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Typologies of neighbourhood environments and children's physical activity, sedentary time and television viewing

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ABSTRACT

This study examined cross-sectional and prospective associations between clusters of neighbourhood attributes (typologies) and non-school moderate-to-vigorous physical activity, sedentary time (objectively measured) and proxy-reported television viewing among children aged 5–6 and 10–12 years. Four distinct clusters were identified from seven objectively-measured neighbourhood attributes (land use mix, traffic exposure, playgrounds, sports venues, intersections and cul-de-sacs within 800 m, crime/postcode). Some cross-sectional associations with behavior were found. Longitudinally, the cluster characterised by mixed land use and many playgrounds and sport venues was associated with less television viewing on weekends three years later. Considering the aggregate effects of urban form elements may help understand how combinations of neighbourhood attributes influence behavior.

1. Introduction

It is well established that physical activity during childhood has a number of important physical and psychological benefits (Janssen and LeBlanc, 2010). More recently, excessive sedentary behavior, particularly television viewing and screen time, has been associated with adiposity, markers of cardio-metabolic disease, poor dietary habits and poor academic performance among children (Pearson and Biddle, 2011; Rey-López et al., 2008; Saunders et al., 2014; Tremblay et al., 2011). In Australia, it is recommended that school-aged children and adolescents participate in 60 min of physical activity every day, spend no more than two hours a day in electronic media use for entertainment purposes, and reduce and break-up the amount of time they spend sitting (Australian Government Department of Health, 2014a, 2014b). However, only 19% of children and adolescents in Australia meet the guideline for physical activity and 29% meet the guideline for electronic media use (Australian Bureau of Statistics, 2013). Insufficient physical activity and excessive sedentary behavior are common around the world (Tremblay et al., 2014).

The last ten years have seen a substantial increase in research on the role of the built environment and neighbourhood conditions in shaping children's physical activity and sedentary behavior (Ding et al., 2011). Identifying aspects of the built and neighbourhood environment that support or discourage physical activity and sedentary behavior is attractive from a policy perspective, as urban planning has the potential to have a lasting impact on the whole population (Giles-Corti and King, 2009). However, most evidence of relationships between the built environment and children's physical activity is cross-sectional and comes from North America, with considerable variation in how neighbourhood attributes are defined and measured (Ding et al., 2011; Timperio et al., 2015). That evidence shows that children's physical activity is most consistently related to the recreation environment (parks/playgrounds, recreation/sport facilities), mixed land use, residential density, street connectivity and pedestrian safety structures (Ding et al., 2011; Timperio et al., 2015). The built environment can also influence sedentary behavior by discouraging outdoor activities and therefore promoting sedentary pursuits indoors, such as television viewing. In Australia, a two-year prospective study found that greater objectively-measured availability of sports options within 800 m of home was associated with less self-reported television viewing at follow-up among adolescents (Timperio et al., 2012), and living in a cul-de-sac was associated with less self-reported television viewing at follow-up among children (Veitch et al., 2011). Crime has been associated with more television viewing among girls (Brown et al., 2008), and access to places for physical activity with less television viewing (Roemmich et al., 2007; Veitch et al., 2011), while one study found no associations with aspects of street design (Roemmich et al., 2007).

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Despite advances in measurement of environmental attributes (Sallis, 2009), studies of neighbourhood environments rarely consider aggregate effects. Indices such as 'walkability' combine different, but correlated, attributes into a score (McCormack et al., 2012). However, neighbourhoods comprise many combinations of attributes, and the features that comprise these combinations may not be correlated and could have synergistic or opposing effects on physical activity and sedentary behavior (Wall et al., 2012). Researchers are beginning to use cluster-based statistical techniques to describe patterns of neighbourhood attributes (typologies) in relation to physical activity in adults (Adams et al., 2011; Charreire et al., 2012; Hooper et al., 2014; McCormack et al., 2012) and adolescents (Jago et al., 2006; McDonald et al., 2012; Nelson et al., 2006; Norman et al., 2010) based on self-report and/or objective assessment. These are data-driven approaches that reflect how attributes pattern 'on the ground' and may therefore provide a fuller picture of neighbourhood environments. Those studies have identified between three and seven distinct clusters of neighbourhood attributes. However, each study included different environmental features, making comparisons difficult. In general, studies among adults have found that typologies characterised as high in aspects of walkability and recreation facilities or destinations are associated with more walking (Adams et al., 2011; Charreire et al., 2012; Hooper et al., 2014; McCormack et al., 2012), but mixed results have been found in studies with adolescents.

Among adolescents, McDonald et al. (2012) identified four typologies that varied according to objectively-measured density of retail and public transport, walkability and distance to recreational facilities within 1.6 km. However, no cross-sectional associations with objectively measured physical activity and sedentary time, or self-reported screen time were found. Norman et al. (2010) identified three typologies based on objectively-assessed park, recreation and residential and other land uses, and the density of cul-de-sacs, and recreational and educational facilities. They found that girls living in residential areas with cul-de-sacs did less objectively-assessed moderate-to-vigorous physical activity (MVPA) than those living in areas characterised by open space or high density of both housing and facilities. They also found that boys accumulated less sedentary time if they lived in an area characterised by open space, compared to areas of high residential land use with cul-de-sacs. Other work used cluster analyses in a national sample to characterise 3 km neighbourhood buffers and identified six clusters based on objective neighbourhood features, crime and a range of socio-economic variables (Nelson et al., 2006). The odds of doing ≥5 bouts of self-reported MVPA were higher among adolescents living in neighbourhoods characterised as 'older suburban' compared to newer areas, and characterised as 'low SES, inner city' compared to 'mixed race, urban'.

There have been no studies examining associations between neighbourhood typologies and physical activity or sedentary behavior among children, and no longitudinal studies in any age group. The aims of this study were to identify neighbourhood typologies based on objectively-assessed neighbourhood attributes, and cross-sectional and three-year longitudinal associations with MVPA, sedentary time and television viewing among children aged 5–6 and 10–12 years at baseline.

2. Methods

Data were drawn from the baseline and first follow-up of the Health, Eating and Play Study (HEAPS), a study of urban 5–6 and 10–12 year-old children that began in 2002/3 (Salmon et al., 2006; MacFarlane et al., 2009). At both time points, participants were asked to wear an accelerometer for one week and their parents completed a proxy-report survey. These data were combined with objective measures of neighbourhood attributes generated using a Geographic Information System, and total reported incidents of crime within residential postcodes. Participants were followed up in 2006. The study was approved by the Deakin University Human Research Ethics Committee. The Department of Education and Training Victoria and the Catholic Education Office also approved data collection via schools.

2.1. Participant selection

Participants in the HEAPS study were recruited from Grade Prep and Grade 5/6 within 17 and 24 primary schools, respectively, in Melbourne and Geelong, Victoria, Australia. These schools were randomly selected from schools located in postcodes in the lowest, middle and highest quintiles of the Socioeconomic Index for Areas Index of Relative Disadvantage 2001 (an area-level measure of socio-economic status derived from Census data) (Australian Bureau of Statistics, 2003) with enrolments of at least 200 students. Recruitment packages were provided to students to take home for a parent or guardian. Active consent from parents was required and 1562 children took part (42% response rate). Parents were asked at baseline if they agree to be recontacted for future research, those that agreed (n=825) provided address details and were recontacted in 2006 and invited to participate in a follow-up study (415 parents provided active consent; children also provided informed written assent).

2.2. Measures

2.2.1. Socio-demographics

The responding parent reported their highest level of education and that of their partner's (if applicable). Maternal education was computed and collapsed into high (university or tertiary education), medium (completed high school or vocational training) and low (less than high school).

2.2.2. Non-school physical activity and sedentary time

Participants wore a hip-mounted ActiGraph accelerometer (AM7164-2-2.2C) for seven days. A custom-designed macro was used to extract minutes of MVPA (≥4 METS (Trost et al., 2011)) based on a standard age-adjusted regression equation (Freedson et al., 2005) and minutes of sedentary time (< 100 counts/min) (Ridgers et al., 2012) outside school hours on each weekday (ie. total weekday minus school hours) and for the whole day on each weekend day. Average minutes/day spent in sedentary time and MVPA, respectively, on weekdays were computed for those with at least three valid weekdays (defined as days on which the ActiGraph wear-time spanned ≥50% of the after-school period). Average minutes/day of sedentary time and MVPA on weekends were calculated for those with ≥8 h of wear-time on at least one weekend day. Accelerometer wear-time was computed by excluding periods of consecutive zero counts of ≥20 min (Cain et al., 2013). Average wear-time per valid day was computed for weekends and for weekdays outside of school hours. Sedentary time and MVPA accumulated during school hours were excluded as it is unlikely that the neighbourhood environment would influence activity during these times.

2.2.3. Television viewing

Parents proxy-reported their child's television viewing at baseline and at follow-up. They were asked the duration their child usually watches: 1) commercial, and 2) non-commercial television/DVDs on weekdays and weekend days. Response options were provided in 30 min increments (Salmon et al., 2006). Total duration (mins/day) of television/DVD viewing was computed for weekdays and for weekends. These items had good test-retest reliability (weekdays: ICC=0.74; weekends: ICC=0.77).

2.2.4. Neighbourhood attributes

Objective measures of neighbourhood attributes at baseline were computed using a Geographic Information System (packages ArcView