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Independent mobility on the journey to school: A joint cross-sectional and prospective exploration of social and physical environmental influences

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ABSTRACT

Background: Despite related physical/mental health benefits, children's independent mobility for school travel (i.e. walking/cycling without adult accompaniment) has declined in recent decades.
Purpose: To examine cross-sectional and longitudinal associations between social/physical environmental variables and independent mobility on the school journey.
Methods: Participants were 1121 9–10 year-olds residing within 1600 m of their school in urban/rural areas of Norfolk, UK in 2007 (T1). At one year (T2) 491 children were followed-up. At T1, parents survey-reported perceptions of the social/physical environment and rules regarding their child's physical activity. Characteristics of the neighborhood, route to school and school environment were measured using a Geographical Information System and school audits. At both time-points children survey-reported their usual travel mode and whether accompanied. Regression analyses were conducted in 2013.
Results: Around half walked/cycled to school without adult accompaniment (T1, 43%; T2, 53%). Parents often allowing their child to play outside anywhere within the neighborhood (adjusted odds ratio (AOR) 3.14 (95% CI 1.24–7.96)) and household car access (AOR 0.27 (95% CI 0.08–0.94)) were associated longitudinally with boys walking/cycling independently to school. Land use mix (AOR 1.38 (95% CI 1.06–1.79)), proportion of main roads in the neighborhood (AOR 0.67 (95% CI 0.47–0.94)) and parental encouragement for walking/cycling (AOR 0.40 (95% CI 0.20–0.80)) were associated longitudinally with girls walking/cycling independently to school.
Conclusions: Interventions should develop parents' skills to teach their children to be independently mobile and to build confidence regarding venturing out without parental accompaniment. Urban planners should consider designing neighborhoods in which residences, business/retail outlets and sports facilities are co-located to promote active transport.

1. Introduction

Having identified physical inactivity as a major risk factor for global mortality, the World Health Organisation (WHO, 2010) recommends that school-aged children engage in at least one hour of moderate-to-vigorous physical activity daily. Nowadays, children's leisure time is increasingly spent indoors, often using electronic entertainment media (Karsten, 2005; Tandy, 1999). Therefore, strategies that promote physical activity among youth are vital. One example is the promotion of active transport (e.g. walking/cycling) to school, as this may encourage habitual physical activity among school-aged children (Tudor-Locke et al., 2001). Two comprehensive literature reviews of predominantly cross-sectional studies identified that children who walk/cycle to school are more physically active overall than those who travel by motorized modes (Faulkner et al., 2009), and that this behavior is associated with lean body composition and improved cardiorespiratory fitness (Lubans et al., 2011).

Independent mobility refers to children's freedom to move around their neighborhood (or similar) without adult accompaniment (Hillman et al., 1990). Independent mobility whilst walking/cycling to destinations within the local neighborhood (e.g. school, shops) provides unsupervised opportunities for interaction with the built (Rissotto and Tonucci, 2002) and natural environments (Bixler et al., 2002) and for development of spatial and navigational skills (Rissotto and Tonucci, 2002). It may

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be beneficial also for building friendships (Prezza et al., 2001) and a sense of community (Prezza and Pacilli, 2007). Despite these benefits children's independent mobility for school travel has declined in recent decades. For example, a study of English schoolchildren (Hillman et al., 1990) reported that between 1971 and 1990 the proportion of seven-year-olds who traveled to school without adult accompaniment declined from more than 70% to less than 10%. A recent Australian study (Carver et al., 2012) reported low rates ($<40\%$) of walking and cycling to school without adult accompaniment among primary (elementary) schoolchildren in urban areas, and even lower rates ($<30\%$) in rural areas.

According to socio-ecological modeling of health behaviors (Sallis and Owen, 1997) there are multiple layers of influence of intrapersonal, social and physical environment variables on an individual's health behaviors. In line with the ecological model, it appears that many children now have limited opportunities to spend time outdoors independently due to parental concern about neighborhood safety. Previous research suggests that social environmental factors such as parental concerns about road safety and 'stranger danger' are associated with lower levels of independent mobility on the school commute (Hillman et al., 1990; Carver et al., 2008). However there is a paucity of longitudinal research that examines environmental predictors of change in independent mobility. Following the rationale of Moudon and Lee (2003), physical environmental variables that may influence independent mobility on the school journey are the neighborhood surrounding the child's home, the route to school, and the school environment. However the relative importance of these environments is not known. Hence, the aim of this study was to examine cross-sectional and longitudinal associations between a range of social and physical environmental variables and independent mobility on the journey to school among primary (i.e. elementary) schoolchildren in Norfolk, UK.

2. Methods

2.1. Sample

Children's data were drawn from the Sport, Physical activity and Eating behavior: Environmental Determinants in Young people (SPEEDY) study and the recruitment methods have been published previously (van Sluijs et al., 2008; Corder et al., 2010). Briefly, at baseline (T1) 2064 children (response rate 57%) aged 9–10 years were recruited from 92 schools in urban and rural areas of Norfolk, UK. Between April and July 2007 children completed a questionnaire at school, and parents completed a questionnaire distributed in take-home packages. Children were followed up by postal communication at one year (T2) between April and July 2008 ($n=1019$; response rate, 49%), when they completed a second questionnaire while still at the same school. No follow-up information was collected from the parents. There were no significant differences in baseline physical activity levels (Corder et al., 2010) or travel mode between participants and non-participants of the follow-up study. At each time-point, parental consent was obtained prior to data collection. Ethical approval was obtained from the University of East Anglia research ethics committee.

2.2. Measures

2.2.1. Independent mobility on the school journey

At each time-point children reported how they usually traveled to school (response options were: by car; bus/train; bicycle; or on foot) and with whom (possible responses were: alone; with a brother/sister; a parent/other adult; a friend; another person – children were asked to select all that applied). At each time-point a dichotomous measure of independent mobility was defined to indicate whether children walked/cycled without adult accompaniment and assigned values of (0) 'walked/cycled to school with adult accompaniment or used a motorized travel mode'; (1) 'no adult accompaniment when walking/cycling to school'. Because the likelihood of using active transport decreases sharply with increasing distance, there was examination only of those children who could feasibly walk/cycle to school independently, defined as those residing within 1600 m of their school (Timperio et al., 2004). Although independent mobility was measured at each time-point, explanatory variables were measured only at T1.

2.2.2. Socio-demographic variables

Parents reported car ownership and their highest education level (a proxy for socioeconomic position). This was collapsed into three categories: low (high school leaving certificate or less); medium (vocational above high school); high (university education or above). Children reported their sex, age, number of siblings and bicycle ownership.

2.2.3. Objective environmental measures

Using a Geographical Information System (ESRI ArcGIS 9.2) and the Ordnance Survey database Mastermap Address Layer 2, children's home addresses were mapped. Area-level socioeconomic deprivation was measured using the English Index of Multiple Deprivation (IMD; Department of Communities and Local Government, 2007) based on these addresses. Objective environmental measures that were significantly associated with active transport to school among these children at T1 (Panter et al., 2010a) were examined as predictors of independent mobility on active school journeys at each time-point. These measures are described previously (Panter et al., 2010b), but briefly are categorized as 'neighborhood', 'route (to school)', and 'school' characteristics (Table 1). Each child's neighborhood was defined as the area within an 800 m pedestrian network buffer around their home, representing an area within 10 min walk. Characteristics of routes to schools were examined within a 100 m buffer of the shortest route between home and school. School characteristics were identified by an on-foot audit of facilities in the school grounds that may promote walking/cycling and by surveying principals on their school policies towards active transport (Panter et al., 2010a).

2.2.4. Perceptions of the social and physical environment

Survey measures of perceptions of the social and physical environment that were significantly associated with active transport to school among these children at T1 (Panter et al., 2010b) were considered and are described in Table 2. Using responses to seven parent's questionnaire items on perceptions of social cohesion and trust, a sense of community score was computed (internal reliability: Cronbach's $\alpha=0.90$) (Panter et al., 2010b). Using child questionnaire responses (1 'yes'; 0 'no'), the following were examined: whether the child was encouraged by a friend or a parent to walk/cycle to school and whether they considered their neighborhood safe for walking or playing alone during the day (Table 2).

A neighborhood walkability score was computed using responses to 24 items in the parent's questionnaire on perceptions of how supportive their neighborhood was for walking/cycling. For example, perceptions of road safety, street connectivity, availability of footpaths/bike trails were measured (internal reliability: Cronbach's $\alpha=0.74$) (Panter et al., 2010a). In addition, parents reported their level of agreement (using a five-point Likert scale) with two items regarding traffic and safety concerns on the route to school (Panter et al., 2010a). Responses were dichotomized: 1 'agree/strongly agree'; 0 'strongly disagree/disagree/neither' (Table 2).

2.2.5. Parental rules regarding their child's physical activity

Parents were asked how often they or their partner (1) restricted their child from walking/cycling to a friend's house and (2) allowed their child to play outside anywhere within the neighborhood. Responses were dichotomized: 1 'often/very often'; 0 'else (i.e. never/rarely/sometimes)' (Table 2).

3. Data analyses

In 2013, independent mobility while walking/cycle on the school journey was examined at each time-point. Chi-squared tests of significance were performed to examine significant differences in independent mobility on the school journey by sex of the child. A series of bivariate logistic regression analyses examined cross-sectional associations between each explanatory social and physical environmental variable and the odds of independent mobility on the school journey at T1. Data analyses were conducted in Stata (Stata, version 12.0) using the 'cluster' option to allow for non-independence of children within the same school. Analyses were stratified by sex as boys tend to be granted independent mobility at an earlier age than girls (Hillman et al., 1990). All variables that were significantly associated ($p<0.05$) with independent mobility at T1 were entered into a multiple logistic regression model.

To examine social and physical environmental variables at baseline as predictors of change in independent mobility, this analysis strategy was repeated except that the outcome variable was independent mobility on the school journey at T2, controlling