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Evaluating the effects of active morning commutes on students' overall daily walking activity in Singapore: Do walkers walk more?

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ABSTRACT

Walking has multiple health benefits. One way to increase students' walking activity is by encouraging active morning commutes. However, students may compensate for active commutes by walking less throughout the day, rendering such initiatives ineffective in increasing overall walking activity. This study aims to assess how morning commuting modes affect students' walking levels, hypothesizing that gains in walking from active morning commutes may not be sustained throughout the day due to compensatory behavior. Our study analyzed objectively measured, sensor-collected data of 5600 children (ages 7 to 18) in Singapore for up to four consecutive weekdays between September and November 2015. Potential confounders of age, socioeconomic status, and built environment characteristics, as well as home-school distance as an effect modifier, were examined. We used linear mixed effects models to analyze differences in step count between students with different morning modes, as well as to analyze 'within students' variations when students switched between different modes over different days.

Students who walked or took public transport walked more than their driven peers during morning commuting hours, by 96.1 steps per hour (95% CI = 71.5, 120.8) and 54.1 steps per hour (95% CI = 32.2, 75.9) respectively. Students who switched morning commute modes from car to public transport took 47.6 more morning steps per hour (95% CI = 10.3, 84.9) when using public transport, compared to when driven. However, the relationship between morning travel modes and step count per hour across the full day was less clear-cut. Both our 'between students' and 'within students' analyses suggest that taking more active morning modes, after controlling for all possible confounders and modifers, was not associated with higher step counts over the entire day. Encouraging students to walk more through more active morning commutes alone may have limited effectiveness in increasing overall daily walking activity.

1. Introduction

Programs such as 'Safe Routes to Schools', 'Walk Safely to School Day' and 'Walking School Bus', which collectively seek to encourage students to adopt active commutes, such as walking or cycling to school, have been initiated in different countries in recent years (Chillón et al., 2011). Advocates of such initiatives see active commutes as a way to boost children's physical activity, which is associated with multiple positive health benefits including lowering risk of depression and anxiety, and improving skeletal and cardiovascular health (Janssen and LeBlanc, 2010; Strong et al., 2005). Physical activity has also been associated with improved academic performance (Rasberry et al., 2011). Active modes, compared to driving, also produce less local and global air pollutants (Rabl and de Nazelle, 2012).

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Both health and transport literatures, however, suggest that the total amount of walking activity one does may be bounded by a set-point. The 'activitystat' model posits that when an individual increases physical activity or energy expenditure in one domain, there is a compensatory change in another domain to maintain an overall stable level of physical activity or energy expenditure (Rowland, 1998; Gomersall et al., 2016). A 2012 meta-review of 30 studies on interventions to boost physical activity found strong evidence that physical activity interventions had only small effects on children's overall activity levels. One explanation for why physical activity interventions proved ineffective was that children compensated for imposed increased activity (Metcalf et al., 2012). Relatively few empirical studies have examined activity compensation in children, and findings from these have been mixed. One study found that students from one school with extensive sporting facilities and more hours of scheduled physical education a week were no more physically active than were students from another with much fewer physical education hours. The study thus concluded that students compensated for school physical activity when out of school (Mallam et al., 2003). Other studies however found no evidence of compensation (Dale et al., 2000; Goodman et al., 2011).

In the transport literature, several empirical studies suggest the existence of a 'walking budget', whereby individuals trade off leisure walking or other forms of activity with utilitarian walking (Oakes et al., 2007; Rodríguez et al., 2006; Krizek, Handy and Forsyth, 2009). Studies of active school commuting initiatives, however, generally do not reflect evidence of a walking budget or compensatory behavior. Literature reviews focused on active school travel and physical activity conclude that a preponderance of evidence supports associations between active school transport and more moderate-vigorous physical activity over the course of the day (Larouche et al., 2014; Faulkner et al., 2009). However, several studies have also found no gains in physical activity from active commutes to school. A recent study of Australian school children found that active travel modes to school were not associated with children's physical activity, though active travel to non-school destinations had a positive impact on increasing activity (Schoeppe et al., 2015). Research has also examined compensatory behavior in specific sub-groups of students. A 2017 study of 700 Canadian school-children found that the students who spent most time participating in sports were also the ones who spent the most time taking inactive modes of transport, compared to other groups of students, which suggests some degree of trade-off between travel and sporting activities (Mitra et al., 2017).

1.1. The current study

While research on active school travel often focuses on moderate-vigorous physical activity as a study outcome, this study focused on students' walking activity largely because of the data collection method. The organizers who designed and administered the data collection (see next section of this paper for details) instructed students not to carry their devices during vigorous activity, such as when playing sports. In this case, the data collection method conditioned our particular focus.

Past studies on school commutes and physical activity have largely focused on walking or cycling initiatives. However, commuting via public transport can also boost activity levels, as the need to walk or cycle at each end of a trip generates additional steps (Rissel et al., 2013; Sener et al., 2016). Our study thus examined the relationship between three modes of morning commuting: walking, taking public transport, and being driven – and overall walking activity of school-going children.

Furthermore, most of the studies on active school commutes were conducted in North American, Europe, Australia and New Zealand, with only few studies based in Asia. Our study sought to increase knowledge in this part of the world, by examining active school commutes in Singapore, a high-density Asian city-state.

Our analysis focused on morning travel mode, as initiatives encouraging active morning commutes are more straight-forward compared to those seeking to influence after-school travel, for several reasons. Morning commutes are more constrained, routine and predictable, as they happen within a narrower window of time and subset of possible travel routes, compared to after-school travel that is less restricted to between school and home. These 'constraints' allow schools to more easily organize programs such as collective walking from home to school, or even from nearby public transport stops to school, especially for younger students who may need adult supervision. Furthermore, compared to after-school commutes, morning commutes are more likely to be by car, as working parents are more available to drive their children to school before work than in the afternoon (Wong et al., 2011, Faulkner et al., 2010). Encouraging active morning commutes as a policy intervention would thus have a greater scope for change here.

While this study's primary focus was on morning school commutes, we also controlled for the effect of students' afternoon travel modes, as students who walked to school may have been more likely to walk home after school. Any net positive differences in step counts observed from those who walked to school in the morning may thus partially result from afternoon mode choices as well.

In addition to afternoon mode, we also controlled for other factors that could affect students' choice of morning mode and their overall walking activity. Specifically, we controlled for age, because older children tend to walk less than younger children (Barreira et al., 2015; Tudor-Locke et al., 2011) and are less likely be driven to school (Mitra and Buliung, 2015). Another factor we controlled for was socioeconomic status, which has been linked to increased walking (Sugiyama et al., 2015) and mode choice differences (Rachele et al., 2015) in adults. Research on the association between family income or parental socioeconomic position, and levels of physical activity in children and adolescents have been more equivocal, with some studies finding positive associations (Drenowatz et al., 2010), and others finding no association (Voss et al., 2008; Ball et al., 2009, Sener et al., 2016). As for school travel mode choice, in Singapore, where car-ownership is very expensive, students from richer families are more likely to be driven to school than those from poorer families (Department of Statistics, Ministry of Trade and Industry, Singapore, 2016)—a pattern observed in studies elsewhere, where lower neighborhood incomes are often associated with more active modes of school travel (Larsen et al., 2009).

We also controlled for the potential impact of neighborhood built environment, which may affect both school mode choice and how much walking one does within an area. Some studies focusing on active school travel have found built environment characteristics such as the density of street intersections, residential densities, and land-use mix to be significantly associated with active