Journal of Physical Activity and Health, 2016, 13, 325-332
http://dx.doi.org/10.1123/jpah.2014-0483

Human Kinetics
ORIGINAL RESEARCH

A Multisite Study of Environmental Correlates of Active Commuting to School in Mexican Children

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***Background*:** Mexican children often use active commuting to school (ACS). In order to maintain high levels of ACS it is important to understand correlates of ACS in this population. However, most evidence comes from high-income countries (HICs). We examined multilevel correlates of ACS in children attending public schools in 3 Mexican cities. ***Methods*:** Information on 1191 children (grades 3 to 5) attending 26 schools was retrieved from questionnaires, neighborhood audits, and geographic information systems data. Multilevel logistic modeling was used to explore individual and environmental correlates of ACS at 400-m and 800-m buffers surrounding schools. ***Results*:** Individual positive correlates for ACS included age (6–8 years vs 9–11 years, odds ratio [OR] = 1.5; 6–8 years vs ≥12 years: OR = 2.1) and ≥ 6 adults at home (OR = 2.0). At the 400-m buffer, more ACS was associated with lower walkability (OR = 0.87), presence of posted speed limits (< 6% vs > 12%: OR = 0.36) and crossing aids (< 6% vs 6–20%: OR = 0.25; > 20%: OR = 0.26), as well as higher sidewalk availability (< 70% vs > 90%: OR = 4.5). Similar relationships with speed limits and crossing aids were observed at the 800m buffer. ***Conclusions*:** Findings contrast with those reported in HICs, underscoring the importance of considering the local context when developing strategies to promote ACS. Future studies are needed to replicate these relationships and investigate the longitudinal impact of improving active transportation infrastructure and policies.

***Keywords*:** active transport, physical activity, built environment, obesity, pediatrics

Most Mexican children fail to meet physical activity guidelines, and physical activity decreases with age.[1] Walking or bicycling to school, or active commuting to school (ACS), can lead to increased physical activity and improve the likelihood of meeting guidelines.[2] In Mexico, children use ACS at high rates (70%) despite the lack of ACS promotion.[3] However, increases in motorization have been reported in the past decade,[4] which may reduce ACS in the future. Understanding correlates of ACS in children is necessary to maintain high levels of ACS in Mexico.

Correlates of ACS exist at multiple levels. In their conceptual framework, Panter et al[5] propose that individual factors, environmental factors (eg, climate) and external factors (eg, policies) are most likely to influence decision making regarding mode of travel and that associations between those factors and the decision made are moderated by age of youth, gender of youth, and distance to destination. Panter et al also propose that the decision may be a result of both parental and child perceptions. This framework is derived from research undertaken in high-income countries (HICs).[5]

Correlates of ACS have been extensively studied in HICs.[5–7] Reports show that boys do more ACS than girls,[6] that ACS is positively associated with the number of children and adults in the household,[8] and negatively associated with family socioeconomic status (SES).[6,8] As for environmental variables, distance to school is the only variable consistently associated with reduced ACS in HICs.[7] To date, there is not a clear understanding of the relationship between other environmental factors and ACS.[7] Associations between the neighborhood walkability index (a combined index of street connectivity, residential density, land-use mix, and ratio of retail building square footage to land area developed in HICs to provide a systematic method for examining relationships between the built environment and physical activity[9]) and ACS have been inconsistent; some show positive[5,10] or null associations.[7] Other street-scale characteristics such as the presence and condition of sidewalks, posted speed limits, and crossing aids have been associated with more ACS in HICs.[6,11,12]Traffic safety features, such as traffic speed and amount of traffic, have also been identified as negative correlates of ACS.[5]

There are few studies of correlates of ACS in low- and middle-income countries, especially in Latin-American countries.[3,13] Preliminary work in Mexico identified family SES, family vehicle ownership, and the north (wealthier) region of the country as negative correlates of ACS, suggesting that ACS may be necessity driven.[3] However, little is known on environmental correlates of ACS in Mexico. Given the unique socioeconomic, cultural and structural differences in Mexico and other Latin-American countries, correlates of ACS may vary[14–16] from those identified by Panter et al.[5] For example, evidence in Mexican adults suggests a negative relationship between the walkability index and total physical activity.[16]

The purpose of this article is to expand current knowledge on ACS in Mexico by examining individual and environmental correlates of ACS in a sample of school-age children in 3 Mexican urban cities.

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Methods

Design

This study used data from the *Understanding Health Habits in Mexican Children* project, a multisite, cross-sectional study conducted in 3 Mexican cities: Guadalajara, Puerto Vallarta, and Mexico City. In 2012, data were collected on health-related behaviors in children attending public elementary schools and environmental data from surrounding neighborhoods.

School Selection

A convenience sample of 26 public schools was selected either by the State of Jalisco Secretary of Education (Guadalajara, n = 10; Puerto Vallarta, n = 3) or by virtue of participating in another study of obesity-related policy implementation in Mexico City (n = 13). Because this study was fully supported and endorsed by the Secretary of Education, it was successfully implemented in all schools. Schools were located in low-SES (n = 4), medium-SES (n = 9), high-SES (n = 7) and very-high-SES (n = 6) neighborhoods. Schools were distributed throughout Guadalajara and Puerto Vallarta and in 2 of the 16 boroughs of Mexico City (Figure 1). The mean number of children attending schools was 73 (range: 9–117).

Participants

Children (Guadalajara, N = 621; Puerto Vallarta, N = 119; Mexico City, N = 485) who were enrolled in grades 3 through 5 and were apparently healthy were recruited to participate. A written informed parent consent form, a child assent form, and a health survey were sent home to parents with children who were present on assessment day. Parents were instructed to review and sign the informed consent, assist children in completing the assent form, and complete the health survey in the home before sending study materials back to the school with their child.

Active Commuting to School

The health survey consisted of a modified version of the 4th grade School Physical Activity and Nutrition (SPAN) survey.[17] The SPAN item measuring mode of transportation to school was translated by native Spanish speakers and adapted for a Mexican audience. Parents were asked: "On most days, how does your child get to school?" Response options were walk, school bus, family car with only your family, bike, city bus, or carpool with children from other families. ACS was defined as walking or biking.

Individual Measures

The SPAN survey also included items measuring the following demographic characteristics: child's age and gender, family income, and the number of adults and children living in the home.

Neighborhood Measures

Neighborhoods were defined as 800- and 400-m radii circumscribed around each school (Figure 1). By using 2 different radii, we intended to test whether environmental characteristics more proximal to schools may have a stronger influence on ACS. Only 6% of the 800m buffer overlapped with others, and no overlap was observed at 400-m buffers. We assessed the built environment using an abbreviated version of the Pedestrian Environment Data Scan (PEDS) and Geographic Information Systems (GIS)-derived attributes.

Pedestrian Environment Data Scan. The PEDS instrument objectively measures environmental features in each street segment that influence walking, including land use, pedestrian infrastructure

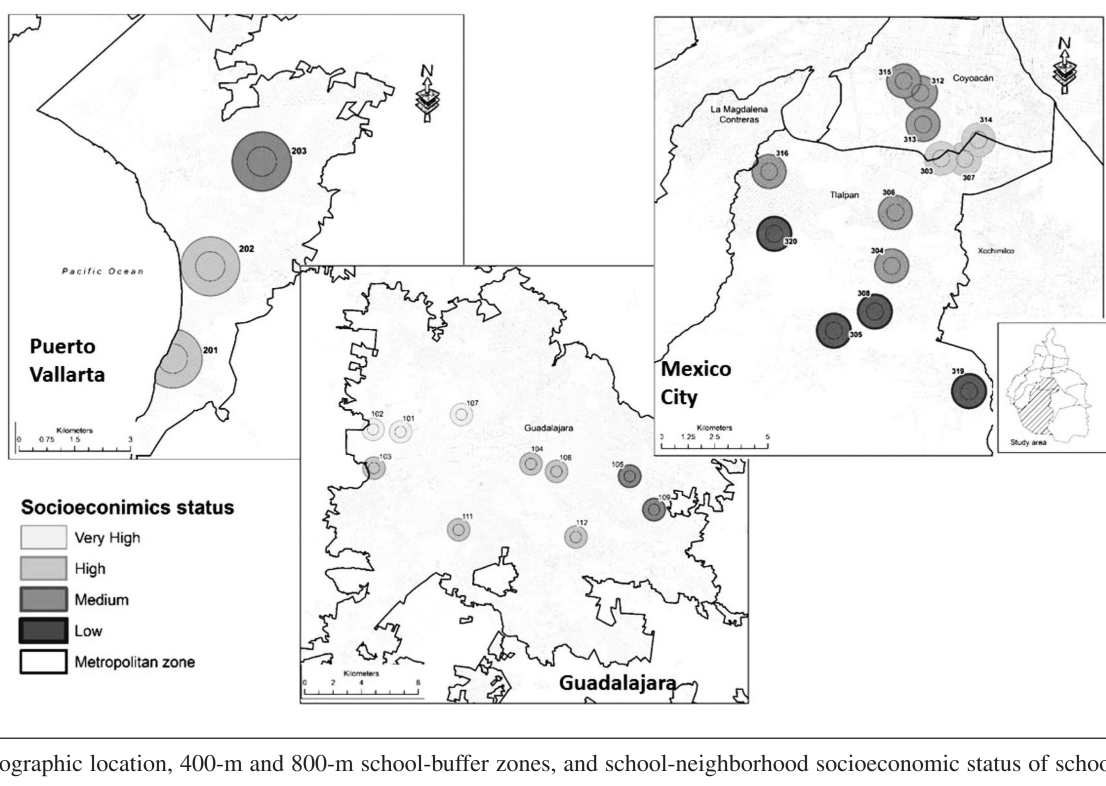

Figure 1 — Geographic location, 400-m and 800-m school-buffer zones, and school-neighborhood socioeconomic status of schools included in the study (n = 26).

(eg, presence of sidewalks), road attributes (eg, presence of crossing aids or posted speed limits), and walking and cycling environment (eg, overall street cleanliness). The abbreviated version was developed on the basis of our previous research[18] showing that some PEDS items are highly intercorrelated with others. Items considered redundant or highly correlated were not included in the abbreviated instrument (eg, building setbacks from streets, bicycle lanes, wayfinding aids). The abbreviated version consisted of 18 items. Trained field assessors audited all arterial street segments and a random sample of 25% of residential street segments within 800-m radius from each school[19–21] and manually geocoded audits in Google Earth. We generated the following variables using PEDS: presence of low-volume roads, sidewalks, pedestrian traffic buffers, path obstructions, posted speed limits, traffic control devices, crossing aids, overall street cleanliness, and path condition. In research conducted in the United States, PEDS has shown moderate to high reliability ($\kappa > 0.7$) for most of these items.[22] We categorized each variable according to predefined "poor," "fair" or "good" categories (for street cleanliness and path condition) or tertiles (for all other environmental variables) (Online Supplementary Table 1). We calculated the proportion of commercial land use, as well as a land-use mix index, using a 3-category land-use entropy score adapted from Frank et al.[9] These variables were used to calculate the walkability index (see below).

GIS-derived Attributes. We calculated the street connectivity (3-way or higher intersection density), residential density (households per km^2), and neighborhood SES (Online Supplementary Table 1). Street connectivity and residential density were used to calculate the walkability index (see below). GIS data sources were the urban cartographic boundary files, the demographics database from the 2010 Census of the National Institute of Geography and Statistics of Mexico, the urban roadway database from the Federal Electoral Institute 2013, and the 2010 Urban Poverty Index from the National Council of Population. We generated all GIS variables using ArcInfo Workstation 9.31 and ArcGIS Desktop 10.0 (ESRI, Inc., Redlands, CA).

Walkability Index. A walkability index was built using information on land-use mix and commercial land use (from PEDS instrument), as well as street connectivity and residential density (from GIS).[9] We calculated *z* scores for these variables and calculated the walkability index (Online Supplementary Table 1).[9]

Data Analysis

All analyses were done using Stata (version 13 SE; StataCorp, College Station, TX). Variables were analyzed descriptively by calculating frequencies or means. An empty model was run to calculate the intraclass correlation coefficient (ICC), which reflects the percentage of the total variance in ACS explained by school neighborhood characteristics.[23] Results showed an ICC of 14.6%, suggesting that a considerable amount of the variation was accounted for by school-environment characteristics and justifying the use of a multilevel analytical approach.

Multilevel logistic regression models were run for 400-m and 800-m buffers separately with ACS as the response variable and individual- and environmental-level variables as independent variables. Our multilevel models were built on the basis of theoretical and empirical criteria using the following hierarchical approach:

1. All individual variables were introduced in multivariate logistic models.
2. A criteria of $P < .05$ was considered for retention of individual-level variables; however, regardless of statistical significance, known confounders for physical activity were retained (sex, age and perceived parental school safety).[6,24]
3. Environmental variables were then introduced one at a time in single-environment-variable models adjusting for the individual variables selected in the previous step, neighborhood SES, and city.
4. If any variable was significant ($P < .05$) or the test for linear trend across categories was significant ($P < .05$), they were considered for inclusion in full models. On the basis of previous findings and a priori assumptions of the relationship between ACS and the walkability index, walkability was included regardless of statistical significance. Full models included all relevant (statistical or theoretical) individual and environmental variables.
5. A final set of models examined the moderating effects of gender on the relationships between ACS and 3-category environmental attributes. Significant ($P < .05$) interactions were introduced in full models.

All models were run as 2-level random-intercept models using the melogit command in STATA. The school was introduced as the grouping variable. Final models were tested for specification error and multicollinearity using the Stata *linktest* procedure and by exploring the variance inflation factor, respectively. If collinearity was present, only 1 factor was selected. All final models had a mean variance inflation factor (VIF) < 3, and no problems were found in the specification of the independent variables (prediction squared $P > 0.1$).

Regression model estimates were considered significant if $P < .05$. Because more than 40% of families (n = 503) did not report family income, we ran the same modeling strategy for the subsample with available income data. However, the fit of these models was not adequate (eg, individual VIFs > 12), therefore results for the full sample are reported.

Results

A total of 1509 children were measured; 318 were excluded for missing demographics, leaving 1191 cases for analysis. Children engaging in ACS represented 50.4% of the sample, whereas almost one third were driven to school in a family car. 7Further details on demographic characteristics and transportation modes are found in Table 1. Table 2 describes the distribution of the sample by school neighborhood characteristics. There was considerable variation in environmental features among participants.

Online Supplementary Table 2 summarizes bivariate and multivariate associations between individual characteristics and ACS. The multivariate model suggested that age category and ≥ 6 adults living at home were positive correlates for ACS. Online Supplementary Table 3 extends these results by examining single-environmental variable models. At the 400-m and 800-m buffer area level, a higher percentage of segments with posted speed limits, crossing aids, and street cleanliness were negative correlates for ACS, whereas a positive correlation was observed for a higher percentage of low-volume roads and path obstructions within 400-m buffers. These variables plus the walkability index were introduced in the full models. After running the first set of analyses, path obstructions and street cleanliness were dropped off the models because of high collinearity (individual VIFs > 13).

Table 3 presents the full multilevel models for both buffer sizes.

Table 1 Demographic Characteristics of Urban Mexican Children Sampled for the Study (N = 1119)

	n	%
School characteristic		
Neighborhood socioeconomic status, schools (children)		
Low	4 (134)	24.9
Medium	9 (470)	39.5
High	7 (291)	24.4
Very high	6 (134)	11.3
Individual characteristics		
Age		
6–8 years	195	16.4
9–11 years	979	82.2
12–14 years	17	1.4
Gender		
Male	565	47.4
Female	626	52.6
Travel mode to school		
Walk	594	49.9
Bike	6	0.5
School bus	46	3.8
City bus	126	10.6
Family car with only your family	381	32
Carpool with children from other families	38	3.2
Adults in the household		
1–2	760	63.8
3–5	373	31.3
≥6	58	4.9
Number of children in the household		
1	222	18.6
2–3	802	67.3
≥4	167	14
Income[a]		
<$5000	352	49.9
≥$5000	354	50.1
How safe does your child feel at school?		
Not safe	31	2.6
A little safe	115	9.7
Somewhat safe	152	12.8
Mostly safe	259	21.8
Very safe	634	53.2

[a] N = 706 children with available income information. Values are in Mexican pesos.

Table 2 School Neighborhood Characteristics of Urban Mexican Children (N = 1191)

	400-m Buffers		800-m Buffers	
Environmental variable	**n**	**%**	**n**	**%**
Walkability category[a]				
Low (< –1.2)	455	38.2	451	37.9
Moderate (–1.2 to 1.1)	329	27.6	321	27.0
High (> 1.1)	407	34.2	419	35.1
Street segments with sidewalk				
Low (< 70%)	365	30.7	363	30.5
Moderate (70–90%)	410	34.4	401	33.7
High (> 90%)	416	34.9	427	35.8
Street segments with posted speed limits				
Low (< 6%)	479	40.2	448	37.6
Moderate (6–12%)	335	28.1	400	33.6
High (> 12%)	377	31.7	343	29.8
Street segments with traffic-calming devices				
Low (< 12.5%)	383	32.2	358	30.1
Moderate (12.5–40.0%)	425	35.6	457	38.4
High (> 40.0%)	383	32.2	376	31.5
Street cleanliness				
Poor	21	1.8	21	1.8
Fair	864	72.5	864	72.5
Good	306	25.7	306	25.7
Street segments with path obstructions				
Low (< 25%)	406	34.1	397	33.3
Moderate (25–55%)	390	32.8	391	32.8
High (> 55%)	395	33.2	403	33.8
Street segments with low-volume roads				
Low (< 55%)	453	38.0	441	37.0
Moderate (55–65%)	391	32.8	338	28.4
High (> 65%)	347	29.2	412	34.6
Path condition				
Poor	21	1.8	43	3.6
Fair	838	70.3	822	69.0
Good	332	27.9	326	27.4

[a] Composite measure of street connectivity, residential density, commercial land use, and land-use mix.[9]

Table 3 Multilevel Models of Individual and Environmental Correlates of Active Commuting to School in Mexican Urban Children[a]

	400-m School Buffer Zones				800-m School Buffer Zones			
	Full model		Full model + interaction		Full model		Full model + interaction	
Independent variable	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
Gender								
Female	1.00	—	1.00	—	1.00	—	1.00	—
Male	0.98	(0.77–1.25)	0.63	(0.40–1.01)	0.98	(0.77–1.26)	**0.48**	**(0.25–0.93)**
Age								
6–8 years	1.00	—	1.00	—	1.00	—	1.00	—
9–11 years	**1.52**	**(1.09–2.13)**	**1.52**	**(1.09–2.13)**	**1.51**	**(1.08–2.11)**	**1.51**	**(1.08–2.10)**
12–14 years	2.14	(0.72–6.35)	2.13	(0.71–6.34)	2.30	(0.78–6.78)	2.28	(0.75–6.80)
P trend	**0.01**		**0.01**		**0.01**		**0.01**	
Adults in the household								
1–2	1.00	—	1.00	—	1.00	—	1.00	—
3–5	1.07	(0.82–1.39)	1.07	(0.82–1.40)	1.04	(0.80–1.37)	1.04	(0.80–1.36)
≥6	**2.11**	**(1.14–3.90)**	**2.06**	**(1.11–3.82)**	**2.00**	**(1.08–3.69)**	**2.00**	**(1.08–3.71)**
P trend	0.11		0.12		0.11		0.10	
Parental perceived school safety								
Not safe	1.00	—	1.00	—	1.00	—	1.00	—
A little safe-very safe	0.64	(0.30–1.37)	0.66	(0.31–1.41)	0.66	(0.31–1.40)	0.65	(0.31–1.38)
Walkability index[b] (*z* score)	**0.87**	**(0.77–0.99)**	**0.84**	**(0.72–0.97)**	1.02	(0.90–1.16)	1.02	(0.90–1.16)
Street segments with posted speed limits								
Low (< 6%)	1.00	—	1.00	—	1.00	—	1.00	—
Moderate (6–12%)	0.67	(0.44–1.02)	**0.64**	**(0.41–0.98)**	0.77	(0.38–1.61)	0.77	(0.37–1.63)
High (> 12%)	**0.36**	**(0.15–0.46)**	**0.37**	**(0.21–0.66)**	**0.27**	**(0.09–0.79)**	**0.25**	**(0.09–0.75)**
P trend	**< .01**		**< .01**		**.01**		**.01**	
Street segments with crossing aids								
Low (< 6%)	1.00	—	1.00	—	1.00	—	1.00	—
Moderate (6–20%)	**0.25**	**(0.14–0.44)**	**0.27**	**(0.15–0.50)**	**0.30**	**(0.11–0.82)**	**0.29**	**(0.11–0.81)**
High (> 20%)	**0.26**	**(0.15–0.47)**	**0.30**	**(0.16–0.58)**	**0.30**	**(0.12–0.72)**	**0.29**	**(0.25–0.72)**
P trend	**< .01**		**< .01**		**.01**		**.01**	
Low-volume roads								
Low (<55%)	1.00	—	1.00	—	1.00	—	1.00	—
Moderate (55–65%)	1.12	(0.63–2.01)	1.09	(0.60–1.97)	0.88	(0.31–2.53)	0.82	(0.28–2.42)
High (>65%)	0.77	(0.45–1.30)	0.74	(0.43–1.27)	0.49	(0.12–2.01)	0.44	(0.11–1.88)
P trend	0.29		0.25				0.77	
Street segments with sidewalk								
Full sample								
Low (<70%)	1.00	—	—	—	1.00	—	—	—
Moderate (70–90%)	1.59	(0.60–1.96)	—	—	1.44	(0.58–3.57)	—	—
High (>90%)	**4.48**	**(1.86–10.78)**	—	—	0.85	(0.37–1.95)	—	—
P trend	**.01**		—		.82		—	—

(continued)

Table 3 *(continued)*

	400-m School Buffer Zones				800-m School Buffer Zones			
	Full model		Full model + interaction		Full model		Full model + interaction	
Independent variable	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
Street segments with sidewalk								
Interaction								
Females[c]								
Low (<70%)	—	—	1.00	—	—	—	1.00	—
Moderate (70–90%)	—	—	1.46	(0.73–2.91)	—	—	1.07	(0.41–2.78)
High (>90%)	—	—	**3.01**	**(1.18–7.67)**	—	—	0.62	(0.25–1.50)
P trend	—		.09		—		.30	
Males[c]								
Low (<70%)	—	—	1.00	—	—	—	1.00	—
Moderate (70–90%)	—	—	1.90	(0.93–3.89)	—	—	2.20	(0.81–5.96)
High (>90%)	—	—	7.46	(2.84–19.53)	—	—	1.26	(0.51–3.09)
P trend	—		< .01		—		.62	

Note. Numbers in boldface indicate significant ($P < 0.05$) associations.

[a] Models control for gender, neighborhood socioeconomic status, and city.

[b] Composite measure of street connectivity, residential density, commercial land use, and land-use mix.[9]

[c] Interaction term Gender × Tertiles of sidewalk availability, $P < .05$ for the highest tertile in all models.

At the individual level, positive correlates for ACS included age category (9–11 years, odds ratio [OR] = 1.5, 95% confidence interval [CI], 1.1–2.1; 12–14 years: OR= 2.2, 95% CI, 0.7–6.8) and having 6 or more adults living in the household (OR = 2.0, 95% CI, 1.1–3.8).

At the 400-m buffer area level, environmental characteristics negatively related with ACS included a higher walkability index (OR = 0.87, 95% CI, 0.77–0.99) and a higher percentage of segments with posted speed limits (6–12%: OR = 0.67, 95% CI, 0.44–1.02; > 12%: OR = 0.36, 95% CI, 0.15–0.46, *P* trend < .05) and crossing aids (6–20%: OR = 0.25, 95% CI, 0.14–0.44; > 20%: OR = 0.26, 95% CI, 0.15–0.58). In addition, a higher percentage of segments with sidewalk within 400-m buffers was positively related with ACS (70–90%: OR = 1.59, 95% CI, 0.6–1.96; > 90%: OR = 4.48, 95% CI, 1.86–10.78, *P* trend < .05).

At the 800-m buffer area level, negative correlates of ACS included a higher percentage of segments with posted speed limits (6–12%: OR = 0.77, 95% CI, 0.38–1.61; > 12%: OR = 0.27, 95% CI, 0.09–0.79, *P* trend < .05) and crossing aids (6–20%: OR = 0.30, 95% CI, 0.11–0.82; >20%: OR = 0.30, 95% CI, 0.12–0.72); no positive correlates of ACS were observed at the 800-m buffer area level.

A significant interaction was observed between gender and the percentage of segments with sidewalk at 400-m buffer areas ($P < .05$) (Table 3): Among girls, having > 90% of segments with sidewalk was associated with 3.0 (95% CI, 1.18–7.67) times greater odds for ACS, whereas this relationship was 2.5 times larger among boys (OR = 7.5, 95% CI, 2.8–19.5 data not shown). The same interaction was found for 800-m buffer sidewalks ($P < .05$), but the relationships between sidewalk availability and ACS by gender were nonsignificant (data not shown). No other significant interactions were observed.

Discussion

This study evaluated family and environmental correlates of ACS in urban Mexican children. As proposed by Panter et al,[5] ACS was associated with individual and environmental variables: engagement in ACS was positively related with child's age, number of adults in the household, and sidewalk availability, whereas a negative correlation was observed with school-neighborhood walkability, posted speed limits, and crossing aids. In addition, the positive relationship between high sidewalk availability and ACS was modified by gender.

A positive relationship was found between age and ACS. In contrast, findings from a nationally representative sample of Mexican adolescents (10–14 years old) showed the opposite.[3] Differences may be explained by the representativeness of the sample. In addition, this study included younger children (≥ 6 years), suggesting that differences may also be due to a nonlinear relationship between age and ACS.[25] The number of adults in the household was positively related with ACS. It is possible that having more adults at home allows children to be escorted and helps overcome parental safety concerns.[26]

Environmental correlates were also identified. Sidewalk availability and street safety features have been identified as important correlates for ACS.[6,11,27] In our sample, sidewalks had a positive relationship with ACS after > 70% of segments had available sidewalks. In addition, sidewalk availability had a stronger relationship with ACS among boys compared with girls. Social tendencies of parents to be more protective of girls might explain this difference.[6] In addition, contrary to previous evidence,[6,11,12] posted speed limits and crossing aids were negatively associated with ACS. Studies in HICs have found a positive association when > 50% of streets have posted speed limits.[12] In our sample, only 2 schools were located in a neighborhood in which more than 50% of streets had posted speed limits. In addition, the negative relationship may be explained by the fact that speed limits in Mexico are generally posted in busy streets. According to our PEDS data, speed limits and crossing aids were 3.5 and 2.5 times more common, respectively, in high-volume roads than in low-volume roads (*P* <

.01) and increased with the number of traffic lanes (OR = 1.41, $P < .01$; crossing aids: OR = 1.58, $P < .01$). The use of 2 different radii allowed us to test whether more proximal environmental characteristics had a stronger relationship with ACS compared with more distal environmental characteristics. Our findings suggest this may be the case because walkability and sidewalks were related with ACS only within 400-m buffer areas.

It has been suggested that highly dense, mixed, and well-connected neighborhoods may encourage more active transportation in adults[7] and children[10] by bringing origins and destinations together, making multipurpose trips using active modes more convenient. Our findings do not support this hypothesis and are consistent with previous research in Mexican adults showing a negative relationship between the walkability index and physical activity.[16] Authors suggested it was possible that a low walkability score in a Mexican city might be equivalent to a high walkability score in a US city, and therefore neighborhoods that are too dense, mixed, and connected may represent a barrier for walking.[16] Although our findings do not imply causal inference, perhaps the unique cultural characteristics (eg, active transportation as a necessity driven behavior) and environmental characteristics (eg, high perceptions of land-use mix diversity and access)[28] in Mexico limit the validity of this index to reflect the theoretical concept of "walkability." Further investigation is needed regarding what active-transportation-friendly environments mean in settings such as Mexico.

Taken together, these findings suggest some directions to design and pilot test interventions to promote ACS in Mexico. At the individual level, the number of adults in the household was one of the most important factors positively associated with ACS. Efforts to organize the school community to engage adults to escort small groups of children, on foot or bicycle, to and from school each day, such as "The Walking School Bus," could be culturally adapted and pilot tested. This program has shown improvements in the proportion of children engaging in ACS.[29] At the neighborhood level, interventions to promote ACS in existing schools should consider improvements to the active transportation infrastructure, specifically sidewalks. For example, interventions such as the Safe Routes to School, which considers walking infrastructure improvements, could be adapted and pilot tested.[30] This program has shown to be effective in increasing ACS.[30]

Although these findings provide insight into ACS in Mexican school children and guidance for future strategies aimed at improving ACS, there were several limitations to this study. The proportion of children engaging in ACS in our sample was lower than that reported by the *Encuesta Nacional de Salud y Nutrición* (National Health and Nutrition Survey) in Mexico.[3] Although this survey is designed to be representative at the national level, our study was limited to urban youth from 3 Mexican cities. Therefore, our results may not be applicable to children living in very-low-SES neighborhoods, indigenous children, or those from rural settings. Despite cultural adaptations and translations, the ACS item and the PEDS instrument have not been rigorously validated for use in Mexico. A similar question on transportation mode to school tested in English- and Spanish-speaking 9- to 11-year old school children showed high validity when compared with parent's report.[31] As for the PEDS instrument, a negative correlation between percentage of low-volume roads and GIS-derived primary roads was found ($\rho = -0.49$, $P < .001$, data not shown). Our study included a convenience sample of schools, limiting the representativeness of our findings. Furthermore, we do not have information on distance from children's home to school, and associations could be modified when accounting for this variable. Nonetheless, data on travel time to school from the latest National Health and Nutrition Survey suggests that most (> 70%) children live within 1-km school buffer zones. In addition, models were not adjusted for family SES, a known confounder for ACS and the built environment. To partially control for this confounder, we adjusted all models for neighborhood SES, which was positively correlated with family SES ($\rho = 0.14$, $P < .001$). However, residual confounding may exist. We used the same analysis strategy including the subsample of children with available income data (n = 706, analysis not shown). After we adjusted for family income, estimates on the relationship between ACS and environmental attributes were similar and consistent in magnitude with those that were reported for the full sample (eg, walkability: OR = 0.77; crossing aids: 6–20%: OR = 0.29 and > 20%: OR = 0.26; sidewalks: > 90% OR = 5.14); however, individual level variables such as age category and number of adults in the household were not significant. The individual components used to define the walkability score do not correspond exactly to those used in previous definitions of walkability[9]; therefore, caution is advised when interpreting the data.

Conclusions

By examining multiple factors at multiple levels of environment, this study provided context-specific evidence on individual and environmental correlates of ACS in Mexican children. Neighborhood posted speed limits, crossing aids, walkability, and sidewalk availability were the most important correlates of ACS. This study can inform future research and health promotion strategies to prevent declines in ACS. Findings contrast with those reported in HIC, underscoring the importance of considering the local context when developing strategies to promote ACS in Mexico.

Acknowledgments

We acknowledge the State of Jalisco Secretaría de Salud and Secretaría de Educación for their assistance in identifying schools and neighborhoods for investigation, as well as the many students and trainees in the United States and Mexico who helped in data collection, entry, and processing. This work was made possible by a Fulbright-García Robles Core Scholar Fellowship awarded to Dr. Lee; the Canadian Institutes for Health Research; and the Public Health Agency of Canada.

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