time. In 1987 120 children died because of a traffic accident. This figure already decreased to 35 in 2005, demonstrating that the traffic safety has improved. The relative improvement of safety is actually even bigger, as the population also has increased over the years. The same line is visible for non-fatal accidents (Stichting Wetenschappelijk Onderzoek Verkeersveiligheid, 2009).

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[4] Although these differences could be caused by coming from different countries, it doesn't seem likely cause the traffic and school systems are comparable.

Another often mentioned concern is stranger danger, that comes in a lot of facets. On the one hand parents mentioned homeless people, gangs or getting bullied. On the other hand parents are afraid their child will get molested or kidnapped. These are mentioned in reviews by Chillón et al. (2014), Mitra (2013), Stewart et al. (2012), Ahlport et al. (2008), Pont et al. (2009). However, just as for traffic, these safety issues are more about the perceived concerns than about actual risks.

All these different safety concerns have been mentioned in abovementioned researches, but the concerns have weaker associations with ATS than factors as age or distance (Yeung, et al., 2008). Stewart et al. (2012) saw parents allowing their children to travel independently to school, even though they were concerned about their safety. Not all parents are in the luxury position to let their concerns influence the travel mode to school and especially households with a lower Social Economic Status have less transportation options to choose from. Sometimes their only option is to let their child travel independently to school, despite their concerns. “This might explain the counter-intuitive finding that children who thought it was unsafe to play in their neighborhood were more likely to walk or bike to school” (Stewart, et al., 2012, p. 244). Yeung et al. (2008) confirm this by stating that “most, but not all […], studies have shown that neighbourhood safety is unrelated to commuting practices [… in …] children”. They conclude with saying that “there is little evidence that such concerns impact upon active transportation modes in children” (p. 898).

2.5.2 Values

Parents don’t make the decision for active or passive transport to school based only on safety concerns. Other values are also of great importance, for example how they think about the environment, the car or physical activity. Furthermore, the values of others can be of influence also. On the one side this can be values of the child that can play a part, but on the other side also people in their social environment influence the decisions.

Values parents

One of the values of the parents that are of influence are about how they view different kind of transport modes. Which transport mode is the most convenient to go to school with? Multiple researches reported an association between being driven to school and viewing the car as a convenient mode of transportation (see reviews (Mitra, 2013; Faulkner, et al., 2010; Lang, et al., 2011; McMillan T. E., 2007; Panter, et al., 2010; Trapp, et al., 2012; Mitra, et al., 2014a)). Although this accounts less for the situation in the Netherlands than the situation in, for instance, the U.S.A., Lorenc et al. (2008) make a fair point that the media also plays a role in the values given to car use. Not only are they promoted as convenient, but also as the standard, as being cool and of higher social status than active transport, contributing to a culture of car use (Lorenc, et al., 2008). Both short and long-term mobility expectations are established, whereby the car is at the center of everyday life (Wong, et al., 2011). This influences less ATS on two sides: on the one side by the opinions of parents, on the other side by opinions of the young children, “as these preferences are already well established by early adolescence” (Lorenc, et al., 2008, p. 855). This culture change is also visible if compared to the fact that the parents in their childhood often travelled more independently from their parents and more actively. In the research of Carver et al. (2013) among almost seven hundred school children, 85 percent of the parents was “allowed to get about alone at a younger age than they allowed their children to do” (Carver, et al., 2013, p. 75). A big part of this difference was explained by lifestyle differences like greater access to cars. However, the trend is undesirable, as some studies found higher ATS rates if the parents also had travelled in an active way to school in their childhood (see reviews by Davison et al. (2008) and Mitra et al. (2014a)). Also the current use of parents’ active transportation influences the rates of ATS (Davison, et al., 2008). Henne et al. (2014) even found in their study for non-distance factors among schoolchildren age 6-11 that “children’s active transport is most associated with their parents’ use of active transport” (p.

645). An important factor therein is whether parents are using active transport to commute to work (Davison, et al., 2008; Henne, et al., 2014).

It is also the case that children are more likely to use active transport to school, if parents have a higher appreciation for active transport (Mitra, 2013). Stewart et al (2012) found in their review that in six out of seven studies, parents who valued ATS less had children who significantly used less ATS than children of parents who thought ATS was important. Different reasons appeared why ATS was considered important. Associations have been found between the environmental consciousness of the parents and more ATS (Mitra, 2013). One parent said for instance that she is "supporting the environment by not using an automobile for a short trip" (Ahlport, et al., 2008, p. 232) (61). Ahlport et al. (2008) also found values as viewing ATS as a way to let the child spend more time outdoors and to engage in regular exercise. Davison et al. (2008) found that parents who value physical activity also have children that use more ATS, although other studies did not find an association for this value (Henne, et al., 2014; Sirard & Slater, 2008). In the review of Stewart et al. (2012), an appreciation of physical activity could help explain a significant difference in 8 out of 40 studies. More important was if parent valued walking and biking specifically. Especially if parents thought of walking or cycling to school as convenient, for example saving time, children are more likely to use ATS (Rodriguez & Vogt, 2009). Some parents in the research of Ahlport et al. (2008) even let it influence their decision of where to buy a house: "they had chosen their home for its proximity to school so that their children could [… go …] walking or biking to and from school" (p. 232).

Values family, friends and neighbors

However, the decision of a transport mode is also influenced by the people in the social environment, together with the prevalent perceived social norms, both for longer and shorter distances (Panter, et al., 2010). These can influence the use of ATS in different manners. Davison et al. (2008) noted that children are more likely to use ATS if other family member agree with letting the child use ATS or if neighborhood children also use ATS. This influence ATS in two ways, by making ATS the social norm, and at the same time improving safety as traffic gets less motorized and children can walk or cycle to school together with other children (Timperio, et al., 2006; Hume, et al., 2009; Faulkner, et al., 2010; Ahlport, et al., 2008; Sirard & Slater, 2008). Some neighborhoods even organize this on a bigger scale, by initiatives as the "walking school buses", whereby only one adult is needed to escort multiple children to school while walking (Timperio, et al., 2006).

Another way the social environment can influence ATS is by social interactions. The chance of ATS increases if parents value social interactions between children (Davison, et al., 2008; Mitra, 2013). The use of ATS is than an opportunity for social interactions on the go. Panter et al. (2008) found in their review five studies with positive associations between social interactions and active school travel.

The social cohesion in a neighborhood also plays a role in using ATS, as the safety is perceived to be higher when the social cohesion is better. People that are greeting and keeping an eye on each other (the 'eyes on the street'), create a safer environment for a child to travel independently than a neighborhood where everything is anonymous and people don´t know each other. Perceptions of better social cohesion therefore cause higher ATS rates (McDonald, et al., 2010).

Lorenc et al. (2008) however mention a contradicting social norm, whereby children aren't allowed to use ATS because it isn't perceived safe, and ATS parents aren't perceived as 'good parents': "the independence of the children is limited in the name of safety" (p. 855). The same accounts for the argument mentioned before, whereby parents drive their children to school by car because other parents do the same (Carver, et al., 2013).

Values child

Table 2-1: Traffic perceptions among parents and children.

Perceived:	% parents	% child (age 10-12)	Difference
Heavy local traffic	60.3%	45.4%	14.9%
Concerned about strangers	81.7%	67.1%	14.6%
Roads not safe	78.0%	57.0%	21.0%

Source: Timperio et al., 2006.

Although parents make the ultimate decision, the perceptions of children sometimes also have an influence on the decision for a transport mode (Chillón, et al., 2014). As Valentine (1997) puts it: “children’s use of space is a product of negotiation between [children and] their parents” (p. 68). Sometimes children’s resistance to ATS can lead to less ATS. Reasons as ‘no energy’ (Timperio, et al., 2006) and ‘child doesn’t like to walk’ (Chillón, et al., 2014) were negatively associated with ATS, while positive associations where found when the child preferred to walk (Chillón, et al., 2014). In their US study, Rodriguez & Vogt (2009) found that the child was more likely to walk to school if the child perceived walking to school as saving time. Liking walking also gave a positive correlation, although it did not give a significant difference (Rodriguez & Vogt, 2009).

Children’s perceptions about it being safe to walk to school also leads to significant higher ATS rates (Chillón, et al., 2014; Rodriguez & Vogt, 2009). However, children are more likely to think it is safe than their parents (Chillón, et al., 2014). Timperio et al. (2006) made a comparison and found that parents are more often concerned than their children, on every subject (see Table 2-1). In the end, that means parents perceptions are influencing the decision again, instead of the actual opinion of the child. That was also what Napier et al. (2011) concluded in their literature review: “Surprisingly, children’s perceptions of barriers are generally unrelated to whether they walked to school” (p. 46). The statement of a parent about their child’s transport mode in the research by Faulkner et al. (2010) is in line with these outcomes: “My husband and I [decide] ... [T]hey’ve never really had a choice, you know” (p. 4).

2.6 Conclusion

So, concluding from the review there are a lot of variables that influence the decision for a transport mode to school. This last paragraph summarizes what knowledge has been gained from previous researches.

Of the individual and household characteristics, age seems to be of big influence on ATS and cycling. With increasing age a child develops more skills and is more often allowed to travel independently. Gender on the other hand gives divergent outcomes, just as ethnicity does in international research. In the Netherlands, no research among primary school children has been done so far, but research among adults and adolescents indicate that non-natives use less ATS and cycle less than natives. Household composition also gives various results, as it can be both stimulating as limiting ATS and cycling. Car ownership only limits ATS, although not all results were significant. Household income decides for a big part to what extend a household is able to own cars, but it sometimes also influences the amount of ATS on its own, because, for instance, a household with two working parents have more time constraints. These children are less likely to use ATS. However, higher social economic status gave divergent outcomes, with sometimes less ATS, and sometimes more ATS.

Increasing distance leads to less ATS. It is the most often cited factor, with the clearest and biggest significant correlation to ATS. Within one kilometer, ninety percent used ATS, but this figure decreased rapidly with increasing distance. Especially the amount of walking declined fast. However, distance is not sufficient to explain totally whether a child travels actively or passively to school. Some children simply don’t have other options than to walk or cycle to school, even over long distances.

Other characteristics of the trip are of way less influence than distance, but in some researches they were of influence on the choice for a transport mode. This was the case with the total travel time, the stuff children had to bring to school, characteristics and policies of the school and the schedule of the child and his/her family during the rest of the day.

The built environmental characteristics that are of most influence are the characteristics of the neighborhood around the home. Neighborhoods that are more walkable and cycle-able are more suited for the use of ATS. A higher land use mix and residential density are characteristics of walkable neighborhoods, although studies about their influence on ATS has found mixed results. In a denser populated neighborhood are more children, and therefore more schools, increasing the chance there is a school within walking or cycling distance. A higher land use mix can let children get used to walking and cycling in general, therefore increasing the chance of ATS. A higher use of ATS is also often found in more urban areas. The infrastructure can stimulate ATS. Especially the presence of walk and bike paths, diverse routes, low traffic and a minimum of road crossings stimulate ATS. Mixed results have been found about the aesthetics, green and recreational areas in a neighborhood, although it should be kept in mind that the built environments also differ much between countries.

Weather is likely to have an influence on the transport mode, although it is still uncertain in what way. It can both have a positive as a negative influence, but not much research on the subject is done so far. Most researches did not find significant results, but also did not focus on the actual weather at time and place of travel. The only study that did focus on the actual weather, found significant results. However, people are creatures of habit and it therefore might be possible that they don’t change transport mode easily because of the weather. Dutch results among adults found that temperature has the most influence and cycling is the transport mode that is most sensitive to weather conditions. Seasonality also did not get a lot of attention so far, and results are divergent. As not only weather differs per season, but also the amount of day light, the influence in the Netherlands still has to be investigated.

From the social environment, the values and concerns of parents are most important. They decide most often what transport mode the child will use to travel to school. Safety concerns as stranger danger or traffic can limit ATS, just as values whereby parents view the car as the most convenient transport mode. Parent’s appreciation of ATS, physical activity or the environment leads to more ATS. The surrounding social environment was also sometimes of influence, with both limiting as stimulating results. A child’s opinions sometimes is of influence, however, in the end, the parents are making the final decision whether the child likes it or not.

3. Research Design

3.1 Study area, population and data

In this research, the target population consists of students who travelled from home to a primary school in the Netherlands. The choice for primary school students is based on a number of reasons, as mentioned in chapter 1. Also the choice for primary school students in the Netherlands is well considered. The cycling culture in the Netherlands creates a special situation that is hard to compare to most other countries. Furthermore, most primary school children live within walking or cycling distance of one or multiple schools. Within the country however, differences are visible, with primary schools in rural areas being less widespread than in urban areas. This can influence the choice of a transport mode to school. Using the OViN database makes it possible to choose the whole of the Netherlands as a study area, but at the same time also compare regions (Bryman, 2012).

The choice has been made to not obtain the data by the researcher herself, but to make use of an existing database. This is the database Onderzoek Verplaatsing in Nederland 2012 versie 1.0 (OViN – Movement research in the Netherlands 2012). This research was conducted by het CBS (Central Bureau of Statistics, CBS) with the purpose to “provide adequate information on daily mobility of the Dutch population for the benefit of the Ministry of Infrastructure and Environment and other policy and research bodies” (CBS, 2013, p. 5). The research has been conducted on a national scale and is a “continuous daily investigation into the movement behavior of the Dutch people” (CBS, 2013, p. 5). Respondents were asked to track all their movements on a certain day. Furthermore, also individual and household characteristics are registered, as well as things as transport modes ownership. Also the residential postal code was asked, which could be used to supplement the database with information from the CBS about built environment variables as address density and land use mix and weather information from the Royal Dutch Meteorological Institute (KNMI). In total, the database consists of over 400,000 journeys made between 2010 and 2012. This database will be used to find an answer to the research questions.

Using an existing database as the OViN database comes with certain advantages. First of all there is, through the use of this database, a large amount of data available (Bryman, 2012; 't Hart, et al., 2009). As the transport mode is influenced by a lot of variables, it is necessary to analysis a lot of data. That way it becomes possible to investigate the role of each variable. Caused by the limited time and money resources available to the researcher, it would never be possible to collect such a large number of respondents. This is further reinforced because a very specific group of respondents is needed: elementary school students taking the journey from home to school (more on this in paragraph 3.1.1 about target population). In the database, these journeys form a part of the bigger picture, making it possible to select this sub-group which meets the target population but at the same time is still of a reasonable size (Bryman, 2012). In addition, the data is of high quality, way higher than would ever be possible if the data had to be gathered by the researcher herself (Bryman, 2012). The collection of data has been carried out by highly experienced researchers who have put a lot of time and effort in selecting cases and preventing non-response, so the database is as representative as possible (CBS, 2013). Also the quality of the research and the database have been heavily guarded.

3.1.1 Target population

To find a workable target population, there has to be worked within the limits of the OViN research, and therefore also within the limits of their target population. The CBS describes the target population as “all persons residing in the Netherlands of 0 years and older who are part of private households and are registered with the GBA [GBA is the municipal administration]. Residents of institutions, facilities and (shelter) homes are excluded” (CBS, 2013, p. 12). The CBS draw a sample of the target population, which gave them a usable sample of almost 72,000 persons (CBS, 2013).

A part of these respondents will be primary school students reporting their rides from home to school. The OViN research specifically asks for the postal code where someone is leaving from, and going to, together with the purpose of the journey they are making. A selection has to be made from children that answer with ‘following education/course’ for the variable ‘destination’. As primary school children are falling within a specific age range the database will be corrected for the variable ‘age’. Children start going to primary school at age four, and leave primary school normally at an age of eleven or twelve, to continue with high school. To make sure most high school students will be sorted out, the decision has been made to draw the age line at eleven, so the sample will get as less deviations as possible. After selecting for destination/target and age, the cases will be selected based on the place where they started their ride. Therefore the four-digit postal code will be compared to the residential postal code. If it is the same, the case will be selected. Finally, the journeys have to be checked for the moment they were made. Dutch primary schools are in general only open on weekdays. To get a database with cases that can be compared the best as possible, only the trip in the morning will be considered. Therefore, departure times have to be checked. Although every school can decide for themselves what time school starts and ends, most primary schools start at 8.30 AM, with most exceptions starting fifteen minutes earlier or later (Rijksoverheid, 2015b). Logically, most children will therefore depart their home between 7.30 AM and 8.30 AM. To include also some exceptions, the range will be taken from 7AM till 8.59 AM. A few students have multiple trips that meet all conditions, maybe because they take a course before primary school starts. As it is unclear which trip is the one to school, these trips are sorted out. Also the five trips whereby the transport mode belongs to the category ‘other’ will be removed, as it is unclear whether the transport mode is passive or active. Finally, the trips whereby the distance exceeds 10 kilometer are removed. Although there are of course children who are travelling further than 10 kilometers from home to school, it is not likely that these children will use active travel. Therefore, these cases do have a big influence on the model, although the conclusions of this research are not applicable for these cases as they will not switch to active travel modes in any case.

After these last selections the sample is complete, leading to a total sample of 8,308 cases used for the analysis of the differences between active and passive transport. 6,337 of these cases walked or cycled to school. This second sample is used for the analysis of the differences between walking and cycling. An overview of the steps taken, together with the used variables, can be found in the appendix in 7.1.

3.1.2 Data preparation

The terms used in this study have to be processed into workable variables. Some of these variables as the age of the respondent can be taken directly from variables of the OViN database and don’t need any further translation. Other variables have to be rewritten, so they can be obtained from the database and can be used to carry out statistical tests. All variables are in Table 3-1, together with the explanation, the scale, the required rewriting and for which statistic test it is used (more on statistical testing in paragraph 3.4).

Table 3-1: All variables, scales and rewriting

		Original variable			Rewriting		Variable used in statistic tests	
	Characteristic:	**Original variable**	**Explanation**	**Scale of variable**	**Rewriting in variables**	**Scale after rewriting**	**Descriptive statistics**	**Logistic regression**
Choice of transport mode	Transport mode	**Transport mode**	1: train 2: private bus transport 3: subway 4: tram 5: public bus transport 6: driver car 7: van 8: truck 9: camper 10: passenger car 11: taxi 12: motorbike 13: moped 14: mini-moped 15: bicycle 16: bicycle as passenger 17: agricultural vehicle 18: boat (ferry) 19: plane 20: skates, rollerblades, step/scooter 21: disabled transportation 22: walking 23: stroller 24: other	Categorical	Transport mode → Active/Passive Passive transport: 1-14, 16-19, 21, 23 Active transport: 15, 20, 22. Passive = 0 → Referent Active = 1	Dichotomous	- Transport mode - Active/Passive	Active/Passive
					Transport mode → Walk/Cycle Walking transport modes: 22 Cycling transport modes: 15 Walking = 0 → Referent Cycling = 1	Dichotomous	- Transport mode - Walk/Cycle	Walk/Cycle
Individual and household characteristics	Age	**Age**	Age in years	Ratio	-	-	Age	Age
	Gender	**Gender**	0: Female 1: Male	Categorical, dichotomous	Referent = Female (0)		Gender	Gender (ref = male)
	Ethnicity	**Ethnicity**	1: Native 2: Non-native, western 3: Non-native, non-western	Categorical	Dummies. Referent = Native (1)	Dummies, so dichotomous	Ethnicity	Ethnicity (ref = native) Ethnicity (western) Ethnicity (non-western)
	Siblings	**HHLft1** **HHLft2** **HHLft3**	Number of household members under 6 year Number of household members 6 till 11 year Number of household members 12 till 17 year	Ratio	Total siblings sum of categories, minus respondent : HHLft1 + HHLft2 + HHLft3 -1 = Siblings	Ratio	Siblings	Siblings
	Marital status parents	**HHSam**	1: Single person household 2: Couple 3. Couple + child(ren) 4. Couple + child(ren) + other(s) 5. Couple + other(s) 6. Single parent household + child(ren) 7. Single parent household + child(ren) + other(s) 8. Another composition	Categorical	HHSam → nr_parents 2 parents/caretakers: 3, 4 1 parent/caretaker: 6, 7 2 parents/ caretakers = 0 → Referent 1 parent/ caretaker =1	Dichotomous	Nr of parents in hh	Nr of parents in hh (ref = 1 parent hh)
	Household transport modes	**Nr of cars in household** **Nr of motorbikes in hh** **Nr of mopeds in hh** **Nr of mini-mopeds in hh** **Nr of bikes in household**	Number of cars in household Number of motorbikes in household Number of mopeds in household Number of mini-mopeds in household Number of bicycles in household	Ratio	-	-	Nr of cars in hh Nr of motorbikes in hh Nr of mopeds in hh Nr of mini-mopeds in hh Nr of bikes in hh	Nr of cars in hh Nr of motorbikes in hh Nr of mopeds in hh Nr of mini-mopeds in hh Nr of bikes in hh
		Respondent owns bike	Respondent owns bike	Dichotomous	0 = no, 1 = yes		Bike owner	x

	Characteristic:	Original variable			Rewriting		Variable used in statistic tests	
		Name variable	Explanation	Scale of variable	Rewriting in variables	Scale after rewriting	Descriptive statistics	Logistic regression
Ind. and hh char.	Household income	**Household income**	Net annual household income classes 1: < €10,000 2: €10,000 – €20,000 3: €20,000 – €30,000 4: €30,000 – €40,000 5: €40,000 – €50,000 6: > €50,000 7: unknown	Categorical	Dummies. Referent = <€10,000 (1)	Dummies, so dichotomous	Household income	Income hh (>10k) Income hh (10-20k) Income hh (20-30k) Income hh (30-40k) Income hh (40-50k) Income hh (>50k) Income hh (unknown)
Trip characteristics	Distance of trip	**Distance**	Movement distance in the Netherlands (in hectometers)	Ratio	-	-	Distance (in classes)	Distance
	Child accompanied?	**Child accompanied**	0 = no, independent 1 = yes, accompanied	Categorical, dichotomous	-	-	Child accompanied	x
	Other trips made by respondent	**Total traveled distance** **Distance**	The travel time to school expressed as a percentage of the total distance the respondent travelled	Ratio	Distance/total traveled distance * 100 = school distance i.r.t. total	Ratio	School distance i.r.t. total	School distance i.r.t. total
Built environment char.	Land use diversity	**Land use diversity index**	Index for land use diversity	Ratio	-	-	Land use diversity index	Land use diversity index
	Residential density	**Address density**	Address density in residential four-digit postal code area	Ratio	-	-	Address density	Address density
	Green in area	**Percentage green**	Combined area percentage green (excl. agricultural land) in residential four-digit postal code area	Ratio	-	-	Percentage green (in classes)	x
	Urbanization	**Urbanization**	1: very strongly urbanized 2: strongly urbanized 3: moderate urbanized 4: low urbanized 5: non-urbanized	Categorical	Dummies. Referent = very strongly urbanized (1)	Dummies, so dichotomous	Urbanization	Urbanization (ref = very strongly) Urbanization (strongly) Urbanization (moderately) Urbanization (low) Urbanization (non)
Weather and seasonal char.	Wind	**Wind speed**	Daily average wind speed, in km/h	Ratio	-	-	Wind speed	Wind seed
	Temperature	**Temperature**	Daily maximum air temperature, in °C	Interval	-	-	Temperature	Temperature
	Precipitation	**Precipitation sum**	Daily precipitation sum, in millimeter	Ratio	-	-	Precipitation sum	Precipitation sum
	Season	**Season**	Division between seasons based on date 1: Spring: 21-03 till 20-6 2: Summer: 21-06 till 20-9 3: Autumn: 21-09 till 20-12 4: Winter: 21-12 till 20-03	Categories	Dummies. Referent = Winter (4)	Dummies, so dichotomous	Season	Season (ref = winter) Season (spring) Season (summer) Season (autumn)

For the choice of transport mode and whether this is an active or a passive one, the variable transport mode can be checked. This variable consists of 23 transport modes, and the value 'other'. These transport modes can be summarized into the categories active[5] and passive transport. The distinction between walking and cycling can also be made from these categories.

To find out what the household composition is, two things can be investigated. First by looking at the marital status of the parents: is it a single parent household or are there two parents? The second thing is checking if the child has siblings, and how many. This can't be obtained directly from the database, but it can be checked how many household members under 18 there are[6]. For the economic environment, as interpreted by Pont et al. (2009), two things can be checked: the household income and what kind of transport modes the family and the respondent himself own.

For the variable schedule there is information available about what other trips the respondent has made that day. The distance of the journey to school can be compared to the total distance travelled during the day to see if it has influence on the transportation mode used to travel to school.

Land use mix can be tested by looking at Shannon's land use diversity mix index. This index compares the diversity of land use mix in residential four-digit postal code areas. The higher the value of the Shannon's index, the more diverse the area is. The percentage of green in the neighborhood gives an indication of the amount of parks, forests and other green areas. Agricultural land is excluded from the green. All built environment variables are measured for the four-digit postal code. The only exception is urbanization, that is measured for the municipality area. This variable measures the addresses in the surroundings for all human activities (living, work, education, shopping, recreation, etc. (CBS)). Address density is also measured based on the density of addresses, but then only on residential addresses.

Some of the variables are measured in categories. The variables gender and the number of parents are categorical variables, but they have only two outcome categories. The other categorical variables, ethnicity, household income classes, urbanization and season have more than two outcome categories. Therefore, they have to be rewritten into dummy variables to make sure they are entered correctly into the model.

Furthermore, also some of the data about whether the child was accompanied or not was altered. Fourteen children were travelling passively by car, moped and as passenger on a bike, but were marked as 'unaccompanied'. This is not possible, as the child can't drive himself. This can be a result of the answer categories in the survey, or the question can be incorrectly answered. As, with the definition of unaccompanied in this research, a child cannot be unaccompanied while travelling passively (unless using public transport), these values were altered to 'accompanied'. This leaded to all passive travelers falling into the category 'accompanied'.

3.2 Conceptual model

By using the theoretical framework from chapter 2 and the OViN database explained in paragraph

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[5] The category skates, step/scooter will be taken into account when looking at the differences between passive and active transport, but not when looking at the differences between walking and cycling. As of all trips, only 0.4 percent of them are made by the use of one of these modes, it won't give big distortions.

[6] All of these will be considered as siblings, though they could contain a different place within the household, as grand children or foster children, etc. As it is impossible to determine, and they are living within the same household, the assumption is made they will live together like siblings. Also siblings of eighteen years or older can be living within the same household, but as the database doesn't give any clearance about the place household members of above eighteen have within the household (parent, child, other), this can't be checked.

3.1, a conceptual model has been drawn up for this study (see next page). In this model the variables that influence the choice between passive and active transport mode to school, and eventually also between cycling and walking, are presented. The same division that was used in the theoretical framework is used here, whereby individual and household characteristics, trip characteristics, the built environment and weather and seasonal characteristics together influence the choice of transport mode. These influence is shown by the grey arrows leading from the gray boxes on the left, to the choice of transport mode on the right.

The variables social environment, other trip characteristics and traffic are left out of the model, as there is no information available about them in the OViN database. Although it would have been interesting to investigate them as well, the advantages of using the large sample of the OViN database are still outweighing this disadvantage.

The conceptual model will be the starting point for the rest of the research.

3.3 Hypotheses

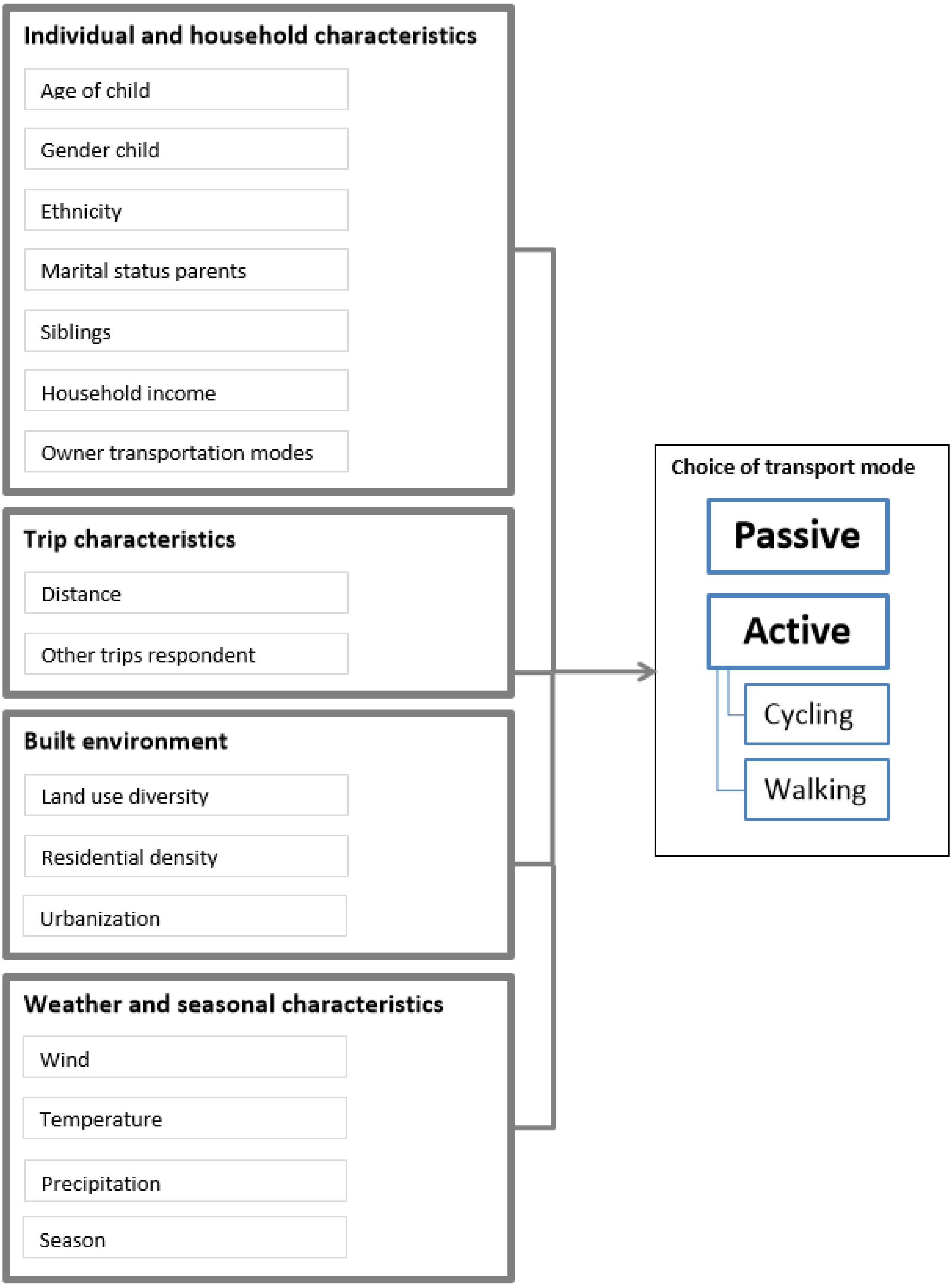
Hypotheses are drawn from the conceptual model and can be tested with statistical tests, serving as guides for answering the research questions. Every hypothesis serves to test the influence of one or more variables on ATS. In some of the hypotheses the influence of variables will be tested, while corrected for the influence of other variables. This will serve as a basis to find what factors influence the choice of ATS in general and walking and cycling in particular.

Hypothesis 1: The older the child is, the more likely it is to travel in an active way to school. The ATS will consists of more cycling among older children than among younger children.

Older children have better developed skills, necessary for active travel. Older children also turned out to not only travel less by car, but also walk less: both in favor of more cycling to school (Van Goeverden & De Boer, 2013).

Hypothesis 2: The characteristics gender, the amount of siblings, the marital status of the parents and household income won't give any significant differences for the use of ATS. Ethnicity will give significant differences between both passive and active transport and walking or cycling.

A lot of studies didn't find significant differences for gender, just as the one Dutch study that reported investigating the influence of gender (Van Goeverden & De Boer, 2013). Contradicting results have been found in earlier researches for the characteristics siblings and the marital position of the parents. Therefore, no significant results are expected as a factor can mean more ATS for one family, but less ATS for another family. For household income no Dutch research has been done yet, but other comparable characteristics did not give significant differences. Dutch research among adolescents found differences between native and non-native students, although the difference was stronger for cycling than for walking.


Individual and household characteristics
Age of child
Gender child
Ethnicity
Marital status parents
Siblings
Household income
Owner transportation modes
Trip characteristics
Distance
Other trips respondent
Built environment
Land use diversity
Residential density
Urbanization
Weather and seasonal characteristics
Wind
Temperature
Precipitation
Season
Choice of transport mode
Passive
Active
Cycling
Walking

Hypothesis 3: The higher the amount of cars and other motorized vehicles in a household, the more likely the child is to travel passively to school.

The accessibility to transport modes is important for the decision of a transport mode to school. Most people in the Netherlands own at least one bike (84 percent of the persons (Fietsersbond, 2015)). However, the amount of cars in the Netherlands is considerably lower (71 percent of the households (CBS Statline, 2015b)). If people own one or more motorized vehicles, the chance increases that children will travel in a passive way to school.

Hypothesis 4: The busier the schedule of the respondent, the less ATS will be used. The amount of cycling will increase at the expense of walking.

A busy schedule means spending more time on the street and therefore being more exposed to traffic and stranger danger. It also leaves less time to spend travelling, making parents choose for the fastest transport mode.

Hypothesis 5: Children who are accompanied to school while using ATS, are more likely to walk than to cycle.

Accompanied children are often younger than unaccompanied children. Younger children are less capable of bike riding and therefore accompanied children are more likely to be walking than to be cycling.

Hypothesis 6: Children living in areas that are very strongly or strongly urbanized, will use more ATS than children living in areas that are moderate, low or non-urbanized. The same accounts for children living in neighborhoods that are mixed-used and have high residential density.

Children living in urbanized areas are more likely to use ATS. The same accounts for children living in areas that have a mixed use and high residential density: all characteristics of a more walkable and cycle-able neighborhood, due to the proximity of facilities.

Hypothesis 7: The higher the percentage of green in the residential area, the lower the use of ATS will be.

Although studies have found positive associations between living in a green environment and active commuting for adults, almost no significant results have been found to prove the same correlation for children. The association more often gives insignificant results or is exactly the other way around; something also found in a Dutch research.

Hypothesis 8: The weather won't have significant influences on ATS. The characteristic with the biggest influence will be the temperature, and will have a bigger influence on cycling than on

People are creatures of habit, who won't re-evaluate the decision for a transport mode every day all over again. Besides, the weather gives contradicting results, whereby one child will change to walking because of the snow, while another child changes to driving instead of using his regular bike. The influence of weather is bigger on cycling than on walking and temperature is expected to have a bigger influence than wind or precipitation.

Hypothesis 9: The least ATS will be used in the winter, the most in the summer.

The expectation is that there will be less ATS in the winter, as the conditions for ATS are the worst in winter: it’s the coldest season and it is also dark in the morning. The best conditions are in summer, with the highest temperatures and the longest days.

Hypothesis 10: Distance is the factor that will have the biggest influence on the decision for a transport mode. This accounts for the choice between passive or active, but also between walking or cycling.

According to a lot of different reviews, distance is the factor that is most often cited and has the clearest and biggest significant correlation with ATS. The effect of distance especially leads to a rapid decrease of walking. It also has an effect on cycling, but in a different direction, as there is also a minimum distance that is needed before a person uses the bike instead of walking.

3.4 Statistical tests

For answering the research questions, the hypotheses need to be tested. In this paragraph the statistical tests used will be explained. The logistic regression analysis will be used to find how much the variables influence the probability of using an active or passive transport mode c.q. walk or cycle to school. The t-tests will be used to interpret the influence and find explanations. Together they make it possible to answer the hypotheses and the research question. This paragraph is based on the book *Discovering statistics using IBM SPSS Statistics* by Andy Field (2013).

3.4.1 Independent-samples t-test

With an independent-samples t-test the means of two independent populations can be tested, to see if the means differ significantly from each other. This can be used if it is expected that two variables might have a correlation with each other. This is for example the case with age and whether or not the child is accompanied. The population can be divided into accompanied and independent travelers. The average age of the two populations can be checked, to see whether or not they differ significantly. If they differ significantly, it might mean they are correlating with each other. This test will be used to check the age and accompaniment in hypothesis 1, household income with cars and bikes in hypothesis 2, and seasons and weather variables in hypothesis 9.

3.4.2 Logistic regression analysis

Every hypothesis formulates an expectation about the influence of one or more variables on the decision of a transport mode. All of these variables are expected to have an influence on the transport mode, some bigger than other. They are expected to have a relationship, based on the theoretical framework. The goal of this research is to use these variables to find a model that predicts the transport mode of a child travelling to school. Therefore, a regression analysis can be done. A regression analysis can be used to predict the value of the dependent variable Y, the outcome variable, based on independent variables X_i, the predictor variables. These predictor variables can make a

Formula 3-1: Linear regression analysis

$$Y = b_0 + b_1{*}X_1 + b_2{*}X_2 + \ldots + b_k{*}X_k$$

Formula 3-2: Logistic regression analysis

$$P(Y) = \frac{1}{1 + e^{-\,logit}}$$

$$logit = B_0 + B_1{*}X_1 + B_2{*}X_2 + \ldots + B_k{*}X_k$$

e = base of natural logarithms

e = 2,718281828459…

model that can predict the value of Y. After establishing this model, the model can give a prediction of the value of Y for every case in the database, based on the values of the predictor variables of that specific case. The goal is to find a model that will give as much correct predictions of Y as possible. This model can be described by a constant (b_0) and by parameters associated with each predictor variable (bs) (see Formula 3-1).

Because the outcome variables in this research are categorical, logistic regression should be used, instead of linear regression. More particular, binary logistic regression, as the outcome variables have two possible outcomes and is therefore dichotomous. For the first research question the outcome can be passive transport or active transport, for the second walking or cycling

With logistic regression the probability that one of the categories occurs can be calculated. For the first question this is the probability that a child travels actively to school, for the second the probability a child cycles to school. This outcome value always lies between 0 and 1, as the probability can't be smaller than 0 or bigger than 1. With linear regression analysis the predicted values of the outcome variable could get bigger than 1 or smaller than 0, as the relationship between the dependent and the independent variables is a linear one.

However, the relationship between the outcome (the probability) and the independent variables is not linear. The most predicted outcomes will lie around the mid value (0.5 → 50%), and changes in the probability are the biggest around that middle value. Less cases will have a predicted outcome of close to 0 or 1, and the closer the line gets to 0 or to the 1, the less the probability will change. The normal distribution of logistic regression therefore follows an S-curve, instead of a linear line. To find this curve, the data is transformed using the logarithmic transformation: "a way of expressing a non-linear relationship in a linear way" (Field, 2013, p. 762). A formula can be written to predict the probability of P(Y), using the method of maximum-likelihood (see Formula 3-2). Hereby the parameters are estimated in a way "that make the data most likely to have happened" (Field, 2013, p. 879). By doing logistic regression analyses, answers to the research questions can be found.

Testing assumptions

Some assumptions have to be checked, to see if things should be changed.

Variables: Logistic regression is only used when the outcome variable is categorical. As the outcome variable in this case is dichotomous, binary logistic regression is used.

The predictors all should be continuous or categorical. That is the case with all predictors. Some of the categorical predictors have more than two categories. These have to be rewritten into dummy variables. In Table 3-1 is stated which variables have to be rewritten into dummy variables.

Evidence of bias: Statistical models can be biased by unusual cases, whereby the model is influenced by a small number of cases. Some of these cases will be outliers: cases that differ substantially from the main trend of the data and can affect the estimates of the regression coefficients. If outliers affect the estimates of the parameters that define the model then it is important to detect these cases. Outliers will have very different scores than other cases and the model will therefore not predict that person's score very accurately. An outlier can be detected by looking at the differences between the observed and the predicted scores: the residuals.

These residuals represent the error present in the model. To interpret and compare the residuals they have to be standardized. Both the standardized residuals as the Studentized standardized residuals are converted to z-scores, therefore use the guidelines of the normal distribution. As the Studentized residuals usually provide a more precise estimate of the error variance of a specific case than the standardized residual, these residuals will be checked by the following guidelines for a normal distribution:

1. Cases above 3 are cause for concern and warrant inspection;
2. Only 1% should lie outside ±2.58;
3. Only 5% should lie outside ±1.96.

If this is not the case, there is evidence that the model is a poor fit of the sample data.

Furthermore, it is important to check whether a single case has a large effect on the model as a whole. Therefore, Cook's distance shall be calculated. Values greater than 1 may be cause for concern. Also the DFBeta's for every predictor can be checked. Cases above 1 could indicate a large effect on the whole model by a single case.

Multicollinearity: Multicollinearity exists when there is a strong correlation between two or more predictors. It is almost unavoidable to have a little collinearity, but luckily, low levels of collinearity pose little threat to the model estimates. If multicollinearity increases, it becomes difficult to assess the individual importance of a predictor. Furthermore, the parameters get untrustworthy and the model is less likely to represent the population.

To identify multicollinearity a correlation matrix of the predictor variables can be made. This can be checked for variables that correlate very highly, with correlations of above 0.80 or 0.90. More subtle forms of multicollinearity can be found by looking at the variance inflation factor (VIF) and the Tolerance (which is 1/VIF). If there are VIF values above 10, there is cause for concern. This is the same as Tolerance below 0.1. Tolerance below 0.2 indicates a potential problem. Lastly, the table collinearity diagnostics can be checked. For every dimension with a high condition index (over 30) the variance propositions should be checked. Variance propositions greater than 0.5 could be indicating multicollinearity.

Fit of the model

After taking the previous steps for testing the assumptions, the analysis can be done. With the analysis it can be checked how much the model improves by adding the predictor variables. The correct predicts percentage before adding the variables can be compared with the correct percentage after adding the variables. The difference is the percentage of cases that is predicted correctly because of the addition of the predictor variables.

The significance and the quality of the model can also be checked. The model with the predictor variables should differ significantly from the model without the predictor variables. The significance of the model is expressed in the differences in -2loglikelihood of the two models. In the outcome table Omnibus Tests of Model Coefficients this differences is expressed in Chi-square (look at the model row). Here it is also visible whether or not this difference is significant. The quality of the model can be checked by looking at Nagelkerke R Square. This is a measure with values between 0 and 1: the higher the value, the better the model.

4. Results

4.1 Fit of the model

The active/passive model predicts 83.6% of the transport modes correct. The amount of passive children that are predicted into the correct category is 38.8%. Of all active children, over 96% are predicted correctly. The model for walking/cycling predicts 81.9% correctly. Over 74% of all walkers are predicted into the correct category, and 86% of cyclers.

Both models are significant by a confidence interval of 99%. The quality of the models is also alright. With Nagelkerke R Square of .373 for active/passive, and an even better .567 for walking/cycling, the coherence between the predictors and the choice of a transport mode is alright. The outcomes of the logistic regression analysis can be found in the appendices in 7.3 and 7.4.

4.2 Testing model assumptions

The data has been checked for evidence of bias by checking the guidelines for the Studentized residuals, the Cook's distance and the DFBeta's as explained in 3.4.2. Based on the data there are 28 possible outliers that are investigated to see if there are reasons to exclude them. On a theoretical basis multiple reasons occurred to exclude some of these cases, based on illogical speed compared to the transportation mode, both fast and slow. Although there were only 28 possible outliers, there were more cases that travelled with illogical speed. Therefore, there were in total 814 cases filtered from the data, including all the possible outliers. After removing these biased cases, the residuals were checked again to see if new possible outliers had appeared. 9 possible outliers occurred, of which 7 were filtered out based on a theoretical basis. The eventual database hereafter exists of 7,464 cases, of which 5,817 use an active way to go to school.

The data is also checked for multicollinearity (see appendix in 7.2). Based on the VIF and the Tolerances, there is no concern for multicollinearity between the variables. There are also no correlations found in the correlation matrix that are considered very high (0.8 or higher). However, the two highest correlations still give reason for concern. The highest correlation is between 'percentage of green' and 'urbanization' (0.686). Both are features of walkable neighborhoods and it seems logical that they might be measuring the same. If the urbanization level is higher, there will be more buildings in the area, leaving less space for green area. Therefore, the variable 'percentage of green' is removed from the model. The other high correlation is between 'total travel time' and 'distance' (0.62). From a theoretical point of view that correlation seems logical, as a longer distance takes a longer time to travel than a shorter distance. Therefore, also ´total travel time´ is removed from the models.

The collinearity diagnostics tables give concern for multicollinearity, as in both the active/passive model as in the walking/cycling model two variables have high variance propositions at dimensions with high condition indices. The most outstanding is the variable 'departure time', whereby 98% in both models gets explained by the dimension with the highest condition index. When looking back at the correlation matrix, the variable 'departure time' correlated the highest with 'total travel time' and 'distance'. From a theoretical view this is explainable: differences in departure time probably will mostly be explained because children who leave early have to travel longer and further to school than children who leave later. Besides, it turns out that there is not a lot of variation within the variable, as almost 80% leaves within a timespan of only 20 minutes, between 8AM and 8.20AM. Therefore, removing the variable 'departure time' from the model won't give big distortions.

The other outstanding variable is ‘bike owner’, whereby 74% resp. 76% is explained by the dimension with the second highest condition index. These high percentages can be explained by the fact that almost all the children (98.8%) own a bike, just as almost all households. Only 0.2% of all households doesn’t own any bike, and only 1.2% owns only one bike. This makes it quite logical that the variables bike owner and ‘number of bikes in household’ measure largely the same. Therefore it is decided to take the variable ‘bike owner’ out.

The variable ‘child accompanied’ is also removed, as it gives deviating values for the regression coefficients in the logistic regression analysis. This is probably caused by the fact that the complete passive travelling population was accompanied to school: none of the passive travelers travelled independently. From a theoretical view this makes sense, as it is almost impossible for a child to travel passively and independently at the same time. Only if a child uses the public transport that could be possible, but that is very unusual for primary school children. That was also visible in this database: just 5 children went by bus or tram to school. All of them were accompanied.

After removing these five variables, another check for multicollinearity is done, but there is no reason for concern anymore.

4.3 Analysis active and passive transport

In this paragraph the outcomes of the statistical test for the active and passive transport model are discussed. Different kind of statistics are used to find the distribution of the data among a variable and to find the influence on the probability of active transport. The outcomes of these statistical tests are separated into descriptive statistics (recognizable by **Descriptive:** in front of the subparagraph) and the logistic regression analysis (recognizable by **Logistic:** in front of the subparagraph). All stated numbers from the logistic regression analysis can be found in Table 4-2. The descriptive statistics and the logistic regression analysis will be compared to each other, to the expectations and to results from previous studies. This interpretation is recognizable by **Interpretation:** in front of the subparagraph.

Of all 7,464 children, over 5,800 uses active travel to go to school, a total of 78% (see Table 4-1). This is quite high compared to the 59% stated by the Kennisplatform CROW (2013) (as described in chapter 1). However, that might be explained by the fact that this research only looked at children travelling a maximum of ten kilometer.

Table 4-1: Distribution of transport modes

Passive	Frequency	% of passive	% of all
Private bus	18	1.1%	0.2%
Public transport	5	0.3%	0.1%
Car	1,586	96.3%	21.2%
Taxi	15	0.9%	0.2%
Motorbike	2	0.1%	0.03%
Moped	6	0.4%	0.08%
Mini-moped	6	0.4%	0.08%
Passenger on bike	8	0.5%	0.1%
Stroller	1	0.06%	0.01%
Total passive	1,647	100%	22.1%
Active	Frequency	% of active	% of all
Walk	2,009	34.5%	26.9%
Bike	3,777	64.9%	50.6%
Skates, step	31	0.5%	0.4%
Total active	5,817	100%	77.9%
Total passive & active	7,464		100%

Of all passive travelers, most of them were brought to school by car. This made up of 96.3% of all passive travelers. 1.1% came with a private bus company. 0.9% came as a passenger of a motor, a moped or a mini-moped, and 0.5% was a passenger on a bike. Just 1.2% used public transport (tram, bus) and taxi’s.

Over half of all children used the bike to go to school. They make up of around two-third of all active travelers, the rest walks. On top of that, there were 31 children that used another active way, as a step or skates. For the distribution of the used transport modes, see Table 4-1.

4.3.1 Individual and household characteristics

Age

Descriptive: Within every age group, active transport is used more than passive transport, with an average of 78%. However, there are differences between the age groups. Of all 4-year olds, 68% travels actively. This number increases in every age group (see Figure 4-2), with the highest numbers among the 11-year olds, whereby almost every child uses active transport (91.6%). The differences between age groups are also visible in the mean age of passive and active travelers. The mean age of passive travelers is 6.84 years, differing a little over a year compared to the mean of active travelers (7.89 year). This is a significant difference (t = -17.689, sig = .000).
Logistic: The effect of age is also visible from the logistic regression analysis. Age has a significant influence on the probability of using active transport. A higher age increases the probability of cycling. For every year a child is older, the probability of cycling increases with 36%. It is with a Wald score of over 378 the variable with the second largest influence.
Interpretation: The variable age has the expected influence on the use of active transport and is in line with previous Dutch research (Aarts, et al., 2013). The reason why active transport differs this much between the different age groups and a higher age increases the probability of active transport, can be found in increasing traffic and travelling skills, as a child has to be able to travel actively (Stewart, et al., 2012).

It is also influenced by whether a child is accompanied or not (Lang, et al., 2011). Young children are often not allowed to travel independently, as they still need to develop the skills to safely travel unaccompanied. This is of importance because, if a child travels unaccompanied, it has to travel actively as children cannot drive the car themselves, but this is different if the child is accompanied. In that case, passive transport becomes a possibility. When the child gets older, at a certain age, he or she will be granted permission to travel independently. Therefore, children with a higher age travel more often independent than younger children. For passive transporters, switching from accompanied travelling to independent travelling means also switching from passive to active travelling. A higher age therefore means a bigger chance to travel independently, and therefore travelling actively. and thus more often actively.

This is increase in both independent as in active travel is also visible in Figure 4-1. Of all 4-year olds not even 1% travels independently. This increases rapidly, with 76% of all 11-year olds travelling independently. The mean age of accompanied children is 6.83 year, differing significantly from the mean age of unaccompanied children with almost three years (9.65 year) (t = 68.748, sig. = .000). With these outcomes, hypothesis 1 can be confirmed.

Figure 4-1: Use of passive and active transport & accompaniment, distributed by age.

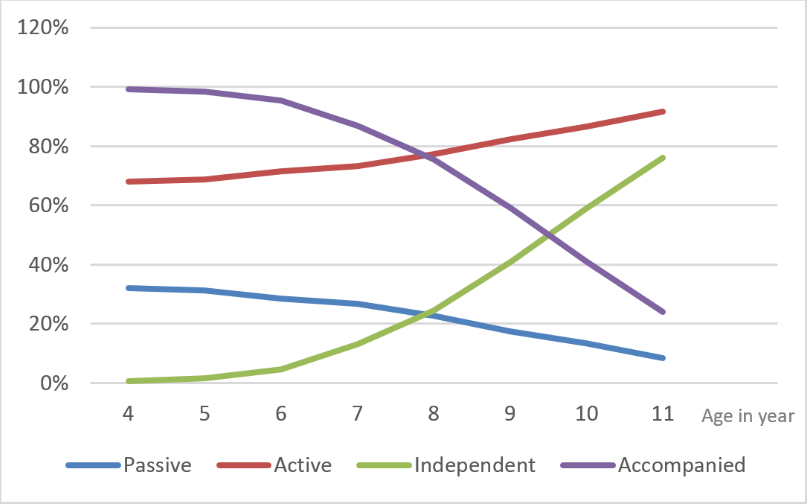


Table 4-2: Variables in the Equation – active/passive.

Variables in the Equation – active/passive							
		Position	B	Wald	Sig.	Exp(B)	% of change of probability with increase of variable by 1 unit
Individual and household characteristics	Age	2	.308	1.360	.000	378.669	36.03%
	Gender (ref = male)	24	-.071	.931	.287	1.135	-6.87%
	Ethnicity (ref = native)	12			.025	7.367	
	Ethnicity (western)	27	-.092	.912	.542	.371	-8.79%
	Ethnicity (non-western)	13	-.318	.728	.007	7.262	-27.25%
	Siblings	28	.027	1.028	.562	.337	2.76%
	Nr of parents in hh (ref = 1 parent household)	6	-.616	.540	.000	19.153	-45.98%
	Nr of cars in hh	3	-.434	.648	.000	84.546	-35.18%
	Nr of motorbikes in hh	21	.087	1.091	.225	1.474	9.13%
	Nr of mopeds in hh	22	.128	1.136	.244	1.358	13.63%
	Nr of mini-mopeds in hh	9	-.425	.654	.000	12.546	-34.59%
	Nr of bikes in hh	4	.140	1.150	.000	30.695	14.97%
	Income hh (ref = >€10k)	8			.009	17.187	
	Income hh (€10-€20k)	33	.086	1.090	.778	.080	8.98%
	Income hh (€20-€30k)	30	.114	1.121	.661	.192	12.07%
	Income hh (€30-€40k)	31	-.102	.903	.686	.163	-9.71%
	Income hh (€40-€50k)	23	-.284	.753	.264	1.249	-24.75%
	Income hh (>€50k)	20	-.307	.736	.223	1.483	-26.44%
	Income hh (unknown)	34	.187	1.206	.800	.064	20.61%
Trip char	Distance	1	-.088	.916	.000	910.841	-8.42%
	School distance i.r.t. total	15	-.005	.995	.019	5.476	-0.48%
Built environmental characteristics	Land use diversity index	17	-.123	.884	.107	2.596	-11.59%
	Address density	32	.000	1.000	.753	.099	0.00%
	Urbanization (ref = very strongly)	11			.104	7.683	
	Urbanization (strongly)	14	-.328	.721	.009	6.855	-27.94%
	Urbanization (moderately)	19	-.165	.848	.221	1.500	-15.25%
	Urbanization (low)	16	-.243	.784	.078	3.107	-21.57%
	Urbanization (non)	18	-.234	.791	.119	2.427	-20.87%
Weather and seasonal characteristics	Wind speed (daily average)	36	.002	1.002	.899	.016	0.23%
	Temperature (daily max)	7	.030	1.030	.000	18.649	3.03%
	Precipitation (daily sum)	5	-.031	.969	.000	19.960	-3.10%
	Season (ref = winter)	25			.888	.638	
	Season (spring)	26	-.089	.915	.467	.528	-8.50%
	Season (summer)	29	-.085	.918	.563	.335	-8.19%
	Season (autumn)	35	-.022	.979	.822	.051	-2.13%
	Constant	10	1.071	2.919	.002	9.212	191.90%

Gender

Descriptive: The use of active transport does not differ much between boys and girls. 78.3% of the girls use active transport, a little bit more than the boys with 77.5%.

Logistic: The use of active transport among girls does not differ enough to let gender have a significant influence on the probability of active transport· The probability decreases a little bit if the respondent is a boy, compared to being a girl. This is a decrease of 6.9%. With a Wald score of .287, it is the variable with the 24th biggest influence.

Interpretation: The non-significance of the influence of gender is in line with both Dutch (Van Goeverden & De Boer, 2013) as several international studies (Black, et al., 2001; Grize, et al., 2010; McDonald, 2012) and the found differences are therefore not surprising. However, the direction of the influence found is remarkable, as the differences between boys and girls found before are mostly the other way around, whereby boys used more active transport than girls (Davison, et al., 2008). The differences between boys and girls are mostly sought in a more protective attitude towards girls (Mitra, et al., 2014a). However, this attitude might not affect the way from home to school as most often the distance is small and the route familiar. Furthermore, children going to primary school have young ages, whereby not only girls will be protected, but that also accounts for the boys. Therefore, it is understandable that there are only small, insignificant differences found between boys and girls.

Ethnicity

Descriptive: The ethnic groups (natives, westerns and non-westerns) in this research don't outrun each other much when looking at the use of active and passive transport. Although natives use the most active transport it only differs 2.2% from the lowest percentage of active transport, which is done by westerns.

Logistic: Regardless of the small differences of the use of active transport between the ethnic groups, significant influences are found for two out of the three ethnic groups on the probability of active transport. If the respondent is non-western, the probability of using active transport decreases significantly when compared to being native, the referent category. The probability decreases with more than 27% in that case. The respondent being a western does not make a significant difference compared to being native, although the probability of active transport does decrease with 8.8%. Being a native also differs significantly from belong to one of the other ethnicity groups. However, the Wald score of this ethnic group is not high, just as the Wald score of non-westerns (both around 7).

Interpretation: The fact that the most active transport used and the probability of using active transport is the highest among natives probably has to do with the fact that active travel (especially cycling) is very popular amongst Dutch people, contradicting to the image active transport has amongst non-natives (Olde Kalter, 2008). Westerns might be more familiar and in line with the Dutch active transport culture and therefore also using more ATS compared to non-westerns. The results are in line with Dutch research among adolescents (Bere, et al., 2008; De Bruijn, et al., 2005). Native students are more often 'choice walkers' (and in the Netherlands choice cyclers): consciously choosing ATS because of the values in their social environment (McDonald, et al., 2010). The values in their social environment are, in this case, influenced by the Dutch cycling culture.

Siblings

Descriptive: Most respondents have 1 or 2 siblings (over 80%) and only 8.4% have more siblings. 10.9% have no siblings at all. These are the respondents that use the least amount of active transport of all respondents (74.8%). However, it differs not even 7% from the highest percentage of active transport. This is among respondents with 3 siblings. The percentages don't outrun each other much.

Logistic: This is confirmed within the logistic regression analysis, as the amount of siblings does not give a significant difference. A higher amount of siblings increases the probability of active transport a bit (2.8%). However, as the highest amount of siblings is 5, the differences between having no siblings and the highest amount of siblings only increases the probability of active transport with 13.8%. As most respondents have only 1 or 2 siblings, the influence is quite low.

Interpretation: The least amount of ATS among children with no siblings is in line with previous American research (Ahlport, et al., 2008). Siblings might take over the role as accompanier but are not allowed to drive cars or other motorized vehicles yet, and therefore have to use active transport (Mitra & Buliung, 2014b). On the other hand, with more siblings, the chances increase that one of them is not skilled enough to travel actively, causing all siblings to travel passively. These different influences can explain why the amount of siblings does not increase or decrease the probability of ATS significantly. Some families will use more active transport with more siblings, others will use less, depending on the preferences and the possibilities of the parents (Stewart, et al., 2012). Therefore it is not surprising that no significant results were found.

Number of Parents

Descriptive: Most respondents live in a household with two parents: almost 92%. Children in two-parent households use more active transport than children in one-parent households: a difference of almost 6%. However, as only a 8.3% of all the children live in one-parent households, not much of the respondents are affected by this.

Logistic: It seems therefore remarkable that the probability of using active transport differs significantly between respondents in one and two-parent households, according to the logistic regression analysis. If there is only one parent in the respondent’s household, the probability of active transport decreases with almost 46%. With a Wald score of 19, it is the variable with the sixth biggest influence.

Interpretation: The differences between one- and two-parent households were unexpected, but may be caused by more time constraints in one-parent households. It might be harder for a parent in a one-parent family to take the time to accompany children actively, therefore resulting in more passive transport. This is in line with the Dutch study by de Bruijn et al. (2005), the American study by Martin et al. (2007) and the American study by Merom et al. (2006) (both in the review of Pont et al. (2009)).

Household income

Descriptive: The percentage of active transport among different household income classes don’t differ much, as all are around the average of 78%. The only remarkable one is the lowest income class, that has the highest amount of passive transport. With 67.7% ATS, it differs over 10% of the average use of active transport. However, only 1.7% of all respondents have a household income in the lowest income class.

Logistic: The lowest income class, households earning €10,000 or less, is the referent class. This class when compared to all other class is the only one that is significant. The rest of the classes are not significant when compared to the lowest income class. In comparison to the first class, the second, the third and the income-unknown class all increase the probability of using active transport. The fourth, fifth and sixth class all give a decrease to the probability of ATS, each one decreasing even further if the class increases. The influence does not show a linear progress.

Interpretation: American research has found evidence for increasing household income leading to lower ATS-rates (Stewart, et al., 2012; McDonald, 2008a). It therefore seems unlikely that the amount of active transport is lowest amongst the lowest income class. Passive transport modes are on overall more expensive than active transport modes and households with lower incomes probably have less schedule constraints than households with higher incomes. However, as only 1.7% of all respondents are in the lowest household income class, the effect is limited. With these results, hypothesis 2 has to be partly rejected (household income, marital status parents and ethnicity have significant influence on ATS). The other part, about gender and siblings not having significant influences, can be confirmed.

Household transport mode ownership

Active and passive transport to school is done by different transport modes (see Table 4-1). However, to make it possible for a respondent to travel by a certain transport mode it is necessary to have the transport mode available. This is measured by the ownership of the transport modes[7].

Descriptive: 4.4% of all households don't own a car. The use of active transport is the highest for this group of respondents. The use of active transport decreases when households own one, two or three cars. With four or more cars, active transport increases a bit again, but only 58 households own that many cars. In total, 22.2% of all households owning a car uses the car to take the child to school. Passive travelers own on average 1.64 cars and although it differs significantly, the 1.45 average cars owned by active travelers is not that much lower (t = 8.765, sig. = .010).

The number of households owning motorbikes, mopeds and mini-mopeds is low, running between 2.8% of the households owning mini-mopeds up to 11.2% owning motorbikes. Only 6 children travelled by mini-moped to school, another 6 by moped and only 2 travelled by motorbike. This means 2.9% of all households owning a mini-moped used it to take the child to school and these figures are even smaller for households owning mopeds and motorbikes. None of the means differ significantly[8] between passive and active travelers.

Active transport modes are less diverse, as this is mostly done by either walking or cycling. Almost all of the households own at least one bike, just as almost every respondent has a bike (98.8%). The average number of bike a household owns is significantly higher for active respondents, with 5 bikes in average active households, compared to 4.71 bikes in average passive households (t = -5.772, sig. = .000).

Logistic: A few of the transport modes owned by households have a significant influence on the probability of using active transport. The biggest influence is the amount of cars, with a Wald score of over 84.5 the variable with the third biggest influence. For every extra car a household owns, the probability decreases with 35.2%, thereby confirming hypothesis 3. The second biggest influencer is the amount of bikes, with a Wald score of 30.7. Every extra bike a household owns increases the probability with 15%. It is the variable with the fourth biggest influence. Also the amount of mini-mopeds a household owns has a significant influence on the use of active transport, decreasing it with 34.6% for every extra mini-moped. The amount of motorbikes and mopeds a household owns both don't have significant influences on the probability of active transport. They both give a small increase of the probability of active transport for every extra vehicle.

Interpretation: The influence of car ownership on ATS is in line with multiple American, Australian, Filipino and New Zealand's studies, as reviewed by Pont et al. (2009) & Sirard & Slater (2008). They all found negative relations between car ownership and ATS rates. The fact that the most active transport is done by households without a car was also expected, as over 96% of all passive travelers travelled by car and without owning a car it can get difficult to travel in a passive way to school (Black, et al., 2001). This also gives an explanation for the fact that the amount of cars is the only motorized vehicle that significantly influences the probability of active transport. As almost all passive travelers use the car, the other motorized vehicles a household owns are not used much to take the child to school. This is supported by the fact that the other motorized vehicles together are only used 14 times to take children to school.

Remarkable is that, contradictory to the 71% of the Dutch households the CBS claims to have a car

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[7] Although it is possible to travel with a transport mode of someone else outside of the household, by getting a ride of for instance a friend, grandparent, neighbor or nanny. However, as only 19 respondents travelled with transport modes that were not owned by the respondent's household (0.25%), this group is small. Therefore, using this variable gives a good enough fit.

[8] Motorbikes: t = .137, sig. = ,891; Mopeds: t = .440, sig. = ,660; Mini-mopeds: t = 1.856, sig. = ,064. Independent samples-t-test.

(CBS Statline, 2015b), in this database over 95% of all households owns at least one car and just 327 households don't own any car. It might be possible that households with children are more likely to own a car than households without children, as the convenience increases.

The influence of the amount of bikes was also as expected, as owning a bike creates a chance to use active transport, also if the school is not within walking distance (Copperman & Bhat, 2007). The influence of bikes on the probability of active transport seems quite small with a 15% increase compared to the 35% decrease by cars and by mini-mopeds. However, most households own more bicycles than cars and only 0.27% of all households own more than 1 mini-moped. It is surprising that the amount of motorbikes and mopeds both give a small (though insignificant) increase of the probability of active transport.

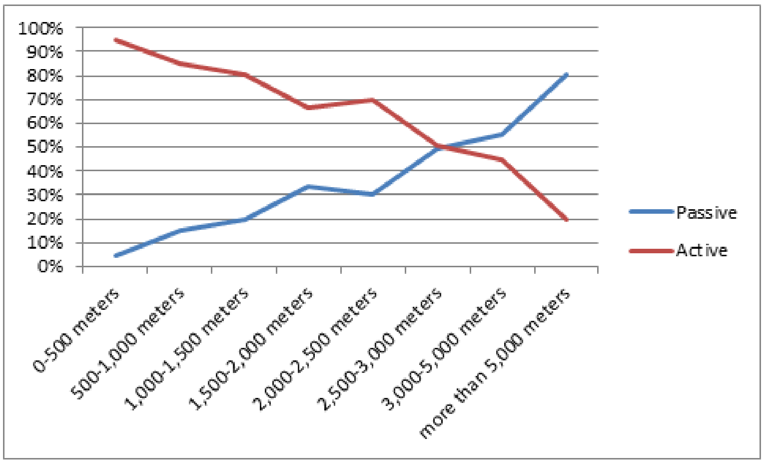
4.3.2 Trip characteristics

Distance

Descriptive: Of all respondents, over 85% travels 2.5 kilometers or less. 14.7% lives further than 2.5 kilometers away. Of all passive travelers, 45% lives further than 2.5 kilometer, compared to 11% of all active travelers. The longer the distance, the less active transport is used, in favor of more passive transport. This is visible in Figure 4-2. Of all children living within 500 meters, only 4.8% travels passively. For all children living 5 kilometers or further, this figure rises over 80%. This is also visible from the average distance travelled. The average distance travelled by passive travelers is 2.72 kilometers. This is more than twice as far and differs significantly from the average active distance of 1.14 kilometers (t = 30.491, sig. =.000).
Logistic: This trend is also confirmed by the logistic regression analysis. If the distance increases, the probability of using active transport decreases. For every extra hectometer, the probability decreases with 8.4%. This is not only a significant influence, but also the most influencing variable. With a Wald score of over 910 it is almost 2.5 times bigger than the second variable.
Interpretation: Distance and active and passive transport react as expected: the longer the distance, the less active transport is used, resulting in more passive transport. A longer distance increases the travel time for the child as well as for the accompanying parent. With bigger distance, children are more often accompanied as the (perceptions of) dangers of traffic and stranger danger increase with bigger distance, claiming even more time and effort of the parents. As parents are expected to choose the mode with the shortest duration (as found in Norwegian research (2011)), they will quicker switch to driving if the distance increases. At the same time, longer distances are more exhausting, and could be too exhausting for young children.

The influence of distance is in line with both international reviews by amongst others Davison et al. (2008), Mitra (2013), Stewart et al. (2012), Panter et al. (2008), Stewart (2011), Wong et al. (2011) and Pont et al. (2009)), as with Dutch research among primary school children (Aarts, et al., 2013; Van Goeverden & De Boer, 2013). The turnover point is around 2.5 kilometer. After that point, more children use passive transport than active transport per distance class, even with increasing age or other changing circumstances.

Figure 4-2: % of active and passive travelers, compared over distance classes.



Distance might also be the reason that, even within the highest age category, not all children use active transport. Besides the fact that it gets more time-consuming to travel actively, it also needs a bigger physical effort, that might be (in the perception of the parents) too much for children.

As expected has distance the biggest influence on the use of active transport of all variables.

School trip in relation to total travelled distance

Descriptive: The less the school trip distance makes up of the total travelled distance, the more ATS is used. For children who's trip to school was up to 10% of the total travelled distance, over 87% of them used ATS. Comparing that to children who's trip to school made up 50% (so only went back and forth to school), the ATS was almost 67%. This is also visible when comparing the mean. The school trip of the passive travelers made on average 32.6% of the total travelled distance. This differed significantly from active travelers, who's school trip on average made up 25.6% of the total travelled distance (t = 14.833, sig. = .000).
Logistic: Within the regression analysis, the difference was found in the same direction, whereby for every percent extra the school trip makes up of the total travelled distance during the day, decreases the probability of active transport by 0.5%. This influence is significant, although with a Wald score of only 5.5, it is the smallest significant variable.
Interpretation: The outcomes of the variable are unexpected. As it was expected that if the distance travelled to school is only a small part of the total travelled distance, the schedule is busy and therefore more passive transport will be used (Fyhri, et al., 2011). However, the data gives a different view. A possible explanation is that, although the total covered distance is known, it is not known wherefore the other trips during the day were made and whether they were planned. A child may walk to school, because it will be picked up after school by car to travel to relatives, or will spontaneously go home with a friend after school. Another explanation could be that the children who's trip to school only makes up a small part of their total traveled distance live very close to school. In that case, the decision for active transport is a logical one and if they travel somewhere else the total traveled distance will increase rapidly, decreasing the percentage the school trip has. Therefore, the question raises whether this variable does measure the schedule of the respondent, whether it is hard to interpret or whether the influence is just unexpected. Further research into the schedule of respondents should be done.

4.3.3 Built environment characteristics

Percentage of green

Descriptive: The percentage of green in areas has a range of 94.8% with an average of 57.6%. The mean percentage of green in areas where active travelers live is a bit lower (57.3%), the mean percentage of green in areas where passive travelers live is a bit higher (58.4%). This difference is not significant (t = 1.731, sig. =.083).
Logistic: Variable showed signs of correlation and is therefore removed from the logistic regression analysis (see paragraph 4.2).
Interpretation: As expected is the use of ATS lower in residential areas with higher percentage of green, confirming hypothesis 7. This is in line with previous Finnish (Broberg & Sarjala, 2015) and Dutch research (Aarts, et al., 2013), although it seems illogical, as green neighborhoods are perceived more walk- and cycle-able. However, it might be the case that in neighborhoods with more green the distances as bigger and facilities are more wide-spread, making people decide to take the car. On the other hand, it could also be possible that the percentage of green just does not influence the decision between active or passive transport modes, as the differences between the active and the passive travelers residential areas are very small.

Land use diversity

Descriptive: The Shannon index measures the land use mix, with a higher number meaning more land use mix. The mean index number of areas where passive travelers live differs only very slightly from the mean of the areas where active travelers live (1.78 c.q. 1.77). This difference is not significant (t = .978, sig. = .328). The index has a range of 2.8 points

Logistic: The Shannon index also does not have a significant influence in the logistic regression analysis. The probability of active transport decreases if the index gets bigger.

Interpretation: The outcomes found are contradicting the expectations based on American and Canadian researches (McMillan T. E., 2007; Kerr, et al., 2006), whereby a higher land use diversity is expected to have children and parents more accustomed to walking and cycling, therefore increasing the ATS used.

However, the outcomes are in line with other American (Ewing, et al., 2004; Yarlagadda & Srinivasan, 2008) and Finnish research (Broberg & Sarjala, 2015), but these as well as the contradicting outcomes cannot easily be generalized to the Dutch context, due to different land-use patterns (De Vries, et al., 2010). They are therefore hard to interpret. A possible explanation could be that a higher land use diversity causes more traffic, making the situation more dangerous. Another explanation could be that although a higher land use attracts more people to the area, only a few land uses are interesting for children (sport clubs, recreational areas) (Stone, et al., 2012). However, the influence is quite small and furthermore insignificant. Especially when considering the range of the index, the decrease of the probability of using ATS between the highest and the lowest case, is only 32.4%.

Residential density

Descriptive: The residential density is measured by the address density in a postal code. This ranges from 1, whereby the respondent's address is the only one in the postal code, to almost 30,000. However, the mean lies around 3,855 addresses in a postal code. Both the means of the areas where active travelers are living as the areas where passive travelers are living do not differ much: they are not even 100 addresses from the overall mean and also give no significant difference (t = -1.534, sig. = .125).

Logistic: The address density also does not have a significant influence on the probability of using ATS. In fact, the influence is almost 0, as the odds ratio is very close to 1. For every address extra within a postal code, the probability of active transport decreases with 0.0004%. This only has a very small influence, but is caused by the range of the variable. As the difference between the minimum and the maximum is almost 30,000, it means that, even for the most extreme values, the decrease in the probability is only 12.6%.

Interpretation: The residential density is the second built environmental characteristic that does not have the expected influence. It was expected that children were more likely to travel actively in dense neighborhoods, as was the case in the researches by Finnish (Broberg & Sarjala, 2015), American (McMillan T. E., 2007; Stewart, et al., 2012) and Canadian research (Kerr, et al., 2006). In more dense areas are more 'eyes on the street', increasing safety for both active as independent travelling (Mitra, 2013; Wong, et al., 2011). On the other side safety conditions could also decrease, because of the increasing traffic (Van Goeverden & De Boer, 2013).

The results found are more in line with Swiss and other American and Canadian research (all in review by Wong, Faulkner & Buliung (2011)), who found no significant correlation between ATS and residential density. However, all American and Canadian research and even the other European research cannot easily be generalized to the Netherlands, with the different built environment (De Vries, et al., 2010). It is possible that the people in the Netherlands (or at least the respondents in the database) live in areas that are too much alike, and therefore significant differences weren't found.

Urbanization

Descriptive: Children living in very strongly urbanized municipalities use the most ATS. In these municipalities, 78.7% of all respondents used ATS, the highest figure of all percentages. However, it is only 0.2% higher than in the lowest urbanized municipalities (non-urbanized municipalities) and also the other municipalities don't differ much.

Logistic: This is also visible from the logistic regression analysis. Most urbanization levels are not significant compared to the referent (very strongly urbanized). The only one that is significant is living in a strongly urbanized municipality, whereby the probability of using active transport decreases with 27.9% compared to very strongly urbanized municipalities. Living in the even lower urbanization classes also decreases the probability of active transport compared to the very strongly urbanized municipalities, although they are not significant.

Interpretation: As expected are children living in stronger urbanized municipalities using more ATS than children living in lesser urbanized municipalities. This is in line with among others American (Sirard, et al., 2005), Swiss (Grize, et al., 2010) and Dutch research (Aarts, et al., 2013), and can partly confirm hypothesis 6. Explanations are found in parking problems (Van Goeverden & De Boer, 2013), less or worse infrastructure (Davison, et al., 2008), more eyes on the street (Mitra, 2013), let alone the longer travel distances in rural areas.

4.3.4 Weather and seasonal characteristics

The weather variables are not expected to have much influence on the choice between active and passive transport, as the weather cannot be changed and people are creatures of habit, that won't re-evaluate a daily decision of a transport mode daily (Black, et al., 2001). Furthermore, only daily averages (wind), daily maximum (temperature) and daily sum(precipitation) are measured, instead of on the moment of travel. Only a few previous studies have found significant outcomes before (Mitra, 2013; Müller, et al., 2008), being also the only studies that examined weather conditions at time of travel. However, both studies did not distinct between weather variables but just spoke about good or bad weather conditions.

Wind speed

Descriptive: The average daily wind speed ranges between 0.6 kilometers per hour and 14.6 kilometers per hour. The averages don't differ significantly between active (4.1 km/h) and passive travelers (4.2 km/h) (t = 1.214, sig. = .225).

Logistic: Wind speed does not have a significant influence on the probability of active transport. The probability increases a little bit with 0.23%. Therefore, the increase in the probability for the most extreme values is only 3.2%. With a Wald score of only .016, it is the variable with the least influence.

Interpretation: Although the fastest daily average wind speed is a lot faster than the slowest daily average wind speed, it still is only a level 3 on the scale of Beaufort: a moderate wind that blows dust around (KNMI, 2016). This won't make a lot of people decide to change transport mode. If the wind speed at the moment of travelling was used, it might have caused bigger differences, as extreme wind speed at time of travel can make a parent re-evaluate the transport mode (Mitra & Faulkner, 2012), something also visible in the transportation mode choices among Dutch adults (Sabir, 2011). However, whether this happened or not can't be seen in the data.

Temperature

Descriptive: The lowest daily maximum is minus 6.5°C. The range of temperature is bigger than of wind speed, as it increases up to over 35°C: an increase of 42°C compared to the lowest figure. However, over 81% of the respondents experienced temperatures between 5°C and 25°C. The average maximum temperature differ a little over 1°C between active and passive travelers, enough to differ significantly (t = -5.563, sig. = .000). The average temperature is lower for passive travelers

(12.1°C compared to 13.2°C).

Logistic: Temperature is the variable with the seventh largest significant influence on the probability of active transport, thereby rejecting hypothesis 8.. For every degree the daily maximum temperature increases, the probability increases with over 3%. For the lowest and highest measured temperatures, this means an increase of 127.3%. However, for the range of the 81% in the middle, this only means an increase of 20 °C and therefore an increase of the probability of 60.6%.

Interpretation: Temperature is expected to have the biggest influence of all-weather variables, as it was in the Dutch research among adults by Sabir (2011). However, this is not the case. This might be caused by the measurement that is used, the daily maximum. The temperature in the morning at time of travel is probably lower than the daily maximum, as it increases during the day. The direction of the influence is as expected, whereby the mean temperature is lower for passive travelers and the probability of active transport increases with a higher temperature. This makes sense, as it is more inviting to travel actively in a warmer temperature than in a lower temperature (Sabir, 2011).

Precipitation

Descriptive: Precipitation has the biggest range of all the weather variables, ranging from 0 millimeters to 106.4. However, this is caused by a few high outliers. Most respondents had way less precipitation. 99% of all cases had less than 20 millimeters, and 66% had less than 1 millimeter. This number is measured by the total sum of the day. Therefore, it could also be caused by one big shower later that day, giving a sunny morning at time of travel. However, even with that in mind, the average difference between active and passive travelers differs significantly with a higher average of precipitation for passive travelers (2.4 mm compared to 2.0 mm) (t = 2.573, sig. =.010).

Logistic: The sum of precipitation also has a significant influence on the probability of active transport. With a Wald score of almost 20 it is the fifth largest influence. For every millimeter precipitation extra, the probability decreases with 3.1%. This means a big difference for the two most extreme cases, as the range of 106.4 millimeters means a decrease of 329.8%. However, as 99% is within the 20 millimeter range, the decrease is only 62% and for the 66% that less than 1 millimeter it only means a decrease of 3.1%.

Interpretation: Although unexpected to have such a big influence, the direction of the influence was expected. After all, you rather walk or cycle to school on a dry, than on a rainy day (Sabir, 2011).

Season

Descriptive: The ATS rates are the lowest in winter with 75.7%. The highest rates are during the summer, with 80.4% of all children using ATS. Hypothesis 9 can therefore be confirmed. The differences are small though, with only 4.7% difference between summer and winter.

Logistic: None of the seasons have a significant influence on the probability of active transport. Compared to winter, all seasons give a decrease in the probability of using active transport.

Interpretation: As there is the shortest amount of daylight in winter (Hume, et al., 2009) and weather conditions are worst in winter, ATS is expected to be used the least during winter (Van Goeverden & De Boer, 2013). The decrease in the probability of active transport for all seasons when compared to winter therefore comes as a surprise, as it is contradicting the descriptive statistics outcomes and the expectations. It might be that the influence of season is negligible after checking the influences of the different weather variables, therefore distorting the results. Weather and season are closely connected to each other, though they did not show multicollinearity. However, season is not only influenced by weather but also by daylight (Hume, et al., 2009), therefore having an influence of its own. It might be that, just as for weather, people don´t change transport modes just because it is a different season but stick to their habits. However, to see if that is the case, longitudinal research is necessary. The small (though contradicting) results might also be caused by the mild seasons that don’t differ that much during the year, especially when comparing it to, for instance, Norway (Børrestad, et al., 2011).

4.4 Analysis walking and cycling

In this paragraph the outcomes of the statistical test for the walking and cycling transport model are discussed. All stated numbers from the logistic regression analysis can be found in Table 4-4.

In total 5,817 children use active transport to travel to school (see Table 4-1). Most of them use the bicycle to travel to school, around two-third of all active travelers, other third part walks. On top of that, there were 31 children that used another active way, as a step or skates. As this is such a small group (only 0.5% of all active travelers) it is not worth bringing a third outcome into the model. Therefore they are left out of the model for walking/cycling. They are included in the active/passive model though.

4.4.1 Individual and households characteristics

Age

Descriptive: Cycling is used the most among all children when compared to walking, regardless of the age group. A little over half of all active 4-year olds cycle to school, and this figure increases with higher age. The difference between the oldest age group and the youngest age group is over 21%. At the highest age over three-quarter of all active respondents are using the bicycle. The difference is also visible from the mean age of the travel groups. The mean age of the walkers is 7.46 years. This differs significantly from the mean age of cyclers, that is 8.11 years on average (t = -10.455, sig. = .000). However, although the amount of cycling increases with a higher age, it only increases to three-quarter of all active travelers and the mean ages differ only 0.65 year from each other. These increases are not as high as the increases in the active/passive model, whereby the amount of active transport increases to almost 92% of all travelers and the mean ages differ 2.82 years from each other.

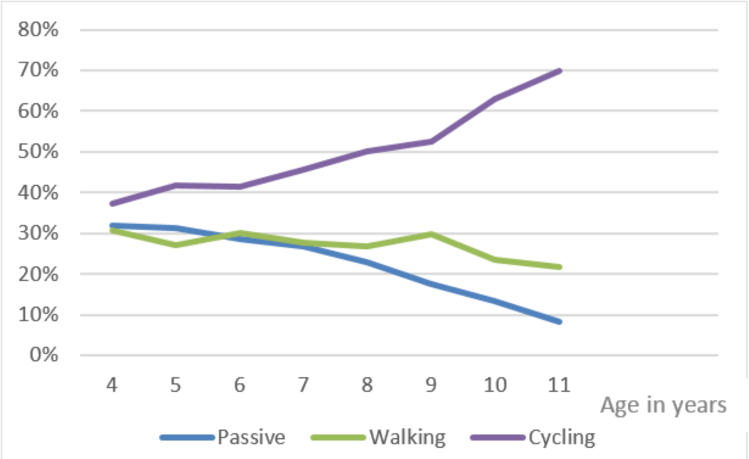
Logistic: Also in the logistic regression analysis is the influence of age visible. The age of a respondent influences the probability of cycling significantly, with a higher probability of cycling of 8.2% for every extra year. Although it is significant, the influence is not as big as it was on the probability of active transport.

Interpretation: The fact that older children use more cycling than younger children can be explained by the developed skills they need to ride their bike, as riding a bike requires more skills than walking (Van Goeverden & De Boer, 2013). Older children are therefore better equipped to cycle, resulting in a higher use of bicycles. The amount of cycling grows from both a decrease of passive travel as well as from a decrease of walking, similar to Dutch studies by Aarts et al. (2013) and (Van Goeverden & De Boer, 2013). This is visible in Figure 4-3, where both percentages of walking and passive transport are decreasing with higher age, in favor of more cycling.

The influence on age is however not as big on walking/cycling as it was on active/passive transport. This probably has to do with the more limited influence of independent travel on walking and cycling, something very closely linked to age.

The decision for active or passive transport is probably

Figure 4-3: Use of passive transport, walking and cycling. Distributed by age.



more influenced by the switch to independent travel than the decision between walking or cycling. Children who were walking accompanied at a young age, don´t have to switch to cycling when being allowed to travel unaccompanied if they get older, something necessary for children switching from passive transport to independent transport. They can remain walking.

Gender

Descriptive: There is not a big difference between boys and girls for walking and cycling, although girls cycled a bit more than boys (66% of the active travelling girls, 64.6% of the boys).

Logistic: The small differences are also visible from the logistic regression analysis. The probability that a boy cycles tend to be a little bit less than the probability that a girl cycle, as being a boy decreases the probability of cycling with 0.9%. This influence is not significant. With a Wald score of 0.015 there are 35 variables with a bigger influence on the probability of cycling.

Interpretation: The small and insignificant differences were expected, as they are in line with previous Dutch research (Van Goeverden & De Boer, 2013). Just as for the difference between active and passive transport, the direction of the difference is surprising, as girls tend to cycle a bit more than boys. In both international (Australian (Timperio, et al., 2006; Leslie, et al., 2010), US (McMillan T. E., 2007), New-Zealand (Yelavich, et al., 2008) as European studies (UK: (Panter, et al., 2010); Ireland: (Nelson, et al., 2008) & Belgium: (Van Goeverden & De Boer, 2013)), boys were found to cycle more often than girls. It might be the case that cycling is more often considered a (dangerous) activity in other countries and thus more suited for boys, instead of a way of transport as it is considered in the Netherlands.

Ethnicity

Descriptive: There is not much difference between natives and westerns when it comes to the percentage of walking or cycling, just as for active and passive transport. However, there is a difference between the non-westerns and the other ethnicity groups. The amount of cycling of non-westerns is quite lower, differencing over 22% with the rest (see Table 4-3).

Logistic: Similar results are found from the regression analysis, whereby the probability of cycling differs significantly if a respondent is native or if a respondent is non-western. Only being a western, compared to being a native (referent), does not give a significant difference. Being a non-western decreases the probability of cycling with almost 49% compared to being a native. Being a western also decreases the probability, when compared to being an native, although only with 24.5%.

Interpretation: These results are comparable with previous Dutch research among adults (Olde Kalter, 2008) and adolescents (Bere, et al., 2011) and were therefore expected. Another research found native adolescents far more likely to use bicycles than non-natives (De Bruijn, et al., 2005), something also visible in this research, although only for the non-westerns.

Table 4-3: Ethnicity and walking, cycling and bike ownership.

	Walking or cycling		Resp. don’t own bike (of active travelers)	
	Walking	Cycling	% of ethnic group	Frequency
Native	32.4%	67.6%	0.5%	23
Western	32.7%	67.3%	2.3%	7
Non-western	55.2%	44.8%	6.4%	37
Total	34.7%	65.3%	1.2%	67

Table 4-4: Variables in the Equation - walking/cycling.

Variables in the Equation – walking/cycling							
		Position	B	Wald	Sig.	Exp(B)	% of change of probability with increase of variable by 1 unit
Individual and household characteristics	Age	9	.079	22.208	.000	1.082	8.20%
	Gender (ref = male)	36	-.009	.015	.901	.991	-0.93%
	Ethnicity (ref = native)	7		27.902	.000		
	Ethnicity (western)	25	.219	1.655	.198	1.245	24.53%
	Ethnicity (non-western)	8	-.672	24.609	.000	.511	-48.95%
	Siblings	15	-.170	10.396	.001	.844	-15.59%
	Nr of parents in hh (ref = 1 parent household)	33	-.079	.226	.635	.924	-7.56%
	Nr of cars in hh	32	-.033	.324	.569	.967	-3.26%
	Nr of motorbikes in hh	30	-.053	.470	.493	.949	-5.14%
	Nr of mopeds in hh	35	.030	.065	.799	1.030	3.00%
	Nr of mini-mopeds in hh	29	-.157	.815	.367	.854	-14.55%
	Nr of bikes in hh	11	.123	18.430	.000	1.131	13.08%
	Income hh (ref = >€10k)	10		21.480	.002		
	Income hh (€10-€20k)	20	.753	3.575	.059	2.124	112.39%
	Income hh (€20-€30k)	28	.332	.864	.353	1.393	39.35%
	Income hh (€30-€40k)	23	.494	1.968	.161	1.638	63.83%
	Income hh (€40-€50k)	24	.469	1.756	.185	1.598	59.76%
	Income hh (>€50k)	18	.801	5.144	.023	2.227	122.70%
	Income hh (unknown)	27	.938	1.285	.257	2.556	155.61%
Trip char	Distance	1	.393	1073.873	.000	1.482	48.18%
	School distance i.r.t. total	22	.004	2.604	.107	1.004	0.37%
Built environmental characteristics	Land use diversity index	34	-.033	.155	.694	.967	-3.26%
	Address density	31	.000	.360	.548	1.000	0.00%
	Urbanization (ref = very strongly)	3		71.052	.000		
	Urbanization (strongly)	17	.347	6.009	.014	1.415	41.52%
	Urbanization (moderately)	6	.805	28.073	.000	2.237	123.66%
	Urbanization (low)	5	.896	33.012	.000	2.451	145.06%
	Urbanization (non)	4	1.260	54.588	.000	3.527	252.65%
Weather and seasonal characteristics	Wind speed (daily average)	16	.059	8.141	.004	1.061	6.13%
	Temperature (daily max)	14	.025	10.407	.001	1.025	2.48%
	Precipitation (daily sum)	26	-.011	1.429	.232	.989	-1.05%
	Season (ref = winter)	12		14.315	.003		
	Season (spring)	21	.258	3.495	.062	1.294	29.43%
	Season (summer)	19	.331	4.076	.044	1.393	39.26%
	Season (autumn)	13	.412	14.004	.000	1.510	51.04%
	Constant	2	-5.432	136.023	.000	.004	-99.56%

The reason for this difference can be found in cultural differences in the popularity and the image of cycling. The Netherlands is a ‘nation of cyclist’, whereas for many non-natives the bicycle represents a lower status (Olde Kalter, 2008). This image difference can also explain the bigger differences between walking and cycling amongst ethnicity groups than between active and passive transport. It is mostly the amount of cycling that gets influenced by these cultural differences, and not the amount of active transport, as non-westerns tend to walk more than natives and westerns (visible in Table 4-3).

The image difference is also visible when looking at whether respondents own bikes or not. Of all 67 active travelling children that don’t own a bike, over half of them are non-western. This means over 6% of all non-westerns don’t own a bike, compared to 0.5% of all natives and 2.3% of all westerns. This is in line with the research by Bere et al. (2008). Western non-natives might be more used to cycling than non-westerns and therefore also using the bike more than non-westerns.

Siblings

Descriptive: Although there are differences in walking and cycling among different amount of siblings, the percentage don´t outrun each other much and it does not give a linear increase or decrease. Around 65% of all active respondents with between 0 and 4 siblings cycle. The only outlier is respondents with 5 or more siblings, whereby over 75% cycles to school. However, as only 41 respondents have 5 or more siblings, there difference is minimal.

LR: The influence of the number of siblings on the probability of cycling turns out to be significant. For every extra sibling, the probability of cycling increases with 15.6%. With a Wald score of 10.4 it is the variable with the 15th biggest score.

Interpretation: The significant increase of the probability of cycling were unexpected, especially because the numbers don’t differ much in the descriptive statistics. An explanation could be that it might be easier to cycle with more siblings, as younger siblings that can’t cycle or walk themselves can be transported on the bike, something that is harder to do when walking. However, the influence is small and that could also mean that siblings don’t make a difference or have contradicting influences whereby they sometimes act as a barrier and sometimes as a possibility. Further research should be done whereby respondents are asked in what way their siblings influence their transport mode decision.

Number of parents

Descriptive: Respondents within households with 1 parent cycle less to school than respondents within households with 2 parents, a decrease of 4.5%. Of all active travelers, only 7.7% live in a one parent household.

LR: The amount of parents in a household does not influence the probability significantly. Being in a 1-parent household decreases the probability of cycling with 7.6%.

Interpretation: This is unexpected, as it seems more logical that the fastest transport mode is chosen, as time is more restricted (Pont, et al., 2009). However, the differences are small and insignificant, especially when realizing that only a small number of respondents live in a one parent household.

Household income

Descriptive: The percentage of cycling differs between the different household income classes (see Table 4-5). The two lowest classes surprisingly don’t have the lowest amount of cycling. However, as only 88 resp. 225 respondents are in these income classes (together 5.4% of all active travelers), they are hard to interpret. When starting at the third income class, households earning between €20,000 and €30,000, have the lowest percentage of cycling (59.1%). This increases over all higher income classes, up to over 70% for the highest income class.

LR: Only the lowest and the highest income classes differ significantly. The lowest class is compared to all other classes, the highest class is compared to the lowest class (referent). The probability of cycling is 122.7% higher if a respondent lives within a household in the highest income class compared to living in the lowest income class. Being in any other income class also increase the probability of cycling compared to being in the lowest income class, especially being in the second income class (€10,000-€20,000). Although it is not significant, the probability of cycling increases with 112.4%. The other income classes also increase the probability, but with lower figures and are also not significant.

Table 4-5: Percentage of walking/cycling by income class.

	Walking	Cycling
<€10,000	33.0%	67.0%
€10,000-20,000	37.3%	62.7%
€20,000-30,000	40.9%	59.1%
€30,000-40,000	37.1%	62.9%
€40,000-50,000	34.7%	65.3%
>€50,000	29.1%	70.9%
Total	34.7%	65.3%

Interpretation: Although no previous researches have made a distinction between walking and cycling and the influence of household income, it was expected that households with higher income would cycle more than households with lower incomes, as is the case. An increasing household income makes it easier to buy and maintain a bicycle for every family member, therefore increasing the percentage of cycling. This is confirmed by the average number of bikes in households, whereby households in the lowest three classes own on average almost a bike less (4.25) than households in the highest three classes (5.2). This difference is significant (t = 19.705, sig. = .000). Another explanation could be that, within households within the highest income class, both parents need to go to work after taking the children to school. Therefore their time is more limited, making them choose the faster cycling over the slower walking. They also might travel by bicycle to work after taking the children to school, something that is less often possible with walking.

The fact that the first two income classes have higher percentages might be because they don't earn enough money to buy a car and therefore rely more on bicycles as transport mode, even for longer distances, something that is different for the higher income classes, who can easier rely on cars.

Household transport mode ownership

Descriptive: As the motorized vehicles a household own are not used to bring the child to school if the child travels actively, they are not expected to differ among walkers and cyclers. For most motorized vehicles this is true[9]. However, the amount of cars in a household does differ significantly between households of walkers and cyclers (t = -3.940, sig. = .000). The amount of bikes in a household also differs significantly between walkers and cyclers, with almost half a bike extra in households of cyclers (t = -9.400, sig. = .000).

If the number of bikes in a household increases, the amount of cycling increases, starting at 40.9% for households with one bike in a household, increasing to over 72% for households with 9 or more bikes (see Table 4-6).

LR: None of the household's ownership of motorized vehicles have any significant influence on the probability of cycling. Although all (except mopeds) decrease the probability of cycling a bit, their influence is not big. Owning mopeds increases the probability of cycling a bit. The amount of

Table 4-6: Percentage of bicycle owning.

	Bike ownership (active respondents)			
	Freq.	%	Walking	Cycling
0	11	.2%	100%	0%
1	66	1.1%	59.1%	40.9%
2	209	3.6%	52.4%	47.6%
3	612	10.5%	41.6%	58.4%
4	1,636	28.1%	37.0%	63.0%
5	1,365	23.5%	32.7%	67.3%
6	915	15.7%	30.8%	69.2%
7	421	7.2%	25.6%	74.4%
8	291	5%	28.2%	71.8%
9 +	290	5%	27.5%	72.5%
Unknown	1	0%	100%	0%
Total	5,817	100	34.7%	65.3%

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[9] Motorbikes: t = .281, sig. = .779. Mopeds: t = .608, sig. = .543. Mini-mopeds: t = 1.076, sig. = .282.

bicycles in a household does give a significant influence, whereby every extra bicycle in a household increases the probability of cycling with 13.1%.

Interpretation: It makes sense that the amount of bicycles in a household has a significant influence on the probability of cycling to school, as a bicycle is necessary if a child wants to cycle to school. This is line with American research (Copperman & Bhat, 2007). The significant difference between the amount of cars is more surprising, as they, just as the other motorized vehicles, are not used for the transportation to school of active travelers. However it might be possible that households that don't own cars more often don't have a lot money and therefore also might have no money to buy bicycles for all family members. Another possible explanation is that they live in a very strongly urbanized area, and they therefore make less use of cars and bikes. Besides, the amount of cars does not give a significant in- or decrease on the probability of cycling.

4.4.2 Trip characteristics

Child accompanied

Descriptive: Of all walking children is 66% accompanied. This is a bit higher than the cycling children, of which 61% are accompanied, thereby confirming hypothesis 5. These figures differ significantly from each other (t = 4.126, sig. = .000).

LR: Variable showed signs of correlation and is therefore removed from the logistic regression analysis (see paragraph 4.2).

Interpretation: It was expected that walkers are more often accompanied than cyclers. This has to do with age, as older children cycle more often, but at the same time are more often not accompanied. Both have to do with increasing skills if the child gets older (Mitra, 2013). The results are in line with both international (Fyhri, et al., 2011; Lang, et al., 2011) and Dutch research (Van Goeverden & De Boer, 2013; Dessing, et al., 2014).

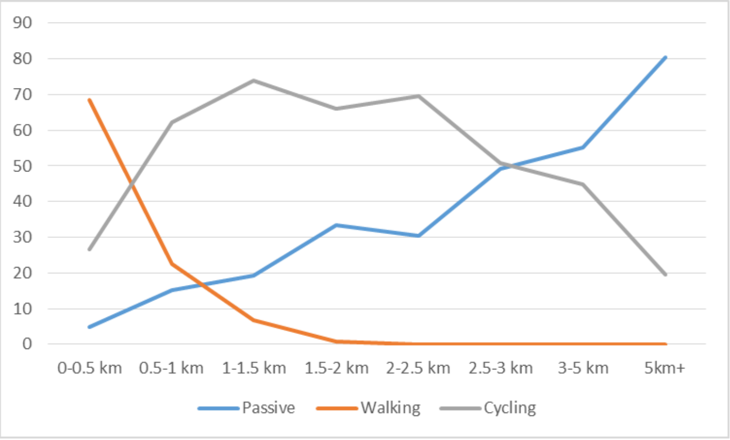
Distance

Descriptive: Of all active travelers, 88.7% lives within 2 kilometers, the distance that is considered cycling distance by Kennisplatform CROW (Kennisplatform CROW, 2013). 66.5% even lives within the considered walking distance of school (1 kilometer), although only within the distance category till 500 meters walking is more used than cycling (28% cycles). This increases up to 100% of active travelers if the distance is further than 2 kilometers. However, as only 11.3% of all active travelers live further than 2 kilometers away, this group is not very big. This is visible in Figure 4-4. The mean distance of walkers is with less than 500 meters significant lower than that of cyclers (1,500 meters) (t = -53.793, sig. = .000).

LR: Distance is the variable with the most influence on the probability of cycling, just as for active transport, thereby confirming hypothesis 10. With a Wald score of over 1073, it is 7.9 times as big as the variable with the second largest significant influence. Every extra hector-meter increases the probability with 48.2%.

Interpretation: As expected does a longer distance increase the percentage of cycling, in line with both international (Schlossberg, et al., 2006) and Dutch research (Aarts, et al., 2013). The percentage even increases up to 100% for respondents living 2

Figure 4-4: % of walking, cycling & passive transport distributed by distance.



kilometer or further away. The threshold point for switching from walking to cycling lies around 500 meter. Over a third of all active travelers live within this distance. A few hundred meters of distance is necessary before it pays off to switch from walking to cycling or passive transport. This creates the same figure as seen in the research by Aarts et al. (2013), visible in Figure 4-4. This also explains why a quarter of the respondents in the highest age group did not switch to cycling, as they live to close to switch from walking to cycling. It also explains why the constant variable has a big influence. With a Wald score of 136 it is the variable with the second biggest influence and it decreases the probability of cycling with 99.6%. Within a short distance of several hectometers, the constant decreases the probability of cycling. After all, it is unlikely that children living 200 meters from school will cycle to school.

School trip in relation to total travelled distance

Descriptive: The less the school trip distance makes up of the total travelled distance, the more children walk. The amount of walking is the highest amongst respondents of which the school trip makes up only 1-10%, decreasing when the trip makes up more of the total travel time. The amount of cycling is the highest among respondents who's school trip makes up 50% of their total travelled distance. The school trip compared to the total travelled of walkers was on average 22.7%: significant lower than of the cyclers (27.2%) (t = -9.783, sig. = .000).

LR: The logistic regression analysis finds an outcome in the same direction, whereby the probability of cycling increases with every extra percent the school trip makes out of the total travelled distance. However, the increase is only small with 0.37% and the influence is not significant.

Interpretation: Expected is that, the busier the day, the more likely the child is to cycle to school instead of walking, as it is faster and expands the area that a child can reach after school hours (Trapp, et al., 2012). However, just as with active and passive transport, it also turns out that within this data it is the other way around. It is possible that children of who the school trip makes up 50% or more have to travel further than other children, and that therefore their school trip makes up more of their total travel time. However, just as for active and passive transport, it is unknown what other trips are made during the day and therefore is this variable hard to interpret.

4.4.3 Built environment characteristics

Percentage of green

Descriptive: The range of the percentage of green in active respondents area is the same as for all respondents. The mean percentage of green in areas where walkers live is lower than average, with 53.9%. This differs significantly from the mean in areas where cyclers live (t = -8.808, sig. = .000). This is, with 59.2%, higher on average.

LR: Variable showed signs of correlation and is therefore removed from the logistic regression analysis (see paragraph 4.2).

Interpretation: Although no previous research has focused on the different influence of green on walking and cycling, it was expected that the percentages of green would be lower in walking areas. A lower percentage of green means more space for other land uses and thus shorter distances (Broberg & Sarjala, 2015). This is confirmed. However, the significance of the difference was not expected, as green in an area makes the area more walkable, but also more cycle-able. This might be caused by bigger distances in these green areas.

Land use diversity

Descriptive: The mean Shannon index differs significantly between the areas where walkers live and where cyclers live, although the difference is small (t = -3.917, sig. = .000). The mean index figure is a bit lower for areas where walkers live (1.74), compared to the areas where cyclers live (1.79). This means that the land use is less diverse in the areas where walkers live than in the areas where cyclers live. The range of the index is also for active respondents 2.8.

LR: The index has no significant influence on the probability of cycling. The probability of cycling decreases with 3.3% for every point the index rises. This influence is very small, it is the variable with the second lowest influence.

Interpretation: As not a lot of researches have focused on the influence of land use diversity, they especially haven't made a distinction between walking and cycling. However, as in areas with more diverse land uses, the schools will be more concentrated and thus closer, decreasing the amount of cycling and increasing the amount of walking. In less urbanized areas, the concentrations are lower and therefore the distances longer, giving more reason to use the bicycle instead of walking (Oliver, et al., 2014). It is therefore unexpected that the land use is more diverse in areas where cyclers live than where walkers live. The influence on the probability of cycling on the other hand is in line with the expectation. However, as the range of the index is quite small, the decrease of the probability of cycling between the most extreme cases is only 10.5%.

Residential density

Descriptive: The mean address density in the postal code areas differ significantly between the areas where walkers and cyclers live, although the difference is small (t = 2.043, sig. =.041). The mean address density in the walkers areas is 3,981 addresses, compared to 3,824 addresses in the areas where cyclers live. The range is almost 30,000.

LR: The address density does not significantly influence the probability of cycling. Just as for active/passive transport, the odds ratio is very close to 1, making the influence almost 0. The probability increases with 0.0009% for every extra address in a neighborhood. For the most extreme cases, the probability of cycling increases with 27%.

Interpretation: Although no previous studies have differentiated between walking and cycling, these small differences in the data are as expected. Walkers living in more dense areas than cyclers makes sense, as distances are shorter and therefore more easily walked. The increase of the probability of cycling however was unexpected, as this is in the opposite direction of descriptive data. However, the increase is even for the most extreme cases very small and the influence is therefore negligible.

Urbanization

Descriptive: The percentages of cycling increases if the municipality is less urbanized. The lowest percentage is 56.6% in very strongly urbanized municipalities. This figure is more than 16% higher in the non-urbanized areas.

LR: All urbanization levels turn out to have significant influence on the probability of cycling. With very strongly urbanized being the referent, all other urbanization classes increase the probability: the lower the urbanization, the higher the probability of cycling. These variables are the variables that have the biggest influence after distance and the constant, taking the third, fourth, fifth and the sixth place. The only exception is the strongly urbanized, that takes the seventeenth place, but still increases the probability of cycling with 41.5% compared to living in a very strongly municipality.

Interpretation: These outcomes were expected, whereby lower urbanization levels mean more cycling. As the schools will be less concentrated in lower urbanized municipalities, the distance grow and walking becomes more time-consuming (Davison, et al., 2008). This is line with Dutch research among adolescents, whereby respondents living in less urbanized cities were more likely to use their than bike than those living in more urbanized cities (De Bruijn, et al., 2005).

4.4.4 Weather and seasonal characteristics

Wind speed

Descriptive: The range of the wind speed is the same as for all respondents: 14 kilometers per hour. The mean daily average wind speed of walkers and cyclers do not differ significantly (t = -1.313, sig. = .189).

LR: The influence of wind speed on the probability of cycling is significant, whereby every extra kilometer daily speed increases the probability of cycling with 6.1%. For the most extreme cases, the increase of the probability of cycling is 84.8%.

Interpretation: Because of the sensitivity of cycling, wind speed is expected to decrease cycling, just as it did in the research by Sabir (2011) among Dutch adults. Ultimately, cycling at high wind speeds is harder and more difficult and people can therefore decide to switch to walking or a passive transport mode. However, these results show a different direction and people cycle more if there is more wind. This seems unlikely, but might be explained by the fact that not the wind speeds at time of travel are measured, but the daily averages. This makes it hard to interpret the variable.

Temperature

Descriptive: The range of the temperature is 42°C: ranging from minus 6.5°C to 35.5°C. However, also here accounts that most respondents (82%) experienced temperatures between 5°C and 25°C. The average daily temperature of cyclers differs significantly with that of walkers, whereby the temperature is a little over 1°C lower (t = -5.885, sig. = .000).

LR: Temperature increases the probability of cycling significantly, with an increase of 2.5% for every degree rise in temperature. This means that, for the most extremes, the probability increases with 104.2%. For the mid 82% with the temperature range of 20°C, the probability increases with almost 50%. It is the weather variable with the biggest influence.

Interpretation: As cycling and walking is both outside and uncovered, temperature was not expected to make a difference between walking and cycling. Occasions as frost or snow fall at cold temperatures can make people switch from cycling to walking, but those occasions are limited and it only happens maybe a few times per year in the Netherlands. Besides, the measured temperature is the maximum daily temperature, that is probably higher than the temperature in the morning. Therefore, it is surprising that the average daily temperature of cyclers differs with that of walkers and the probability of cycling increases with higher temperatures. Although more people cycled with higher temperatures in the research by Sabir (2011) among Dutch adults, this did not seem to be at the expense of walking and therefore this result was not expected. It was expected though that it was the weather variable with the biggest influence.

Precipitation

Descriptive: The precipitation ranges from 0 millimeter to over 57 millimeter. However, most respondents had way less, as over 90% had less than 7 millimeters, and over 67% had less than 1 millimeter. The mean sum of precipitation is almost equal for walking and cycling and therefore does not differ significantly (t = .592, sig. = .554).

LR: The sum of precipitation also has no significant influence on the probability of cycling. For every extra millimeter of precipitation, the probability decreases with 1.05%. This means a decrease of 60% for the most extreme cases.

Interpretation: The influence of precipitation is not big. It could have been that that people switch to walking if it rains, so they can hold an umbrella. On the other hand, if they take the bike instead of walking they arrive faster at the destination. The relationship with precipitation is therefore unclear, also because the sum of the whole day is measured, instead of the precipitation the time of travel. This is line with results among Dutch adults, whereby extreme precipitation affects the amount of cycling more than the amount of walking (Sabir, 2011).

Season

Descriptive: The percentage of cycling is the highest in summer, whereby almost 70% of all active travelers cycle to school. The lowest amount of cycling is in winter, with 58.6% of the active respondents using the bike.

LR: 3 out of the 4 season variables have a significant influence on the probability of cycling. Only the influence of travelling in spring compared to travelling in winter (referent season) does not influence the probability significantly, although it still increases the probability with 29.4%. Summer and autumn both increase the probability of cycling compared to the winter: summer with 39.3%, autumn with 51%.

Interpretation: It was expected that the most cycling was done in summer, as the conditions are best in summer with the longest day light and the best weather conditions (Børrestad, et al., 2011). This was also expected, as cycling in the dark is seen as more dangerous than during daylight (Hume, et al., 2009). Furthermore, the cold, snow and frost can make it more difficult and less attractive to cycle, making people therefore switch to walking. It is contradicting that the influence of autumn looks bigger than of summer in the logistic regression, just as was the case with the active/transport model. This also might be caused by the close connection between seasons and weather variables.

5. Discussion and conclusion

Over the last years, childhood obesity is increasing all over the world, also in the Netherlands (Rijksinstituut voor Volksgezondheid en Milieu, 2014) (TNO, 2013). A way of counteracting this problem is to increase the amount of active travelling to school (ATS) (Trapp, et al., 2012) and therefore sufficient and specific information is needed. This research tries to fill the gap of information about the Dutch situation, so the factors stimulating and limiting ATS or cycling are better understood and comprehensive policies can be better written or adapted in the future.

5.1 Answering research questions

To investigate what variables are of influence on the decision for a transport mode, two research questions have been formulated. The first is focusing on the decision between active and passive transport, the second is focusing on active transport specifically, whereby the decision between the two most used active transport modes, walking and cycling, is investigated. This is especially interesting in the Netherlands, as cycling is more used in the Netherlands than in other countries. That is also visible from the results: of all respondents, over half of them cycles to school. In total 78% of all children use ATS. This group of active travelers consists for a third of walkers, and for two third of cyclers. This is quite high when compared to for instance American (Schlossberg, et al., 2006), Swiss (Grize, et al., 2010) or Belgium research (Van Goeverden & De Boer, 2013), whereby respectively only 5%, 16.9% and 25.6% of the respondents cycled to school. Therefore, the decision has been made to make a distinction between active and passive transport on the one side, and walking and cycling on the other side, resulting in the following research questions:

1. *To what extent is the decision for active or passive transport to school by Dutch primary school children influenced by the individual’s and other characteristics?*
2. *To what extent are differences between walking and cycling to school by Dutch primary school children influenced by individual’s, household’s and other characteristics?*

The decision for both active or passive transport as for walking and cycling is mostly influenced by the distance that needs to be travelled. With a bigger distance, the chance becomes smaller that a child uses ATS, but if it uses ATS it will probably cycle. The fact that distance is the biggest influencer on the decision of both ATS and cycling was expected and in line with earlier conducted researches (amongst others the reviews by Davison et al. (2008), Mitra (2013), Stewart et al. (2012), Panter et al. (2008), Stewart (2011), Wong et al. (2011) and Pont et al. (2009)). This makes sense, as with both passive transport and cycling bigger distances can be covered with a faster speed than by active transport resp. walking. The threshold point for active transport lies around 2.5 kilometer, whereby children use more passive transport than ATS. However, as over 85% lives within this distance, most children use ATS. Of all passive travelers, 45% lives further than 2.5 kilometers. This means that 55% of all passive travelers live within a distance that can be traveled actively. Therefore, the decision for ATS can’t be explained only by the variable distance. For the decision between walking and cycling, this is a little different. Up to a distance of 500 meter, the majority walks to school. After all, if a child lives only (a few) hundred meter from school, the child will walk instead of cycling. After 500 meter the number of cyclers increases, up to 100% of all active respondents travelling 2,000 meter or more. However, as only 11.3% of all active travelers travels 2 kilometers or more, this group is not big.

Age is the variable with the second biggest influence on ATS, starting at 68% of all 4-year olds and increasing up to almost all 11-year olds (91.6%). This is mostly caused by the influence of accompanying the child to school, a thing closely linked to age. With a higher age, physical abilities and skills to cope with traffic develop, allowing children to switch from accompanied to independent travel. For some children this switch brings along the switch from passive to active transport, as children have almost no possibilities to travel actively when they are not accompanied[10]. These increased skills also apply to cycling skills, thereby increasing cycling from 55% of all active 4-year olds up to 76% of all active 11-year olds. This increase is quite smaller than the increase of ATS rates and does not extend to (almost) all 11-year olds. The differences in cycling among age groups cannot be explained by the accompaniment of the respondents, as children can walk and cycle to school both independently as well as accompanied. There does seem to be a relationship between the two though, as walking children are more often accompanied than cycling children, and also have a lower age. However, if a child lives within a few hundred meters from school, aging does not give a reason to switch to cycling and children will keep walking to school. It is therefore not surprising that it is the variable with only the ninth biggest influence.

Third and fourth biggest influencers on ATS are the amount of cars and bikes a household owns, whereby more cars mean less ATS and more bikes mean more ATS. Logically, a higher amount of cars means a lower amount of ATS, as a child can only travel passively if there is a passive transportation mode available. Most children that are travelling passively are going by car (96.3%) and owning more cars increases the chance a car is available to take the child to school. It is not surprising that the amount of cars does not affect cycling in the same way. The amount of bicycles in a household are of more influence on cycling, and, although it is not as big as on ATS, a higher amount of bicycles means both more active transport as more cycling. This was as expected, as it is necessary to have a bicycle to cycle to school and, at the same time, it increases the possibility to travel actively to school as bigger distances can be covered by cycling than by walking. The amount of other vehicles in a household had on both ATS as on cycling small and mostly insignificant influence.

Ethnicity is the variable with the biggest influence of all individual and household characteristics on the decision between walking and cycling, and, although it is only the twelfth biggest influencer on ATS-decision, the influence on both ATS as on cycling is in the same direction. Belonging to the non-western ethnic group means a smaller chance of both ATS and cycling and being a native increasing that chance. With these outcomes it can be confirmed that ethnicity has the same influence on Dutch primary school children as on Dutch adolescents, as found in the research by Bere et al. (2008). Natives use the most ATS and cycling, caused by the huge active transport culture (especially cycling) in the Netherlands. Cycling has a low status in some cultures and therefore, cycling is not as popular amongst non-natives and especially among non-westerns (Olde Kalter, 2008). The difference in cycling rates between natives and non-westerns is 22%. The same is visible from the lower amount of bike owning rates among especially non-westerns. The ATS-rates show smaller differences though, as non-westerns have higher walking rates than natives and westerns. The ATS and cycling rates of western non-natives differ less compared to natives. They might be more used to the cycling culture than non-westerns are.

The lower use of ATS among respondents living in a one parent household compared to respondents living in two parent households was surprising. The difference might be caused by tighter schedules of the parent, that does not have much time to accompany the child to school and therefore chooses the fastest mode, the car. However, as it also seems logical that children in one parent households are more often travelling independently and thus actively, the influence was unexpected. The same accounts for the influence of the respondents' schedule on both ATS and on cycling. As the decision for a transport mode is not only decided by the home-to-school trip but also by the trip after school, back to home or to another destination, this variable was expected to have an influence. However,

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[10] Public transport makes unaccompanied passive transport possible, but is scarcely used by primary school children in the Netherlands.

this might be caused by the way the variable was measured or by the different kind of influences caused by this variable: sometimes causing more ATS/cycling, sometimes less.

ATS is as expected less used in more rural areas, although the differences are small. Areas that are less urbanized are, overall, less walk- and cycle-able and more adjusted to car-use. This makes them less suited for ATS, especially for walking. The influence of urbanization on the cycling rates is bigger than on ATS rates and the amount of cycling increases if the area is less urbanized. The level of urbanization is closely related to distance, as a non-urbanized area has a less diverse land use and both residential as school density is lower. This increases the average distance from home to school, compared to urbanized areas. The other built environmental characteristics have negligible influences, probably because their influence is already measured within the variables distance and urbanization.

The least amount of ATS is, logically, done on days with low temperatures or more precipitation, as these conditions are unattractive for ATS. The influence of the weather variables are bigger on the decision between active and passive transport than on walking or cycling. This was expected, as walking and cycling are both outdoor activities and are therefore both influenced by rain, wind or temperature. Therefore it is surprising that higher wind speed and temperature give an increase in cycling rates. However, the weather variables are not measured at time of travel and therefore there influence has to be treated with caution.

5.2 Strengths, limitations and recommendations for further research

Strengths

The biggest strength of this research is the distinction that is made between ATS as a whole and walking and cycling. A lot of international (amongst others the reviews by Davison et al. (2008), Mitra (2013), Stewart et al. (2012), Panter et al. (2008), Stewart (2011), Wong et al. (2011) and Pont et al. (2009)) and some smaller Dutch researches (Aarts et al. (2013), Dessing et al. (2014), de Vries et al. (2010); Van Goeverden & de Boer (2013)) has been done so far, but none have focused deeply on how walking and cycling differs from each other and from ATS as a whole. That distance has a big influence on both was expected, but the different influence of urbanization, weather or ethnicity were unexpected.

It is especially in the Netherlands of great importance that the different influences are becoming clear, as the ATS situation in the Netherlands differ much from the situation in other countries. The Netherlands is famous for its cycling culture with even children of young ages already using bikes (J/M Ouders, 2015). In other countries, active travelling to school is mostly done by walking (Stewart, et al., 2012) and it is therefore logically that the focus is also on walking. Cycling however is a preferable travelling mode, as bigger distances can be covered in the same time by cycling, therefore enabling more children to travel actively to school.

A focus on the Dutch situation is furthermore of importance, as, apart from the cycling culture, the schools systems differ and the urban form is way more set to active travelers than in other countries. It is therefore a good addition that the data used in this research is Dutch data, originating from a national database. A big plus was the large amount of cases that could be used to investigate the home-to-school travel. With this database statements can be made based on the Dutch ATS situation, a foundation that is necessary for policy alterations.

This research is also the first Dutch research to focus on the different use of ATS and cycling among primary school children with different ethnic backgrounds. The results are in line with the results for adolescents (Bere, et al., 2008), emphasizing that especially the non-westerns are a priority group to focus on when it comes to the use of active school transport. Future research should make a distinction between different non-western ethnicities, to see if there are differences between the ethnic groups.

Limitations

The use of secondary data brought along a few limitations. The main limitation was the lack of precise information about the actual route a respondent travelled. The available data was about the area around the home and around the destination, but it was not known what a child faced along the way. This limited both the investigation of the influence of built environmental variables along the route, as the selection of the cases. They could only be selected by the travel purpose of 'following education/course', what led to insecurities about the in- and exclusion of certain cases. Because of that, generalizations of the results of this study should be taken with precautions, and it is unsure whether results apply to all Dutch primary school children. Another consequence of lacking information about the actual route is that it is only possible to investigate the trip from home to school in the morning, and not in the afternoon or the way back school to home. Further research should investigate the actual route and whether these trips differ from each other, to see if different policy is necessary for different trips.

The use of secondary data also meant that it was not always possible to investigate all variables as in-depth as hoped-for. This accounts for instance to the schedule of both respondent and other family members, the accompanier and the perceptions and values of the social environment. It also accounts to the weather variables, that were recorded on daily basis instead on time of travel. So far only two studies investigated the weather on time of travel, being also the only studies that found significant outcomes (Mitra, 2013; Müller, et al., 2008). If the decision for a transport mode is made based on the weather conditions it becomes clear that writing or adapting policies to increase ATS is useless, as we cannot alter the weather with a policy. More research is therefore necessary on the influence of these missing variables.

Another limitation is the use of a cross-sectional database. This immediately eliminated the possibility to investigate in what way ATS is changing and declining and which variables seem to have a key role in that process. Also causality could not be investigated with this cross-sectional database. Further research should be based on longitudinal data to investigate the declining ATS, instead of only looking at one particular moment. The influence of weather and seasons are variables that differ for a respondent on different days and can therefore have different influence at different times. As almost no research has investigated the influence properly, a longitudinal research could fill this gap.

An interesting approach for future research can also be found in using a different study design, whereby a multi-logistic regression analysis is done. Because of the use of the binary logistic regression analysis, it was possible to put a strong emphasize on the differences between walking and cycling. However, the choice for a transport mode is not made first between passive and active, and after that between walking and cycling, but is made between transport modes, resulting in passive or active transport. With a multi-logistic regression analysis passive travelling, cycling and walking can be put in one model and be compared all together at the same time.

5.3 Recommendations for policies

By changing or writing policies, it could be possible to alter some variables with the goal of increasing the ATS and the cycling rates. As this is desired, policies can be written or adapted to achieve the highest possible ATS and cycling rates.

The first focus is, of course, on distance. Children who have to travel too far to school won't be travelling actively anyway. It is therefore important to make sure not too much schools are closed (as is happening in the past years (Rijksoverheid, 2015a)) and that even in less dense areas primary schools are kept widespread. That way, it is possible for all children to visit a school nearby. However, the decision between schools is also influenced by the preferences of the parents, who might favor a school further away because of religion or education system at a certain school. To also give those children the possibility to travel actively, a policy could be written whereby children have to walk the last part of their journey. If parents have to drop their children off 500 meters from the school, this means at least a partly active trip of 5 to 10 minutes walking in the morning or could make parents switch to active travelling for the complete trip. This could also be combined with 'walking school buses', whereby one parent is responsible for walking to school with children from multiple families, dividing the time constraints over different parents that way.

Another focus area is age. Although age can't be altered by policies, policies can be adapted to age. Connected to age are the skills children need to walk or cycle. Schools can put more focus on learning children to cope with traffic and practice walking and cycling skills. Traffic situations around schools can be made more safely, giving parents, children and teachers more confidence that the child can cope with active travelling. At the same time is the accompaniment of importance, as young children are almost always accompanied. If parents combine the accompaniment, they divide the burden and give their children the chance to travel to school actively. Also here could the walking school bus or cycling school bus be used. To make this happen, it is of great importance that parents value ATS or cycling to school, because otherwise they won't cooperate. Information campaigns are therefore also necessary, to emphasize the good effects of ATS.

A special focus hereby is needed for children with non-western backgrounds. Not only the children, but also their parents use less ATS than western people and especially native people, as especially cycling has a low status and is seen as dangerous. By teaching both the children and the parents more about cycling and maybe even how to cycle, the image can change and the use can increase.

The use can also increase by making sure neighborhoods and home-to-school routes are safe, have good infrastructure for active travelers and are attractive. However, as said before, it is still unclear which of these factors are most important and more research is therefore needed.

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7. Appendixes

7.1 Sample selecting

Steps taken to select the sample from the OViN Database.

For active/passive sample:

Step	Purpose of step	Variables involved	Selection
1	Selecting the correct age	Age	Between 4 and 11 years
2	Selecting educational trips	Destination/target (**Doel**)	Doel = 7, following education/courses
3	Selecting home as departure place	Postalcode departure place (**dept_pc4**) and Postalcode residential place (**res_pc4**)	Dept_pc4 = res_pc4
4	Selecting only weekdays	Day of the week (**Weekdag**)	Weekday = Monday (2), Tuesday (3), Wednesday (4), Thursday (5), Friday (6).
5	Selecting correct times	Time of departure: hour and minute (**VertUur**)	VertUur: 7 and 8
6	Selecting cases from same respondents	ID number respondents (**OPID**)	Only unique ID numbers
7	Sorting out 'other' transport mode	Transport mode	Sorting out category 24, 'other'

For walking/cycling sample:

Step	Purpose of step	Variables involved	Selection
1	Selecting total sample (passive and active)	Sample active/passive	See all steps in previous table
2	Selecting active cases for walking/cycling sample	Transport mode	Selecting category 15 'cycling' and 22 'walking'

7.2 Correlation

Correlation data (before removing correlating variables)

Correlation matrix (before correlating removing variables)

	Age	Gender	Ethnicity	Siblings	Nr of parents in hh	Nr of cars in hh	Nr of motorbikes in hh	Nr of mopeds in hh	Nr of mini-mopeds in hh	Nr of bikes in hh	Income hh	Distance	School distance i.r.t.	Land use diversity	Address density	Percentage of green	Urbanization	Wind speed	Temperature	Precipitation	Seasons	Child accompanied?	Bike owner	Departure time	Travel time
Age	1	-.013	-.015	.010	.059	-.002	.006	.009	.000	.074	.022	.045	-.092	.023	.005	.021	.040	.011	-.001	.007	-.003	-.563	.052	-.077	.077
Gender	-.013	1	.006	.001	.006	-.030	.004	-.001	-.009	.018	-.002	.002	.014	-.006	-.003	-.004	.012	-.001	-.012	-.009	.002	-.017	-.015	-.005	-.023
Ethnicity	-.015	.006	1	-.006	.129	-.168	-.047	-.005	-.008	-.250	-.168	-.027	.080	-.150	.155	-.239	-.259	.005	.003	.003	.002	.052	-.150	-.001	.039
Siblings	.010	.001	-.006	1	-.153	.020	-.026	-.008	-.023	.494	.070	.029	-.003	.015	-.045	.076	.083	.004	-.018	-.011	.009	-.037	-.024	.041	.043
Nr of parents in hh	.059	.006	.129	-.153	1	-.284	-.057	.004	-.016	-.299	-.340	.046	.024	-.064	.078	-.090	-.099	.008	.015	.014	-.014	-.005	-.028	-.027	.050
Nr of cars in hh	-.002	-.030	-.168	.020	-.284	1	.111	.031	.029	.197	.298	.032	-.028	.128	-.108	.149	.166	-.014	-.003	-.010	-.002	-.018	.076	.013	-.039
Nr of motorbikes in hh	.006	.004	-.047	-.026	-.057	.111	1	.308	.217	.076	.035	.012	-.011	.037	-.047	.061	.070	.013	-.015	.004	.012	-.008	.020	-.004	-.013
Nr of mopeds in hh	.009	-.001	-.005	-.008	.004	.031	.308	1	.332	.032	-.042	.025	.015	.004	-.023	.018	.013	.007	-.021	-.002	.022	-.020	.002	-.018	.021
Nr of mini-mopeds in hh	.000	-.009	-.008	-.023	-.016	.029	.217	.332	1	.010	-.022	-.002	.015	-.005	-.004	-.018	-.032	.003	-.003	.008	-.005	.006	-.006	-.016	-.019
Nr of bikes in hh	.074	.018	-.250	.494	-.299	.197	.076	.032	.010	1	.248	.032	-.055	.099	-.106	.168	.166	-.014	-.002	.000	-.006	-.078	.169	-.006	.022
Income hh	.022	-.002	-.168	.070	-.340	.298	.035	-.042	-.022	.248	1	-.010	-.035	.042	-.013	.013	-.004	-.006	-.001	-.021	.004	-.021	.056	.000	-.006
Distance	.045	.002	-.027	.029	.046	.032	.012	.025	-.002	.032	-.010	1	.272	.003	-.037	.050	-.007	.008	-.023	-.009	.005	.141	.010	-.278	.620
School distance i.r.t. total	-.092	.014	.080	-.003	.024	-.028	-.011	.015	.015	-.055	-.035	.272	1	-.045	.034	-.049	-.076	.014	-.039	.025	.032	.130	-.032	-.109	.234
Land use diversity index	.023	-.006	-.150	.015	-.064	.128	.037	.004	-.005	.099	.042	.003	-.045	1	-.092	.443	.381	-.026	.010	-.034	-.007	-.072	.052	.032	-.063
Address density	.005	-.003	.155	-.045	.078	-.108	-.047	-.023	-.004	-.106	-.013	-.037	.034	-.092	1	-.442	-.402	-.043	.004	-.015	.017	.057	-.035	.002	.042
Percentage of green	.021	-.004	-.239	.076	-.090	.149	.061	.018	-.018	.168	.013	.050	-.049	.443	-.442	1	.686	.017	-.031	-.013	.006	-.103	.077	.012	-.064
Urbanization	.040	.012	-.259	.083	-.099	.166	.070	.013	-.032	.166	-.004	-.007	-.076	.381	-.402	.686	1	-.012	-.018	-.025	-.003	-.131	.072	.039	-.116
Wind speed	.011	-.001	.005	.004	.008	-.014	.013	.007	.003	-.014	-.006	.008	.014	-.026	-.043	.017	-.012	1	-.102	.239	.091	.010	-.002	-.006	-.003
Temperature	-.001	-.012	.003	-.018	.015	-.003	-.015	-.021	-.003	-.002	-.001	-.023	-.039	.010	.004	-.031	-.018	-.102	1	.052	-.550	-.001	-.001	.016	-.039
Precipitation	.007	-.009	.003	-.011	.014	-.010	.004	-.002	.008	.000	-.021	-.009	.025	-.034	-.015	-.013	-.025	.239	.052	1	-.024	.010	.009	.006	-.017
Seasons	-.003	.002	.002	.009	-.014	-.002	.012	.022	-.005	-.006	.004	.005	.032	-.007	.017	.006	-.003	.091	-.550	-.024	1	.010	-.004	-.014	.018
Child accompanied?	-.563	-.017	.052	-.037	-.005	-.018	-.008	-.020	.006	-.078	-.021	.141	.130	-.072	.057	-.103	-.131	.010	-.001	.010	.010	1	-.022	.032	.044
Bike owner	.052	-.015	-.150	-.024	-.028	.076	.020	.002	-.006	.169	.056	.010	-.032	.052	-.035	.077	.072	-.002	-.001	.009	-.004	-.022	1	-.020	-.011
Departure time	-.077	-.005	-.001	.041	-.027	.013	-.004	-.018	-.016	-.006	.000	-.278	-.109	.032	.002	.012	.039	-.006	.016	.006	-.014	.032	-.020	1	-.346
Travel time	.077	-.023	.039	.043	.050	-.039	-.013	.021	-.019	.022	-.006	.620	.234	-.063	.042	-.064	-.116	-.003	-.039	-.017	.018	.044	-.011	-.346	1

VIF/tolerance (before correlating removing variables)

Coefficients[a]				Coefficients[a]		
Model		Collinearity Statistics			Collinearity Statistics	
		Tolerance	VIF		Tolerance	VIF
1	Age	.653	1.531	Age	.605	1.653
	Gender	.996	1.004	Gender	.995	1.005
	Ethnicity	.842	1.188	Ethnicity	.830	1.204
	Siblings	.717	1.396	Siblings	.716	1.397
	Nr of parents in hh	.793	1.262	Nr of parents in hh	.796	1.256
	Nr of cars in hh	.829	1.206	Nr of cars in hh	.815	1.227
	Nr of motorbikes in hh	.942	1.062	Nr of motorbikes in hh	.935	1.070
	Nr of mopeds in hh	.949	1.054	Nr of mopeds in hh	.944	1.059
	Nr of mini-mopeds in hh	.986	1.014	Nr of mini-mopeds in hh	.988	1.012
	Nr of bikes in hh	.607	1.648	Nr of bikes in hh	.603	1.657
	Bike owner	.943	1.061	Bike owner	.943	1.061
	Income hh	.802	1.248	Income hh	.796	1.256
	Distance	.818	1.223	Distance	.796	1.256
	Child accompanied?	.638	1.568	Child accompanied?	.614	1.629
	Departure time	.909	1.100	Departure time	.858	1.166
	School distance i.r.t. total	.898	1.113	School distance i.r.t. total	.917	1.091
	Land use diversity index	.841	1.190	Land use diversity index	.834	1.200
	Address density	.823	1.215	Address density	.825	1.212
	Urbanization	.671	1.490	Urbanization	.665	1.504
	Wind speed	.926	1.080	Wind speed	.914	1.094
	Temperature	.571	1.750	Temperature	.572	1.747
	Precipitation	.934	1.071	Precipitation	.924	1.083
	Seasons	.575	1.738	Seasons	.576	1.737
	a. Dependent Variable: Active or passive travelling			a. Dependent Variable: Walking or Cycling		

Collinearity diagnostics (before removing correlating variables) – active/passive

Collinearity Diagnostics

Model		Eigenvalue	Condition Index	Variance Proportions																							
				(Constant)	Age	Gender	Ethnicity	Siblings	Nr of parents in hh	Nr of cars in hh	Nr of motorbikes in hh	Nr of mopeds in hh	Nr of mini-mopeds in hh	Nr of bikes in hh	Bike owner	Income hh	Distance	Child accompanied?	Departure time	School distance i.r.t. total	Land use diversity index	Address density	Urbanization	Winds peed	Temperature	Precipitation sum	Seasons
1	1	15.905	1.000	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	2	1.178	3.675	.00	.00	.00	.00	.00	.02	.00	.26	.35	.12	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	3	.996	3.995	.00	.00	.00	.00	.00	.55	.00	.01	.04	.09	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	4	.943	4.108	.00	.00	.00	.00	.00	.05	.00	.10	.08	.76	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	5	.829	4.381	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88	.00
	6	.742	4.630	.00	.00	.00	.00	.00	.05	.00	.59	.52	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00
	7	.522	5.521	.00	.00	.24	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.45	.01	.00	.04	.00	.00	.00	.00	.00	.00	.00
	8	.475	5.785	.00	.00	.73	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.14	.00	.00	.01	.00	.02	.00	.00	.00	.01	.00
	9	.405	6.269	.00	.00	.01	.02	.03	.07	.01	.01	.00	.00	.00	.00	.00	.01	.06	.00	.02	.00	.33	.03	.00	.00	.00	.00
	10	.342	6.818	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.01	.26	.00	.09
	11	.303	7.245	.00	.01	.00	.00	.05	.00	.01	.00	.00	.00	.00	.00	.00	.11	.31	.00	.00	.00	.18	.01	.00	.00	.00	.00
	12	.275	7.599	.00	.01	.00	.00	.49	.01	.05	.01	.00	.00	.01	.00	.00	.00	.07	.00	.00	.00	.00	.01	.01	.00	.00	.00
	13	.240	8.134	.00	.00	.00	.06	.00	.01	.02	.00	.00	.00	.00	.00	.00	.12	.05	.00	.70	.00	.07	.00	.00	.00	.00	.00
	14	.198	8.974	.00	.00	.00	.46	.00	.06	.06	.00	.00	.00	.01	.00	.00	.05	.00	.00	.19	.00	.10	.00	.05	.00	.01	.00
	15	.159	10.008	.00	.00	.00	.18	.00	.02	.26	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.55	.01	.06	.00
	16	.142	10.589	.00	.00	.00	.01	.03	.04	.45	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.03	.01	.12	.29	.00	.02	.02
	17	.098	12.758	.00	.03	.00	.05	.03	.00	.06	.00	.00	.00	.05	.00	.08	.00	.00	.00	.00	.03	.19	.34	.05	.05	.00	.09
	18	.066	15.530	.00	.01	.00	.05	.11	.02	.04	.00	.00	.00	.23	.00	.09	.00	.01	.00	.00	.01	.00	.00	.00	.42	.00	.52
	19	.054	17.227	.00	.00	.00	.02	.17	.00	.02	.00	.00	.00	.48	.00	.42	.00	.00	.00	.00	.14	.01	.03	.00	.02	.00	.03
	20	.051	17.670	.00	.33	.00	.02	.04	.01	.00	.00	.00	.00	.14	.00	.00	.01	.14	.00	.00	.45	.01	.16	.00	.03	.00	.04
	21	.049	17.936	.00	.30	.00	.04	.01	.04	.02	.00	.00	.00	.02	.00	.30	.02	.12	.00	.00	.27	.04	.24	.00	.04	.00	.04
	22	.022	26.936	.00	.25	.00	.04	.01	.02	.00	.00	.00	.00	.07	.25	.08	.01	.17	.00	.01	.05	.02	.05	.02	.12	.00	.12
	23	.007	48.597	.01	.04	.00	.05	.01	.00	.00	.00	.00	.00	.00	.74	.03	.00	.04	.02	.01	.02	.01	.01	.01	.04	.00	.04
	24	.000	292.757	.98	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.06	.00	.98	.00	.00	.00	.00	.00	.00	.00	.00

a. Dependent Variable: Active or passive travelling

Collinearity diagnostics (before removing correlating variables) – walking/cycling

Collinearity Diagnostics

Model		Eigenvalue	Condition Index	Variance Proportions																							
				(Constant)	Age	Gender	Ethnicity	Siblings	Nr of parents in hh	Nr of cars in hh	Nr of motorbikes in hh	Nr of mopeds in hh	Nr of mini-mopeds in hh	Nr of bikes in hh	Bike owner	Income hh	Distance	Child accompanied?	Departure time	School distance i.r.t. total	Land use diversity index	Address density	Urbanization	Winds peed	Temperature	Precipitation sum	Seasons
1	1	15.871	1.000	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	2	1.182	3.664	.00	.00	.00	.00	.00	.02	.00	.28	.36	.09	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	3	.998	3.987	.00	.00	.00	.00	.00	.62	.01	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	4	.959	4.069	.00	.00	.00	.00	.00	.00	.00	.07	.04	.89	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	5	.817	4.406	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.86	.00
	6	.731	4.661	.00	.00	.00	.00	.00	.04	.00	.61	.52	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00
	7	.500	5.632	.00	.00	.82	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.08	.01	.00	.02	.00	.00	.00	.00	.00	.00	.00
	8	.459	5.880	.00	.00	.00	.01	.00	.02	.00	.00	.00	.00	.00	.00	.00	.15	.24	.00	.00	.00	.10	.01	.00	.00	.00	.00
	9	.425	6.111	.00	.00	.15	.00	.02	.03	.01	.00	.00	.00	.00	.00	.00	.37	.02	.00	.10	.00	.01	.01	.00	.00	.01	.00
	10	.352	6.714	.00	.00	.00	.01	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.17	.00	.00	.00	.35	.01	.00	.05	.00	.02
	11	.337	6.859	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.01	.02	.00	.02	.00	.10	.00	.01	.20	.00	.07
	12	.279	7.537	.00	.00	.00	.00	.52	.01	.04	.01	.00	.00	.01	.00	.00	.02	.01	.00	.04	.00	.00	.01	.00	.00	.00	.00
	13	.253	7.922	.00	.00	.00	.05	.04	.01	.02	.00	.00	.00	.00	.00	.00	.17	.05	.00	.64	.00	.03	.00	.00	.01	.00	.01
	14	.199	8.933	.00	.00	.00	.46	.00	.08	.09	.00	.00	.00	.01	.00	.00	.04	.00	.00	.15	.00	.11	.00	.03	.00	.00	.00
	15	.155	10.115	.00	.00	.00	.16	.00	.02	.24	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.59	.01	.07	.00
	16	.144	10.487	.00	.00	.00	.02	.02	.04	.44	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.02	.12	.26	.00	.03	.02
	17	.096	12.831	.00	.03	.00	.05	.03	.00	.07	.00	.00	.00	.04	.00	.08	.02	.00	.00	.00	.03	.18	.32	.05	.06	.00	.10
	18	.065	15.617	.00	.01	.00	.05	.11	.02	.04	.00	.00	.00	.21	.00	.10	.01	.01	.00	.00	.01	.00	.00	.00	.42	.00	.51
	19	.052	17.474	.00	.00	.00	.02	.18	.00	.01	.00	.00	.00	.49	.00	.27	.00	.00	.00	.00	.26	.02	.07	.00	.03	.00	.03
	20	.050	17.744	.00	.08	.00	.01	.04	.00	.00	.00	.00	.00	.14	.00	.10	.00	.04	.00	.00	.59	.02	.30	.00	.01	.00	.02
	21	.046	18.543	.00	.52	.00	.06	.02	.05	.02	.00	.00	.00	.03	.00	.33	.02	.20	.00	.00	.02	.02	.08	.00	.05	.00	.06
	22	.021	27.575	.00	.30	.00	.04	.01	.02	.00	.00	.00	.00	.06	.23	.07	.01	.20	.00	.01	.04	.01	.05	.02	.11	.00	.12
	23	.006	50.076	.01	.03	.00	.06	.01	.00	.00	.00	.00	.00	.00	.76	.02	.00	.03	.01	.01	.01	.01	.01	.01	.04	.00	.04
	24	.000	331.484	.99	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.11	.00	.98	.00	.00	.00	.00	.00	.00	.00	.00

a. Dependent Variable: walking or cycling

Correlation data (after removing correlating variables)

Correlation matrix (after correlating removing variables)

Correlations

	Age	Gender	Ethnicity	Siblings	Nr of parents in hh	Nr of cars in hh	Nr of motorbikes in hh	Nr of mopeds in hh	Nr of mini-mopeds in hh	Nr of bikes in hh	Income hh	Distance	School distance i.r.t. total	Land use diversity index	Address density	Urbanization	Wind speed	Temperature	Precipitation	Seasons
Age	1	-.013	-.015	.010	.059	-.002	.006	.009	.000	.074	.022	.045	-.092	.023	.005	.040	.011	-.001	.007	-.003
Gender	-.013	1	.006	.001	.006	-.030	.004	-.001	-.009	.018	-.002	.002	.014	-.006	-.003	.012	-.001	-.012	-.009	.002
Ethnicity	-.015	.006	1	-.006	.129	-.168	-.047	-.005	-.008	-.250	-.168	-.027	.080	-.150	.155	-.259	.005	.003	.003	.002
Siblings	.010	.001	-.006	1	-.153	.020	-.026	-.008	-.023	.494	.070	.029	-.003	.015	-.045	.083	.004	-.018	-.011	.009
Nr of parents in hh	.059	.006	.129	-.153	1	-.284	-.057	.004	-.016	-.299	-.340	.046	.024	-.064	.078	-.099	.008	.015	.014	-.014
Nr of cars in hh	-.002	-.030	-.168	.020	-.284	1	.111	.031	.029	.197	.298	.032	-.028	.128	-.108	.166	-.014	-.003	-.010	-.002
Nr of motorbikes in hh	.006	.004	-.047	-.026	-.057	.111	1	.308	.217	.076	.035	.012	-.011	.037	-.047	.070	.013	-.015	.004	.012
Nr of mopeds in hh	.009	-.001	-.005	-.008	.004	.031	.308	1	.332	.032	-.042	.025	.015	.004	-.023	.013	.007	-.021	-.002	.022
Nr of mini-mopeds in hh	.000	-.009	-.008	-.023	-.016	.029	.217	.332	1	.010	-.022	-.002	.015	-.005	-.004	-.032	.003	-.003	.008	-.005
Nr of bikes in hh	.074	.018	-.250	.494	-.299	.197	.076	.032	.010	1	.248	.032	-.055	.099	-.106	.166	-.014	-.002	.000	-.006
Income hh	.022	-.002	-.168	.070	-.340	.298	.035	-.042	-.022	.248	1	-.010	-.035	.042	-.013	-.004	-.006	-.001	-.021	.004
Distance	.045	.002	-.027	.029	.046	.032	.012	.025	-.002	.032	-.010	1	.272	.003	-.037	-.007	.008	-.023	-.009	.005
School distance i.r.t. total	-.092	.014	.080	-.003	.024	-.028	-.011	.015	.015	-.055	-.035	.272	1	-.045	.034	-.076	.014	-.039	.025	.032
Land use diversity index	.023	-.006	-.150	.015	-.064	.128	.037	.004	-.005	.099	.042	.003	-.045	1	-.092	.381	-.026	.010	-.034	-.007
Address density	.005	-.003	.155	-.045	.078	-.108	-.047	-.023	-.004	-.106	-.013	-.037	.034	-.092	1	-.402	-.043	.004	-.015	.017
Urbanization	.040	.012	-.259	.083	-.099	.166	.070	.013	-.032	.166	-.004	-.007	-.076	.381	-.402	1	-.012	-.018	-.025	-.003
Wind speed	.011	-.001	.005	.004	.008	-.014	.013	.007	.003	-.014	-.006	.008	.014	-.026	-.043	-.012	1	-.102	.239	.091
Temperature max	-.001	-.012	.003	-.018	.015	-.003	-.015	-.021	-.003	-.002	-.001	-.023	-.039	.010	.004	-.018	-.102	1	.052	-.650
Precipitation sum	.007	-.009	.003	-.011	.014	-.010	.004	-.002	.008	.000	-.021	-.009	.025	-.034	-.015	-.025	.239	.052	1	-.024
Seasons	-.003	.002	.002	.009	-.014	-.002	.012	.022	-.005	-.006	.004	.005	.032	-.007	.017	-.003	.091	-.650	-.024	1

VIF/tolerance (after correlating removing variables)

Coefficients[a]				**Coefficients[a]**		
Model		Collinearity Statistics			Collinearity Statistics	
		Tolerance	VIF		Tolerance	VIF
1	Age	.971	1.030	Age	.945	1.058
	Gender	.997	1.003	Gender	.996	1.004
	Ethnicity	.849	1.178	Ethnicity	.839	1.192
	Siblings	.728	1.373	Siblings	.725	1.380
	Nr of parents in hh	.795	1.257	Nr of parents in hh	.798	1.254
	Nr of cars in hh	.829	1.207	Nr of cars in hh	.817	1.225
	Nr of motorbikes in hh	.872	1.147	Nr of motorbikes in hh	.892	1.121
	Nr of mopeds in hh	.828	1.208	Nr of mopeds in hh	.876	1.142
	Nr of mini-mopeds in hh	.871	1.148	Nr of mini-mopeds in hh	.925	1.081
	Nr of bikes in hh	.624	1.604	Nr of bikes in hh	.616	1.623
	Income hh	.802	1.247	Income hh	.796	1.256
	Distance	.909	1.100	Distance	.900	1.111
	School trip i.r.t. total	.901	1.110	School trip i.r.t. total	.917	1.090
	Land use diversity index	.842	1.188	Land use diversity index	.836	1.197
	Address density	.824	1.214	Address density	.826	1.211
	Urbanization	.676	1.479	Urbanization	.671	1.490
	Wind speed	.926	1.080	Wind speed	.914	1.094
	Temperature	.571	1.750	Temperature	.573	1.747
	Precipitation	.934	1.071	Precipitation	.924	1.082
	Seasons	.575	1.738	Seasons	.576	1.736
a. Dependent Variable: Active or passive travelling				a. Dependent Variable: Walking or Cycling		

Collinearity diagnostics (after removing correlating variables) – active/passive

				Variance Proportions																				
Model		Eigenvalue	Condition Index	(Constant)	Age	Gender	Ethnicity	Siblings	Nr of parents in hh	Nr of cars in hh	Nr of motorbikes in hh	Nr of mopeds in hh	Nr of mini-mopeds in hh	Nr of bikes in hh	Income hh	Distance	School distance i.r.t. total	Land use diversity index	Address density	Urbanization	Winds peed	Temperature	Precipitation sum	Seasons
1	1	13.225	1.000	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	2	1.509	2.960	.00	.00	.00	.00	.00	.00	.00	.14	.20	.19	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	3	.995	3.646	.00	.00	.00	.00	.00	.63	.00	.01	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00
	4	.827	3.998	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88	.00
	5	.743	4.218	.00	.00	.00	.00	.00	.02	.00	.54	.00	.53	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	6	.619	4.623	.00	.00	.00	.00	.00	.01	.00	.27	.77	.25	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	7	.511	5.085	.00	.00	.33	.00	.00	.00	.00	.00	.01	.00	.00	.00	.49	.03	.00	.01	.00	.00	.00	.00	.00
	8	.471	5.300	.00	.00	.64	.00	.01	.01	.00	.00	.00	.00	.00	.00	.22	.01	.00	.03	.00	.00	.00	.01	.00
	9	.387	5.843	.00	.00	.00	.02	.03	.08	.01	.01	.00	.00	.00	.00	.01	.03	.00	.42	.04	.00	.00	.00	.00
	10	.342	6.219	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.01	.26	.00	.09
	11	.277	6.905	.00	.00	.00	.00	.53	.01	.06	.01	.00	.00	.01	.00	.02	.03	.00	.02	.01	.01	.00	.01	.00
	12	.246	7.336	.00	.00	.00	.06	.02	.01	.03	.00	.00	.00	.00	.00	.18	.63	.00	.11	.00	.00	.00	.00	.00
	13	.198	8.180	.00	.00	.00	.46	.00	.06	.06	.00	.00	.00	.01	.00	.05	.21	.00	.10	.00	.06	.00	.01	.00
	14	.160	9.105	.00	.00	.00	.18	.00	.02	.27	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.53	.01	.05	.00
	15	.142	9.658	.00	.02	.00	.00	.03	.04	.42	.00	.00	.00	.00	.00	.00	.00	.03	.01	.13	.29	.00	.03	.02
	16	.097	11.685	.00	.14	.00	.04	.04	.00	.05	.00	.00	.00	.05	.08	.01	.00	.03	.16	.31	.04	.04	.00	.08
	17	.075	13.315	.00	.56	.00	.01	.00	.00	.01	.00	.00	.00	.00	.01	.01	.02	.00	.01	.01	.00	.26	.00	.35
	18	.063	14.448	.00	.18	.00	.07	.14	.05	.07	.00	.00	.00	.31	.21	.00	.00	.03	.00	.00	.00	.17	.00	.20
	19	.053	15.725	.00	.00	.00	.02	.19	.00	.01	.00	.00	.00	.55	.37	.00	.00	.12	.01	.03	.00	.03	.00	.03
	20	.050	16.251	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.02	.19	.00	.00	.70	.04	.40	.00	.00	.00	.00
	21	.009	38.284	1.00	.08	.01	.13	.00	.04	.01	.00	.00	.00	.04	.14	.00	.03	.07	.05	.07	.05	.21	.00	.22

Collinearity diagnostics (after removing correlating variables) – walking/cycling

Collinearity Diagnostics

Model		Eigenvalue	Condition Index	Variance Proportions																				
				(Constant)	Age	Gender	Ethnicity	Siblings	Nr of parents in hh	Nr of cars in hh	Nr of motorbikes in hh	Nr of mopeds in hh	Nr of mini-mopeds in hh	Nr of bikes in hh	Income hh	Distance	School distance i.r.t. total	Land use diversity index	Address density	Urbanization	Winds peed	Temperature	Precipitation sum	Seasons
1	1	13.284	1.000	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	2	1.402	3.078	.00	.00	.00	.00	.00	.00	.00	.17	.24	.20	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	3	.999	3.646	.00	.00	.00	.00	.00	.64	.01	.01	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	4	.818	4.030	.00	.00	.00	.00	.00	.01	.00	.06	.03	.16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.67	.00
	5	.807	4.056	.00	.00	.00	.00	.00	.00	.00	.25	.04	.54	.00	.00	.00	.00	.00	.00	.00	.00	.00	.20	.00
	6	.662	4.479	.00	.00	.00	.00	.00	.03	.00	.48	.68	.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	7	.499	5.158	.00	.00	.81	.00	.00	.00	.00	.00	.00	.00	.00	.00	.12	.01	.00	.00	.00	.00	.00	.00	.00
	8	.423	5.603	.00	.00	.17	.01	.01	.01	.01	.00	.00	.00	.00	.00	.55	.07	.00	.01	.00	.00	.00	.01	.00
	9	.390	5.838	.00	.00	.00	.03	.01	.07	.01	.01	.00	.00	.00	.00	.00	.03	.00	.45	.03	.00	.01	.00	.00
	10	.339	6.262	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.02	.00	.01	.24	.00	.09
	11	.280	6.888	.00	.00	.00	.01	.41	.01	.03	.00	.00	.00	.01	.00	.06	.16	.00	.04	.01	.01	.01	.01	.00
	12	.261	7.128	.00	.01	.00	.03	.14	.00	.05	.01	.00	.00	.00	.00	.14	.50	.00	.07	.00	.00	.00	.00	.01
	13	.199	8.180	.00	.00	.00	.47	.01	.07	.08	.00	.00	.00	.01	.00	.04	.16	.00	.11	.00	.04	.00	.01	.00
	14	.155	9.246	.00	.00	.00	.16	.00	.01	.20	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.64	.01	.07	.00
	15	.143	9.639	.00	.01	.00	.02	.03	.04	.46	.00	.00	.00	.00	.00	.00	.00	.04	.03	.15	.19	.00	.02	.02
	16	.094	11.868	.00	.08	.00	.05	.03	.00	.08	.00	.00	.00	.04	.09	.03	.00	.02	.16	.29	.04	.08	.00	.12
	17	.072	13.594	.00	.53	.00	.01	.01	.00	.00	.00	.00	.00	.01	.00	.03	.02	.00	.00	.00	.00	.27	.00	.37
	18	.061	14.728	.00	.27	.00	.07	.16	.05	.05	.00	.00	.00	.32	.16	.00	.00	.05	.00	.00	.00	.13	.00	.13
	19	.052	15.996	.00	.00	.00	.02	.17	.00	.01	.00	.00	.00	.48	.26	.00	.00	.29	.02	.08	.00	.02	.00	.03
	20	.050	16.377	.00	.02	.00	.00	.01	.01	.02	.00	.00	.00	.07	.34	.00	.00	.52	.03	.36	.00	.00	.00	.00
	21	.009	38.459	1.00	.08	.01	.14	.00	.04	.01	.00	.00	.00	.05	.13	.00	.03	.07	.05	.07	.06	.22	.00	.22

7.3 SPSS outcomes Logistic regression active/passive

Logistic Regression

Case Processing Summary

Unweighted Cases		N	Percent
Selected Cases	Included in Analysis	7454	99.9
	Missing Cases	10	.1
	Total	7464	100.0
Unselected Cases		0	.0
Total		7464	100.0

Dependent Variable Encoding

Original Value	Internal Value
Passive	0
Active	1

Categorical Variables Codings

			Parameter coding					
		Frequency	(1)	(2)	(3)	(4)	(5)	(6)
Income hh	<€10000	130	.000	.000	.000	.000	.000	.000
	€10000-€20000	289	1.000	.000	.000	.000	.000	.000
	€20000-€30000	1143	.000	1.000	.000	.000	.000	.000
	€30000-€40000	1966	.000	.000	1.000	.000	.000	.000
	€40000-€50000	1654	.000	.000	.000	1.000	.000	.000
	>€50000	2249	.000	.000	.000	.000	1.000	.000
	unknown	23	.000	.000	.000	.000	.000	1.000
Urbanization	Very strongly urbanized	836	.000	.000	.000	.000		
	Strongly urbanized	1823	1.000	.000	.000	.000		
	Moderately urbanized	1537	.000	1.000	.000	.000		
	Low urbanized	1917	.000	.000	1.000	.000		
	Non-urbanized	1341	.000	.000	.000	1.000		
Seasons	spring	1831	1.000	.000	.000			
	summer	1404	.000	1.000	.000			
	autumn	2259	.000	.000	1.000			
	winter	1960	.000	.000	.000			
Ethnicity	native	6298	.000	.000				
	western	396	1.000	.000				
	nonwestern	760	.000	1.000				
Nr of parents in hh	2 parents	6833	.000					
	1 parent	621	1.000					
Gender	female	3709	.000					
	male	3745	1.000					

Block 0: Beginning Block

Classification Table[a,b]

			Predicted		
			Active or passive travelling		Percentage Correct
	Observed		Passive	Active	
Step 0	Active or passive travelling	Passive	0	1645	.0
		Active	0	5809	100.0
	Overall Percentage				77.9

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	1.262	.028	2040.648	1	.000	3.531

Variables not in the Equation[a]

			Score	df	Sig.
Step 0	Variables	Age	276.091	1	.000
		Gender (ref = male)	.752	1	.386
		Ethnicity (ref = native)	2.601	2	.272
		ethnicity(western)	.898	1	.343
		ethnicity(non-western)	1.502	1	.220
		Siblings	8.163	1	.004
		Nr of parents in hh (ref = 1 parent)	11.775	1	.001
		Nr of cars in hh	78.736	1	.000
		Nr of motorbikes in hh	.025	1	.874
		Nr of mopeds in hh	.193	1	.661
		Nr of mini-mopeds in hh	4.874	1	.027
		Nr of bikes in hh	33.530	1	.000
		Income hh (ref = >10k)	18.578	6	.005
		Income hh (10-20k)	.031	1	.860
		Income hh (20-30k)	2.973	1	.085
		Income hh (30-40k)	4.608	1	.032
		Income hh (40-50k)	.005	1	.946
		Income hh (>50k)	6.743	1	.009
		Income hh (unknown)	.001	1	.970
		Distance	1525.221	1	.000
		School distance i.r.t. total	212.858	1	.000
		Land use diversity index	.922	1	.337
		Address density	2.499	1	.114
		Urbanization (ref = very strongly)	3.809	4	.432
		Urbanization (strongly)	3.721	1	.054
		Urbanization (moderately)	.403	1	.526
		Urbanization (low)	.150	1	.699
		Urbanization (non)	.333	1	.564
		Wind speed	1.429	1	.232
		Temperature	31.133	1	.000
		Precipitation	8.977	1	.003
		Season (ref = winter)	12.248	3	.007
		Season (spring)	1.697	1	.193
		Season (summer)	6.195	1	.013
		Season (autumn)	.486	1	.486

a. Residual Chi-Squares are not computed because of redundancies.

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	2079.514	31	.000
	Block	2079.514	31	.000
	Model	2079.514	31	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	5788.570[a]	.243	.373

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Classification Table[a]

	Observed		Predicted		
			Active or passive travelling		Percentage Correct
			Passive	Active	
Step 1	Active or passive travelling	Passive	639	1006	38.8
		Active	220	5589	96.2
	Overall Percentage				83.6

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Age	.308	.016	378.669	1	.000	1.360
	Gender (ref = male)	-.071	.067	1.135	1	.287	.931
	Ethnicity (ref = native)			7.367	2	.025	
	Ethnicity (western)	-.092	.151	.371	1	.542	.912
	Ethnicity (non-western)	-.318	.118	7.262	1	.007	.728
	Siblings	.027	.047	.337	1	.562	1.028
	Nr of parents in hh (ref = 1 parent)	-.616	.141	19.153	1	.000	.540
	Nr of cars in hh	-.434	.047	84.546	1	.000	.648
	Nr of motorbikes in hh	.087	.072	1.474	1	.225	1.091
	Nr of mopeds in hh	.128	.110	1.358	1	.244	1.136
	Nr of mini-mopeds in hh	-.425	.120	12.546	1	.000	.654
	Nr of bikes in hh	.140	.025	30.695	1	.000	1.150
	Income hh (ref = >10k)			17.187	6	.009	
	Income hh (10-20k)	.086	.304	.080	1	.778	1.090
	Income hh (20-30k)	.114	.260	.192	1	.661	1.121
	Income hh (30-40k)	-.102	.253	.163	1	.686	.903
	Income hh (40-50k)	-.284	.254	1.249	1	.264	.753
	Income hh (>50k)	-.307	.252	1.483	1	.223	.736
	Income hh (unknown)	.187	.740	.064	1	.800	1.206
	Distance	-.088	.003	910.841	1	.000	.916
	School distance i.r.t. total	-.005	.002	5.476	1	.019	.995
	Land use diversity index	-.123	.076	2.596	1	.107	.884
	Address density	.000	.000	.099	1	.753	1.000
	Urbanization (ref = very strongly)			7.683	4	.104	
	Urbanization (strongly)	-.328	.125	6.855	1	.009	.721
	Urbanization (moderately)	-.165	.135	1.500	1	.221	.848
	Urbanization (low)	-.243	.138	3.107	1	.078	.784
	Urbanization (non)	-.234	.150	2.427	1	.119	.791
	Wind speed	.002	.018	.016	1	.899	1.002
	Temperature	.030	.007	18.649	1	.000	1.030
	Precipitation	-.031	.007	19.960	1	.000	.969
	Season (ref = winter)			.638	3	.888	
	Season (spring)	-.089	.122	.528	1	.467	.915
	Season (summer)	-.085	.148	.335	1	.563	.918
	Season (autumn)	-.022	.096	.051	1	.822	.979
	Constant	1.071	.353	9.212	1	.002	2.919

a. Variable(s) entered on step 1: Age, Gender, Ethnicity, Siblings, Nr of parents in hh, Nr of cars in hh, Nr of motorbikes in hh, Nr of mopeds in hh, Nr of mini-mopeds in hh, Nr of bikes in hh, Income hh, Distance, School distance i.r.t. total, Land use diversity index, Address density, Urbanization, Wind speed, Temperature, Precipitation, Season.

7.4 SPSS outcome Logistic regression – walking/cycling

Logistic Regression

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	5778	77.4
	Missing Cases	1686	22.6
	Total	7464	100.0
Unselected Cases		0	.0
Total		7464	100.0

a. If weight is in effect, see classification table for the total number of cases.

Dependent Variable Encoding

Original Value	Internal Value
Walking	0
Cycling	1

Categorical Variables Codings

			Parameter coding					
		Frequency	(1)	(2)	(3)	(4)	(5)	(6)
Income hh	<€10000	88	.000	.000	.000	.000	.000	.000
	€10000-20000	223	1.000	.000	.000	.000	.000	.000
	€20000-30000	907	.000	1.000	.000	.000	.000	.000
	€30000-40000	1561	.000	.000	1.000	.000	.000	.000
	€40000-50000	1283	.000	.000	.000	1.000	.000	.000
	>€50000	1698	.000	.000	.000	.000	1.000	.000
	Unknown	18	.000	.000	.000	.000	.000	1.000
Urbanization	Very strongly urbanized	655	.000	.000	.000	.000		
	Strongly urbanized	1384	1.000	.000	.000	.000		
	Moderately urbanized	1202	.000	1.000	.000	.000		
	Low urbanized	1490	.000	.000	1.000	.000		
	Non-urbanized	1047	.000	.000	.000	1.000		
Seasons	Spring	1435	1.000	.000	.000			
	Summer	1121	.000	1.000	.000			
	Autumn	1742	.000	.000	1.000			
	Winter	1480	.000	.000	.000			
Ethnicity	Native	4903	.000	.000				
	Western	299	1.000	.000				
	nonwestern	576	.000	1.000				
Nr of parents in hh	2 parents	5332	.000					
	1 parent	446	1.000					
Gender	female	2896	.000					
	male	2882	1.000					

Block 0: Beginning Block

Classification Table[a,b]

			Predicted		
			walking or cycling		
	Observed		Walking	Cycling	Percentage Correct
Step 0	walking or cycling	Walking	0	2007	.0
		Cycling	0	3771	100.0
	Overall Percentage				65.3

a. Constant is included in the model.

b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	.631	.028	521.040	1	.000	1.879

Variables not in the Equation[a]

			Score	df	Sig.
Step 0	Variables	Age	107.855	1	.000
		Gender (ref = male)	1.338	1	.247
		Ethnicity (ref = native)	120.305	2	.000
		Ethnicity (western)	.732	1	.392
		Ethnicity (non-western)	120.305	1	.000
		Siblings	.069	1	.793
		Nr of parents in hh (ref = 1 parent)	3.504	1	.061
		Nr of cars in hh	15.613	1	.000
		Nr of motorbikes in hh	.043	1	.836
		Nr of mopeds in hh	.365	1	.546
		Nr of mini-mopeds in hh	1.798	1	.180
		Nr of bikes in hh	86.850	1	.000
		Income hh (ref = >10k)	45.078	6	.000
		Income hh (10-20k)	.632	1	.427
		Income hh (20-30k)	18.061	1	.000
		Income hh (30-40k)	5.527	1	.019
		Income hh (40-50k)	.001	1	.982
		Income hh (>50k)	33.767	1	.000
		Income hh (unknown)	1.247	1	.264
		Distance	1326.050	1	.000
		School distance i.r.t. total	97.989	1	.000
		Land use diversity index	15.668	1	.000
		Address density	4.482	1	.034
		Urbanization (ref = very strongly)	65.158	4	.000
		Urbanization (strongly)	16.775	1	.000
		Urbanization (moderately)	.141	1	.707
		Urbanization (low)	5.331	1	.021
		Urbanization (non)	31.852	1	.000
		Wind speed	1.824	1	.177
		Temperature	36.212	1	.000
		Precipitation	.366	1	.545
		Season (ref = winter)	41.839	3	.000
		Season (spring)	4.854	1	.028
		Season (summer)	10.055	1	.002
		Season (autumn)	1.321	1	.250

a. Residual Chi-Squares are not computed because of redundancies.

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	3058.665	31	.000
	Block	3058.665	31	.000
	Model	3058.665	31	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	4404.107[a]	.411	.567

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

Classification Table[a]

	Observed		Predicted		
			walking or cycling		Percentage Correct
			Walking	Cycling	
Step 1	walking or cycling	Walking	1490	517	74.2
		Cycling	529	3242	86.0
	Overall Percentage				81.9

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Age	.079	.017	22.208	1	.000	1.082
	Gender (ref = male)	-.009	.075	.015	1	.901	.991
	Ethnicity (ref = native)			27.902	2	.000	
	Ethnicity (western)	.219	.171	1.655	1	.198	1.245
	Ethnicity (non-western)	-.672	.136	24.609	1	.000	.511
	Siblings	-.170	.053	10.396	1	.001	.844
	Nr of parents in hh (ref = 1 parent)	-.079	.166	.226	1	.635	.924
	Nr of cars in hh	-.033	.058	.324	1	.569	.967
	Nr of motorbikes in hh	-.053	.077	.470	1	.493	.949
	Nr of mopeds in hh	.030	.116	.065	1	.799	1.030
	Nr of mini-mopeds in hh	-.157	.174	.815	1	.367	.854
	Nr of bikes in hh	.123	.029	18.430	1	.000	1.131
	Income hh (ref = >10k)			21.480	6	.002	
	Income hh (10-20k)	.753	.398	3.575	1	.059	2.124
	Income hh (20-30k)	.332	.357	.864	1	.353	1.393
	Income hh (30-40k)	.494	.352	1.968	1	.161	1.638
	Income hh (40-50k)	.469	.354	1.756	1	.185	1.598
	Income hh (>50k)	.801	.353	5.144	1	.023	2.227
	Income hh (unknown)	.938	.828	1.285	1	.257	2.556
	Distance	.393	.012	1073.873	1	.000	1.482
	School distance i.r.t. total	.004	.002	2.604	1	.107	1.004
	Land use diversity index	-.033	.084	.155	1	.694	.967
	Address density	.000	.000	.360	1	.548	1.000
	Urbanization (ref = very strongly)			71.052	4	.000	
	Urbanization (strongly)	.347	.142	6.009	1	.014	1.415
	Urbanization (moderately)	.805	.152	28.073	1	.000	2.237
	Urbanization (low)	.896	.156	33.012	1	.000	2.451
	Urbanization (non)	1.260	.171	54.588	1	.000	3.527
	Wind speed	.059	.021	8.141	1	.004	1.061
	Temperature	.025	.008	10.407	1	.001	1.025
	Precipitation	-.011	.009	1.429	1	.232	.989
	Season (ref = winter)			14.315	3	.003	
	Season (spring)	.258	.138	3.495	1	.062	1.294
	Season (summer)	.331	.164	4.076	1	.044	1.393
	Season (autumn)	.412	.110	14.004	1	.000	1.510
	Constant	-5.432	.466	136.023	1	.000	.004

a. Variable(s) entered on step 1: Age, Gender, Ethnicity, Siblings, Nr of parents in hh, Nr of cars in hh, Nr of motorbikes in hh, Nr of mopeds in hh, Nr of mini-mopeds in hh, Nr of bikes in hh, Income hh, Distance, School distance i.r.t. total, Land use diversity index, Address density, Urbanization, Wind speed, Temperature, Precipitation, Season.