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Adolescents who engage in active school transport are also more active in other contexts: A space-time investigation

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ABSTRACT

Background: Although active school travel (AST) is important for increasing moderate-to-vigorous physical activity (MVPA), it is unclear how AST is related to context-specific physical activity and non-school travel. This study investigated how school travel is related to physical activity and travel behaviours across time- and space-classified domains.

Methods: A total of 196 adolescents wore a Global Positioning System receiver and an accelerometer for 7 days. All data were classified into one of four domains: home, school, transport, or leisure. Generalized linear mixed models were used to compare domain-specific PA and non-school trips between active and passive school travellers.

Results: Active travellers accumulated 13 and 14 more min of MVPA on weekdays and weekend days, respectively. They also spent 15 min less time in vehicular travel during non-school trips, and accrued an additional 9 min of MVPA while walking on weekend days. However, those with no AST still achieved most of their MVPA in the transport domain.

Conclusions: AST is related to out-of-school physical activity and transportation, but transport is also important for those who do not use AST. As such, future studies should consider overall mobility and destinations other than school when assessing travel and physical activity behaviours.

1. Introduction

Being physically active during adolescence is important for physical, social, and emotional wellbeing (Janssen and Leblanc, 2010), and the development of physical activity behaviours which may persist into adulthood (Trudeau et al., 2004). Walking or cycling for transportation has been recognised as an effective way for young people to engage in physical activity, yet the mode share of these 'active travel' trips has been steadily declining over the last few decades, including in New Zealand (McDonald, 2007; Ministry of Transport, 2015). Consequently, more attention is being placed on understanding the environments and policies that support physical activity and active transportation across the lifespan (Sallis et al., 2006).

The majority of studies investigating how young people's travel behaviours relate to physical activity and the environment have focused exclusively on school travel (Larouche et al., 2014; Wong et al., 2011). The school trip's prominence is due to its commonality among all young people, the frequency of the school commute (10 times per week), and hence the cumulative physical activity potential of these trips. Although a significant contributor to physical activity on weekdays (Larouche et al., 2014), school travel may not truly represent the totality of an individual's activity patterns and travel behaviours, especially for those who live too far from school for walking or cycling to be a feasible travel mode choice (Duncan et al., 2016). The priority placed on the school trip has likely contributed to the conflicting evidence surrounding school travel and weight-related health markers, as indicated by recent reviews of over 70 studies (Faulkner et al., 2009; Larouche et al., 2014).

Adolescents can be physically active within numerous other contexts, particularly on non-school days. However, defining exposure to contextual or environmental influences is challenging, as movement through the environment occurs across space and time, varies from person to person, and is highly individualised (Kwan, 2009). Defining contexts in which people spend their time is shifting from static conceptualisations of place, which ignore the important role of time (i.e., the neighbourhood), to more fluid and dynamic constructs that take both time and space into account (Cummins et al., 2007; Kwan, 2013).

Global Positioning System (GPS) technology and custom-designed data processing software have been used to classify young people's

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activity behaviours into various domains which can be defined both temporally and/or spatially (Klinker et al., 2015; Rainham et al., 2012). The identification of these 'space-time' domains not only makes it easier to conceptualise activity patterns across time and space, but also how these domains are related to each other, and how these patterns vary among different groups of people. For example, travel behaviours may be related to physical activity accrued during leisure time, but these trends may differ between individuals living in urban and rural areas. Establishing where these disparities lie is important as they will likely aid the development of context- and population-specific behavioural, environmental, and policy initiatives.

Earlier studies investigating how school travel decisions are related to overall activity behaviours have focused purely on temporally-classified domains, such as before, during, and after school, and in the weekend (Cooper et al., 2003; Duncan et al., 2008; Smith et al., 2012). Although these studies demonstrated that active school travel was positively associated with out-of-school physical activity, they were unable to determine where, how, and for how long these activities occurred. Whether school travel behaviours are related to context-specific physical activity, or if these behaviours are representative of overall transportation practices, is not well understood. By utilising a combination of accelerometer-based activity monitors, GPS receivers, and innovative data processing methodology, the aims of this study were (1) to determine how objectively-assessed school travel mode is related to physical activity accumulated within various space-time domains, and (2) to determine how school travel behaviours correspond with non-school trips.

2. Methods

2.1. Participants

A total of 196 adolescents (12–18 years old) were recruited from seven secondary schools in Auckland and Wellington, located on New Zealand's North Island. Participants were a subsample of those recruited for the Built Environment and Adolescent New Zealanders (BEANZ) study. The BEANZ recruitment methodology has previously been described in detail (Hinckson et al., 2014). In brief, socio-economic status (SES) and meshblock-level (smallest census tract units available in New Zealand) walkability indices were calculated for all participants at the selected schools based on their residential addresses (obtained from the school prior to the consent process). These scores were organised into tertiles, and the highest and lowest tertiles were retained to create four strata: (1) high walkability, high SES; (2) high walkability, low SES; (3) low walkability, high SES and (4) low walkability, low SES. All participants residing in one of these strata were invited to participate via invitations distributed through each school. This strategy was chosen to maximise heterogeneity in the built environment and SES variables. Written informed consent and assent was obtained from parents and adolescents (respectively) prior to participation. From this pool of consenting students, a stratified subsample of approximately 30 students per school was selected to balance participants across the four strata. Participants in this subsample were assessed concurrently with the main BEANZ sample. Ethical approval was granted by the Auckland University of Technology Ethics Committee.

2.2. Instruments

2.2.1. GPS receiver

GPS receivers are able to predict their geographical location by processing signals received from satellites orbiting the earth. By logging this information over a period of time, movement across space can be recorded. The QStarz BT-Q1000XT is a commercially available GPS receiver that utilises the MTK II chipset. This device is known to have high accuracy while stationary (Duncan et al., 2013) and while moving in free-living conditions (Schipperijn et al., 2014). Using QTravel software (v1.46, Taipei, Taiwan) each device was initialised to log data every 15 s to maximise the frequency of data points whilst reserving memory capacity for a one-week period. Additional satellite information such as signal-to-noise ratio was also recorded to assist with indoor/outdoor detection and thus trip identification (see data reduction below).

2.2.2. Accelerometer

The activity monitor used in this study was the Actigraph GT3X+ (Actigraph, Pensacola, FL). This activity monitor contains a capacitive accelerometer capable of collecting raw acceleration information at a sampling frequency up to 100 Hz. These are small (46 mm×33 mm×15 mm) lightweight (19g) devices, and are widely used due to their ability to assess free-living physical activity intensity over an extended period with a low degree of participant burden (Cain et al., 2013). Each device was initialised to log raw data at 30 Hz using Actilife v6 (Actigraph, Pensacola, FL). The system time on the computer used to initialise all devices was synchronised with Coordinated Universal Time (UTC) so the internal clock of each accelerometer was aligned with each GPS receiver to allow the precise matching of data points during processing.

2.3. Procedure

Participant details were obtained from each child and parent during the consent process. Each school provided weekly timetables from which the start and end times for each school day were extracted. During school time, each participant was fitted with an accelerometer and GPS receiver using an elastic waist belt. Only those in the subsample wore a GPS receiver, while all participants in the BEANZ study received an accelerometer. The accelerometer was positioned over the right hip, and the GPS receiver was placed alongside in a small pouch. Each participant was taught how to wear the devices and how to charge the GPS receiver before they went to sleep at night. Participants were told that the GPS receiver should remain on at all times, but were provided with instructions how turn the device off and on again if necessary. The equipment was collected from the school eight days later, at which point each participant received a $20 shopping mall voucher thanking them for participating. Upon retrieval, accelerometer data were downloaded and aggregated to a 15-s epoch (using Actilife v6) to match the sampling frequency of the GPS receivers. All GPS and accelerometer data were converted to comma-separated values (csv) format in preparation for processing.

2.4. Data reduction

2.4.1. PALMS

All GPS and accelerometer data were uploaded to the Personal Activity Location Measurement System (PALMS; https://ucsd-palms-project.wikispaces.com). PALMS is a web-based tool designed to clean, merge and process multiple time-stamped data streams. PALMS was used to remove spurious points based on a set of filter criteria: points with a speed above 130 km/h, points with a change in elevation greater than 1000 m, or points with less than 10 m of movement over 3 sequential fixes were removed. After the accelerometer and GPS data were merged, PALMS identified individual trips based on sequential GPS points accumulated over a period of at least 2 min that spanned at least 100 m. Trip pauses were identified based on clusters of sequential points at a single location. The end of a trip was signified by a pause greater than 3 min or a loss-of-signal. Each GPS point was categorised as indoors or outdoors based on the signal-to-noise ratio (SNR): all points with a sum SNR of less than 225 were considered indoor points, and these were removed from the beginning and end of all trips. Each trip was assigned a mode of travel based on speed; minimum speeds were 35 km/h for vehicle, 10 km/h for bicycle, and 1 km/h for walking,