Systematic Review of Active Commuting to School and Children’s Physical Activity and Weight

Brief running head: Systematic Review of Active Commuting to School

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ABSTRACT

Background: The recent decline in children’s active commuting (walking or biking) to school has become an important public health issue. Recent programs have promoted the positive effects of active commuting on physical activity and overweight. However, the evidence supporting such interventions among schoolchildren has not been previously evaluated.

Methods: This paper presents the results of a systematic review of the association between active commuting to school and outcomes of physical activity, weight, and obesity in children.

Results: Thirty-two studies were found that assessed the association between active commuting to school and physical activity or weight in children. The majority of studies assessing physical activity outcomes found a positive association between active commuting and overall physical activity levels. However, almost all studies were cross-sectional in design, and do not indicate whether active commuting leads to increased physical activity or whether active children are simply more likely to walk. Only three of eighteen studies examining weight found consistent results, suggesting that there may be no association between active commuting and reduced weight or body mass index.

Conclusion: While there are consistent findings from cross-sectional studies associating active commuting with increased total physical activity, interventional studies are needed to help determine causation.
INTRODUCTION

The remarkable rise in rates of obesity among children worldwide has attracted an extraordinary amount of attention. Many observers have noted that accompanying this phenomenon has been another equally pervasive trend: the decline in the proportion of children walking to school. Across nations, walking to school has been replaced by motorized transport, particularly in private vehicles driven by parents.

The loss of such a routine and easy source of physical activity at a time of burgeoning rates of obesity is unfortunate. It seems self-evident that by coaxing children out of cars and onto sidewalks we can increase their physical activity and improve their physical health. But while this linkage seems to make common sense, is it supported by evidence?

This paper presents a systematic review of the literature on active commuting (walking or bicycling) and the outcomes of physical activity and weight/obesity in school-age children.

The International Decline of Active Commuting to School

Over the last 30 to 40 years, there has been a significant and pervasive shift in the manner in which children are transported to school. In the United States, walking as a mode share fell from 50% to 12% for all children and from 87% to 31% for those who live within one mile of school.1 Similar declines have been noted elsewhere, including Australia and the UK.2,3 A corresponding increase has been seen in the proportion of children traveling by car. Many theories have been advanced as to the cause of this decline, including perceptions of traffic safety, parental fear of injury and abduction, and alterations in the urban form that favor building schools in more sprawling, less walkable neighborhoods.4,5 The actual cause of the change is unknown and is
likely complex and multifactorial; its universality suggests a social phenomenon that belies easy explanation.

The loss of this widely available and easy form of physical activity is a concern to public health. Many of the chronic diseases burdening society, including diabetes, depression, heart disease, some cancers, osteoporosis and obesity, are mitigated by physical activity. Walking is seen as an ideal health promotion intervention—it is cheap and easy, with little equipment and no training required. Utilitarian walking—that is, traveling by foot for activities such as running errands, visiting friends or traveling to work or school—is particularly desirable, as it may be associated with higher adherence rates than deliberate exercise or walking for fitness. Currently, there is a public health push to increase utilitarian walking in general and walking and cycling to school in particular. However, while there is some evidence that active commuting improves health in adults there is no such evidence regarding children. There is, in fact, very little literature exploring whether walking to school even increases physical activity.

It is reasonable to suspect that the school commute and physical activity are connected. Theoretically, walking to school could be expected to increase total activity in a number of ways. First, the commute itself could be a significant source of activity. Second, an active commute may enable other activity if opportunities arise for extra activity and spontaneous play during the walk to school or on the return trip home. Finally, walking or cycling may encourage active behavior in other areas of the child’s life. However, an active commute is not necessarily associated with increased physical activity. Consider, for instance, the fact that the majority of children who actively commute live very close to school: it may be that their commute is neither long enough nor intense enough for it to make a significant contribution to daily activity.

Currently there is broad support for interventions to increase physical activity by
encouraging walking to school. Effective interventions require an understanding of whether walking to school increases physical activity, and if so, how. Moreover, given that the impetus for these interventions is primarily drawn from the obesity epidemic, it is important to know whether walking to school is itself associated with weight status.

METHODS
A systematic review was conducted to identify all published literature relating to the association between active commuting to school and children’s physical activity or weight. The search was conducted by an epidemiologist with experience in literature searching and data extraction. A number of different databases were accessed, including PubMed, SportDiscus, and the TRIS Online National Transportation Library. The search strategy involved combining three sets of keywords:

a) active commut*, active transport*, walk*, bicycl*, bik*, or cycl* (the asterisk denotes the use of all possible suffixes or word endings. Commut* therefore represents commute, commuting, commuter, commuted, etc. Some databases—such as PubMed—allow the use of an asterisk in this way. For other databases, all suffixes were added to the search);

AND b) activity, physical activity, exercise, weight, overweight, obesity, body mass index, BMI, or body composition;

AND c) school*, child*, adolescen*, or youth.

The results included all publications that included at least one search term from each of the three categories. No restrictions were placed on language, location or date. 1,277 articles were initially identified through SportDiscus; 885 articles through the TRIS database, and 4,885 through PubMed. In addition, the reference lists of relevant articles were hand-searched, and the
archives of relevant journals (Obesity, the Journal of Physical Activity & Health, and Medicine, Science, Sport & Exercise) were searched. Google and Google Scholar were both queried to identify any additional Internet-based sources or other leads. The searches were last repeated on December 29, 2007.

The titles and abstracts of all identified articles were examined for relevance. To be included in the review, studies had to be restricted to children (any school age below university); explicitly examine active commuting to school (as opposed to active transportation to all locations combined); differentiate between active school commuters and passive commuters; and present quantitative results on the association between active commuting and some aspect of physical activity or weight. No studies were identified that were not in English; therefore, language was not a barrier. A total of 32 relevant studies were identified, 25 of which addressed active commuting and physical activity, and 18 of which addressed active commuting and weight (several studies examined both). No review articles or meta-analyses on the topic were found.

Each relevant study was classified by date, location, study type, population age and sex, and by method used to assess physical activity or weight. The association between active commuting and physical activity / weight was defined by reported statistical significance, regardless of whether an association was claimed by the authors.

RESULTS

Active Commuting and Physical Activity in Children

Twenty-five studies were found that presented data on the association between children’s commute mode and physical activity. Descriptive characteristics of these studies are presented in Table 1. The majority of the studies were cross-sectional, with only one using a
prospective design. The studies were generally well-powered, with relatively large study populations, and covered a diverse range of ages and geographical locations. The proportion of active commuters ranged from around 5% to a high of over 90%.

Physical activity was defined and assessed in diverse ways among the studies. While most studies defined physical activity as time spent in moderate-to-vigorous physical activity (MVPA), a number of studies did not clearly identify the difference between higher and lower activity, or used other indices. Twenty-two studies gathered physical activity data via self- or parental report, and ten studies used an accelerometer or pedometer to objectively assess activity (several studies employed both methods).

Of these 25 studies, 24 examined the association between active commuting and the child’s total level of physical activity. That is, the studies looked at whether children who actively commuted also had higher levels of physical activity from all sources combined—the school commute itself, active commuting to other destinations, recreational activity, organized sport, or in-school physical activity. Of these 24 studies, 12 found that children who actively commute to school had significantly higher total physical activity levels than passive commuters (or irregular active commuters in some circumstances). Four additional studies found mixed results when data were stratified by gender or activity type. Eight studies found no significant association.

The magnitude of the difference between active and passive commuters varied greatly among studies. Seven studies examined the effect size in terms of additional minutes per day of activity. Results ranged from as little as 4.7 additional minutes of MVPA per day to as much as 45 additional minutes of MVPA per day with an average of approximately 28 minutes.
Potential differences by sex were examined in nine studies, but no consistent results emerged. Three studies found that higher physical activity was associated with active commuting for both boys and girls\textsuperscript{14, 16, 33}, one study found associations in boys but not girls\textsuperscript{35}, two studies found associations in girls but not in boys\textsuperscript{17, 22} and three studies found no association for either sex.\textsuperscript{3, 24, 29}

Similarly, there were no clear distinctions in results by age. Among adolescents (ages 13 to 18), six\textsuperscript{10, 11, 14, 15, 18, 20} of seven\textsuperscript{10, 11, 14, 15, 18, 20, 22} studies found a positive association between walking and total physical activity. Among 10 studies in younger children (age 12 or under)\textsuperscript{3, 16, 17, 19, 23, 25, 26, 29, 32, 34} six found mixed or positive results and four\textsuperscript{3, 26, 29, 32} found no association. One study examined two age groups separately, finding an association among younger children but not among adolescents.\textsuperscript{12}

Although active commuting includes both walking and cycling (as well as less common travel modes such as skateboard or rollerblades), only one study presented results separately for walkers and cyclists.\textsuperscript{22} This study found a significant association with total physical activity among walkers, but not among cyclists. This finding may be in part due to the use of accelerometers, which perform poorly at quantifying the activity involved in cycling. The remainder of the studies either looked at walking alone or at a pool of active commuters that included both cyclists and walkers. As such there is little data by which to compare the independent associations of active commute mode and physical activity.

\textit{Contribution to Total Physical Activity}

Four studies quantified active transport as a percent of total daily physical activity (PA).\textsuperscript{3, 14, 33, 35} In other words, these studies attempted to assess to what extent the commute itself contributed to children’s overall activity. The results varied greatly, ranging from 50\% to ‘negligible’.
The highest figure, obtained from a secondary analysis of a nationally representative dataset in Russia, found that active transportation to school accounted for 40-50% of total daily physical activity, implying that the walk to school itself may have been the children’s main source of activity. The questionnaire, however, had a limited definition of total physical activity, including the school commute, physical education classes and out-of-school active pursuits, but excluding walking to other destinations or other activity. The authors do not provide any data on the amount of time spent in the school commute or on the amount of total physical activity reported by the parents; this makes it difficult to judge how representative or unrepresentative the students might be of other locations.

A questionnaire-based study in Germany reported that active commuting accounted for 28.4% of daily activity. In this case, however, the pool of active commuters was restricted to those who traveled at least 1.5 km to school, thus excluding over 58% of potential participants and introducing a selection bias that accentuates the contribution of an active commute to total activity.

The two remaining studies used accelerometers to quantitatively assess physical activity, and both obtained much lower estimates. A study among five-year-olds in the UK found that the commute represented only 2% of total activity, and a study of nine-year-olds in Denmark gauged the contribution of the commute as “negligible”. However, the trip lengths in both these studies was short; the average trip took only 6 minutes (0.7 km) in the UK study, and 85% of students in the Denmark study had a trip of less than 15 minutes.

Active Commuting and Weight Levels in Children

Eighteen studies (Table 2) reported associations between active commuting and weight levels, as
assessed by body-mass index (BMI), overweight, obesity, or percent body fat. Two of the studies followed subjects prospectively and the remainder were cross-sectional. Fifteen studies used clinically measured weight values, while three studies relied on self-report and/or proxy-reporting by parents. Nine of the 18 studies found no significant association between active commuting and any measure of body composition. An additional five found significant results only for subgroups of the study population or for limited measures. Only three studies found a consistent association between active commuting and lower body weight, and the remaining one study found a significant association between active commuting and higher BMI.

The eight studies that found mixed or positive results were heterogeneous in terms of age, gender, geography and weight measurement. Li et al. found that overweight status was associated with active commuting among children age 7-17 in China; de Bourdeaudhuij et al. found similar results for children ages 11-19 in Belgium, and Gordon-Larsen et al. for children in grades 7-12 in the US. However, Tudor-Locke et al. and Rosenberg et al. both found an association in boys but not in girls; Ortega et al. found no association for BMI but an association among girls for smaller waist circumference (although not for boys); Evenson et al. found an association for children in grades 6-8 but not among those in grades 9-12; and Heelan et al. found an association with BMI among overweight children but not among normal-weight children. Interestingly, the study by Evenson et al. was the only study to differentiate between overweight children (BMI ≥85th percentile and < 95th percentile) and obese children (BMI ≥95th percentile) in the presentation of results. This study found that although overweight children were significantly less likely to walk to school than normal weight children, there was no
difference in active commuting between obese children and normal weight children.

**DISCUSSION**

Our review of the 32 studies that comprise this literature focuses on three fundamental questions: Is active commuting associated with overall physical activity in children? Is the commute itself a significant component of total physical activity? And is there an association between active commuting and BMI, weight or obesity?

Of 24 studies on active commuting and overall physical activity levels in children, 13 found a consistent positive association, and an additional three found positive results in subsets of the study population. A summary of these overall research findings is given in Table 3. The strength of the association is mixed, and a summary estimate is not possible due to the heterogeneity in study design. Nevertheless, in multiple studies in a number of countries, a significant association between physical activity and walking or cycling to school has been noted across many age groups of school children.

Regardless of this association, it remains unclear as to whether the commute trip itself is a significant component of total physical activity. Only two studies have used objective measurements to quantify the contribution of the trip to and from school.\(^3\),\(^35\) Neither study found the school journey itself to be significant, representing 2% or less of children’s overall activity. While data from two other studies assessed the contribution of the commute to be much larger, these two studies relied on self- or parental report, and in one case was restricted by definition to children with longer trip lengths.\(^14\),\(^33\) Given the paucity of this data, it is not yet possible to determine whether or to what degree the commute itself may be responsible for potentially higher levels of physical activity in children who walk or cycle.
With regards to the 18 studies that examined the association between commute mode and weight levels, only three found a consistent association, while an additional five found results in subsets of the population or for limited outcome measures. From this information, there does not appear to sufficient evidence to support an association between active commuting and body-mass index, overweight or obesity in schoolchildren.

There are several problems common to these studies that limit the interpretation of these results. The first of these has to do with the definition of active commuting and the potential for misclassification bias. Most studies dichotomized respondents into active commuters vs. passive commuters based on the student’s reported mode of “usual” transportation. However, if a sizable proportion of the students use a combination of modes to travel to school (e.g., walking on some days, traveling by car on others), the categorization may not be accurate, and a bias towards the null would occur. Two studies that have examined this question found quite different results. Tammelin et al. assessed the test-retest reliability of a questionnaire item on commuting to school among 15-16 year olds, and found an intraclass correlation coefficient of only 0.57 after two weeks.45 However, Heelan et al. found a concordance of 97% when elementary school students were questioned two days apart about their commute mode.23

Another limitation in this literature is the methodology of measuring physical activity. Only 10 of the 25 studies assessing physical activity levels used accelerometers or pedometers to objectively quantify the child’s activity. The remainder of the studies relied on self- or parental report. At a minimum, this is likely to introduce inaccuracy, especially in the estimate of the contribution of the commute to total daily physical activity. It also raises the potential for bias in the association between commute mode and physical activity, if active commuters recall or estimate their activity differently than passive commuters.
Perhaps most important among limitations is the issue of study design. Almost all of these studies examined cross-sectional associations between active commuting and physical activity/weight. As a result, causality cannot be inferred. While it is possible that active commuting stimulates additional physical activity in children, it is equally plausible that more highly active children are the ones who choose to walk or cycle. The findings in the literature lend support to the notion that active commuting could be a potentially important source of physical activity in school age children. However, to make this claim, the question of causation is a primary concern.

An active commute could lead to increased activity via any of three mechanisms: through the school trip itself, through increased opportunities for activity presented on the way to and from school, or from inducing physical activity at other times during a child’s week. Only on the first mechanism—the contribution of the commute itself to total physical activity—does the current literature offer any evidence. As described above, the evidence does not at this time support the contention that active commute trips comprise a significant component of children’s total physical activity.

As for the other potential mechanisms by which an active commute may cause increased physical activity, the literature is mute. Nevertheless, they are important considerations in the design of walking to school interventions. For instance, a walking school bus, where children are escorted to school in groups by supervising adults may have no effect if the true association between active commuting and increased physical activity is a result of spontaneous play that arises on the walk home. Although the walking school bus may expose more children to an active commute, in this example the design of the intervention would block the actual causal pathway that links the walk to school to increased total physical activity.
Finally, there is the issue of whether active commuting engenders activity elsewhere a child’s life: will a child who walks or cycles to school become more likely to walk or cycle elsewhere in his or her life? Or, conversely, does the active commute time come with an opportunity cost, limiting a child’s access to more organized and active forms of exercise? Only prospective quantitative analyses, particularly of successful walk-to-school programs, will be able to answer these questions.

Although interventions to increase the proportion of children walking to school have been successfully implemented, research investigating their impact on activity levels and health outcomes is virtually non-existent. Until such interventional data are available it is premature to suggest that promotion of active commuting will by itself result in an increase in physical activity or reduction in the rate of childhood obesity.

CONCLUSIONS

Overall, the studies examined in this systematic review suggest an association between children’s active commuting and higher physical activity levels. However, the research at this point hinges almost entirely on cross-sectional data, and is not able to address issues of causality. The association between active commuting and BMI/overweight is far less clear, with most studies finding no significant association. Future research should focus on measuring the impact of interventions that succeed in changing commuting behavior and quantifying the contribution of the commute to children’s daily activity.

Finally, when it comes to the school commute, physical activity and obesity are only two possible health outcomes. The decline in walking to school and interventions to reverse it must also be considered in a broader health context; traffic safety, air pollution (and exposure to it), and psychosocial benefits are other equally relevant potential health impacts. While evidence for
active commuting as an important intervention point for obesity is weak, cumulative positive health impacts may be substantial both for children and for their neighborhoods. If interventions to increase walking to school are effective in promoting walking, the full effect they have on the health of children should be more fully considered and investigated.

ACKNOWLEDGMENT

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REFERENCES


### TABLE 1 Association between Active Commuting to School and Physical Activity in Children

<table>
<thead>
<tr>
<th>Author, Year. Location</th>
<th>Study Design</th>
<th>Physical Activity Measurement</th>
<th>Participant Ages / Sex</th>
<th>Number of Children in Study (N)</th>
<th>Percent of Children Classified as Active Commute</th>
<th>Active Commute as % of Total Daily Activity</th>
<th>Association Between Active Commute Status and Overall Daily Activity Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bungum and Lounsbery, 2007. USA</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Mean age 15 / Both</td>
<td>2,689</td>
<td>4.7%</td>
<td>Not reported</td>
<td>Active commuters significantly more likely to meet guidelines for MVPA.</td>
</tr>
<tr>
<td>Dollman and Lewis, 2007. Australia</td>
<td>Cross-sectional</td>
<td>Parental report</td>
<td>Ages 9-15 / Both</td>
<td>1,643</td>
<td>31%</td>
<td>Not reported</td>
<td>No significant association with free-time physical activity. Active school commuters significantly more likely to use active transport to other neighborhood destinations.</td>
</tr>
<tr>
<td>Ford et al., 2007. UK</td>
<td>Cross-sectional</td>
<td>Accelerometer</td>
<td>Ages 5-11 / Both</td>
<td>239</td>
<td>48%</td>
<td>Not reported</td>
<td>No significant association with weekday or weekend activity, or with out-of-school activity.</td>
</tr>
<tr>
<td>Landsberg et al., 2007. Germany</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Age 14 / Both</td>
<td>626</td>
<td>62.6%</td>
<td>28.4%</td>
<td>Overall physical activity significantly higher in active commuters vs. non-active commuters for boys and girls, 9.3 vs. 6 hrs/week and 7.9 vs. 3.0 hrs/week, respectively.</td>
</tr>
<tr>
<td>Loucaides et al., 2007. Canada</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Mean age 15.6 / Both</td>
<td>1,398</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Significantly correlated with MVPA in urban and rural youth.</td>
</tr>
<tr>
<td>Saksvig et al., 2007. USA</td>
<td>Cross-sectional</td>
<td>Self-report and Accelerometer</td>
<td>Age 12 / Girls</td>
<td>1,596</td>
<td>15.7%</td>
<td>Not reported</td>
<td>Girls walking before and after school experienced significantly more total physical activity and MVPA than girls who did not; additional 13.7 minutes total PA and 4.7 minutes MVPA per day.</td>
</tr>
<tr>
<td>Martin et al., 2007, USA</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Ages 11-15 / Both</td>
<td>2,256</td>
<td>47.9%</td>
<td>Not reported</td>
<td>Children who live within a mile of school and who actively commute were significantly less likely to participate in organized physical activity. No association with free time physical activity.</td>
</tr>
<tr>
<td>Cooper et al., 2006. Denmark</td>
<td>Cross-sectional</td>
<td>Self-report and Accelerometer</td>
<td>Ages 10 and 15 / Both</td>
<td>919</td>
<td>73.5%</td>
<td>“Negligible”.*</td>
<td>Children who walked to school were more physically active than those using passive transport; 737 vs. 624 accelerometer counts per minute (cpm). Significant for girls, but not boys, when stratified by gender. No association in adolescents. No significant association with time spent on MVPA and active commuting.</td>
</tr>
<tr>
<td>Rosenberg et al., 2006. USA</td>
<td>Cross-sectional **</td>
<td>Self-report and Accelerometer</td>
<td>Grades 4-5 / Both</td>
<td>1,083</td>
<td>32.5%</td>
<td>Not reported</td>
<td>No association in girls or boys at baseline. No follow-up data provided.</td>
</tr>
<tr>
<td>Spinks et al., 2006. Australia</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Ages 5-12 / Both</td>
<td>518</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Active commuters were significantly less likely to have insufficient levels of physical activity; Odds</td>
</tr>
</tbody>
</table>
## Evidence on Walking to School

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Method</th>
<th>Age Group</th>
<th>Sample Size</th>
<th>Response Rate</th>
<th>Physical Activity</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexander et al., 2005. Scotland</td>
<td>Cross-sectional</td>
<td>Self-report and Accelerometer</td>
<td>Ages 13-14 / Both</td>
<td>92</td>
<td>38%</td>
<td>Not reported</td>
<td>MVPA was significantly higher in walkers vs. non-walkers; 123 vs. 97 minutes per day.</td>
</tr>
<tr>
<td>Fulton et al., 2005. USA</td>
<td>Cross-sectional</td>
<td>Self-report and Parental report</td>
<td>Grades 4-12 / Both</td>
<td>1,395</td>
<td>14%</td>
<td>Not reported</td>
<td>Active commuters were significantly more likely to partake in moderate physical activity 5+ times per week compared to passive commuters; Odds ratio=1.8.</td>
</tr>
<tr>
<td>Gordon-Larsen et al., 2005. USA</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Grades 7-12 / Both</td>
<td>10,771</td>
<td>26.7%</td>
<td>Not reported</td>
<td>Active commuters were significantly more likely to meet physical activity recommendations. (37.0% of participants meeting PA recommendations used active transport vs. 25.6% of participants not meeting PA recommendations).</td>
</tr>
<tr>
<td>Heelan et al., 2005. USA</td>
<td>Cross-sectional **</td>
<td>Self-report</td>
<td>Ages 9-11 / Both</td>
<td>320</td>
<td>33.3%</td>
<td>Not reported</td>
<td>Moderate activity was significantly higher in walkers vs. non-walkers; 56 vs. 45 minutes per day. No association with total physical activity or sedentary behavior.</td>
</tr>
<tr>
<td>Santos et al., 2005. Portugal.</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Grades 7-12 / Both</td>
<td>450</td>
<td>23.1%</td>
<td>Not reported</td>
<td>No association.</td>
</tr>
<tr>
<td>Schofield et al., 2005. Australia</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Grades 8 and 11 / Both</td>
<td>1,033</td>
<td>10.4%</td>
<td>Not reported</td>
<td>Active commuters were significantly more likely to be moderately active than passive commuters, OR=5.76.</td>
</tr>
<tr>
<td>Sirard et al., 2005. USA</td>
<td>Cross-sectional</td>
<td>Self-report and Accelerometer</td>
<td>Age 10 / Both</td>
<td>219</td>
<td>5%</td>
<td>Not reported</td>
<td>MVPA was significantly higher in regular active commuters vs. irregular and non-active commuters; an additional 24 minutes of activity per day.</td>
</tr>
<tr>
<td>Kremers et al., 2004. Netherlands</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Ages 12-18 / Both</td>
<td>3,859</td>
<td>36.8%</td>
<td>Not reported</td>
<td>No association.</td>
</tr>
<tr>
<td>Metcalf et al., 2004. UK</td>
<td>Cross-sectional</td>
<td>Accelerometer</td>
<td>Age 5 / Both</td>
<td>275</td>
<td>67%</td>
<td>2%</td>
<td>No association.</td>
</tr>
<tr>
<td>Ziviani et al., 2004. Australia</td>
<td>Cross-sectional</td>
<td>Parental report</td>
<td>Grades 1-7 / Both</td>
<td>164</td>
<td>Not reported</td>
<td>Not reported</td>
<td>No association.</td>
</tr>
<tr>
<td>Cooper et al., 2003. UK</td>
<td>Cross-sectional</td>
<td>Accelerometer</td>
<td>Age 10 / Both</td>
<td>114</td>
<td>65%</td>
<td>Not reported</td>
<td>In boys, MVPA significantly higher in walkers vs. non-walkers; 200 vs. 155 minutes per day. No association observed among girls.</td>
</tr>
<tr>
<td>Michaud-Thomson et al., 2003. Australia</td>
<td>Cross-sectional</td>
<td>Self-report and Pedometer.</td>
<td>Grades 4-7 / Both</td>
<td>491</td>
<td>11.5%</td>
<td>Not reported</td>
<td>Step counts significantly higher in walkers vs. non-walkers for both girls and boys; approx. 30-35 minutes of additional physical activity per day.</td>
</tr>
<tr>
<td>Tudor-Locke et al., 2003. Philippines</td>
<td>Cross-sectional</td>
<td>Self-report and Accelerometer</td>
<td>Ages 14-16 / Both</td>
<td>1,518</td>
<td>41.7%</td>
<td>Not reported</td>
<td>Boys and girls who walked to school had significantly higher Caltrac-derived energy expenditures than those that used motorized transport; 375 kcal vs. 331 kcal and 289 vs. 255, respectively.</td>
</tr>
</tbody>
</table>
**Evidence on Walking to School**

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Data Source</th>
<th>Ages</th>
<th>MVPA (%)</th>
<th>Physical Activity Level</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Tudor-Locke et al., 2002, Russia | Cross-sectional | Parental report, Ages 7-13 / Both | 1,094 | 91.6% | 40-50% *** | **Not reported.** ****Although the overall study design was prospective, data on total physical activity was treated cross-sectionally.*** ** Reported in Tudor-Locke et al. Active Commuting to School: An Overlooked Source of Children’s Physical Activity? Sports Med. 2001;3:309-313.** ** Reported in Cooper AR et al. Physical activity levels of children who walk, cycle, or are driven to school. Am J Prev Med. 2005;2:179-184.***

*MVPA* - Moderate-to-vigorous physical activity
### TABLE 2 Association Between Active Commuting to School and BMI / Overweight in Children

<table>
<thead>
<tr>
<th>Author, Year, Location</th>
<th>Study Design</th>
<th>Weight Measurement</th>
<th>Participant Ages / Sex</th>
<th>Number of Children in Study (N)</th>
<th>Percent of Children Classified as Active Commuters</th>
<th>Association Between Active Commute Status and BMI and/or Overweight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ford et al., 2007.</strong>&lt;br&gt;<strong>UK</strong>&lt;br&gt;Cross-sectional</td>
<td>Clinically measured</td>
<td>Ages 5-11 / Both</td>
<td>239</td>
<td>48%</td>
<td>No association with percent body fat or fat mass in boys or in girls, or by age group.</td>
<td></td>
</tr>
<tr>
<td><strong>Landsberg et al., 2007. Germany</strong>&lt;br&gt;Cross-sectional</td>
<td>Clinically measured</td>
<td>Age 14 / Both</td>
<td>626</td>
<td>62.6%</td>
<td>No association in boys or girls.</td>
<td></td>
</tr>
<tr>
<td><strong>Li et al., 2007.</strong>&lt;br&gt;<strong>China</strong>&lt;br&gt;Cross-sectional</td>
<td>Clinically measured</td>
<td>Age 7-17 / Both</td>
<td>6,826</td>
<td>Not reported.</td>
<td>Overweight children had significantly lower participation rates for active transport to school compared to normal weight children; 85% vs. 92%. Time spent in active transport, however, was not significantly different. Children who walked for transport to/from school had a significantly reduced risk for overweight compared to children who use the bus; Prevalence of 5.5 vs. 15.0, OR 0.6.</td>
<td></td>
</tr>
<tr>
<td><strong>Mota et al., 2007.</strong>&lt;br&gt;<strong>Portugal</strong>&lt;br&gt;Cross-sectional</td>
<td>Clinically measured</td>
<td>Grades 7-12 / Girls</td>
<td>705</td>
<td>52.6%</td>
<td>No association.</td>
<td></td>
</tr>
<tr>
<td><strong>Ortega et al., 2007. Spain</strong>&lt;br&gt;Cross-sectional</td>
<td>Clinically measured</td>
<td>Ages 13-18 / Both</td>
<td>2,859</td>
<td>10%</td>
<td>No association in boys. Active commuting associated with smaller waist circumference but not with BMI in girls.</td>
<td></td>
</tr>
<tr>
<td><strong>Saksvig et al., 2007. USA</strong>&lt;br&gt;Cross-sectional</td>
<td>Clinically measured</td>
<td>Age 12 / Girls</td>
<td>1,596</td>
<td>15.7%</td>
<td>No association.</td>
<td></td>
</tr>
<tr>
<td><strong>Cooper et al., 2006. Denmark</strong>&lt;br&gt;Cross-sectional</td>
<td>Clinically measured</td>
<td>Aged 9 and 15 / Both</td>
<td>919</td>
<td>73.5%</td>
<td>No association.</td>
<td></td>
</tr>
<tr>
<td><strong>Mota et al., 2006.</strong>&lt;br&gt;<strong>Portugal</strong>&lt;br&gt;Cross-sectional</td>
<td>Clinically measured</td>
<td>Grades 7-12 / Both</td>
<td>550</td>
<td>Not reported.</td>
<td>No association.</td>
<td></td>
</tr>
<tr>
<td><strong>Rosenberg et al., 2006. USA</strong>&lt;br&gt;Prospective cohort</td>
<td>Clinically measured</td>
<td>Grades 4-5 / Both</td>
<td>1,083</td>
<td>32.5%</td>
<td>Boys who actively commute had significantly lower BMI values at baseline; 17.25 vs. 18.0. No association in girls at baseline. No association between change in BMI values and active commuting over 2-year period. Active commuting not associated with overweight status.</td>
<td></td>
</tr>
<tr>
<td><strong>Fulton et al., 2005. USA</strong>&lt;br&gt;Cross-sectional</td>
<td>Proxy and Self-report</td>
<td>Grades 4-12 / Both</td>
<td>1,395</td>
<td>14%</td>
<td>No association.</td>
<td></td>
</tr>
<tr>
<td><strong>Gordon-Larsen et</strong>&lt;br&gt;<strong>Cross-sectional</strong></td>
<td>Clinically measured</td>
<td>Grades 7-12 / Both</td>
<td>10,771</td>
<td>26.7%</td>
<td>Active commuters significantly less likely to be overweight</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Study Design</td>
<td>Measurement</td>
<td>Age</td>
<td>N</td>
<td>Percentage</td>
<td>Results</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------</td>
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<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Heelan et al., 2005. USA</td>
<td>Prospective cohort</td>
<td>Clinically measured</td>
<td>Age 9-11 / Both</td>
<td>320</td>
<td>33.3%</td>
<td>Significant positive correlation between BMI and active commuting in overweight children; partial r=0.10. No association in normal weight children.</td>
</tr>
<tr>
<td>Klein-Platat et al., 2005. France</td>
<td>Cross-sectional</td>
<td>Clinically measured</td>
<td>Age 12 / Both</td>
<td>2,714</td>
<td>38.6%</td>
<td>Children actively commuting to/from school had significantly higher BMI values compared to those who did not. Length of commute (≤20 min vs. &gt;20 min) appeared to have no effect. Active commuters had BMI of 19.1-19.2 (boys) and 19.2-19.4 (girls) vs. passive commuters 18.6 (boys) and 18.8 (girls).</td>
</tr>
<tr>
<td>Sirard et al., 2005. USA</td>
<td>Cross-sectional</td>
<td>Clinically measured</td>
<td>Age 10 / Both</td>
<td>219</td>
<td>5%</td>
<td>No association between BMI or overweight status and commuting mode.</td>
</tr>
<tr>
<td>De Bourdeaudhuij et al., 2005. Belgium</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Ages 11-19 / Both</td>
<td>6,078</td>
<td>Not reported.</td>
<td>Normal-weight children spent significantly more time in active commuting than overweight / obese children (0.47 vs. 0.35 hours per week).</td>
</tr>
<tr>
<td>Cooper et al., 2003. UK</td>
<td>Cross-sectional</td>
<td>Clinically measured</td>
<td>Age 10 / Both</td>
<td>114</td>
<td>65%</td>
<td>No association.</td>
</tr>
<tr>
<td>Evenson et al., 2003. USA</td>
<td>Cross-sectional</td>
<td>Self-report</td>
<td>Grades 6-8 and Grades 9-12 / Both</td>
<td>4,448</td>
<td>7.1%-10.5%</td>
<td>Children in grades 6-8 within 85th to 95th percentile for BMI less likely to report walking to school compared to those below 85th percentile; no association found in this age above the 95th percentile. No association for students grade 9-12.</td>
</tr>
<tr>
<td>Tudor-Locke et al., 2003. Philippines</td>
<td>Cross-sectional</td>
<td>Clinically measured</td>
<td>Ages 14-16 / Both</td>
<td>1,518</td>
<td>41.7%</td>
<td>Boys using only motorized transport had significantly higher BMI values than boys who only walked; 18.9 vs. 18.2. No association in girls.</td>
</tr>
</tbody>
</table>

**BMI – Body Mass Index**
TABLE 3 Summary of Literature on Active Commuting to School, Physical Activity and Weight

<table>
<thead>
<tr>
<th>Number of studies reporting a statistically significant association</th>
<th>Active commuting and higher physical activity</th>
<th>Active commuting and lower weight / obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Inverse</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>No Association</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Mixed</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Not reported</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>18</td>
</tr>
</tbody>
</table>