ORIGINAL ARTICLE

Relationship between walking levels and perceptions of the local neighbourhood environment

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Objective: To explore the relationship between frequency of walking trips, perceptions of the local environment and individual travel preferences in children.

Design: Cross-sectional questionnaire-based study.

Setting: Six primary schools in Birmingham, UK, range of socioeconomic classifications.

Participants: 473 children aged 9–11 years (82% response rate), including 250 (52.9%) boys and 160 (33.8%) from ethnic minority populations.

Outcome measures: The primary outcome measure was level of walking (high or low) based on self-reported walking frequency in the past week. Secondary outcome measures included child perceptions of seven aspects of the local environment and individual travel preference. All outcomes were measured through questionnaires administered at school in the presence of a researcher.

Results: 198 (41.9%) children were classified as high walkers and 275 (58.1%) as low walkers. After adjusting for confounding factors, high walkers were more likely to perceive heavy traffic surrounding their homes (odds ratio (OR) 1.55, 95% confidence interval (CI) 1.03 to 2.33), unsafe streets (OR 1.88, 95% CI 1.27 to 2.80) and prefer healthier modes of travel (OR 1.67, 95% CI 2.56 to 1.08). High walkers were less likely to worry about strangers (OR 0.66, 95% CI 0.45 to 1.02) and less likely to report no parks or sports grounds nearby (OR 0.66, 95% CI 0.42 to 1.02). Children from ethnic minority groups walked significantly less than white children (mean number of walking trips 16.8 and 21.9, respectively, $p < 0.001$).

Conclusions: Certain environmental perceptions are related to walking levels in children. Awareness of these may help in the development of future interventions, and also enable healthcare professionals to encourage walking by providing case-specific and appropriate advice.

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The prevalence of childhood obesity is rising both in the UK¹ and globally,² and is associated with an increased risk of psychological morbidity,³ type 1 and type 2 diabetes,⁴ asthma⁵ and adult cardiovascular risk factors.⁵ Around 50% of obese children become obese adults, with resulting morbidity and mortality.^{5–6}

Increasing evidence suggests the health benefits of moderate intensity physical activity (defined as 3–6 metabolic equivalent-hours) in relation to cardiorespiratory fitness and diabetes prevention.^{7–8} Daily walking is the simplest form of moderate intensity physical activity,⁹ and can definitely be incorporated into daily life routines.^{10–11} A reduction in walking levels by children has been suggested as one factor for the rise in childhood obesity.^{12–14} It is recommended that children perform at least 60 min of moderate intensity physical activity every day,¹⁵ yet only around two thirds of children aged 2–11 years achieve this level.¹⁶ Interventions to increase physical activity among children have met with limited success, indicating the need for a greater variety of intervention types.^{17–18} An intervention trial in London to increase walking to school failed to considerably increase walking among participants,¹⁹ and was thought to be hampered by parental fears of child safety and traffic congestion. However, a walking intervention in a rural area of California, USA, which included, as a key component, employment of a traffic engineer to identify and create safe routes, succeeded in increasing walking to school.²⁰ Physical environmental factors (perceived and objectively measured) are associated with levels of physical activity in children.²¹ Relatively few of these studies have examined the effects of the broader neighbourhood. However, a cross-sectional study of more than 1200 primary school children in Australia found associations between children's walking levels and their perceptions of the local neighbourhood environment.²² Further studies are needed¹⁴

to confirm these findings and determine which factors contribute to walking levels, so as to aid the development of future interventions.

This cross-sectional questionnaire-based study investigates whether perceptions of the local environment and individual travel preference are related to walking levels in children attending schools in Birmingham, UK.

PARTICIPANTS AND METHODS

Participants

Purposive sampling was used to recruit six primary schools representative of Birmingham's population. We ensured one school was of high, three of medium and two of low socioeconomic classification, based on the percentage of pupils eligible for free school meals, and that two schools comprised at least 50% pupils from ethnic minority groups. Schools meeting these criteria were contacted until six were willing to participate. All pupils in classes five and six (9–11-year-olds) at these schools with informed parental consent and who were present on the day of data collection participated. This age group was chosen because of the evidence that lifelong patterns of physical activity are being established at around that age.²³ Questionnaires were completed in schools, with researchers present to read the questions aloud, answer queries and ensure no "copying" of answers. Parents were asked to complete questionnaires at home.

The proposal was approved by the South Birmingham Student Research Ethics Committee.

Measures

The child questionnaire comprised three sections. The first covered sociodemographic information including questions

Table 1 Background characteristics of the participating children (n = 473)

Characteristics	n (%)
Sex	
Male	250 (52.9)
Female	223 (47.1)
School year (age)	
Class 5 (9–10 years)	264 (55.8)
Class 6 (10–11 years)	209 (44.2)
Ethnicity	
White	310 (65.5)
Minority ethnic group	160 (33.8)
Asian	68 (14.4)
Black	51 (10.8)
Chinese	8 (1.7)
Mixed	28 (5.9)
Other	5 (1.1)
Not specified	3 (0.6)
Number of cars	
0	75 (15.9)
1	187 (39.5)
2	208 (44.0)
Not specified	3 (0.6)
Number of rooms in the principal house (excluding kitchen, halls, bathrooms)	
1–3	84 (17.8)
4–6	294 (62.2)
7–10	77 (16.3)
>10	10 (2.1)
Not specified	8 (1.7)

about sex, ethnicity, family vehicle ownership and number of rooms in primary residence, as a proxy for socioeconomic status. The second section asked about walking frequency in the past 7 days, to or from a list of destinations. This list was derived after consultation with a group of parents and their 9–11-year-old children. The group of seven boys and girls and six parents was obtained through convenience sampling. DA conducted this consultation, and members were asked about where children had walked in the past month, where they normally walk to and what made children and parents choose walking over other means of transport for each destination. All members of the group mentioned that if the child's school was en route to the parents' workplace, the child would be driven to school, regardless of perceptions of the local environment. We therefore did not include school as a destination in the second section of the questionnaire. The third section asked about the children's perceptions of the local environment. These questions were modified from questions developed by Timperio *et al*,²² with test–retest reliability ranging between 0.72 and 0.85. Modifications were based on the results of a pilot study on a group of 20 children, aged 9–11 years-old, obtained through convenience sampling. These children indicated that minor rephrasing of the response options would make the questions easier to understand and respond to. For example, the original questionnaire asked children the extent of agreement with the statement the “roads are safe around where I live” on a Likert scale. This was modified to ask children to rate the safety of the roads where they live on a Likert scale (very safe, fairly safe, not that safe, dangerous, I don't know). This alternative response classification also reduces acquiescent bias—the tendency of participants to agree with statements. A question on travel preference was also included, asking how, if they lived a 15-min walk away, children would prefer to travel to school.

Parental reports of children's physical activity levels are relatively accurate,^{24–25} whereas evidence of the validity of children's self-report is more ambiguous.^{26–27} The parental questionnaire therefore asked about the frequency of the child walking to or from destinations in the past 7 days. This was designed to measure the construct validity of questions regarding the frequency of the child's walking by comparison of the walking frequency as reported by each child with that reported by the parents.

Data storage and analysis

Data were entered into a password-protected database. Ten per cent of the data were double entered to check for data entry errors. Descriptive statistics were used to characterise the sample and describe the perceptions of their local environment. Walking frequency was defined as the total number of walking trips to or from the various destinations. We used the *t* test to compare the mean number of walking trips, categorised by sex, ethnicity and car ownership. Responses to the questions on perception of the local environment were collapsed into dichotomous variables of low or high anxiety. For example, responses to the question on safety of roads in the neighbourhood were categorised as low anxiety if the respondent had indicated “very safe” or “fairly safe”, and as high anxiety if the response was “not that safe” or “dangerous”. Travel preference was also categorised into healthy (if preferred to travel by walking or bicycle) or unhealthy (if preferred to travel by bus or car).

Children who walked more than the mean number of walking trips were classified as high walkers, with the remaining children classified as low walkers. A separate categorisation of children into high and low walkers was made on the basis of reported child walking from the parental questionnaires. This classification was compared with the classification based on child questionnaires, through calculation of a Cohen's κ value.

We examined the relationship between walking levels (high or low walker) and travel preference and perceptions of the local environment (high or low anxiety) using the χ^2 test. We first obtained crude odds ratios (ORs) and 95% confidence intervals (CIs) for the likelihood of being a high walker, according to the perception of each factor in the environment, and for healthy and unhealthy travel preference. Binary logistic regression was used to obtain values adjusted for potential confounding factors (including school year, sex, ethnicity, car ownership and number of rooms in the principal house).

RESULTS

Parents of 579 children were informed of the study and 473 (81.7%) consented to their children participating in data

Table 2 Mean number of walking trips to or from each destination in the past 7 days

Destination	Mean (%) number of walking trips in the past 7 days
Shops	4.1 (20.4)
Just going for a walk	3.3 (16.2)
Parks or playgrounds	2.8 (14.1)
Friend's houses	2.8 (14.1)
Bus stops or train stations	1.7 (8.3)
Walking the dog	1.6 (8.2)
Leisure centres	1.1 (5.3)
Places of worship	1.02 (5.1)
Other destinations	1.65 (8.2)

Table 3 Perceptions of the local environment and other factors associated with high levels of walking, based on children's questionnaire

Factor	n (%)	Unadjusted OR (95% CI), predicting high walkers	Adjusted OR (95% CI) predicting high walkers†
Think there is heavy traffic in the streets near where you live			
High anxiety	161 (34.0)	1.50 (1.02 to 2.21)*	1.55 (1.03 to 2.33)*
Low anxiety	312 (66.0)	1	1
Parents think there is heavy traffic in streets near where you live			
High anxiety	156 (33.0)	1.58 (1.07 to 2.33)*	1.67 (1.11 to 2.51)*
Low anxiety	317 (67.0)	1	1
Worry about strangers when out alone			
High anxiety	297 (62.8)	0.66 (0.45 to 0.96)*	0.66 (0.45 to 1.02)
Low anxiety	176 (37.2)	1	1
Parental warning about strangers when going out alone			
High anxiety	360 (76.1)	0.84 (0.55 to 1.29)	0.85 (0.55 to 1.34)
Low anxiety	113 (23.9)	1	1
Safety of roads near where you live			
High anxiety	206 (43.6)	1.81 (1.25 to 2.62)**	1.88 (1.27 to 2.80)**
Low anxiety	267 (56.4)	1	1
Parental perception of safety of roads where you live			
High anxiety	179 (37.8)	1.88 (1.29 to 2.74)**	2.02 (1.36 to 3.00)**
Low anxiety	294 (62.2)	1	1
No parks or sports grounds near where you live			
Agree	126 (26.6)	0.70 (0.46 to 1.06)	0.66 (0.42 to 1.02)
Disagree	347 (73.4)	1	1
Preferred transport mode			
Car or bus	332 (70.2)	0.59 (0.39 to 0.90)*	0.60 (0.39 to 0.93)*
Walk or cycle	141 (29.8)	1	1

*p<0.05; **p<0.005; ***p<0.001.

†Adjustment for school year, sex, ethnicity, car ownership and number of rooms in primary residence.

collection. Of the 579 parental questionnaires administered, only 191 (33.0%) were returned.

Background characteristics

Table 1 summarises demographic characteristics of the children: 250 (52.9%) were boys, 132 (27.9%) were from ethnic minority groups and 395 (83.5%) had at least one vehicle owned by their family.

Construct validity of walking questions

We found 82.8% agreement between the classifications from the child questionnaire and those from the adult questionnaire, with Cohen's $\kappa = 0.59$.

Walking frequency

The mean number of reported walking trips made in the past 7 days was 20.1 (median 18.0, range 0–77). In all, 198 (41.9%) children were classified as high walkers and 275 (58.1%) as low walkers. The most common destination was the shops (table 2).

We found no significant difference between boys and girls in the mean number of walking trips (20.7 v 19.5, respectively; $p = 0.38$). Children from minority ethnic groups walked significantly less than white children (mean walking trips 16.8 v 21.9, respectively; $p < 0.001$). Using the number of rooms in their residence as a proxy for social class, we found no difference in the mean number of walking trips between those living in houses with 1–10 rooms, but the small proportion (2.1%) living in a house with >10 rooms were significantly less likely to walk compared with the rest (mean number of walking trips 5.8 for >10 rooms v 20.3 for ≤ 10 rooms; $p < 0.001$). Children from families without access to a vehicle walked significantly more than those with access to a vehicle (mean number of walking trips 23.2 v 19.6, respectively; $p = 0.04$), but there was no significant difference in walking level between

those with access to one car and those with access to two or more cars.

Perception of the local environment

A minority (about a third) of children rated their neighbourhoods as having heavy traffic or the roads as being dangerous. Child and parental anxiety about strangers were the most prevalent perceptions (62.8% and 76.1%, respectively). A perceived lack of suitable nearby parks or sports grounds was the least common perception (26.6%).

Preferred method of travelling to school

While travelling to school, walking was most popular (172/473 children; 36.4%) method, followed by cycling (160/473 children; 33.8%) and travel by car (123/473 children; 26.0%). Only 16 (3.4%) children preferred to travel by bus.

Relationship between perception of the local environment and walking level

High walkers were more likely to perceive that there is heavy traffic in the streets near their homes and that the roads are dangerous. They also tended to be in the older years in school. Low walkers, on the other hand, were more likely to worry about strangers, to report that there were no suitable parks or sports grounds to play near their residence and to prefer travelling to places by car or bus. After adjustment for potential confounding factors, most of these relationships remained significant (table 3). The exception was worry about strangers, which was of borderline statistical significance.

DISCUSSION

To our knowledge, this is the first study in a UK population to examine the effects of perceptions of the local environment on walking in children. Studies in adults have identified

neighbourhood aesthetics and convenience as perceptions strongly associated with walking levels,^{28, 29} calling for urban planning interventions. However, our study is one of few that have examined this relationship in children.

We found that children's perceived lack of suitable leisure space in their neighbourhood and worry about strangers were associated with lower walking levels. Conversely, perception of heavy traffic and low road safety in the vicinity were associated with higher walking levels. In addition, children from ethnic minority groups and those living in a larger home and who had at least one car in the household tended to walk less. We also observed a relationship between preference for travel by car or bus and lower walking levels. Our study was based on 473 children from a range of different schools, which provided sufficient power to examine a range of factors. The questionnaire used was a modified version of a previously validated instrument, and the levels of walking reported by children were validated against those given by a sample of the children's parents.

Most of our findings are consistent with those of a previous study in Australia that found an association between concerns about heavy traffic and higher walking levels, and perception of a lack of parks and lower walking levels.²² In contrast with our study, however, the Australian study did not find any relationship between reported fear of strangers and walking. The prevalence of worry about strangers was higher in our study. This may be because Birmingham, being a relatively congested, deprived city,³⁰ is perceived as more dangerous, and worry about strangers may be a greater concern. Another study on 10-year-olds in Australia used a combination of qualitative and quantitative methods to examine the effect of perceptions of the local environment on physical activity levels.²¹ Hume *et al*²¹ found a relationship between perception of opportunities for physical activity in the neighbourhood and physical activity among girls. However, they found no relationship between physical activity levels and number of streets or number of parks in the neighbourhood. The difference in methods makes comparison with our study difficult.

Interpretation and implication of findings

The finding that child perception of parental concern over road safety and heavy traffic was associated with a higher walking level may seem unexpected. However, children who are high walkers may often be warned by their parents about road danger, and therefore begin to perceive the roads as dangerous. Such parental warnings should not, however, lead children to avoid walking in the future. Along with increasing pedestrian walkways and crossings,³¹ a structured road safety education programme in primary schools may promote safe walking.²⁰

Worry about strangers was associated with a low walking level, possibly in a causal relationship. Fear of strangers may be a contributing factor in the trend towards children having to be older before being allowed to go out alone.³²

Children who preferred healthy travel were more likely to be high walkers. This may be causal, but certain children may lack the autonomy to choose how much they can walk.³² High walkers may therefore learn to prefer more active travel. Any intervention that increases children's walking may therefore be self-sustaining, in that children who walk more will prefer healthy transport and walk or cycle more in future.

In summary, our findings suggest that perceptions of the local environment are related to walking levels in children. In the context of the increasing obesity epidemic, and the tracking of behaviours from childhood to adulthood, promoting walking in childhood can have major beneficial health consequences in the long term. Our study can contribute to planning interventions for promoting physical activity in children, and hence

What is already known on this topic

- The prevalence of childhood obesity is rising and innovative interventions are needed to prevent this rise.
- Perceptions of the local environment affect walking levels in adults and may also affect levels in children.

What this study adds

- Certain environmental factors are associated with walking levels in children. Perception of lack of leisure facilities in the neighbourhood, worry about strangers when out alone and a preference for travel by car or bus are associated with low walking levels in children.
- Awareness of these factors may inform the development of interventions to increase walking by children.

prevent obesity. We have also identified that children from ethnic minority groups, especially Asian children, walk considerably less than white children, and should be particularly targeted for such interventions.

Our study has certain limitations. Although the findings have highlighted several hypotheses about the influence of perceptions of the local environment on children's walking levels, the cross-sectional nature prevents drawing causal inferences. Walking levels in this population may be higher than in the general child population, as the schools that agreed to participate may have more interest in promoting exercise, leading to an unrepresentative sample. However, this is countered by the advantage of a high response rate and using a variety of schools of different socioeconomic and ethnic mix.

Self-report of walking levels may be subject to social acceptability and recall bias, both resulting in over-reporting. However, we did partially validate our findings by comparing these against parental reports in a sample, and found good agreement. Although parental reports are shown to be relatively accurate, further validation using an objective measure would have been preferable. The questionnaires were administered in February and March, when walking levels may have been lower as a result of weather conditions, and therefore may not reflect average walking levels. Also, we measured walking levels as the number of walking trips, which does not take into account the distance travelled in each trip.

CONCLUSIONS

We found that perceptions of the local environment are associated with walking levels in children. These findings need to be confirmed in longitudinal studies, and by using more objective measures of physical activity. However, our findings provide hypotheses for the development of interventions to promote physical activity in children.

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Ethical approval: The proposal was reviewed by the South Birmingham Student Research Ethics Committee before the start of the study. Informed, written consent was obtained from parents or guardians of participants before their recruitment into the study.

All research was conducted independently of the sponsors.

Contributors: DA designed the study, collected the data, analysed the results and wrote the paper; he acts as guarantor. PA advised on study design, data collection, data analysis and paper writing. LR advised on study design, data collection and paper writing. TB assisted in the development of the original idea and questionnaire design.

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