The Environmental Barriers to Active School Travel Among Private School Students in Dubai

العوائق البيئية التي تحول دون النقل المدرسي النشط بين طلاب المدارس الخاصة في دبي

by

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Abstract

Childhood obesity rates are increasing, partly caused by a deficiency of physical activity (PA). Active school travel (AST) is one way to counteract this, but its rates are globally dropping. Little is known about AST situation in the Middle Eastern countries generally and the UAE in particular. This study investigates the influence of different environmental factors on the decision between active and inactive school travel modes, and identifies the built environment barriers to AST among private school students in the Dubai emirate. Using a quantitative research approach, parents of 408 students attending different private schools in Dubai completed an online questionnaire. The statistical analysis determined significant correlation between school travel behaviours and most of the suggested influencing factors including distance, time length of the school trip, built environment features, parent perceptions of the built environment features, weather conditions, and parent perceptions of AST. Distance is the most influencing factor on the travel mode choices, followed by weather and time length of the trip to/from school. Among built environment features, street connectivity and traffic calming measures are significant factors. Since most of the private school students in Dubai are living beyond the walking distance threshold, it may be concluded that distance between home and school is the main barrier to AST.

Abstract in Arabic نبذة مختصرة

تتزايد معدلات السمنة لدى الأطفال ، ويرجع ذلك جزئيًا إلى نقص النشاط البدني. يعد النقل المدرسي النشط إحدى الطرق لمواجهة ذلك ، لكن معدلاته تنخفض عالميًا. لا يُعرف سوى القليل عن حالة النقل المدرسي النشطة في دول الشرق الأوسط بشكل عام والإمارات العربية المتحدة على وجه الخصوص. تبحث هذه الدراسة في تأثير العوامل البيئية المختلفة على القرار بين وضعي السفر المدرسي النشط وغير النشط وتحدد عوائق البيئة المبنية أمام النقل المدرسي النشط بين طلاب المدارس الخاصة في إمارة دبي. باستخدام نهج البحث الكمي ، أكمل أولياء أمور 408 طالبًا يدرسون في مدارس خاصة مختلفة في دبي استبيانًا عبر الإنترنت. حدد التحليل الإحصائي الارتباط الكبير بين سلوكيات السفر إلى المدرسة ومعظم العوامل المؤثرة المقترحة بما في ذلك المسافة ، وطول الرحلة المدرسية ، وخصائص البيئة المبنية ، وتصورات الوالدين لخصائص البيئة المبنية ، والظروف الجوية ، وتصورات الوالدين للنقل المدرسي النشط . المسافة هي العامل الأكثر تأثيرًا على خيارات وضع السفر ، يليها الطقس والمدة الزمنية للرحلة من / إلى المدرسة. من بين ميزات البيئة المبنية ، يعد اتصال الشوارع وتدابير تهدئة حركة المرور من العوامل المهمة. نظرًا لأن معظم طلاب المدارس الخاصة في دبي يعيشون خارج عتبة مسافة المشي ، يمكن الاستنتاج أن المسافة بين المنزل والمدرسة هي العائق الرئيسي أمام النقل المدرسي النشط.

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List of Abbreviations

AST	Active school travel
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CVD	Cardiovascular disease
df	degrees of freedom
GIS	Global positioning system
GPS	Geographic information system
GSHS	Global School Health Survey
KHDA	Knowledge and Human Development Authority
MOE	Ministry of Education
MVPA	Moderate-to-vigorous physical activity
NCD	Non-communicable disease
PA	Physical activity
p	p-value (probability of evidence against the null hypothesis)
SD	Standard Deviation
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
x^2	Pearson chi-square

Chapter 1: Introduction

This Chapter highlights the global obesity epidemic among children in different countries and presents the importance of WHO guidelines on child PA in reducing the risk of many chronic diseases in different life stages, and revealing the association between PA and AST behaviours in addition to the benefits of these behaviours on health, academic performance, and environment. Secondly, the chapter presents the research problem. Thirdly it discusses the importance and the focus of the study. Lastly, the aim and objectives of the study are presented.

1.1 Study Background

1.1.1 Obesity and Over-weight Rates in Children

Millions of children and adults in both developed and developing countries are diagnosed with obesity-related diseases, including diabetes, CVD, and cancer, as claimed by Rahman (2019). Childhood obesity is a global epidemic and is one of the significant public health challenges of the 21st century. The prevalence of obesity among children has globally increased at an alarming rate (WHO 2020). The NCD Risk Factor Collaboration (NCD-RisC) (2017) states that the prevalence rate has reached 20% - 30% among children and adolescents aged 5-19 in many countries. For Instance, Yu & Zhu (2016) declared that child obesity is a significant public health issue in the US, as nearly one-third of the U.S. children are obese or overweight. Day (2016) and Tarun et al. (2017) also highlighted the child obesity concerns in China and India. They noted that the prevalence of obesity and overweight ranges between four and twenty per cent among children. Moreover, Ikeda et al. (2018) disclosed that New Zealand is one of the countries with the highest obesity rates among children worldwide. Compared to global statistics, the Middle East is one of the regions with the highest increase in obesity rates among children and adolescents classifications (Figure 1-1).

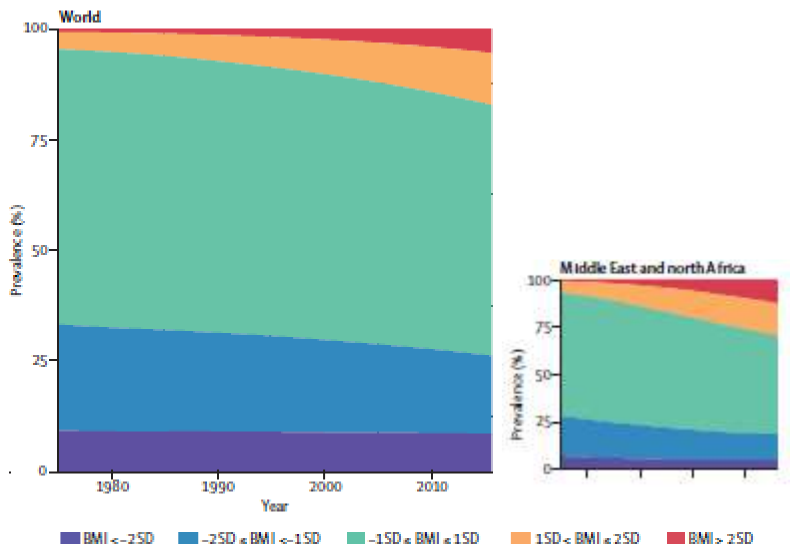

Figure 1-1 Prevalence of Child Obesity and Overweight in the World, and the Middle East (NCD Risk Factor Collaboration (NCD-RisC 2017).

According to WHO (2020), obesity and overweight are abnormal or excessive fat build-up that threatens health. Obese and overweight children are likely to remain obese into adulthood and are more vulnerable to non-communicable diseases like diabetes and CVD at a younger age. Obesity and overweight in childhood and adolescence correlate with an early onset of chronic diseases, besides psychosocial and educational disorders (NCD Risk Factor Collaboration (NCD-RisC) 2017). Furthermore, Child obesity negatively correlates with physical and social health outcomes that continue to adulthood (Yu & Zhu 2016). Frank et al. (2019), Kobel, Wartha & Steinacker (2019), and Carver (2019) added that obesity correlates with a higher risk of many chronic diseases, including different types of cancer and mental disorders.

A long-term energy imbalance between the intake and expenditure of calories is mainly the underlying cause of obesity and overweight (Brown et al. 2017; Frank et al. 2019). WHO (2020) clarified that childhood obesity is primarily related to the increased intake of energy-dense foods (unhealthy food) and decreased PA levels. This decline in PA levels is due to the increasingly sedentary activities during recreation times, changing to inactive modes of transportation and growing urbanization.

1.1.2 PA Guidelines

According to the WHO (2020), overweight and obesity, and their associated NCD diseases, are largely preventable. Since obesity and overweight usually start from childhood, preventing childhood obesity is essential and needs a high global priority. The aim of preventing childhood obesity is to attain an energy balance and maintain it throughout life. Therefore, the WHO recommends that children stay physically active and accumulate at least 60 minutes of regular, moderate- to vigorous-intensity PA (MVPA) daily.

PA has significant health outcomes for children, as Wilson, Clark & Gilliland (2018) confirmed. Therefore, consistent PA behaviours during childhood may reduce many NCD chronic diseases in later life stages. Also, Amornsriwatanakul et al. (2017) stated that engaging in PA proved to have many health advantages for children and youth. Many recent studies, including Marzi, Demetriou & Reimers (2018), Frank et al. (2019), Kobel, Wartha & Steinacker (2019), and Carver (2019), agreed that sufficient PA is likely to prevent obesity among children and adolescents, besides other advantages. On the other hand, Da Silva et al. (2017) claimed that physical inactivity leads to 5.3 million deaths every year. Moreover, Rahman (2019) reported that besides its environmental advantages, as little as thirty minutes of PA per day might reduce obesity-related co-morbidities, such as cancer, CVD, and diabetes.

The prevalence of PA among children and youth varies between different countries. According to Amornsriwatanakul et al. (2017), only one out of every five kids aged 13-15 years meets WHO recommendations worldwide. Moreover, Verhoeven et al. (2017) noted that most adolescents hardly accomplish the suggested 60 minutes MVPA every day. At the same time, Da Silva et al. (2017) specified that four out of five adolescents fail to attain the suggested 60 minutes of PA per day. According to Amornsriwatanakul et al. (2017), a higher percentage of American youth (15.9%) fulfil the WHO recommendation compared with the rate of Canadian children and youth (7%). While in Asia, 13 to 30% of school children in Hong Kong, Taiwan, Thailand, and South Korea meet the WHO recommendation. On the other hand, in China, only 5.6% of school children and youth achieve the daily 60 minutes of MVPA. Compared to the global statistics, in the UAE, Paulo et al. (2018) noted that just 16% of children meet the WHO guidelines on PA, compared with 20% in 2005, the percentage has dropped by 2% every five years since 2005. Likewise, Egypt, Jordan, Libya, Morocco, and Oman revealed that 75% of boys and 85% of girls between 13 – 15 years failed to meet the daily standard of PA.

Also, the prevalence of PA among children and youth varies between different age groups. According to many studies, children are more physically active than adolescents; for example, Deweese et al. (2017) confirmed that 8% of adolescents and nearly 50% of children between the ages of six and eleven achieve the suggested 60 minutes of daily PA. Similarly, Cain et al. (2018) noted that American children between the ages of six and eleven remarkably exceed the daily recommendations of PA, while adolescents fail to meet PA guidelines. Therefore it is essential to promote PA among adolescents to achieve the expected health benefits.

1.1.3 Active School Travel (AST)

AST is an approach to transport involving PA in the journey between home and school, such as cycling, walking and scooting. Studies found that it is a significant source of child PA (Pang, Kubacki & Rundle-thiele 2017; Tarun et al. 2017; Carver 2019). Consequently, children who engage in AST are likely to achieve the PA suggested guidelines (Marzi, Demetriou & Reimers 2018). Furthermore, Countries with lower obesity rates, remarkably, have higher rates of active travel behaviours. Therefore, the WHO considers AST a significant component of promoting PA (Kobel, Wartha & Steinacker 2019).

Despite its documented health outcomes, the prevalence of AST varies between countries; the rates generally record a consistent decline (Mandic et al. 2016; Vitale, Millward & Spinney 2019). Furthermore, Kobel, Wartha & Steinacker (2019) reported that more than 70% of primary school students use motorized school travel modes, causing a drop of 17% in walking rates and 70% in cycling rates in the past ten years.

- **AST Improves PA Levels among Children and Adolescents**

AST modes, including cycling and walking, are likely to increase daily PA levels in children and adolescents between six and eighteen (Ross, Rodríguez & Searle 2017; Verhoeven et al. 2017; Villa-González et al. 2018; Larouche et al. 2018; Buttazzoni, Clark & Seabrook 2019). It is a common form of PA, as most children transport to and from school twice daily. Many studies found that children and adolescents who actively travel to school are more likely to achieve the recommended PA levels than peers who use motorized modes. For Instance, Zhu & Yoon (2017) considered that AST modes are healthy physical activities.

- **AST is a Convenient and Efficient Form of PA for Children and Adolescents.**

AST is an inexpensive and efficient approach to PA. Moreover, adolescents who actively travel to and from their schools are more likely to accumulate an extra 20 minutes of MVPA (García-Hermoso et al. 2017). Likewise, Aparicio-Ugarriza et al. (2020) reported that AST is cost-effective while increasing PA levels among children and adolescents. Furthermore, AST is a convenient chance for children to be involved in PA consistently and integrate it into their daily routines. The trip between home and school is the most familiar travel activity among children. (Vitale, Millward & Spinney 2019).

- **AST Correlation with PA levels among Children and Adolescents**

AST contributes to MVPA and total accumulated PA rates in children, which helps them to meet the WHO recommendations (Žaltauskė and Petrauskienė 2016; Marzi, Demetriou & Reimers (2018)). Villa-González et al. (2017) and Ikeda et al. (2018) also confirmed that AST correlates with a proportionate increase in total PA levels among children. Furthermore, Aparicio-Ugarriza et al. (2020) reported that cycling and walking to school significantly associate with different child's PA levels, including moderate and vigorous activity levels.

1.1.4 The Built Environment and AST

AST is a complex behaviour that correlates with multiple levels of influence. Therefore, some studies used a four-level socio-ecological model to evaluate AST behaviours (Smith et al. 2020). The four levels include individual level, household level, community level, and political contexts. At the community level, the built environment is the main focus area. Carver (2019) reported that built environment features might facilitate or impede AST, such as neighbourhood walkability. Additionally, parent perceptions of the built environment safety significantly influence AST behaviours among children.

Moreover, Aerts (2018) disclosed that children up to 18 years represent one-third of the world population. They share the same human rights as adults; however, they need more protection and safety. According to the UNICEF's announcement at the United Nations Conference on Housing and Urban Development (Habitat III), it is crucial to investigate the child's vulnerabilities in urban environments to provide better life quality. To facilitate that, UNICEF has classified child vulnerabilities associated with the built environment into three categories: environmental health, participation, and protection constraints (Figure1-1).

This classification explains that built environments may lead to environmental health issues. For example, rates of NCD, including obesity, CVD, and cancer, are increasing globally, mainly among adolescents in urban areas. Physical inactivity is primarily the reason for this rise in obesity and other NCD rates among children and adolescents. Moreover, built environments with unsafe roads, inadequate infrastructure for active travel modes, and insufficient safety guidelines can be life-threatening for children and may limit their participation in PA behaviours. Additionally, vehicle oriented transportation policies possibly lead to unsafe streets for pedestrians and, consequently, restrict CIM.

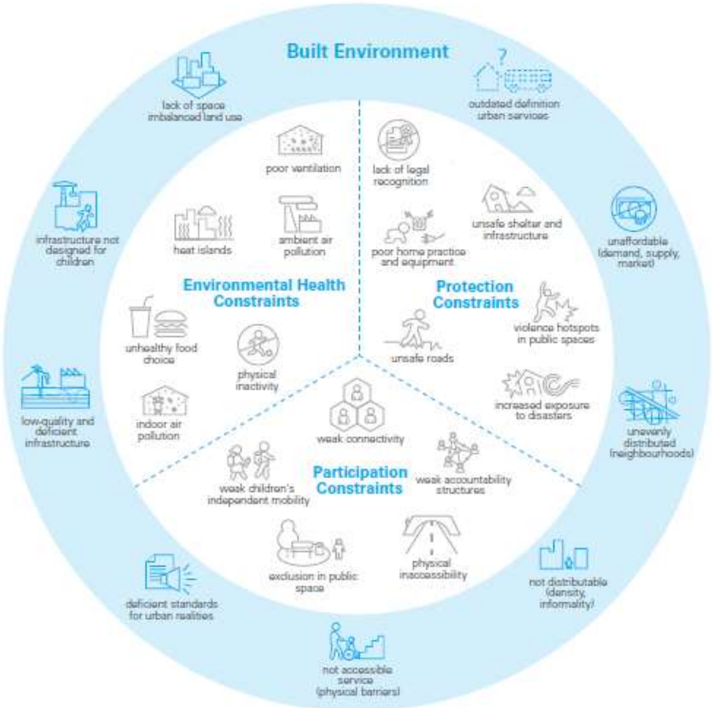

Figure 1-2 Child Vulnerabilities associated with the built environment (Aerts 2018).

1.2 The Study Problem

Trends in child overweight and obesity are noticeable in the UAE. Badri (2013) reported that more than 50% of the UAE children are obese, while the Health Authority in Abu Dhabi (HAAD) reported that 30% of school children in the city are overweight or obese. The rates rise steadily among children in the UAE, with one-fourth of them between 11 – 14 years are obese or extremely obese. At the same time, about 10% of the boys and 3% of the girls aged 15 – 18 years are highly obese (Alblooshi et al. 2016).

Sulaiman et al. (2017) found that amongst a sample of 1440 school children in the UAE, 14.7% were overweight, and 18.9% were obese. Another study found that the frequency of overweight among the UAE school children ranges between 11.5% - 41.2%, while the incidence of obesity ranges between 5.2% - 19.3% in ages 3 – 18 years. Haroun, Elsaleh & Wood (2017) also confirmed that the overweight and obesity rates in the UAE are incredibly high.

Furthermore, Paulo et al. (2018) reported that only 41% of adolescents aged 13 – 17 years in the UAE have a healthy body size according to the WHO standards. It is also noteworthy that the UAE is one of the twenty countries at the highest risk of having a significant childhood obesity issue in the next ten years, according to the World Obesity Federation WOF (2019).

At the same time, the country faces growing levels of physical inactivity among children and adolescents, accompanying the increasing urbanization and changing lifestyles in recent years. According to the Global Matrix 3.0 assessment results, sedentary behaviours are significantly high among UAE children, while the overall PA, including AST, is low. Almost 73% of them fail to meet the WHO guidelines on PA (Paulo et al. 2018), and only 4% of the student population cycle or walk to school in Dubai (KHDA 2017).

This research aims to find out which factors have the strongest influences on the decision for Dubai private school students to use AST. It may help to introduce new policies to stimulate AST among those students and consequently reduce the obesity rates among students in Dubai

1.3 The Importance and Focus of the Study

During the past decades, researchers have been concerned to study the environmental factors that influence AST, such as distance, physical features, and safety. Although these studies have been conducted in different regions of the world, only a few were in the Middle Eastern countries and the UAE. For this reason, more studies are required in this part of the world with a different culture and geography. Furthermore, no studies have investigated the environmental factors correlated with AST among Dubai students.

According to the latest statistics on the MOE website, Dubai has 262 public and private schools (27% public schools. 73% private schools) with 310.473 students (10% in public schools, 90%

in private schools). The current study will focus on 1 – 12 grade students in different private schools in Dubai.

The study may eliminate the gap in the existing pool of literature. The results could support existing evidence and increase the efforts to encourage AST in Dubai, the UAE, and other countries with similar cultures and geography. Understanding the barriers to AST is an important step to develop appropriate strategies to increase PA levels and reduce obesity among school students.

1.4 Aim and Objectives

This research investigates the influence of different environmental factors on the decision between active and inactive school travel modes to identify the built environment factors that inhibit AST among private school students in the Dubai emirate.

The following objectives would have to be met to achieve the intended results from this study:

- Identify the different influencing factors related to the built environment on school travel modes and highlight their impacts by reviewing the related literature.
- Investigate the school travel behaviours among Dubai private school students based on the identified influencing factors from the literature review.
- Evaluate the relationship between the school travel behaviours and the identified influencing factors.
- Identify the main influencing factors on the decision between active and inactive school travel modes and define the main barriers to AST in Dubai among private school students.

- Provide recommendations to encourage AST behaviours in Dubai among private school students based on the literature review and the results of this study.

1.5 The Research Structure

This research includes five chapters as below:

- **Chapter I: Introduction**

This chapter presents the background of the topic, explains the study problem, highlights its importance and focus, and states the aim and objectives of the study. An overview of the research structure is described at the end.

- **Chapter II: Literature Review**

This chapter provides an overview of previous literature about school travel approaches and the influencing factors, identifying their unique characteristics and relationships. The chapter also introduces the hypotheses used in this study.

- **Chapter III: Research Methodology**

This chapter explains the methodological approach and describes the methods of data collection and analysis, in addition to the study sample.

- **Chapter IV: Data Analysis, Results, and Discussion**

This chapter reports the results of the questionnaire. It also presents the descriptive analysis and the results of the statistical tests, supported by tables and graphs. Then it interprets the key findings, comparing them with results from the previous studies and provides suggestions.

- **Chapter V: Conclusion and Recommendations**

This chapter provides a general conclusion, followed by recommendations to enhance AST among private school students in Dubai. It also presents the limitation of the study and provides suggestions for future work.

Chapter 2: Literature Review

This chapter reviews the relevant literature related to school travel behaviours (active and inactive) and the different influencing factors. The chapter starts with reviewing the literature on school travel behaviours, focusing on AST benefits and statistics. Next, a literature review on the variables for this study and their relationships with school travel behaviours are explored. Finally, the chapter ends with the proposed hypotheses and a study framework that explains the relationship between the study variables.

2.1 Benefits of AST

Transportation is recognised for its contribution to the obesogenic environment through motorised approaches, in addition to its ability to decrease obesity rates in society (Brown et al. 2017). Usually, health effects related to travel modes are limited to injuries and emissions; however, recent international health assessments counted PA as a significant health impact of travel behaviours. Furthermore, the latest studies observed a correlation between the mode of transportation and obesity.

As defined previously in chapter 1, AST is an approach to transport involving PA in the journey between home and school, such as cycling, walking, and scooting. Smith et al. (2020) confirmed that AST correlates with several physical and social outcomes for children and their communities. At the child level, it increases PA levels, reduces rates of overweight, and maintains cardiovascular health. While at the community level, it encourages social relationships and urban life. AST also reduces the dominance of auto-mobility, which results in less traffic congestion, air pollution, and greenhouse gases.

2.1.1 Health Benefits

Travel to school mode choice has a significant effect on child health. Vitale, Millward & Spinney (2019) confirmed the associated health outcomes of AST, including weight status and cardio-respiratory fitness. Also, Macmillan et al. (2020) noted that shifting towards active travel modes increases PA levels and has significant health benefits related to non-communicable disease, traffic injuries, and air pollution. Similarly, Ross, Rodríguez & Searle (2017) asserted that AST has potential health benefits. Tremblay et al. (2016) reported the health outcomes of constant PA in children and adolescents and confirmed the public health fears related to physical inactivity.

The selection of a travel method results in different energy expenditure levels, and consequently, BMI changes. Brown et al. (2017) proposed an overview of the obesity-related impacts of motorised and non-motorised travel modes in Australia (Figure 2-1). The study reported the health effects of obesity-related diseases on Australians, including osteoarthritis, different cancers, heart disease, and type 2 diabetes.

Although regular walking may reduce chronic disease possibilities across a lifetime, Frank et al. (2019) claimed that exposure to polluted air while walking or cycling might considerably offset health benefits from active travel. Also, studies that examined the dangers of active travel suggested that cyclists and pedestrians are more exposed to injury than other road users.

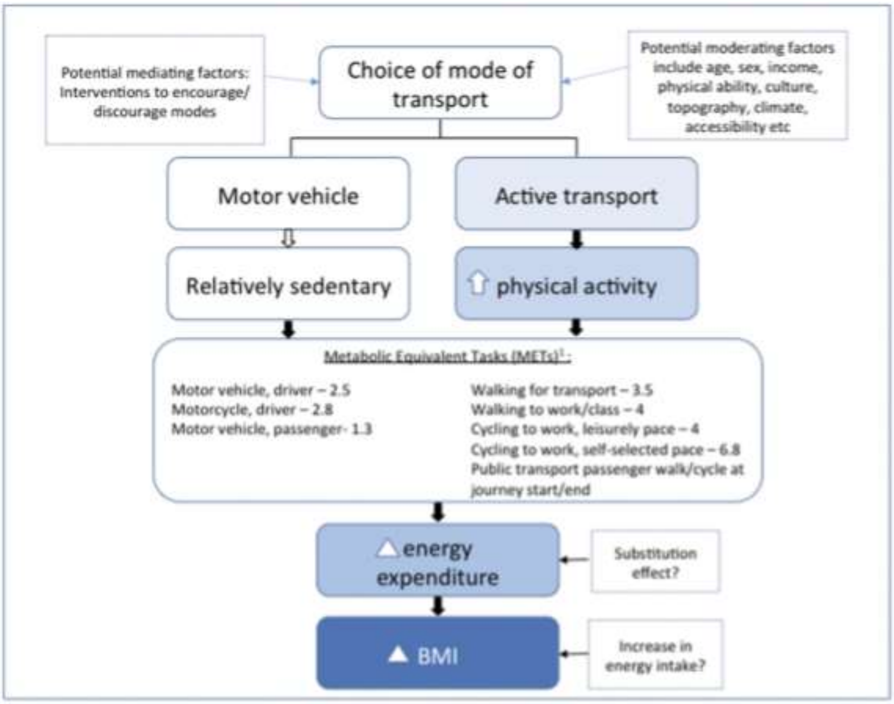

Figure 2-1 The Influence of the Choice of Mode of Travel on Energy Expenditure Levels and the BMI (Brown et al. 2017)

2.1.1.1 Cardiovascular and Respiratory System

Carver (2019), Cain et al. (2018) and Villa-González et al. (2018) agreed that PA behaviour at school age reduces the risk of CVD, which consequently lowers related morbidity and mortality rates among adults.

AST has health benefits for youth and is positively associated with higher levels of cardiorespiratory fitness (Villa-González et al. 2017). García-Hermoso et al. (2017) and Larouche et al. (2018) also agreed that AST improves adolescents' cardiovascular fitness, including walking and cycling.

Kallio et al. (2016) reported that cycling is more correlated with a healthy cardiovascular system, body fitness, and healthy weight compared to walking to school. Villa-González et al. (2017) also confirmed that cycling to school provides higher muscular endurance and aerobic capacity than walking in 15-19-year-old students. Moreover, a school-based intervention study found that cycling to school improves cardiorespiratory fitness in 10-13-year-old students.

2.1.1.2 Body Mass Index (BMI) and obesity

AST results in low BMI, low waist circumferences, and low odds of obesity among children (Ross, Rodríguez & Searle 2017; Yu & Zhu 2016). Moreover, Pang, Kubacki & Rundle-thiele (2017) and Carver (2019) confirmed that consistent AST helps to reduce BMI and obesity-related ailments.

Compared with children walking or cycling to school, Kobel, Wartha & Steinacker (2019) found that obesity rates are 10.8% higher in primary school children using inactive travel modes in Germany. Likewise, Marzi, Demetriou & Reimers (2018) noted that children who use AST have lower BMI than other children. However, Masoumi & E. (2017) found only a few studies confirming the relationship between AST and BMI among children. Therefore, with large samples and a wide selection of environments and cultures, further research is recommended to prevent the global childhood obesity epidemic.

2.1.2 Cognitive, Psychological, and Social Benefits

Further advantages of AST are building positive emotions, enhancing way-finding skills, and improving school grades (Larouche et al. 2018; Barnett et al. 2019). Ikeda et al. (2018), Wilson, Clark & Gilliland (2018) and Vitale, Millward & Spinney (2019) confirmed that PA enhances cognitive health in children. Conversely, insufficient PA is associated with depression and anxiety among children. Also, AST enables children to improve social skills, perceive and control risks, and experience decision making.

Recent studies evidenced an association between AST and academic performance among children and adolescents (Pang, Kubacki & Rundle-thiele 2017; Buttazzoni, Clark & Seabrook 2019). García-Hermoso et al. (2017) found that Chilean adolescents who spent between 30 and 60 minutes on AST were likely to achieve high academic performance levels and accomplish

23% of the total recommended PA levels. Moreover, Žaltauskė and Petrauskienė (2016) and Carver (2019) confirmed that AST positively influences mental health and social interaction.

2.1.3 Environmental Benefits

AST is a sustainable model of transportation (Barnett et al. 2019). Kobel, Wartha & Steinacker (2019) noted that it has environmental benefits, such as reducing traffic congestion, carbon emissions, motorized transport use, and fuel consumption, in addition to the several health benefits. On the other hand, studies found that motorized road transport is responsible for a quarter of greenhouse gas emissions globally, according to Vitale, Millward & Spinney (2019), and Macmillan et al. (2020).

2.2 AST Statistics

AST continues to decline worldwide; however, it is a practical way to enhance PA levels and initiate an environmentally sustainable commuting approach (Mandic et al. 2016). Therefore, research into AST has grown over the past decades in different related fields, including urban planning, transportation, and health (Ross, Rodríguez & Searle 2017). The decline in AST started in 1960 (Zhu & Yoon 2017). Pang, Kubacki & Rundle-thiele (2017) affirmed that the rates had demonstrated a substantial decrease throughout the last thirty years. Verhoeven et al. (2017) highlighted that the physical and social environmental features and the individual aspects are strong determinants of active travel behaviours among adolescents.

Many studies recorded the decline in AST levels. Wilson, Clark & Gilliland (2018) and Larouche et al. (2018) reported that AST approaches decreased among children and adolescents significantly in many countries. In Spain, for Instance, Villa-González et al. (2017) and Villa-González et al. (2018) confirmed that rates of AST had declined considerably during the previous years. While Buttazzoni, Clark & Seabrook (2019) reported that AST continues to decline in several countries, such as Australia, Canada, and Switzerland. Similarly, in the US, Ross, Rodríguez & Searle (2017) confirmed a significant decline. Also, Marzi, Demetriou & Reimers (2018) reported that car use increased in Denmark and Finland. For example, walking to school proportions declined by 40% in Denmark with a concurrent increase in motorized transportation.

AST prevalence varies between countries; the rates generally record a consistent decline among youths in developed countries (Mandic et al. 2016; Vitale, Millward & Spinney 2019). Furthermore, Kobel, Wartha & Steinacker (2019) reported that more than 70% of primary school students use motorized school travel modes, causing a drop of 17% in walking rates and 70% in cycling rates past ten years.

The Global Matrix is an international study including report cards on child and adolescent PA from different countries. The reports involve nine indicators of children's PA, including active transport and built environment, and a grading system ranging from A (excellent achievement) to F (poor performance).

Tremblay et al. (2016) reported that grades significantly vary between 38 countries in Global Matrix 2.0. For Instance, Netherlands reported an (A), Zimbabwe an (A-), seven countries a (B), nineteen countries a (C), five countries a (D);. In comparison, only two countries, including the UAE and the USA, reported an F. Remarkably, African countries achieved higher grades than other countries. In contrast, countries from North America scored the lowest grades. Australia, Canada, and the Netherlands reported an A for the built environment indicator, while Zimbabwe, Mozambique, and Ghana reported an F.

Aubert et al. (2018) reported that Global Matrix 3.0 involves forty-nine countries and includes the nine PA indicators present in Global Matrix 2. Regarding the active transport indicator, Nepal, Japan, and Zimbabwe achieved A-. At the same time, only the UAE and Qatar failed to assign a grade to the Active Transport indicator. Many developing countries reported high grades, including Colombia (B), Nigeria (B), and Venezuela (B-). In comparison, sixteen of the thirty top developed countries reported low grades ranging between C- and F. (Table 2-1) shows a comparison between the results of Global Matrix 2 and Global Matrix 3 regarding active travel among children and adolescents.

Table 2-1 Comparison between the results of Global Matrix 2 and Global Matrix 3 regarding Active Transport (Author).

Country	**Global Matrix 2 Grades**	**Global Matrix 3 Grades**
Australia	C-	D+
Belgium	C-	C+
Brazil	C+	C
Chile	C-	F
China	C-	C+
Denmark	B	B+
England	C-	C-
Finland	B	B+
Ghana	C	C+
Hong Kong	B	B+
India	C	B-
Japan	B	A-
Mexico	C	C+
The Netherlands	A-	B-
New Zealand	C	C-
Nigeria	B	B
Poland	C	C
Portugal	C	C-
Scotland	C	C
Slovenia	C	C
South Africa	C	C
South Korea	C+	B+
Spain	C	B-
Sweden	C+	C
Thailand	B	C
United Arab Emirates	**F**	**Incomplete (INCL)**
United States	F	D-
Wales	C	D+
Zimbabwe	A-	A-

Paulo et al. (2018) informed that reports from Australia and the USA showed a drop in rates of AST, from 37% to 26% in almost ten years. In New Zealand, Ikeda et al. (2018) reported relatively low AST rates, with nearly 29% of 5-17-year-old children walk and only 3% cycle to school. At the same time, Canadian children are less frequently engaging in AST than twenty years before (Vitale, Millward & Spinney 2019).

In Europe, studies from Denmark, Finland, and Norway reported increasing tendencies towards motorized travel to school. Furthermore, Kobel, Wartha & Steinacker (2019) stated that between 10% and 20% of children walk to school in Portugal and Spain. Aparicio-Ugarriza et al. (2020) confirmed that AST has dramatically dropped in Spain, where almost 55.4% of the children fail to meet the PA guidelines suggested by the WHO. Likewise, In England, Goodman et al. (2019) reported that the percentage of AST dropped from 67% in 1975-1976 (4% cycling, 63% walking) to 46% in 2015-2016 (2% cycling, 44% walking). However, in Denmark and the UK, between 67% and 83% of children actively travel to school, and in Germany, a study found that 50% of children aged 6-10 walk or cycle to school, and 46% use motorized transportation.

In Vietnam. Leung, Phuong & Le (2019) reported that cycling and walking among adolescents decreased due to the domination of motorised modes and lack of active travel culture. In comparison, Barnett et al. (2019) reported that adolescents in Hong Kong are among the highest in the world to have top AST rates.

2.2.1 Statistics in the UAE

Only 9.4% of school children in Abu Dhabi bike or walk to their schools, while (45%) use private vehicles, and (38.1%) use school buses as the most common modes of travel to school (Badri 2013). Moreover, most of the children who engage in AST live in gated communities close to their schools, while the majority attend schools inaccessible by active transport modes.

Paulo et al. (2018) reported that recent results are not publically available, while estimates from 2005 and 2010 WHO UAE-GSHS report revealed that just one-fifth of UAE adolescents in secondary schools use AST once a week. However, KHDA (2017) showed that only 4% of the student population cycle or walk to school, while 47% go by private vehicles, 46% take the school bus, and 3% use public transport Dubai (Figure 2-2).

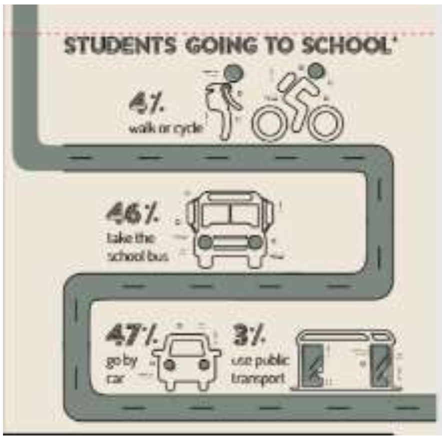

Figure 2-2 Travel to School Modes in Dubai, UAE (KHDA 2017).

2.3 Classification of the Factors Influencing AST

The choice between active and inactive travel modes is composite and involves different influential factors. The most critical factor is the distance between home and school. Other factors include built environment characteristics, child and parent characteristics, and seasonal conditions. Furthermore, Ross, Rodríguez & Searle (2017) claimed that research classified AST influences into three physical, safety, and socio-cultural domains.

Rahman (2019) also classified the factors influencing PA behaviours into three main categories: (1) objective, including accessibility and proximity; (2) subjective, including perception and reaction towards active travel (3) neighbourhood streetscape, including landscaping, width and quality of sidewalks, and traffic safety.

At the same time, Smith et al. (2020) agreed that AST is a complex behaviour that correlates with multiple levels of influence. Therefore, studies used a four-level socio-ecological model to evaluate AST behaviour, including individual, household, community and political groups. The individual level consists of gender, age, and ethnicity; the household level represents the family structure, ownership of cars and bikes, parent perceptions, and socio-economic status of the residential area. Physical built environments, school practices, and school policies are the main components of the community level. The political group includes school siting policies, budgets for walking and cycling infrastructure. Also, Larouche et al. (2018) agreed with the social-ecological models that suggest multiple levels of determinants, including the built environment attributes.

Furthermore, Wilson, Clark & Gilliland (2018) identified three independent variables correlating with AST, including the physical environment, the interpersonal, and the intrapersonal factors.

2.3.1 Trip Characteristics

2.3.1.1 Distance and Length of School Trip

Distance to school is the most frequently mentioned obstacle to AST in previous studies; also, it is the predominant determinant of AST. (Ross, Rodríguez & Searle 2017; Huertas-Delgado et al. 2017; Ikeda et al. 2018; Wilson, Clark & Gilliland 2018; Villa-González et al. 2018; Kobel, Wartha & Steinacker 2019; Fitch, Rhemtulla & Handy 2019; Sener, Lee & Sidharthan 2019; Leung, Phuong & Le 2019; Aparicio-Ugarriza et al. 2020; Smith et al. 2020). Therefore, it is essential to consider factors that affect the distance to school, including school location and zoning, in school planning decisions (Ikeda et al. 2018). Moreover, the influence of distance is evident in walking and cycling but is more dominant for walking (Sener, Lee & Sidharthan 2019).

Distance is a main parental barrier to AST among students in Spain (Huertas-Delgado et al. 2017; Aparicio-Ugarriza et al. 2020). Similarly, Yu & Zhu (2016) confirmed that long-distance to school negatively impacts parental perceptions of AST in the US. Therefore, they suggested developments in school planning policies to overcome this obstacle.

Moreover, Zhu & Yoon (2017) studied the travel behaviours of students in a new neighbourhood school in Texas. Before opening the new school, students travelled long distances to reach their schools, using inactive travel modes. Those who moved to the new school in the neighbourhood experienced changes in distance and environment features. These changes resulted in shifting to AST when parents perceived a shorter distance to school.

Studies reported the threshold distance for walking and cycling to school in different countries. Ikeda et al. (2018) indicated that students living within 1.6 km of their schools in the US are three times more likely to engage in AST than others living at greater distances. However, studies on cycling to school in the US and Spain reported threshold distances of 5 km. Wilson, Clark & Gilliland (2018) confirmed that distance significantly associates with AST, even among students living within walking distance (1.6 km). While in New Zealand, the threshold distance correlated with walking to school among students between 6 - 19 years is 1.4 km. Moreover, the odds of AST are reduced by a third at distances between 1.3- 2.3 km, and it reached zero at distances beyond 2.3 km. Smith et al. (2020) reported that children residing farther than 2.3 km are unlikely to walk to school.

In Abu Dhabi, Badri (2013) confirmed the negative correlation between distance and AST and found that 85% of the students using AST take less than 30 minutes to reach their schools, while merely 14% of them live further than 5 km. While, In Saudia Arabia, Rahman (2019) investigated the travel behaviour and perception of walking in two neighbourhoods within Dhahran city. The results revealed that children living within 448 m from their schools actively travel to school by walking or cycling, while children living within 448m to 1.3 km from school most likely use school buses or private cars. Moreover, walking is more frequent in winter than in summer, as it is difficult to walk in heat and humidity.

Studies also highlighted the influence of distance with other factors on AST, such as age and weather conditions. For Instance, in Spain, the threshold distance of walking to school is 0.9 km for children and 1.3 km for adolescents (Sener, Lee & Sidharthan 2019). In Germany, Kobel, Wartha & Steinacker (2019) found that Primary school students using AST live at 0.7

km (median) away from their schools. Conversely, children using inactive travel modes live 2 km away. Another study among the same age group recommended that 1.7 km is the optimal distance for primary school students to engage in AST and attain the daily 60 minutes of PA. Kallio et al. (2016) confirmed that AST is significantly related to distance and seasonal conditions in Finland. AST showed to be the lowest among students aged 10 -16 years residing beyond 5 km from the school. It is also comparatively low in winter, mainly in distances beyond 2 km.

Placing schools in central locations distant from existing neighbourhoods may be why AST rates decrease among children, mainly in rural areas (Vitale, Millward & Spinney 2019; Ikeda et al. 2018; Yu & Zhu 2016). Moreover, Lee (2020) suggested that school siting should consider the neighbourhood features, including distance, street connectivity, density, and sidewalk networks. Also, it should consider traffic safety features, including traffic signs, speed limit signs, and crosswalks, to assure pedestrian safety.

Vitale, Millward & Spinney (2019) confirmed that the extensive catchment areas significantly limit the opportunity for AST in Canada. Moreover, walkability significantly differs between rural and urban areas. Almost 90% of school catchment areas in urban settings are within the walking range (2.4 km), while this percentage remarkably declines to 2% in rural areas. Therefore, in rural areas, only 5% of students use AST modes. Moreover, policies on bussing eligibility considered 1.6 km a cut-off distance in Ontario elementary schools, which influenced AST (Buttazzoni, Clark & Seabrook 2019). In Hong Kong, Barnett et al. (2019) also suggested encouraging students to join schools within their catchment zone because proximity to school has a significant association with AST.

Also, education tendency towards private schools located in central locations is associated with a rise in school travel distances and, consequently, the decline of AST (Sener, Lee & Sidharthan

2019). Furthermore, flexibility and lack of policies restricting school choice conflict with attempts to alleviate the distance barrier to AST. Studies found that only a few high school students reside within convenient cycling and walking to their schools compared with primary school students (Fitch, Rhemtulla & Handy 2019).

2.3.1.2 Travel to and from School

Some studies recognised a variance between active commuting to and from school (Wilson, Clark & Gilliland 2018). Also, Sener, Lee & Sidharthan (2019) found that active travel from school in the afternoon is more familiar than travel to school in the morning. It increases by nearly 3-10% for the trip from school. Since school and work times are more aligned than finish times, it is convenient for parents to drop off their children at school instead of picking them up in the afternoon. Moreover, parents find it convenient to combine school travel with their work travel due to safety concerns.

2.3.2 The Built Environment Features

The built environment represents an urban area's functional and physical features, including buildings, open space, and infrastructure (Aerts 2018). Further, built environments have different spatial measurements levels, including (1) The Micro-level, which indicates the immediate surrounding environment of residence, school, or work; (2) The Meso-level, which refers to small scale environments such as neighbourhoods, (3) the Macro-level is a larger scale such as cities (Day 2016).

Walkable built environments are pedestrian-oriented environments that allow the inhabitants to transport safely without motorised transportation (Stafford & Baldwin 2017). According to a general theory of Walkability by Jeff Speck, the main features of walkable streets are: to be proper, comfortable, safe, and exciting (Rahman 2019).

Previous studies proved that built environment characteristics, such as active transport facilities, road safety features, and distance, significantly influence AST. (Mandic et al. 2016; Žaltauskė and Petrauskienė 2016; Da Silva et al. 2017). Also, Fitch, Rhemtulla & Handy (2019) confirmed that urban features at the neighbourhood level or the area surrounding home or school correlate with AST in addition to distance. On the other hand, built environments with unsafe roads, inadequate space for active travel modes, and insufficient safety guidelines discourage PA and can be life-threatening for children (Aerts 2018).

Parent perceptions of the built environment features also play a crucial role in enhancing PA levels among children (Cain et al. 2018). Pang, Kubacki & Rundle-thiele (2017) and Ross, Rodríguez & Searle (2017) claimed that studies on AST deterioration found that parental perception about traffic safety is one cause of the issue. Moreover, positive parent and child perceptions of built environment features are essential to enhancing AST behaviours (Wilson, Clark & Gilliland 2018).

Built environments encourage or discourage active lifestyles (Poulsen et al. 2018; Frank et al. 2019). More specifically, built environments affect health through behaviour and exposure (Figure 2-3). The behaviour indicates maintaining an energy balance, where individuals expend an equal amount of energy to their intake through healthy daily behaviours. For instance, built environments with pedestrian infrastructure encourage PA behaviours, such as active travel. At the same time, exposure relates to environmental stressors (noise, traffic, and air pollution) and characteristics.

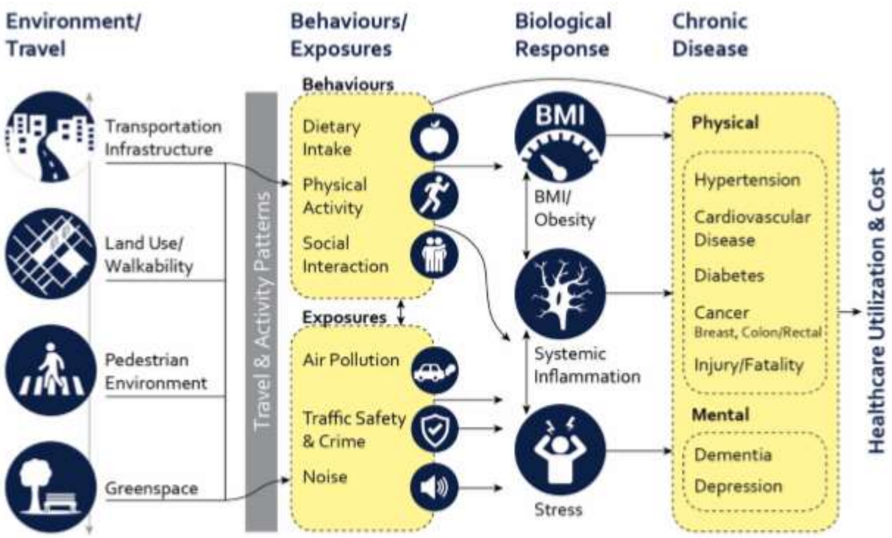

Figure 2-3 The Relationship of Built Environment with Chronic Disease and Healthcare Cost (Frank et al. 2019).

The built environment's impact varies depending on many circumstances, including age (Frank et al. 2019). For instance, built environment features that encourage walking among adults may differ for children or older adults. Furthermore, built environment features that influence PA among children vary geographically; however, most studies investigated homogenous geographies, mainly urban settings. Therefore, Poulsen et al. (2018) noted a lack of geographical variation in research that restricted identifying different built environment features.

2.3.2.1 Macro-Level Built Environment Features

At the macro level, the built environment features, including land-use mix, intersection density, and residential density, influence AST (Mandic et al. 2016; Da Silva et al. 2017; Stafford & Baldwin 2017; Ikeda et al. 2018; Buttazzoni, Clark & Seabrook 2019). Studies on AST found that moderate density and direct routes encourage students to walk to their schools. Additionally, street conditions and urban-form aesthetics encourage independent mobility in children.

Compared with children from urban areas, children in rural areas are generally more active, as García-Hermoso et al. (2017) noted. However, studies suggested that urban children are more likely to use AST than children from rural areas because of more sufficient pedestrian facilities and shorter distances to school. Žaltauskė and Petrauskienė (2016) also confirmed that the level of urbanization and accessibility to playing areas correlate with PA in children.

The macro-environmental features are more costly and challenging to modify in existing settings than micro-environmental, according to Verhoeven et al. (2017). However, many studies into the relationship between the built environment and adolescent active transport mainly focused on macro-environmental features, such as street connectivity, land-use mix, and residential density.

2.3.2.2 Micro-Level Built Environment Features

Children living in walkable built environments, with connected streets, safe crossings, accessible destinations, and pedestrian facilities, are more active than children in non-walkable settings (Villanueva et al. 2016; Carver 2019). Also, Zhu & Yoon (2017) reported the correlation between walkable-environment features, including sidewalks, crosswalks, street lights, slow traffic, and short distances; and AST. Moreover, Carver (2019) found that street connectivity is a significant feature of walkability in home and school environments.

Research on the association between adolescent's active travel and physical environmental features at the micro-level is rare, and results are inconsistent (Verhoeven et al. 2017). For example, few studies found a positive relationship between adolescent's active travel and the availability of walking and cycling paths in the US. Still, reviews on the same topic rejected the relationship among adolescent girls in Portugal. Also, Zhu & Yoon (2017) claimed that it is essential to target inactive mode users living within a walkable distance to their school, which may happen due to the perception of neighbourhood environment features.

Ross, Rodríguez & Searle (2017) researched the influence of the built environment and safety on AST odds. Considering that children can cross the street unaccompanied by ten years, the study involved parents of U.S. children in grades 3-8 and involved the active trips that repeat three or more times a week. The results revealed that the absence of sidewalks, lack of school crossing guards, high vehicle traffic, and unsafe street crossings, significantly discourage AST. Moreover, Tarun et al. (2017) confirmed that private schools that are lacking walking and cycling facilities in the outdoor environment, such as safe pedestrian crossings, cycle lanes, and traffic calming features, though, having drop-off and parking areas, encourage inactive transportation modes among Indian children between 5 and 17 years.

At the same time, Da Silva et al. (2017) and Poulsen et al. (2018) confirmed that pedestrian and cycling facilities are the most influencing features on AST. Similarly, Ikeda et al. (2018) noted that AST odds are three times higher in neighbourhoods with high street connectivity than other neighbourhoods. Additionally, connectivity in school settings through walking and cycling paths will likely enhance AST in New Zealand. However, studies from Australia and Canada conflicted with these results. They reported a negative correlation between connectivity and active school travel, claiming that highly connected streets are dominated by motorized travel approaches, which expose children and adolescents to traffic risks. Besides street connectivity, Buttazzoni, Clark & Seabrook (2019) and Smith et al. (2020) found that pleasant scenery, in addition to the presence of pedestrian walkways and crosswalks, positively correlate with AST.

Furthermore, Sener, Lee & Sidharthan (2019) reported that the density of sidewalks is positively associated with active school travel. Similarly, street connectivity is a positive determinant of active school travel but only in low traffic areas. Also, Fitch, Rhemtulla & Handy (2019) reported that the width and quality of sidewalks, and other linear features, such as street directness, significantly correlate with AST among children and adolescents. Conversely, the lack of safe crossings or traffic signals presents a significant barrier to AST (Aerts 2018; Sener, Lee & Sidharthan 2019; Carver 2019)

Frank et al. (2019) found that traffic safety features in addition to pedestrian and bicycle infrastructures significantly encourage active travel and provide a sense of safety by separating the active travel approaches from the motorized traffic. Additionally, green space in the pedestrian environment has a protective effect as well as purifying polluted air. Likewise, Verhoeven et al. (2017) agreed that the most influencing built environment features on cycling among 11-13-year-olds is the separation of cycling paths from traffic, followed by distance and co-participation in cycling. Moreover, the amount of vegetation, speed limit signs, and speed bumps are the least influential features on adolescent bicycling for transportation.

2.3.2.3 Combinations of Built Environment Features Approach

Recent research found that the environmental features are composite and interact in multiple forms; therefore, the relevant studies need to consider the potential influence of the combined presence or absence of different environmental elements (Deweese et al. 2017; Poulsen et al. 2018). Also, Cain et al. (2018) agreed that limitations occur in studies analysing individual built environment features separately. For example, high and low are walkability characteristics; however, variation may occur in low and high neighbourhood settings when introducing additional neighbourhood features. Therefore, new studies identify the possible combinations of built environment features and consider the associations between the resultant profiles and PA.

2.3.3 Child Independent Mobility (CIM)

Aerts (2018) pointed out that unhealthy and unsafe travel mode choices, in addition to poor street design, restrict a child’s independent mobility. Moreover, vehicle oriented transportation policies lead to dangerous streets for pedestrians and, consequently, limit the CIM. It is crucial to understand the particular spatial requirements of children in the urban environment for every age. The proximity of essential services and walkability in the neighbourhoods allows children and their caretakers to access these services by walking, cycling, or public transportation (Figure 2-4).

Studies defined three types of CIM measures (Lee 2020). The first type is related to the allowed travel distance. The second reflects a set of restrictions by parents to control the level of travel independence, for example, approval to cross the roads or to cycle independently. The third type is related to a specific time to reach a destination. Studies that considered the child age suggested that children by ten years can cross the street unaccompanied (Ross, Rodríguez & Searle 2017).

Sener, Lee & Sidharthan (2019) reported that parents have a significant influence on the choice of school travel mode, especially for younger children who are incapable of independently travelling to school. Also, Fitch, Rhemtulla & Handy (2019) stated that adolescents have more freedom to travel independently than children; however, the school travel mode is a shared decision between parents and children. On the other hand, parent perception of barriers to AST is more influential than child perception (Wilson, Clark & Gilliland 2018; Rahman 2019).

Studies confirmed that CIM significantly influences active travel and that both have decreased in association with traffic concerns increases and lifestyle changes (Tremblay et al. 2016; Marzi, Demetriou & Reimers 2018; Carver 2019). For example, in Australia, CIM had dropped from 61% in 1991 to 32% in 2012. Also, in Helsinki, Finland's studies recorded a significant drop from 82% to 50% over two decades. Children are less independent regarding their mobility and are more influenced by their environments than adults. Therefore, understanding CIM's physical and social environmental influences is essential to develop potent interventions to stimulate independent, active travel among children.

Regarding the social environment, perceived neighbourhood features and parental opinion of independent mobility in addition to vehicle ownership are significant CIM associates.

Additionally, gender differences exist regarding the correlation between the physical environmental features and CIM. Distance and traffic safety are two features that significantly correlate with CIM (Marzi, Demetriou & Reimers 2018). Furthermore, parent perceptions of safety measures demonstrated a stronger correlation with AST than other built environment features (Ross, Rodríguez & Searle 2017; Zhu & Yoon 2017; Wilson, Clark & Gilliland 2018; Buttazzoni, Clark & Seabrook 2019). For example, unsafe intersections and distance are the main barriers to AST, as reported by parents of Spanish students (Aparicio-Ugarriza et al. (2020) and Huertas-Delgado et al. 2017).

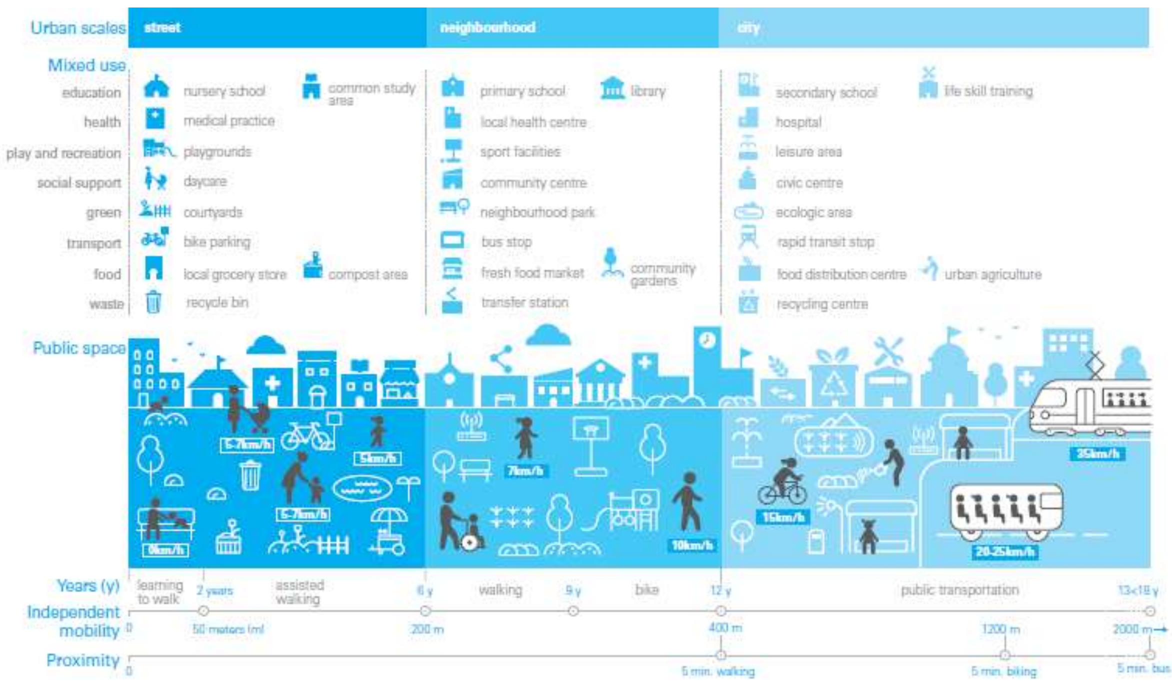

Figure 2-4 Child independent mobility in the urban environment (Aerts 2018).

2.3.4 Individual, Sociocultural and Socioeconomic Characteristics

Individual and social factors influence school travel behaviours, such as the child's age, gender, parents' income, and peer impact (Zhu & Yoon 2017; Buttazzoni, Clark & Seabrook 2019). For example, Verhoeven et al. (2017) confirmed that peer impact and co-participation significantly encourage cycling for transportation among adolescents. Sociocultural factors also correlate with school travel behaviours (Ross, Rodríguez & Searle 2017).

Active travel behaviours in intermediate socio-economic settings are commonly related to a need than a choice, regardless of the low quality of built environment features (Da Silva et al. 2017). Rahman (2019) confirmed that walking for transportation is an obligation rather than an option for a large population of low-income expatriates living in Saudi. Moreover, the country has experienced rapid population growth since the 1970s due to economic development. Such changes directly impacted walking behaviours among residents. Furthermore, studies on school travel behaviours found that students from low-income households and public schools are more likely to walk or cycle to school (Kobel, Wartha & Steinacker 2019; Sener, Lee & Sidharthan 2019).

Children of well-educated parents and physically active mothers are also more likely to use AST. Thus, parent culture and perception of AST are another significant influence on school travel mode. Studies also revealed that parents and children in Newzealand perceive the school bag as a barrier to AST in addition to distance, length of trip, traffic safety, and weather (Mandic et al. 2018).

2.4 Interventions and Policies

Considering the significant decline of PA levels, there is a severe need for interventions to encourage PA behaviours, including AST. Interventions involving built environment developments are necessary to stimulate PA activities among students (Da Silva et al. 2017; Tarun et al. 2017; Pang, Kubacki & Rundle-thiele (2017). Moreover, there is an urge for more school-based interventions built on strategies to change the perception of AST in both children and parents (Villa-González et al. 2017). Additionally, imposing traffic regulations and policies, such as crossing guard initiatives, encourages AST and enhance safety perception (Buttazzoni, Clark & Seabrook 2019; Leung, Phuong & Le 2019).

Global efforts to improve PA levels for children have started in various countries, such as the Canadian Report Card on PA for Children (Tremblay et al. 2016). It resulted in a Global Matrix of Grades that reflects extensive global experiences and provides reliable data for related studies. Furthermore, intervention programs in different countries, such as the Safe Routes to School program, Walking School Bus, and Walk to School programs, enhanced AST behaviours and influenced parent perceptions. (Yu & Zhu 2016; Zhu & Yoon 2017; Villa-González et al. 2017; Larouche et al. 2018).

Active travel interventions can contribute to progress across several goals and targets of the 2030 Agenda for Sustainable Development (Macmillan et al. 2020). For example, Goal 3 (Health and wellbeing), Goal 10 (Reduced inequalities), Goal 11 (Make cities and human settlements inclusive, safe, resilient and sustainable) and Goal 13 (Climate change). Interventions to replace short motorised trips with cycling and walking contribute to decreasing NCD, traffic injuries, and air pollution. It is also crucial to consider equity globally while designing communities because inequities in living in safe and appropriate built environments correlate with health and social inequalities. Consequently, these efforts may help cities to reduce energy consumption and respond to climate change while improving life quality, as explained by Zhao et al. (2013) and Fernandes & Marsden (2020) in the definition of resilient cities

Engineering and Environmental Interventions

Engineering interventions, such as pedestrian and cycling infrastructure developments, improve safety and walkability in the built environment, promote CIM, and influence AST behaviours (Carver 2019; Buttazzoni, Clark & Seabrook 2019; Leung, Phuong & Le (2019). These improvements are necessary to address parent concerns about traffic safety (Huertas-Delgado et al. 2017). Furthermore, developing cycling infrastructure encourages cycling as part of AST interventions since it is a convenient mode of travel for school trips of mid-length between 3-8 km (Goodman et al. 2019).

Few studies investigated the effects of built environment modifications on travel behaviours (Zhu & Yoon 2017). However, there was a significant shift to AST among U.S. students after installing sidewalks, crossing signals, crosswalks and traffic control aids. Moreover, improvements to traffic safety and walkability, such as adding safe intersections, traffic calming features, and providing tree cover for shading along the route to school, might influence how parents perceive AST (Yu & Zhu 2016; Leung, Phuong & Le 2019).

Pang, Kubacki & Rundle-thiele (2017) highlighted the need for infrastructural development and traffic control interventions to lessen the apparent risk of AST. Additionally, it is equally important to consider interventions that target parent perceptions of AST in addition to the infrastructure (Sener, Lee & Sidharthan 2019).

Education and Encouragement interventions

Studies also reported an increase in AST related to education and encouragement school programs (Zhu & Yoon 2017). However, interventions based on both infrastructure modifications and school activities resulted in a significant increase in AST. In comparison, interventions based mainly on road safety developments influenced parent perceptions concerning AST (Larouche et al. 2018).

Multi-faceted Interventions

Multi-faceted interventions are more effective than isolated projects to encourage AST and accommodate its complexity (Smith et al. 2020). Moreover, the use of multiple continuous concepts is required to achieve meaningful changes in AST. One solution is not efficient to fit all children, parents, and school communities. For example, the Canadian School Travel Plan (STP) program employed engineering, encouragement, and education initiatives to promote

AST (Buttazzoni, Clark & Seabrook 2019). Generally, the intervention succeeded in improving parent and child perceptions of AST barriers, but it was less influential on AST behaviours. Therefore, it is crucial to address the perception-behaviour gap in AST and consider strategies that target parent perceptions of built environment features (Huertas-Delgado et al. 2017).

Another example is a model created by Smith et al. (2020) that demonstrates five AST variables and seven suggested interventions (Figure 2-5). The interventions include: (A) developing leisure facilities near schools; (B) encouraging AST programs and enhance safety skills; (C) hiring crossing guards, promoting group AST programs, enforcing traffic policies and infrastructural developments; (D) developing zoning regulations, encouraging cycle training, providing bicycle parking, and integrating relevant courses to the curriculum; (E) promoting active travel in the community to enhance the perceived safety; (F) improving traffic safety and enhancing the active travel culture in the community; (G) encouraging the community to participate and support AST programs.

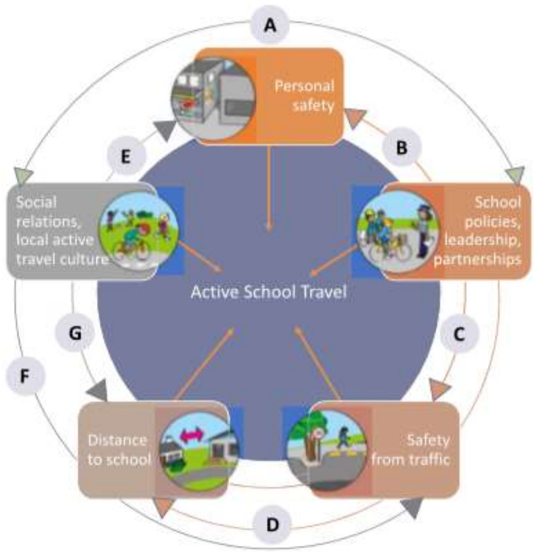

Figure 2-5 Conceptual Model of Correlated Five Variables of Active School Travel and the Suggested Interventions (Smith et al. 2020).

2.4.1 Interventions in the UAE

It is crucial to implement suitable interventions to increase PA rates among children and adolescents in the UAE. Examples of the current initiatives in the UAE are Plan Abu Dhabi 2030, Dubai Plan 2021, and Dubai Safe-School-Drive campaign.

2.5 Hypotheses Formulation

Concluding from the review, several variables influence the decision for school travel mode. Of the trip characteristics, distance to school seems to be of significant impact on school travel behaviours. It is the most frequently cited factor, with the strongest significant correlation to AST. Increasing distance leads to less AST; the threshold distance for cycling (4-5 km) is higher than walking (1.4-1.7 km). The time length of the journey to and from school is another influencing factor. This information leads to the first and second hypotheses of this study:

- **H1**: There is a significant correlation between distance and school travel behaviours
- **H2**: There is a significant correlation between time length of trip and school travel behaviours.

Previous studies confirmed that built environment features significantly influences the decision between active and inactive school travel. (Mandic et al. 2016; Žaltauskė and Petrauskienė 2016; Da Silva et al. 2017). The built environmental features of the most impact are street connectivity, infrastructures for cycling and walking, traffic calming measures, landscaping, and traffic safety measures. This information leads to the third hypothesis of this research:

- **H3**: There is a significant correlation between the built environment features and school travel behaviours.

Parents have a significant influence on school travel mode, especially for younger children (Sener, Lee & Sidharthan 2019). Students who travel to school accompanied by adults most probably use inactive travel modes. Therefore, the lack of CIM would limit the opportunities of AST. This information leads to the fourth hypothesis:

- **H4**: There is a significant correlation between CIM and school travel behaviours.

Parent perceptions of the built environment features, mainly traffic safety measures, considerably impact the decision for the school travel mode (Cain et al. 2018). Studies pointed out that positive parent perceptions of built environment features are crucial to enhance AST behaviours (Wilson, Clark & Gilliland 2018). This information induces the fifth hypothesis of this study:

- **H5**: There is a significant correlation between parent's perceptions of the built environment features and school travel behaviours.

Studies also highlighted the significant impact of weather conditions during winter and summer on school travel behaviours in different countries (Mandic et al. 2018). This information leads to the sixth hypothesis:

- **H6**: There is a significant correlation between weather changes and school travel behaviours.

Parent culture and perceptions of AST benefits is another significant influence on the choice of school travel mode (Mandic et al. 2018). Therefore, studies recommended enhancing the active travel culture in the community. This information leads to the seventh hypothesis:

- **H7:** There is a significant correlation between parents’ perceptions of AST and school travel behaviours.

2.6 Conceptual Framework

As indicated in Chapter 1, this research aims to investigate the influence of different environmental factors on the decision between active and inactive school travel modes and identify the built environment factors that inhibit AST among private school students in Dubai.

Seven hypotheses have been developed based on the research objectives and the literature review. The hypotheses are reflected in a conceptual framework that explains the relationships between the different factors (Figure 2-6). This study includes main independent variables: trip characteristics (distance and length of the trip), CIM (adult companion, other students), built environment features (street connectivity, traffic calming measures, pedestrian infrastructure, cycling infrastructure, Landscaping), parent perception of the built environment features (walking and cycling infrastructure, traffic safety measures, landscaping), weather conditions, and parent culture/perceptions of AST. These variables are believed to be influencing school travel behaviours (active and inactive) as dependent variables. The study investigates the relations between the independent and dependent variables among private school students in Dubai.

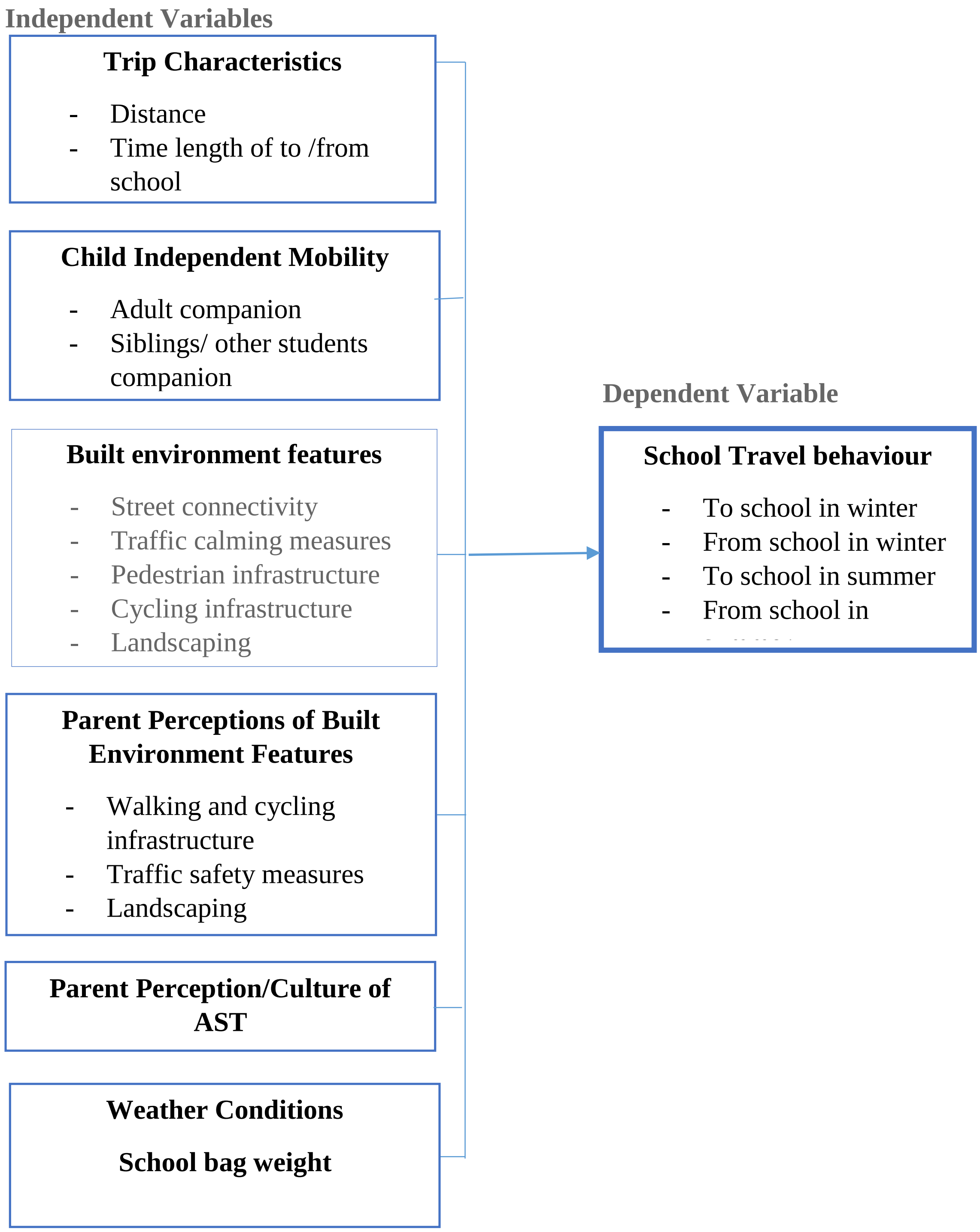

Figure 2-6 The Proposed Conceptual Framework: Relationships between Independent Variables and School Travel Behaviours (Author 2020)

Chapter 3: Research Methodology

This chapter explains the methodological approach and the methods implemented to collect data to achieve the aim and objectives of this study. The chapter starts with describing the research quantitative approach and design, followed by a detailed explanation of the study's hypotheses and variables developed in the previous chapter. Next, the sampling, data collection, and data analysis methods are presented. Finally, the chapter ends with discussing the reliability, validity, and ethical considerations.

3.1 Research Approach

The current study was initially intended to adopt a mixed-methods research design, which combines quantitative and qualitative methods using parental survey and qualitative observation tools in addition to existing data analysis (Appendix C). However, due to the school closures related to the Covid-19 pandemic, the study adopted a quantitative approach with a correlational design which allows to measure the study variables and evaluate the relation between them. In contrast to qualitative research, the quantitative method deals with numerically measurable data and involves hypotheses testing. The advantages of using the quantitative approach in the current study are:

- It allows studying a large sample size, which provides statistically accurate results
- It helps to collect a large amount of data in a short time that statistical software can analyse.
- It results in convenient response rates because participants have enough time and less pressure to participate without being observed.
- It is the most suitable method to study correlations between variables and test proposed hypotheses.

This study administered a survey process to collect, analyse, and interpret the data required to evaluate the relationship between school travel behaviours and the influencing factors among private school students in different residential areas in Dubai. The survey included a parent questionnaire since parents mostly decide the school travel mode and the difficulty of reaching stuents during the COVID-19 pandemic when schools were closed.

3.2 Research Design

This study used a correlational cross-sectional research design to explore the relationships between school travel behaviours and the influencing factors considered in the study variables. This relation was discussed extensively in chapter 2; however, the present research validated the proposed research hypotheses among the private school students in Dubai.

The conceptual framework (Figure 2-6) graphically demonstrates the study variables and the suggested correlations based on the proposed hypotheses. As illustrated, school travel modes and influencing factors are the variables. Moreover, school travel modes have been detailed into four sub-variables to study further the effect of seasonal characteristics and time of the day on the relationships. The sub-variables are travel to school in winter, from school in winter, to school in summer, and from school in summer. Furthermore, the study used the demographic data only to assure that the sample was representative of the population, but their relationships were not studied.

3.3 Study Variables and Hypotheses

In this study, school travel behaviour (to school in winter, from school in winter, to school in summer, and from school in summer) was the dependent or outcome variable. Active modes included cycling and walking, while school bus, private, and public transportation represented the inactive modes. The study considered the travel mode that repeats at least three days a week to distinguish between active and passive methods (Rodríguez & Searle 2017). The school travel behaviour was detailed into four sub-variables considering the seasonal characteristics (winter and summer) and the time of the day (morning and afternoon) as suggested by Kallio et al. (2016) and Wilson, Clark & Gilliland (2018).

While, the independent variables included trip characteristics (distance and length of the trip), CIM (adult companion, other students), built environment features (street connectivity, traffic calming measures, pedestrian infrastructure, cycling infrastructure, Landscaping), parent perception of the built environment features (walking and cycling infrastructure, traffic safety measures, landscaping, and parent perceptions of AST). Also, the study included other secondary variables, such as the weather and school-bag weight. However, the environmental attributes are the primary independent variables in this study. The variables, level of measurements and the related questions are shown in Appendix B.

Moreover, this study tested seven hypotheses that proposed significant correlations between the study variables based on the existing knowledge presented in the previous chapter:

- **H1**: There is a significant correlation between distance and school travel behaviours
- **H2**: There is a significant correlation between time length of trip and school travel behaviours
- **H3**: There is a significant correlation between the built environment features and school travel behaviours
- **H4**: There is a significant correlation between CIM and school travel behaviours
- **H5**: There is a significant correlation between the parent's perceptions of the built environment features and school travel behaviours.
- **H6**: There is a significant correlation between weather changes and school travel behaviours.
- **H7**: There is a significant correlation between parents’ perceptions of AST and school travel behaviours.

3.4 Sampling

The population of this study was the private school students in Dubai. According to Dubai Statistical Center (2019), 228,000 students study in Dubai private schools in grades G1-G12, including 25 embassy schools (18218 students). Considering that the average number of children in the family is three, and after excluding the students in the embassy schools, the targeted population is 69927 students. A sample size calculator indicated that 383 participants compose a sample with an ideal size, a confidence level of 95%, and a margin of error equal to 5%.

After a pilot study that included thirty participants, 34 private schools were invited to participate in the survey through email. The invitation had an explanation of the nature and purpose of the study. The schools were asked to forward an online questionnaire link to parents of students from both genders in grades G1-G12. Invitations were also sent through online parent groups. The sampling involved a random selection of participants. For ethical considerations, parents were informed about the purpose of the study, and confidentiality was assured. Moreover, they were allowed to ask questions through email.

The selected schools were from different residential areas in Dubai, including Al Barsha, Al Mamzar, Al Warqaa, Al Sufouh, Al Safa, Dubai Land, Dubai Investment Park, Dubai Festival City, The Meadows, Arabian Ranches, and Jebel Ali. The email addresses for all the invited schools were obtained from the KHDA online school directory.

Parents of 424 students attending different private schools in Dubai completed the online questionnaire. Sixteen responses from parents of students in the kindergarten or outside Dubai (Ajman, Sharjah, or India) were excluded, so the final sample included 408 participants (96% of total respondents).

3.5 Data Collection

Questionnaires are primary tools to collect data in quantitative research and are commonly used to evaluate PA environments, with limited resources and less burden on researchers (Carlson, Dean & Sallis 2017; Verhoeven et al. 2017). Zhu & Yoon (2017), Deweese et al. (2017), and Ross, Rodríguez & Searle (2017) used parent questionnaires to investigate the environmental factors and PA and school travel mode among students in different countries. While, Žaltauskė and Petrauskienė (2016), García-Hermoso et al. (2017), and Aparicio-Ugarriza et al. (2020) used self-report questionnaires. Moreover, Kallio et al. (2016) and Verhoeven et al. (2017) used online self-report questionnaires. A difference in results between parent and child surveys regarding perspectives on school travel behaviours, built environment, and barriers to AST was recognized (Poulsen et al. 2018).

The survey process involved an online parent questionnaire that included a set of closed-ended questions. The Google Docs application facilitated the distribution of the survey and collection of responses. Initially, the questionnaire was presented to the dissertation supervisor and once approved, the survey process started. The Data collection procedure took place between May and July 2020. The questionnaire included thirteen items, in addition to four introductory questions (Appendix A). It consisted mainly of closed-ended questions (multiple-choice, Likert-scale) with a few open-ended. Parents were also asked to write their comments at the end of the survey. All questions were mandatory, except one was optional (Question 11), and it covered the following topics:

1. **Individual characteristics**

Four introductory questions collected information related to the neighbourhood/area, school name/area, the grade, and gender of the child.

2. **School travel mode**

School travel mode was evaluated with consideration of weather changes. Since the temperature is quite different between winter and summer in Dubai, parents were asked separately for both conditions to choose the mode of travel that repeats three or more times per week.

2.1 To school in winter and summer

Questions 4 and 6 'In winter months, how does your child arrive at school?' and 'In summer months, how does your child arrive at school?'

2.2 From school in winter and summer

Questions 5 and 7 'In winter months, how does your child leave from school?' and 'In summer months, how does your child leave from school?'

The response choices were: walk, cycle, school bus, private vehicle, public transport (bus, metro, taxi), and others.

3. Trip characteristics

3.1 Distance to school

Question 1 'How far does your child live from school?' The response choices were: 0 – 0.5 km, 0.5 –1 km, 1–1.5 km, 1.5 – 3 km, more than 3 km, and not sure.

3.2 Time Length of the trip to and from school

Questions 8 and 9 'How long does it usually take your child to get to school?' and How long does it usually take your child to get home from school?' The response choices were: Less than 5 minutes, 5 – 10 minutes, 11 – 20 minutes, more than 20 minutes, don't know / not sure.

4. Influencing factors on school travel mode choices

The examined environmental features that promote or restrict AST fall into three main categories:

- Community design features such as access to schools (distance and length of trip).
- Transportation system features including street connectivity and bicycle infrastructure network
- Streetscape (micro-level) features, including sidewalks, street crossings, and traffic calming measures. And aesthetic features, including landscape and views.

Question 10, regarding the factors influencing the choice of school travel mode 'Which of the following factors affected your decision to allow or not allow your child to walk or cycle to/from school?' The response choices included five streetscape features: street connectivity, traffic-calming measures, pedestrian infrastructure, cycling infrastructure, and landscaping; two trip characteristics: distance and length of the trip; and three other influences: adult to walk or cycle with, the weight of school bags, weather, and other. This question allowed the participants to select all factors that apply to them.

Question 11 was an optional question that asked parents who are not allowing their children to walk or cycle to school ' Which of the following features if changed or improved; you would probably let your child walk or cycle to/from school?' The response choices were traffic-calming measures, pedestrian infrastructure, cycling infrastructure, landscaping, distance, and others.

5. Parent perceptions of the built environment features

Question 12 asked the respondents to select yes or no regarding their perception of six primary built environment features in the school zone: (a) the sidewalks are wide enough for walking, (b) the sidewalks are continuous, (c) the sidewalks are in good condition without any large cracks or dips, (d) the crosswalks are marked clearly, (e) there are crossing signals or crossing guards near the school, (f) there is traffic calming measures such as speed humps, (g) there are speed limit signs, (h) there are trees that provide shade along the path to school, (i) and there are many beautiful natural things to look at such as gardens and views.

6. **Child independent mobility**

Questions 2 ‘At what grade would you allow your child to walk or cycle to/from school without an adult?’ As there were no response choices for this question, few parents mentioned the age instead of the grade.

Question 3 asked the parents, ‘Would you probably allow your child to walk or cycle to/from school with older siblings or other children?’ The answer choices were yes or no.

7. **Parent perception/culture of AST**

Question 13 ‘How far do you agree or disagree with the following statements: (a) the neighbourhood environment may encourage or discourage walking and cycling to/from school, (b) walking or cycling to school is healthy for children, (c) replacing motorized school trips with active modes would result in reduced traffic congestion, and reduced emissions of air pollutants, noise, and greenhouse gases, and (d) walking to school with other families is a great way to build an active community and create safer friendlier streets?’ The response choices for this question were on a five-point Likert scale ranging between 1: strongly agree and 5: strongly disagree.

3.6 Data Analysis

The data from the questionnaires were collected online, checked, and transferred to an Excel sheet. Statistical analyses were performed using the IBM Statistical Package for the Social Sciences (SPSS) software version 27.0. Descriptive statistics were used to summarize and inspect the data from each variable using frequency distribution tables and bar charts. Additionally, the study used inferential statistics (Cross tabulation, Chi-square tests) to examine the correlation between school travel behaviour and the independent variables and test the proposed hypotheses followed by interpreting the findings. In this analysis, scoring a p value below .05 was a sign of a significant association between the study variables and the Cramer’s V value indicated the strength of association

3.7 Reliability and Validity

The survey used questions from existing parent survey instruments that have demonstrated valid and reliable scores, for example, the Safe Routes to School (SRTS), the Built Environment and Active Transport to School Study (BEAST), and the PA Neighborhood Environment Scale (PANES).

The questionnaire was piloted before starting the survey to check its clarity and appropriateness for parents' culture in the UAE (Wilson, Clark & Gilliland 2018). Thirty participants performed a pilot test and found the questions clear and relevant. It took them only 5 – 7 minutes to complete it. However, 12 participants refused to answer a question regarding home address details, and they recommended deleting it for privacy concerns. Then, the questionnaire was accordingly modified. Furthermore, Cronbach's alpha (α) was calculated to evaluate the internal reliability of the questionnaire, with a minimum of 0.7 as the acceptance limit. Remarkably, all of the 13 questions were accepted since the values of Cronbach's Alpha were above 0.7.

Chapter 4: Data Analysis, Results and Discussion

This chapter reports the relevant results of the study survey. It starts with descriptive statistics to describe the frequency distribution and proportion of the collected data through the online parent questionnaire. Next, the results of the statistical tests are reported to assess the correlations between the school travel variables and the independent variables and state whether or not the research hypotheses are supported. Lastly, a comprehensive discussion is included to interpret and evaluate the research findings considering the literature review. The chapter consists of the following sections:

- Demographic information
- Descriptive statistics
- Inferential Statistics
- Discussion of the findings

4.1 Demographic Information

The demographic information, including the gender and educational stage of the 408 students, was obtained to assure that the sample was representative of the population.

4.1.1 Gender

Table 44-1and Figure 4-1 show that of all 408 students, the majority were male (N= 258, 63%) while N=150, 37% were Female.

Table 44-1 Distribution of students’ Genders

Gender	**Frequency (N)**	**Percent (%)**
Male	258	63
Female	150	37
Total	408	100

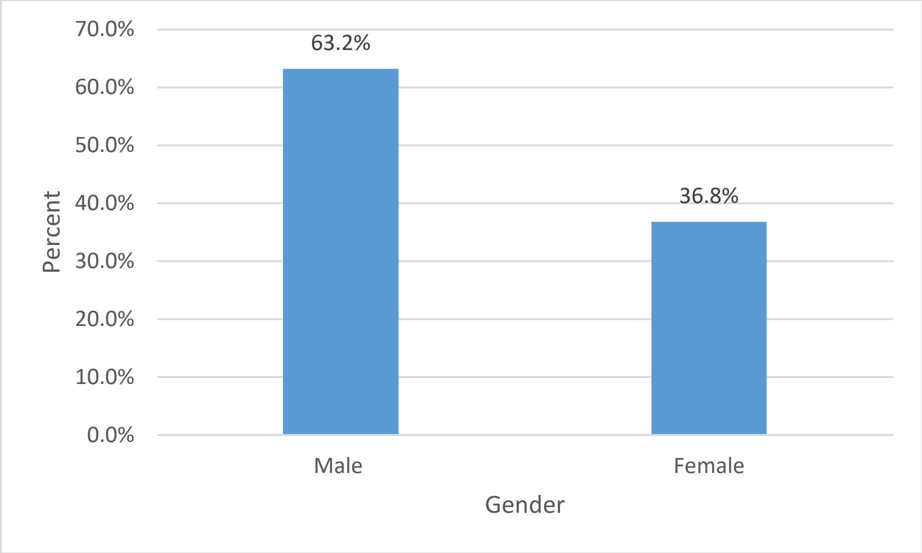

Figure 4-1 Distribution of students' Genders

4.1.2 Educational Stages

Table 4 - 2 and Figure 4 - 2 show that most of the students were in grades 1- 4 (42.4%) while 34.3% were in grades 5 - 8 and 23% are in grades 9 - 12.

Table 44-2 Distribution of educational stages

Educational stage (Grades)	**Frequency (N)**	**Percent (%)**
G1 - G4	173	42.4
G5 - G8	140	34.3
G9 - G12	95	23.3
Total	408	100

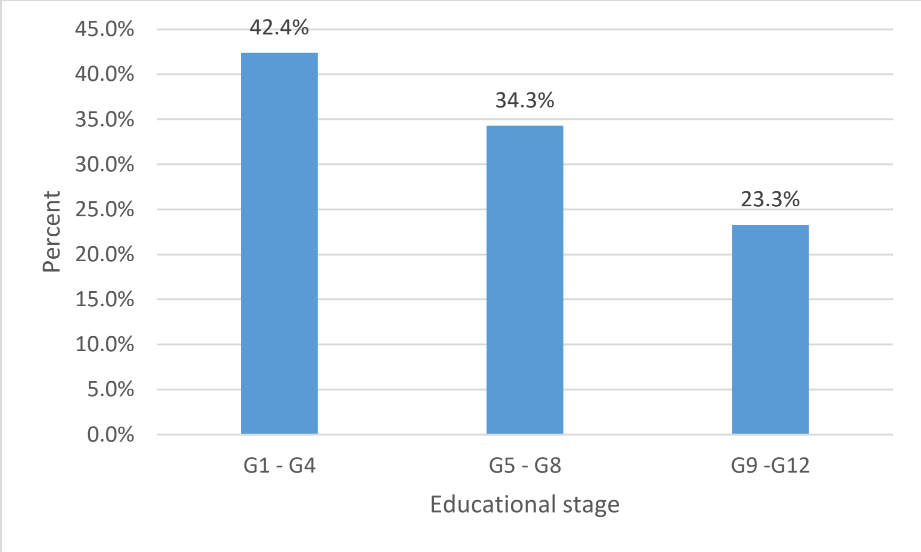

Figure 4-2 Distribution of educational stages

4.2 Descriptive Statistics

This section summarizes the frequency distribution of parents' responses within the different variables by numbers and percentages presented in tables and graphs.

4.2.1 Distance

Q1: 'How far does your child live away from school?'

0 – 0.5 km, 0.5 –1 km, 1–1.5 km, 1.5 – 3 km, more than 3 km, and not sure.

Table 4-3 and Figure 4-3 show that the majority (N=256; 63%) attend schools beyond 3 km away. Whereas 33% of the students live within a walkable distance (1.5 km) from their schools, and a few (N=16, 4 %) live between 1.5 - 3 km of school.

Table 4-3 Distribution of the distances between home and school

Distance	**Frequency (N)**	**Percent (%)**
0 – 0.5 km	33	8
0.5 – 1 km	61	15
1 – 1.5 km	41	10
1.5 – 3 km	16	4
More than 3 km	257	63
Total	408	100

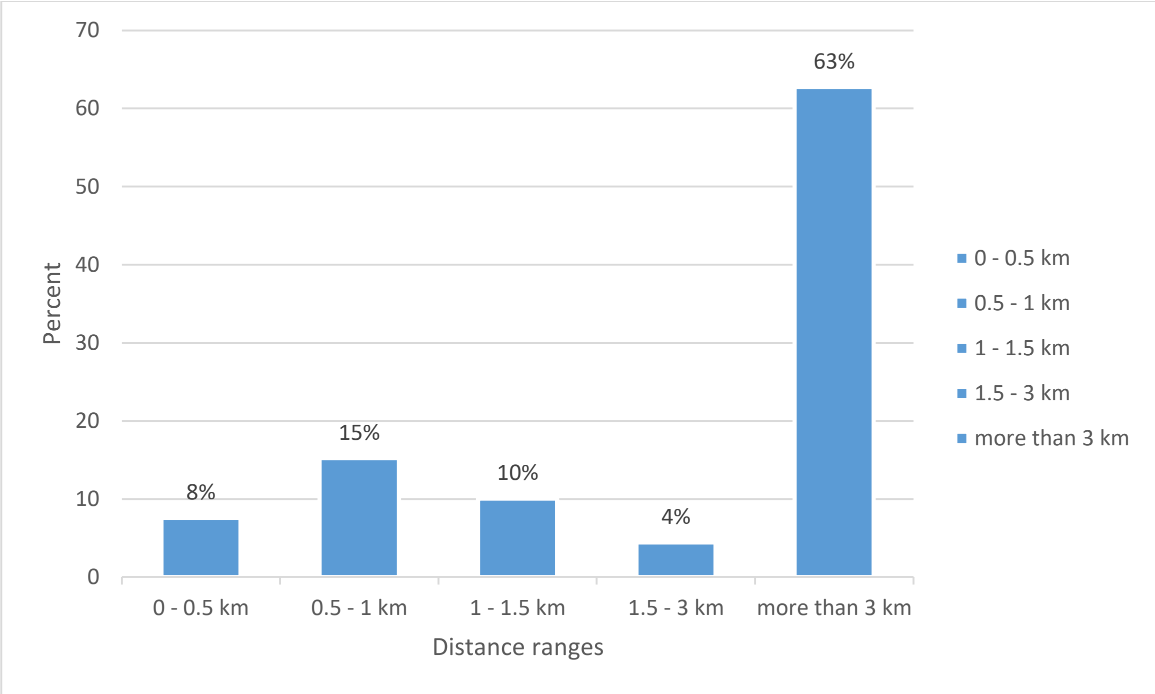

Figure 4-3 % Distribution of the distances between home and school

4.2.2 Child Independent Mobility (without an adult and with siblings and other students)

Q2: 'At what grade would you allow your child to walk or cycle to/from school without an adult?'

Table 4-4 and Figure 4-4 present the distribution of parents permission to walk or cycle to school without an adult within three categories of educational stages (elementary: G1 – G4; preparatory: G5 – G8; secondary: G9 – G12). Most of the students (N=151, 38%) are allowed to walk and cycle to school independently between grades 5 – 8, 24% between grades 9 – 12, while 31% are not allowed at any grade.

Table 44-4 Distribution of parents 'permission to walk or cycle to school independently

Grade at which AST without an adult is allowed	Frequency (N)	Percent (%)
G1 – G4	27	7
G5 – G8	151	38
G9 – G12	104	24
Not Allowed at any grade	126	31
Total	408	100

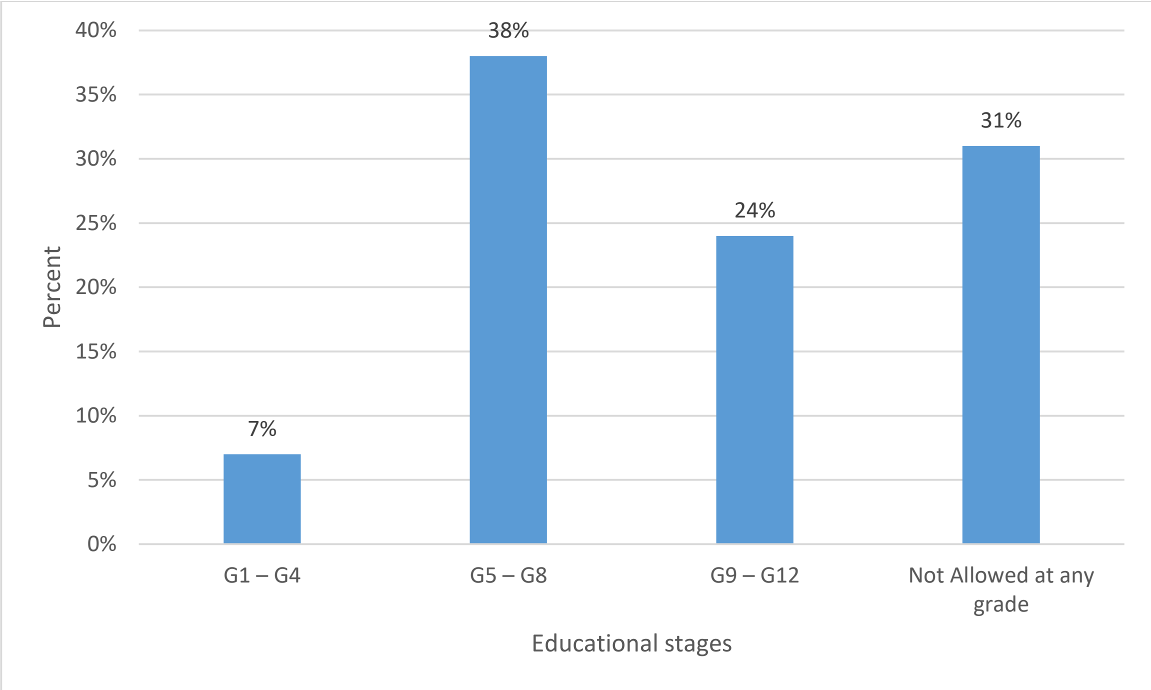

Figure 4-4 Distribution of parents ‘permission to walk or cycle to school independently

Q3: ‘Would you probably allow your child to walk or cycle to/from school with older siblings or other children?’

Yes or **No**.

Table 4-5 and Figure 4-5 illustrate the statistics of permissions to cycle or walk to school with siblings or other students for the 408 participants. More than half of the students (N=212, 52%) are allowed to walk or cycle to school with siblings or other students, whereas 48% are restricted.

Table 4-5 Distribution of the permission to walk or cycle to school with siblings or other students

Permission to AST with siblings or other students	**Frequency (N)**	**Percent (%)**
Allowed	212	52
Restricted	196	48
Total	408	100

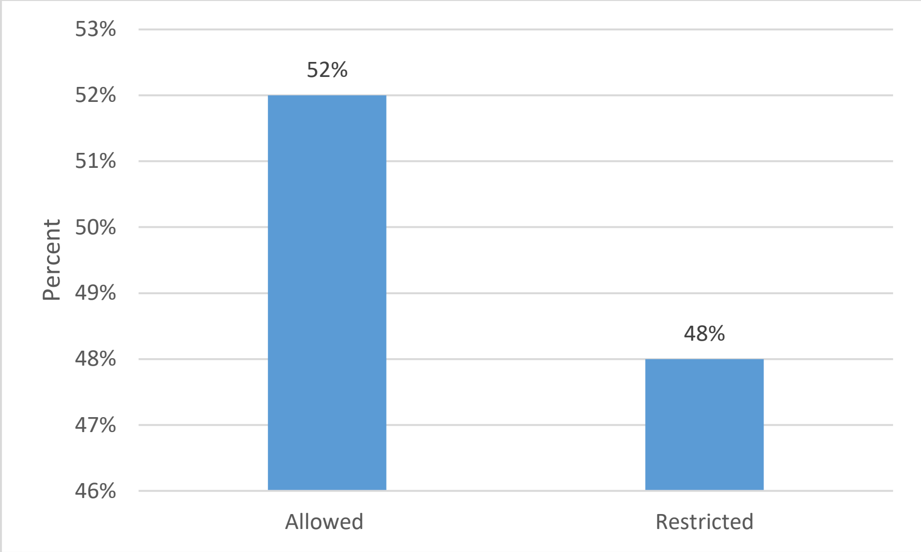

Figure 4-5 Distribution of the permission to walk or cycle to school with siblings or other students

4.2.3 Modes of Travel to School

4.2.3.1 In winter to/from school

Q4: 'In winter months, how does your child arrive at school? (Select the choice that repeats on three or more days per week).'

walk, cycle, school bus, private vehicle, public transport

Table 4-6 and Figure 4-6 show the distribution of the students' mode of travel to school within five types of transportation approaches in winter. Over half of all students use private cars (N= 212, 52%) and school buses (N= 110, 27%) to travel to school in the winter. In comparison, only 19% (5% cycle and 14% walk) actively travel to school. Only a few students (3%) use public transport

Table 4-6 Distribution of travel to school modes in winter

Travel to School in winter	Frequency (N)	Percent (%)
Walk	57	14
Cycle	21	5
School bus	110	27
Private vehicle	212	52
Public transport	8	2
Total	408	100

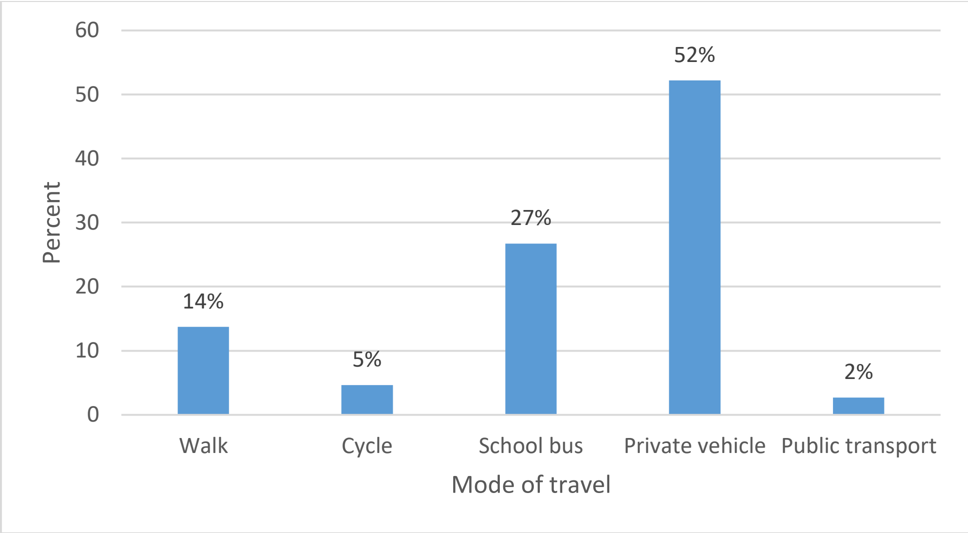

Figure 4-6 Distribution of travel to school modes in winter

Q5: 'In winter months, how does your child leave from school? (Select the choice that repeats on three or more days per week).'

walk, cycle, school bus, private vehicle, public transport

Similar to the trip to school, Table 4-7 and Figure 4-7 show that most students use private cars (N= 208, 51%) and school buses (N= 106, 26%) to get from school. Whereas 20% (5% cycle and 15% walk) actively travel from school.

Table 4-7 Distribution of modes of travel from school in winter

Travel from School in Winter	**Frequency (N)**	**Percent (%)**
Walk	61	15
Cycle	21	5
School bus	106	26
Private vehicle	208	51
Public transport	12	3
Total	408	100

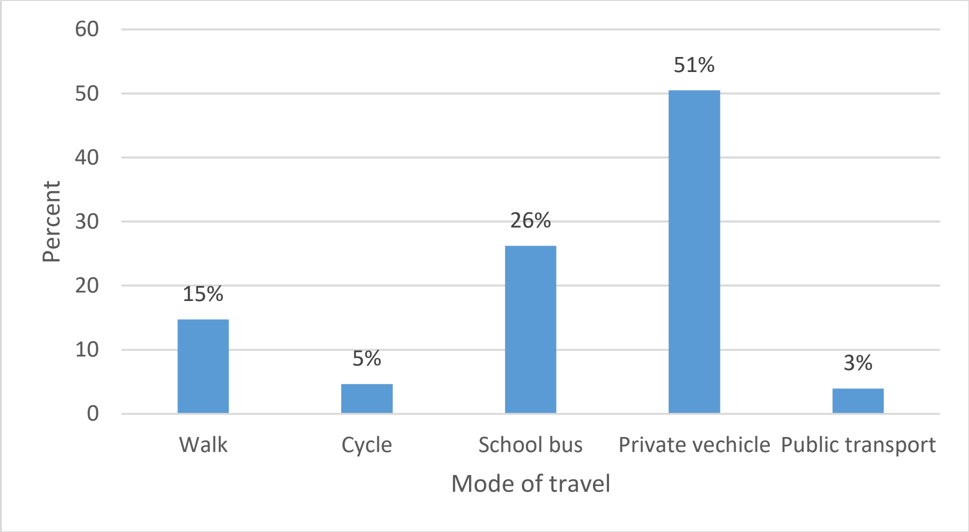

Figure 4-7 Distribution of modes of travel from school in winter

4.2.3.2 In summer to/ from School

Q6: 'In summer months, how does your child arrive at school? (Select the choice that repeats on three or more days per week).

Walk, cycle, school bus, private vehicle, public transport.

Table 4-7 and Figure 4-7 demonstrate the distribution of the students' mode of travel to school within five types of transportation in summer. Of all the 408 students, the majority use private cars (N=208, 51%) and school buses (N=110, 27%) in their journey to school. At the same time, students who travel actively are only 18% (5% cycle and 13% walk).

Table 4-8 Distribution of modes of travel to school in summer

Travel to School in Summer	**Frequency (N)**	**Percent (%)**
Walk	53	13
Cycle	21	5
School bus	110	27
Private vehicle	208	51
Public transport	16	4
Total	408	100

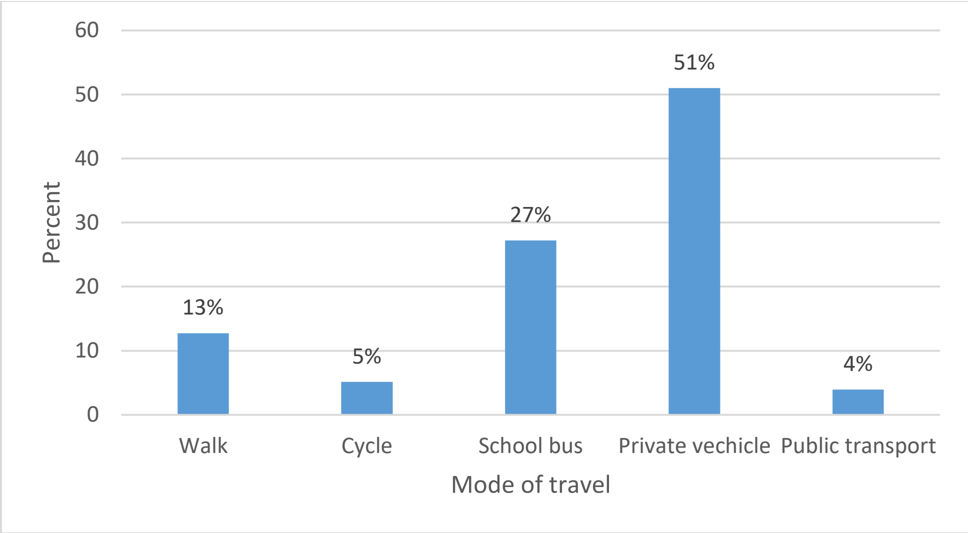

Figure 4-8 Distribution of modes of travel to school in summer

Q7: 'In summer months, how does your child leave from school? (Select the choice that repeats on three or more days per week).

Walk, cycle, school bus, private vehicle, public transport.

Similar to the trip to school in summer, Table 4-7 and Figure 4-7 show that over half of the students use private cars (N=216, 53%) and school buses (N=110, 27%) in their journey from school. On the other hand, just 17% (5% cycle and 13% walk) actively travel from school.

Table 4-9 Distribution of modes of travel from school in summer

Travel from School in Summer	Frequency (N)	Percent (%)
Walk	45	11
Cycle	21	5
School bus	110	27
Private vehicle	216	53
Public transport	16	4
Total	408	100

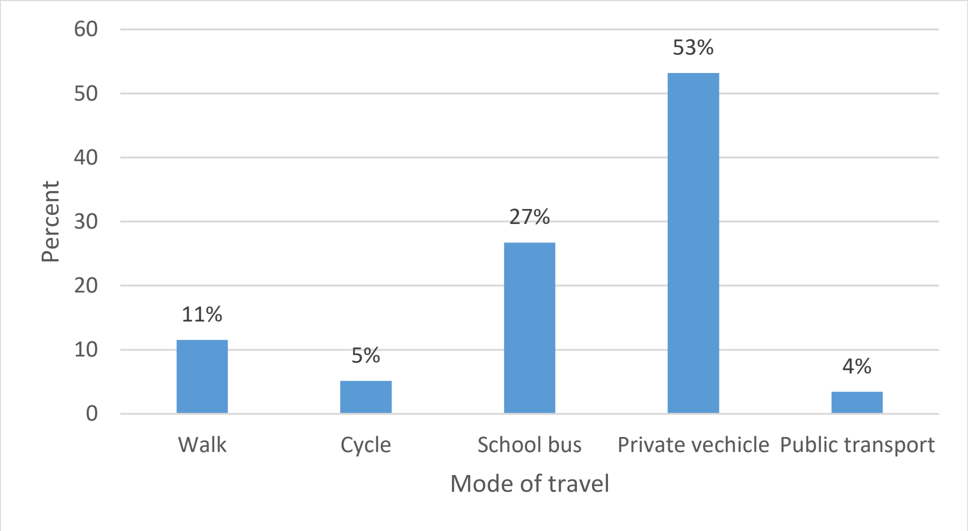

Figure 4-9 Distribution of modes of travel from school in summer

Table 4-10 and Figure 4-10 demonstrate the frequency distribution of the students' travel modes based on active (walk, cycle) and inactive (school bus, private vehicles, public transport) transport classifications. Of all the 408 students, above 80% passively travel to/ from school in winter and summer. The use of active transport does not differ much between the trip to school in winter and summer. 19% of the students walk or cycle to school in winter, a little bit higher than in summer with 18%. Similarly, between active travel to school (19%) and from school (20%) in winter. On the other hand, more students (20%) actively get back from school in winter compared to just 16% in summer. Also, more students (18%) actively travel to school than from school (16%) in summer. Of all the active travellers (walking and cycling), the majority walk to school (73% in winter, 72% in summer) and from school (74% in winter, 68% in summer).

Table 4-10 Summary distribution of modes of school travel in winter and summer (Active/Inactive)

Travel mode Active/Inactive	**To school in winter**		**To school in summer**		**From school in winter**		**From school in summer**		**Mean**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Active	78	19	74	18	82	20	66	16	75	18
Inactive	330	81	334	82	326	80	342	84	333	82
Total	408	100	408	100	408	100	408	100	408	100

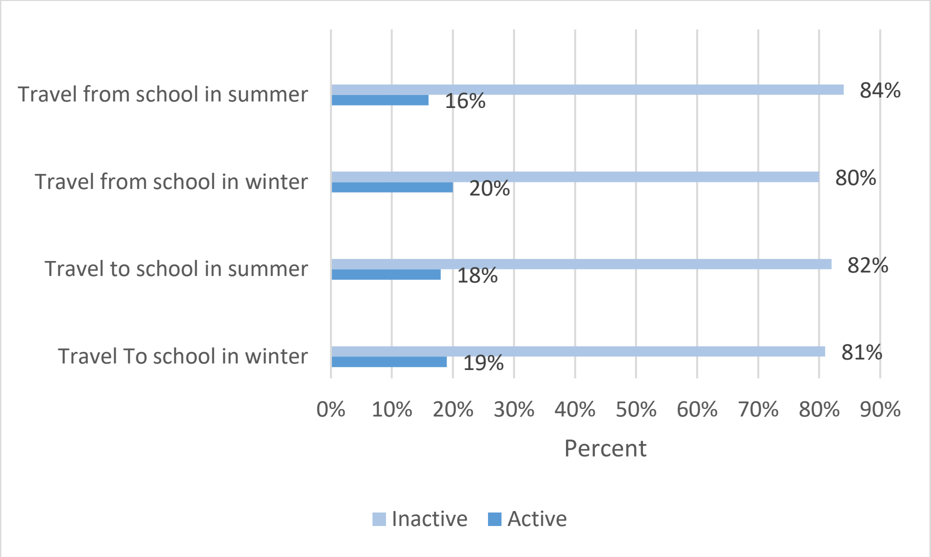

Figure 4-10 Summary distribution of modes of school travel in winter and summer (Active/Inactive)

4.2.4 Time length of the Trip to/from school

Q8: ‘How long does it usually take your child to **get to school**?’

Less than 5 minutes, 5 - 10 minutes, 11 - 20 minutes, More than 20 minutes.

Table 4-11 and Figure 4-11 show the grouped frequency distribution of the length of the journey to school within four-time categories. As reported by the parents, most of the students (N=163, 40%) get to their schools in more than 20 minutes. At the same time, 29% arrive at their schools within 10 minutes (11% less than 5 minutes, 18% 5 – 10 minutes) and 31% in 11 – 20 minutes.

Table 4-11 Distribution of the time lengths of the journey to school

Length of trip to school	**Frequency (N)**	**Percent (%)**
Less than 5 min.	45	11
5 - 10 min.	74	18
11 - 20 min.	126	31
More than 20 min.	163	40
Total	408	100

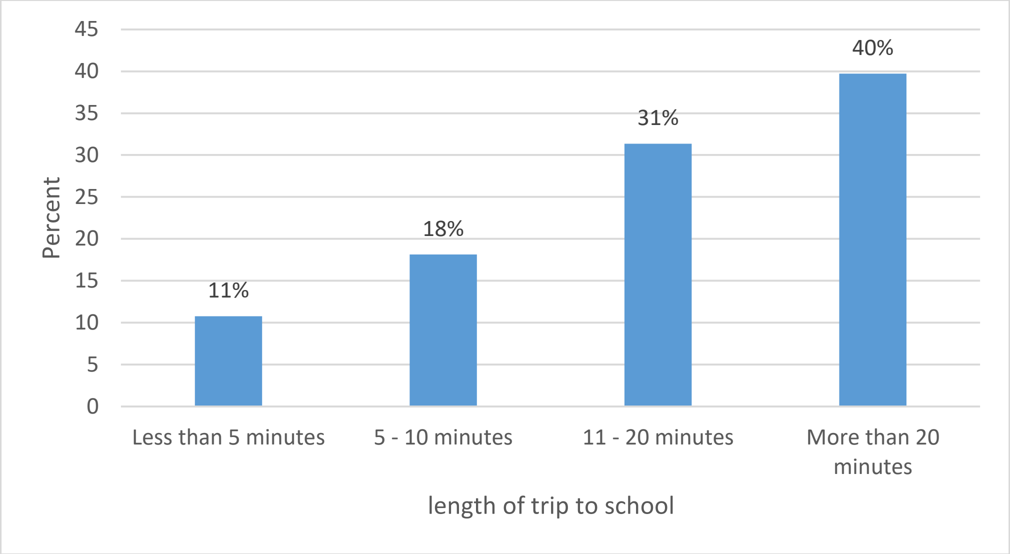

Figure 4-11 Distribution of the time lengths of the journey to school

Q9: 'How long does it usually take your child to get home from school?'

Less than 5 minutes, 5 - 10 minutes, 11 - 20 minutes, More than 20 minutes.

Similarly, Table 4-12 and Figure 4-12 illustrate the distribution of the length of the journey from school within the four-time categories. Most of the students (N=180, 44%) get from their schools in more than 20 minutes, 29% within 10 minutes (11% less than 5 minutes, 18% 5 – 10 minutes) and 27 % in 11 – 20 minutes.

Table 4-12 Distribution of the time lengths of the journey from school

Length of trip from school	**Frequency (N)**	**Percent (%)**
Less than 5 min.	24	6
5 - 10 min.	94	23
11 - 20 min.	110	27
More than 20 min.	180	44
Total	408	100

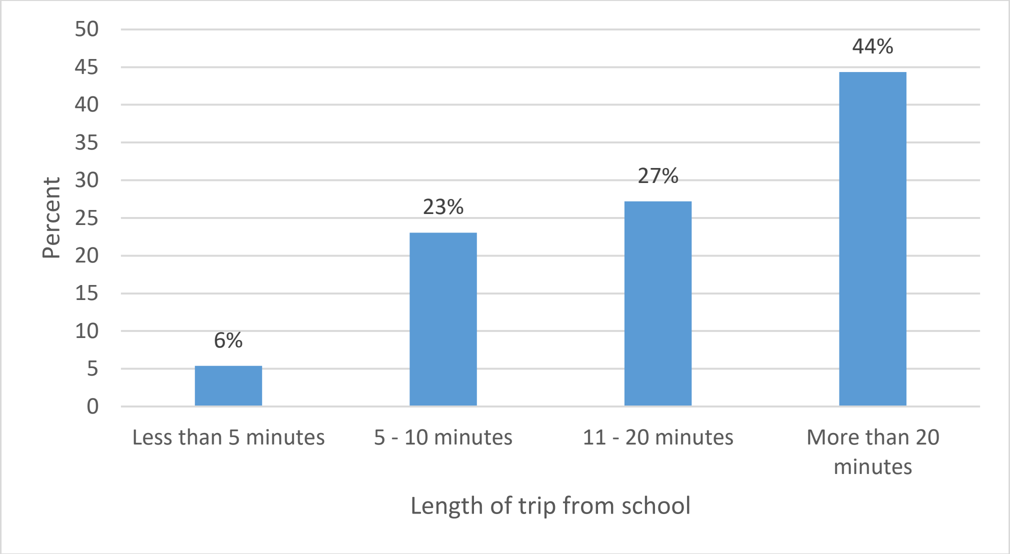

Figure 4-12 Distribution of the time lengths of the journey from school

4.2.5 Factors influencing the choice of travel to school modes

Q10: ‘Which of the following issues affected your decision to allow or not allow your child to walk or cycle to/from school? (Select ALL that apply).’

Distance, Length of the trip, Street connectivity, Traffic-calming measures, Pedestrian infrastructure, Cycling infrastructure, Landscaping, Adults to walk or cycle with, Weight of school bags, Weather.

Table 4-13 and Figure 4-13 show the multi-response distribution of the most influential factors on parents choices of the school travel modes within ten variables representing four influential categories (trip characteristics: distance and time; built environment features: street connectivity, traffic-calming measures, pedestrian infrastructure, cycling infrastructure, and landscaping; CIM: adults to walk or cycle with; other factors: weather or seasonal characteristics, and school bag weight).

The majority of parents (68%) agreed that the distance factor is the most influential factor by the weather (55%) and the length of the school trip (47%). Concerning the built environment features, it seems that street connectivity (45%) and traffic-calming measures (44%) are the most influential. Less effective are the pedestrian and cycling infrastructures (28% and 21%). In comparison, the least influencing factor is landscaping (13%). Interestingly, 43% of parents attributed travel mode choices to the school-bag weight, while just 14% recognized the effect of CIM.

Table 4-13 Distribution of multiple reponse frequency

Main categories of influencing variables	Influences on the decision to allow /restrict AST	Multiple response frequency (N)	Percent (%)
Trip characteristics	Distance	277	68
	Time length of trip	192	47
Built environment features	Street connectivity	184	45
	Traffic calming measures	180	44
	Pedestrian infrastructure	114	28
	Cycling infrastructure	86	21
	Landscaping	53	13
CIM	Adults to walk or cycle with	57	14
Other factors	Weight of school bag (Appendix D)	175	43
	weather	224	55

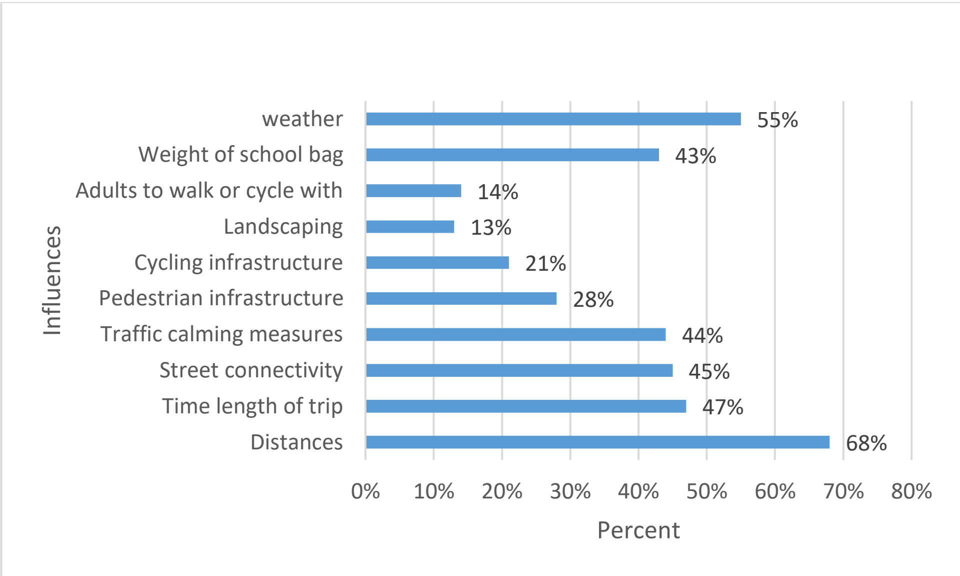

Figure 4-13 Distribution of parents' perceptions of factors that influenced school travel choices

Q11: 'Which of the following features if changed or improved, you would probably let your child walk or cycle to/from school? (In case your child is not walking or cycling to school)'.

Traffic calming measures, Pedestrian infrastructure, Cycling infrastructure, Landscaping, Distance.

Table 4-14 and Figure 4-14 demonstrate the multi-response distribution of the factors, which, if modified, may increase parents' choices of AST within five variables representing distance and built environment features. Of all parents restricting walking and cycling to school (N=333, 82%), the majority (59%) agreed that modifying the distance factor is the most influential, followed by the provision of traffic calming measures (51%). The distance threshold for cycling is higher than walking, so developing a cycling infrastructure may encourage 44% of the parents to permit cycling to school. In comparison, they find that changes in the pedestrian infrastructure (35%) and landscaping (32%) are likely sufficient for shifting to AST.

Table 4-14 Distribution of parents' perceptions of modifications to shift AST

Variables	**Multiple response Frequency (N)**	**(Mean inactive) Percent (%) N= 330**
Traffic calming measures	168	51
Pedestrian infrastructure	143	35
Cycling infrastructure	180	44
Landscaping	131	32
Distance	241	59

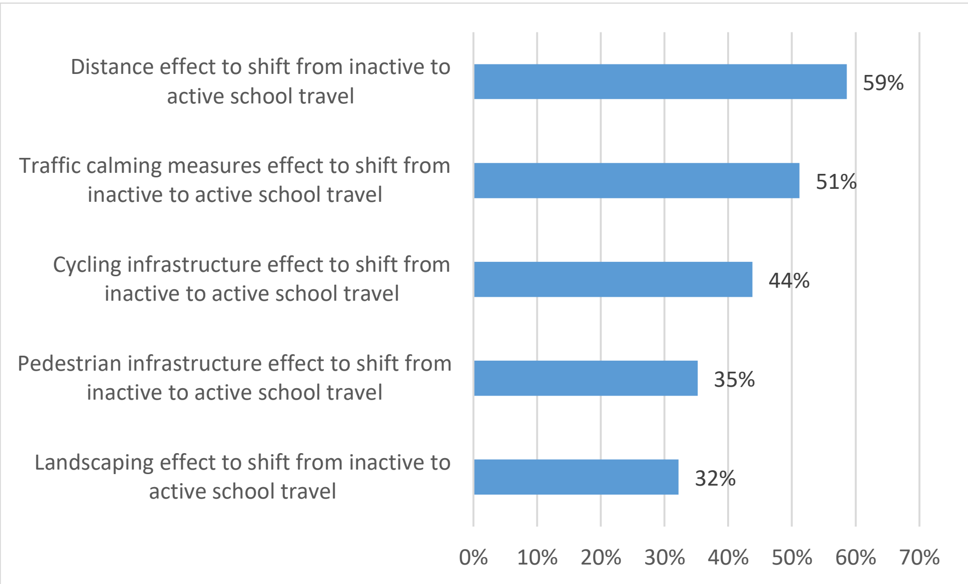

Figure 4-14 Distribution of parents' perceptions of modifications to enhance AST

4.2.6 Parents' perceptions of the built environment features

Q12: 'Please select the answer that best applies to your child's school zone: : (a) the sidewalks are wide enough for walking, (b) the sidewalks are continuous, (c) the sidewalks are in good condition without any large cracks or dips, (d) the crosswalks are marked clearly, (e) there are crossing signals or crossing guards near the school, (f) there is traffic calming measures such as speed humps, (g) there are speed limit signs, (h) there are trees that provide shade along the path to school, (i) there are many beautiful natural things to look at such as gardens and views.

Yes or **No**.

Table 4-15 and Figure 4-15 show the multi-response distribution of parents' perceptions of built environment features near schools within nine variables representing the walking and cycling infrastructure, traffic safety measures, and landscaping. The majority perceived the presence of traffic safety measures (92%: speed limit signs; 89% clear crosswalks; 87%: traffic-calming measures; 84%: crossing signals). Fewer parents agreed that the sidewalks are in good condition (76%), wide enough for walking and cycling (66%), and continuous (48%). In comparison, just 40% and 32% recognized natural views and shading trees, respectively.

Table 4-15 Distribution of parents' perceptions of built environment features near schools

Main categories	**Built environment features**	**Multiple response Frequency (N)**	**Percent(%) N = 408**
Walking and cycling infrastructure	sidewalks are wide enough for walking	269	66
	sidewalks are continuous	195	48
	sidewalks are in good condition	310	76
Traffic safety measures	crosswalks are marked clearly	363	89
	crossing signals or crossing guards near the school	343	84
	traffic calming measures	355	87
	speed limit signs	375	92
Landscaping	trees that provide shade along the path to school	131	32
	gardens and natural views	163	40

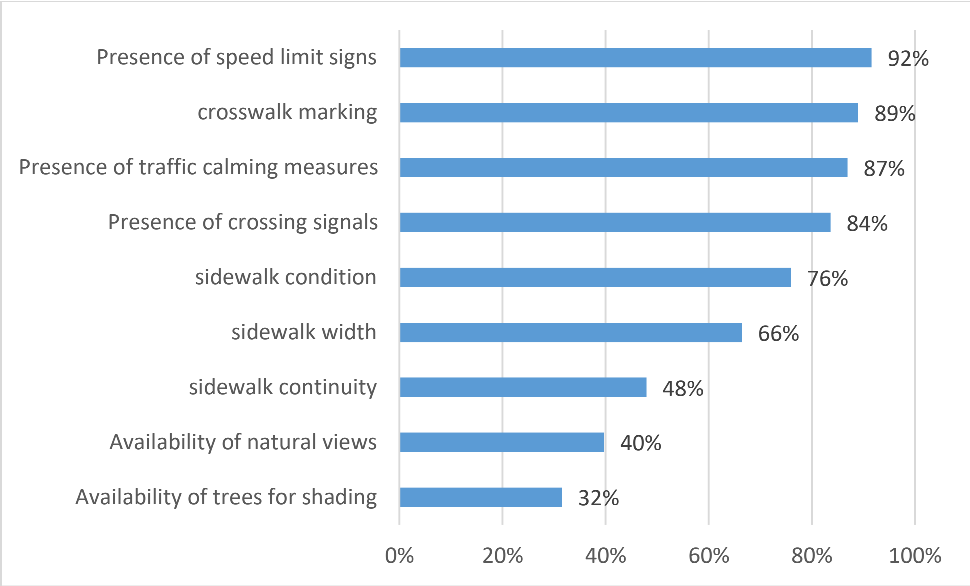

Figure 4-15 Distribution of parents' perceptions of built environment features near schools

4.2.7 Parents' perceptions of AST

Q13: 'How far do you agree or disagree with the following statements: (a) the neighbourhood environment may encourage or discourage walking and cycling to/from school, (b) walking or cycling to school is healthy for children, (c) replacing motorized school trips with active modes would result in reduced traffic congestion, and reduced emissions of air pollutants, noise, and greenhouse gases, (d) walking to school with other families is a great way to build an active community and create safer friendlier streets?'

Strongly agree, Agree, Neutral, Disagree, strongly disagree.

Table 4-15 and Figure 4-15 demonstrate parents' perceptions of AST within four statements. 57% of the parents strongly agreed (38%) or agreed (19%) that the neighbourhood environment influences the mode of travel to school and that AST has environmental benefits. Likewise, 52% strongly agreed (34%) or agreed (18%) that AST is healthy for children and creates active communities and safer streets.

Table 4-16 Distribution of parents' perceptions of AST

Statements	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
	N	%	N	%	N	%	N	%	N	%
Built environment may encourage or discourage AST	155	38	78	19	73	18	20	5	82	20
AST is healthy for children	139	34	73	18	73	18	41	10	82	20
AST reduces traffic congestion and air pollution	155	38	78	19	73	18	20	5	82	20
AST creates active communities and safer streets	139	34	73	18	73	18	41	10	82	20

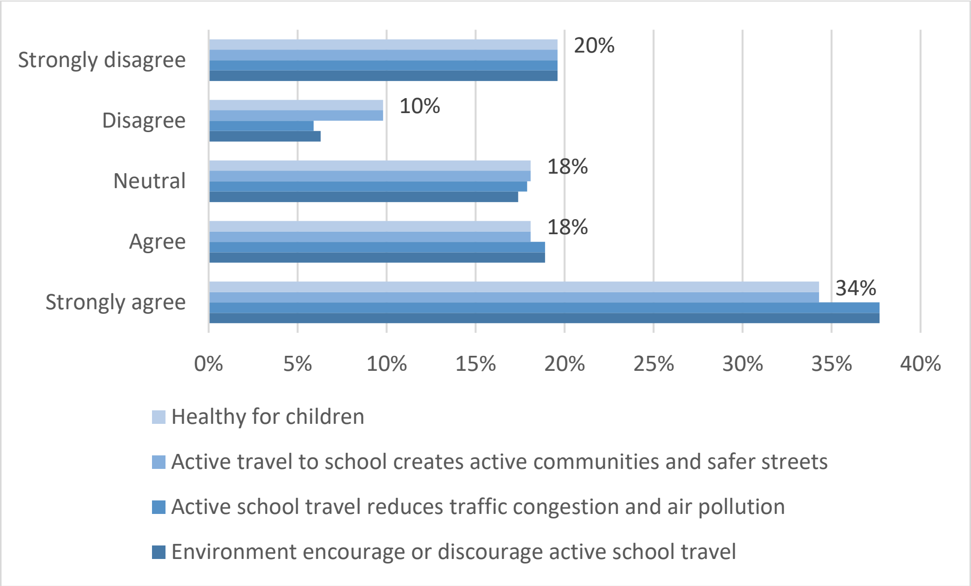

Figure 4-16 Distribution of parents' perceptions of AST

4.3 Inferential Statistics: Hypotheses Testing

This section tests the seven proposed hypotheses using correlation statistics. A chi-square test for association examines the relationship between variables and determine its significance. Chi-squared x^2 (degree of freedom, N = sample size) = chi-square statistic value, p = p-value.

4.3.1 The correlation between distance and travel modes (active /inactive)

H1: There is a significant correlation between distance and school travel behaviours

- **Cross tabulation**

The trip to school in winter

In the sample (N=408), under one fourth (N=78, 19%) use active travel to school in winter. Table 4-17 and Figure 4-17 show that 61% of all students living between 0– 0.5 km actively travel to school, 59% between 0.5 – 1 km, and 54% of those living between 1 – 1.5 km away. In comparison, 0.0%actively travel to school in distances further than 1.5 km. The results indicate a negative correlation between distance and AST in winter.

Table 4-17 Distance * Active/ Inactive travel to school in winter

Travel mode Active/Inactive		**0 – 0.5 km**	**0.5 - 1 km**	**1 - 1.5 km**	**1.5 - 3 km**	**> 3 km**	**Total**	
Active	Count	20	36	22	0	0	78	19%
	% within Distance	61%	59%	54%	0.0%	0.0%		
Inactive	Count	13	25	19	16	257	330	81%
	% within Distance	39%	41%	46%	100%	100%		
Total		33	61	41	16	257	408	100%

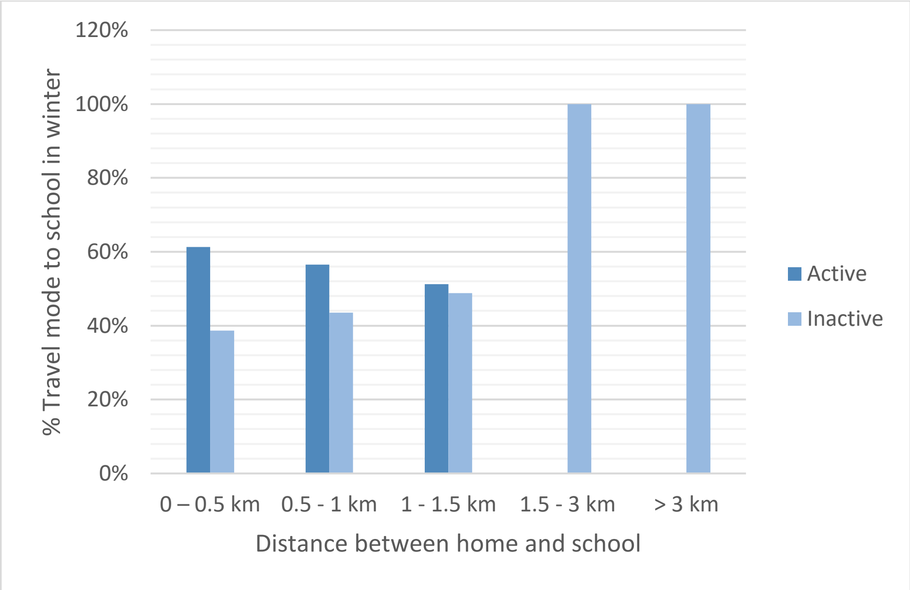

Figure 4-17 Distance * Active/ Inactive travel to school in winter

The trip from school in winter

More students (N=82, 20%) use active travel from school in winter. Table 4-18 Table 4-17and Figure 4-18 show that 61% of students living between 0.5 – 1 km, 61% between 0.5 – 1 km, and 52% of those living between 1 – 1.5 km away use active travel from school in winter. In comparison, 0.0% actively travel from school in distances further than 1.5 km.

Table 4-18 Distance * Active/ Inactive travel from school in winter

Travel mode Active/Inactive		**0 – 0.5 km**	**0.5 - 1 km**	**1 - 1.5 km**	**1.5 - 3 km**	**>3 km**	**Total**	
Active	Count	20	37	21	0	0	82	20.%
	% within Distance	61%	61%	52%	0.0%	0.0%		
Inactive	Count	13	24	20	16	257	326	80%
	% within Distance	39%	39%	48%	100.0%	100.0%		
Total	Count	33	61	41	16	257	408	100%

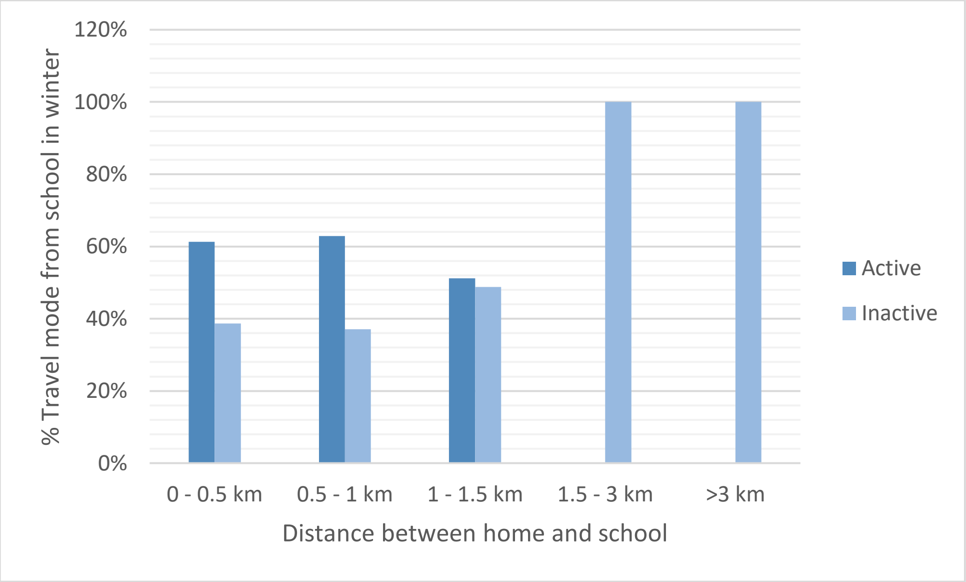

Figure 4-18 Distance * Active and Inactive travel from school in winter

- The trip to school in summer

In the sample (N=408), under one fourth (N=74, 18 %) use active modes to travel to school in summer. Table 4-19 and Figure 4-19 show that 61% of students living between 0.5 – 1 km, 61% between 0.5 – 1 km, and 41% of those living between 1 – 1.5 km away use active travel from school in winter. In comparison, 0.0% actively travel from school in distances further than 1.5 km.

Table 4-19 Distance* Active/ Inactive travel to school in summer

Travel mode Active/Inactive		**0 – 0.5 km**	**0.5 - 1 km**	**1 - 1.5 km**	**1.5 - 3 km**	**> 3 km**	**Total**	
Active	Count	20	37	17	0	0	74	18%
	% within Distance	61%	61%	41%	0.0%	0.0%		
Inactive	Count	13	24	24	16	257	334	82%
	% within Distance	39%	39%	59%	100%	100%		
Total		33	61	41	16	257	408	

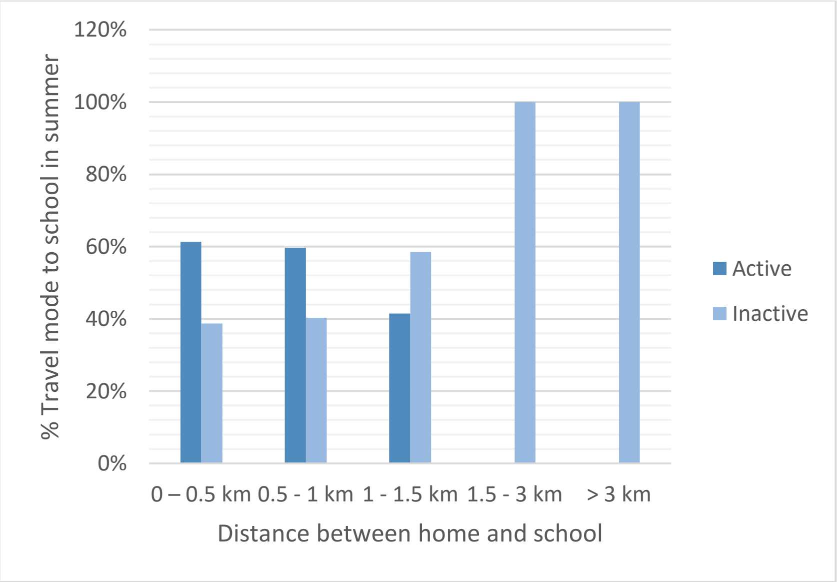

Figure 4-19 Distance * Active and Inactive travel to school in summer

- The trip from school in summer

Fewer students (N=66, 16%) use active modes to travel from school in summer**.** Table 4-20 and Figure 4-20 show that 58% of students living between 0.5 – 1 km, 57% between 0.5 – 1 km, and 27% of those living between 1 – 1.5 km away use active travel from school in winter. In comparison, 0.0% actively travel from school in distances further than 1.5 km.

Table 4-20 Distance* Active and Inactive travel from school in summer

Travel mode Active/Inactive		**0 – 0.5 km**	**0.5 - 1 km**	**1 - 1.5 km**	**1.5 - 3 km**	**> 3 km**	**Total**	
Active	Count	19	35	12	0	0	66	16%
	% within Distance	58%	57%	27%	0.0%	0.0%		
Inactive	Count	14	26	29	16	257	342	84%
	% within Distance	42%	44%	73%	100%	100%		
Total		33	61	41	16	257	408	100%

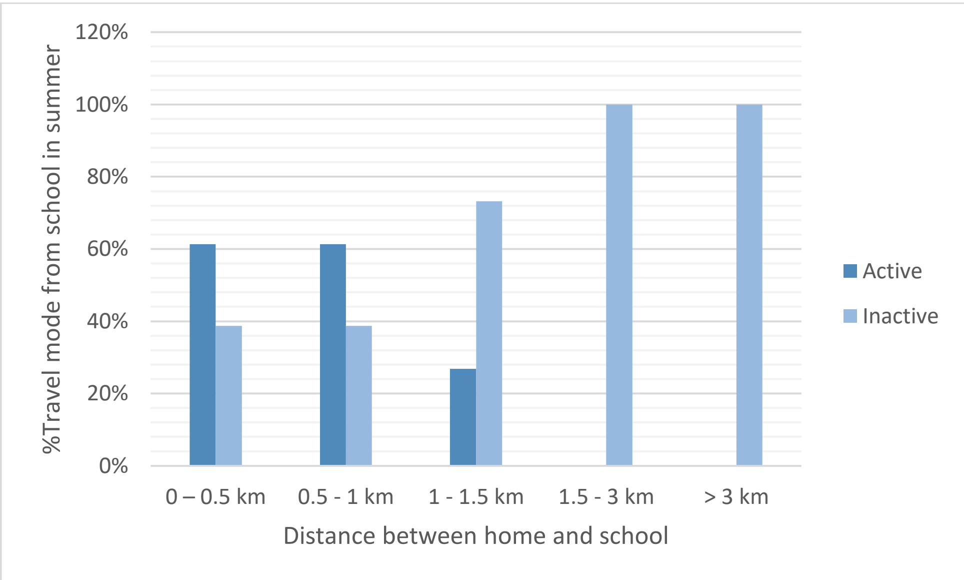

Figure 4-20 Distance * Active and Inactive travel from school in summer

Hypothesis Testing with Chi-squared

Chi-square tests for association were conducted between distance and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. The distance variable had five levels: 0 – 0.5 km, 0.5 - 1 km, 1 - 1.5 km, 1.5 - 3 km, and > 3 km. Table 4-21 shows the existing correlation between distance and the travel mode categories.

There was a statistically **significant association** between distance and travel to school (χ^2 (4) = 189.11, p < .001) and from school (χ^2 (4) = 202.62, p < .001) in winter; to school (χ^2 (4) = 188.64, p < .001) and from school (χ^2 (4) = 188.64, p < .001) in summer. Cramer's V value was significant (Cramer's V ≥ .68, p < .001) for all trip categories and it indicated a **high strength of the association**.

Table 4-21 Chi-Square Test between distance and travel mode (H1)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	189.109	4	.000
	Cramer's V	.68		
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	202.624	4	.000
	Cramer's V	.71		.
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	188.643	4	.000
	Cramer's V	.68		
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	191.184	4	.000
	Cramer's V	.69		
	N of Valid Cases	408		

4.3.2 The correlation between time length of trip and school travel modes (active /inactive)

H2: There is a significant correlation between time length of trip and school travel behaviours.

- **Cross tabulation**

The trip to school in winter

In the sample (N=408), less one fourth (N=78, 19%) use active travel to school in winter**.** Table 4-22 and Figure 4-21 show that in trip lengths 0–5 minutes and 5–10 minutes, 45% and 59% of the children travel to school actively. In comparison, in the trip length 11–20 minutes, just

9% of the students walk or cycle to school, and this percentage reaches zero in trip lengths longer than 20 minutes.

Table 4-22 Length of the trip to school* Active/ Inactive travel to school in winter

Travel mode Active/Inactive		**< 5 min**	**5 - 10 min**	**11 - 20 min**	**> 20 min**	**Total**	
Active	Count	20	47	11	0	78	19%
	% within length of trip	45%	64%	9%	0.0%		
Inactive	Count	25	27	115	163	330	81%
	% within length of trip	55%	36%	91%	100%		
Total		45	74	126	163	408	100%

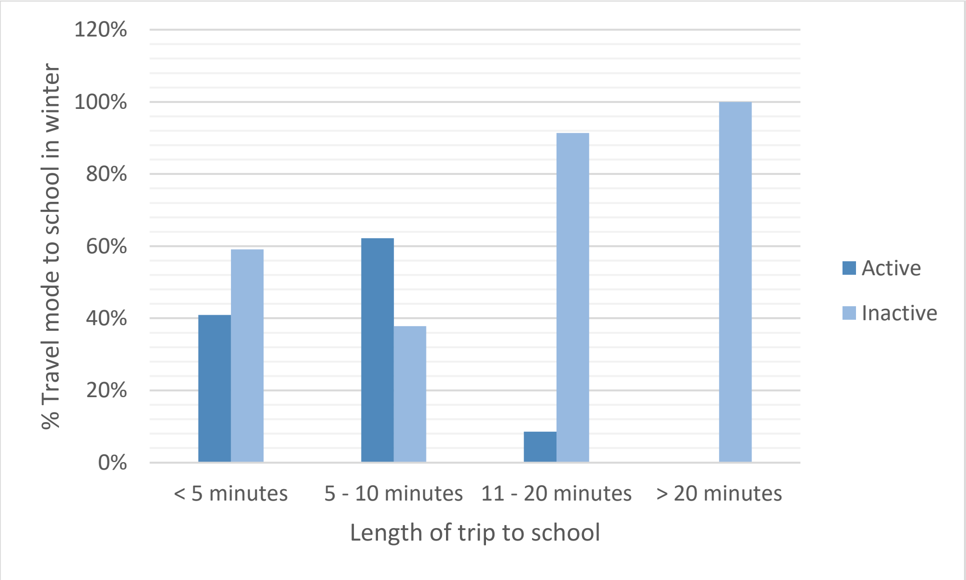

Figure 4-21 Length of the trip to school* Active/ Inactive travel to school in winter

The trip from school in winter

More students (N=82, 20%) use active travel from school in winter. Table 4-23 Table 4-17and Figure 4-22 show that in trip lengths 0–5 minutes and 5–10 minutes, 42% and 66.0% of the students travel from school actively. In comparison, in the trip length 11–20 minutes, only 9%

walk or cycle from school, and this percentage reaches zero in trip lengths longer than 20 minutes.

Table 4-23 Length of the trip from school* Active/ Inactive travel from school in winter

Travel mode Active/Inactive		**< 5 min**	**5 - 10 min**	**11 - 20 min**	**> 20 min**	**Total**	
Active	Count	10	62	10	0	82	20%
	% within length of trip	42%	66.0%	9%	0.0%		
Inactive	Count	14	32	100	180	326	80%
	% within length of trip	58%	34.0%	91%	100.0%		
Total		24	94	110	180	408	100%

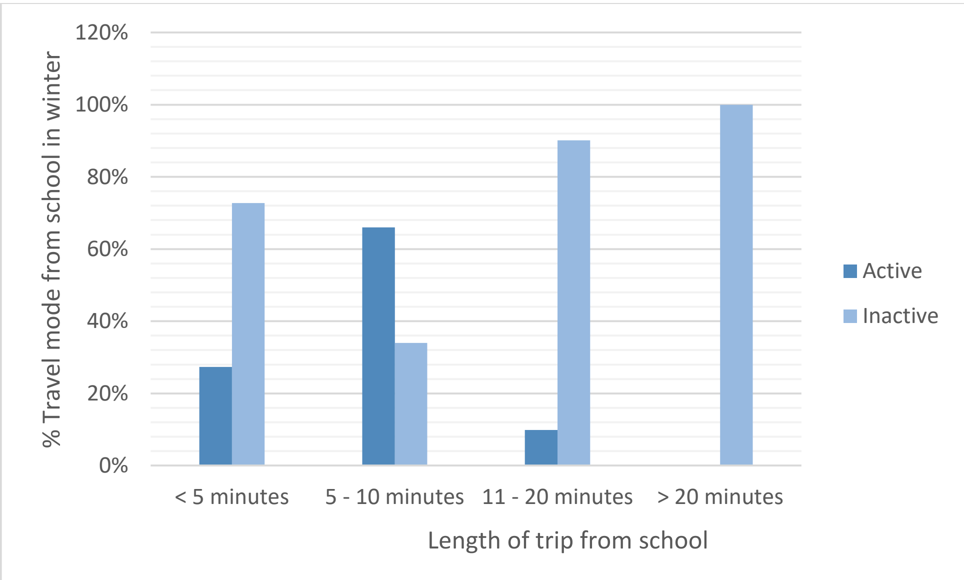

Figure 4-22 Length of the trip from school* Active/ Inactive travel from school in winter

The trip to school in summer

In the sample (N=408), under one fourth (N=74, 18 %) use active modes to travel to school in summer. Table 4-24 and Figure 4-23 show that in trip lengths 0 – 5 minutes and 5 – 10 minutes, 45% and 59% of the students travel to school actively. In comparison, in the trip length of 11

– 20 minutes, only 8% walk or cycle to school, and this percentage reaches zero in trip lengths longer than 20minutes.

Table 4-24 Length of the trip to school* Active/ Inactive travel to school in summer

Travel mode Active/Inactive		**< 5 min**	**5 - 10 min**	**11 - 20 min**	**> 20 min**	**Total**	
Active	Count	20	44	10	0	74	18%
	% within length of trip	45%	59%	8%	0.0%		
Inactive	Count	25	30	116	163	334	82%
	% within length of trip	55%	41%	92%	100.0%		
Total		45	74	126	163	408	100%

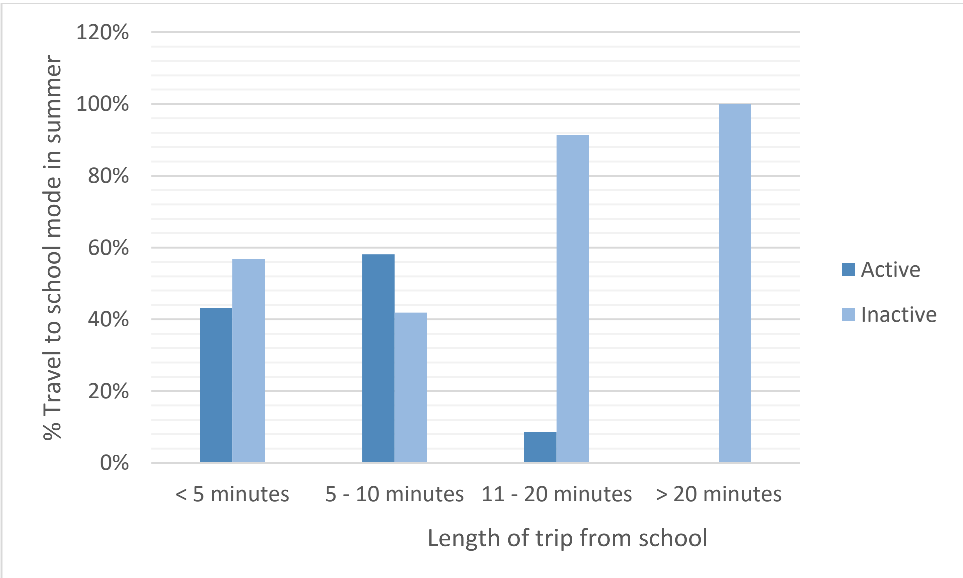

Figure 4-23 Length of the trip to school* Active/ Inactive travel to school in summer

The trip from school in summer

Fewer students (N=66, 16%) use active modes to travel from school in summer. Table 4-25 and Figure 4-24 show that in trip lengths 0–5 minutes and 5–10 minutes, 42% and 58% of the students travel to school actively. In comparison, in the trip length 11–20 minutes, only 6% walk or cycle to school, and this percentage reaches zero in trip lengths longer than 20 minutes.

Table 4-25 Length of the trip from school* Active/ Inactive travel from school in summer

Travel Mode Active/Inactive		< 5 min	5 - 10 min	11 - 20 min	> 20 min	Total	
Active	Count	10	49	7	0	66	16%
	% within length of trip	42%	52%	6%	0.0%		
Inactive	Count	14	46	103	180	342	84%
	% within length of trip	58%	48%	94%	100.0%		
Total		24	94	110	180	408	100%

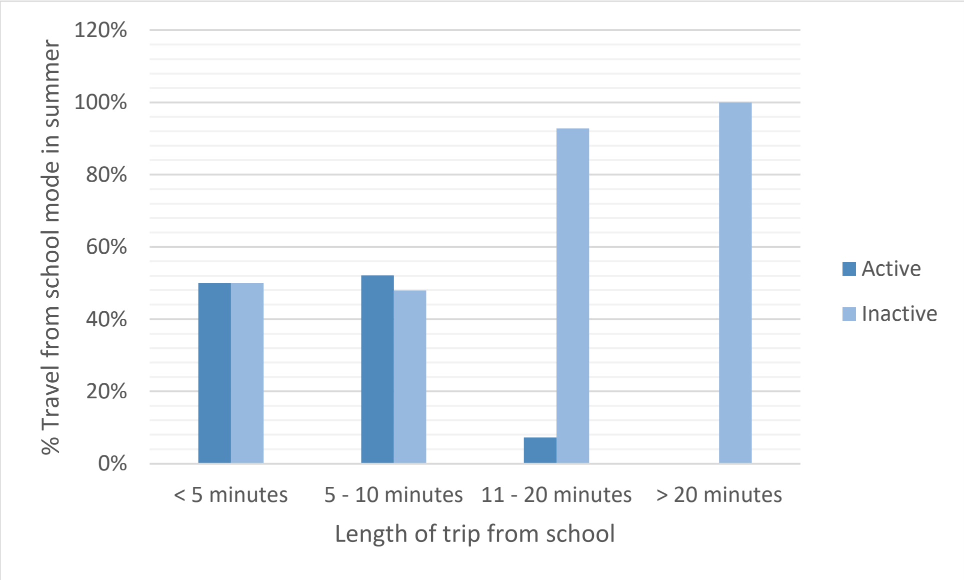

Figure 4-24 Length of the trip from school* Active/ Inactive travel from school in summer

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between the time length of the trip and the four categories of students' travel mode: to school in winter, from school in winter to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. The time length variable (to/ from school) had four levels: < 5 minutes, 5 - 10 minutes, 11 - 20 minutes, and > 20 minutes. Table 4-26 shows the existing correlation between time length of the trip and the travel mode categories.

There was a statistically **significant association** between time length of the trip and travel to school **(**χ^2 (3) = 154.08, p < .001) and from school **(**χ^2 (3) = 181.40, p < .001) in winter; to school **(**χ^2 (3) = 143.46, p < .001) and from school **(**χ^2 (3) = 146.06, p < .001) in summer.

Cramer's V value was significant (Cramer's V ≥ .60, p < .001) for all trip categories , and it indicated a **high strength of the association**.

Table 4-26 Chi-Square Test between time length and travel mode (H2)

Variables	**Statistics**	**Value (χ^2)**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square	154.08	3	.000
	Cramer's V	.62		
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square	181.40	3	.000
	Cramer's V	0.67		
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square	143.46	3	.000
	Cramer's V	0.60		
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square	146.06	3	.000
	Cramer's V	0.60		
	N of Valid Cases	408		

4.3.3 The correlation between built environment features and school travel modes (active /inactive)

H3: There is a significant correlation between built environment features and school behaviours.

4.3.3.1 Street Connectivity

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), less than half the respondents (N=184, 45%) agreed that street connectivity influenced their school travel mode choice. Table 4-27 shows that 25% of the agreeing respondents allow their children to cycle or walk to/from school in winter. At the same time, of the disagreeing parents (N=224, 55%), only 13% allow active travel to school, and 15% from school.

Table 4-27 Street connectivity* Active/ Inactive travel to/from school in winter

Travel mode		To the school in winter			From the school in winter		
Active/Inactive		Yes	No	Total	Yes	No	Total
Active	Count	47	31	78 (19%)	47	35	82 (20%)
	% within Street connectivity	25%	13%		25 %	15%	
Inactive	Count	137	193	330 (81%)	137	189	326 (80%)
	% within Street connectivity	74%	87%		74%	85%	80%
Total	Count	184	224	408 (100%)	184	224	408 (100%)

The trip to and from school in summer

Table 4-28 shows that 24% of the agreeing respondents allow their children to cycle or walk to school in summer. In comparison, 19% of them enable their children to travel actively from school in summer. The same table shows that of the disagreeing parents (N=224, 55%), only 13% allow active travel to school and 15% from school.

Table 4-28 Street connectivity* Active/ Inactive travel to/from school in summer

Travel Mode		To school in summer			From school in summer		
Active/Inactive		Yes	No		Yes	No	Total
Active	Count	45	29	74 (18%)	33	33	66 (16%)
	% within Street connectivity	24%	13%		19%	15%	
Inactive	Count	139	195	334 (82%)	151	191	342 (84%)
	% within Street connectivity	76%	87%		81%	85%	
Total	Count	184	224	408 (100%)	184	224	408 (100%)

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between street connectivity and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. The street connectivity had two levels: yes and no. Table 4-26 shows the existing correlation between street connectivity and the travel mode categories.

There was a statistically **significant association** between street connectivity and travel to school (χ^2 (1) = 10.331, p = .001) and from school (χ^2 (1) = 7.355, p = .007) in winter, and to school (χ^2 (1) = 8.721, p = .003) in summer, while there was an **insignificant association** between **travel from school** in summer and the street-connectivity (χ^2 (1) = 1.455, p >.05). Cramer's V value was insignificant for all trip categories, which indicated **weak associations** between the variables.

Table 4-29 Chi-Square Test between Street connectivity and travel mode (H3)

Variables	**Statistics**	**Value (χ^2)**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square	10.331	1	.001
	Cramer's V	.159		.001
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square	7.355	1	.007
	Cramer's V	.134		.007
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square	8.721	1	.003
	Cramer's V	.146		
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square	1.455	1	.228
	Cramer's V	.122.		
	N of Valid Cases	408		

4.3.3.2 Traffic-Calming Measures

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), less than half the respondents (N=180, 44%) agreed that traffic-calming measures influenced their school travel mode choice. Table 4-30 shows that 25% of the agreeing respondents allow their children to cycle or walk to/from school in winter. While of the total disagreeing parents (N=220, 56%), only 13% allow active travel to school and 16% from school.

Table 4-30 Traffic calming measures* Active/ Inactive travel to/from school in winter

Travel Mode Active/Inactive		To school in winter			From school in winter		
		Yes	No	Total	Yes	No	Total
Active	Count	47	29	78 (19%)	47	35	82 (20%)
	% within Traffic calming	25%	13%		25%	16%	
Inactive	Count	141	189	330 (81%)	141	185	326 (80%
	% within Traffic calming	75%	86%		75%	84%	
Total	Count	188	220	408 (100%)	188	220	408 (100%)

The trip to and from school in summer

In the sample (N=408), less than half the respondents (N=180, 44%) agreed that traffic-calming measures influenced their school travel mode choice. Table 4-31 shows that 24% of the agreeing respondents allow their children to cycle or walk to school in summer. In comparison, 19% of them enable their children to travel actively from school in summer. While of the total disagreeing parents (N=220, 56%), only 13% allow active travel to school and 11% from school.

Table 4-31 Traffic calming measures* Active/ Inactive travel to/from school in summer

Travel Mode Active/Inactive		To the school in summer			From the school in summer		
		Yes	No		Yes	No	Total
Active	Count	45	29	74 (18%)	41	25	66
	% within Traffic calming	24%	13%		19%	11%	16%
Inactive	Count	143	191	334 (82%)	147	195	342
	% within Traffic calming	76%	87%		78%	89%	84%
Total	Count	188	220	408 (100%)	188	220	408 (100%)

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between traffic calming measures and the four categories of students' travel mode: to school in winter, from school in winter to school in summer, and from school in summer. Each category of the travel mode variable had two levels:

active travel and inactive travel. The traffic calming had two levels: yes and no. Table 4-32 shows the existing correlation between traffic calming measures and the travel mode categories.

There was a statistically **significant association** between street connectivity and travel to school **(**χ^2 (1) = 9.95, *p* = .002) and from school **(**χ^2 (1) = 7.09, *p* = .008) in winter; to school **(**χ^2 (1) = 8.72, *p* = .003) and **from school** (χ^2 (1) = 6.90, *p* = .014) in summer.

Cramer's V value was insignificant for all trip categories, which indicated **weak associations** between the variables.

Table 4-32 Chi-Square Test between traffic calming measures and travel mode (H3)

Variables	**Statistics**	**Value (χ^2)**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square	9.95	1	.002
	Cramer's V	.156		
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square	7.09	1	.008
	Cramer's V	.132		
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square	6.90	1	.009
	Cramer's V	.130		
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square	6.07	1	.014
	Cramer's V	.122.		
	N of Valid Cases	408		

4.3.3.3 Pedestrian Infrastructure

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), less than one-third of the respondents (N=114, 28 %) agreed that the pedestrian infrastructure influenced their school travel mode choice. Table 4-33 shows that

35% of the agreeing respondents allow their children to cycle or walk to school in winter. In comparison, 39% of them enable their children to travel actively from school in winter. At the same time, of the disagreeing parents (N=294, 72%), only 13% allow active travel to school, and 15% from school.

Table 4-33 Pedestrian infrastructure* Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		**To school in winter**			**From school in winter**		
		Yes	**No**		**Yes**	**No**	**Total**
Active	Count	40	38	78 (19%)	44	38	82 (20%)
	% within Pedestrian infrastructure	35%	13%		39%	13%	
Inactive	Count	74	256	330 (81%)	70	256	326 (80%)
	% within Pedestrian infrastructure	65%	87%		61%	87%	
Total	Count	114	294	408 (100%)	114	294	408 (100%)

The trip to and from school in summer

Table 4-34 shows that 35% of the agreeing respondents allow their children to cycle or walk to school and from school in summer. While of the total disagreeing parents (N=294, 72%), 12% allow active travel to school and 9% from school.

Table 4-34 Pedestrian infrastructure* Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		**To school in summer**			**From school in summer**		
		Yes	**No**		**Yes**	**No**	**Total**
Active	Count	40	34	74 (18%)	40	26	66 (16%)
	% within Pedestrian infrastructure	35%	12%		35%	9%	
Inactive	Count	74	260	334 (82%)	74	268	342 (84%)
	% within Pedestrian infrastructure	65%	88%		65%	91%	
Total	Count	114	294	408 (100%)	114	294	408 (100%)

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between pedestrian infrastructure and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. The traffic calming had two levels: yes and no. Table 4-35 shows the existing correlation between pedestrian infrastructure and the travel mode categories.

There was a statistically **significant association** between pedestrian infrastructure and travel to school **(**$\chi 2$ (1) = 26.22, p <.001) and from school (χ^2 (1) = 34.16, p <.001) in winter; to school ($\chi 2$ (1) = 28.43, p <.001) and **from school** (χ^2 (1) = 38.28, p <.001) in summer.

Cramer's V value indicated **moderately strong association** for the trip to school (Cramer's V = 0.25, p <.001) and from school (Cramer's V = .29, p <.001) in winter. Likewise, there was a **moderately strong association** between pedestrian infrastructure and the trip to school in summer (Cramer's V = 28.43, p <.001), but a **strong association** with the trip from school (Cramer's V = .31, p <.001).

Table 4-35 Chi-Square Test between pedestrian infrastructure and travel mode (H3)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	26.224	1	.000
	Cramer's V	.254		
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	34.161	1	.000
	Cramer's V	.289		
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	28.431	1	.000
	Cramer's V	.264.		
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	38.276	1	.000
	Cramer's V	.306.		
	N of Valid Cases	408		

4.3.3.4 The Cycling Infrastructure

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), less than one-fourth of the respondents (N=86, 21%) agreed that the cycling infrastructure influenced their school travel mode choice. Table 4-36 shows that 21% of the agreeing respondents allow their children to cycle or walk to school in winter. In comparison, 23% of them enable their children to travel actively from school in winter. At the same time, of the disagreeing parents (N=322, 79%), 18% allow active travel to school and 20% from school.

Table 4-36 Cycling infrastructure* Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		To school in winter			From school in winter		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active	Count	18	60	78 (19%)	19	63	82 (20%)
	% within Cycling infrastructure	21%	18.0%		23.0%	20%	
Inactive	Count	68	262	330 (81%)	67	259	326 (80%)
	% within Cycling infrastructure	79%	82.0%		77%	80%	
Total	Count	86	322	408 (100%)	86	322	408 (100%)

The trip to and from school in summer

Table 4-37 shows that 18% of the agreeing respondents allow their children to cycle or walk to school and 19% from school in summer. While of the total disagreeing parents (N=322, 79%), 18% allow active travel to school and 20% from school.

Table 4-37 Cycling infrastructure* Active/ Inactive travel to/from school in summer

Travel Mode Active/Inactive		To school in summer			From school in summer		
		Yes	**No**		**Yes**	**No**	**Total**
Active	Count	18	56	74 (18%)	14	52	66 (16%)
	% within Cycling infrastructure	21%	17%		16%	16%	
Inactive	Count	68	266	334 (82%)	72	270	342 (84%)
	% within Cycling infrastructure	79%	83%		84%	84%	
Total	Count	86	322	408 (100%)	86	322	408 (100%)

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between cycling infrastructure and the four categories of students’ travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. The cycling infrastructure had two levels: yes and no. Table 4-38 shows the existing correlation between cycling infrastructure and the travel mode categories.

There was a statistically **insignificant association** between cycling infrastructure and all the travel to school categories ($p > 0.05$).

Table 4-38 Chi-Square Test between cycling infrastructure and travel mode (H3)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	.187	1	.665
	Cramer's V	.021		
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	.028	1	.867
	Cramer's V	.008		
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	.325	1	.569
	Cramer's V	.028.		
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	.003	1	.957
	Cramer's V	.003.		
	N of Valid Cases	408		

4.3.3.5 Landscaping

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), less than one-fourth of the respondents (N=53, 13 %) agreed that landscaping influenced their school travel mode choice. Table 4-39 demonstrates that just 11% of the agreeing respondents allow their children to cycle or walk to school and from school in winter. The same table shows that of the total disagreeing parents (N=355, 87%), 20% allow active travel to school and 21% from school.

Table 4-39 Landscaping* Active/ Inactive travel to/from school in winter

Travel Mode Active/Inactive		To school in winter			From school in winter		
		Yes	No	Total	Yes	No	Total
Active	Count	6	72	78 (19%)	6	76	82 (20%)
	% within Landscaping	11%	20%		11%	21%	
Inactive	Count	47	283	330 (81%)	47	279	326 (80%)
	% within Landscaping	89%	80%		89%	79%	
Total	Count	53	355	408 (100%)	53	355	408 (100%)

The trip to and from school in summer

Table 4-40 shows that of all the agreeing parents (N=53, 13 %), just 11% allow their children to cycle or walk to school to school in summer. In comparison, less of them (6 %) enable their children to travel actively from school in summer. The same table shows that of all disagreeing parents (N=355, 87%), 19% allow active travel to school and 18% from school.

Table 4-40 Landscaping* Active/ Inactive travel to/from school in summer

Travel Mode Active/Inactive		To school in summer			From school in summer		
		Yes	No	Total	Yes	No	Total
Active	Count	6	68	74	3	63	66 (16%)
	% within Landscaping	11%	19%	(18%)	6%	18%	
Inactive	Count	47	287	334	50	292	342 (84%)
	% within Landscaping	89%	81%	(82%)	94%	82%	
Total	Count	53	355	408(100%)	53	355	408(100%)

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between landscaping and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. The landscaping had two levels: yes and no. Table 4-41 presents the existing correlation between landscaping and the travel mode categories.

There was a statistically **insignificant association** between landscaping and all the travel to school categories ($p > 0.05$), except the **trip from school** in summer (χ^2 (1) = .92, $p = 0.027$).

However, there was a **weak association** between the two variables (Cramer's V = .109, p = .027).

Table 4-41 Chi-Square Test between landscaping and travel mode (H3)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	1.701	1	.192
	Cramer's V	.0697		
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	2.155	1	.142
	Cramer's V	.073		
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	1.490	1	.222
	Cramer's V	.060.		.222
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	4.881	1	.027
	Cramer's V	.109.		.027
	N of Valid Cases	408		

4.3.3.6 Summary

Table 4-42 Summary of the correlation between the travel mode to school and the built environment featuresstreet connectivity, traffic-calming measures, pedestrian infrastructure, cycling infrastructure, and landscaping. Interestingly, the study found that the school-bag weight has a more significant influence on the school travel mode than the built environment features, as reported by the parents in question 10 (Appendix D)

Table 4-42 Summary of the correlation between the travel mode to school and the built environment features

Built environment features	**Travel to School**		**Travel from School**	
	Winter	**Summer**	**Winter**	**Summer**
Street Connectivity	Significant Weak	Significant Weak	Significant Weak	Insignificant
Traffic-Calming Measures	Significant Weak	Significant Weak	Significant Weak	Significant Weak
Pedestrian Infrastructure	Significant Moderate	Significant Moderate	Significant Moderate	Significant Strong
Cycling Infrastructure	Insignificant	Insignificant	Insignificant	Insignificant
Landscaping	Insignificant	Insignificant	Insignificant	Significant Weak

4.3.4 The correlation between adult companion and school travel mode (active /inactive)

H4: There is a significant correlation between CIM and school travel behaviours.

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), less than one-fourth of the respondents (N=57, 14 %) agreed that adult companion influenced their school travel mode choice. Table 4-43 shows that 26% of the agreeing respondents allow their children to cycle or walk to school and from school in winter. The same table shows that of all disagreeing parents (N=351, 86%), 18% allow active travel to school and 19% from school.

Table 4-43 adult companion * Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		**To school in winter**			**From school in winter**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active	Count	15	63	78 (19%)	15	67	82 (20%)
	% within Adults companion	26%	18%		26%	19%	
Inactive	Count	42	288	330 (81%)	42	284	326 (80%)
	% within Adults companion	74%	82%		74%	81%	
Total	Count	57	351	408 (100%)	57	351	408(100%)

The trip to and from school in summer

Table 4-44 shows that about one-fourth (26%) of the agreeing respondents allow their children to cycle or walk to school in summer. In comparison, 21% of the agreeing parents enable their children to travel actively from school in summer. The same table illustrates the total disagreeing parents (N=351, 86%), 17% allow active travel to school and 15% from school.

Table 4-44 Active and Inactive travel to/from school in summer* Adults companion Cross-tabulation

Travel mode Active/Inactive		**To school in summer**			**From school in summer**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active	Count	15	59	74 (18%)	12	54	66 (16%)
	% within Adults companion	26%	17%		21%	15%	
Inactive	Count	42	292	334 (82%)	45	297	342 (84%)
	% within Adults companion	74%	83%		79%	85%	
Total	Count	57	351	408 (100%)	57	351	408 (100%)

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between adult companions and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. The adult companion had two levels: yes and no. Table 4-45 presents the existing correlation between adult companions and the travel mode categories.

There was a statistically **insignificant association** between adult companion and all the travel to school categories (p >.05).

Table 4-45 Chi-Square Test between adult companion and travel mode (H4)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	2.779	1	.095
	Cramer's V	.83		.095
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	2.052	1	.152
	Cramer's V	.71		.152
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	3.200	1	.074
	Cramer's V	.089		.074
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	.918	1	.338
	Cramer's V	.047		.338
	N of Valid Cases	408		

4.3.5 The correlation between parents' perceptions of the built environment features and school travel modes (active /inactive)

H5: There is a significant correlation between the parent's perceptions of the built environment features and school travel behaviours.

4.3.5.1 Perception of the sidewalk width

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), more than one-half of the respondents (N=269, 66%) perceived the sidewalks as wide enough for walking. Table 4-46 and Figure 4-25 show that of the 269 respondents, 26% allow their children to cycle or walk to school and 27% from school in winter. At the same time, of the total disagreeing parents (N=139, 34%), just 5% allow active travel to school, and 6% from school.

Table 4-46 Perception of the sidewalk width* Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		**To school in winter**			**From school in winter**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	71	7	78 (18%)	73	9	82 (20%)
	% within perception of sidewalk width	26%	5%		27%	6%	
Inactive Travel	Count	198	132	330 (82%)	196	130	326 (80%)
	% within Perception of sidewalk width	74%	95%		73%	94%	
	Total Count	269	139	408	269	139	408

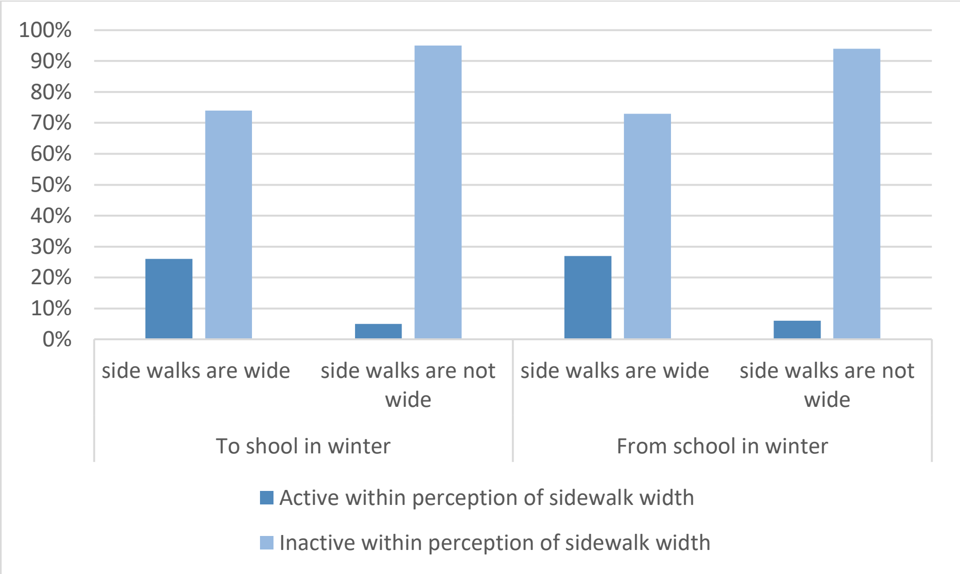

Figure 4-25 Perception of the sidewalk width* Active/ Inactive travel to/from school in winter

The trip to and from school in summer

In the sample (N=408), more than one-half of the respondents (N=269, 66%) perceived the sidewalks as wide enough for walking. Table 4-47 and Figure 4-26 show that of the 269 respondents, 26% allow their children to cycle or walk to school and 23% from school in summer. At the same time, of the total disagreeing parents (N=139, 34%), just 3% allow active travel to school, and 2% from school.

Table 4-47 Perception of the sidewalk width* Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		To school in summer			From school in summer		
		Yes	No	Total	Yes	No	Total
Active travel	Count	71	4	74	63	3	66
	% within perception of sidewalk width	26%	3%	18%	23%	2%	16%
Inactive Travel	Count	198	135	334	206	136	342
	% within perception of sidewalk width	74%	97%	82%	77%	98%	84%
	Total Count	269	139	408	269	139	408

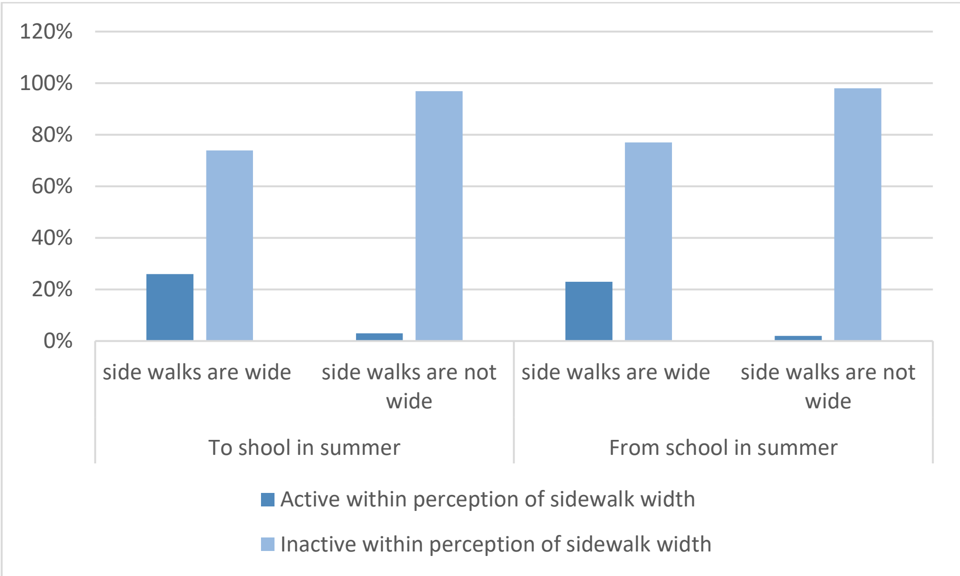

Figure 4-26 Perception of the sidewalk width* Active/ Inactive travel to/from school in summer

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between the perception of the sidewalk width and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of the sidewalk width had two levels: yes and no. Table 4-48 presents the existing correlation between perception of the sidewalk width and the travel mode categories.

There was a statistically **significant association** between perception of the sidewalk width and travel to school ($\chi 2$ (1) = 26.49, p <.001) and from school (χ^2 (1) = 29.44, p <.001) in winter; to school ($\chi 2$ (1) = 36.95, p <.001) and **from school** (χ^2 (1) = 33.04, p <.001) in summer. Cramer's V value indicated **moderately strong association** for the trip to school (Cramer's V = 0.25, p <.001) and from school (Cramer's V = .27, p <.001) in winter. Likewise, there was a **moderately strong association** between perception of the sidewalk width and the trip from school in summer (Cramer's V = .285, p <.001), but a **strong association** with the trip to school (Cramer's V = 36.95, p <.001).

Table 4-48 Chi-Square Test between the perception of the sidewalk width and travel mode (H5)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	26.493	1	.000
	Cramer's V	.255		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	29.438	1	.000
	Cramer's V	.269		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	36.950	1	.000
	Cramer's V	.301		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	33.039	1	.000
	Cramer's V	.285		.000
	N of Valid Cases	408		

4.3.5.2 Perception of the sidewalk continuity

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), less than one-half of the respondents (N=195, 48%) perceived the sidewalks as continuous. Table 4-49 and Figure 4-27 show that of the 195 respondents, 31%

allow their children to cycle or walk to school and 36% from school in winter. At the same time, of the total disagreeing parents (N=213, 52%), just 8% allow active travel to school, and 5% from school.

Table 4-49 Perception of the sidewalk continuity* Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		**To school in winter**			**From school in winter**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	60	18	78 (19%)	71	11	82 (20%)
	% within perception of sidewalk continuity	31%	8%		36%	5%	
Inactive Travel	Count	135	195	330 (81%)	124	141	326 (80%)
	% within perception of sidewalk continuity	69%	91%		64%	95%	
Total Count		195	213	408	195	213	408

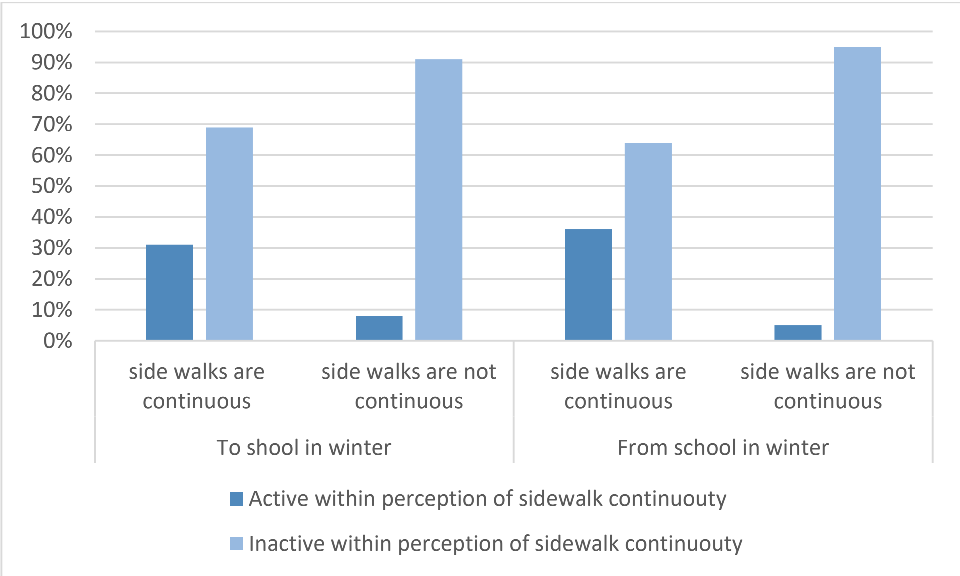

Figure 4-27 Perception of the sidewalk continuity* Active/ Inactive travel to/from school in winter

The trip to and from school in summer

Table 4-50 and Figure 4-28 show that of the 195 respondents, 33% allow their children to cycle or walk to school and 30% from school in summer. At the same time, of the total disagreeing parents (N=213, 52%), just 5% allow active travel to school, and 3% from school.

Table 4-50 Perception of the sidewalk continuity* Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		To school in summer			From school in summer		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	64	10	74 (18%)	59	7	66 (16%)
	% within perception of sidewalk continuity	33%	5%		30%	3%	
Inactive Travel	Count	131	202	334 (82%)	136	206	342 (84%)
	% within perception of sidewalk continuity	67%	95%		70%	97%	
Total Count		195	213	408	195	213	408

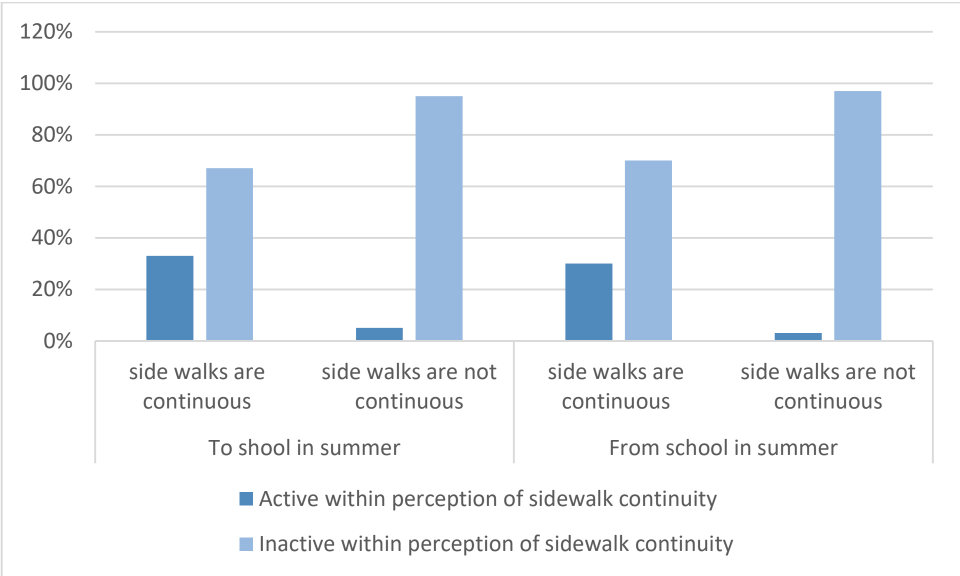

Figure 4-28 Perception of the sidewalk continuity* Active/ Inactive travel to/from school in summer

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between the perception of the sidewalk continuity and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of the sidewalk continuity had two levels: yes and no. Table 4-48 presents the existing correlation between perception of sidewalk continuity and the travel mode categories.

There was a statistically **significant association** between perception of the sidewalk continuity and travel to school ($\chi 2$ (1) = 47.44, p <.001) and from school (χ^2 (1) = 29.44, p <.001) in winter; to school ($\chi 2$ (1) = 54.44, p <.001) and from school (χ^2 (1) = 47.44, p <.001) in summer. Cramer's V value indicated **strong association** for the trip to school in winter (Cramer's V = .34, p <.001) and in summer (Cramer's V = .27, p <.001). At the same time, there was a **moderately strong association** between perception of the sidewalk continuity and the trip from school in winter (Cramer's V = .27, p <.001) and summer (Cramer's V = .341, p <.001).

Table 4-51 Chi-Square Test between the perception of the sidewalk continuity and travel mode (H5)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	47.437	1	.000
	Cramer's V	.341		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	29.438	1	.000
	Cramer's V	.269		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	54.437	1	.000
	Cramer's V	.366		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	47.437	1	.000
	Cramer's V	.341		.000
	N of Valid Cases	408		

4.3.5.3 Perception of sidewalk condition

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), most of the respondents (N=310, 76%) perceived the sidewalks as in good condition. Table 4-52 and Figure 4-29 show that of the 310 respondents, 23% allow their children to cycle or walk to school and 24% from school in winter. At the same time, of the total disagreeing parents (N=98, 24%), just 8% allow active travel to and from school.

Table 4-52 Perception of sidewalk condition * Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		To school in winter			From school in winter		
		Yes	No	Total	Yes	No	Total
Active travel	Count	70	8	78 (19%)	74	8	82 (20%)
	% within Perception of sidewalk condition	23%	8%		24%	8%	
Inactive Travel	Count	240	90	330 (81%)	236	90	326 (80%)
	% within Perception of sidewalk condition	77%	92%		76%	92%	
Total Count		310	98	408	310	98	408

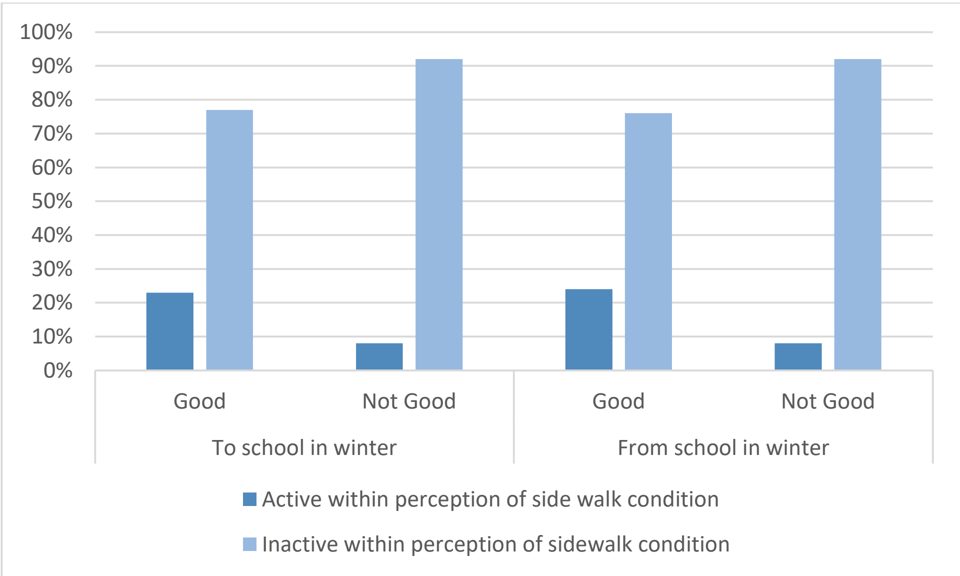

Figure 4-29 Perception of the sidewalk condition* Active/ Inactive travel to/from school in winter

The trip to and from school in summer

Similarly, Table 4-53 and Figure 4-30 show that of the 310 respondents, 23% allow their children to cycle or walk to school and 20% from school in summer. While, of the total disagreeing parents (N=98, 24%), just 4% allow active travel to school and 3% from school.

Table 4-53 Perception of sidewalk condition * Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		To school in summer			From school in summer		
		Yes	No	Total	Yes	No	Total
Active travel	Count	70	4	74 (18%)	63	3	66 (16%)
	% within Perception of sidewalk condition	23%	4%		20%	3%	
Inactive Travel	Count	240	94	334 (82%)	247	95	342 (84%)
	% within Perception of sidewalk condition	77%	96%		80%	97%	
	Total Count	310	98	408	310	98	408

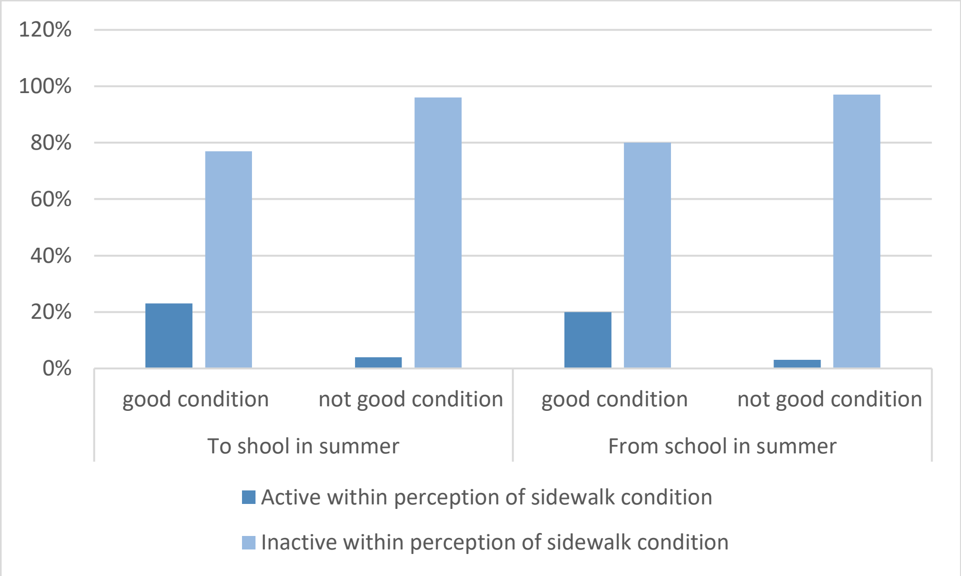

Figure 4-30 Perception of the sidewalk condition* Active/ Inactive travel to/from school in summer

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between the perception of the sidewalk condition and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of the sidewalk condition had two levels: yes and no. Table 4-54 presents the existing correlation between perception of the sidewalk condition and the travel mode categories.

There was a statistically **significant association** between perception of the sidewalk condition and travel to school ($\chi2$ (1) = 12.99, *p* <.001) and from school (χ^2 (1) = 14.76, *p* <.001) in winter; to school ($\chi2$ (1) = 21.55, *p* <.001) and from school (χ^2 (1) = 19.06, *p* <.001) in summer. Cramer's V value indicated **weak association** for the trip to school (Cramer's V = .18, *p* <.001) and from school (Cramer's V = .19, *p* <.001) in winter. At the same time, there was a **moderately strong association** between perception of the sidewalk condition and the trip to school (Cramer's V = .23, *p* <.001) and from school (Cramer's V = .22, *p* <.001) in summer.

Table 4-54 Chi-Square Test between the perception of the sidewalk condition and travel mode (H5)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	12.999	1	.000
	Cramer's V	.178		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	14.764	1	.000
	Cramer's V	.190		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	21.551	1	.000
	Cramer's V	.230		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	19.061	1	.000
	Cramer's V	.216		.000
	N of Valid Cases	408		

4.3.5.4 Perception of crosswalk marking

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), most respondents (N=363, 89%) perceived the crosswalks marking as clear. Table 4-55 and Figure 4-31 show that of the 363 respondents, 20% allow their children to cycle or walk to school and 21% from school in winter. At the same time, of the total disagreeing parents (N=45, 11%), just 9% allow active travel to and from school.

Table 4-55 Perception of crosswalk marking * Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		To school in winter			From school in winter		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	74	4	78 (19%)	78	4	82 (20%)
	% within Perception of crosswalk marking	20%	9%		21%	9%	
Inactive Travel	Count	289	41	330 (81%)	285	41	326 (80%)
	% within Perception of crosswalk marking	80%	91%		79%	91%	
Total Count		363	45	408	363	45	408

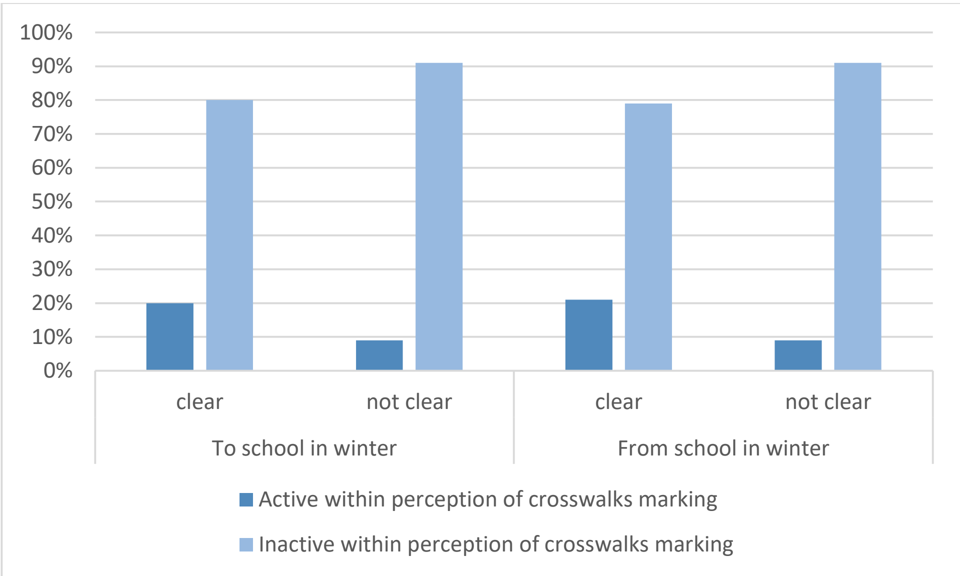

Figure 4-31 Perception of the crosswalks marking* Active/ Inactive travel to/from school in winter

Table 4-56 and Figure 4-32 show that of the 363 respondents, 20% allow their children to cycle or walk to school and 18% from school in summer. At the same time, none of the total disagreeing parents (N=45, 11%) allow active travel to and from school.

Table 4-56 Perception of crosswalk marking * Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		To school in summer			From school in summer		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	74	0	74 (18%)	66	0	66 (16%)
	% within Perception of crosswalk marking	20%	0%		18%	0%	
Inactive Travel	Count	289	45	334 (82%)	297	45	342 (84%)
	% within Perception of crosswalk marking	80%	100%		82%	100%	
	Total Count	363	45	347	363	45	408

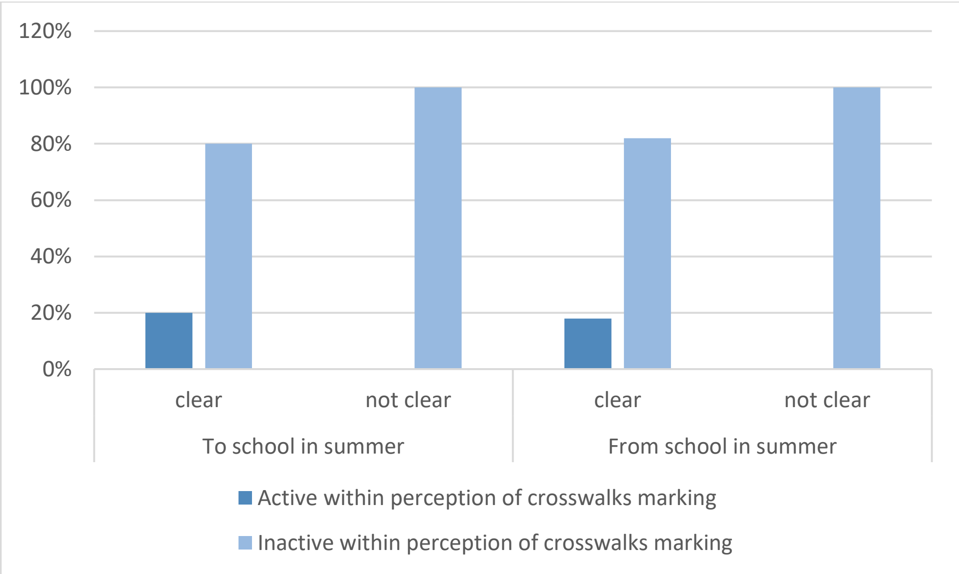

Figure 4-32 Perception of the crosswalks marking* Active/ Inactive travel to/from school in summer

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between the perception of the crosswalks marking and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of the crosswalks marking had two levels: yes and no. Table 4-57 presents the existing correlation between perception of crosswalks marking and the travel mode categories.

There was a statistically **significant association** between perception of the crosswalks marking and travel to school ($\chi 2$ (1) = 6.68, p =.010) and from school (χ^2 (1) = 7.53, p =.006) in winter; to school ($\chi 2$ (1) = 15.62, p <.001) and from school (χ^2 (1) = 14.34, p <.001) in summer. Cramer's V value indicated **weak association** for the trip to school (Cramer's V = .13, p =.010) and from school (Cramer's V = .14, p =.006) in winter; for the trip to school (Cramer's V = .19, p <.001), and from school (Cramer's V = .18, p <.001) in summer.

Table 4-57 Chi-Square Test between the perception of crosswalk marking and travel mode (H5)

Variables	**Statistics**	**Value**	**df**	**Asymptotic Significance (2-sided) (p)**
Travel to school in winter	Pearson Chi-Square (χ2)	6.685	1	.010
	Cramer's V	.128		.010
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ2)	7.533	1	.006
	Cramer's V	.136		.006
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ2)	15.629	1	.000
	Cramer's V	.196		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ2)	14.345	1	.000
	Cramer's V	.188		.000
	N of Valid Cases	408		

4.3.5.5 Perception of the crossing signals or crossing guards

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), most respondents (N=343, 84%) perceived the crossing signals or crossing guards as existing. Table 4-58 shows that of the 343 respondents, 22% allow their children to cycle or walk to school and 23% from school in winter. At the same time, of the total disagreeing parents (N=65, 16%), just 6% allow active travel to and from school.

Table 4-58 Perception of crossing signals or crossing guards * Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		**To school in winter**			**From school in winter**		
		Yes	No	Total	Yes	No	Total
Active travel	Count	74	4	78 (19%)	78	4	82 (20%)
	% within Perception of crossing signals	22%	6%		23%	6%	
Inactive Travel	Count	269	61	330 (81%)	265	61	326 (80%)
	% within Perception of crossing signals	78%	94%		77%	94%	
Total Count		343	65	408	343	65	408

Table 4-59 and Figure 4-34 show that of the 343 respondents, 22% allow their children to cycle or walk to school and 21% from school in summer. At the same time, none of the total disagreeing parents (N=65, 16%) allows active travel to and from school.

Table 4-59 Perception of crossing signals or crossing guards * Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		**To school in summer**			**From school in summer**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	74	0	74 (18%)	66	0	66 (16%)
	% within Perception of crossing signals	22%	0%		21%	0%	
Inactive Travel	Count	269	65	334 (82%)	277	65	342 (84%)
	% within Perception of crossing signals	78%	100%		79%	100%	
Total Count		343	65	408	343	65	408

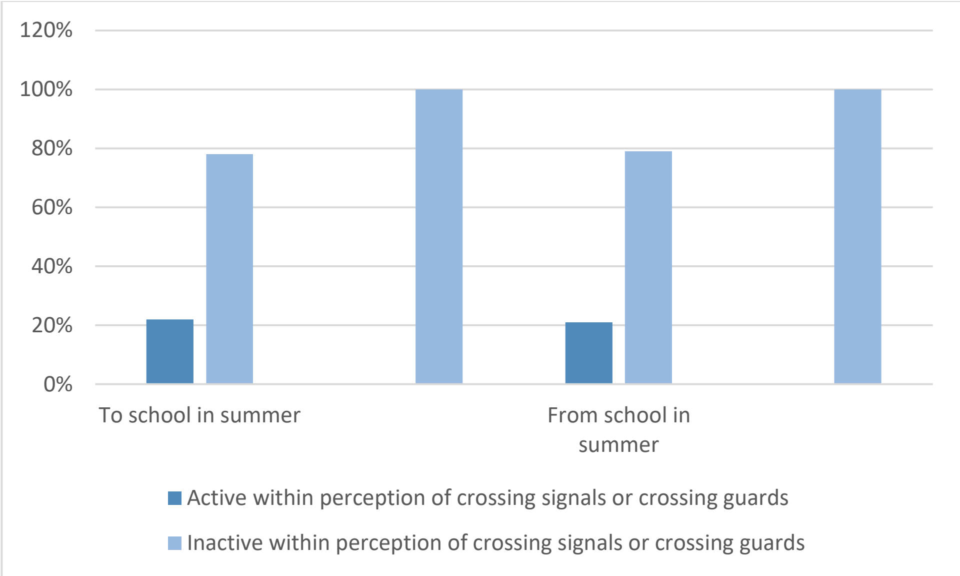

Figure 4-33 Perception of crossing signals or crossing guards * Active/ Inactive travel to/from school in summer

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between the perception of crossing signals or crossing guards and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of crossing signals or crossing guards had two levels: yes and no. Table 4-60 presents the existing correlation between perception of crossing signals or crossing guards and the travel mode categories.

There was a statistically **significant association** between the perception of the crossing signals or crossing guards and travel to school ($\chi2$ (1) = 12.47, p <.001) and from school (χ^2 (1) = 13.79, p <.001) in winter; to school ($\chi2$ (1) = 22.36, p <.001) and from school (χ^2 (1) = 20.52, p <.001) in summer.

Cramer's V value indicated **weak association** for the trip to school (Cramer's V = .17, p <.001) and from school (Cramer's V = .18, p <.001 in winter. At the same time, there was a **moderately strong association** between perception of crossing signals or crossing guards and the trip to school (Cramer's V = 22.36, p <.001), and from school (Cramer's V = .22, p <.001) in summer.

Table 4-60 Chi-Square Test between Perception of crossing signals or crossing guards and travel mode (H5)

Variables	Statistics	Value	*df*	Asymptotic Significance (2-sided) (*p*)
Travel to school in winter	Pearson Chi-Square (χ^2)	12.474	1	.000
	Cramer's V	.175		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	13.790	1	.000
	Cramer's V	.184		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	22.363	1	.000
	Cramer's V	.234		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	20.525	1	.000
	Cramer's V	.224		.000
	N of Valid Cases	408		

4.3.5.6 Perception of the traffic-calming measures

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), most respondents (N=355, 87%) perceived the traffic-calming measures as existing. Table 4-61 shows that of the 355 respondents, 21% allow their children to cycle or walk to school and 22% from school in winter. At the same time, of all disagreeing parents (N=53, 13%), just 8% allow active travel to and from school.

Table 4-61 Perception of traffic-calming measures * Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		To school in winter			From school in winter		
		Yes	No	Total	Yes	No	Total
Active travel	Count	74	4	78 (19%)	78	4	82 (20%)
	% within Perception of traffic-calming measures	21%	8%		22%	8%	
Inactive Travel	Count	281	49	330 (81%)	277	49	326 (80%)
	% within Perception of traffic-calming measures	79%	92%		78%	92%	
Total Count		355	53	408	355	53	408

Table 4-62 shows that of the 355 respondents, 21% allow their children to cycle or walk to school and 20% from school in summer. At the same time, none of the total disagreeing parents (N=53, 13%) allows active travel to and from school.

Table 4-62 Perception of traffic-calming measures * Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		To school in summer			From school in summer		
		Yes	No	Total	Yes	No	Total
Active travel	Count	74	0	74 (18%)	66	0	66 (16%)
	% within Perception of traffic-calming measures	21%	0.0%		20%	0.0%	
Inactive Travel	Count	281	53	334 (82%)	289	53	342 (84%)
	% within Perception of traffic-calming measures	79%	100%		80%	100%	
Total Count		355	53	408	355	53	408

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between the perception of traffic calming measures and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of traffic calming measures had two levels: yes and no. Table 4-63 presents the existing correlation between perception of traffic calming measures and the travel mode categories.

There was a statistically **significant association** between the perception of the traffic calming measures and travel to school ($\chi 2$ (1) = 8.77, p = .003) and from school (χ^2 (1) = 9.79, p = .002) in winter; to school ($\chi 2$ (1) = 18.10, p <.001) and from school (χ^2 (1) = 16.61, p <.001) in summer.

Cramer's V value indicated **weak association** for the trip to school (Cramer's V = .15, p = .003) and from school (Cramer's V = .15, p = .002) in winter. At the same time, there was a **moderately strong association** between perception of traffic calming measures and the trip to school (Cramer's V =.21, p <.001) and from school (Cramer's V = .20, p <.001) in summer.

Table 4-63 Chi-Square Test between Perception of traffic calming measures and travel mode (H5)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	8.767	1	.003
	Cramer's V	.147		.003
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	9.788	1	.002
	Cramer's V	.155		.002
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	18.096	1	.000
	Cramer's V	.211		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	16.609	1	.000
	Cramer's V	.202		.000
	N of Valid Cases	408		

4.3.5.7 Perception of the speed limit signs

Cross tabulation

- The trip to and from school in winter

In the sample (N=408), most respondents (N=375, 92%) perceived the speed limit signs as existing. Table 4-64 shows that of the 375 respondents, 19% allow their children to cycle or walk to school and 21% from school in winter. At the same time, of the total disagreeing parents (N=33, 8%), 16% allow active travel to and from school.

Table 4-64 Perception of speed limit signs * Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		To school in winter			From school in winter		
		Yes	No	Total	Yes	No	Total
Active travel	Count	73	5	78 (19%)	77	5	82 (20%)
	% within Perception of speed-limit signs	19%	16%		21%	16%	
Inactive Travel	Count	302	28	330 (81%)	298	28	326 (80%)
	% within Perception of speed-limit signs	81%	84%		79%	84%	
Total		375	33	408	375	33	408

Table 4-65 shows that of the 375 respondents, 19% allow their children to cycle or walk to school and 17% from school in summer. While, of the total disagreeing parents (N=33, 8%), only 9% allow active travel to school and 3% from school.

Table 4-65 Perception of speed limit signs * Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		To school in summer			From school in summer		
		Yes	No	Total	Yes	No	Total
Active travel	Count	71	3	74 (18%)	65	1	66 (16%)
	% within Perception of speed-limit signs	19%	9%		17%	3%	
Inactive Travel	Count	304	30	334 (82%)	310	32	342 (84%)
	% within Perception of speed-limit signs	81%	91%		83%	97%	
Total Count		375	33	408	375	33	408

Hypothesis Testing with Chi-squared

Chi-square tests for association were conducted between the perception of speed limit signs and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of speed limit signs had two levels: yes and no. Table 4-66 presents the existing correlation between the perception of speed limit signs and the travel mode categories.

There was a statistically **insignificant association** between speed limit signs and all the travel to school categories ($p > 0.05$).

Table 4-66 Chi-Square Test between Perception of speed limit signs and travel mode (Hypothesis 5)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	.157	1	.692
	Cramer's V	.020		.692
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	.329	1	.566
	Cramer's V	.028		.566
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	3.588	1	.058
	Cramer's V	.094		.058
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	2.899	1	.089
	Cramer's V	.084		.089
	N of Valid Cases	408		

4.3.5.8 Perception of trees for shading

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), about one-third of the respondents (N=131, 32%) perceived the trees for shading as existing. Table 4-67 shows that of the 131 respondents, 38% allow their children to cycle or walk to school and 41% from school in winter. At the same time, of the disagreeing parents (N=277, 68%), 10% allow active travel to and from school.

Table 4-67 Perception of trees for shading * Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		**To school in winter**			**From school in winter**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	50	28	78 (19%)	54	28	82 (20%)
	% within Perception of trees for shading	38%	10%		41%	10%	
Inactive Travel	Count	81	249	330 (81%)	77	249	326 (80%)
	% within Perception of trees for shading	62%	90%		59%	90%	
Total Count		131	277	408	131	277	408

Table 4-68 shows that of the 131 respondents, 42% allow their children to cycle or walk to school and 40% from school in summer. While, of the total disagreeing parents (N=277, 68%), just 7% allow active travel to school and 5% from school.

Table 4-68 Perception of trees for shading * Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		**To school in summer**			**From school in summer**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	55	19	74 (18%)	53	13	66 (16%)
	% within Perception of trees for shading	42%	7%		40%	5%	
Inactive Travel	Count	76	258	334 (82%)	78	264	342 (84%)
	% within Perception of trees for shading	58%	93%		69%	95%	
	Total Count	131	277	408	131	277	408

Hypothesis Testing with Chi-squared

Chi-square tests for association were conducted between the perception of trees for shading and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of trees for shading had two levels: yes and no. Table 4-69 presents the existing correlation between perception of speed limit signs and the travel mode categories.

There was a statistically **significant association** between perception of trees for shading and travel to school **(**χ^2 (1) = 46.15, $p < .001$) and from school **(**χ^2 (1) = 55.09, $p < .001$) in winter; to school **(**χ^2 (1) = 71.27, $p < .001$) and from school **(**χ^2 (1) = 88.51, $p < .001$) in summer. Cramer's V value was significant (Cramer's V ≥ .34, $p < .001$) for all trip categories and it indicated a **high strength of the association**.

Table 4-69 Chi-Square Test between Perception of trees for shading and travel mode (Hypothesis 5)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	46.146	1	.000
	Cramer's V	.336		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	55.084	1	.000
	Cramer's V	.367		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	71.268	1	.000
	Cramer's V	.418		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	88.513	1	.000
	Cramer's V	.466		.000
	N of Valid Cases	408		

4.3.5.9 Perception of the natural views

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), less than half the respondents (N=163, 40%) perceived the natural views as existing. Table 4-70 shows that of the 163 respondents, 31% allow their children to cycle or walk to school and 33% from school in winter. At the same time, of the disagreeing parents (N=245, 60%), only 11% allow active travel to and from school.

Table 4-70 Perception of natural views * Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		**To school in winter**			**From school in winter**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	50	28	78 (19%)	54	28	82 (20%)
	% within Parent Perception of natural views	31%	11%		33%	11%	
Inactive Travel	Count	113	217	330 (81%)	109	217	326 (80%)
	% within Parent Perception of natural views	69%	89%		67%	89%	
Total Count		163	245	408	163	245	408

Table 4-71 shows that of the 163 respondents, 32% allow their children to cycle or walk to school and 31% from school in summer. While, of the total disagreeing parents (N=245, 60%), just 9% allow active travel to school and 6% from school.

Table 4-71 Perception of natural views * Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		**To school in summer**			**From school in summer**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	52	22	74 (18%)	51	15	66 (16%)
	% within Perception of natural views	32%	9%		31%	6%	
Inactive Travel	Count	111	223	334 (82%)	112	238	342 (84%)
	% within Perception of natural views	68%	91%		69%	94%	
Total Count		163	245	408	163	245	408

-

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between the perception of natural views and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Perception of natural views had two levels: yes and no. Table 4-69 presents the existing correlation between the perception of natural views and the travel mode categories.

There was a statistically **significant association** between perception of trees for shading and travel to school (χ^2 (1) = 23.75, p < .001) and from school (χ^2 (1) = 29.53, p < .001) in winter; to school (χ^2 (1) = 41.71, p < .001) and from school (χ^2 (1) = 55.28, p < .001) in summer. Cramer's V value indicated **moderately strong association** for the trip to school (Cramer's V = .24, p <.001) and from school (Cramer's V = .27, p <.001 in winter. At the same time, there was a **strong association** between perception of natural views and the trip to school (Cramer's V = .32, p <.001), and from school (Cramer's V = .37, p <.001) in summer.

Table 4-72 Chi-Square Test between Perception of natural views and travel mode (H5)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	23.753	1	.000
	Cramer's V	.241		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	29.532	1	.000
	Cramer's V	.268		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	41.706	1	.000
	Cramer's V	.320		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	55.286	1	.000
	Cramer's V	.368		.000
	N of Valid Cases	408		

4.3.5.10 Testing results of Hypothesis H5

Table 4-73 summarizes the correlation between the travel mode categories and built environment features: sidewalk width, continuity, condition, crosswalk marking, crossing signals, traffic calming measures, speed limit signs, trees for shading, and natural views.

Table 4-73 Summary of the correlation between the travel mode to school and built environment features (H5)

Main categories	Built environment features	Mode of travel to School		Mode of travel from School	
		Winter	Summer	Winter	Summer
Walking and cycling infrastructure	Sidewalk width	Significant Moderate	Significant Moderate	Significant Strong	Significant Moderate
	Sidewalk continuity	Significant Strong	Significant Moderate	Significant Strong	Significant Moderate
	Sidewalk condition	Significant Weak	Significant Weak	Significant Moderate	Significant Moderate
Traffic safety measures	Crosswalk marking	Significant Weak	Significant Weak	Significant Weak	Significant Weak
	Crossing signals or guards	Significant Weak	Significant Weak	Significant Moderate	Significant Moderate
	Traffic calming measure	Significant Weak	Significant Weak	Significant Moderate	Significant Moderate
	Speed limit signs	Insignificant	Insignificant	Insignificant	Insignificant
Landscaping	Trees for shading	Significant Strong	Significant Strong	Significant Strong	Significant Strong
	Natural views	Significant Moderate	Significant Moderate	Significant Strong	Significant Strong

4.3.6 The correlation between weather (seasonal changes) and school travel modes (active /inactive)

H6: There is a significant correlation between weather changes and school travel behaviours.

- **Cross tabulation**

The trip to and from school in winter

In the sample (N=408), more than half the respondents (N=224, 55%) agreed that the weather changes influenced their school travel mode choice. Table 4-74 and Figure 4-43 show that only 9% of the agreeing respondents allow their children to cycle or walk to school, and 10% from school in winter. In comparison, of the disagreeing parents (N=184, 45%), less than one-third (31%) allow active travel to school, and 32% from school in summer.

Table 4-74 Weather * Active/ Inactive travel to/from school in winter

Travel mode Active/Inactive		To school in winter			From school in winter		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	21	57	78 (19%)	23	59	82 (20%)
	% within Weather	9%	31%		10%	32%	
Inactive Travel	Count	203	127	330 (81%)	201	125	326 (80%)
	% within Weather	91%	69%		90%	68%	
Total Count		224	184	408	224	184	408

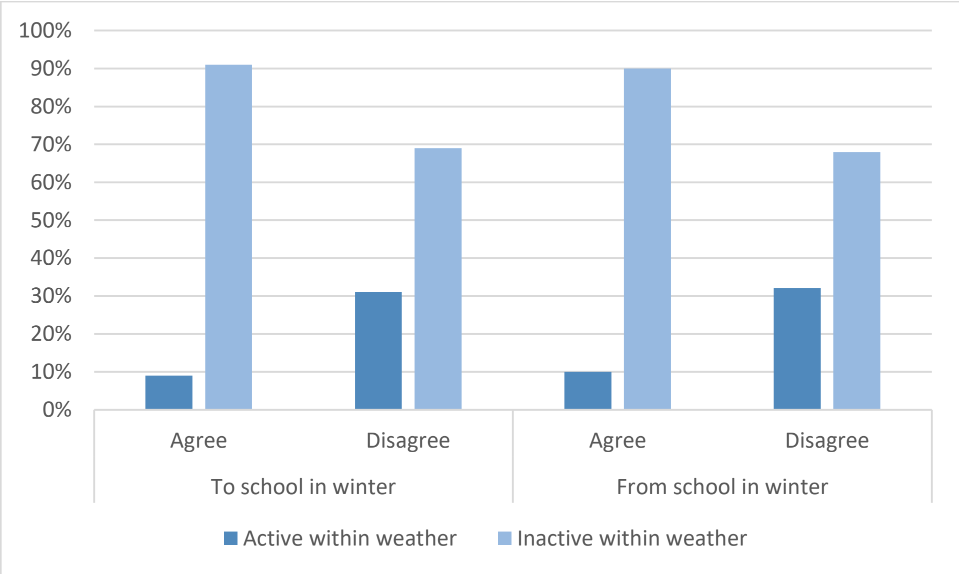

Figure 4-34 Weather * Active/ Inactive travel to/from school in winter

Table 4-75 and Figure 4-44 show that only 9% of the agreeing respondents allow their children to cycle or walk to school, and 8% from school in summer. In comparison, of the total disagreeing parents (N=184, 45%), more than one-quarter (29%) allow active travel to school, and 26% from school in summer.

Table 4-75 Weather* Active/ Inactive travel to/from school in summer

Travel mode Active/Inactive		To school in summer			From school in summer		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	20	54	74 (18%)	18	48	66 (16%)
	% within Weather	9%	29%		8%	26%	
Inactive Travel	Count	204	130	334 (82%)	203	136	342 (84%)
	% within Weather	91 %	71%		92%	74%	
	Total Count	224	184	408	224	184	408

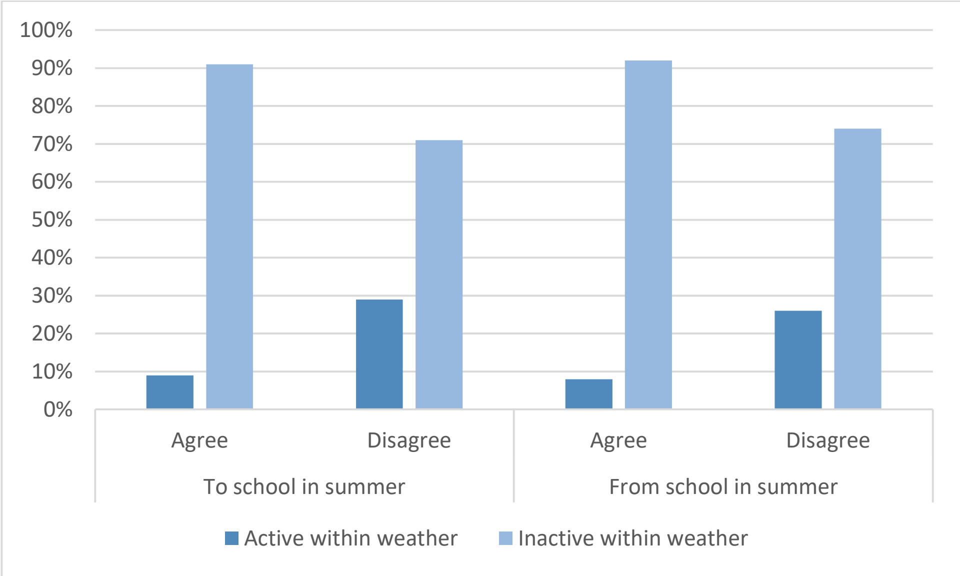

Figure 4-35 Weather * Active/ Inactive travel to/from school in summer

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between weather and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. The weather had two levels: yes and no. Table 4-76 presents the existing correlation between weather changes and the travel mode categories.

There was a statistically **significant association** between weather changes and travel to school **(**χ^2 (1) = 24.85, $p < .001$) and from school **(**χ^2 (1) = 29.47, $p < .001$) in winter; to school **(**χ^2 (1) = 27.84, $p < .001$) and from school **(**χ^2 (1) = 22.17, $p < .001$) in summer. Cramer's V value indicated **moderately strong association** for the trip to school (Cramer's V = .25, p <.001) and from school (Cramer's V = .27, p <.001) in winter; to school (Cramer's V = .26, p <.001), and from school (Cramer's V = .23, p <.001) in summer.

Table 4-76 Chi-Square Test between weather and travel mode (H6)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	24.851	1	.000
	Cramer's V	.247		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	29.472	1	.000
	Cramer's V	.269		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	27.842	1	.000
	Cramer's V	.261		
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	22.168	1	.000
	Cramer's V	.233		
	N of Valid Cases	408		

4.3.7 The correlation between parents' perceptions of AST and school travel modes (active /inactive)

H7: There is a significant correlation between parents' perceptions of AST and school travel behaviours.

4.3.7.1 Statement 1: Built Environment encourage or discourage active school travel

- **Cross tabulation**

The trip to/ from school in winter

In the sample (N=408), more than one-third of the respondents (N=155, 38%) strongly agreed and (N=78, 19%) agreed that the built environment encourage or discourage AST. Table 4-77 shows that 10% of the strongly agreed to allow their children to cycle or walk to school in winter, 13 % from school, while of all the agreed parents, 24% allow AST to and from school. In comparison, of the strongly disagreed (N=82, 20%) and disagreed (N=20, 5%), more respondents (38%) permit AST to and from school in winter.

The trip to/ from school in summer

Table 4-77 shows that 13% of the strongly agreed with statement 1, allow their children to cycle or walk to school in summer, and 14 % from school, while of all the agreed parents 19% allow AST to and from school . In comparison, of the strongly disagreed (N=82, 20%) and disagreed (N=20, 5%), more respondents (38% and 27%) permit AST to and from school in summer.

Table 4-77 Statement 1 * Active/ Inactive travel to/from school in winter/summer

Active travel mode		Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Total
To school in winter	Count	16	19	12	0	31	78 (19%)
	% within statement 1	10%	24%	17%	0%	38%	
From school in winter	Count	20	19	12	0	31	82 (20%)
	% within statement 1	13%	24%	17%	0%	38%	
To school in summer	Count	20	15	8	0	31	74 (18%)
	% within statement 1	13%	19%	11%	0%	38%	
From school in summer	Count	21	15	8	0	22	66 (16%)
	% within statement 1	14%	19%	11%	0%	27%	
Total Count (Active/Inactive)		155(38%)	78(19%)	73(18%)	20(5%)	82(20%)	408

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between parents' perceptions of statement 1 and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Parents 'perceptions had five levels: strongly agree, agree, neutral, disagree, and strongly disagree. Table 4-78 presents the existing correlation between the variables.

There was a statistically **significant association** between parents' perceptions of **statement 1** and travel to school (χ^2 (4) = 34.39, p < .001) and from school (χ^2 (4) = 29.04, p < .001) in winter; to school (χ^2 (4) = 31.38, p < .001) and from school (χ^2 (4) = 18.39, p = .001) in summer. Cramer's V value indicated **moderately strong association** for the trip to school (Cramer's V = .29, p <.001) and from school (Cramer's V = .27, p <.001) in winter; to school (Cramer's V = .28, p <.001), and from school (Cramer's V = .21, p =.001) in summer.

Table 4-78 Chi-Square Test between Perception of statement 1 and travel mode (H7)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	34.394	4	.000
	Cramer's V	.290		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	29.036	4	.000
	Cramer's V	.267		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	31.377	4	.000
	Cramer's V	.277		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	18.387	4	.001
	Cramer's V	.212		.001
	N of Valid Cases	408		

4.3.7.2 Statement 2: Active school travel is healthy for children

- **Cross tabulation**

The trip to/ from school in winter

In the sample (N=408), about one-third of the respondents (N=139, 34%) strongly agreed and (N=73, 18%) agreed that AST is healthy for children. Table 4-79 illustrates that 18% of the strongly agreed parents allow their children to cycle or walk to school in winter, and 21 % from school, while of all the agreed, 19% allow AST to and from school. In comparison, of the strongly disagreed (N=82, 20%) and disagreed (N=41, 10%), more respondents (34%) permit AST to and from school in winter.

The trip to/ from school in summer

Table 4-79 shows that 22% of the strongly agreed with statement 2, allow their children to cycle or walk to school in summer, and 23 % from school, while of all the agreed parents, 13% allow AST to school, and 9% from school . In comparison, of the strongly disagreed (N=82, 20%) and disagreed (N=41, 10%), more respondents (34% and 26%) permit AST to and from school in summer.

Table 4-79 Statement 2 * Active/ Inactive travel to/from school in winter/summer

Active travel mode		**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**	**Total**
to school in winter	Count	25	14	4	7	28	78 (19%)
	% within statement 2	18%	19%	5%	18%	34%	
from school in winter	Count	29	14	4	7	28	82 (20%)
	% within statement 2	21%	19%	5%	18%	34%	
to school in summer	Count	30	9	4	3	28	74 (18%)
	% within statement 2	22%	13%	5%	7%	34%	
from school in summer	Count	32	6	4	3	21	66 (16%)
	% within statement 2	23%	9%	5%	7%	26%	
Total Count (Active/Inactive)		139(34%)	73(18%)	73(18%)	41(10%)	82(20%)	408

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between parents' perceptions of statement 2 and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Parents 'perceptions had five levels: strongly agree, agree, neutral, disagree, and strongly disagree. Table 4-80 presents the existing correlation between the variables.

There was a statistically **significant association** between parents' perceptions of **statement 2** and travel to school **(**χ^2 (4) = 21.10, p < .001) and from school **(**χ^2 (4) = 20.11, p < .001) in winter; to school **(**χ^2 (4) = 26.21, p < .001) and from school **(**χ^2 (4) = 22.04, p <.001) in summer. Cramer's V value indicated **moderately strong association** for the trip to school (Cramer's V = .23, p <.001) and from school (Cramer's V = .22, p <.001) in winter; to school (Cramer's V = .25, p <.001), and from school (Cramer's V = .23, p =.001) in summer.

Table 4-80 Chi-Square Test between Perception of statement 2 and travel mode (H7)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	21.096	4	.000
	Cramer's V	.227		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	20.117	4	.000
	Cramer's V	.222		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	26.213	4	.000
	Cramer's V	.253		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	22.040	4	.000
	Cramer's V	.232		.000
	N of Valid Cases	408		

4.3.7.3 Statement 3: Active travel to school reduces traffic congestion and air pollution

- **Cross tabulation**

The trip to/ from school in winter

In the sample (N=408), more than one-third of the respondents (N=155, 38%) strongly agreed and (N=78, 19%) agreed that AST reduces traffic congestion and air pollution. Table 4-81 shows that 10% of the strongly agreed to allow their children to cycle or walk to school in winter, 13 % from school, while of all the agreed parents, 24% allow AST to and from school. In comparison, of the strongly disagreed (N=82, 20%) and disagreed (N=20, 5%), more respondents (38%) permit AST to and from school in winter.

The trip to/ from school in summer

Table 4-81 shows that 13% of the strongly agreed with statement 3, allow their children to cycle or walk to school in summer, and 14 % from school, while of all the agreed parents, 19% allow AST to and from school. In comparison, of the strongly disagreed (N=82, 20%) and disagreed (N=20, 5%), more respondents (38% and 27%) permit AST to and from school in summer.

Table 4-81 Statement 3 * Active/ Inactive travel to/from school in winter/summer

Active travel mode		**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**	**Total**
To school in winter	Count	16	19	12	0	31	78 (19%)
	% within statement 3	10%	24%	17%	0%	38%	
From school in winter	Count	20	19	12	0	31	82 (20%)
	% within statement 3	13%	24%	17%	0%	38%	
To school in summer	Count	20	15	8	0	31	74 (18%)
	% within statement 3	13%	19%	11%	0%	38%	
From school in summer	Count	21	15	8	0	22	66 (16%)
	% within statement 3	14%	19%	11%	0%	27%	
Total Count (Active/Inactive)		155(38%)	78(19%)	73(18%)	20(5%)	82(20%)	408

- **Hypothesis Testing with Chi-squared**

Chi-square tests for association were conducted between parents' perceptions of statement 3 and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Parents 'perceptions had five levels: strongly agree, agree, neutral, disagree, and strongly disagree. Table 4-82 presents the existing correlation between the variables.

There was a statistically **significant association** between parents' perceptions of **statement 3** and travel to school **(**χ^2 (4) = 34.39, p < .001) and from school **(**χ^2 (4) = 29.04, p < .001) in winter; to school **(**χ^2 (4) = 31.38, p < .001) and from school **(**χ^2 (4) = 18.39, p = .001) in summer.

Cramer's V value indicated **moderately strong association** for the trip to school (Cramer's V = .29, p <.001) and from school (Cramer's V = .27, p <.001) in winter; to school (Cramer's V = .28, p <.001), and from school (Cramer's V = .21, p =.001) in summer.

Table 4-82 Chi-Square Test between Perception of statement 3 and travel mode (H7)

Variables	**Statistics**	**Value**	***df***	**Asymptotic Significance (2-sided) (*p*)**
Travel to school in winter	Pearson Chi-Square (χ^2)	34.394	4	.000
	Cramer's V	.290		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	29.036	4	.000
	Cramer's V	.267		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	31.377	4	.000
	Cramer's V	.277		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	18.387	4	.001
	Cramer's V	.212		.001
	N of Valid Cases	408		

4.3.7.4 Statement 4: Active travel to school creates active communities and safer streets

- **Cross tabulation**

The trip to/ from school in winter

In the sample (N=408), about one-third of the respondents (N=139, 34%) strongly agreed and (N=73, 18%) agreed that AST creates active communities and safer streets. Table 4-83 illustrates that 18% of the strongly agreed parents allow their children to cycle or walk to school in winter, and 21 % from school, while of all the agreed, 19% allow AST to and from school. In comparison, of the strongly disagreed (N=82, 20%) and disagreed (N=41, 10%), more respondents (34%) permit AST to and from school in winter.

The trip to/ from school in summer

Table 4-83 shows that 22% of the strongly agreed with statement 4, allow their children to cycle or walk to school in summer, and 23 % from school, while of all the agreed parents, 13% allow AST to school, and 9% from school. In comparison, of the strongly disagreed (N=82, 20%) and disagreed (N=41, 10%), more respondents (34% and 26%) permit AST to and from school in summer.

Table 4-83 Statement 4 * Active/ Inactive travel to/from school in winter/summer

Active travel mode		**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**	**Total**
To school in winter	Count	25	14	4	7	28	78 (19%)
	% within statement 2	18%	19%	5%	18%	34%	
From school in winter	Count	29	14	4	7	28	82 (20%)
	% within statement 2	21%	19%	5%	18%	34%	
To school in summer	Count	30	9	4	3	28	74 (18%)
	% within statement 2	22%	13%	5%	7%	34%	
From school in summer	Count	32	6	4	3	21	66 (16%)
	% within statement 2	23%	9%	5%	7%	26%	
Total Count (Active/Inactive)		139(34%)	73(18%)	73(18%)	41(10%)	82(20%)	408

Hypothesis Testing with Chi-squared

Chi-square tests for association were conducted between parents' perceptions of statement 4 and the four categories of students' travel mode: to school in winter, from school in winter, to school in summer, and from school in summer. Each category of the travel mode variable had two levels: active travel and inactive travel. Parents 'perceptions had five levels: strongly agree, agree, neutral, disagree, and strongly disagree. Table 4-84 presents the existing correlation between the variables.

There was a statistically **significant association** between parents' perceptions of **statement 4** and travel to school **(**χ^2 (4) = 21.10, p < .001) and from school **(**χ^2 (4) = 20.11, p < .001) in winter; to school **(**χ^2 (4) = 26.21, p < .001) and from school **(**χ^2 (4) = 22.04, p <.001) in summer.

Cramer's V value indicated **moderately strong association** for the trip to school (Cramer's V = .23, *p* <.001) and from school (Cramer's V = .22, *p* <.001) in winter; to school (Cramer's V = .25, *p* <.001), and from school (Cramer's V = .23, *p* =.001) in summer.

Table 4-84 Chi-Square Test between Perception of statement 2 and travel mode (H7)

Variables	Statistics	Value	*df*	Asymptotic Significance (2-sided) (*p*)
Travel to school in winter	Pearson Chi-Square (χ^2)	21.096	4	.000
	Cramer's V	.227		.000
	N of Valid Cases	408		
Travel from school in winter	Pearson Chi-Square (χ^2)	20.117	4	.000
	Cramer's V	.222		.000
	N of Valid Cases	408		
Travel to school in summer	Pearson Chi-Square (χ^2)	26.213	4	.000
	Cramer's V	.253		.000
	N of Valid Cases	408		
Travel from school in summer	Pearson Chi-Square (χ^2)	22.040	4	.000
	Cramer's V	.232		.000
	N of Valid Cases	408		

4.3.7.5 Testing results of hypothesis H7

Table 4-85 summarizes the correlation between the travel mode categories and parents' perceptions of the four statements about AST.

Table 4-85 Summary of the correlation between the school travel mode and perceptions of AST (H7)

Statements	Mode of travel to School		Mode of travel from School	
	Winter	Summer	Winter	Summer
Statement 1: Built Environment encourage or discourage active school travel	Significant Moderate	Significant Moderate	Significant Moderate	Significant Moderate
Statement 2: Active school travel is healthy for children	Significant Moderate	Significant Moderate	Significant Moderate	Significant Moderate
Statement 3: Active travel to school reduces traffic congestion and air pollution	Significant Moderate	Significant Moderate	Significant Moderate	Significant Moderate
Statement 4: Active travel to school creates active communities and safer streets	Significant Moderate	Significant Moderate	Significant Moderate	Significant Moderate

4.4 Summary of findings

4.4.1 Descriptive Analysis

In the sample (N=408), the majority of students (63%) lives further than 3km away from school, and less than one-third (29%) get to or from school in ten minutes or less. More than one-third of the parents (38%) believed that children can start traveling to/ from school unaccompanied between grades G5 – G8. In comparison, 31% disagreed to allow independent mobility at any grade. At the same time, a majority (52%) would permit active travel with siblings and other students.

On average, 82% of all students use inactive travel modes, mainly private cars followed by school buses. The AST rates are the highest from school in winter with 20%. While the lowest rates are from school during the summer, with 16% of all students using AST. The differences are small though, with only 4% difference between summer and winter. In comparison to walking, less than one-third cycle to or from school among all active travellers.

Distance is the most influencing factor on the travel mode choices, followed by the weather and the time length of the trip to/from school. Among the built environment features, street connectivity and traffic-calming measures are significant factors. Parents of inactive travellers agreed that modifications mostly related to distance, traffic-calming measures, and cycling infrastructure are crucial to shift to AST modes. At the same time, most parents recognized the presence of traffic safety measures, the good condition of the sidewalks, and its width near the schools. Also, almost half the parents perceived the benefits of AST and its correlation with the built environment.

4.4.2 Hypotheses Testing Results

Table 4-86 shows the results of testing the study hypotheses:

Table 4-86 Hypotheses testing results

Hypothesis	Accepted / Rejected
H1: There is a significant correlation between distance and school travel behaviours	Accepted: to/from school in winter and summer
H2: There is a significant correlation between time length of trip and school travel behaviours	Accepted: to/from school in winter and summer
H3: There is a significant correlation between the built environment features and school travel behaviours	Accepted: **Street connectivity**: to/ from school in winter, and to school in summer. **Traffic-calming measures:** to/from school in winter and summer **Pedestrian Infrastructure:** to/from school in winter and summer **Landscaping:** from school in summer Rejected: **Street connectivity**: from school in summer **Cycling infrastructure**: to/from school in summer and winter **Landscaping:** to/from school in winter and to school in summer
H4: There is a significant correlation between CIM and school travel behaviours	Rejected: to/from school in winter and summer
H5: There is a significant correlation between the parents' perceptions of the built environment features and school travel behaviours.	Accepted: to/ from school in winter and summer for: **Sidewalk width** **Sidewalk continuity** **Sidewalk condition** **Crosswalk marking** **Crossing signals or guards** **Traffic calming measure** **Trees for shading** **Natural views** Rejected: to/from school in winter and summer for: **Speed limit signs**
H6: There is a significant correlation between the weather changes and school travel behaviours.	Accepted: to/from school in winter and summer
H7: There is a significant correlation between parents' perceptions of AST and school travel behaviours.	Accepted: to/from school in winter and summer

4.5 Discussion of the research findings

This section explains and evaluates the current study's findings and compares them with the reviewed literature. Remarkably, these findings are in line with most of the previous relevant research, which indicates the validity of the implemented study model.

4.5.1 School travel behaviours among students.

The current study finds that 82% of the total students use different inactive travel modes, mainly private vehicles (52%) followed by school buses (27%), to get to and from school throughout the year, which is consistent with KHDA (2017) reports. That might be explained by the fact that almost two-thirds of the students (63%) live further than 3 km away from their schools, while the threshold distance for walking to school is between 1.4 – 1.7 km (Ikeda et al. 2018; Wilson, Clark & Gilliland 2018; Kobel, Wartha & Steinacker 2019). Furthermore, 42% of the students are in grades G1- G4, though children can independently cross the road not before they are ten years old (Ross, Rodríguez & Searle 2017). Other reasons are possibly the high car ownership in Dubai and parents' desire to protect their children by driving them to and from school.

There seem to be no significant differences in travel mode preference between summer and winter. However, more students walk to and from school in winter than in summer; this result is expected due to the high temperatures in summer and is in line with previous studies (Rahman 2019). Moreover, more students engage in AST from school than to school; the reason is possible because it is more convenient for working parents to drop off their children at school in the morning rather than to pick them up in the afternoon (Wilson, Clark & Gilliland 2018; Sener, Lee & Sidharthan 2019). Also, the results showed that among the AST modes, walking is more common than cycling throughout the year.

The majority of reviewed studies in chapter two agreed that AST rates had dropped recently. Consequently, the tendency towards the motorised modes has increased in many countries (Paulo et al. 2018; Ikeda et al. 2018; Vitale, Millward & Spinney 2019; Goodman et al. 2019). However, Kobel, Wartha & Steinacker (2019) and Barnett et al. (2019) reported considerably high rates of AST, mainly walking in Denmark, Hong Kong, and the UK. Compared to the results from other countries, the percentage of students engaging in AST in the current study (18%) is relatively very low, which may be due to Dubai's different climate and culture. However, the results from this study are in line with the previous studies conducted in the UAE (Badri 2013; Paulo et al. 2018).

4.5.2 Factors Influencing the school travel behaviours

4.5.2.1 Distance and school travel behaviours

In previous studies, distance to school was the most frequently mentioned obstacle to AST and a predominant determinant. Likewise, the empirical research in this study shows that a strong association between both variables exists. There are significant differences between the travel modes per distance throughout the year. AST modes are never used for distances greater than 1.5 km. This threshold is within the range associated with walking (1.4-1.7 km) stated by Ross, Rodríguez & Searle (2017), Ikeda et al. (2018), Wilson, Clark & Gilliland (2018), and Kobel, Wartha & Steinacker (2019). At the same time, the current study revealed that most private school students are attending schools that are more than 3 km away from their homes, which limits AST (Vitale, Millward & Spinney 2019). The reason for that might be the parent choices of international branded schools, or schools with special offerings and curricula in central locations (Sener, Lee & Sidharthan 2019).

The distance to school influences parents decisions about their children's school travel mode, and a majority would reconsider allowing their children to walk to school if the current distance is shortened in the future. . Compared with other factors including built environment features, weather, adult companion, and school-bag weight, the distance between home and school is the most influential factor on the parents' choices of school travel modes. These results are in line with Badri (2013), Kallio et al. (2016), Yu & Zhu 2016; Ross, Rodríguez & Searle (2017), Ikeda et al. (2018), Wilson, Clark & Gilliland (2018) Kobel, and Wartha & Steinacker (2019) reports. In summary, hypothesis H1 is supported in this research.

4.5.2.2 Length of the trip and school travel behaviours

In previous studies, parents and children perceived the length of the trip as one of the barriers to AST in addition to distance (Mandic et al. 2018). Similarly, this study found it the third most influencing factor after distance and weather on parent's decision about the mode of school travel, with the agreement of almost half the parents. The time length of active trips to school might be affected by distance, street connectivity, and walking and cycling infrastructure. The majority of the students who take between 11-20 minutes to get to or from school use AST. When the length of the trip is shorter, the probability of walking or cycling increases and when it gets longer than 20 minutes, it is less likely to choose a mode of active transport than inactive transport. However, Badri (2013) reported that most of the students using AST in Abu Dhabi take less than 30 minutes to reach their schools, which is a longer time than the reported threshold in the current study. This difference might be due to the availability of pedestrian and cycling infrastructure that encourages active travel for a longer time in Abu Dhabi.

Moreover, the results of the trips to school were almost similar to those from school; however, more parents reported that their children take more time to get from school. This difference might be due to the traffic condition at the school zone in the afternoon when all students finish simultaneously. The current study finds a significant and strong correlation between the length of trip and the school travel behaviours in the winter and summer, supporting hypothesis H2.

4.5.2.3 The built environment features and school travel behaviours

Compared with distance, weather, and length of the trip factors, parents find that built environment features including street connectivity, traffic-calming measures, pedestrian infrastructure, cycling infrastructure, and landscaping are less effective on their decision to allow AST. Moreover, unexpectedly the results indicated that other factors, such as the weight of the school bag, are of concern to parents (Appendix B). This study suggests that different features of the built environment have various relations with parent's decision between active and inactive school travel, and the results partially support the hypothesis H3

Although it is only the fifth-biggest influencer on parents' decisions, the pedestrian infrastructure is the feature with the strongest association of all the built environment features with the school travel behaviour. This result is expected and in line with research conducted by Da Silva et al. (2017) and Poulsen et al. (2018), which indicated that pedestrian infrastructure is one of the most influencing built environment features on AST.

Also, other features such as street connectivity and traffic-calming measures are significantly associated with the school travel behaviour, but comparatively less than the pedestrian infrastructure. Previous research highlighted the significant influence of street connectivity on school travel mode choices (Ikeda et al. 2018; Carver 2019; Sener, Lee & Sidharthan 2019). The results are also in line with Aerts (2018) and Frank et al. (2019) studies which found that the traffic safety measures such as crosswalks and traffic signals significantly influence school travel behaviours. However, it contradicts Verhoeven et al. (2017) report, which stated that speed limit signs and speed bumps are the least influencing features, mainly cycling. Also, the results revealed that half the parents who are not allowing AST would reconsider that in the future if the traffic-calming measures are developed.

The absence of a significant association between school travel behaviours and cycling infrastructure is observed in this study; the small number of students who cycle to and from school could be the reason. This result contradicts the claims of Tarun et al. (2017), Da Silva et al. (2017), Poulsen et al. (2018), Ikeda et al. (2018), Kobel, Wartha & Steinacker (2019), and Frank et al. (2019), that cycling infrastructure significantly influence parents' decisions between active and inactive school travel. Especially that cycling is more convenient for longer distances and can be encouraged by developing the infrastructure. Therefore, according to the results, developing cycling infrastructures in different areas of Dubai may encourage almost half the parents who restrict AST to allow it. While developing or modifying the pedestrian infrastructures may encourage fewer parents to allow AST. The reason is that the distance threshold for cycling is higher than that for walking (Goodman et al. 2019; Smith et al. 2020).

There is no significant relationship between the landscaping feature and school travel modes, except for the trip from school in the summer, which might be caused by the importance of the shading effect of trees in summer afternoons, mainly for students who travel actively from school. Only a few studies drew attention to the correlation between the two variables and primarily focused on landscape aesthetic and air purification impacts in the built environment (Frank et al. 2019). Moreover, those research studies were conducted in the west with different climates compared to the UAE. The results are in line with Verhoeven et al. (2017) research which found that in comparison with the other built environment features, landscaping has the least influencing impact on school travel behaviours. However, the current study results found that modifications in the landscaping may encourage 32% of the parents to shift to AST.

4.5.2.4 Adult companion and school travel behaviours

The results of the study indicate that the relationship between adult companions and school travel behaviour is insignificant. Therefore, hypothesis H4 is not supported. The results contradict the previous studies, which confirmed that both variables significantly correlate

(Tremblay et al. 2016; Marzi, Demetriou & Reimers 2018; Carver 2019). The reason might be the dominating distance factor in this study which significantly influences CIM (Marzi, Demetriou & Reimers 2018). Furthermore, almost 43% of the students are in grades G1-G4, while just 7% of the parents believe that independent school travel may start within this educational stage.

Conversely, the majority agreed that students between grades G5-G12 are granted more freedom to travel independently. This result is in line with previous studies (Fitch, Rhemtulla & Handy 2019). Furthermore, only 14% of the parents agreed that CIM influences their choice of school travel mode. However, almost 50% of them would allow their children to cycle or walk to school with older siblings or other students. In comparison, Badri (2013) informed that 69% of the parents in Abu Dhabi would allow their children to travel to school actively. Consequently, it is advisable to consider group travel programs, such as the Walking School Bus and Cycle Trains (Larouche et al. 2018; Zhu & Yoon 2017; Villa-González et al. 2017; Villa-González et al. 2018; Smith et al. 2020).

4.5.2.5 Parents' perceptions of the built environment features and school travel behaviours

Using perception measurements reflects the importance of parent opinion when deciding between active and inactive school travel. The literature found that parent perception of the built environment may be more strongly associated with travel behaviours than objective measures (Ross, Rodríguez & Searle 2017, Carver 2019). Yet, parent perception of the built environment features may indicate actual availability and condition, or it may reflect a lack of awareness of existing features.

The current study finds that school travel behaviour significantly correlates with parent perceptions of the pedestrian infrastructure's width, continuity, and condition. It also associates with landscaping for shading and aesthetic purposes and the availability of traffic safety measures, including crosswalks, crossing signals. These results are consistent with previous studies and the expected contribution of parent perception of the built environment and traffic safety to the school travel behaviour (Pang, Kubacki & Rundle-thiele 2017; Ross, Rodríguez & Searle 2017; Cain et al. 2018; Wilson, Clark & Gilliland 2018). However, 92% of the parents perceived the availability of speed limit signs near schools; unexpectedly, the school travel behaviour did not differ between those who perceived it and those who did not observe it, possibly because this feature is equally critical for active and inactive travel modes. Therefore, hypothesis H5 is supported except regarding the speed limit signs.

4.5.2.6 Weather conditions and school travel behaviours

This study indicates that weather changes are the second influencing factor on parents' decisions between active and inactive travel modes. The relationship between the two variables is significant; therefore the hypothesis H6 is supported. These findings are expected and in line with Badri (2013) and Rahman (2019) reports that emphasize the strong correlation between weather variations and school travel behaviours in Abu Dhabi and Dhahran, where walking is more frequent in winter than in winter hot and humid summer. Likewise, this study finds that AST decreases in summer afternoons. In general, the weather conditions resulted in a lack of PA culture in the Gulf countries (Sulaiman et al. 2017). Using shade trees along the routes to school may protect students from excessive exposure to direct sunlight in summer whilst encourages AST (Yu & Zhu 2016; Leung, Phuong & Le 2019).

4.5.2.7 Parents' perceptions of AST and school travel behaviours

The current study finds that school travel behaviour significantly correlates with parents' perceptions of AST's health, environmental, and social benefits. Also, with parent awareness of the role of the built environment in encouraging or discouraging AST. Therefore the results support hypothesis H7. The results are also in line with previous research, which confirmed the significant influence of parent culture and perception of AST on the choice of school travel mode (Mandic et al. 2018; Kobel, Wartha & Steinacker 2019; Sener, Lee & Sidharthan 2019).

However, over half of the parents in this study appreciate the benefits of AST; almost half of the students living within walking distance (less than 1.5 km) from their schools use inactive travel modes. The reason might be parents' concerns about exposure to traffic injuries and air pollution, which offsets the benefits of AST (Frank et al. 2019). Another reason is possibly the relative time advantage of inactive over active travel modes. Moreover, the results confirm the perception-behaviour gap in the decision process between active and inactive school travel modes among parents. (Buttazzoni, Clark & Seabrook 2019). Therefore AST interventions must focus on strategies that change AST behaviours through parental education and motivation programs Huertas-Delgado et al. 2017; Yu & Zhu 2016; Zhu & Yoon 2017; Aerts 2018). Also, Pedestrian and cycling infrastructure developments in the built environment may influence AST behaviours and are crucial to address parental concerns about traffic safety (Huertas-Delgado et al. 2017; Carver 2019; Leung, Phuong & Le 2019).

Chapter 5: Conclusion and Recommendations

This chapter concludes by deducing the crucial conclusions of the study and making recommendations. It also presents the limitations, and the suggestions for future research.

5.1 Conclusion

This study investigated the influence of different environmental factors on the decision between active and inactive school travel modes to identify the factors that inhibit AST among private school students in the Dubai emirate. This process was initiated by reviewing the previous literature on the relationship between school travel behaviours and environmental influences to understand the studied topic comprehensively. Then, as part of a quantitative survey process, questionnaires were distributed online to parents of students in grades G1-G12 from different private schools.

This empirical research supported the reviewed literature and resulted in valuable findings related to the context of Dubai that can be beneficial for future research in similar contexts. The results confirmed the relationship between school travel behaviours and most of the suggested influencing factors, including distance, time length of the school trip, built environment features, parent perceptions of the built environment features, weather conditions, and parent perceptions of AST. The results also defined the strength of these relationships. At the same time, it denied the influence of CIM and the presence of speed limit signs on school travel behaviours in Dubai private schools. Furthermore, the results limited the effect of street connectivity to the trips to/ from school in winter and only the journey to school in summer. In contrast, the impact of landscaping was recognized only on the journey from school in summer. Consistent with previous studies, distance to school is the primary determinant of the school travel mode in this study, followed by weather and time length of the trip. Since most of the private school students in Dubai live beyond the walking distance threshold, it may be concluded that distance between home and school is the main barrier to AST. The study suggests a strong negative relationship between the two variables. Considering the built environment features, street connectivity and traffic calming measures are the most significant factors in deciding between active and inactive school travel modes. As previous studies and parents recommended in this study, developing the cycling infrastructure in school zones may encourage them to consider AST for reasonable distances beyond the walking distance limits.

5.2 Recommendations

Based on the findings of this study and the relevant interventions in the reviewed literature, the researcher can make the following recommendations for policymakers and practitioners:

- School siting policies need to give careful attention to providing a diversity of schools with different curriculums near the residential communities, considering that shorter distance is a crucial influence on the school travel mode (Ikeda et al. 2018; Lee 2020).
- Promote group AST programs at the community and school levels, such as the Bicycle Train (BCT) and The Walking School Bus (WSB). Such programs involve students cycling or walking to and from school in groups, guided by one or more adults, with pick up and drop off stops (Zhu & Yoon 2017; Larouche et al. 2018). These programs succeeded in encouraging AST in other countries, such as Australia, Newzealand, and the UK.
- Implement strategies to encourage AST by bicycle, such as developing cycle-friendly routes to school and providing bicycle parking at schools (Verhoeven et al. 2017). The strategy may also include offering cycle training at schools to improve students' safe cycling skills and enhance the social perception about cycling, considering that distance thresholds for cycling are higher than walking (Goodman et al. 2019).
- Develop urban-based interventions and modifications to street design that influences solar exposure. For example, expanding the canopy coverage on the routes to school to

minimise the exposure to the harsh sun significantly during summer may reduce the negative impact of weather conditions on AST.

- Implement school safety zones by developing the traffic safety measures in these zones, such as the traffic-calming features, the waiting and parking restrictions, the pedestrian crossings, and the speed limit signs. Schools may also play an essential role by hiring crossing guards and identifying the safe routes to school. Such developments address parent safety concerns and are likely to encourage AST behaviours and CIM (Carver 2019; Buttazzoni, Clark & Seabrook 2019; Leung, Phuong & Le (2019).
- Initiate education and awareness campaigns for parents and students on AST. These initiatives should mainly focus on parental perceptions of their built environment features that facilitate active school transport. Education, along with encouragement strategies, could increase AST opportunities and the knowledge of its benefits. Additionally, it improves student's safety knowledge.
- Contribute effectively to the global efforts to support AST and other forms of PA among children and adolescents, such as the Global matrix international study, by providing the relevant data to support the research efforts on AST.

5.3 Study Limitations

This study has two limitations caused mainly by the school closures in Dubai during the COVID-19 pandemic in 2020. One limitation is the use of one method of data collection, instead of the mixed-method approach planned in the research proposal, and included survey and observation methods. The lockdown and school closures prevented using the observation method; however, it would be more beneficial to consider both approaches. Another limitation is that the sample of the study was restricted to the parents. Still, it was necessary to consider the participation of the students to get a balanced view of the research topic. Comparing and contrasting the different perceptions of parents and students on school travel behaviours would add more insight to the study.

5.4 Recommendations for Future Research

The current study has recognised the following recommendations for future research on the same topic:

- Future research should consider student perceptions by including them in the study sample and using student questionnaires to collect the relevant data.
- Future research should target the population living within walkable distances from their schools. It would help reduce the dominant impact of the distance variable on the choice between active and inactive school travel modes.
- Future studies would be prudent to focus on the population at grades G4-G12 who can independently commute to school and share the decision of the school travel mode with their parents
- Future research should use a mixed-methods approach to effectively evaluate the association between the school travel behaviours and the influencing factors (Smith et al. 2020).

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Appendix A The Survey Questionnaire

Active Travel to School Survey
Barriers to active school travel in Dubai

Neighborhood / Area *

Your answer

School Name / Area *

Your answer

What is the grade of the child? *

Your answer

What is the gender of the child? *

Female
Male

1. How far does your child live from school? *

0 - 0.5 km
0.5 - 1 km
1 - 1.5 km
1.5 - 3 km
More than 3 km
Not sure

2. At what grade would you allow your child to walk or cycle to/from school without an adult? *

Your answer

3. Would you probably allow your child to walk or cycle to/from school with older siblings or other children? *

Yes
No

4. In winter months, how does your child arrive at school? (Select the choice that repeats on three or more days per week) *

Walk
Cycle
School Bus
Private Vehicle
Public Transport (bus, metro, taxi)
Other:

5. In the winter months, how does your child leave school? (Select the choice that repeAST on three or more days per week) *

Walk
Cycle
School Bus
Private Vehicle
Public Transport (bus, metro, taxi)
Other:

6. In the summer months, how does your child arrive at school? (Select the choice that repeats on three or more days per week) *

Walk
Cycle
School Bus
Private Vehicle
Public Transport (bus, metro, taxi)
Other:

7. In the summer months, how does your child leave school? (Select the choice that repeats on three or more days per week) *

Walk
Cycle
School Bus
Private Vehicle
Public Transport (bus, metro, taxi)
Other:

8. How long does it usually take your child to get to school? *

Less than 5 minutes
5 - 10 minutes
11 - 20 minutes
More than 20 minutes
Don't know / Not sure

9. How long does it usually take your child to get home from school? *

Less than 5 minutes
5 - 10 minutes

11 - 20 minutes
More than 20 minutes
Don't know / Not sure

10. Which of the following issues affected your decision to allow or not allow your child to walk or cycle to/from school? (Select ALL that apply) *

Distance
Length of trip
Street connectivity
Traffic calming measures
Pedestrian infrastructure
Cycling infrastructure
Landscaping
Adults to walk or cycle with
Weight of school bags
Weather
Other:

11. Which of the following features, if changed or improved, you would probably let your child walk or cycle to/from school? (In case your child is not walking or cycling to school)

Traffic calming measures
Pedestrian infrastructure
Cycling infrastructure
Landscaping
Distance
Other:

12. Please select the answer that best applies to your child's school zone

A. The sidewalks are wide enough for walking *

Yes
No

B. The sidewalks are continuous. *

Yes
No

C. The sidewalks are in good condition, without any large cracks or dips. *

Yes
No

D. The crosswalks are marked *

Yes
No

E. There are crossing signals or crossing guards near the school. *

Yes
No

F. There are traffic-calming measures such as speed humps. *

Yes
No

G. There are speed limit signs *

Yes
No

H. There are trees that provide shade along the path to school. *

Yes
No

I. There are many beautiful natural things for my child to look at (e.g., gardens, views). *

Yes
No

13. How far do you agree or disagree with the following statements?

A. The neighbourhood environment may encourage or discourage walking and biking to/from school. *

Strongly agree

1
2
3
4
5

Strongly disagree

B. Walking or cycling to school is healthy for children. *

Strongly agree

1
2
3
4
5

Strongly disagree

C. Replacing motorized school trips with active modes results in reduced traffic congestion and reduced emissions of air pollutants, noise, and greenhouse gases. *

Strongly agree

1
2
3
4
5

Strongly disagree

D. Walking to school with other families is a great way to build an active community and create safer, friendlier streets. *

Strongly agree

1
2
3
4
5

Strongly disagree

Please provide your comments below

Your answer

Thank you for participating in this survey

Appendix B Individual and trip Characteristics

Table B1 Individual Characteristics of the Sample

	Gender	Educational stage	Educational stage at which students are allowed to walk or cycle to school without an adult	Permission to walk or cycle to school with siblings or other students
Male	258			
Female	150			
G1- G4		173	27	
G5-G8		140	151	
G9-G12		95	104	
Not allowed at any grade			126	
Allowed with other children				212
Not allowed with other children				196

Table B2 Trip characteristics of the sample

Response choices	**Distance**	**Time length of trip**		**Mode of travel in winter**		**Mode of travel in summer**	
		To school	**From school**	**To school**	**From school**	**To school**	**From school**
0 – 0.5 km	33						
0.5 – 1 km	61						
1 – 1.5 km	41						
1.5 – 3 km	16						
More than 3 km	257						
Less than 5 min.		45	24				
5 - 10 min.		74	94				
11 - 20 min.		126	110				
More than 20 min.		163	180				
Walk				57	61	53	45
Cycle				21	21	21	21
School bus				110	106	110	110
Private vehicle				212	208	208	216
Public transport				8	12	16	16

Appendix C The study variables, measurement levels, and related questions

Table C1 Variables, level of measurement, value, and related questions

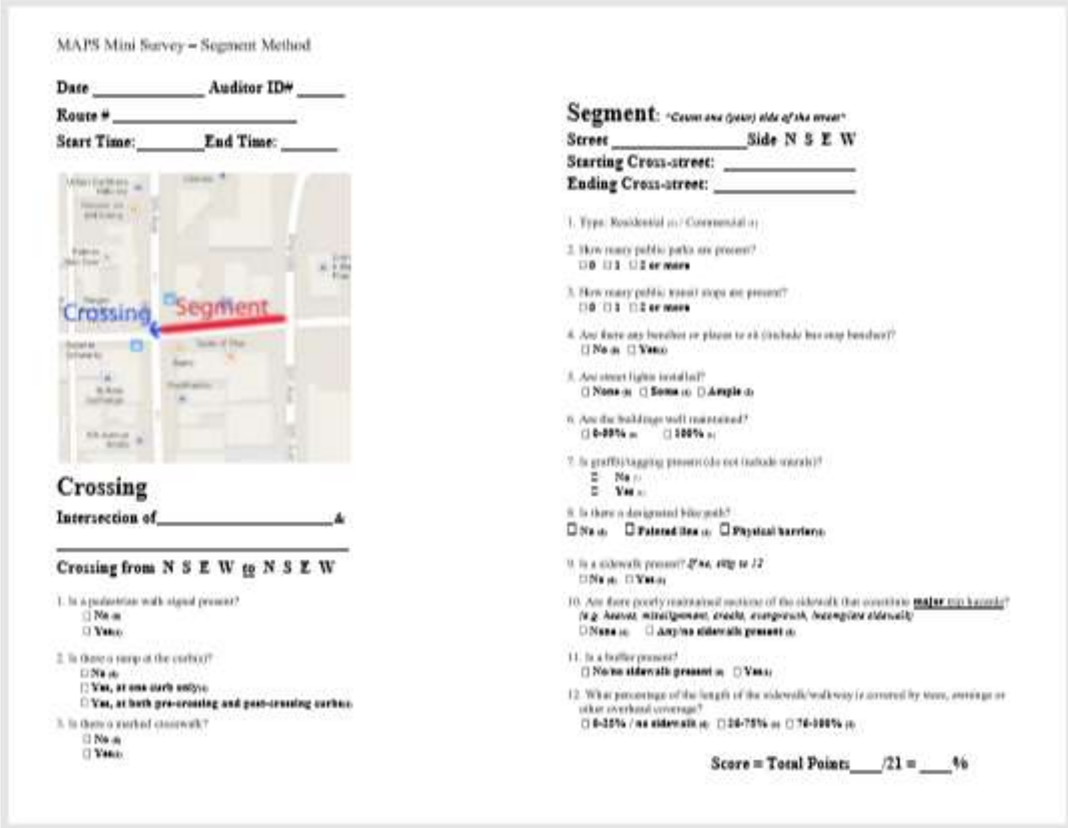
Variables	**Type of variable**	**Level of measurement**	**Value**	**Related Question**
School travel behaviour	Dependent			
- To school in winter - From school in winter - To school in summer - From school in summer		Nominal	1= Walk 2= Cycle 3= School Bus 4=Private Vehicle 5=Public Transport	Q4,Q5,Q6,Q7
Trip Characteristics	Independent			
Distance		Nominal	1= 0 - 0.5 km 2= 0.5 -1 km 3= 1- 1.5 km 4= 1.5 - 3 km 5= > 3km 6= not sure	Q1
Time length of the trip to school Time length of the trip from school		Nominal	1= < 5 min 2= 5 -10 min 3= 11- 20 min 4= > 20 min 5= Not sure	Q8,Q9
CIM	Independent			
Grade at which child is allowed to travel actively without an adult		Scale	Grade	Q2
The child is allowed to walk or cycle with older siblings or other children		Nominal	1= Yes 2 = No	Q3
Influencing factors	Independent			
Factors influencing the school travel mode choices		Nominal	1= Distance 2= Length of trip 3=Street connectivity 4=Traffic-calming aids 5=Pedestrian infrastructure 6=Cycling infrastructure 7=Landscaping 8=Accompanying adult 9=School-bag weight 10= Weather	Q10
Changes to shift to active travel mode (in case the child is not actively travelling to school)		Nominal	1=Traffic-calming aids 2=Pedestrian infrastructure 3=Cycling infrastructure 4= Landscaping 5= Distance	Q11 (optional)

Parent Perception of the built environment	Independent			Q12
Sidewalks are wide enough Sidewalks are continuous Sidewalks are in good condition Crosswalks are clearly marked Crossing signals/guards Traffic calming measures Speed limit signs Trees for shading Beautiful natural things to look at		Nominal	1= Yes 2= No	A B C D E F G H I
Parentperception/culture of AST	Independent			
- Built environment encourage/discourage AST - Walking/cycling to school is healthy - AST reduces traffic congestion and pollution - AST builds active community and creates safer streets		Ordinal	1= Strongly agree 2= Agree 3= Neutral 4= Disagree 5=Strongly disagree	A B C D

Appendix D Qualitative Survey: Built Environment Observation

The observational survey in this study intended to assess the situation around school entrances and roads servicing the school in the environment, which has the highest AST percentage, based on the quantitative survey results. The Microscale Audit of Pedestrian Streetscapes (MAPS) collects audit data on neighbourhood walkability and pedestrian environment (Sallis et al. 2015). reported that. It has three versions that differ in the level of complexity, including the MAPS-Full (120 items), MAPS Abbreviated (60 items), and MAPS-Mini (15 items). This study intended to adapt an observation audit tool from the MAPS- Mini tool and to use the percentage score in Figure C1. Also, the study was designed to use remote observation tools, such as Google Earth and Google Streetview maps, and a camera. The audit included the following built environment micro-scale variables in the school zone.

- Pedestrian crossings
- Speed limit signs
- Traffic calming measures
- Cycling Lanes
- Intersections
- Sidewalks


MAPS Mini Survey – Segment Method

Date ____________ **Auditor ID#** _____
Route # ____________________
Start Time: _______ **End Time:** ______

Crossing

Intersection of ____________________ **&** ____________________

Crossing from N S E W to N S E W

1. Is a pedestrian walk signal present?
   - ☐ No
   - ☐ Yes
2. Is there a ramp at the curb(s)?
   - ☐ No
   - ☐ Yes, at one curb only
   - ☐ Yes, at both pre-crossing and post-crossing curbs
3. Is there a marked crosswalk?
   - ☐ No
   - ☐ Yes

Segment: *Count one (your) side of the street*

Street ________________ **Side N S E W**
Starting Cross-street: ______________
Ending Cross-street: ______________

1. Type: Residential / Commercial
2. How many public parks are present?
   ☐ 0 ☐ 1 ☐ 2 or more
3. How many public transit stops are present?
   ☐ 0 ☐ 1 ☐ 2 or more
4. Are there any benches or places to sit (include bus stop benches)?
   ☐ No ☐ Yes
5. Are street lights installed?
   ☐ None ☐ Some ☐ Ample
6. Are the buildings well maintained?
   ☐ 0-99% ☐ 100%
7. Is graffiti/tagging present (do not include murals)?
   ☐ No
   ☐ Yes
8. Is there a designated bike path?
   ☐ No ☐ Painted line ☐ Physical barrier
9. Is a sidewalk present? *If no, skip to 12*
   ☐ No ☐ Yes
10. Are there poorly maintained sections of the sidewalk that constitute **major** trip hazards?
    (e.g. heaves, misalignment, cracks, overgrowth, incomplete sidewalk)
    ☐ None ☐ Any/no sidewalk present
11. Is a buffer present?
    ☐ No/no sidewalk present ☐ Yes
12. What percentage of the length of the sidewalk/walkway is covered by trees, awnings or other overhead coverage?
    ☐ 0-25% / no sidewalk ☐ 26-75% ☐ 76-100%

Score = Total Points ____/21 = ____%

Figure C1 Microscale Audit of Pedestrian Streetscapes (MAPS-Mini)

Figure C1 MAPS-Mini %Score

Figure C3 built environment micro-scale variables in the school zone.

Appendix E The correlation between school-bag weight and school travel mode

The trip to/from school in winter

A chi-square test for association was conducted between travel to/from school mode in winter and the school-bag weight effect on the decision to allow or not allow active travel to school. There was a statistically **significant association** between travel to school in winter and the school bag weight effect on the decision to allow or not allow active travel to school, there was a **moderately strong association** between the two variables

Likewise, there was a statistically **significant association** between travel from school in winter and the school-bag weight effect on the decision to allow or not allow active travel to school. There was a **moderately strong association** between the two variables.

Table E1 Active and Inactive travel to/from school in winter * school-bag weight Cross-tabulation

Travel mode Active/Inactive		To school in winter			From school in winter		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	15	60	75	15	64	79
	% within School bag weight effect on decision to allow or not active travel to school	8.8%	25.3%	18.4%	8.8%	27.0%	19.4%
Inactive Travel	Count	156	177	333	156	173	329
	% within School bag weight effect on decision to allow or not active travel to school	91.2%	74.7%	81.6%	91.2%	73.0%	80.6%
	Total Count (Active +Inactive)	171	237	408	171	237	408

Table E2 Chi-Square Test Statistics (to/from school in winter)

	To school in winter			From school in winter		
	Value	**df**	**Significance**	**Value**	**df**	**Significance**
Pearson Chi-Square	18.122	1	.000	21.148	1	.000
Cramer's V	.211			.228		
N of Valid Cases	408			408		

The trip to/from school in summer

A chi-square test for association was conducted between summer travel to/from school mode and the school-bag weight effect on the decision to allow or not allow active travel to school. There was a statistically **significant association** between travel to school in summer and the school bag weight effect on the decision to allow or not allow active travel to school, and there was a **weak association** between the two variables

Likewise, there was a statistically **significant association** between travel from school in summer and the school-bag weight effect on the decision to allow or not allow active travel to school. There was a **moderately strong association** between the two variables.

Table E3 Active and Inactive travel to/from school in summer* school-bag weight Cross-tabulation

Travel mode Active/Inactive		**To school in summer**			**From school in summer**		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
Active travel	Count	15	60	75	15	64	79
	% within School bag weight effect on decision to allow or not active travel to school	8.8%	25.3%	18.4%	8.8%	27.0%	19.4%
Inactive Travel	Count	156	177	333	156	173	329
	% within School bag weight effect on decision to allow or not active travel to school	91.2%	74.7%	81.6%	91.2%	73.0%	80.6%
	Total Count (Active +Inactive)	171	237	408	171	237	408

Table E4 Chi-Square Test Statistics (to/from school in summer)

	To school in summer			**From school in summer**		
	Value	**df**	**Significance**	**Value**	**df**	**Significance**
Pearson Chi-Square	12.667	1	.000	22.199	1	.000
Cramer's V	.176			.233		
N of Valid Cases	408			408		