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Built Environment Features that Promote Cycling in School-Aged Children

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Abstract Previous research shows that children and youth who cycle to/from school are more active and fitter than those who travel by motorized modes. However, rates of cycling are low in many countries, and a better understanding of the correlates of cycling may inform the development of future interventions. This review summarizes the current literature on the built environment correlates of cycling among school-aged children and youth. While both studies of transportation and recreational cycling were eligible, the majority of the 12 included studies focused on the trip to/from school and consistently indicated that shorter distance between home and school is associated with greater odds of cycling. However, little is known about the correlates of cycling for other purposes. Furthermore, other built environment features have not been studied enough to allow strong conclusions to be drawn. Recommendations for future studies are proposed to address the limitations of current evidence.

Keywords Bicycling · Youth · Built environment · Social-ecological models

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Introduction

Current physical activity (PA) guidelines recommend that school-aged children and youth (5–17 year olds) accumulate at least 60 min of daily moderate-to-vigorous PA [1–3]. However, the majority of today's children and youth fail to meet these guidelines [4–7]. Furthermore, over the last few decades, there has been a marked decrease in children's physical fitness [8, 9] accompanied by a rising prevalence of childhood obesity [9, 10].

Coinciding with these deleterious changes in measures of physical health, the prevalence of active school transportation (AST; e.g., the use of active modes such as walking or cycling to/from school) has decreased markedly in many countries across the world [11–17]. This is concerning because a recent systematic review has concluded that AST is associated with higher daily PA [18•].

Furthermore, this systematic review noted consistent evidence that children and youth who cycled to/from school had greater aerobic fitness than those who used motorized modes. In contrast, the relationship between walking to/from school and aerobic fitness remains unclear [18•]. Examining a broader range of destinations (e.g., school, work, and errands), Larouche et al. [19] noted that both utilitarian walking and cycling were associated with greater daily moderate-to-vigorous PA among youth who participated in the 2007–2009 Canadian Health Measures Survey. However, cycling, but not walking, was associated with greater aerobic fitness and lower body mass index, waist circumference, and total cholesterol/high-density lipoprotein (HDL) cholesterol ratio. These differences between walking and cycling may be attributable to the higher PA intensity of cycling compared to walking, as postulated by Shephard [20]. Together, these findings suggest that cycling to/from school and other destinations should be promoted as a source of health-enhancing PA among school-aged children and youth.

Rates of cycling to/from school vary substantially between countries, with very low rates in countries such as Australia, Canada, the UK, and the USA and much higher rates in Northern European countries [21, 22]. Due to the low prevalence of cycling in the former countries, researchers have often combined cyclists with walkers in their analyses or excluded cyclists altogether [18•]. An implication of this practice is that relatively little is known about the correlates of cycling among children and youth.

This caveat notwithstanding the objectives of the present review was threefold. First, it provides a brief overview of the social-ecological model within which the environmental correlates of cycling can be contextualized. Second, it summarizes current research on the built environment correlates of cycling among school-aged children and youth. All forms of cycling (recreational and utilitarian) were considered in this review. Finally, key recommendations for future research on cycling are outlined.

Social-Ecological Models of Children's Physical Activity

Based on the seminal work of Bronfenbrenner [23], social-ecological model strives to capture the whole range of individual and environmental factors that affect human behavior. In the context of PA research, social-ecological models have been used for over 25 years [24–26]. Figure 1 illustrates a simplified ecological model as applied to a specific behavior (cycling) in a specific population (children and youth). Three important aspects are illustrated in this figure. First, the child's personal characteristics are shown at the center of the figure and, moving away from the center, are the more distal levels of influence which include (1) interpersonal factors (e.g., social support from family and friends), (2) community/organizational factors (e.g., school policies and practices that may promote or discourage cycling), (3) public policies (e.g., policies related to cycling facilities, school siting, etc.), and (4) built and physical environment factors (e.g., accessibility of destinations, presence and quality of cycling infrastructure, neighborhood walkability or bikeability, etc.). Second, the arrows between the circles indicate that there can be reciprocal interactions between the levels of influence. Finally, the size of the arrows pointing toward the behavior of interest (cycling) is greatest for the more proximal levels of influence, suggesting that they generally have a greater impact on individual behavior. Nevertheless, it is worth emphasizing that an important assumption of social-ecological models is that interventions targeting the more distal levels of influence (i.e., policies and built environment characteristics) have the potential to reach a greater number of individuals over a long period of time [26, 27].

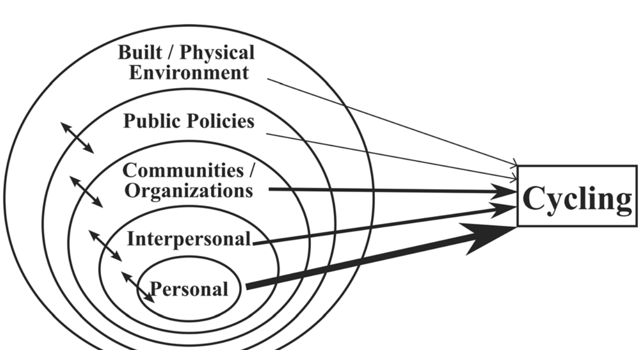

Fig. 1 Social-ecological model of the correlates of cycling. The *circles* represent the different levels of influence according to the social-ecological model. The *size of the arrows* pointing toward cycling illustrates the hypothetical effect of each level of influence on cycling. While built environment features may have a small direct impact on individual behavior, changes in the built environment have the potential to affect many individuals over a long period of time. Finally, the *bidirectional arrows* suggest that there may be interactions between the different levels of influence (e.g., a public policy may require changes to the built environment which may promote cycling)

Built Environment Correlates of Cycling

Studies that examined at least one feature of the built environment in relation to cycling among school-aged children and youth (e.g., 5–17 year olds) were considered eligible for this section of the review. While the review considered cycling in general, most included studies have focused on the trip between home and school. Studies that examined active transportation and did not report specific results for cycling were ineligible. Qualitative studies that did not quantify the association between cycling and built environment features were considered only for discussion purposes. Table 1 summarizes the characteristics of the included studies. Information on year of publication, country, sample size, age of participants, measure of cycling, and the main built environment features examined was extracted from each study. Of note, all included studies were cross-sectional.

First, de Bruijn and colleagues [28] assessed the association between urbanization and transportation cycling in a large sample of Dutch adolescents. Overall, 79.2 % of participants reported that they occasionally or always traveled by bike. In the final multivariate model which included multiple socio-demographic variables and the components of the theory of planned behavior, participants who lived in cities with 50,000 inhabitants or more cycled substantially less often (OR=0.64). The authors speculated that this may be attributable to higher traffic volume and speed in more urbanized areas.

Table 1 Overview of studies investigating the built environment correlates of cycling in school-aged children and youth

Lead author (year), country	Sample size	Age	Measure of cycling	Main built environment features measured
de Bruijn (2005), the Netherlands	3859	14.8±1.6 year	To school (usual mode), self-report	Degree of urbanization (<50,000 vs. ≥50,000 inhabitants)
Sisson (2006), USA	N/A[a]	Primary school	To school (direct observation)	Bikeability measured by an audit of all street segments within 0.25 mile (0.4 km) of the school
Bere (2008), Netherlands	1361	14.1±1.2 year	To school, self-report	Distance estimated with an Internet program (www.routenet.nl)
Tal (2008), USA	1084	4–18[b]	To soccer games, parent report	GIS-measured distance between home and playing field
de Vries (2010), Netherlands	448	8.3±1.5 year	Transportation and recreational cycling (diary)	Fifty-four item checklist assessing residential density, sport, recreation and play facilities, traffic safety, walking and cycling infrastructure, green spaces, etc.
Panter (2010), UK	2012	9–10 year olds	To school (usual mode), self-report	GIS-measured home-school distance. Urban/rural status. Parent-perceived neighborhood walkability (24 items), concerns about traffic, and neighborhood safety.
Trapp (2011), Australia	1197	Grades 5 to 7	To school (≥ once a week), self-report	GIS measures of school walkability index, road traffic volume, street connectivity, and distance. Perceived features of the built and physical environment (14 items).
Emond (2012), USA	1357	Grades 10 to 12	To school (usual mode), self-report	GIS-measured distance and perception of distance. Perception that there is a safe bicycle route and that there is a direct bicycle route. Dummy variable for living across the freeway.
Ducheyne (2012), Belgium	850	10.4±1.0 year	To school, number of cycling trips, parent-report	Parent-reported home-school distance. Parent-perceived neighborhood walkability and characteristics of the route to/from school (8 items).
Aarts (2013), Netherlands	5963	7.8±2.4 year	To school (usual mode), parent report	Parent-reported measures of home-school distance, neighbourhood type, housing density, presence of green spaces and water, quality of walking/cycling infrastructure, connectivity, and traffic safety.
Carlson (2015), USA	690	14.1±1.6 year	All cycling (GPS-measured)	GIS measures of residential density, intersection density, retail density, entertainment density, and neighbourhood walkability.
Carver (in press), Australia	640	11.6±2.0 year	All cycling, child report	Access to play spaces (parent report). Urban/rural status. Counts of sport facilities and parks, total area of parkland, and length of cycle paths and walking/cycling paths within 800 and 5000 m buffers.

All studies were cross-sectional

GIS geographic information system, *GPS* global positioning system

[a] This study estimated the prevalence of cycling to school by dividing the number of bicycles on the racks by the student population of the school

[b] Exact age not reported, but children were recruited in U6-U19 soccer teams (presumably 4–18 years old)

In an ecological analysis, Sisson and colleagues [29] examined the relationship between bikeability of the school neighborhood and the prevalence of cycling to school in a sample of 14 elementary schools in Arizona. Bikeability was assessed with a street audit, and the prevalence of cycling was estimated by dividing the number of bikes observed in the school bike racks by the student population of the school. Bikeability was not associated with cycling, but this finding may be due to the very low prevalence of cycling (3.1 % in low-busing schools and 1.3 % in high-busing schools) and the low variability of the bikeability measure (all schools except one were rated as "very good"). Another major limitation was the lack of control for potential confounders.

Bere et al. [30] examined the association between home-school distance and travel mode in Dutch adolescents. Youth living further away from school was less likely to be regular cyclists after adjusting for socio-demographic characteristics (OR=0.83).

Tal and Handy [31] examined the effect of distance on children and youth's travel mode to their soccer game in Davis, California. Parent-reported travel mode was dichotomized as cycling vs. driving. For each additional mile (1.6 km), participants were 3.37 times more likely to travel by car. An important limitation was that parents were only questioned about their child's travel mode on the day of the survey.

de Vries et al. [32] examined the built environment correlates of walking and cycling for three purposes: (1) to travel to/from school, (2) to travel to/from other destinations, and (3) for recreational purposes. Participants were 6–11 year olds living in 10 different neighborhoods in the Netherlands. Built environment features were assessed with a 54-item checklist, and conceptually similar items were combined into different subscales. The number of reported cycling trips to/from school and other destinations was positively associated with the number of recreation facilities, and the frequency of pedestrian crossings and parallel parking spaces in the neighborhood. No other built environment feature was associated with cycling. Furthermore, none of the built environment features examined were associated with recreational cycling.

Panter et al. [33] examined the relationship between perceived environmental attributes and cycling to school among British children while stratifying for geographic information system (GIS)-measured distance (i.e., <1, 1–2, and >2 km). Within each distance group, children living further away from school were less likely to cycle. Parental concern about traffic safety en route to school was associated with lower odds of cycling for trips longer than 1 km (OR=0.05 for 1–2 km and 0.19 for >2 km). Conversely, parent perception that it is safe to walk or play in the neighborhood was strongly associated with cycling for trips <1 km (OR=2.50). Each unit increase in parent-perceived neighborhood walkability score (ranging from 24 to 96) was associated with a 4–5 % increase in the likelihood of cycling for trips ≤2 km. Finally, children were more likely to cycle to school if they lived in an area categorized as "town or fringe" (OR=2.29 for <1 km) or "village, hamlet, or isolated dwelling" (OR=7.38 for <1 km and 3.85 for 1–2 km) when the school was located ≤2 km.

Trapp and colleagues [34] assessed the correlates of cycling to/from school at least once per week among Australian children. Their analyses were stratified by gender. Boys were less likely to cycle if they lived further away from school (OR=0.70 for each kilometer). Conversely, they were more likely to cycle if they lived in a neighborhood that had both low traffic volume and high connectivity (OR=5.58) and if their parent perceived their neighborhood as safe for cycling (OR=1.74). Girls were less likely to cycle if their parents reported that they would have to cross a busy road on their way to school (OR=0.44). School site walkability index was not associated with cycling in multivariate analyses. Of particular interest, they identified parental confidence in their child's ability to cycle without an adult as a mediator. Specifically, parents who perceived that the neighborhood is safe enough for children to cycle to school with friends were more likely to be confident in their child's ability to cycle without an adult (OR=5.52) and, in turn, their child was more likely to cycle to school at least once per week (OR=8.63). When controlling for parental confidence, the relationship between perceived neighborhood safety and cycling was attenuated (OR=1.91 vs. 2.85).

Emond and Handy [35] examined the individual, social environment, and built/physical environment correlates of cycling to school among older adolescents in Davis (California), a city known for its extremely high rates of cycling by North American standards; 36.4 % of students usually cycled to school. Their final multivariate logistic regression model shows that the perception of living too far from school (OR=0.69) and the need to cross the freeway (OR=0.38) are associated with lower odds of cycling. GIS-measured distance was no longer associated with the likelihood of cycling after controlling for these two variables, suggesting that perceived distance may be more important than actual distance. In addition, perceived route directness and the perception of having a safe bicycle route were not associated with cycling.

Ducheyne et al. [36] investigated the correlates of cycling to/from school among Belgian children living within 3 km from their school based on the social-ecological model. Children were classified as "never cycling" (0 trips/week), "always cycling" (10 trips/week), or other. Children whose parents perceived the route to school as safe were more likely to always cycle (OR=1.18). However, children with a route that had walking and cycling facilities (e.g., presence of sidewalks and cycle paths) were more likely to never cycle (OR=1.18) and less likely to always cycle (OR=0.92). The authors speculated that this counter-intuitive finding may be due to the fact that, in Belgium, roads equipped with such facilities usually have higher traffic volume. No other built environment feature was associated with cycling frequency.

Aarts et al. [37••] investigated the correlates of AST in a very large sample of Dutch children aged 4–12 years. Walking was the dominant travel mode for trips <1 km, whereas cycling was the dominant mode for trips of 1–2 km. As distance increased, the use of motorized modes became more common, especially for trips >5 km. Parent-perceived diversity of routes

Table 2 Summary of the relationship between built environment features and cycling in school-aged children and youth

Built environment attribute	Negative relationship	No relationship	Positive relationship
Distance (objectively measured)	Bere et al. (2008), Tal (2008), Panter et al. (2010), Trapp et al. (2011)—boys only	Emond (2012)—after adjusting for perceived distance	
Perceived distance	Emond (2012), Aarts (2013)		
Living in an urban area[a]	De Bruijn (2005), Panter et al. (2010)—trips ≤2 km	Carver (in press)	
Number of play facilities —parent report		De Vries (2010), Carver (in press)	
Presence of green space —parent report		De Vries (2010), Aarts (2013)	
Presence of water —parent report		De Vries (2010), Aarts (2013)	
Frequency of sidewalks —parent report		De Vries (2010), Trapp (2011)	
Frequency/presence of pedestrian crossings —parent report		Trapp (2011)	De Vries et al. (2010)[b]
Parental concerns about traffic	Panter et al. (2010)—trips >1 km; Ducheyne (2012), Trapp et al. (2011)	De Vries (2010), Carver (in press)	Aarts (2013)
Child concerns about traffic		Panter et al. (2010), Trapp (2011), Emond (2012)	
Perception of the quality of walking/cycling infrastructure	Aarts et al. (2013)	Ducheyne (2012)	
Access to bicycle rack (or ease of use) —child-perceived		Trapp (2011), Emond (2012)	
Residential density —parent-perceived		Ducheyne (2012), Aarts (2013)	

Only built environment features that have been assessed in at least two studies are shown. The valence of the relationship (i.e., negative, null, positive) was taken from the final model presented in each article

GIS geographic information system

[a] Compared to a less urbanized area

[b] Relationships were found only for transportation cycling

was associated with greater odds of cycling (OR=1.12). Children were less likely to cycle when their parents perceived the traffic around the school to be safe (OR=0.72), but they were more likely to cycle when school board officials perceived that the traffic was safe (OR=1.25). To explain these inconsistent results, the authors speculated that parents of cyclists may be more concerned about their child safety en route to school. Parental perception of the quality of walking/cycling infrastructure was not associated with cycling, potentially because the Dutch environment is generally very conducive to cycling.

Carlson and colleagues [38••] examined the relationship between cycling and objectively measured built environment features in 12–16 year olds living in two regions of the USA (Baltimore, MD/Washington, DC, and Seattle/King County, WA). Time spent cycling was determined as any trip between locations with a GPS-measured speed ≥9 and <25 km/h. Time spent cycling increased by 30 % for each additional 20 intersections/km^2, and it was 97 % higher among adolescents living in a high walkability compared to a low walkability neighborhood. However, cycling was not associated with residential density, retail density, and entertainment density. Furthermore, adolescents who engaged in any cycling did so only 1.4 min/day.

Finally, Carver and colleagues [39•] assessed the relationship between measures of access to play spaces, parks, and sport facilities and overall cycling in grades 3–10 students in Victoria, Australia. Based on self-reports, participants were classified as noncyclists vs. cyclists (i.e., cycling at least once a week). A greater number of sports facilities within a 5000-m road network buffer were associated with lower odds of being a cyclist (OR=0.87). In contrast, greater access to bike paths (defined as kilometers of paths within a 5000 m buffer) was associated with higher odds of being a cyclist (OR=1.70). Neither of these variables was significant when an 800-m buffer was used. Furthermore, parental concern about their child's risk of traffic accident was not associated with cycling.

Table 2 provides an overview of the built environment features that have been examined in relation to cycling among children and youth. For brevity, only features that were assessed in at least two studies are shown in Table 2.

Discussion

The present review aimed to summarize the literature on the built environment correlates of cycling among children and youth. While this literature remains fragmented, there is consistent evidence showing that the likelihood of cycling to school decreases as the distance between home and school increases. Only Emond and Handy [35] found that the association between objectively measured distance and the likelihood of cycling to school was not significant after controlling for the perception that the school is too far and the need for youth to cross the highway en route to school.

In the broader AST literature, greater distance between home and school has been described as the most consistent correlate of AST [40–43]. Due to the very large effect of distance, it is possible that some correlates of cycling (or AST) are overlooked when distance is included in a multivariate model. To address this issue, three strategies have been used. First, some researchers have restricted their analyses to children living within a certain distance from school. These studies have used either empirically derived "criterion distances"—like the study by Ducheyne and colleagues [36] in this review—or the distance at which children become eligible for bus transportation (i.e., [44]). However, such an approach may reduce sample size dramatically, and it automatically excludes participants who live beyond the criterion distance, but who may still cycle. Second, some studies have stratified their analyses by distance. An advantage of this approach is the possibility to test the theoretical framework of Panter and colleagues [41] which stipulates that distance is a key moderator of the relationship between built environment features and AST. In support of their framework, Panter et al. [33] reported a moderating effect of distance, whereby parental attitudes appeared to be stronger predictors of cycling for short distances, and safety concerns more important for longer distances. The third approach consists of matching children who use different travel mode but live very close to one another. This allows the researchers to use a case-control methodology to examine how cases (e.g., cyclists) differ from controls (noncyclists). However, this approach requires a very large sample size with children living close to one another. It has nevertheless been used successfully in a study of the factors associated with AST among children in Austin, Texas [45]. Interestingly, this study found, among other things, that even though active and motorized travelers lived within less than 200 ft and attended the same school, the parents of motorized travelers were much more likely to perceive that the school was too far [45]!

While distance is hereby discussed as a characteristic of the built environment, it is influenced by many factors from different levels of influence [46]. Parental neighborhood and school choices, the design of the road network, and the policies that govern school choice and where new schools are built are among the many factors that may influence this distance. For instance, McDonald [47] found that while residential density had little direct impact on children's school travel mode, it was strongly associated with the home-school distance. In denser areas, school had smaller catchment areas, implying that, all other things being equal, the average child had to travel a shorter distance.

Evidence for an association between parental road safety concerns and cycling was somewhat inconsistent (Table 2). It is worth emphasizing that the included studies used different items related to road safety, some of which may be more important concerns than others. Moreover, some studies assessed road safety in the home neighborhood, the school neighborhood, and/or the route between home and school. It is possible that some safety concerns may be specific to one of these areas. In addition, due to the cross-sectional study designs employed, the possibility of reverse causality, whereby parents of cyclists may be more concerned about traffic safety cannot be ruled out. Such a hypothesis was formulated by Aarts and colleagues [37] to explain their counterintuitive finding that children of parents who perceived the school environment as safe were less likely to walk or cycle to school. However, reviewing the broader PA literature, Carver and colleagues [48] found consistent evidence that road safety concerns were associated with a reduced likelihood of active transportation and less outdoor play among children. Furthermore, several qualitative studies have emphasized that parental road safety concerns are an important reason for not cycling [49–52]. Interestingly, Trapp and colleagues [34] found that parents' perception of their child's cycling skills partially mediated the relationship between perceived neighborhood safety and the likelihood that children cycle to school.

In comparison, ecological studies of adults emphasize that the prevalence of utilitarian cycling is much greater in countries where cycling is safer and infrastructure more developed (e.g., Denmark and Germany, and the Netherlands) compared to countries such as Australia, Canada, the UK, and the USA [53–55]. Similar patterns have been reported for children [21], but these results should be interpreted cautiously given the heterogeneity in participant sampling and the assessment of cycling. Several studies have shown that adults are more likely to cycle if they perceive safe and high-quality cycling infrastructure [56–59] and traffic safety issues are particularly important for women [60, 61]. In their systematic review, Fraser and Lock [62] concluded that physical separation of cyclists from traffic, high population density, short trip distance, and proximity to cycle paths and green spaces were positively associated with utilitarian cycling. Conversely, heavy traffic, long trip distance, steep inclines, and long distance from cycle paths were important barriers to cycling [62]. However, a major limitation of this review is that no information was provided about the built environment attributes that were assessed in the studies that did not show significant associations. Therefore, the consistency of these findings remains uncertain.

As new studies on the relationship between built environment features and cycling among children are likely under way, it is important to bear in mind that relationships may differ according to the geographic area considered. For instance, Carver and colleagues [39] reported that cycling was associated with the number of recreational facilities and bike path coverage measured within a 5000-m buffer but not within an 800-m buffer. This phenomenon is known by geographers as the modifiable areal unit problem [63]. For instance, Mitra and Buliung [63] examined the relationship between children's school travel patterns and built environment features measured within six different buffer sizes or shapes. They found that the statistical significance, and sometimes even the direction of the relationships, varied across geographical units. This problem has been identified as a potential explanation for the inconsistent results revealed by a systematic review of the relationship between GIS-measured built environment attributes and AST [64]. Therefore, researchers using GIS measures should be aware of this issue and should provide a clear explanation for their chosen buffer size [63]. While buffers of 1 mi (1.6 km) or less are often used to assess the correlates of AST because they correspond to a "walkable" distance, larger buffers could perhaps be more relevant when examining the built environment correlates of cycling.

Similarly, the definition of "neighborhood" is not univocal. There is evidence that the perception of neighborhood boundaries varies markedly between individuals [65–67]. Therefore, when survey respondents are questioned about the built environment characteristics of their neighborhood, they may not be thinking about the same geographical area. Heterogeneous perception of neighborhood boundaries may contribute to the uncertainty of effects when researchers examine how child- and/or parent-perceived built environment features are associated with children's cycling.

Limitations of Current Studies

This review is limited by the cross-sectional design of included studies which cannot establish the direction of the relationship between built environment features and cycling. While a number of studies have evaluated the effectiveness of AST interventions [68], most studies did not distinguish between walking and cycling, and the multi-faceted nature of most interventions makes it impossible to determine the contribution of specific built environment features on changes in cycling. Second, due to the small number of studies that have examined recreational cycling, it is impossible to conclude whether the pattern of associations differs according to trip purpose (i.e., recreation vs. transportation). Third, studies have only been conducted in five high-income countries, and it is unclear whether the findings would apply to low and middle income countries. Fourth, only one study used an objective measure of cycling. Nevertheless, a previous systematic review found that child- and parent-reported school travel mode generally showed substantial test-retest reliability and convergent validity [69]. However, these good psychometric properties may be due to the habitual nature of the school trip, so it remains unclear if similar findings would be obtained with measures of cycling for nonschool purposes. Finally, because several potential built environment correlates of cycling have been examined in only a few studies, it is premature to draw strong conclusions in their regard.

Recommendations for Future Research

1. There is a clear need for prospective and intervention studies examining the relationships between built environment changes and cycling among children and youth.
2. A recent meta-analysis found a strong moderating effect of age on the relationship between objectively measured built environment features and children and youth's physical activity as measured by accelerometers or pedometers [70•]. Thus, future studies should examine if age moderates the relationship between built environment features and cycling.
3. Because many studies have found that girls cycle much less than boys [19, 21, 35], there is a clear need to investigate which features of the built environment have the potential to promote cycling among girls. Studies of adults suggest that a safer cycling environment may be of particular importance [60, 61].
4. Most of the studies included in this review have focused on the trip to/from school. Therefore, future studies should examine the correlates of cycling to/from other destinations (i.e., parks, friends' and relatives' houses, sport fields, shops, etc.) as well as the correlates of recreational cycling among children and youth.
5. As shown in Table 2, few built environment features have been examined in more than two studies. Hence, there is a need for replication of previous studies so that conclusions can be drawn about the relationship between these features and cycling.

Conclusion

Based on the social-ecological model, the built environment has the potential to influence the behaviors of many individuals over a long period of time. Following this premise, researchers have started to investigate how the built environment influences cycling among children. To date, this research provides consistent evidence that the distance between home and school is negatively associated with cycling to/from school. Other potential environmental correlates have been examined in too few studies to allow strong conclusions to be drawn. Of particular importance, because all studies included in this review have used cross-sectional designs, there is a clear need for future studies to examine the correlates of changes in cycling and to assess the effectiveness of interventions aiming to promote cycling among children and youth.

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Compliance with Ethics Guidelines

Conflict of Interest Richard Larouche declares that he has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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•• Of major importance

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