Children' s active trips to school: a review and analysis

Rojas Lopez, Maria Cecilia; Wong, Yiik Diew

2016

Rojas Lopez, M. C., & Wong, Y. D. (2016). Children' s active trips to school: a review and analysis. *International Journal of Urban Sustainable Development*, 9(1), 79-95.

<https://hdl.handle.net/10356/84684>

<https://doi.org/10.1080/19463138.2016.1264405>

© 2016 Informa UK Limited. This is the author created version of a work that has been peer reviewed and accepted for publication by *International Journal of Urban Sustainable Development*, Informa UK Limited. It incorporates referee' s comments but changes resulting from the publishing process, such as copyediting, structural formatting, may not be reflected in this document. The published version is available at:
[<http://dx.doi.org/10.1080/19463138.2016.1264405>].

Downloaded on 26 Apr 2023 17:39:15 SGT

Children's active trips to school: a review and analysis

Rojas Lopez, M. C. & Wong, Y. D. – Centre for Infrastructure Systems, School of Civil and Environmental Engineering, Nanyang Technological University, Singapore

To cite this article: M. C. Rojas Lopez & Y. D. Wong (2016): Children's active trips to school: a review and analysis, International Journal of Urban Sustainable Development, DOI: 10.1080/19463138.2016.1264405.

To link to this article: <http://dx.doi.org/10.1080/19463138.2016.1264405>

Abstract

This paper provides a review of academic articles in English and some in Spanish, concerning active trips (walking and cycling) to school. It was found that decision on transport mode to travel to school can be rather complex, which is affected by environmental, social, economic, and geographical factors. Experiences from existing programmes and policies highlight the importance of complementing engineering approaches with education to increase active trips and to improve safety. "Proactive trips" programmes should consider parental concerns and time constraints. Active trips provide benefits for children and parents, yet an attendant risk of being involved in traffic accident exists. There is a notable dearth of research into children's active trips to school (ATS) for tropical environments, and analysis of the economic impact of ATS is minimal. Practices highlighted in this paper can be implemented in countries with conducive active trips infrastructure such as Singapore.

Keywords: Children, active mobility, non-motorised transport, trips to school, influencing factors

1. Introduction

In line with the growing research interest in sustainability and "green" transport modes, authorities, researchers and planners have, in recent years, started to focus on non-motorised transport or active mobility, mainly walking and cycling. Children's mobility recently gained popularity in many fields of studies, for example, medical, social science and engineering disciplines, and increasing number of research articles has been published in this regard. Trips to/from school are part of most children's daily activity. Thus, many researchers choose these trips to analyse children's active trips characteristics, determine factors that affect children's mobility, and develop policies and/or programmes that encourage walking and/or cycling among children

(Morency and Demers, 2010; Stanley et al., 2015). Given that trips TO school are more routine, that is, less variation and follows an approximately common commuting time, they are more often analysed than trips FROM school (Hume et al., 2009b; McMillan, 2007; Yeung et al., 2008).

Trips to school have undergone changes. Around three decades ago, most children commuted to school on foot or by bicycle. However, in recent years, walking and cycling have been overtaken by motorised transport modes. Child(ren) being driven to school engenders inactivity and contributes to traffic congestion, especially in the AM peak hour (Carver et al., 2013a; McDonald and Aalborg, 2009). To address the situation, ways to “revive” active trips to school (ATS) are being analysed (Buliung et al., 2011). Influences of different factors upon school mode choice have been much studied (Bringolf-Isler et al., 2008; Larsen et al., 2009; Mitra et al., 2010). Impacts of trips to school on physical health have also been examined, with walking and cycling trips being the most common trips studied (Mitra and Buliung, 2015; Stanley et al., 2015).

The current paper presents a comprehensive review of the available literature (mostly in English language domain, with some in Spanish) on children’s ATS. Following Mitra’s framework, the paper helps to gain insights into the main issues that affect ATS, highlights best practices, forestalls the potential of value-add areas for future research. In addition, aspects that affect children’s ATS that are specific to certain geographical areas are also indicated. Three main areas were considered and compared for the review:

- (1) Factors that exert influence on children’s ATS;
- (2) Policies and programmes that encourage/facilitate ATS; and
- (3) Benefits and risks of walking and/or cycling to school.

Following this introduction, the methodology for gathering “trips to school literature database” is elaborated and the most common areas covered by researchers are presented (Section 2). In Section 3, key frameworks previously formulated to analyse children’s trips to school are introduced. Afterwards, environmental factors influencing ATS discussed in the literature are presented (Section 4), followed by social and economic factors (Section 5). Then, most relevant external factors are discussed (Section 6). Finally, the current review concludes with gaps found in the literature, highlighting the niches for future research with discussion on ways to address them.

2. Data Retrieving Method

To gather a comprehensive database, available articles regarding children's trips to school were collected. An online search was carried on "Scopus" platform. Scopus is a major database for different types of literature, and it covers international journals for most disciplines (Elsevier, 2011). In addition, "Google Scholar" was selected to collect additional publications, for example, references cited in core papers, pertaining to areas covered in this review study. The first online search was conducted using the following keywords: "child* AND trips to school AND travel to school OR journey to school". Using Scopus' default search settings, "article titles, abstracts and/or keywords" were considered (Stanford, 2014). All types of documents either in English (97%) or Spanish (3%) were considered for this study. On October 2016, a final search (using the same keywords) was performed to include recently published literature relevant to the areas of interest as indexed up to October 2016. All relevant articles were included in the review.

A total of 188 documents (in English and Spanish) were obtained, of which, 80% (150) are journals articles and 7% (14) are conference papers. The remaining documents are review papers, book chapters, or articles in the mass media. Retrieved documents date from 1968 to present. The topic has received more attention primarily in the past 10 years; hence, most documents (88%) date from 2005 onwards. All retrieved documents were analysed. Abstracts were reviewed and 107 articles were found to contain information somewhat relevant to the areas of interest. From the 107 reviewed articles, 78 considered "children's ATS" (with oldest from 2003). Relevant references within the core articles were retrieved and most relevant ones were also included in the analysis. Figure 1 shows the articles' eligibility criteria, and articles analysed by publication year and continent where the studies were conducted.

Trips to school are a multidisciplinary subject studied from different angles, including transport, environment, and health. While the subject matters are somewhat interrelated, the approach taken by researchers differs. From the core articles ($n=78$), the majority (64%) analysed environmental, demographic and social factors that affect children's trips to school. The second most commonly analysed topic was the health impact of ATS (17%), followed by policies and/or programmes that promote ATS (13%). Other included articles analysed less common topics, such as independent mobility to school and economic impact of ATS. Taking into consideration the geographical area of study of the available literature ($n=78$, Figure 1), almost 60% studied trips to school characteristics and trends in America (especially the United States US and Canada), followed

by Oceania (especially New Zealand and Australia) and Europe at 17% each. Very few studies analysed ATS in Asia or Africa.

<< Insert **Figure 1.** Eligibility criteria and articles reviewed per year around here>>

3. Trips to School Analysis Frameworks

Children's travelling characteristics are, most of the time, shaped by the features of the place where they live, self and/or parents'/guardians' perceptions about these places, and social conditions (Booth et al., 2007; Carver et al., 2014; He and Giuliano, 2015; Pont et al., 2013). To explain relationship among factors, models and frameworks have been presented. Many have been used to analyse trips to school (McMillan, 2005; Mitra, 2012; Panter et al., 2008; Pont et al., 2011). Some of the most relevant ones are: (1) the social-ecological (or human-ecological) model, (2) the McMillan framework, (3) the ecological and cognitive active commuting (ECAC) framework, (4) the model of children's active travel (M-CAT), and (5) the Mitra's framework (Mitra, 2012; Pont et al., 2011; Sirard and Slater, 2008). Frameworks are not completely independent on each other. They usually built upon previous models by adding/improving specific areas. Figure 2 presents a broad outline of these frameworks which are described as follows.

- (1) The social-ecological model considers how the environment (social and physical) interacts with personal attitudes towards an activity. The model has been used to analyse trips in general and some have applied it to study ATS. Personal characteristics, social interactions, the built environment, and policymaking factors are considered as layers, one affecting the other and altogether affecting children's active trips (Christiansen et al., 2014; Sirard and Slater, 2008; Timperio et al., 2004). Some factors act as mediators (variable that links cause and effect) and others as moderators (variable that modifies causal effect) (Christiansen et al., 2014; Wu and Zumbo, 2008).
- (2) Later on, McMillan (2005) proposed a similar framework built specifically for trips to school. According to her model, parents have an important role in the decision about their child(ren)'s trip to school mode, especially parents of younger children. Their decision is mainly influenced by the urban form, as well as the mediators (real and perceived traffic, personal safety, and transportation options) and moderators (social characteristics, attitudes towards different modes, and socio-demographics) (McMillan, 2005).

- (3) By fusing factors of the afore-mentioned frameworks, and including the social-cognition theory, the ECAC framework was developed. This framework asserts that socio-demographic factors of all household members strongly affect the parents' decision of allowing the use of active modes to commute to school. Thus, these are considered after the effect of all other variables has been studied (Sirard and Slater, 2008).
- (4) The M-CAT model proposed in 2011 highlights the complexity regarding child(ren)'s engagement in walking and cycling. It includes social, environmental, personal, familial, and individual (parents' and child(ren)'s perceptions) factors (Pont et al., 2013, 2011). This model has specific applications to plan alternatives to promote active mobility to school.
- (5) The most recently formulated framework is the behavioural model of school transportation or Mitra's-framework. It explains how the built environment, household characteristics and household members' interaction, and transport policies have a multilevel influence in trips to school (Mitra, 2012). In addition, the model asserts that parents/guardians allow child(ren) escorted or independent school trips based on children capabilities (physical and cognitive), household activities, and transport options (Mitra, 2012).

Mitra's framework presents a holistic overview of children's mobility to school (based particularly in the North-American context). The current research is guided by Mitra's framework to reaffirm the common factors affecting trips to school and identify specific factors that impact ATS. Influences of the environment – built, perceived, and natural (weather) are discussed first. Then, this review presents a sum of the social and economic factors influencing ATS at child(ren) and household level. Afterwards, external factors, such as policies and programmes are presented. Finally, gaps in the current literature are highlighted for future research.

<<Insert **Figure 2.** Frameworks to analyse active trips to school (Christiansen et al., 2014; McMillan, 2005; Mitra, 2012; Pont et al., 2013; Sirard and Slater, 2008; Timperio et al., 2004) around here>>

4. Environmental Factors Influencing ATS

Most researchers agree that the predominant factor affecting trips to school is **distance** from residence to school (Carver et al., 2013b; Ermagun and Samimi, 2015; Hume et al., 2009a, 2009b; McDonald, 2008a; Schlossberg et al., 2006). Regardless of child(ren)'s age, short distances from home to school favours walking and cycling (Lang et al., 2011; McDonald, 2008a; Oliver et al., 2014; Panter et al., 2008; Schlossberg et al., 2006). In many countries, most walking trips to school are

made by children living within 1—1.6 km from school (Christiansen et al., 2014; Heelan et al., 2005; Pojani and Boussauw, 2014; Villa González et al., 2011). For cycling, researchers note that children travel slightly longer distance to school than those who walk. Yet, an average distance is yet to be established (de Vries et al., 2010; Larouche et al., 2013). It is also reported that, in general, the active trip's distance increases as child(ren) get older (Morency and Demers, 2010).

With the nascence of '*school-sprawl*' schools are built away from residential areas (McDonald, 2007a; Schlossberg et al., 2005). As a result, children live further away from school (McDonald, 2007a; Panter et al., 2008; Yang et al., 2016). This phenomenon has been reported to occur mostly in America, where schools are built away from the centre of the community. At these locations, wider and cheaper lands are available, which allows schools to have larger campuses (Schlossberg et al., 2005). Larger campuses can provide better facilities, including sport fields and cater for more students. Political issues are also involved in establishment of larger school campuses; however, these are out of the scope of this paper. To engage child(ren) active mobility regardless of school-sprawl, researchers recommend that parents could drop-off children at a "walkable" distance from school so that they can complete the trip using active modes (Larouche et al., 2013). Such proactive policies as the Walking School Bus (WSB) will be discussed later.

The influence of ***levels of urbanisation*** on trips to school has been discussed from contradictory points of view. Urban (high urbanisation of residential and commercial land-use), suburban (mid-urbanisation), and in rural (low urbanisation) areas are the common classifications (Carver et al., 2013a, 2013b; Sirard et al., 2005a). Not much difference in ATS was reported between urban and suburban areas (Sirard et al., 2005a). More ATS were reported in urban and suburban areas than in rural areas (Bringolf-Isler et al., 2008; Kemperman and Timmermans, 2014; Sirard et al., 2005b; Yang et al., 2016). However, some studies reported more walking trips to school in rural areas (Larouche et al., 2014b). Two points affecting trips to school in rural areas are: (1) child(ren) live far from school limiting their choice of walking or cycling; and (2) limited choice in transport modes result in child(ren) using the same mode daily (Carver et al., 2013b; Larouche et al., 2014b; Noland et al., 2014). In many cases, virtually all students in rural areas who live near to school (which is a longer distance in rural than urban and suburban areas) commute by active modes (Larouche et al., 2014b).

Regarding accessibility and connectivity, some have reported a positive association between these variables and trips on foot or by bicycle (Noland et al., 2014; Wong et al., 2011; Yang et al., 2012).

Accessibility (for example, pedestrian and cyclist infrastructure, roads, distance, etc.) exerts influence on adult walking behaviour (Koh and Wong, 2013; McMillan, 2005; Mitra et al., 2010; Schlossberg et al., 2006), yet research is limited on children's mobility. Accessible neighbourhoods seem to have a positive relation with walking/cycling among children (Christiansen et al., 2014; de Sá et al., 2015a; Ewing et al., 2004; Yang et al., 2012). Especially in high income economies, parents prefer high walkability levels in promoting ATS (Christiansen et al., 2014; Oliver et al., 2014; Pojani and Boussauw, 2014). Studies have also noted the positive influence of **connectivity** (paths connecting child's home and school) on ATS (Noland et al., 2014; Oliver et al., 2014; Wong et al., 2011; Yang et al., 2016). Nonetheless, other reported that connectivity is associated with reduced ATS (Helbich et al., 2016; Mitra et al., 2010; Sirard and Slater, 2008; Timperio et al., 2006), mostly because well-connected layouts attract motorised traffic thereby increasing traffic-safety concerns (Helbich et al., 2016).

It must be noted that parents' and child(ren)'s **perception** towards accessibility and connectivity is influenced by preferences (Hume et al., 2009a; Yang et al., 2012). Perception might differ from actual operating conditions. Researchers have found that a more positive perception can increase the number of ATS regardless of the actual operating conditions (DeWeese et al., 2013; Veitch et al., 2012; Zuniga, 2012). For child(ren) who already make ATS, their or their parents' perception towards accessibility and connectivity affects the roads/paths taken to commute to school (McMillan, 2007).

Moreover, ATS are affected by **traffic-safety** and **personal-safety**. The former refers to traffic accident exposure and the latter to risks related to crime or violence (Lavoie et al., 2014; Pont et al., 2011) (see Figure 3). As for accessibility and connectivity, safety perception of the environment also plays an important role in ATS (Boarnet et al., 2005; DeWeese et al., 2013; Potoglou and Arslangulova, 2016; Timperio et al., 2004). In most cases, positive safety perception, that is, few traffic accidents, low crime rate, and absence of stranger-danger (harassment, bullying), prompts parents to allow/encourage ATS (Al-Homoud and Al-Oun, 2009; Faulkner et al., 2010; Trapp et al., 2011). Contradictorily, some parents who chauffeur child(ren) to school do it because of traffic-safety concerns (Buliung et al., 2011; Carver et al., 2013a; Lang et al., 2011), thereby themselves contributing to traffic accident exposure (see Figure 3). Safety concerns are more common among parents of younger children, that is, 5-11 years (McDonald, 2008b), and of girls (Al-Homoud and Al-Oun, 2009; Yang et al., 2012). Commonly, parents have lower perception of safety levels than

actual conditions and child(ren) have more positive perception of safety in their neighbourhoods than their parents (Faulkner et al., 2010; McMillan, 2007; Timperio et al., 2004).

Increased motorised traffic has been related to higher accident risk exposure (Merom et al., 2006; Yeung et al., 2008). Children are inexperienced road users with distinctive task and physical capabilities (slow walking speed, low eye-sight level, and short attention periods). Thus, they are considered at higher risk than their parents or caregivers, that is, adults. When comparing trips to/from school with other accident scenarios, some have found that the school trips post less risk to children as pedestrians or cyclists (Boarnet et al., 2005; Schofield et al., 2008; Wong et al., 2011). Cycling to school is considered riskier than walking (Schofield et al., 2008; Trapp et al., 2011), mainly due to low cycling proficiency of children, higher travelling speed, and higher interaction with motorised traffic. Indeed, cycling accidents, not necessarily while travelling to school, are a common cause of children's physical injury (Briem et al., 2004; Pucher and Buehler, 2008; Trapp et al., 2011).

<< Insert **Figure 3**. Safety perception and accident exposure around here>>

Finally, regarding **weather**, although it has been cited as a barrier for walking and cycling, no actual relationship has been established between weather conditions and walking trips to school (Oliver et al., 2014; Sirard et al., 2005a). Even in countries with very low temperatures (below zero, for example, Canada and Norway), the distance between home and school, and trips' habits are found to be more closely associated with ATS than weather conditions (Børrestad et al., 2011; Faulkner et al., 2010; Mitra and Faulkner, 2012). Nevertheless, cycling to school is affected by snow. To remove snow from streets and bicycle lanes takes time and child(ren) would prefer (or be advised) to choose other modes to go to school than bicycle (Børrestad et al., 2011). Hardly any tropical country reported weather influences on ATS. Indeed, only a few tropical countries (for example, Singapore) have reported mobility patterns in general. This area is of special interest since the hot, humid, and rainy weather of these countries affects users' willingness to commute by walking or cycling (Meng et al., 2016).

5. Social and Economic Factors Influencing ATS

Society plays a big role in mobility. Studies have reported that higher levels of **social-cohesion** induce parents to perceive a safer environment and thus increases the likelihood of allowing their child(ren) to actively commute to school (Kemperman and Timmermans, 2014; McDonald, 2007b;

Mitra, 2012). In addition, parents and their son's and daughter's perception of other children in the neighbourhood has been shown to increase the odds of ATS (Bringolf-Isler et al., 2008; Hume et al., 2009a; Timperio et al., 2006). Girls in particular prefer to commute to school in company of others (Mikkelsen and Christensen, 2009). It has been hypothesised that the reason for this is gender socialisation and tendency of girls' aversion of "vulnerability feeling" (Mikkelsen and Christensen, 2009).

Mixed results are found regarding the influence of **child(ren)'s age and gender** on ATS. Twelve of the reviewed articles specifically considered age and gender influence on ATS (Bringolf-Isler et al., 2008; Cooper et al., 2003a; Deka, 2013; Hume et al., 2009c; Larsen et al., 2009; McDonald, 2012, 2008b; Merom et al., 2006; Mitra and Buliung, 2015; Noland et al., 2014; Potoglou and Arslangulova, 2016; Trapp et al., 2011). In general, as shown in Figure 4, it has been commonly reported that older male children are more likely to actively commute to school and also to do it independently. The reasons for these high or low ATS may not be age itself, but distance to school, car ownership, and accessibility to public transport (Deka, 2013; Elias, 2015; Morency and Demers, 2010). Regarding gender, the previously mentioned gender socialisation has also been hypothesised as the reason for fewer and less independent active trips among girls (McDonald, 2012; Merom et al., 2006; Noland et al., 2014).

<<Insert **Figure 4.** Age and gender influence on trips to school around here>>

Different influence about household characteristics has also been presented in the literature. Some reported that the higher number of siblings, the more common the ATS (Deka, 2013; McDonald, 2008b). This is because children travelling together increases parents' confidence in allowing ATS. In contradiction, others suggested that ATS decrease as the number of siblings increases since parents apply "economy of scales" in chauffeuring them to school (McMillan, 2007; Yarlagadda and Srinivasan, 2008). Yet, other researchers did not find any correlation between number of siblings and mode taken to school (Pojani and Boussauw, 2014; Potoglou and Arslangulova, 2016).

Moreover, some researchers have found **adult-availability** to be inversely associated with child(ren)'s ATS and public transport usage to/from school (Carver et al., 2013a; Mitra and Buliung, 2015). In other words, adults with "free time" were found to be likely to chauffeur child(ren) to/from school. It has also been found that parents who commute to work by private transport in the morning commonly drive their child(ren) to school "on their way" (Deka, 2013; McDonald,

2008b; McDonald and Aalborg, 2009; Park et al., 2013; Schlossberg et al., 2006; Wen et al., 2008). However, other researchers have suggested that allowing parents flexible hours, that is, eliminating the “rush” to work/increasing morning “free time”, can reduce the number of children being driven to school and thus increases ATS (Faulkner et al., 2010; Larsen et al., 2012, 2009; Wen et al., 2008).

Attitudes towards walking and cycling in general have also been found to affect ATS (Bringolf-Isler et al., 2008; Rodríguez-López et al., 2013; Zuniga, 2012). Parents’ attitude can be positive, negative, supportive, and/or protective (Bringolf-Isler et al., 2008; Pojani and Boussauw, 2014; Yeung et al., 2008). Attitudes, as well as the earlier mentioned factors, need to be taken into consideration when designing policies and programmes aimed at increasing ATS and/or ensuring children’s safe trips from home to school.

Car ownership, which is related to **household income (HI)** (He and Giuliano, 2015; Yarlagadda and Srinivasan, 2008), is widely mentioned as a factor affecting ATS. Researchers explained that high HI and availability of a car in the household decrease the likelihood of ATS (McDonald, 2008c; Oliver et al., 2014; Pont et al., 2009; Villa González et al., 2011). Interestingly, only one study, from the Netherlands, attempted to analyse association between children’s **bicycle ownership** and participation in ATS (Kemperman and Timmermans, 2014). In that study, 96% of the children owned a bicycle and the ATS rate was at 63% (36% cycling and 27% walking). Yet, results cannot be generalised given the pervasive “cycling-centric culture” in the Netherlands (Heinen et al., 2010).

Walking and cycling are virtually free modes of transport (Pucher and Buehler, 2008; Waller, 2005). Yet not much research exists about the actual economic benefit of ATS, individually or to the society. One research explained that, in the US, by remedying hazardous traffic situations, policies such as hazard bussing (when school provides bus service even for short distance because the environment to walk to school is unsafe) can be reviewed. By reducing bussing demand, the cost of 100—500 million US\$ in such transport per year can be reduced (McDonald et al., 2014). Hazards elimination provides economic benefits to the community, and attendant shift to free transport modes reduces travel cost of individuals. The research study affirmed that if after hazards remediation, parents still choose to drive their child(ren) to school, transportation costs shall be reduced for the community but increased for families (McDonald et al., 2014).

6. External Factors Influencing ATS – Programmes and Policies

It has been highlighted by researchers that most schools face a high amount of motorised traffic and congestion when children arrive (usually morning) and leave (usually afternoon) the school (Ermagun and Samimi, 2015; Lang et al., 2011; McMillan, 2007). Increasing the number of ATS entails a reduction in motorised traffic. Such reduction alleviates traffic congestion and its associated negativities, such as environmental air and noise pollution and accident exposure at school zones (SZs) (Yeung et al., 2008). Policies that advocate to promote ATS have been suggested to reduce motorised traffic (therefore emissions) at SZs.

Planners, authorities, and schools themselves have developed and implemented programmes and policies to entice children to walk and/or cycle to school and elevate levels of safety for children in the trips to/from school (Buliung et al., 2009; Hume et al., 2009b; McDonald, 2007a; McMillan, 2007). Based on the literature, there are three main schemes that affect ATS: (1) Safe Routes to School (SRTS or SR2S); (2) The WSB; and (3) school-siting policies. Interestingly, most of these have been mostly applied in Europe, North America, and Oceania (Boarnet et al., 2003; de Sá et al., 2015b; McDonald et al., 2011; Smith et al., 2015) and virtually none in tropical or Asian countries. This highlights another gap in the ATS research area. At tropical and Asian countries, not only the weather is different from other countries (hot and humid weather that can be seen as a constraint to implement such programmes), but there exists quite different household and societal composition, and activities scheduling. Such factors must be taken into consideration in developing empirical research on ATS in tropical and/or Asian countries.

The **SRTS programme** gained popularity in the last two decades (SafeRoutes, 2015). Some countries have implemented it as a national health/wellness programme to increase children's physical activity (Fyhri et al., 2011; Hendricks et al., 2009). Others as a transport measure to improve traffic situation outside schools (Boarnet et al., 2005; Ermagun and Samimi, 2015; McDonald and Aalborg, 2009; McMillan, 2007). Allocation of funds to specific SRTS features also varies. Some allocate more money on improving the environment around schools, while others (for example, schools with conducive walking/cycling environment) choose to focus on different features (Boarnet et al., 2005; McDonald et al., 2013; Morency and Demers, 2010). These differences have relationship with each school "needs" for the success of the programme. Most SRTS have yielded positive results, especially in increasing ATS (thus physical activity). Better social interaction, economic benefits, and higher safety levels have also been registered (de Sá et al., 2015a; Fyhri et al., 2011; McDonald,

2007a; McDonald et al., 2014, 2013). However, whether these benefits are a direct or indirect impact of SRTS is yet to be evaluated.

SRTS programmes are commonly developed using the 5Es approach (engineering, education, encouragement, enforcement, and evaluation) (Boarnet et al., 2005; Elias, 2015; McDonald et al., 2014). This is important because research shows that engineering improvements alone, while necessary, are not sufficient to increase walking or cycling (Boarnet et al., 2005; McDonald, 2008b; McDonald and Aalborg, 2009; McMillan, 2007). Improvements are complemented with users' education in traffic-safety behaviour, encouragement to participate in the programme, and enforcement to ensure compliance with recommendations (Deka, 2013; Park et al., 2013). When evaluating SRTS, its overall efficiency in increasing ATS is analysed. Some combinations of the approaches, for example, engineering + education, are considered (McDonald et al., 2013).

Moreover, the **WSB** entails students meeting at a designated point and from there walk to school with adult supervision (McDonald, 2012). This addresses parental time constraint that involves them walking their child(ren) part-way to school (parents do not need to walk or cycle all the way to school everyday) and concerns about independent travel (Fyhri et al., 2011; McDonald, 2008b; McDonald and Aalborg, 2009). Overall, the WSB has shown success in increasing ATS rates (Kingham and Ussher, 2007; Park et al., 2013; Wen et al., 2008). Besides encouraging child(ren) "independent" active mobility, WSB also increases levels of interaction with other children and the environment (Kingham and Ussher, 2007; Sidharthan et al., 2011; Smith et al., 2015). Some limitations of the WSB are recruitment of adult companion volunteer (parents or other members of the society) and encouraging children to participate in such programme (Mackett et al., 2003; Smith et al., 2015).

To measure feasibility of implementing and maintaining the WSB, it has been suggested that pre, during, and post-WSB data be collected from school members, children, parents, and volunteers (Mackett et al., 2003). Geographical differences also need to be considered. "Social geography" (income level, political characteristics, etc.) was found to have correlation with effectiveness of the programme. Research pointed that children from neighbourhoods with high economic income are more likely to take part in the programme (Collins and Kearns, 2010; Lang et al., 2011). "Environmental-geography" (landscape, weather, etc.) effects on the WSB are yet to be studied in depth.

Other policies affecting ATS are ***school-siting*** or ***school-assignment policies*** that define catchment areas of schools (McDonald, 2007b; McDonald et al., 2011; Yang et al., 2012). Some countries allow for “school-choice” policy (child can attend any school, even if it is located outside the neighbourhood of his/her residence) while others advocate for “neighbourhood-only” policy (child attends a school within the neighbourhood of his/her residence). Well planned neighbourhood-only policies can help to reduce the travel distance to school, which increase ATS, maximise the effects of SRTS (Sidharthan et al., 2011), and reduce transport cost and air pollutants (especially CO₂, CO) within the neighbourhood (Marshall et al., 2010; Yang et al., 2012). However, while reduced distance can be suitable for ATS (perceived or actual) unsafe transport characteristics within neighbourhoods can promote the use of motorised modes even for short distances.

Other factors besides mobility are also affected by school-siting policies. While some argue that neighbourhood-only policies provide students of different social levels with the same education, such policies can also cause racial aggregation, especially in countries where people of different demographics tend to cluster at specific neighbourhoods (McDonald et al., 2011; Yang et al., 2012). School-choice can affect unbiased access to education. Some argue that the policy favours child(ren) from high-income households, causing parents’ choice of school to be shifted to better schools regardless of their location (Boarnet et al., 2005; Marshall et al., 2010; Voss et al., 2015; Yang et al., 2012).

Additionally, although not widely considered, perceived and actual health benefits of ATS also exert influence on mode of transport taken to school and success rate of programmes and policies. In general, children who walk or cycle to school on a regular basis (3—5 times a week) are more physically active throughout the week (7 days), as compared to those who travel by car (Cooper et al., 2003b; Larouche et al., 2014a; Morency and Demers, 2010; Sirard et al., 2005b). ATS cause an increase in children’s moderate-vigorous physical activity (Chillon, 2008; Cooper et al., 2003b; Pizarro et al., 2013; Sirard et al., 2005b). Although minimal (around 10 min), this increase helps to reduce sedentary lifestyles and childhood obesity (Bere et al., 2011; Laguna Nieto et al., 2011; Pizarro et al., 2013; Sirard et al., 2005b). Emotional benefits of ATS have also been studied. ATS encourage social interaction among children and help them reach maturity by independent travel (Laguna Nieto et al., 2011; Yeung et al., 2008). Positive emotions were shown to be associated with active trips as well (Lambiase et al., 2010; Lewicka, 2005; Ramanathan et al., 2014), and as a result, a reduction in stress and cardiovascular reactivity can be achieved by increasing ATS (Lambiase et

al., 2010). Policies and programmes should consider making parents and children aware of such benefits. Such awareness may increase the percentage of children who actively commute to school.

7. Current Gaps and Discussion

After a careful review of most relevant academic articles, guided by the most recently proposed framework regarding ATS – Mitra's Framework, influences of environmental, social and economic, and external factors were highlighted. Two notable dearth of research into children's ATS were identified (see Figure 5). First it was found that there is minimal research about school trips in general (not only active trips) for tropical environments. Also, analysis of the economic impact of ATS is minimal and no specific analysis approach has been suggested. Alternatives to address found niche areas and overall findings are discussed next.

Most research has been developed by analysing school trips in North America, thus a gap exists in similar studies in the tropical countries in Africa and Asia. Future research shall focus on analysing ATS in these geographical areas, including factors such as economic income, societal composition and weather (hot, humid, and rainy) conditions, as these differ the most from European and American countries. Weather characteristics of tropical countries can deter people from walking and cycling. Thus there is a reduced chance of ATS among children. A comparison of trips to school across different continents shall help to shed light on "global" factors concerning trips to school as well as "localised" factors. By understanding these factors, suitable alternatives can be proposed and implemented to further increase the number of walking and cycling trips to school worldwide. Moreover, the reason why economic impact of ATS has not been widely studied could be the complexity of the issue and a holistic approach is needed. Transport, economic, social and even health concepts and evaluations need to be applied to evaluate the cost-effectiveness of walking and cycling and the implementation of different policies and programmes (Litman, 2009). Direct (money not spent in transport) and indirect savings (for example, medical expenses, reduced congestion) of ATS on households (and its' members), schools, and neighbourhoods need to be considered to estimate overall benefit of different alternatives (Litman, 2010; Speck, 2012). In addition, in order to fully weight the economic impact of ATS, the variation in transport demand during arriving/leaving (school peak period) and off-school periods should also be included in the economic analysis (Litman, 2010, 2009).

Different economic impacts of ATS are expected from different geographical areas of similar economic level (Speck, 2012). This is related to different usages of modes of transport in general (for example, High income countries: US – mainly private transport (McDonald et al., 2011), the Netherlands – mainly active modes (Dessing et al., 2014), Singapore – mainly public transport (SINGSTATS, 2011)). Such differences can be explained by cultural issues, weather and/or transport characteristics. Nevertheless, researchers studying ATS should follow a standard economic-analysis approach so that findings can be compared internationally.

<<Insert **Figure 5.** Gaps in the active trips to school literature around here>>

Regarding findings from the current review, distance is reaffirmed as the most influential factor affecting ATS. Children living within a range of 1–1.6km to school are more likely to walk or cycle to school. School-sprawl and level of urbanisation affect the school location, thereby affecting distance and mode taken to school. Perception plays an important role in ATS. An environment perceived to be accessible, safe, and secure is more conducive for walking and cycling. It has been noted that perception and actual operating conditions might be different and parents' perceptions are different from child(ren)'s.

Actual traffic-safety condition highlights that travelling situations other than ATS are riskier. Children travelling to school as cyclists are more vulnerable than those travelling as pedestrians. Increasing children cycling proficiency and encouraging safe cycling approaches, for example, proper crossing behaviour and traffic schemes to look out for traffic, can help to reduce traffic vulnerability when cycling. Although the use of helmets can reduce the severity of traffic accidents, the use of helmets among children travelling on bicycles has not been well studied (or reported).

Although inconsistent results were reported, most studies agree that older male children are more likely to make independent ATS. It is rationalised that maturity (physical and cognitive) and gender-socialisation contribute to such travelling differences. Moreover, parents' availability plays an important role in allowing child(ren) to walk or cycle to different locations, including schools.

Also, car availability has been consistently shown to be inversely related to the likelihood of walking or cycling to school. Children's bicycle availability, on the other hand, is yet to be investigated as a specific factor encouraging ATS. Bicycle ownership is related to high number of cycling trips in general. Thus, it is hypothesised that it will have impacts on trips to school.

Common distance suitable for active trips (1—1.6 km) has encouraged the promotion of well-planned “neighbourhood-only” school-siting policy. The policy can help to maximise the number of ATS and effectiveness of programmes such as SRTS. However, besides transport considerations, social and educational impacts of the “neighbourhood-only” school-siting policy need to be considered.

Regarding the SRTS, the programme focuses on enhancing safety by infrastructural modifications at SZs (if necessary), education of users, encouragement for participation, and enforcement of safe behaviour when travelling. The programme is focused on children and parents to increase ATS in general. Evaluated programmes have yielded positive results in increasing ATS (thus reducing traffic at SZs and increasing levels of safety). Yet, SRTS impacts on social interaction, economic benefits, and accident reduction are yet to be properly evaluated.

As discussed, the WSB addresses parental concerns about children independent travel and time constraints. By walking from designated locations to school with adult companions, children get the benefits of active mobility and also get to interact with other children and the environment. Benefits of the SRTS programme and the WSB are very appealing; however, these are not widely applied (or are not yet studied) in Asian and African countries. Reasons might include the costs needed for engineering modifications and the challenge in recruiting volunteers. Future research can focus on analysing the feasibility and benefits (social, personal, and economic) of this kind of schemes to promote ATS. Geographical differences need to be considered as well as these have shown to have influence in such programmes.

Health benefits of walking and cycling influence ATS and efficiency of discussed programmes and policies are not widely factored in. Besides increasing children’s levels of social interaction, physical and emotional health benefits can be derived from ATS.

Findings highlighted in this paper and presented gaps can be used by researchers in analysing children’s mobility and ATS benefits. These are also useful for planners and schools of different countries to develop children-friendly alternatives aimed to increase the number of walking and cycling trips to school and encourage a healthy lifestyle. Based on results and best practices, well-fitting programmes and policies can be implemented considering specific geographic characteristics. Special interest exists for countries that have an overall safe environment; already-

conductive walking/cycling infrastructure and well-trained professionals and technology access, such as the case of Singapore.

Acknowledgements

This study is conducted as part of first author's PhD research project; the research is supported by Singapore Ministry of Education Academic Research Fund Tier 2 MOE 2014-T2-2-097.

References

- Al-Homoud, M., Al-Oun, S., 2009. Jordan's Badia school location effects on the perception of child safety. *Plan. Pract. Res.* 24, 495–511.
- Bere, E., Oenema, A., Prins, R.G., Seiler, S., Brug, J., 2011. Longitudinal associations between cycling to school and weight status. *Int. J. Pediatr. Obes.* 6, 182–187.
- Boarnet, M.G., Anderson, C., Day, K., McMillan, T., Alfonzo, M., 2003. Safe routes to school. *Indiana State* 2.
- Boarnet, M.G., Day, K., Anderson, C., McMillan, T., Alfonzo, M., 2005. California's safe routes to school program: impacts on walking, bicycling, and pedestrian safety. *J. Am. Plan. Assoc.* 71, 301–317.
- Booth, M.L., Okely, A.D., Denney-Wilson, E., Hardy, L.L., Dobbins, T., Wen, L.-M., Rissel, C., 2007. Characteristics of travel to and from school among adolescents in NSW, Australia. *J. Paediatr. Child Health* 43, 755–761.
- Børrestad, L.A.B., Andersen, L.B., Bere, E., 2011. Seasonal and socio-demographic determinants of school commuting. *Prev. Med. (Baltim).* 52, 133–135.
- Briem, V., Radeborg, K., Salo, I., Bengtsson, H., 2004. Developmental aspects of children's behavior and safety while cycling. *J. Pediatr. Psychol.* 29, 369–377.
- Bringolf-Isler, B., Grize, L., Mäder, U., Ruch, N., Sennhauser, F.H., Braun-Fahrlander, C., 2008. Personal and environmental factors associated with active commuting to school in Switzerland. *Prev. Med. (Baltim).* 46, 67–73.
- Buliung, R., Faulkner, G., Beesley, T., Kennedy, J., 2011. School travel planning: mobilizing school and community resources to encourage active school transportation. *J. Sch. Health* 81, 704–712.

- Buliung, R.N., Mitra, R., Faulkner, G., 2009. Active school transportation in the Greater Toronto Area, Canada: an exploration of trends in space and time (1986–2006). *Prev. Med. (Baltim)*. 48, 507–512.
- Carver, A., Timperio, A., Crawford, D., 2013a. Parental chauffeurs: what drives their transport choice? *J. Transp. Geogr.* 26, 72–77.
- Carver, A., Veitch, J., Sahlqvist, S., Crawford, D., Hume, C., 2014. Active transport, independent mobility and territorial range among children residing in disadvantaged areas. *J. Transp. Heal.* 1, 267–273.
- Carver, A., Watson, B., Shaw, B., Hillman, M., 2013b. A comparison study of children’s independent mobility in England and Australia. *Child. Geogr.* 11, 461–475.
- Chillon, P., 2008. Importance of active commuting to school in the health of the Spanish schoolars. The AVENA study [Importancia del desplazamiento activo al colegio en la salud de los escolares españoles. Estudio AVENA]. *Deport. y Act. física para todos* 4, 94–101.
- Christiansen, L.B., Toftager, M., Schipperijn, J., Ersbøll, A.K., Giles-Corti, B., Troelsen, J., 2014. School site walkability and active school transport – association, mediation and moderation. *J. Transp. Geogr.* 34, 7–15.
- Collins, D., Kearns, R.A., 2010. Walking school buses in the Auckland region: A longitudinal assessment. *Transp. Policy* 17, 1–8.
- Cooper, A.R., Page, A.S., Foster, L.J., Qahwaji, D., 2003a. Commuting to school. Are children who walk more physically active? *Am. J. Prev. Med.* 25, 273–276.
- Cooper, A.R., Page, A.S., Foster, L.J., Qahwaji, D., 2003b. Commuting to school. Are children who walked more physically active? *Am. J. Prev. Med.* 25, 273–276.
- de Sá, T.H., Garcia, L.M.T., Mielke, G.I., Rabacow, F.M., De Rezende, L.F.M., 2015a. Changes in travel to school patterns among children and adolescents in the São Paulo Metropolitan Area, Brazil, 1997–2007. *J. Transp. Heal.* 2, 143–150.
- de Sá, T.H., Parra, D.C., Monteiro, C.A., 2015b. Impact of travel mode shift and trip distance on active and non-active transportation in the São Paulo Metropolitan Area in Brazil. *Prev. Med. Reports* 2, 183–188.

- de Vries, S.I., Hopman-Rock, M., Bakker, I., Hirasing, R.A., van Mechelen, W., 2010. Built environmental correlates of walking and cycling in Dutch urban children: results from the SPACE study. *Int. J. Environ. Res. Public Health* 7, 2309–2324.
- Deka, D., 2013. An explanation of the relationship between adults' work trip mode and children's school trip mode through the Heckman approach. *J. Transp. Geogr.* 31, 54–63.
- Dessing, D., de Vries, S.I., Graham, J.M., Pierik, F.H., 2014. Active transport between home and school assessed with GPS: a cross-sectional study among Dutch elementary school children. *BMC Public Health* 14, 227.
- DeWeese, R.S., Yedidia, M.J., Tulloch, D.L., Ohri-Vachaspati, P., 2013. Neighborhood perceptions and active school commuting in low-income cities. *Am. J. Prev. Med.* 45, 393–400.
- Elias, W., 2015. Children's independent mobility in Israel: Case study of the Arab population group, in: *Sustainable Urban Transport (Transport and Sustainability, Volume 7)*. Emerald Group Publishing Limited 7, pp. 65–91.
- Elsevier, 2011. About Scopus [WWW Document]. URL <https://www.elsevier.com/> (accessed 6.1.16).
- Ermagun, A., Samimi, A., 2015. Promoting active transportation modes in school trips. *Transp. Policy* 37, 203–211.
- Ewing, R., Schroeder, W., Greene, W., 2004. School location and student travel analysis of factors affecting mode choice. *Transp. Res. Rec. J. Transp. Res. Board* 1895, 55–63.
- Faulkner, G.E., Richichi, V., Buliung, R.N., Fusco, C., Moola, F., 2010. What's "quickest and easiest?": parental decision making about school trip mode. *Int. J. Behav. Nutr. Phys. Act.* 7, 62.
- Fyhri, A., Hjorthol, R., Mackett, R.L., Fotel, T.N., Kyttä, M., 2011. Children's active travel and independent mobility in four countries: development, social contributing trends and measures. *Transp. Policy* 18, 703–710.
- He, S.Y., Giuliano, G., 2015. Factors affecting children's journeys to school: a joint escort-mode choice model. *Transportation (Amst)*.
- Heelan, K. a., Donnelly, J.E., Jacobsen, D.J., Mayo, M.S., Washburn, R., Greene, L., 2005. Active commuting to and from school and BMI in elementary school children - preliminary data. *Child. Care. Health Dev.* 31, 341–349.

- Heinen, E., van Wee, B., Maat, K., 2010. Commuting by bicycle: an overview of the literature. *Transp. Rev.* 30, 59–96.
- Helbich, M., Emmichoven, M.J.Z. van, Dijst, M.J., Kwan, M.-P., Pierik, F.H., Vries, S.I. de, 2016. Natural and built environmental exposures on children's active school travel: a Dutch global positioning system-based cross-sectional study. *Health Place* 39, 101–109.
- Hendricks, K., Wilkerson, R., Vogt, C., TenBrink, S., 2009. Transforming a small midwestern city for physical activity: from the sidewalks up. *J. Phys. Act. Health* 6, 690–698.
- Hume, C., Jorna, M., Arundell, L., Saunders, J., Crawford, D., Salmon, J., 2009a. Are children's perceptions of neighbourhood social environments associated with their walking and physical activity? *J. Sci. Med. Sport* 12, 637–641.
- Hume, C., Timperio, A., Salmon, J., Carver, A., Giles-Corti, B., Crawford, D., 2009b. Walking and cycling to school. Predictors of increase among children and adolescents. *Am. J. Prev. Med.* 36, 195–200.
- Hume, C., Timperio, A., Salmon, J., Carver, A., Giles-Corti, B., Crawford, D., 2009c. Walking and cycling to school. Predictors of increases among children and adolescents. *Am. J. Prev. Med.* 36, 195–200.
- Kemperman, A., Timmermans, H., 2014. Environmental correlates of active travel behavior of children. *Environ. Behav.* 46, 583–608.
- Kingham, S., Ussher, S., 2007. An assessment of the benefits of the walking school bus in Christchurch, New Zealand. *Transp. Res. Part A Policy Pract.* 41, 502–510.
- Koh, P.P., Wong, Y.D., 2013. Influence of infrastructural compatibility factors on walking and cycling route choices. *J. Environ. Psychol.* 36, 202–213.
- Laguna Nieto, M., Aznar Laín, S., Lara Hernández, M.T., 2011. Physical activity patterns by gender and levels of obesity in Spanish children. EYHS Study [Patrones de actividad física en función del género y los niveles de obesidad en población infantil española. Estudio EYHS]. *Rev. Psicol. del Deporte.* 20, 621–636.
- Lambiase, M.J., Barry, H.M., Roemmich, J.N., 2010. Effect of a simulated active commute to school on cardiovascular stress reactivity. *Med. Sci. Sport. Exerc.* 42, 1609–1616.

- Lang, D., Collins, D., Kearns, R., 2011. Understanding modal choice for the trip to school. *J. Transp. Geogr.* 19, 509–514.
- Larouche, R., Barnes, J., Tremblay, M., 2013. Too far to walk or bike? *Can. J. Public Heal.* 104, 487–489.
- Larouche, R., Faulkner, G.E.J., Fortier, M., Tremblay, M.S., 2014a. Active transportation and adolescents' health. *Am. J. Prev. Med.* 46, 507–515.
- Larouche, R., Oyeyemi, A.L., Prista, A., Onywera, V., Akinroye, K.K., Tremblay, M.S., 2014b. A systematic review of active transportation research in Africa and the psychometric properties of measurement tools for children and youth. *Int. J. Behav. Nutr. Phys. Act.* 11, 129.
- Larsen, K., Gilliland, J., Hess, P., Tucker, P., Irwin, J., He, M., 2009. The influence of the physical environment and sociodemographic characteristics on children's mode of travel to and from school. *Am. J. Public Health* 99, 520–526.
- Larsen, K., Gilliland, J., Hess, P.M., 2012. Route-based analysis to capture the environmental influences on a child's mode of travel between home and school. *Ann. Assoc. Am. Geogr.* 102, 1348–1365.
- Lavoie, M., Burigusa, G., Maurice, P., Hamel, D., 2014. Active and safe transportation of elementary-school students: comparative analysis of the risks of injury associated with children travelling by car, walking and cycling between home and school. *Chronic Dis. Inj. Can.* 34, 195–202.
- Lewicka, M., 2005. Ways to make people active: The role of place attachment, cultural capital, and neighborhood ties. *J. Environ. Psychol.* 25, 381–395.
- Litman, T., 2010. Transportation demand management. Physical constraints, in: *Transport Forum 2012. Inclusive and Sustainable Transport*.
- Litman, T., 2009. Transportation cost and benefit analysis; techniques, estimates and implications. *Victoria Transp. Policy Inst.* 1–15.
- Mackett, R.L., Lucas, L., Paskins, J., Turbin, J., 2003. A methodology for evaluating walking buses as an instrument of urban transport policy. *Transp. Policy* 10, 179–186.
- Marshall, J., Wilson, R., Meyer, K., Rajangam, S., McDonald, N., Wilson, E., 2010. Vehicle emissions during children's school commuting: impacts of education policy. *Environ. Sci. Technol.* 44,

1537–1543.

McDonald, N., 2012. Is there a gender gap in school travel? An examination of US children and adolescents. *J. Transp. Geogr.* 20, 80–86.

McDonald, N., 2008a. Children's mode choice for the school trip: the role of distance and school location in walking to school. *Transportation (Amst)*. 35, 23–35.

McDonald, N., 2008b. Household interactions and children's school travel: the effect of parental work patterns on walking and biking to school. *J. Transp. Geogr.* 16, 324–331.

McDonald, N., 2008c. Critical factors for active transportation to school among low-income and minority students. *Am. J. Prev. Med.* 34, 341–344. doi:10.1016/j.amepre.2008.01.004

McDonald, N., 2007a. Active transportation to school trends among U.S. school children, 1969–2001. *Am. J. Prev. Med.* 32, 509–516.

McDonald, N., 2007b. Travel and the social environment: evidence from Alameda County, California. *Transp. Res. Part D Transp. Environ.* 12, 53–63.

McDonald, N., Aalborg, A., 2009. Why parents drive children to school: implications for safe routes to school programs. *J. Am. Plan. Assoc.* 75, 331–342.

McDonald, N., Brown, A., Marchetti, L., Pedroso, M., 2011. U.S. school travel, 2009: an assessment of trends. *Am. J. Prev. Med.* 41, 146–151.

McDonald, N., Steiner, R., Palmer, M., Bullock, A., Sisiopiku, V., Lytle, B., 2014. Costs of school transportation: quantifying the fiscal impacts of encouraging walking and bicycling for school travel. *Transportation (Amst)*.

McDonald, N., Yang, Y., Abbott, S., Bullock, A., 2013. Impact of the Safe Routes to School program on walking and biking: Eugene, Oregon study. *Transp. Policy* 29, 243–248.

McMillan, T.E., 2007. The relative influence of urban form on a child's travel mode to school. *Transp. Res. Part A Policy Pract.* 41, 69–79.

McMillan, T.E., 2005. Urban form and a child's trip to school: the current literature and a framework for future research. *J. Plan. Lit.* 19, 440–456.

Meng, M., Zhang, J., Wong, Y.D., Au, P.H., 2016. Effect of weather conditions and weather forecast

- on cycling travel behavior in Singapore. *Int. J. Sustain. Transp.* 10, 773–780.
- Merom, D., Tudor-Locke, C., Bauman, A., Rissel, C., 2006. Active commuting to school among NSW primary school children: implications for public health. *Health Place* 12, 678–687.
- Mikkelsen, M.R., Christensen, P., 2009. Is children's independent mobility really independent? A study of children's mobility combining ethnography and GPS/mobile phone technologies. *Mobilities* 4, 37–58.
- Mitra, R., 2012. Independent mobility and mode choice for school transportation: a review and framework for future research. *Transp. Rev.* 33, 21–43.
- Mitra, R., Buliung, R., 2015. Exploring differences in school travel mode choice behaviour between children and youth. *Transp. Policy* 42, 4–11.
- Mitra, R., Buliung, R., Roorda, M., 2010. Built environment and school travel mode choice in Toronto, Canada. *Transp. Res. Rec. J. Transp. Res. Board* 2156, 150–159.
- Mitra, R., Faulkner, G., 2012. There's no such thing as bad weather, just the wrong clothing: climate, weather and active school transportation in Toronto, Canada. *Can. J. Public Heal.* 103, S35–S41.
- Morency, C., Demers, M., 2010. Active transportation as a way to increase physical activity among children. *Child. Care. Health Dev.* 36, 421–427.
- Noland, R.B., Park, H., Von Hagen, L.A., Chatman, D.G., 2014. A mode choice analysis of school trips in New Jersey. *J. Transp. Land Use* 7, 111–113.
- Oliver, M., Badland, H., Mavoa, S., Witten, K., Kearns, R., Ellaway, A., Hinckson, E., Mackay, L., Schluter, P.J., 2014. Environmental and socio-demographic associates of children's active transport to school: a cross-sectional investigation from the URBAN Study. *Int. J. Behav. Nutr. Phys. Act.* 11, 70.
- Panther, J.R., Jones, A.P., van Sluijs, E.M., 2008. Environmental determinants of active travel in youth: a review and framework for future research. *Int. J. Behav. Nutr. Phys. Act.* 5, 34.
- Park, H., Noland, R., Lachapelle, U., 2013. Active school trips: associations with caregiver walking frequency. *Transp. Policy* 29, 23–28.
- Pizarro, A.N., Ribeiro, J.C., Marques, E.A., Mota, J., Santos, M.P., 2013. Is walking to school associated with improved metabolic health? *Int. J. Behav. Nutr. Phys. Act.* 10, 12.

- Pojani, D., Boussauw, K., 2014. Keep the children walking: Active school travel in Tirana, Albania. *J. Transp. Geogr.* 38, 55–65.
- Pont, K., Wadley, D., Ziviani, J., Khan, A., 2013. The influence of urban form and family decision making on children's travel to school. *J. Urban Des.* 18, 363–382.
- Pont, K., Ziviani, J., Wadley, D., Abbott, R., 2011. The model of children's active travel (M-CAT): a conceptual framework for examining factors influencing children's active travel. *Aust. Occup. Ther. J.* 58, 138–144.
- Pont, K., Ziviani, J., Wadley, D., Bennett, S., Abbott, R., 2009. Environmental correlates of children's active transportation: a systematic literature review. *Health Place* 15, 849–862.
- Potoglou, D., Arslangulova, B., 2016. Factors influencing active travel to primary and secondary schools in Wales. *Transp. Plan. Technol.* 0, 1–21.
- Pucher, J., Buehler, R., 2008. Making cycling irresistible: lessons from The Netherlands, Denmark and Germany. *Transp. Rev.* 28, 495–528.
- Ramanathan, S., O'Brien, C., Faulkner, G., Stone, M., 2014. Happiness in motion: emotions, well-being, and active school travel. *J. Sch. Health* 84, 516–523.
- Rodríguez-López, C., Villa-González, E., Pérez-López, I.J., Delgado-Fernández, M., Ruiz, J.R., Chillón, P., 2013. Family factors influence active commuting to school in Spanish children [Los factores familiares influyen en el desplazamiento activo al colegio de los niños españoles]. *Nutr. Hosp.* 28, 756–763.
- SafeRoutes, 2015. History of Safe Routes to School [WWW Document]. Natl. Cent. Safe Routes to Sch. USA.
- Schlossberg, M., Greene, J., Phillips, P.P., Johnson, B., Parker, B., 2006. School trips: effects of urban form and distance on travel mode. *J. Am. Plan. Assoc.* 72, 337–346.
- Schlossberg, M., Phillips, P.P., Johnson, B., Parker, B., 2005. How do they get there? A spatial analysis of a "Sprawl School" in Oregon. *Planning, Pract. Res.* 20, 147–162.
- Schofield, G.M., Gianotti, S., Badland, H.M., Hinckson, E. a., 2008. The incidence of injuries traveling to and from school by travel mode. *Prev. Med. (Baltim)*. 46, 74–76.
- Sidharthan, R., Bhat, C., Pendyala, R., Goulias, K., 2011. Model for children's school travel mode

choice: accounting for effects of spatial and social interaction. *Transp. Res. Rec. J. Transp. Res. Board* 78–86.

SINGSTATS, 2011. Census of population 2010 statistical release 3 - Geographic distribution and transport. Dep. Stat. Minist. Trade Ind. Singapore.

Sirard, J.R., Ainsworth, B.E., Mclver, K.L., Pate, R.R., 2005a. Prevalence of active commuting at urban and suburban elementary schools in Columbia, SC. *Am. J. Public Health* 95, 236–237.

Sirard, J.R., Riner, W.F., Mclver, K.L., Pate, R.R., 2005b. Physical activity and active commuting to elementary school. *Med. Sci. Sport. Exerc.* 37, 2062–2069.

Sirard, J.R., Slater, M.E., 2008. Walking and bicycling to school: a review. *Am. J. Lifestyle Med.* 2, 372–396.

Smith, L., Norgate, S.H., Cherrett, T., Davies, N., Winstanley, C., Harding, M., 2015. Walking School Buses as a form of active transportation for children - A review of the evidence. *J. Sch. Health* 85, 197–210.

Speck, J., 2012. Walkable city: how downtown can save America, one step at a time. *Urban Plan.* 321.

Stanford, 2014. What is Scopus? *Stanford Med. Libr.* 1–2.

Stanley, R.M., Maher, C., Dollman, J., 2015. Modelling the contribution of walking between home and school to daily physical activity in primary age children. *BMC Public Health* 15, 445.

Timperio, A., Ball, K., Salmon, J., Roberts, R., Giles-Corti, B., Simmons, D., Baur, L., Crawford, D., 2006. Personal, family, social, and environmental correlates of active commuting to school. *Am. J. Prev. Med.* 30, 45–51.

Timperio, A., Crawford, D., Telford, A., Salmon, J., 2004. Perceptions about the local neighborhood and walking and cycling among children. *Prev. Med. (Baltim).* 38, 39–47.

Trapp, G.S., Giles-Corti, B., Christian, H.E., Bulsara, M., Timperio, A.F., McCormack, G.R., Villaneuva, K.P., 2011. On your bike! A cross-sectional study of the individual, social and environmental correlates of cycling to school. *Int. J. Behav. Nutr. Phys. Act.* 8, 123.

Veitch, J., Robinson, S., Ball, K., Salmon, J., 2012. Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play. *Health Place* 12, 3–19.

- Villa González, E., Rodríguez-López, C., Huertas Delgado, F.J., Tercedor, P., R. Ruiz, J., Chillón, P., 2011. Personal and environmental factors associated with active movement to school of Spanish students [Factores personales y ambientales asociados con el desplazamiento activo al colegio de los escolares españoles]. *Rev. Psicol. del Deport.* 21, 343–349.
- Voss, C., Winters, M., Frazer, A., McKay, H., 2015. School-travel by public transit: rethinking active transportation. *Prev. Med. Reports* 2, 65–70.
- Waller, M., 2005. High cost or high opportunity cost? Transportation and family economic success. *Brookings Inst.* 35, 35–49.
- Wen, L.M., Fry, D., Rissel, C., Dirkis, H., Balafas, A., Merom, D., 2008. Factors associated with children being driven to school: implications for walk to school programs. *Health Educ. Res.* 23, 325–334.
- Wong, B.Y.-M., Faulkner, G., Buliung, R., 2011. GIS measured environmental correlates of active school transport: a systematic review of 14 studies. *Int. J. Behav. Nutr. Phys. Act.* 8, 39.
- Wu, A.D., Zumbo, B.D., 2008. Understanding and using mediators and moderators. *Soc. Indic. Res.* 87, 367–392. doi:10.1007/s11205-007-9143-1
- Yang, Y., Abbott, S., Schlossberg, M., 2012. The influence of school choice policy on active school commuting: a case study of a middle-sized school district in Oregon. *Environ. Plan. A* 44, 1856–1874.
- Yang, Y., Ivey, S.S., Levy, M.C., Royne, M.B., Klesges, L.M., 2016. Active travel to school: findings from the survey of US health behavior in school-aged children, 2009-2010. *J. Sch. Health* 86, 464–471.
- Yarlagadda, A.K., Srinivasan, S., 2008. Modeling children's school travel mode and parental escort decisions. *Transportation (Amst)*. 35, 201–218.
- Yeung, J., Wearing, S., Hills, A.P., 2008. Child transport practices and perceived barriers in active commuting to school. *Transp. Res. Part A Policy Pract.* 42, 895–900.
- Zuniga, K.D., 2012. From barrier elimination to barrier negotiation: a qualitative study of parents' attitudes about active travel for elementary school trips. *Transp. Policy* 20, 75–81.

FIGURES

Figure 1. Eligibility criteria and articles reviewed per year.

Figure 2. Frameworks to analyse active trips to school (adapted from Timperio et al. 2004; McMillan 2005; Sirard & Slater 2008; Mitra 2012; Pont et al. 2013; Christiansen et al. 2014).

Figure 3. Safety perception and accident exposure.

Figure 4. Age and gender influence on trips to school.

Figure 5. Gaps in the active trips to school literature.