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Neighborhood built environments and Hispanic/Latino adults' physical activity in the U.S.: The Hispanic community health study/study of Latinos community and surrounding areas study

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abstract

Despite experiencing health inequities, less is known about neighborhood environments and physical activity among Hispanic/Latino adults compared to other populations. We investigated this topic in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). Hispanic/Latino adults in the San Diego, California area of the U.S. completed measures of overall moderate-to-vigorous physical activity (MVPA) via accelerometry and domain-specific MVPA via questionnaire at Visits 1 (2008–2011; $n = 4086$) and 2 (2014–2017; $n = 1776$), ~6 years apart. 800-m home neighborhood buffers were used to create objective measures of residential, intersection, and retail density, bus/trolley stops, greenness, parks, and recreation area at Visit 1. Regression models tested the association of each neighborhood feature with MVPA at Visit 1 and over 6 years, adjusting for individual characteristics and neighborhood socioeconomic deprivation. At Visit 1, those in neighborhoods with higher vs. lower retail density or recreation area (+1 vs. −1 standard deviation from the mean) engaged in 10% more overall MVPA and 12–22% more active transportation. Those in neighborhoods with higher vs. lower residential density engaged in 22% more active transportation. Those in neighborhoods with higher vs. lower greenness and park count engaged in 14–16% more recreational MVPA. Neighborhood features were unassociated with changes in MVPA over 6 years. Although changes in MVPA over time were similar across neighborhoods, Hispanic/Latino adults living in neighborhoods with design features supportive of walking and recreational activity (e.g., greater residential and retail density, more parks and recreation facilities) were consistently more active. Improving neighborhood environments appears important for supporting physical activity among Hispanic/Latino adults.

Keywords

Greenness; Income; Parks; Transit; Walkability; Walking

1. Introduction

Hispanic/Latino individuals, who encompass the second-largest racial/ethnic group in the U.S. (United States Census Bureau, 2020) and are projected to comprise 25% of the U.S. population by 2045 (United States Census Bureau, Population Division, 2020), experience greater rates of type 2 diabetes than those who are White non-Hispanic (Centers for Disease

Control and Prevention, 2020; Schneiderman et al., 2014; Avilés-Santa et al., 2017; Isasi et al., 2015). While physical activity has been established as a critical behavior in the prevention and control of chronic diseases (U.S., 2018), few Hispanic/Latino adults meet U.S. Physical Activity Guidelines (Troiano et al., 2008; Arredondo et al., 2016). Thus, more research is needed that could inform efforts to increase physical activity among Hispanic/Latino adults.

Studies based on ecological models of health behavior have shown that individual, interpersonal, and environmental factors can influence physical activity (Sallis et al., 2015). The neighborhood built environment has been shown to play a critical role in providing opportunities for physical activity, particularly walking, for both recreation and transportation (Ding and Gebel, 2012; Bauman et al., 2012; Saelens and Handy, 2008; Sallis et al., 2012; Sallis et al., 2020; Van Cauwenberg et al., 2018; Jáuregui et al., 2021). Although many studies have identified positive associations between neighborhood built environment features (e.g., mixed land use, which reflects having destinations such as shopping and restaurants within a walkable distance of the home) and physical activity, few have focused on Hispanic/Latino populations (Murillo et al., 2019; Silfee et al., 2016). It is important to expand neighborhood environment research in this population, as some evidence suggests physical activity-supportive neighborhood environment features may predominantly benefit socioeconomically advantaged groups (Smith et al., 2017).

Previous neighborhood environment research has been limited to mostly cross-sectional studies, and reviews have pointed to the need for more prospective evidence (Ding and Gebel, 2012; Bauman et al., 2012; Smith et al., 2017; Kärmeniemi et al., 2018). While cross-sectional studies can show whether physical activity is greater in neighborhoods that are more supportive of walking and activity, it is also important to determine whether changes in physical activity over time are more favorable in neighborhoods that are more supportive of walking/activity, for example to prevent declines in activity with aging.

The current study investigated whether Hispanic/Latino adults' physical activity differed by neighborhood built environment characteristics and whether baseline built environment characteristics predicted changes in physical activity over 6 years. Multiple neighborhood environment features and physical activity outcomes were investigated in a large population of Hispanic/Latino adults in the San Diego, California area of the U.S. Neighborhood socioeconomic deprivation was explored as a moderator of these associations given previous evidence suggestive of such interactions (Smith et al., 2017).

2. Methods

2.1. Participants and procedures

The HCHS/SOL is a prospective cohort study of self-identified Hispanic/Latino adults aged 18–74 years at enrollment residing in the U.S. Participants were recruited at four field centers using a stratified two-stage area probability sampling design (Lavange et al., 2010; Sorlie et al., 2010) and attended a baseline examination in 2008–2011 (Visit 1) and second examination in 2014–2017 (Visit 2). The present analyses involved the Study of Latinos Community and Surrounding Areas Study (SOL CASAS), an ancillary study to HCHS/SOL at the San Diego, CA, field center. SOL CASAS involved 4086 participants at Visit 1 from 158 census block groups, and follow-up measures for 1776 of these participants at Visit 2 (~6 years later) who were from 153 of the 158 census block groups based on their Visit 1 residence (Gallo et al., 2019). Ethical approval for conducting this study was received from the sponsoring institutions.

2.2. Measures

2.2.1. Neighborhood environment features—Each participant's home neighborhood was defined using a circular buffer with an 800-m radius around their geocoded home address at Visit 1. Each participant's home address was also compared between Visits 1 and 2 to account for having moved residence in statistical models investigating changes in physical activity over time. Neighborhood environment variables were derived using data from the 2008–2013 American Community Survey, 2009–2015 local San Diego County government, and 2010 annual composite Landsat satellite imagery. Neighborhood socioeconomic deprivation was defined using principal components analysis of nine indicators covering education, employment, and income, with greater values indicating lower socioeconomic conditions among residents (i.e., higher deprivation) (Gallo et al., 2019).

The neighborhood built environment variables included net residential density (housing units/acre of residential land use in buffer), intersection density (intersections/km^2 of land area in buffer), retail density (percent of land use in buffer that is retail), count of bus/trolley stops (number in buffer), greenness (Normalized Difference Vegetation Index) (Robinson et al., 2017), reflects percent of buffer with green vegetation), count of parks (number in buffer), and recreation area (percent of buffer; includes parks, recreation centers, bicycle paths, and natural features such as coastlines). Greater residential density, intersection density, and retail density are hypothesized to impact walking (primarily for transportation) as they indicate closer proximity of residences with one another, allow for more direct routes between origins and destinations, and reflect residential areas being close to shopping and entertainment, respectively (Carlson and Sallis, 2017). Use of public transit (buses/trollies) can support physical activity as riders typically walk to and from transit stops (Saelens et al., 2014). Parks, recreation areas, and greenness can indicate spaces for engaging in recreational activity and destinations for walking to/from (Carlson and Sallis, 2017). Greenness can also make it attractive to be outdoors, where physical activity is more likely to occur (Beyer et al., 2018).

Four built environment indices were calculated. A walkability index was derived as the sum of z-scores of net residential density, intersection density, and retail density (Frank et al., 2010). Three additional 'physical activity supportiveness' indices were computed by sequentially adding walkability and count of bus/trolley stops (transit), greenness, and recreation area using a sum of z-scores. Park count was not incorporated into the indices because park area was a component of the recreation area variable.

2.2.2. Device-based overall moderate-to-vigorous intensity physical activity (MVPA)—At Visits 1 and 2, CASAS participants wore an Actical accelerometer (version

B-1; model 198–0200–03; Philips Respironics®, Bend, OR) on their hip for up to one week during waking hours (Evenson et al., 2015). Actical data were processed using 1-min epochs. Non-wear was defined as consecutive zero counts for ≥90 min, allowing for time intervals with nonzero counts lasting up to 2 min (Choi et al., 2011). Only days with ≥10 h of wear time and participants with ≥3 such days were included in analyses. MVPA was defined as ≥1535 cpm (Colley et al., 2011; Colley and Tremblay, 2011). Overall MVPA minutes/day were calculated for each participant by taking an average across wear days.

2.2.3. Self-reported domain-specific MVPA—At Visits 1 and 2, participants completed the Global Physical Activity Questionnaire (Bull et al., 2009) to self-report the frequency and duration, in a typical week, of engaging for ≥10 min continuously in various transportation (i.e., walking/cycling for transportation) and recreational (e.g., walking/cycling for recreation) activities, and work activity, that met thresholds for moderate or vigorous activity. Average minutes/day of active transportation, recreational MVPA, and occupational MVPA were used in present analyses (occupational MVPA was only used descriptively, as it was not hypothesized to be impacted by the home neighborhood environment).

2.2.4. Sociodemographic characteristics—At Visit 1, participants reported their date of birth, sex (female or male), Hispanic/Latino background (recoded as Mexican or other for present analyses given most San Diego cohort members reported having a Mexican background), education (high school diploma, yes/no), annual household income (≥$30 K or < $30 K), place of birth (born in U. S. 50 states or DC, yes/no), years living in the U.S., and employment status (part- or full-time, yes/no).

2.3. Statistical analyses

Unweighted and weighted (using complex sampling design procedures) descriptive statistics were calculated in IBM SPSS Statistics (Version 24). All regression analyses were performed in Mplus (Version 7.4) and accounted for the complex sampling design (stratification, clustering, and sampling weights). Weights were trimmed and calibrated to the 2010 U.S. Census according to age, sex, and Hispanic/Latino background to support generalization of the results to the underlying population in the target area (census tracks from which participants were recruited) (Lavange et al., 2010).

Analyses of Visit 1 MVPA (minutes/day) were performed using linear regression models with each MVPA variable at Visit 1 regressed on socioeconomic deprivation and the seven built environment variables in one model, and each of the four built environment indices in separate models. All models were adjusted for the sociodemographic characteristics listed above. Models investigating overall MVPA were additionally adjusted for accelerometer wear time. All independent variables (including indices) were standardized to have a mean of 0 and standard deviation (SD) of 1 to support the comparison of effect sizes (i.e., magnitude of the regression coefficients) across variables. Reported MVPA variables were natural log-transformed due to non-normal distributions, and corresponding regression coefficients and standard errors were exponentiated to facilitate their interpretation as percent differences in MVPA for a 1 SD difference in the independent variable.

The same modeling approach was used for analyses of 6-year changes in MVPA, except the MVPA variables at Visit 2 were regressed on the neighborhood environment variables (all of which corresponded with Visit 1), and models were additionally adjusted for MVPA values at Visit 1, time between visits, and whether the participant moved residences between visits. Because those who moved between Visits 1 and 2 would not have been 'exposed' to their Visit 1 neighborhood for the full 6-year period, sensitivity analyses were conducted by fitting the models again after excluding those who had moved.

Interactions between socioeconomic deprivation and each built environment variable and index were explored by adding interaction terms, one at a time, to the models. All independent variables comprising the interactions were continuous. Eleven interactions (one per each neighborhood environment variable and index) were tested for each of the 3 MVPA variables within the models investigating Visit 1 MVPA and within those investigating 6-year changes in MVPA. Interactions with $p < .05$ were plotted by calculating the value of the dependent variable based on the regression equation, using a value of ±1 SD to reflect low and high values for each continuous independent variable comprising the interaction.

2.4. Missing data

The number of participants with data for each variable is presented in Table 1. Missing neighborhood environment data were due to challenges in geocoding some addresses, and missing accelerometer data were due to non-adherence. The number of participants with missing data for ≥1 variable in the analyses of Visit 1 physical activity was 1037 (25.4%) for device-based overall MVPA, 271 (6.6%) for active transportation, and 272 (6.7%) for recreational MVPA. The number of participants with missing data for ≥1 variable in the analyses of 6-year changes in physical activity was 450 (25.3%) for device-based overall MVPA, 183 (10.3%) for active transportation, and 244 (13.7%) for recreational MVPA. At each visit, those with any missing data were younger (41.5 vs. 47.0 years old at Visit 1 and 46.2 vs. 49.3 at Visit 2) and more likely to be born in the U.S. (29.4% vs. 20.9% at Visit 1 and 25.9% vs. 17.8% at Visit 2) than those with no missing data ($p < .05$). To account for accelerometer missingness at each visit, inverse probability weights were used (Evenson et al., 2015). The final weight was a product of the inverse probability weight and sampling weight. Maximum likelihood robust estimation was also used to account for missing data in all statistical models. Thus, all models included all 4086 participants at Visit 1 and all 1776 at Visit 2.

3. Results

Descriptive statistics are presented in Table 1. In the cross-sectional analyses of Visit 1 MVPA, the mean age was 43.8 years and mean overall MPVA was 21.0 min/day. In the prospective analyses of 6-year change in MVPA, the mean age was 37.6 years at Visit 1 and mean overall MVPA was 23.3 and 20.8 min/day at Visit 1 and Visit 2, respectively. The population reported relatively high occupational MVPA as compared to active transportation and recreational MVPA at each visit.

Data not presented in the tables were as follows. The mean duration between Visit 1 and 2 was 6.6 years (SD = 1.1), and 633 participants (35.6%) had moved residences. Between visits, there was a mean decrease of 3.1 min/day (SD = 26.5) in overall MVPA. The differences in log transformed minutes/day of active transportation and recreational MVPA were − 0.2 (SD = 1.9) and 0.2 (SD = 2.1).

3.1. Cross-sectional analyses of Visit 1 MVPA

Individuals in neighborhoods with higher (+1 SD from mean) vs. lower (−1 SD from mean) retail density or recreation area had 2.0 more minutes/day (10% more) of device-based overall MVPA (same effect size for each environmental variable; Table 2). Those in neighborhoods with higher vs. lower residential density, retail density, or recreation area had 22%, 22%, or 12% more reported active transportation, respectively. The walkability and physical activity supportiveness indices were also significantly positively associated with active transportation, having similar effects sizes as observed for their derivative variables. Those in neighborhoods with higher vs. lower greenness or park counts had 14% and 16% more reported recreational MVPA. Those in neighborhoods with higher vs. lower socioeconomic deprivation had 24% more active transportation but 20% less recreational MVPA.

3.2. Prospective analyses of 6-year changes in MVPA

Greater park count was associated with favorable changes in recreational MVPA over 6 years (Table 3), but this finding was not upheld in the sensitivity analysis that excluded those who had moved residences between visits (Table 4). Thus, no neighborhood environment feature was consistently associated with 6-year change in device-based overall MVPA or reported active transportation or recreational MVPA.

3.3. Interactions with neighborhood socioeconomic deprivation

Five of 33 and 0 of 33 neighborhood environment by socioeconomic deprivation interactions were significant in the analyses of Visit 1 MVPA outcomes and 6-year changes in MVPA outcomes (device-based and self-reported measures), respectively. Three of the five interactions were observed for active transportation and involved residential density, count of bus/trolley stops, and the walkability index. These three interactions showed that higher values for the neighborhood environment feature were associated with more active transportation among individuals residing in areas with higher socioeconomic deprivation, and unassociated with active transportation among those in areas with lower socioeconomic deprivation, except for a small negative association between bus/trolley count and active transportation (Figs. 1a–c). The opposite pattern was shown for the one interaction that involved recreational MVPA, which indicated higher park count was associated with more recreational MVPA among individuals in areas with lower socioeconomic deprivation, and unassociated with recreational MVPA among those in areas with higher socioeconomic deprivation (Figs. 1d). The final interaction involved overall MVPA and revealed a distinct pattern showing a small positive association between greenness and overall MVPA among individuals residing in areas with lower socioeconomic deprivation, and a larger negative association between greenness and overall MVPA among those in areas with higher socioeconomic deprivation (Fig. 1e).

4. Discussion

The cross-sectional associations showed Hispanic/Latino adults living in neighborhoods more supportive of walking and recreational activity engaged in more physical activity than those living in neighborhoods less supportive of walking and recreational activity. These findings are generally in agreement with prior research in a range of populations (Bauman et al., 2012; Sallis et al., 2020; Van Cauwenberg et al., 2018; Jáuregui et al., 2021; Smith et al., 2017), yet extend previous research in Hispanic/Latino adults by including objective measures of neighborhood environment features and device-based physical activity (Murillo et al., 2019; Silfee et al., 2016). Findings suggest neighborhood features are of similar importance for supporting physical activity in Hispanic/Latino adults as compared to other populations. Retail density, an indicator of having destinations to walk to/from, and recreation area, an indicator of nearby opportunities for recreational activity, may be particularly important features for supporting physical activity among Hispanic/Latino adults given their association with device-based overall physical activity. Changes in physical activity over 6 years were similar across neighborhoods, suggesting the investigated neighborhood environment features may not protect against declines (e. g., associated with aging) in Hispanic/Latino adults' physical activity over time.

Associations of neighborhood environment features with reported active transportation and recreational physical activity were generally consistent with the premise that specific environmental variables support specific domains or purposes of physical activity (Sallis et al., 2006). These findings have promising health implications given both active transportation and recreational physical activity have health benefits (e.g., in relation to type 2 diabetes prevention and control), including among Hispanic/Latino adults (Divney et al., 2019). Neighborhood features that indicated the presence of nearby destinations to walk to/from (residential and retail density) were related to more active transportation, and features that reflected nearby opportunities for recreational activity and walking for leisure (greenness and park count) were related to more recreational physical activity. The exception was that recreation area was associated with more active transportation. This may indicate recreation spaces can be common destinations for active transportation for this Hispanic/Latino population. Findings for the indices, all four of which included walkability variables, and three of which included transit access, were also consistent with the domain-specific premise, as indicated by associations with active transportation but not recreational physical activity. These findings around domain-specificity and the multi-variable indices suggest multiple features from each domain need to be targeted to support both active transportation and recreational physical activity, which aligns with recommendations from The Guide to Community Preventive Services (The Community Guide, n.d.).

Some associations with domain-specific physical activity carried over to device-based overall physical activity. Specifically, greater retail density and recreation area were related to more active transportation and device-based overall physical activity, and greater park count was related to more recreational physical activity. These findings suggest the benefits of neighborhood features on domain-specific activity can contribute to overall physical activity. However, other components of the walkability construct, residential and intersection density, as well as the walkability index, were unrelated to Hispanic/Latino adults' overall physical activity. This is in contrast to several previous studies in other adult populations that found the accumulation of these features to be important correlates of device-based overall physical activity (Bauman et al., 2012; Smith et al., 2017; The Community Guide, n.d.; Sallis et al., 1982). One potential explanation for the lack of carryover of some domain-specific associations into overall physical activity is the magnitude of association in minutes often reflected only a small portion of overall physical activity (though a large portion of domain-specific activity). Relatedly, it is likely that an aggregation or pattern of environmental features that support multiple physical activity domains (rather than only one or two features, settings, or domains) is needed to have substantial impacts on overall physical activity (Sallis et al., 2015; Sallis et al., 2020).

Neighborhood socioeconomic deprivation appears to play an important and somewhat complex role in Hispanic/Latino adults' physical activity. Present findings indicated that while active transportation was higher in more socioeconomically disadvantaged neighborhoods, recreational physical activity was lower. Relatedly, the beneficial associations of walkability and transit access with active transportation were observed only in neighborhoods with higher socioeconomic deprivation, as shown in the interaction plots. These findings around active transportation were likely at least in part due to socioeconomic deprivation being linked with lower access to private automobiles and higher reliance on alternative transportation modes such as walking/bicycling for transportation and public transit (Lachapelle et al., 2016; Freeland et al., 2013). Based on the present findings, we hypothesize that targeting built environment improvements that support walking and transit access in the most economically disadvantaged neighborhoods may be particularly effective for increasing active transportation among Hispanic/Latino adults and potentially reducing health inequities. This positive finding is in contrast to a recent review that found some indication that infrastructure improvements may predominantly benefit socioeconomically advantaged groups (Smith et al., 2017). Unfortunately, the benefit of living near a park on recreational physical activity was only observed in neighborhoods with lower socioeconomic deprivation, and a similar finding was observed for greenness. Possible explanations are that parks and greenspaces in more socioeconomically disadvantaged areas may be of lower quality, less safe, or less accessible, or residents of disadvantaged areas may be working multiple jobs or particularly long hours and thus have reduced leisure time.

The findings for 6-year changes in physical activity do not support a beneficial impact of baseline (i.e., static) neighborhood environment features on preventing declines in physical activity over time. Thus, findings indicate Hispanic/Latino adults living in neighborhoods that are more supportive of walking and recreational activity appear to experience similar physical activity trajectories over time, but consistently engage in more physical activity (e.g., at both time points), than those living in neighborhoods that are less supportive of these activities. However, it is important to note that on average across cohort members, physical activity decreased only slightly over the 6-year period (e.g., 3.1 min/day for overall MVPA). Additionally, while the present study assessed neighborhood environment features at a single time point, and these features generally do not change meaningfully over 6 years (Hirsch et al., 2016), previous evidence showed that increases (i.e., changes) in neighborhood environment physical activity supportiveness were related to increases in physical activity, though such studies have not focused on Hispanic/Latino adults

(Kärmeniemi et al., 2018; Ding et al., 2018). Thus, future studies in Hispanic/Latino adults should aim to evaluate geographic areas where changes are planned to occur (e.g., natural experiments) and/or study people who move to more or less physical activity-supportive neighborhoods.

4.1. Strengths and limitations

Strengths included the use of both device-based and domain-specific reported physical activity measures at two time points, objective measures of a wide range of neighborhood environment features, integration of neighborhood socioeconomic deprivation into analyses, and a population-based cohort of Hispanic/Latino adults. A limitation of the present study was the population was recruited from a relatively small geographic area in South San Diego County, which resulted in limited variability in the neighborhood variables, reducing power to detect associations with physical activity. Net residential density, for example, had a low mean and SD of 2.7 ± 0.8 housing units/acre of residential land, whereas studies that purposefully selected participants from low-and high-walkable neighborhoods observed greater variability (e.g., 6.2 ± 9.5 housing units/acre of residential land) (Carlson et al., 2015). The high amount of occupational physical activity among those who were employed[44] may have limited the ability to detect associations between the neighborhood features and overall physical activity, as neighborhood features were not expected to relate to occupational activity and occupational activity may have reduced opportunities for recreational activity. The observed effect sizes were generally small with regard to minutes/day of physical activity. However, they appear meaningful relative to the low amounts of daily physical activity observed in this population (e.g., 21 min/day of device-based overall physical activity) and at the population level, given neighborhood environment interventions can reach large numbers of people. Lastly, the present sample consisted almost exclusively of Hispanic/Latino adults of Mexican background, so results may not generalize to other Hispanic/Latino groups.

5. Conclusion

These findings provide support for the importance of neighborhood built environment features in facilitating physical activity among Hispanic/Latino adults. Although changes in physical activity over time were similar across neighborhoods, Hispanic/Latino adults living in neighborhoods that were more supportive of walking and recreational activity were consistently more physically active than those living in less supportive neighborhoods. Efforts to increase residential and retail density, overall walkability, and transit access appear promising for increasing physical activity among Hispanic/Latino adults, particularly those living in socioeconomically disadvantaged areas, though more rigorous study designs are needed to test this hypothesis. Strategies for increasing opportunities for recreational activity also appear especially important to target in areas with high socioeconomic deprivation, including supporting increases in park use and park-based physical activity. Thus, there is potential for built environment interventions to be a means of reducing health inequities in some of the most disadvantaged Hispanic/Latino communities.

Disclosures

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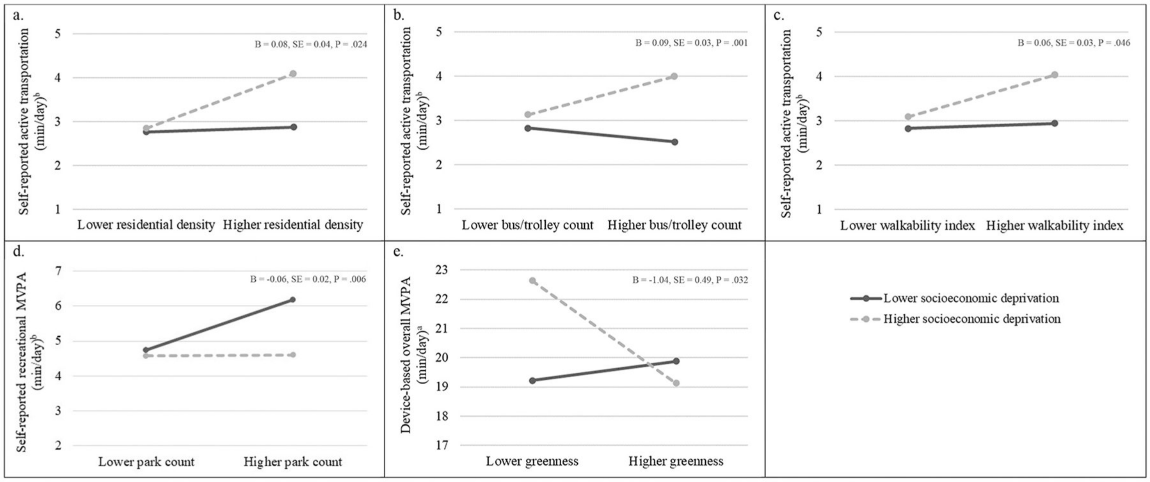

Fig. 1.

Interactions between socioeconomic deprivation and built environment features in relation to physical activity at Visit 1, SOL CASAS (*n* = 4086).

B = unstandardized regression coefficient for interaction; SE = standard error for interaction; P = p value for interaction; Min = minutes; MVPA = moderate to vigorous physical activity; Lower = 1 standard deviation below mean; Higher = 1 standard deviation above mean.

All models were adjusted for age, sex, education, household income, place of birth, and years living in U.S., and neighborhood socioeconomic deprivation.

The regression lines were derived from continuous variables comprising each interaction term and the circles in each plot are used for interpretative purposes, reflecting the adjusted mean value in the MVPA variable for each combination of values for the independent variables (i.e., low-low, low-high, high-low, high-high).

[a]Additionally adjusted for accelerometer wear time.

[b]Geometric rather than arithmetic means are reflected.

Table 1

Population and participant sociodemographic characteristics, physical activity, and neighborhood environment features, SOL CASAS.

	Cross-sectional sample (*n* = 4086)			Prospective sample (n = 1776)		
	n	**Population Weighted mean (SE) or %**	**Participants Unweighted mean (SD) or %**	**n**	**Population Weighted mean (SE) or %**	**Participants Unweighted mean (SD) or %**
Sociodemographics (at visit 1)						
Age, years[b]	4086	43.8 (0.4)	45.6 (14.0)	1776	37.6 (0.7)	48.7 (12.7)
Female	4086	63.8%	64.9%	1776	53.7%	67.5%
Born in U.S. 50 states/DC	4065	26.9%	23.1%	1775	35.5%	19.4%
High school diploma or greater	4060	65.7%	65.2%	1772	71.0%	63.7%
Annual household income >$30 k	3931	40.9%	41.2%	1722	41.8%	39.1%
Employed part- or full-time	4064	50.0%	52.8%	1774	51.4%	54.2%
Physical activity (at visits 1 and 2)						
Device-based overall MVPA visit 1, min/day	3251	21.0 (0.4)	20.7 (24.5)	1507	23.3 (0.7)	20.1 (22.6)
Device-based overall MVPA visit 2, min/day	–	–	–	1622	20.8 (1.6)	16.4 (23.0)
Self-reported active transportation visit 1, min/day[a]	4058	3.4 (1.0)	3.2 (5.4)	1773	3.6 (1.1)	3.1 (5.3)
Self-reported active transportation visit 2, min/day[a]	–	–	–	1629	2.7 (1.1)	2.5 (4.8)
Self-reported recreational MVPA visit 1, min/day[a]	4059	5.3 (1.0)	4.9 (6.4)	1774	7.2 (1.1)	4.5 (6.0)
Self-reported recreational MVPA visit 2, min/day[a]	–	–	–	1688	7.9 (1.1)	5.4 (6.3)
Self-reported occupational MVPA visit 1, min/day[a]	4020	7.8 (1.0)	7.8 (12.1)	1760	9.1 (1.1)	7.1 (11.6)
Self-reported occupational MVPA visit 2, min/day[a]	–	–	–	1719	14.9 (1.1)	7.4 (11.8)
Neighborhood environment (at visit 1)[c]						
Socioeconomic deprivation principal component for buffer	3851	0.94 (0.06)	0.94 (0.75)	1682	0.89 (0.08)	0.92 (0.76)
Net residential density, housing units/acre of residential land use in buffer	3851	2.8 (0.1)	2.7 (0.8)	1682	2.7 (0.1)	2.5 (0.6)
Intersection density, intersections/km^2 of land area in buffer	3851	70.9 (2.3)	70.6 (27.2)	1682	71.1 (2.9)	70.5 (27.2)
Retail density, % of land use in buffer that is retail	3851	7.2 (0.6)	7.1 (6.4)	1682	6.8 (0.6)	7.1 (6.5)
Count bus/trolley stops, number in buffer	3851	20.3 (1.0)	20.1 (10.7)	1682	20.1 (1.2)	19.9 (10.8)
Greenness, % of buffer	3851	19.5 (0.4)	19.6 (4.6)	1682	20.3 (0.5)	19.8 (4.6)

	Cross-sectional sample (*n* = 4086)			Prospective sample (n = 1776)		
	n	**Population Weighted mean (SE) or %**	**Participants Unweighted mean (SD) or %**	**n**	**Population Weighted mean (SE) or %**	**Participants Unweighted mean (SD) or %**
Park count, number in buffer	3851	2.1 (0.1)	2.1 (1.7)	1682	2.1 (0.2)	2.2 (1.8)
Recreation area, % of buffer	3851	47.2 (0.9)	47.3 (10.5)	1682	46.6 (1.1)	47.0 (10.7)

Min = minutes; MVPA = moderate to vigorous physical activity; n = sample size (number of participants); SD = standard deviation; SE = standard error.

[a] Geometric means, SEs, and SDs are reported.

[b] By design, HCHS/SOL oversampled adults aged 45–74 years. Therefore, the unweighted mean age for SOL CASAS participants was considerably larger than the weighted mean in the population (i.e., all non-institutionalized adults aged 18–74 years living in the 158 census blocks selected).

[c] Calculated using an 800-m circular buffer around each participant’s home residence.

Table 2

Associations between neighborhood environment features and physical activity at Visit 1, SOL CASAS (n = 4086).

	Device-based overall MVPA (min/day)[a]		Self-reported active transportation (min/day)[b]		Self-reported recreational MVPA (min/day)[b]	
Neighborhood environment variable	**B (95% CI)**	**P**	**B (95% CI)**	**P**	**B (95% CI)**	**P**
Socioeconomic environment variable						
Socioeconomic deprivation (z score)	0.35 (−0.60, 1.30)	0.468	0.12 (0.06, 0.19)	<0.001	−0.10 (−0.16, −0.05)	0.001
Built environment variables						
Net residential density (z score)	−0.03 (−1.08, 1.02)	0.953	*0.11 (0.01, 0.22)*	*0.032*	−0.06 (−0.13, 0.02)	0.167
Intersection density (z score)	−0.14 (−1.05, 0.77)	0.763	0.05 (−0.02, 0.12)	0.164	0 (−0.06, 0.06)	0.979
Retail density (z score)	0.98 (0.22, 1.74)	0.012	0.11 (0.04, 0.17)	0.002	−0.04 (−0.10, 0.02)	0.188
Count bus/trolley stops (z score)	0.04 (−1.10, 1.17)	0.950	*0.07 (−0.02, 0.16)*	*0.125*	−0.06 (−0.13, 0.02)	0.143
Greenness (z score)	*−0.40 (−1.35, 0.56)*	*0.415*	−0.01 (−0.09, 0.07)	0.766	0.07 (0, 0.15)	0.050
Park count (z score)	0.87 (−0.08, 1.82)	0.074	−0.01 (−0.07, 0.05)	0.813	*0.08 (0.02, 0.15)*	*0.006*
Recreation area (z score)	0.99 (0.22, 1.77)	0.012	0.06 (0.01, 0.13)	0.031	0.04 (−0.02, 0.11)	0.157
Indices						
Walkability index (z score)	0.11 (−0.75, 0.97)	0.803	*0.09 (0.03, 0.17)*	*0.005*	−0.01 (−0.08, 0.06)	0.936
Walkability and transit index (z score)	0.29 (−0.81, 1.38)	0.611	0.12 (0.03, 0.21)	0.008	−0.06 (−0.13, 0.02)	0.156
Walkability, transit, and greenness index (z score)	0.06 (−0.82, 0.95)	0.886	0.08 (0.01, 0.16)	0.018	−0.02 (−0.09, 0.05)	0.546
Walkability, transit, greenness, and recreation index (z score)	0.64 (−0.13, 1.41)	0.103	0.11 (0.04, 0.19)	0.002	0.01 (−0.05, 0.07)	0.828

B = unstandardized regression coefficient; CI = confidence interval; min = minutes; MVPA = moderate to vigorous physical activity; n = sample size (number of participants); P = *p* value.

Italic typeface is used to denote associations that involved a significant interaction with socioeconomic deprivation (shown in Fig. 1).

All models were adjusted for age, sex, education, household income, place of birth, and years living in U.S., and neighborhood socioeconomic deprivation.

[a] Additionally adjusted for accelerometer wear time.

[b] The dependent variable was natural log transformed and regression coefficients were exponentiated, interpretable as percent difference.

Table 3

Associations of Visit 1 neighborhood environment features with changes in physical activity over 6 years, SOL CASAS (n = 1776).

	Device-based overall MVPA (min/day)[a]		Self-reported active transportation(min/day)[b]		Self-reported recreational MVPA (min/day)[b]	
Neighborhood environment variable	**B (95% CI)**	**P**	**B (95% CI)**	**P**	**B (95% CI)**	**P**
Socioeconomic environment variable						
Socioeconomic deprivation (z score)	−1.27 (−3.06, 0.52)	0.163	0.05 (−0.08, 0.20)	0.468	−0.10 (−0.24, 0.06)	0.214
Built environment variables						
Net residential density (z score)	1.63 (−1.67, 4.92)	0.333	0.07 (−0.16, 0.38)	0.575	0.20 (−0.02, 0.45)	0.078
Intersection density (z score)	0.13 (−2.07, 2.32)	0.909	−0.10 (−0.24, 0.09)	0.301	−0.04 (−0.21, 0.17)	0.715
Retail density (z score)	0.63 (−1.64, 2.91)	0.586	−0.01 (−0.15, 0.15)	0.864	0.11 (−0.08, 0.34)	0.277
Count bus/trolley stops (z score)	−1.22 (−4.82, 2.38)	0.508	−0.12 (−0.28, 0.08)	0.220	0.12 (−0.07, 0.32)	0.230
Greenness (z score)	0.68 (−1.79, 3.14)	0.591	−0.05 (−0.23, 0.17)	0.638	−0.13 (−0.28, 0.06)	0.161
Park count (z score)	0.15 (−1.46, 1.76)	0.854	0 (−0.11, 0.12)	0.939	0.12 (0, 0.26)	0.050
Recreation area (z score)	−2.34 (−4.87, 0.19)	0.070	0.04 (−0.09, 0.18)	0.533	−0.04 (−0.18, 0.13)	0.626
Indices						
Walkability index (z score)	0.66 (−1.33, 2.66)	0.514	−0.07 (−0.22, 0.12)	0.428	0.01 (−0.16, 0.23)	0.898
Walkability and transit index (z score)	−0.03 (−2.66, 2.59)	0.980	−0.09 (−0.27, 0.14)	0.408	0.12 (−0.09, 0.39)	0.270
Walkability, transit, and greenness index (z score)	0.27 (−1.73, 2.28)	0.787	−0.10 (−0.24, 0.06)	0.210	0.04 (−0.11, 0.22)	0.625
Walkability, transit, greenness, and recreation index (z score)	−1.39 (−4.04, 1.25)	0.300	−0.06 (−0.20, 0.11)	0.485	0.01 (−0.16, 0.20)	0.958

B = unstandardized regression coefficient; CI = confidence interval; min = minutes; MVPA = moderate to vigorous physical activity; n = sample size (number of participants); P = *p* value.

All models were adjusted for age, gender, education, household income, place of birth, years living in U.S., neighborhood socioeconomic deprivation, time between Visit 1 and Visit 2, whether the participant moved between visits, and baseline values for the physical activity dependent variable.

[a] Additionally adjusted for accelerometer wear time at both time points.

[b] The dependent variable was natural log transformed and regression coefficients were exponentiated, interpretable as percent difference.

Table 4

Associations of Visit 1 neighborhood environment features with changes in physical activity over 6 years, excluding those who moved residences between visits, SOL CASAS (n = 1143).

	Device-based overall MVPA (min/day)[a]		Self-reported active transportation (min/day)[b]		Self-reported recreational MVPA (min/day)[b]	
Neighborhood environment variable	**B (95% CI)**	**P**	**B (95% CI)**	**P**	**B (95% CI)**	**P**
Socioeconomic environment variables						
Socioeconomic deprivation (z score)	0.86 (−1.26, 2.99)	0.504	0 (−0.15, 0.17)	0.990	−0.10 (−0.23, 0.07)	0.340
Built environment variables						
Net residential density (z score)	3.34 (−0.14, 6.81)	0.114	0.17 (−0.12, 0.57)	0.356	0.16 (−0.06, 0.43)	0.240
Intersection density (z score)	−0.78 (−3.07, 1.51)	0.575	−0.12 (−0.27, 0.07)	0.291	−0.10 (−0.25, 0.11)	0.409
Retail density (z score)	1.44 (−1.21, 4.10)	0.372	0 (−0.16, 0.19)	0.995	0.03 (−0.13, 0.21)	0.800
Count bus/trolley stops (z score)	−1.17 (−4.91, 2.56)	0.605	−0.16 (−0.33, 0.04)	0.182	−0.04 (−0.20, 0.14)	0.687
Greenness (z score)	1.41 (−1.43, 4.25)	0.415	−0.12 (−0.30, 0.09)	0.332	−0.11 (−0.28, 0.08)	0.333
Park count (z score)	−2.05 (−4.64, 0.55)	0.196	0.03 (−0.16, 0.25)	0.830	0.07 (−0.06, 0.22)	0.362
Recreation area (z score)	−3.09 (−6.44, 0.26)	0.129	0.06 (−0.10, 0.23)	0.554	−0.07 (−0.20, 0.07)	0.414
Indices						
Walkability index (z score)	1.20 (−1.34, 3.75)	0.437	−0.07 (−0.22, 0.12)	0.428	0 (−0.17, 0.22)	0.977
Walkability and transit index (z score)	0.11 (−2.72, 2.94)	0.950	−0.11 (−0.30, 0.14)	0.463	−0.02 (−0.20, 0.20)	0.898
Walkability, transit, and greenness index (z score)	0.61 (−1.31, 2.53)	0.599	−0.14 (−0.27, 0.02)	0.153	−0.06 (−0.19, 0.09)	0.477
Walkability, transit, greenness, and recreation index (z score)	−1.32 (−4.02, 1.37)	0.420	−0.09 (−0.23, 0.08)	0.389	−0.10 (−0.24, 0.07)	0.345

B = unstandardized regression coefficient; CI = confidence interval; min = minutes; MVPA = moderate to vigorous physical activity; n = sample size (number of participants); P = *p* value.

All models were adjusted for age, gender, education, household income, place of birth, years living in U.S., neighborhood socioeconomic deprivation, time between Visit 1 and Visit 2, whether the participant moved between visits, and baseline values for the physical activity dependent variable.

[a] Additionally adjusted for accelerometer wear time at both time points.

[b] Natural log transformed.