Associations between neighbourhood walkability, active school transport and physical activity levels in primary and secondary school students: A pilot-study

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ABSTRACT

Objectives: This longitudinal pilot-study examined the associations of neighbourhood walkability with active school transport (AST) and pedometer-determined physical activity (PA) immediately before and after the transition from primary to secondary school.
Methods: Fifty-five grade 6 students were recruited from 4 primary schools in Ottawa in May/June 2012. They were asked to complete a diary indicating their mode of transport to/from school for 1 week and wear a SC-StepMX pedometer for 8 consecutive days. 48 study packages were returned at baseline and 29 at follow-up (September/October 2012). The Walk Score® application was used as a proxy for walkability around the home and around the school. The associations of walkability with AST and average daily step counts at both time points were respectively examined with binary logistic regression and linear regression models adjusted for gender.
Results: At baseline, only walkability around the school was positively associated with AST (OR = 1.04). At follow-up, higher Walk Score ratings around the home and the school were both associated with greater odds of AST (OR = 1.12 and 1.29 respectively). Furthermore, walkability around the home was associated with higher step counts with a large effect size ($\eta 2 = 0.19$).
Conclusions: There was a negative association between having a regular medical doctor and high self-perceived health, modified by age. The findings suggest that individual access to care does not predict health in the same way as physician density.

RÉSUMÉ

Objectifs: Cette étude pilote longitudinale vérifiait l'association entre les quartiers favorables à la marche, le transport actif scolaire (TAS) et le niveau d'activité physique (AP) déterminé à l'aide d'un podomètre, immédiatement avant et après la transition de l'école primaire à l'école secondaire.
Méthodes: En mai et juin 2012, 55 élèves de la sixième année ont été recrutés dans 4 écoles primaires d'Ottawa. On leur a demandé de remplir quotidiennement un journal de bord dans lequel ils devaient indiquer leur mode de transport pour se rendre à l'école et en revenir durant une semaine. Ils devaient également porter un podomètre SC-StepMX durant huit jours consécutifs. À la première étape, 48 trousses d'étude ont été retournées à la première étape et 29 lors du suivi en septembre et octobre 2012. L'application Walk Score® a été utilisée comme témoin pour déterminer si le milieu environnant le domicile et l'école était favorable à la marche. L'association entre les quartiers favorables à la marche, le TAS et le nombre moyen de pas faits dans une journée a été examinée respectivement aux deux étapes de l'étude à l'aide d'une régression logistique binaire et d'un modèle de régression linéaire ajusté selon le sexe.
Résultats: À l'étape initiale, seul un milieu favorable à la marche autour de l'école était associé positivement au TAS (RC = 1,04). Lors du suivi, un indice Walk Score élevé aux alentours de la maison et de l'école était associé à une probabilité supérieure de TAS (RC = 1,12 et 1,29 respectivement). De plus, un quartier favorable à la marche autour du domicile était associé à un nombre plus élevé de pas avec une taille d'effet élevée ($\eta 2 = 0{,}19$).
Conclusion: Ces observations préliminaires suggèrent qu'il peut s'avérer plus important pour les étudiants de l'école secondaire que leur milieu soit favorable à la marche. Puisqu'aucune autre étude longitudinale n'a été menée pour évaluer si l'association entre les quartiers favorables à la marche, le TAS et le niveau d'AP varie au fil du temps, il serait justifié de procéder à de grandes études prospectives.

INTRODUCTION

Recent survey findings indicate that the majority of children and youth do not meet current physical activity (PA) guidelines, which recommend 60 minutes of moderate-to-vigorous physical activity per day [1,2]. Even in the pediatric population, insufficient PA levels are associated with detrimental health parameters such as cardiovascular disease risk factors [3,4], underscoring the need for interventions that promote PA. Since children and youth must travel to and from school on a regular basis, active school transport (AST; e.g. using non-motorized travel modes such as walking and cycling to travel to/from school) is regarded as a promising strategy to increase PA at the population level [5,6].

During the last two decades, there has been a rapid in crease in the number of scientific studies assessing the association between characteristics of the built environment (i.e. density, land use mix, street connectivity, availability of sidewalks and cycle paths, etc.) and individuals' active transport and PA levels [7]. Researchers have developed composite measures of neighbourhood characteristics that favour "walkability", which refers to the potential for individuals to walk to local destinations [8,9]. Measures of neighbourhood walkability have consistently been shown to be associated with adults' travel mode and PA [10,11]. However, the evidence regarding the association between characteristics of the built environment and children's AST and PA remains inconsistent [12,13]. In their systematic review of 14 studies that used objective measures of environmental characteristics, Wong et al. found that distance between home and school was the only consistent correlate of AST [13].

Giles-Corti et al. [14] hypothesized that the influence of the built environment on AST and PA may be stronger in adolescents than in children because the former generally have greater independent mobility. This concept refers to the degree of freedom of children and youth to move around in public spaces without adult supervision [15]. To date, most studies that examined the association between the built environment and AST have only considered associations with individual characteristics rather than composite measures of walkability [13]. One US study found that characteristics of the built environment had a stronger association with walking in youth aged 12-15 years old compared to younger participants [16]; however the cross-sectional design is an important limitation of this study.

Therefore, the objective of the present pilot-study was to examine the associations of neighbourhood walkability with AST and PA at the end of primary school (grade 6) and the beginning of secondary school (grade 7) among the same participants. The school transition is a major life event that coincides with a large decrease in PA [17]. It was hypothesized that the associations of neighbourhood walkability with AST and PA would be stronger in secondary school.

METHODS

Participants and setting

Fifty-five grade 6 students were recruited from four primary schools in Ottawa (Canada) in May/June 2012 (33.3% response rate). Of these four schools, two were located in census tracts with high population density (3531-4100 inhabitants/km2), according to the 2006 Canadian census data [18]. The two schools were located in lower density areas (988-2159 inhabitants/km2), thereby providing variability in built environment characteristics. Parents indicated their child's prospective school for grade 7 and either their phone number or e-mail address for follow-up purposes. 48 children (24 girls and 24 boys) returned their study package at baseline and 29 (16 girls and 13 boys) at follow-up (September/October 2012). Ethical approval was obtained from institutional Research Ethics Boards and from the 2 participating school boards.

Measures

At both time points, participants were asked to: 1) complete a travel diary indicating their mode of transport to/from school for each day during 1 week; 2) wear a SC-StepMX pedometer (Stepscount, Deep River, ON) on the right hip for 8 consecutive days; and 3) complete a log recording their daily step counts and the time the pedometer was worn during waking hours. This pedometer has been shown to be valid and reliable [19]. Parents of each participant indicated their postal code, which allowed for the estimation of neighbourhood walkability.

Data treatment

Participants were classified as active travelers if they reported using active travel modes for at least 50% of school trips. This classification method showed very high test-retest reliability over two consecutive weeks of measurement [20]. Pedometry data were screened based on established criteria including: 1) between 1,000 and 30,000 steps/day [21]; 2) ≥ 10 hours of data/day [22] and 3) ≥ 3 days of valid data (e.g. meeting the daily wear threshold values) [23]. Application of these thresholds led to the exclusion of pedometer data from 2 participants at baseline and none at follow-up. The postal codes provided by the parent were used as a proxy for residential address, based on evidence that Canadian postal codes are a suitable proxy in urban areas [24,25]. The Walk Score® application (http://www.walkscore.com/) was used as an estimate of neighbourhood walkability around the participants' residence (using postal codes) and around their school (using the street address) at both time points. The Walk Score is a composite measure of accessibility to a variety of destinations including schools, parks, shops, and public transit by walking. Amenities located within a 1.6 km linear buffer contribute to a location's Walk Score, but amenities within a 400 meters buffer receive higher points than those within 800 meters, 1.2 km and 1.6 km buffers. Walk Score ratings range from 0 to 100 with higher values indicating greater walkability. A validation study has found strong correlations between Walk Score ratings and objective measures of the built environment (i.e. residential density, intersection density, street density, average block length and access to public transit) [26].

Analyses

First, Pearson correlations assessed the association between Walk Score ratings around the home and around the school at both time points. Second, the associations of neighbourhood walkability with AST and average daily step counts at both time points were examined with binary logistic regression and linear regression models respectively, and adjusted for gender. The η2 statistic was used as a measure of the independent effect size of neighbourhood walkability within the regression models. Analyses were performed with IBM SPSS 20 and the probability of type I error was set at 5%.

Table 1. Descriptive characteristics of the sample at baseline and follow-up.

Variable	Categories	Healthy	Baseline
Gender (n)	Girls	24	16
	Boys	24	13
Travel mode	Active	27 (14G, 13B)	13 (8G, 5B)
	Inactive	19 (9G, 10B)	15 (7G, 8B)
	Missing	2 (1G, 1B)	1 (1G)
Distance (km)	N/A	2.3 ± 2.4	3.9 ± 3.4
Walk Score† around the home	N/A	62.4 ± 17.8	62.0 ± 19.3
Walk Score around the school	N/A	62.0 ± 20.2	61.5 ± 27.8
Average steps/ day	Overall	16,805 ± 3,744*	14,071 ± 3,680*
	Girls	15,235 ± 2,973	12,728 ± 3,301
	Boys	18,447 ± 3,820	15,415 ± 3,662

Baseline data was collected in May/June 2012 and follow-up data was collected in September/October 2012. G = girls; B = boys. †Walk Score ratings range from 0 to 100 with higher scores indicating greater walkability. Walk Score ratings, distance and steps/day are presented as mean ± SD. * denotes statistically significant differences between boys and girls ($p < 0.05$). Two participants provided insufficient information to allow for the determination of their primary travel mode at baseline and one at follow-up

RESULTS

Descriptive characteristics of the participants at baseline and follow-up are provided in Table 1. Baseline data did not differ between participants who provided follow-up data and those who provided only baseline data with respect to gender, Walk Score, AST and PA (all $p > 0.49$). Walk Score ratings around the home and around the school were significantly correlated at baseline ($r = 0.70$; $p < .001$) and follow-up ($r = 0.53$; $p = .003$); therefore, to avoid multi-collinearity, separate models were done to assess the effect of walkability around the home and around the school.

At baseline, Walk Score ratings around the home did not differ between active and inactive travelers (OR = 0.99; 95% CI = 0.96-1.03; $p = .87$), but children attending schools with higher ratings were more likely to engage in AST (OR = 1.04; 95% CI = 1.01-1.07; $p = .03$) (Table 2). At follow-up, higher Walk Score ratings around the home (OR = 1.12; 95% CI = 1.03-1.21; $p = .01$) and around the school (OR = 1.29; 95% CI = 1.00-1.66; $p = .05$) were both associated with greater odds of AST. Of note, these odds ratios represent the change in the odds of AST associated with each unit increase in Walk Score. For instance, a 10-point increase in Walk Score around the home at follow-up would be associated with a 3-fold increase (OR = 3.02) in the odds of AST.

Table 3 illustrates the association between Walk Score and average daily step counts at both time points. At baseline, Walk Score ratings around the home and around the school were not associated with step counts (all $p > .79$). At follow-up, children living in more walkable areas were significantly more active ($F = 5.21$; $p = .03$) with a large effect size ($\eta 2 = 0.19$), but no association was found for walkability around the school ($F = 1.97$; $p = .17$). In all regression models, boys were more active than girls (all $p \leq .04$); however, there were no gender differences in travel modes at any time point ($p \geq .62$).

DISCUSSION

The present pilot-study assessed the influence of neighbourhood walkability on AST and PA immediately before and after the transition from primary to secondary school, a major life event that has been understudied with respect to AST. At baseline, walkability measures were not associated with PA, and only Walk Score ratings around the school were associated with AST. At follow-up, Walk Score ratings around the home and the school were both strongly associated with AST. Walkability around the home was significantly associated to PA with a large effect size; however, this relationship was not found for walkability around the school. Despite some inconsistencies, these findings provide preliminary evidence supporting Giles-Corti and colleagues' [14] hypothesis that the influence of neighbourhood walkability on AST and PA levels is stronger in secondary school students than in primary school students.

Previous systematic reviews have concluded that the evidence supporting associations between neighbourhood walkability (or different built environment constructs), AST and PA is inconsistent and that most included studies were cross-sectional [12,13]. Inconsistent findings could be due to many factors including methodological differences in the assessment of built environment characteristics [13,27] or PA levels [12] and failure to

Table 2. Associations between neighbourhood walkability and participant's primary travel mode at baseline and follow-up.

Time point	Walk Score	Active Travellers (mean ± SD)	Inactive Travellers (mean ± SD)	OR (95% CI)	p-value
Baseline	Home	61.5 ± 17.4	62.8 ± 18.8	0.99 (0.96-1.03)	.87
	School	68.3 ± 18.1	54.7 ± 19.7	1.04 (1.01-1.07)	.03
Follow-up	Home	76.3 ± 9.7	51.7 ± 17.1	1.12 (1.03-1.21)	.01
	School	79.5 ± 1.5	45.9 ± 31.4	1.29 (1.00-1.66)	.05

Differences in Walk Score ratings between active and inactive travelers were assessed at baseline (May/June 2012) and follow-up (September/October) using binary logistic regression adjusted for gender.

consider potential moderators such as age, gender, ethnicity and socioeconomic status [28,29].

In addition, it has been suggested that the influence of built environment characteristics may be additive [7,30], so studies that examine individual characteristics instead of using a composite measure of walkability may underestimate the strength of observed associations. McDonald [31] reported that the direct influence of population density on AST was weak, but that higher density may lead to shorter distances between home and school, which is in turn strongly associated with AST. Furthermore, there may be complex interactions between barriers and facilitators of AST. For example, high density and street connectivity may be associated with both shorter distance to school and heavier traffic exposure [14].

Another potential reason for the lack of association between Walk Score ratings and PA at baseline is that school journeys may account for a lower proportion of daily PA in children than in adolescents [32,33]. Primary school children may accumulate a greater proportion of their PA through active play than secondary school youth. Therefore, low density neighbourhoods with larger lots and cul-de-sacs may be more conducive to active play than high density neighbourhoods with heavy traffic and associated road safety concerns. In contrast, as children get older, active transport (not only to/from school) may become a more important source of PA; hence, walkable neighbourhoods could become increasingly important for fostering PA.

The school transition might be a good time for interventions that promote AST because travel habits are likely to be modified due to changes in school location. In a Scottish study, travel habits explained a significant proportion of the variance in step counts during the trip to school over and above planned behaviour constructs (e.g. attitudes, subjective norms and perceived behavioural control) [34]. In addition, Panter et al. [29] suggested that parental safety concerns might become less influential in travel mode decisions as children acquire independent mobility.

Table 3. Associations between neighbourhood walkability and step counts at baseline and follow-up.

Time point	Walk Score	Variable	F	*p*	η2
Baseline	Home	Corrected model	4.28	.02	.19
		Walk Score	0.04	.85	<.01
		Gender	8.12	<.01	.18
	School	Corrected model	4.91	.01	.01
		Walk Score	0.71	.79	<.01
		Gender	9.38	<.01	.18
Follow-up	Home	Corrected model	4.88	.02	.30
		Walk Score	5.21	.03	.19
		Gender	6.83	.02	.23
	School	Corrected model	2.99	.07	.21
		Walk Score	1.97	.17	.08
		Gender	5.02	.04	.18

Physical activity was measured with SC-StepMX pedometers at baseline (May/June 2012) and follow-up (September/October); that is immediately before and after the school transition.

The main limitations of this study are the small sample size and the low response rate suggesting that the sample population may not be representative of the general population. As a result, there may have been a selection bias with highly active children being more likely to participate at baseline. Furthermore, the small sample size precludes the adjustment of regression models for a larger range of socio-demographic variables that may influence travel mode choices and PA patterns (i.e. parental education and employment status, car ownership). Children may have increased their level of PA when wearing a pedometer; however, a recent review of pedometer use among children reported conflicting findings regarding the issue of pedometer reactivity [35]. Thus, it remains unclear whether reactivity may have contributed to the observed changes in physical activity. However, the observed changes are consistent with the declines in physical activity commonly seen during this transitional period [17]. Further studies are needed to confirm the present findings. Many studies have shown that children are more active during summer months, thus the observed differences in step counts may be partially explained by seasonal variations [36]. In this study, the follow-up was done as early as possible in the school year to minimize seasonality bias. Interestingly, previous research in Toronto (Canada) has shown no seasonal differences in travel modes among 11-12 years old children [37]. The observed decrease in the proportion of participants engaging in AST may be attributable to a 50% increase in the distance between home and school across the school transition [20]. Although Walk Score ratings have been shown to be correlated with other aspects of the built environment (i.e. density, diversity and design), it may fail to capture characteristics associated with younger children's travel and PA patterns. Finally, postal codes were used as a proxy of residential address as required by Research Ethics Boards. Nevertheless, previous research in Calgary (Canada) has shown that 87.9% of postal code locations were within 200 meters of the true address location [24].

The main strength of the study is the assessment of neighbourhood walkability, AST and PA immediately before and after the school transition, a major life event usually characterized by a large decrease in PA levels. Moreover, walkability was assessed both around the home and around the school. The use of an objective measure of PA, rather than a questionnaire, is another important strength because using a questionnaire can lead to a large overestimation of children's PA level [38]. To our knowledge, only one other study has assessed the influence of the school transition on AST [39], but no associations of built environment characteristics with AST and PA were reported.

CONCLUSION

In this longitudinal pilot-study, the association between neighbourhood walkability (as assessed by the Walk Score application) and measures of AST and PA was stronger in secondary school compared to primary school. This suggests that neighbourhood walkability may be more important for supporting adolescents' AST and PA levels. However, given the small sample size, future prospective studies are needed to confirm these findings. Since the school transition has been shown to coincide with a large decrease in PA [17], there is a need for studies to examine whether walkable environments can attenuate this decline.

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