

# TeMA

Journal of  
Land Use, Mobility and Environment

There are a number of different future-city visions being developed around the world at the moment: one of them is Smart Cities: ICT and big data availability may contribute to better understand and plan the city, improving efficiency, equity and quality of life. But these visions of utopia need an urgent reality check: this is one of the future challenges that Smart Cities have to face.

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METHODS, TOOLS AND BEST PRACTICES TO INCREASE THE CAPACITY OF URBAN SYSTEMS TO ADAPT TO NATURAL AND MAN-MADE CHANGES

## METHODS, TOOLS AND BEST PRACTICES TO INCREASE THE CAPACITY OF URBAN SYSTEMS TO ADAPT TO NATURAL AND MAN-MADE CHANGES

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**Editorial correspondence**

Laboratory of Land Use Mobility and Environment  
DICEA - Department of Civil, Architectural and Environmental Engineering  
University of Naples "Federico II"  
Piazzale Tecchio, 80  
80125 Naples  
web: [www.tema.unina.it](http://www.tema.unina.it)  
e-mail: [redazione.tema@unina.it](mailto:redazione.tema@unina.it)

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## METHODS, TOOLS AND BEST PRACTICES TO INCREASE THE CAPACITY OF URBAN SYSTEMS TO ADAPT TO NATURAL AND MAN-MADE CHANGES

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## ACTIVE TRANSPORT TO SCHOOL AND CHILDREN'S BODY WEIGHT

A SYSTEMATIC REVIEW

HOUSHMAND E. MASOUMI

Center for Technology and Society,  
Technische Universität Berlin, Germany  
e-mail: [masoumi@tu-berlin.de](mailto:masoumi@tu-berlin.de)

### ABSTRACT

Because of decreasing physical activity of children, they are becoming more obese. Moreover, commuting to school has become more passive during the past decades. The objective was to update the previous systematic reviews by narrowing down the topic to body mass index of children (3-12 years) as a representative of body composition. Applying search terms such as active transport to school, body mass index, childhood obesity, and so on in four online databases: PubMed, ScienceDirect, WorldCat, and Google Scholar. Peer-reviewed English journal papers published between 2005 and 2015 presenting empirical quantitative studies were eligible studies to be reviewed. 310 journal papers were screened, 27 of which were reviewed by studying the full text. The final 13 papers were limited to those that focused only on active commuting to school and body mass index of children and adolescents. Out of 13 final studies, 3 found conclusive associations, three indicate partial associations in subgroups or societal or geographical limitations, and seven show no correlations. The existing literature are still inconsistent, so this study suggests conducting surveys with larger samples on less-studied contexts and applying more complex statistical methods for adjusting some of the variables. It is also argued that this topic can be culturally and contextually specific.

### KEYWORDS:

Active transport to school, body mass index, childhood obesity, overweight, children.

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## 主动学校通勤与儿童体重： 系统评价

HOUSHMAND E. MASOUMI

Center for Technology and Society,  
Technische Universität Berlin, Germany  
e-mail: [masoumi@tu-berlin.de](mailto:masoumi@tu-berlin.de)

### 摘要

由于儿童的身体运动量在不断减少，他们也因此而变得越来越肥胖。而且，在过去的几十年里，被动方式的学校通勤已成为一种常态。本文的目的是为了通过详述反映儿童（3-12岁）身体结构的体重指数来更新以前的系统评价。在以下四个在线数据库中使用主动学校通勤、体重指数、儿童肥胖等搜索术语：PubMed、ScienceDirect、WorldCat 和 Google Scholar。2005 和 2015 年间发表的同行评审英文期刊论文对实证定量研究进行了介绍，符合审查资格。对 310 篇期刊论文进行了筛选，并对其中 27 篇进行了通篇研究审查。最后的 13 篇论文仅限于那些只关注主动学校通勤以及儿童和青少年的体重指数的研究。在最后 13 项研究中，有 3 项研究发现了存在明确的联系，3 项研究表示在群体或社会或地域限制方面存在部分联系，而另外 7 项研究没有联系。现有的文献仍然存在不一致，因此本研究建议对大量较少研究的情况进行调查，并应用更复杂的统计方法来调整一些变量。也可以针对具体的文化和内容来开展这类研究。

### 关键词：

主动学校通勤，体重指数，儿童肥胖，超重，儿童

## 1 INTRODUCTION

With continuous increase in body weight of the youth in several regions of the world, researchers and practitioners have recently sought for passive ways for prevention of obesity as a driver of a handful of diseases. The Active Transport to School (ATS)- Body Mass Index (BMI) studies as a part of research on ATS and children's body composition has been noted to be inconsistent in a couple of studies (Ford et al. 2007; Landsberg et al. 2008; Pabayo et al. 2010; Mendoza et al. 2011; Drake et al. 2012; Saksvig et al. 2012; Heelan et al. 2013). The objective of this study is to update our knowledge using the most up-to-date observations conducted recently and to check if the knowledge produced by the scholars of this topic has become consistent. It is meant to refer to a similar study done by Lubans et al. and update their work after six years, though that study targeted both children and adolescents and also investigated not only BMI but a broader range of health-related fitness. Although this review attempts to complete the previous ones, it is new because it narrows down childhood age and only to BMI as a body composition measure.

Respecting the fast-growing field of children's active commuting and their body weight, it would be appealing to test the inclusiveness of the results of the recent empirical studies. After six year of the previous systematic study, it would be relevant to update the feedback using the new quantitative investigations. The field is very much progressive, so it is logical to refresh the systematic reviews occasionally by means of the results of several research groups actively publishing their findings. The studies related to active transportation to school and the effects on children's body weight is currently being developed in several developing countries, thus the new findings may show contextual disparities.

Apart from the clear connections of the research theme to urban transportation planning and urban land use, there are direct connection between the subject and infrastructure planning and indirect but considerable associations with urban environment. The more sustainable transport modes children and their parents take for school commuting, the cleaner will the urban environment be; there are less air and sound pollution. The infrastructure side will be related to development of the sidewalks, bike routes and tracks, infrastructure customized for safety of children, safer and secure playgrounds, customized routes from populated areas to school, and the like. In addition to the benefits for the public health of the society, increasing suitability of the urban environment for walking and biking of children to school can lead to other outcomes in mobility and environment; our understanding about the relationship between the behavior of children and their parents show that changing the travel behavior of children can be associated in change in their parents' travels. Hence, undertaking fundamental research on the commute trips of children can help providing more sustainable mobility for several age groups. These interrelations between sub-topics form a multifaceted subject resulting in healthier, safer, and more livable urban environment for children and their parents.

For such an updating, systematic review without meta-analysis is applied in this paper. Few systematic reviews have been done on the theme of this paper for children and adolescents. Systematic review is considered to be suitable for concluding the results of quantitative studies during the past years since they "Systematic reviews are not only instrumental for implementing evidence-based practice but also for taking stock relative to a particular question (or set of questions) and for the shaping of future research. For development, the primary role of systematic reviews rests with the creation of data-based rationales for newly proposed development activities." (Schlosser, 2006).

## 2 BACKGROUND

Urban planning has gained importance in promoting public health during the past years (Hoehner et al. 2003). Built environment has been recently addressed by scholars as a determinant of public health (Frumkin, 2003; Jackson, 2003). The role of planners in enhancing public health has been highlighted in academic research

(Bors et al. 2009; Bors & Lee, 2012; Silver, 2012). Urban planning efforts such as interventions in form of community design, housing development, community organizing, greenspace planning, etc. are applied as Active Living by Design provide environments that support active living of residents (i.e. Miller & Scofield, 2009). During the past years, scholars have tried to draw attentions to the potentials of public policy approaches to urban transportation and land development to provide better conditions of public health (Frank & Engelke, 2001). Certain approaches to urban planning or the related shortcomings may be considered as sustainable forms suitable for promotion of public health, while others may be named as unhealthy urban development, i.e. urban sprawl is considered as unhealthy by some researchers: "among those with chronic conditions, including hypertension, diabetes, and lung disease, those who live in areas with more highly connected street networks have higher rated health." (Kelly-Schwartz, 2004).

The existing literature depicts a holistic image of the influences of the physical environment on physical activity (PA) as an important aspect of public health (Sallis et al. 2006; Aytur et al. 2008; Timmermans et al. 2016). Sustainable urban form is associated with forms of PA, when urban planning targets the concept of smart growth principles including housing opportunities, walkable neighborhoods, community and stakeholder collaborations, attractive communities with sense of place, mixed land use, diverse transport mode choices, preserved open spaces, etc.

The role of physical activity in obesity and overweight of children (Goran et al. 1999; Steinbeck, 2001; Hills, et al. 2012; Corder et al. 2016). The linkage between the physical environment and physical activity is built by active transportation, bicycling, and particularly walking as elements of sustainable urban transportation planning (Craig et al. 2002, Handy et al. 2002; van Dyck et al. 2010a & van Holle et al. 2014). Walkability is not the only essence of urban form that can increase PA; some other qualities such as regional accessibility, sidewalks, bike facilities and recreation facility access are also associated with physical activity and concludingly body weight and high blood pressure (Ulmer et al. 2014). This correlation may affect body weight of all age groups (Smith et al. 2008). Neighborhood walkability can be decisive for children's PA (D'Haese et al. 2014). Walkability of the local space around residential places as well as the way to school can be of importance regarding physical activity of the youth. Researchers have majorly suggested to adopt policy to make the surrounding of schools more walkable. The examples are providing safer environment for children to promote their walking to and from school (Shbeeb & Awad, 2013) and selection of school site according to street connectivity (Giles-Corti et al. 2011). In general, 14 different interventions were identified by Chillón et al. (2011) for promotion of active commuting to school in the United States, the United Kingdom, and Australia. The physical activity of children has decreased compared to previous decades (Tanter & Doyle, 1996; Karsten, 2005; Hillman, 2006). The reasons can lay in very different aspects of modern life such as built environment, lifestyles, socio-economics, objective and subjective safety and security, etc. Outdoor physical activities and organized sport practice of US children has been significantly reduced between 1981 and 1997. Lack of PA in children may come together with hypertension, insulin resistance, dyslipidemia, cardiometabolic risk, and finally obesity (Ekelund et al. 2006; Ness et al. 2007; Leary et al. 2008; Owen et al. 2010).

The literature attempting to analyze the circumstances of diminishing PA of children and its correlates are have discussed many aspects including the urban form and neighborhood, socio-economics and social interactions, safety, and security. In many cases, the results of the empirical studies are consistent and reliable. A newer topic that has drawn attention of scholars is the concept of ATS. During the past decades, children's walking and biking to and from school has been weakened. Children are chauffeured to school much more than previous decades in several countries (Department of Transport, 2001, 2009; Sturm, 2004; Karsten, 2005; Salmon et al. 2005; McDonald, 2007; van der Ploeg et al. 2008; Garrard, 2011). There is also evidence that childhood outdoor PA is decreasing (e.g. Sturm, 2004; McDonald et al. 2009) and their body weight is continuously increasing in several countries. The findings related to this topic clearly describe the advantages

of ATS and its contributions to PA. Nevertheless, when it comes to the associations of ATS with children's body weight, obesity, and BMI, the study results are not clear.

### 3 METHODOLOGY

The present paper presents a systematic review of literature dealing with ATS, BMI, and their associations. The objective is to clarify if the inconsistency in the results addressed in a couple of studies mentioned above still exists. The question that is to be answered by this study is are there significant associations between ATS and children's BMI? This study focuses only on children and avoids to broaden the age to adolescents; the age criterion of this study is thus limited to 3 to 12 years. It is clear that three to six-year old children do not go to school, but in this paper, ATS refers to a wider meaning than only attending elementary school. Here, both elementary school and kindergarten are addressed. The topic is studied in an international context using all the literature from high-income and emerging economies.

ATS and similar terms as well as BMI, "body weight", and obesity were searched for online. Nine different combinations were searched for as illustrated in Table 1. English peer-reviewed journal papers were searched and the results were arranged in Citavi citation management software. Location of published papers played no role in the search. As a result, 310 citations were collected.

<b>CHILDREN'S MOBILITY PATTERNS</b>		<b>WEIGHT</b>
Active Transport to School		BMI
Active Commuting to School	+	Body Weight
Active School Transportation		Obesity

Tab. 1 Search Parameters

Searches in four databases (PubMed, ScienceDirect, WorldCat, and Google Scholar) identified 310 citations published in 2005 and later. Fig. 1 depicts the inclusion/exclusion procedure.

The criteria employed for quality assessment of the final bibliography based on an adaptation of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement, which is also taken by Lubans et al. (2011). The six assessment criteria of Elm et al. were slightly changed to fit within the topic of this study. For making this study consistent with that of Lubans et al. (2011), the three common studies are assessed according to Lubans et al. These three studies are Heelan et al. (2005), Rosenberg et al. (2006), and Owen et al. (2010).

### 4 RESULTS

The number of studies on the target topic conducted in the recent years is increasing; four studies have been published in 2015. Nine studies (less than 70 percent) were published between 2010 and 2015, while between 2005 and 2010 only four were out. Five out of 13 studies (38.5%) were conducted in the US. Two studies (15.4%) were done in Canada. Australia, Norway, Sweden, Spain, and China had each one, and one study was international (Table 3). Four studies are longitudinal (Rosenberg et al. 2006; Pabayo et al. 2010; Chillón et al. 2012; Mendoza et al. 2014), which provides a higher quality in discussing causation than the existing evidence back in 2011 by Lubans et al. (2 out of 27 which equals 7.4%). Except Fulton et al. (2005) and DeWees & Ohri-Vachaspati (2015), who applied random-digit dial survey, others took self-reported questionnaires for collecting ATS and other data. Body composition data were measured by research staff, or by other equipment, or were self-reported. Sample sizes differ from 262 in Sweden (Chillón et al. 2012) to 21596 in China (Sun et al. 2015). Samples of one thousand or more have mostly been taken between 2013

and 2015. The widest age range has been 3-18 years (DeWees & Ohri-Vachaspati, 2015), while the narrowest ranges was  $10.2 \pm 0.7$  years (Heelan et al. 2005). All 13 studies examined both sexes. Walking and biking were the essential modes of ATS of the selected studies. Only Yeung et al. (2008) did not observe bicycle trips. ATS ranged from 8.67% (Mendoza et al. 2014) to 69% (Gutiérrez-Zornoza et al. 2015) within the children of the samples, both conducted in the US.

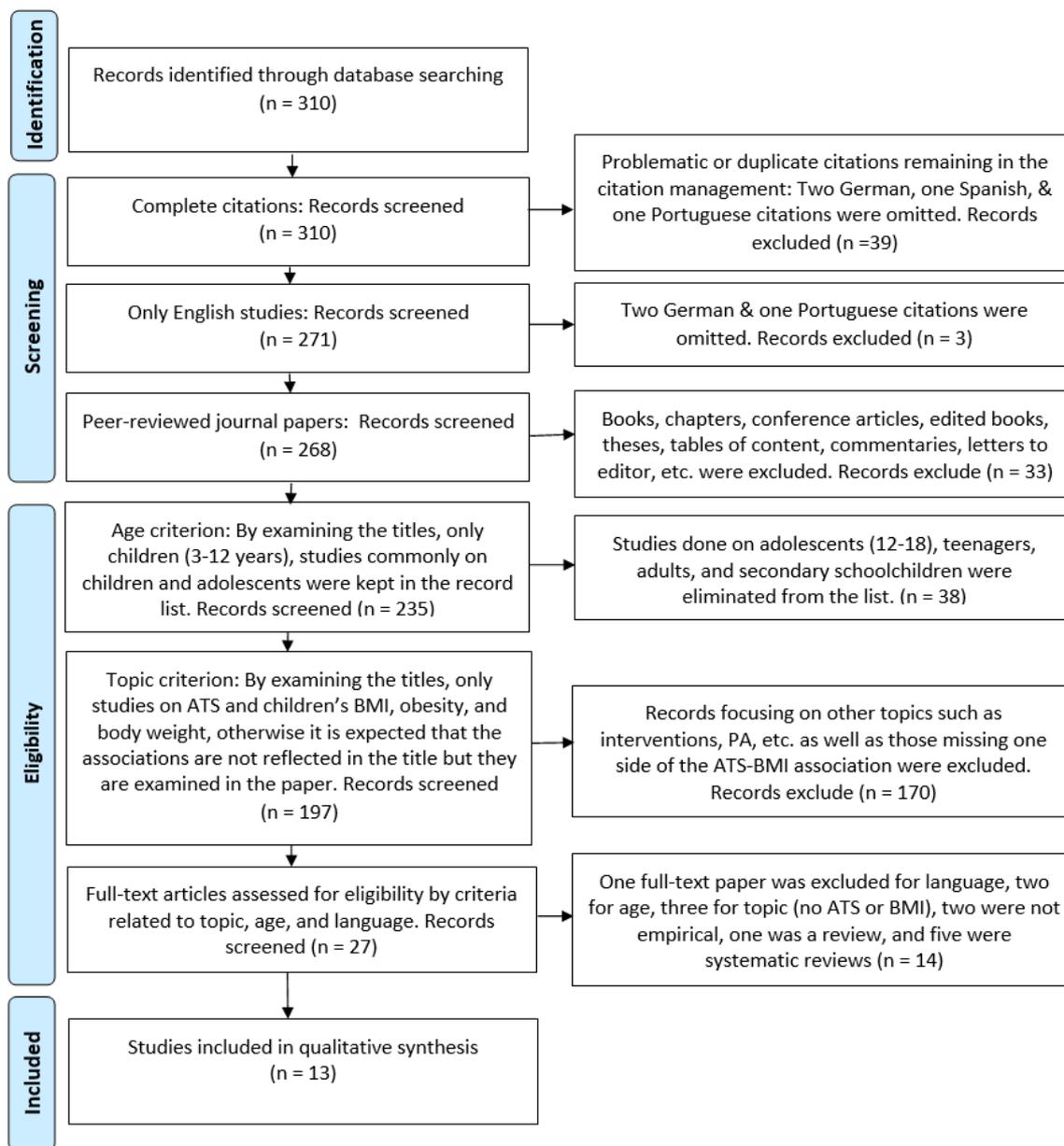


Fig. 1 Flow diagram of study selection. Note: ATS = Active Transport to School

As illustrated in Table 2, six out of 13 studies (46.2%) scored  $\geq 4$ , which is almost comparable with the quality of 27 studies analyzed in 2011 (Lubans et al.). Only five studies succeeded to provide convincing information concerning random selection of participants/schools (Fulton et al. 2005; Pabayo et al. 2010; Østergaard et al. 2013; Gutierrez-Zornoza et al. 2015; DeWeese and Ohri-Vachaspati, 2015). Reporting the sources and details of BMI was the strength of 10 studies. Most of the studies failed to fulfill the requirement of the last question regarding the number of respondents who completed each of the different measures, and if they succeeded to do so, they did not catch the 80% threshold.

Out of 13 studies, three conclusively confirmed existence of associations between ATS and BMI (Larouche et al. 2011; Sarmiento et al. 2015; Sun et al. 2015), three partially confirm such associations in certain conditions (Rosenberg et al. 2006; Mendoza et al. 2014; DeWeese and Ohri-Vachaspati, 2015), and seven reject any association (Fulton et al. 2005; Heelan et al. 2005; Yeung et al. 2008; Pabayo et al. 2010; Chillón et al. 2012; Østergaard et al. 2013; Gutiérrez-Zornoza et al. 2015). The example of the studies that found associations in specific conditions is Rosenberg et al. (2006) that found significant associations only for boys. The significant associations found by Mendoza et al. (2014) were limited to less safe neighborhoods. Finally, DeWees & Ohri-Vachaspati, (2015) reported inverse associations only for children who walk, bike, or skateboard to school beyond half a mile. The average sample size of the three conclusively confirming studies is 9569, while those of the three studies that found associations in subgroups and some of the measures and seven studies finding no correlations are 4784 and 2769 respectively (Table 3). Table 3 also depicts that more recent studies have found associations more than older ones; three fourth of studies published in 2015 found general or partial relations, four studies out of five conducted between 2005 and 2010 did not report any associations. Except Larouche et al. who found an association from a sample of 315 students, all the other five studies that reported correlations were based on larger samples of around one thousand students or more. Two out of three studies that reported general correlations (Sarmiento et al. 2015; Sun et al. 2015) were done in less-studied contexts or internationally. Both cross-sectional and longitudinal studies found correlations. Except Larouche et al. that did not report clearly about the modes of active transport to school in their study, only Yeung et al. (2008) took a one-mode ATS (walking). This only study found no relations with BMI.

<b>STUDIES</b>	<b>(I)</b>	<b>(II)</b>	<b>(III)</b>	<b>(IV)</b>	<b>(V)</b>	<b>(VI)</b>	<b>QUALITYSCORE TOTAL/6</b>
DeWees & Ohri-Vachaspati, (2015)	1	1	1	0	0	0	3
Sun et al. (2015)	1	0	1	1	1	1	5
Sarmiento et al. (2015)	0	0	1	1	1	0	3
Gutiérrez-Zornoza et al. (2015)	1	1	1	1	0	0	4
Mendoza et al. (2014)	1	0	1	1	1	0	4
Østergaard et al. (2013)	1	1	1	1	1	0	5
Chillón et al. (2012)	1	0	0	1	0	0	2
Larouche et al. (2011)	1	0	0	1	1	0	3
Pabayo et al. (2010)	1	1	1	1	1	0	5
Yeung et al. (2008)	1	0	0	0	0	1	2
Rosenberg et al. (2006)	1	0	0	1	0	1	3
Heelan et al. (2005)	1	0	1	1	1	0	4
Fulton et al. (2005)	0	1	0	0	0	1	2

Tab. 2 Assessment of study quality

- (I) Did the study describe the participant eligibility criteria?  
 (II) Were the study schools/ participants randomly selected (or representative of the study population)?  
 (III) Did the study report the sources and details of ATS measurement and did the methods have acceptable reliability for the specific age group?  
 (IV) Did the study report the sources and details of body weight assessment and did the all of the methods have acceptable reliability for the specific age group?  
 (V) Did the study report a power calculation and was the study adequately powered to detect hypothesized relationships?  
 (VI) Did the study report the numbers of individuals who completed each of the different measures and did participants complete at least 80% of measure

Author, Year	Observation Location and Time	Study Design / Analysis Method	Data Collection Method	Sample Size	Participants' Age and Sex	ATS Type	Percent of Children Classified as Active Commuters	Result
DeWees & Ohri-Vachaspati, 2015	4 low-income cities in New Jersey (Camden, Newark, New Brunswick, and Trenton) / 2009-2010	Cross-sectional, T-Test and Chi-square tests with some demographic, food consumption and PA variables as covariates.	Random digit-dial household survey: An adult in the household (often parents) talked on phone and did the measurements.	1408 households: 1 randomly selected school-going student per household	3-18 / Both	walking, biking, or skateboarding	47.2%	Without fixing distance, no association were reported. Inverse associations between ATS and overweight/ obesity were found among students who commute beyond half a mile.
Sun et al. 2015	8 cities in different parts of China (Shenyang, Shanghai, Hefei, Wuhan, hengzhou, Chongqing, Kunming, Guangzhou) / 2010	Cross-sectional, multivariate linear regression	Questionnaires administered by research staff in classrooms. Measurements were done by staff.	21596 children and adolescents (9445 boys and 12151 girls), 21280 of whom had BMI information.	Students of grade 1 to 12 / Both	Walking, biking	Not reported	ATS is associated with lower body weight represented by BMI, percentage of body fat, and waist circumference. Children who walked to school were significantly less likely to be obese.
Sarmiento et al. 2015	15 cities in 12 countries (Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, UK, and USA) / 2011-2013	Cross-sectional / linear mixed model	Questionnaires. Measurements were done by staff.	6797 children	Students of age 9 to 11 years / Both	walking, biking, roller blades and scooter	37.2% walking and 4.9% bicycling, roller-blade, skateboard, scooter	ATS is associated with lower BMI.
Gutiérrez-Zornoza et al. 2015	Cuenca, Spain / May and June 2006	Cross-sectional / T-Test and Pearson's Chi-square test	Cluster randomized trial	956 participants (472 boys and 484 girls), who join 18 public schools in rural areas.	Students of age 10 to 12 in Grades 5 and 6 / Both	Walking, biking	69% (boys: 68.4%, girls: 69.5%)	No associations.

Mendoza et al. 2014	USA / 1998-2004	Longitudinal / ANCOVA	Questionnaires. Research staff did the measurements using a Shorr board and weight using a Seca digital scale.	12022	Kindergarten to fifth grade / Both	Walking, biking	8.67%	Children from less safe neighborhoods who did ACS had lower fifth-grade BMI z-scores than their peers who did not do ACS, and there was no difference in fifth grade BMI z-scores among children from more-safe neighborhoods.
Østergaard et al. 2013	Norway / 2005-2006	Cross-sectional / multiple linear regression	Questionnaires. Measurements were done by research staff.	2299	Children of age 9-15 from 40 elementary schools and 23 high schools /Both	Walking, biking	48.7% walking, 3.6% bicycling.	No association were found between transport to school and BMI after adjusting for age, gender and leisure time physical activity.
Chillón et al. 2012	Sweden / 1998-2005	Longitudinal / ANCOVA	Computerized self-reported questionnaire	262	9-15 / Both	Walking, biking	Walkers decreased from 54% to 35% during the study time, while bikers increased from 12% to 31%.	No associations were found between ATS and fatness (BMI, waist circumference, and sum of 5 skinfolds)
Larouche et al. 2011	Eastern Ontario, Canada / 2009-2010	Cross-sectional / T-Test, ANCOVA	Self-reported questionnaires. Measurements were done using a portable stadiometer (SECA: Hamburg, Germany)	315	Grades 4 to 6 /Both	Not reported.	21.0% and 30.9% in the Fall/Winter and Spring/Summer seasons	Children who use ATS had lower BMI values, and were less likely to be overweight and obese.
Pabayo et al. 2010	Quebec, Canada / 1997-1998	Longitudinal / growth curve analyses was applied to examine the relationship between sustained ATS and BMI Z-scores.	Questionnaires. Measurements were done by research staff.	1170	From kindergarten to grade 2 /Both	Walking, biking	ATS at age 6: 14.4%.	No association was found between ATS and being overweight (between 75% and 85% percentiles) or obese (>95% percentile).

Yeung et al. 2008	Brisbane, Australia / ?	Cross-sectional / Mann-Whitney U test	Self-administered parental questionnaire	318 participants (46.9% boys and 53.1% girls)	4-12 / Both	Walking	33.6%	No association
								Boys who actively commuted to school had lower BMI ( $p < 0.01$ ). No such association was found for girls. Active commuting to school over 2 years was not associated with BMI change or overweight status.
Rosenberg et al. 2006	Southern California, USA / 1990-1992	Longitudinal / ANOVA	Supervised questionnaire in the classroom. Caltrac accelerometers.	924 participants in 5 <sup>th</sup> grade at the end of the study period (53.2% boys; 46.8% girls)	4 <sup>th</sup> and 5 <sup>th</sup> grade students in 7 suburban elementary schools / Both	walking, biking, skateboarding	20%	
								36% of the children who lived between 0.8 and 1.6 km from their school actively commuted at least 50% of the time. 9% actively commuted more than 75% of the time each week.
Heelan et al. 2005	Nebraska, USA /	Cross-sectional / multiple regression	Questionnaires sent to children's houses. Research staff did the measurements in schools using Seca Platform Scale, model 707.	320 participants (44% boys and 56% girls) in 8 rural schools	Age 10.2 ± 0.7 years /Both	Walking, biking, skateboarding / scooter		Significant positive associations were found between active commuting to school index (number of active commutes by distance to school) and BMI. No results were reported indicating ability of ATS in attenuating BMI.
								No associations: compared to obese/overweight participants, those with normal BMI have 0.8 (0.5-1.1) times the odds of using ATS.
Fulton et al. 2005	USA / 1996	Cross-sectional / multivariate logistic regression analysis	Random digit-dial household survey, Computer-assisted telephone interviews	1458 parent-child pairs	Students of grades 4 to 12 / Both	Walking, biking	Walk: 11.4%, bike: 2.6%.	

Tab. 3 Review results

## 5 DISCUSSION AND CONCLUSION

The results of this systematic review shows that after an increase in the number of studies on ATS and BMI of children, the results are still not consistent. No conclusive result is thus to be derived from the studies published after 2005. However, the partial conclusion can be active transport to school may lead to lower BMIs in children, particularly for longer walking/cycling distances, for boys, and in less safe neighborhoods. Despite conduction of several interesting studies during the past five years, the finding of this review is still in line with five older systematic reviews that did not find the international findings consistent and compelling (Lee et al. 2008; Faulkner et al. 2009; Lubans et al. 2011; Schoeppe et al. 2013; Larouche et al. 2014).

It is noteworthy that this study has been narrowed down to only children and BMI in hope of better quality of research, while most of the abovementioned systematic reviews have much wider topics; i.e. the associations of ATS with children's PA and weight (Lee et al. 2008; Schoeppe et al. 2013), the same associations in children and the youth (Faulkner et al. 2009), ATS with health-related fitness in children (Lubans et al. 2011), and finally ATS with PA, body composition, and cardiovascular fitness in children and adolescents (Larouche et al. 2014). For undertaking this study, it is assumed that narrowing down the effective factors of the associations as well as the age limit may promote the quality of the review.

Based on the results of this review, more studies are needed to clarify the possible associations. Two points are necessary to be cared about in the future research: (1) larger sample sizes; (2) less-studied contexts. The results of this review reveals that most of studies that found significant correlations were carried out enjoying at least one of the above conditions.

The findings of this study confirms the comment of Bere and Anderson (2009) who believe higher sample sizes may provide higher statistical power for finding associations of ATS and BMI. The literature studied in this paper suggest that in case seeking universal and conclusive associations may fail, investigating subgroups, geographical and contextual settings, or different socio-economics can lead to identifying relationships, e.g. some studies address the ATS-BMI relationship stronger in boys, or the associations may be stronger for cycling rather than walking. More complex statistical methods for controlling for some of the variables may help identify relative relationships.

Two recent studies published in 2015 focused on less-studied contexts like China (Sun et al. 2015) and an international group of countries mostly among emerging economies (Sarmiento et al. 2015) found conclusive correlations. This suggests that if the future studies are directed towards these regions, a better understanding of different ATS-BMI relationships are provided and more significant outputs maybe resulted. This idea is supported by limited number of a recent research that show the correlated of ATS may be context-specific (Larouche et al. 2015) and that in a multi-ethnic society like England, the ATS habits are different among ethnicities: "white European children were more likely to walk/cycle, black African Caribbeans to travel by public transport and South Asian children to travel by car" (Owen et al. 2012). If ATS behaviors are different inside a single country, then it can be hypothesized that habits like the speed and intensity of walking or biking to school may be various in different geographies and cultures. This may cause changes on the effectiveness of ATS on children's body weight. While in some cultures children may have interest to walk or bike faster than some other contexts, PA may be affected differently, and consequently BMI may be attenuated in a higher level. We have very little evidence about the culturally and contextually specificity of ATS-BMI correlations. Thus, this topic deserves more observations and analyses.

To sum up, this systematic review of recent literature indicates inconsistency in ATS-BMI relationship research results. Further research by means of larger samples in less-studied contexts and cultures may be useful for shaping the overall structure of the subject.

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## IMAGE SOURCES

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## AUTHOR'S PROFILE

Houshmand E. Masoumi is senior researcher in Center for Technology and Society, Technical University of Berlin, where he did a postdoc research on the interactions of land use and urban travel behavior in Iranian cities. He holds PhD in urban planning and development from Technical University of Dortmund. His research interests include the effects of urban transformations on travel behavior, walkable neighborhoods, traditional urban form, sustainable transportation, and urban sprawl.