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Perceived Urban Environment Attributes and Device-Measured Physical Activity in Latin America: An 8-Nation Study

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Introduction: Attributes of the neighborhood-built environment are associated with self-reported physical activity, but only a few studies have concentrated on device-measured physical activity in Latin America. This study examines the associations of perceived neighborhood-built environment attributes, device-measured sedentary time, and light-intensity and moderate-to-vigorous physical activity in adults from 8 Latin American countries.

Methods: Data from *Estudio Latinoamericano de Nutrición y Salud* adult study, an observational multicountry study (N=2,478), were analyzed in 2020. Data were collected between 2014 and 2015. Perceived neighborhood-built environment attributes were measured using the Neighbourhood Environment Walkability Survey. Sedentary time, light-intensity physical activity, and moderate-to-vigorous physical activity data were collected using accelerometers.

Results: No associations between perceived neighborhood-built environment attributes and sedentary time were found. Positive perceptions of walking/cycling facilities (β=6.50, 95% CI=2.12, 10.39) were associated with more light-intensity physical activity. Perceptions of better aesthetics (Argentina) and better walking/cycling facilities (Brazil and Ecuador) were positively associated with light-intensity physical activity. Land use mix−diversity (β=0.14, 95% CI=0.03, 0.25), walking/cycling facilities (β=0.16, 95% CI=0.05, 0.27), aesthetics (β=0.16, 95% CI=0.02, 0.30), and safety from traffic (β=0.18, 95% CI=0.05, 0.24) were positively associated with moderate-to-vigorous physical activity. Land use mix−diversity, street connectivity, and safety from traffic were positively associated with moderate-to-vigorous physical activity in Venezuela.

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Conclusions: These findings have implications for policy recommendations, which can guide policies to promote physical activity in the region. Land use mix−diversity, walking/cycling facilities, aesthetics, and safety from traffic can maintain or increase the levels of light-intensity and moderate-to-vigorous physical activity among Latin American adults.

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INTRODUCTION

International consensus has been reached on a new term, movement behavior, which includes sedentary time (ST) and all intensities of physical activity (PA).[1] Many studies suggest that engagement in moderate-to-vigorous PA (MVPA) can promote health benefits, such as lower risk of cardiovascular disease, cognitive decline, lower risk of different types of cancer, and lower risk of all-cause mortality.[2−4] *Sedentary behavior*—defined as any waking behavior with low energy expenditure (≤1.5 METs) while sitting, reclining, or lying down[1] is also associated with negative health outcomes, including all-cause mortality.[5,6]

Latin American cities are experiencing rapid urbanization and globalization processes in which behaviors, lifestyles, and living situations are changing at a significant pace,[7] resulting in different urban characteristics from those of high-income countries. These include social inequalities, criminality, and higher urban density.[8−10] Examining how urban environment attributes are associated with PA in Latin America can help to guide public policies and strategies for healthy lifestyle promotion. Built perceived neighborhood characteristics have been associated with PA, with studies from other regions than Latin America indicating that living in neighborhoods with good (versus living in those with poor) access to commercial destinations, public transport, parks, and recreational facilities are associated with higher levels of device-measured MVPA and lower levels of ST in older adults,[11,12] adults,[13,14] and children.[15,16]

Specifically, in Latin America, neighborhood aspects such as good access to destinations, high land use *mix−diversity* (defined as a "perceived walking proximity from home to different types of destinations"), *better aesthetics* (defined as "whether there are many interesting things to look at while walking in the neighborhood"), and greater safety from crime have been linked to more self-reported PA among adults.[17,18] Device-measured MVPA and ST can enhance precision and credibility of total time spent sedentary and at different PA intensities.[19] Most previous research that showed a positive association of perceived neighborhood-built environment attributes with device-based MVPA and ST were conducted in cities in middle- and high-income countries.[20,21] Considering the distinct features of Latin American cities, it is not likely that these results directly translate from high-income cities to the Latin American region.[22−26]

Studies have tended to focus on MVPA (i.e., approximately ≥3 METs) and ST, although there is a lack of evidence of light-intensity PA (i.e., activities ranging between 1.5 and <3 METs) such as casual walking, lifting lightweight objects, light household chores or yard work, and stretching.[27,28] Light-intensity PA is associated with important health outcomes, such as obesity, cancer, lipid markers, and mortality.[29−31] Light-intensity PA also has much potential for increasing daily PA energy expenditure[32] because it occupies a large amount of overall wake time in daily life.[33] Previous studies[17,34] and 2 systematic reviews[35,36] from Latin America indicate that most studies have not focused on the associations between built environment and light-intensity PA in adults. The purpose of this study is to examine the overall and country-specific associations of perceived neighborhood-built environment with device-measured ST, light-intensity PA, and MVPA in adults from 8 Latin American countries.

METHODS

The Latin American Study of Nutrition and Health (*Estudio Latinoamericano de Nutrición & Salud* [ELANS]) is an observational, epidemiologic, multinational, cross-sectional study conducted across 8 countries from Latin American region (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, and Venezuela) and focuses on the urban population.[37] Study dates ranged from 2014 to 2015. The overarching ELANS protocol was approved by the Western IRB and is registered at ClinicalTrials.gov. Ethical approval was obtained from each local IRB. All participants provided written informed consent.

Study Population

Details about participant recruitment have been described previously.[37,38] The participants were selected using a random complex, multistage sampling frame with a random selection of Primary Sampling Unit (PSU) areas (e.g., counties, municipalities, neighborhoods, residential areas). An *n* size proportional to population weight was used for the selection of PSU. In this case, a simple random sampling of *n* with replacement was performed to adhere to the principle of statistical independence of the selection of the areas included in the PSU sample. Within each of the areas included in the PSU distribution, a representative sample of Secondary Sampling Units was randomly designated using the probability proportional to size method.

For the selection of households, a 4-step, systematic randomization procedure was implemented by establishing a selection interval: (1) the total urban population was used to proportionally describe the main regions and select cities representing each region, (2) the sampling points (survey tracts) of each city were randomly designated, (3) clusters of households were selected from each sampling unit, and (4) the designated respondent within each household was selected using the birthday method. In each country, stratified recruitment of participants was done across sex, age, and SES. The ELANS design and sample size have been described in detail elsewhere.[37]

A total sample of 10,134 (aged 15.0−65.0 years) people was invited to participate in the ELANS study. However, 9,218 (4,809 women) participants were included (response rate=91%). Device-measured PA was collected for 40% of the sample randomly selected to fill quotas by sex, age, and SES, thereby ensuring a representative subsample across these dimensions. For logistical and financial reasons, efforts were made to ensure that a range of 23.4%−34.2% of each sample wore the device on all 5 days.[38,39] The sample with accelerometer data included 2,732 participants aged 15−65 years, which represented 29.6% of the total ELANS cohort (n=9,218).[33,38] Details have been published elsewhere.[38]

Adolescents aged 15−17 years were excluded from the analysis because ELANS did not include adolescents of younger ages. This study is based on a sample of 2,478 participants aged 18−65 years. The response rate for valid accelerometer data and a completed survey of perceived neighborhood-built environment attributes were 90.5% and 98.9% of the total subsample, respectively.

Measures

The Neighbourhood Environment Walkability Scale (NEWS)-A assesses perceived neighborhood-built environment attributes. NEWS-A variables have been associated with higher levels of PA in several countries, mainly in the U.S., Europe, and Australia.[14,17,35] The validated NEWS-A previously translated into Spanish and adapted for use in Latin America was used to assess neighborhood-built environment attributes.[40−42]

The following NEWS-A subscales were used: land use mix −diversity, land use mix−access, street connectivity, walking/cycling facilities, aesthetics, safety from traffic, and safety from crime. The land use mix−diversity scale reflects average perceived walking proximity (i.e., an average of 5-point ratings ranging from ≤5-minute walk, coded as 5 to ≥30-minute walk, coded as 1 from home to 23 different types of destinations [e.g., supermarket, school, and other stores and services]). The remaining 6 scales are average ratings of items answered on a 4-point Likert scale (1=*strongly disagree* to 4=*strongly agree*). Scales were scored in a direction consistent with higher scores reflecting higher walkability and more safety, with individual items reversed when necessary. Scoring details are described elsewhere.[43] Finally, the importance of using these environmental attributes in research has been documented in systematic reviews for children[15,16] and adults.[35]

The internal consistency of the scales in this subsample with accelerometer data was similar to the internal consistency of the full sample.[17] Appendix Table 1 (available online) shows the Cronbach's α values for NEWS-A subscales.

The ActiGraph GT3X+ accelerometer was used to assess mean minutes/day of ST, light-intensity PA, and MVPA, which are valid and reliable tools to assess ST, light-intensity PA, and MVPA in adults during laboratory and in free-living conditions.[44−46]

The accelerometer was worn on an elasticized belt at hip level on the right hip (mid-axillary) line for 7 consecutive days during waking hours, except when engaging in water-based activities and when sleeping. Days with ≥10 hours of recorded wear time were considered valid.[47] A participant was included in the analysis if they had ≥5 valid days of data, including ≥1 weekend day. After exclusion of the nocturnal sleep period time, periods with ≥60 minutes of consecutive zero accelerometer counts were categorized as nonwear time.[48] Details on accelerometer data have been published elsewhere.[33,38]

Data were processed using ActiLife software, version 6.0. Data were collected at a sampling rate of 30 Hz and downloaded in epochs of 60 seconds.[49] *ST, light-intensity PA,* and *MVPA* were defined as time accumulated at <100, ≥100−1,951, and ≥1,952 activity counts/minute, respectively.[44,50] Participants were categorized as meeting (≥150 minutes/week) or not meeting (<150 minutes/week) MVPA guidelines as defined by the WHO.[51]

Statistical Analysis

Analyses were conducted in 2020 using SPSS, version 26.[52] Descriptive statistics included means, SDs, and percentages. This study also presents medians and IQRs specifically for ST, light-intensity PA, and MVPA owing to the nonparametric distribution of MVPA. Weighting was calculated according to sociodemographic correlates and country.[37]

Cronbach's α was conducted to measure the internal consistency of the NEWS-A scales. Linear regression models (β-coefficient, 95% CI) were estimated using unstandardized coefficient values to estimate the overall associations of neighborhood characteristics with ST, light-intensity PA, and MVPA (minutes/day). Owing to the non-normality of MVPA, the variable was transformed using the square root function. The models were adjusted for sex, age, SES, country, and device-measured wear time. Separate regression models were then run in each country. A probability level of 5% was considered. Results were computed for the overall sample and by country.

RESULTS

There were no significant differences (p>0.05) between the participants who were asked to wear an accelerometer and those who were not by sex, SES and educational level, ethnicity, and marital status. Table 1 shows the descriptive results for the demographic characteristics and device-based movement behaviors for the overall sample and specifically for each country. The mean age was 38.2 years, 46.7% of participants were male, and 51% and 38.9% were classed as having a low and medium SES, respectively. Overall, the mean ST, light-intensity PA, and MVPA were 566.9, 315.1, and 34.0 minutes/day, respectively. Further details on differences by countries can be found elsewhere.[33]

Table 1. Sample Characteristics: Sociodemographic and Device-Measured Sedentary Time and Physical Activity

Variables	Overall	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	Peru	Venezuela
Sample size, *n*	2,478	266	516	271	313	237	245	296	334
Age, years, mean (SD)	38.2 (13.4)	40.6 (13.0)	39.1 (13.3)	38.7 (13.2)	39.3 (13.9)	38.1 (12.6)	36.5 (13.6)	37.2 (13.4)	36.0 (13.2)
Sex, %									
Men	46.7	41.7	44.2	46.1	49.5	46.8	49.8	47.0	49.4
Women	53.3	58.3	55.8	53.9	50.5	53.2	50.2	53.0	50.6
Socioeconomic level, %									
Low	51.0	51.5	41.9	41.7	63.9	34.2	44.5	46.3	80.8
Medium	38.9	43.6	50.0	47.2	30.7	54.0	40.4	31.1	14.4
High	10.1	4.9	8.1	11.1	5.4	11.8	15.1	22.6	4.8
Device-measured									
Sedentary time (minutes/day)									
Mean (SD)	566.9 (114.3)	576.8 (116.1)	555.5 (119.6)	548.2 (113.7)	564.1 (103.0)	558.5 (115.4)	575.5 (114.7)	591.3 (111.6)	572.2 (112.2)
Median (IQR)	564.4 (493.2–640.5)	572.9 (502.4–655.4)	552.2 (478.9–621.5)	548.0 (477.7–629.6)	560.2 (496.8–629.5)	566.0 (488.8–628.3)	565.8 (492.4–646.3)	591.5 (518.8–670.3)	565.7 (499.1–646.0)
Light-intensity physical activity (minutes/day)									
Mean (SD)	315.1 (89.9)	314.0 (91.3)	324.4 (92.3)	327.5 (91.2)	302.8 (88.1)	301.2 (90.0)	317.4 (88.5)	318.4 (91.4)	308.6 (82.2)
Median (IQR)	302.7 (246.2–369.6)	299.3 (235.0–371.9)	318.3 (253.4–391.6)	313.2 (260.4–383.7)	292.6 (240.8–356.3)	282.5 (228.5–248.9)	308.1 (250.0–372.5)	302.5 (250.1–370.7)	297.1 (249.3–352.8)
MVPA (minutes/day)									
Mean (SD)	34.0 (23.5)	32.8 (22.7)	32.7 (23.4)	39.4 (23.7)	33.6 (22.0)	31.4 (23.0)	37.9 (26.8)	35.7 (24.3)	30.8 (21.3)
Median (IQR)	28.8 (16.5–47.1)	27.1 (16.2–44.8)	27.1 (15.9–44.8)	35.0 (23.0–51.8)	31.0 (16.8–46.3)	25.7 (13.4–43.6)	32.1 (18.4–53.3)	29.7 (16.5–52.1)	25.5 (14.5–43.2)
Meeting MVPA guidelines, %	61.1	58.0	56.7	75.5	64.6	55.5	67.5	63.2	53.3
Not meeting MVPA guidelines, %	38.9	42.0	43.3	24.5	35.4	44.5	32.5	36.8	46.7

MVPA, moderate-to-vigorous physical activity.

The overall average score of land use mix–diversity (5-point scale from 1 to 5; higher scores reflect more diversity) was 2.8. The overall scores were 3.0 for land use mix–access, 2.8 for street connectivity, 2.8 for walking/cycling facilities, 2.6 for aesthetics, 2.6 for safety from traffic, and 2.5 for safety from crime (4-point scales from 1 to 4; higher scores reflect more activity friendliness) (Appendix Table 2, available online).

Overall, no significant associations were observed between the perceived neighborhood-built environment attributes and ST; however, when conducting country-specific analyses, some distinct associations were identified. Argentina was the only country where high street connectivity was associated (β= −15.82, 95% CI= −30.62, −1.02) with less ST. Perceiving more and better walking/cycling facilities was associated (β= −17.07, 95% CI= −32.79, −3.70) with less ST in Chile. Finally, Venezuela was the only country with a significant and negative association (β= −23.04, 95% CI= −45.73, −0.35) between safety from crime and ST (Table 2).

Overall, perceiving more and better walking/cycling facilities was associated (β= 6.50, 95% CI= 2.12, 10.39) with more light-intensity PA. Some distinct associations by country were observed. Only in Argentina, perceptions of better aesthetics were associated (β=14.01, 95% CI=4.78, 24.91) with more light-intensity PA. Perceiving more and better walking/cycling facilities was positively associated with light-intensity PA in Brazil (β= 11.45, 95% CI= 2.39, 20.51) and Ecuador (β=18.90, 95% CI=3.40, 33.40) (Table 3).

Overall, land use mix–diversity (β= 0.14, 95% CI= 0.03, 0.25), walking/cycling facilities (β= 0.16, 95% CI= 0.05, 0.27), aesthetics (β= 0.16, 95% CI=0.02, 0.30), and safety from traffic (β= 0.18, 95% CI: = 0.05, 0.24) were positively associated with MVPA (minutes/day). Distinct associations by country were detected between perceived neighborhood-built attributes characteristics and MVPA. Venezuela was the country with the strongest associations between perceived neighborhood-built environment attributes (land use mix–diversity: β= 0.36, 95% CI= 0.07, 0.65; street connectivity: β= 0.45, 95% CI= 0.09, 0.81; safety from traffic: β= 0.24, 95% CI= 0.02, 0.48) and MVPA (Table 4).

DISCUSSION

This study aimed to verify the associations of perceived neighborhood-built environment attributes with device-measured ST, light-intensity PA, and MVPA in representative samples of adults from 8 Latin American countries. The perception of walking/cycling facilities and longer distances to shopping centers were positively related to light-intensity PA. Land use mix–diversity,

Table 2. Association (Unstandardized β, 95% CI) Between Perceived Neighborhood-Built Environmental Attributes and Sedentary Time (Minutes/Day)

Independent variables	Overall, β (95%CI)	Argentina, β (95%CI)	Brazil, β (95%CI)	Chile, β (95% CI)	Colombia, β (95%CI)	Costa Rica, β (95%CI)	Ecuador, β (95%CI)	Peru, β (95%CI)	Venezuela, β (95% CI)
Land use mix–diversity (score 1–5)[a]	4.04 (−2.71, 10.79)	−10.07 (−31.87, 11.74)	12.28 (−2.61, 27.17)	6.85 (−19.16, 32.86)	0.08 (−17.06, 17.22)	6.62 (−15.70, 28.94)	−0.26 (−28.07, 27.55)	−8.52 (−33.11, 16.08)	3.10 (−15.85, 22.06)
Land use mix–access (score 1–4)[a]	3.23 (−9.10, 15.55)	−11.64 (−53.89, 30.61)	−2.07 (−29.42, 25.29)	16.06 (−31.59, 63.71)	−2.05 (−39.79, 35.70)	8.32 (−30.31, 46.95)	17.80 (−35.24, 70.85)	27.86 (−14.84, 70.57)	−3.16 (−35.72, 29.40)
Street connectivity (score 1–4)[b]	−1.06 (−6.17, 4.12)	**−15.82 (−30.62, −1.02)**	−5.53 (−18.19, 7.16)	6.70 (−8.38, 21.82)	5.70 (−9.59, 21.01)	5.08 (−12.32, 22.48)	−3.44 (−23.42, 16.53)	9.29 (−8.03, 26.61)	1.13 (−12.73, 15.00)
Walking/cycling facilities (score 1–4)[b]	4.45 (−1.19, 10.11)	−7.16 (−26.45, 12.13)	−0.15 (−13.99, 13.68)	**−17.07 (−32.79, −3.70)**	9.53 (−4.45, 23.53)	−17.47 (−39.88, 4.94)	2.06 (−19.58, 23.71)	16.46 (−3.38, 36.28)	10.95 (−8.05, 29.96)
Aesthetics (score 1–4)[a]	2.89 (−4.52, 10.30)	11.09 (−18.55, 40.73)	2.32 (−13.98, 18.62)	14.52 (−8.92, 37.97)	−4.46 (−26.16, 17.23)	−5.96 (−29.49, 17.57)	4.43 (−25.43, 34.28)	15.63 (−9.15, 40.41)	5.96 (−12.17, 24.09)
Safety from traffic (score 1–4)[b]	2.20 (−3.68, 8.08)	−11.81 (−30.09, 6.47)	14.17 (−0.56, 28.89)	9.27 (−6.93, 25.46)	−9.69 (−25.40, 6.01)	−1.07 (−20.59, 18.46)	10.36 (−11.04, 31.76)	7.41 (−12.02, 26.83)	−2.76 (−20.95, 15.43)
Safety from crime (score 1–4)[a]	−5.73 (−14.36, 2.91)	−1.23 (−30.96, 28.49)	−4.57 (−25.55, 16.41)	−2.93 (31.33, 25.46)	−16.44 (−41.22, 8.33)	8.39 (−18.84, 35.62)	11.61 (−21.99, 45.20)	−2.95 (−34.37, 28.48)	**−23.04 (−45.73, −0.35)**

Note: Boldface indicates statistical significance (p<0.05).
Linear regression models adjusted for sex, age, socioeconomic level, and device-measured wear time.
[a]Higher scores indicate a perception of higher land use mix–diversity, higher land use mix–access, better aesthetics, and more safety from crime.
[b]4-point scale: 1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree.

Table 3. Association (Unstandardized β, 95% CI) Between Perceived Neighborhood-Built Environmental Attributes and Light-Intensity Physical Activity (Minutes/Day)

Independent variables	Overall, β (95%CI)	Argentina, β (95%CI)	Brazil, β (95%CI)	Chile, β (95% CI)	Colombia, β (95%CI)	Costa Rica, β (95%CI)	Ecuador, β (95%CI)	Peru, β (95%CI)	Venezuela, β (95% CI)
Land use mix—diversity (score 1–5)[a]	−0.80 (−5.95, 4.35)	1.41 (−15.82, 18.63)	5.87 (−5.41, 17.12)	1.48 (−18.41, 21.37)	1.32 (−13.24, 15.87)	−3.11 (−20.24, 14.02)	2.98 (−17.99, 23.95)	−8.51 (−27.90, 10.89)	−9.95 (−23.67, 3.77)
Land use mix—access (score 1–4)[a]	0.53 (−8.90, 9.96)	20.22 (−13.16, 53.59)	4.02 (−16.71, 24.74)	−17.07 (−53.50, 19.36)	−0.88 (−32.93, 31.16)	−8.74 (−38.38, 20.91)	5.99 (−34.00, 45.99)	10.15 (−23.53, 43.83)	1.66 (−21.91, 25.23)
Street connectivity (score 1–4)[b]	0.91 (−3.02, 4.85)	4.25 (−7.42, 15.95)	−0.60 (−10.17, 8.96)	2.84 (−8.72, 14.40)	−2.71 (−15.70, 10.29)	−8.52 (−21.88, 4.83)	2.57 (−12.50, 17.64)	3.50 (−10.14, 17.16)	−0.36 (−10.40, 9.68)
Walking/cycling facilities (score 1–4)[b]	**6.50 (2.12, 10.39)**	−3.17 (−23.10, 16.75)	**11.45 (2.39, 20.51)**	6.58 (−18.36, 31.53)	5.14 (−10.31, 20.59)	−11.22 (−27.78, 5.35)	**18.90 (3.40, 33.40)**	−13.86 (−30.51, 2.80)	−10.96 (−25.95, 4.03)
Aesthetics (score 1–4)[a]	−2.88 (−8.55, 2.80)	**14.01 (4.78, 24.91)**	−0.62 (−12.97, 11.73)	−9.31 (−27.23, 8.61)	4.95 (−13.47, 23.37)	5.01 (−13.05, 23.07)	−9.41 (−31.92, 13.09)	−1.57 (−21.11, 17.98)	−1.80 (−14.92, 11.32)
Safety from traffic (score 1–4)[b]	−2.03 (−6.53, 2.47)	−2.49 (−16.93, 11.96)	−2.13 (−13.29, 9.03)	7.09 (−5.29, 19.47)	−1.41 (−14.75, 11.92)	2.87 (−12.11, 17.85)	−11.33 (−27.47, 4.80)	3.65 (−11.67, 18.97)	−8.32 (−21.48, 4.85)
Safety from crime (score 1–4)[a]	1.88 (−4.71, 8.48)	13.48 (−10.00, 36.96)	−3.57 (−19.47, 12.32)	2.49 (−19.22, 24.20)	0.89 (−20.15, 21.92)	−10.66 (−31.56, 10.24)	−15.32 (−40.64, 10.01)	4.93 (−19.85, 29.72)	5.84 (−10.58, 22.27)

Note: Boldface indicates statistical significance ($p<0.05$).
Linear regression models adjusted for sex, age, socioeconomic level, and device-measured wear time.
[a]Higher scores indicate a perception of higher land use mix—diversity, higher land use mix—access, better aesthetics, and more safety from crime.
[b]4-point scale: 1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree.

Table 4. Association (Unstandardized β, 95% CI) Between Perceived Neighborhood-Built Environmental Attributes and Moderate-to-Vigorous Physical Activity (SQRT [Minutes/Day])

Independent variables	Overall, β (95%CI)	Argentina, β (95% CI)	Brazil, β (95%CI)	Chile, β (95% CI)	Colombia, β (95%CI)	Costa Rica, β (95%CI)	Ecuador, β (95%CI)	Peru, β (95%CI)	Venezuela, β (95% CI)
Land use mix—diversity (score 1–5)[a]	**0.14 (0.03, 0.25)**	**0.56 (0.21, 0.92)**	0.00 (−0.24, 0.24)	0.27 (−0.15, 0.68)	−0.11 (−0.42, 0.21)	−0.24 (−0.60, 0.13)	0.33 (−0.18, 0.83)	**0.46 (0.03, 0.89)**	**0.36 (0.07, 0.65)**
Land use mix—access (score 1–4)[a]	−0.17 (−0.37, 0.04)	−0.21 (−0.89, 0.48)	−0.03 (−0.47, 0.41)	−0.29 (−1.05, 0.47)	−0.10 (−0.80, 0.60)	−0.28 (−0.92, 0.35)	−0.68 (−1.64, 0.27)	−0.42 (−1.17, 0.32)	−0.03 (−0.53, 0.48)
Street connectivity (score 1–4)[b]	−0.05 (−0.16, 0.06)	0.29 (−0.04, 0.63)	0.00 (−0.24, 0.25)	−0.16 (−0.51, 0.18)	0.06 (−0.30, 0.42)	−0.06 (−0.41, 0.29)	−0.01 (−0.41, 0.37)	0.06 (−0.39, 0.50)	**0.45 (0.09, 0.81)**
Walking/cycling facilities (score 1–4)[b]	**0.16 (0.05, 0.27)**	0.08 (−0.33, 0.49)	0.01 (−0.22, 0.25)	0.24 (−0.28, 0.76)	0.10 (−0.24, 0.43)	−0.11 (−0.46, 0.25)	0.23 (−0.21, 0.68)	**0.45 (0.08, 0.82)**	0.03 (−0.29, 0.36)
Aesthetics (score 1–4)[a]	**0.16 (0.02, 0.30)**	−0.22 (−0.70, 0.26)	−0.07 (−0.33, 0.20)	−0.29 (−0.67, 0.08)	0.08 (−0.32, 0.48)	−0.15 (−0.54, 0.24)	−0.16 (−0.70, 0.38)	−0.20 (−0.63, 0.23)	−0.18 (−0.46, 0.10)
Safety from traffic (score 1–4)[b]	**0.18 (0.05, 0.24)**	0.07 (−0.23, 0.37)	**0.24 (0.01, 0.47)**	**0.30 (0.11, 0.49)**	**0.34 (0.06, 0.62)**	0.29 (0.00, 0.59)	−0.16 (−0.53, 0.22)	0.08 (−0.24, 0.40)	**0.24 (0.02, 0.48)**
Safety from crime (score 1–4)[a]	0.06 (−0.08, 0.21)	−0.04 (−0.52, 0.45)	0.23 (−0.10, 0.57)	0.15 (−0.30, 0.61)	−0.27 (−0.73, 0.19)	−0.07 (−0.52, 0.38)	0.32 (−0.28, 0.93)	0.04 (−0.50, 0.59)	−0.16 (−0.51, 0.19)

Note: Boldface indicates statistical significance ($p<0.05$).
Linear regression models adjusted for sex, age, socioeconomic level, and device-measured wear time.
[a]Higher scores indicate a perception of higher land use mix—diversity, higher land use mix—access, better aesthetics, and more safety from crime.
[b]4-point scale: 1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree.
SQRT, square root function.

walking/cycling facilities, aesthetics, and safety from traffic in the neighborhood were positively associated with MVPA. On the other hand, no significant associations were observed between the perceived neighborhood-built environment attributes and ST. However, some specific associations with ST were observed for each country.

This study contributes to the previous literature by examining how neighborhood attributes are associated with ST and light-intensity PA, which are emerging risk factors for adverse health outcomes and tend to present substantial bias when self-reported.[6,29] Overall, the authors did not observe an association between perceived neighborhood-built environment attributes and ST. Individually, Argentina, Chile, and Venezuela showed a negative association of street connectivity, walking/cycling facilities, and safety from crime in the neighborhood with ST. Latin American countries tend to have high population density patterns, and the transition from traditional public transportation systems to private cars and motorcycles has resulted in increased traffic congestion.[10] Latin America has also become a region of pronounced inequalities, having the largest proportion in the world living in slums,[53] as well as increasingly high crime rates. For instance, researchers hypothesized a priori that certain established constructs from high-income countries were not applicable to Latin American cities.[23] Findings from Mexico and Colombia showed that the relationship between PA and the walkability index is not consistent with what has been reported for high-income countries.[23] In fact, recent studies have observed inconclusive effects of perceived neighborhood-built environment attributes with device-measured ST.[12,54]

Study findings extend previous similar results and confirm the positive link between walking/cycling facilities and device-measured light-intensity PA in adults.[55,56] A study from high-income countries also observed positive associations of perceived walking/cycling facilities with recreational walking.[57] The present findings are not surprising given that walking is the most common form of PA, and in most Latin American cities, walking is also an essential part of urban mobility.[58] In this study, Brazil and Ecuador showed a positive association between walking/cycling facilities and light-intensity PA. The results support the hypothesis that people who use or have access to public transport are more likely to walk and be more physically active than those who do not.[59,60] As reported elsewhere, the use or access to public transport was associated with some walking but not with reaching recommended PA levels.[60,61] A potential explanation is that the Bus Rapid Transit (BRT) system is faster than the regular bus system. The BRT systems are common in multiple Latin American cities. This could motivate people to spend more time walking to the BRT stations to save time overall in reaching destinations than using standard transit systems.[62] BRT systems tend to be more geographically dispersed and available than regular bus systems, so these might not be at a walking distance for everyone in Latin American cities.[36] Thus, these findings suggest that walking/cycling facilities are important urban infrastructure for adults' accumulation of daily PA in the neighborhood.[63]

Overall, these findings are in line with previous studies that showed positive associations between perceived neighborhood-built environment attributes and MVPA.[12,64] The Active Lifestyle and the Environment in Chinese Seniors study reported positive associations of device-measured MVPA with a number of recreation locations.[12] Among the examined destinations, recreation facilities are those where residents are the most likely to engage in higher-intensity PA.[65] Recreation facilities are also appropriate destinations for exercise in Latin America.[66] Support for the positive impacts of perceived neighborhood-built environment attributes on adults' MVPA can also be found in recent studies from the United Kingdom[67] and Canada.[68] Furthermore, an international study including Colombia, Brazil, and Mexico found perceptions of land use mix−diversity, aesthetics, street connectivity, pedestrian infrastructure, and safety to be associated with MVPA.[20] Similarly, the results showed a positive association of land use mix −diversity, aesthetics, and safety from traffic with MVPA.

The actual impacts of neighborhood characteristics deemed to provide opportunities for an active lifestyle on PA, although statistically significant, were weak. Therefore, the clinical application is limited. For example, the change of 3 points results in a 0.48 increase in square root minutes/day of MVPA. Thus, the aesthetics score needed to achieve a relevant difference in MVPA is challenging.

Historical, political, physical, economic, and social environments not explored by this study might be capable of impacting PA, given that they independently impact environmental associations with PA in the different countries.[7,36,69] For example, Brazil has a different urban planning and design approach from those of other countries in the region. Argentina, Colombia, Ecuador, Peru, and Venezuela were mainly colonized by Spain; therefore, their urban morphology is different from that of Brazil, which was colonized by Portugal. Although Latin American countries share multiple sociocultural values and characteristics, there are nuances that differentiate them. As in most areas of public health, evidence from many countries suggests that policy and environmental strategies will be an essential part of combating physical inactivity.

Limitations

Limitations include the cross-sectional study design. The results are not generalized to the rural inhabitants. An additional general limitation of accelerometers is that they do not properly capture some activities such as cycling and static exercise,[39] which would have impacted the findings. The use of self-reported perceptions of the built environment can lead to information bias. Residential density was not evaluated because perceived and objective residential density have a weak association[70] and a nonlinear relationship with device-measured PA.[71] However, Spatial Lifecourse Epidemiology Reporting Standards Statement guidelines can improve the quality of reporting of spatial lifecourse epidemiologic studies.[72] Furthermore, objective measures of the neighborhood-built environment would permit an additional and perhaps more accurate assessment of neighborhood-built environment−PA associations.

CONCLUSIONS

Perceived neighborhood-built environment attributes are associated with device-measured light-intensity PA and MVPA in adults. Walking/cycling facilities were associated with more light-intensity PA; land use mix−diversity, walking/cycling facilities, aesthetics, and safety from traffic in the neighborhood were positively associated with MVPA. However, the results showed substantial differences in associations between countries. For the total sample, no significant associations were observed between the perceived neighborhood-built environment attributes and ST, but some specific associations with ST were observed for each country.

These findings have implications for policy recommendations and urban planning choices, which can in turn guide policies to promote PA in the region. Improving urban environment attributes through changes in the actual neighborhood-built environment could be a strategy for maintaining or increasing PA among Latin American adults.

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SUPPLEMENTAL MATERIAL

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