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The Hispanic Community Health Study/Study of Latinos Community and Surrounding Areas Study: sample, design, and procedures

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ABSTRACT

Purpose: We describe the sample, design, and procedures for the Community and Surrounding Areas Study (CASAS), an ancillary to the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). The aim of SOL CASAS was to test an ecological model of macro- and micro-neighborhood environment factors, intermediate behavioral (physical activity) and psychosocial (e.g., depression and stress) mechanisms, and changes in cardiometabolic health in Hispanics/Latinos.
Methods: Between 2015 and 2017, approximately 6 years after the HCHS/SOL baseline (2008–2011), 1776 San Diego HCHS/SOL participants enrolled in SOL CASAS and completed a repeat physical activity assessment. Participants' residential addresses were geoprocessed, and macroenvironmental features of the home were derived from publicly available data concurrent with the HCHS/SOL baseline and Visit 2 (2014–2017). Microscale environmental attributes were coded for 943 unique routes for 1684 participants, with a validated observational tool, concurrent with Visit 2, for SOL CASAS participants only.
Results: Of 2520 HCHS/SOL participants approached, 70.5% enrolled (mean age 55.3 years; 94% Mexican; 67.5% female). Accelerometer adherence (three or more days with at least 10 hours wear time) was outstanding (94%).
Conclusions: With its more comprehensive ecological model and well-characterized Hispanic/Latino population, SOL CASAS will advance the science concerning the contribution of neighborhood factors to cardiometabolic health.

Introduction

In 2016, Hispanics/Latinos comprised 18% of the U.S. population and are expected to approach 30% by 2060 [1]. To better understand the health of this growing U.S. demographic group, the National Heart Lung and Blood Institute initiated the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). HCHS/SOL is a prospective epidemiologic cohort study of 16,415 U.S. Hispanic/Latino adults aged 18–74 years recruited from four U.S. communities between 2008 and 2011 [2,3]. HCHS/SOL has provided critical insight into the cardiovascular disease (CVD) risks of U.S. Hispanics/Latinos by revealing a high prevalence of cardiometabolic risk factors [4], including obesity [5], metabolic syndrome [6], diabetes [7], dyslipidemia [8], and poor hypertension awareness and control [9].

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When compared with non-Hispanic Whites, significant disparities in cardiometabolic risks have been observed in the HCHS/SOL population, with substantial variation by Hispanic/Latino background group. For example, diabetes prevalence was nearly 17% in HCHS/SOL, relative to 9.3% estimated for Non-Hispanic Whites in the 2011–2014 National Health and Nutrition Examination Survey [10]. However, diabetes prevalence in HCHS/SOL varied from 18.3% in self-identified Mexicans to 10.2% in South Americans [7]. Such findings emphasize the relevance of heritage, place, and context in Hispanic/Latino health and are consistent with the tenets of ecological models that emphasize the interplay of individual and broader social, built, and policy environmental factors in health [11,12].

The present study describes the sample, design, and procedures for the SOL "Community and Surrounding Areas Study (SOL CASAS)," an ancillary to the HCHS/SOL grounded in literature showing that macroscale built and social neighborhood features relate to cardiometabolic risk factors, morbidity, and mortality [13–16]. In this regard, prior studies have found built environmental characteristics such as greater diversity in land use, increased park access, more walkable neighborhoods, and lower traffic density and noise are often linked with increased physical activity and lower prevalence or incidence of cardiometabolic risk factors (e.g., blood pressure, metabolic syndrome, and obesity) and coronary events [13,15]. Other studies have found that features of the neighborhood social environment, including lower neighborhood socioeconomic status, greater crime and social disorder, and lower social cohesion, relate in conceptually expected patterns with physical activity and cardiometabolic health [13,15]. Some research suggests that the magnitude of neighborhood effects on health could differ by socioeconomic status or ethnicity [13,16], but research in diverse populations including Hispanics/Latinos has been limited.

Importantly, relative to physical activity and other behavioral pathways, less research has focused on psychosocial correlates of neighborhood features and how these might explain how neighborhoods "get under the skin" to affect cardiometabolic risk. Certain social and physical characteristics of neighborhoods including crime and safety concerns, visual cues of social disorder such as graffiti, and trash, and a lack of green spaces, may serve as stressors, whereas others, such as parks, mixed land use, and residential stability, could foster interpersonal exchange and social support, attenuate stress, and improve emotional well-being [17–19]. In turn, these psychosocial consequences of neighborhood environments can affect cardiometabolic risk through their influence on the autonomic nervous system and underlying pathophysiological processes [20].

Many studies examining neighborhood environments and health do not consider multiple environmental features and the specific pathways that may explain their links with health. This impedes the ability to inform prevention and intervention approaches. In addition, studies have not typically considered both macro- and micro-scale environment features in the same context. In the SOL CASAS study, we address several limitations of the literature by testing a more comprehensive ecological model of macro- and micro-scale social and built neighborhood environmental factors, intermediate psychosocial and behavioral mechanisms, and changes in cardiometabolic health across approximately 6 years, in the HCHS/SOL San Diego cohort. Our focus on a well-characterized Hispanic/Latino, primarily Mexican population, builds on the limited research that has examined environmental correlates of cardiometabolic health among underserved groups. Ultimately, SOL CASAS aims to inform future multilevel interventions to reduce cardiometabolic disease risks for U.S. Hispanics/Latinos.

As shown in Figure 1, SOL CASAS is testing the following specific aims:

(1) To determine if baseline macroscale social and built neighborhood environmental factors are associated with 6-year changes in physical activity, depression, and cardiometabolic health and whether baseline levels and changes in physical activity and depression help explain associations between the environment and changes in cardiometabolic health;
(2) To determine if 6-year changes in macroscale neighborhood environmental factors are associated with 6-year changes in physical activity, depression, and cardiometabolic health and if changes in physical activity and depression help explain associations between changes in neighborhood environment and changes in cardiometabolic health; and
(3) Using variables available only at Visit 2 to investigate cross-sectional associations of, and interactions among, macro- and micro-scale social and built neighborhood environmental factors with physical activity, multiple psychosocial factors, and cardiometabolic health and whether physical activity and psychosocial factors partially underlie associations of neighborhood environments with cardiometabolic health.

MATERIALS AND METHODS

Overview of the HCHS/SOL

HCHS/SOL is a community-based prospective cohort study of 16,415 self-identified Hispanics/Latinos, aged 18–74 years at recruitment, from the Bronx, NY, Chicago, IL, Miami, FL, and San Diego, CA. As described previously, the study used a two-stage probability sample of household addresses with oversampling of participants aged 45 years and older [2]. Participants underwent a baseline clinical examination (2008–2011) [2], a second clinical examination approximately 6 years later (Visit 2; 2014–2017), and yearly telephone follow-up assessments starting after baseline to identify new clinical events and mortality. The examinations included comprehensive physiological, behavioral (including self-reported and accelerometer measures of physical activity and sedentary behavior), and sociodemographic assessments (for details, see the study by Sorlie et al. [3] and https://sites.cscc.unc.edu/hchs/).

SOL CASAS design and setting

SOL CASAS is an ancillary study to the HCHS/SOL that includes cross-sectional and longitudinal components. The San Diego site was selected mainly for pragmatic reasons, including the need for common geographic information systems (GIS) data in creating macrolevel built environmental variables, the cost of direct observation of microlevel environmental variables, and general budget limitations. The San Diego field center differs from the other HCHS/SOL field centers as it is the most homogenous in Hispanic/Latino background (with most participants of Mexican descent) and is spread across a relatively large geographic, lower population density area (e.g., relative to Chicago and the Bronx).

SOL CASAS recruitment and sample

Between December 17, 2015, and September 30, 2017, 1776 HCHS/SOL San Diego participants were enrolled in SOL CASAS. Participants were recruited by phone or in person at HCHS/SOL Visit

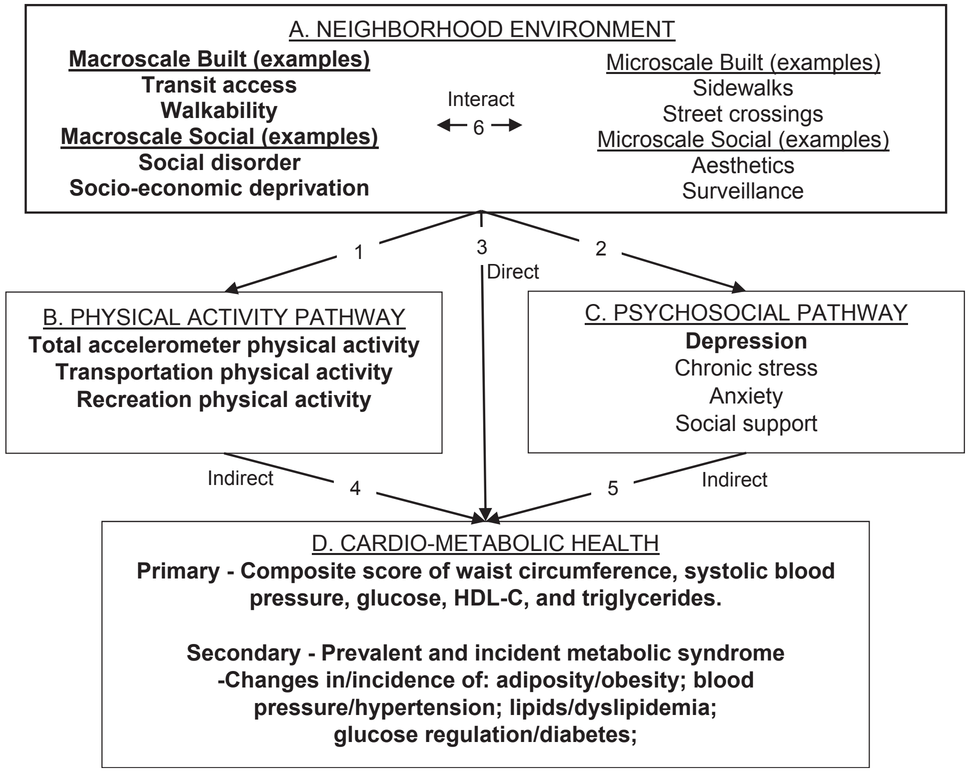

Fig. 1. Conceptual model tested in SOL CASAS. Bold font indicates variable assessed as part of HCHS/SOL baseline and Visit 2. The model posits that an array of built and social features of macroscale and microscale neighborhood environments (Box A) impact physical activity (Box B, Line 1), psychosocial factors (Box C, Line 2), and cardiometabolic health markers (Box D, Line 2). This will be tested longitudinally in aims 1 and 2 (bold variables only) and cross-sectionally in aim 3 (all variables). The neighborhood environment is expected to have both direct (Line 3) and indirect associations with cardiometabolic health, with the indirect associations occurring through physical activity (Line 4) and psychosocial factors (Line 5). The model also posits that macroscale and microscale neighborhood environment features will interact (Line 6) in their associations with physical activity, psychosocial factors, and cardiometabolic health, which will be tested in aim 3.

2, during an annual follow-up call and/or while scheduling other ancillary studies. Overall, 51.5% of participants completed their SOL CASAS visit concurrently with Visit 2, whereas others completed visits within several days to 35 months after their Visit 2 examination (interquartile range: 10.05 and 21.1 months). Eligibility criteria were completion of Visit 2, ability to provide informed consent, and ability to walk at least one block unassisted. Of 2520 HCHS/SOL participants screened, 88 (3.5%) were not eligible, 161 declined participation (6.4%), and 495 (19.6%) did not present for their SOL CASAS examinations, for a final sample of 1776 participants (70.5% enrollment rate).

SOL CASAS cohort characteristics are presented in Table 1. Because of the HCHS/SOL's complex survey design, including different probabilities for a participant being selected (e.g., oversampling in adults aged 45–74 years and adjustment for nonresponse), weighted statistics are included, with inference to the target area population (noninstitutionalized Hispanic/Latino adults aged 18–74 years, residing in defined census block groups). Whereas the mean age in the target population was 46.1 years, the mean age in the SOL CASAS sample was 55.3 ± 12.8 years, reflecting oversampling of older participants. Mirroring the HCHS/SOL San Diego cohort (93.4% Mexican heritage; 64.9% women), 1672 SOL CASAS (94%) participants were of Mexican heritage, and 1198 (67.5%) were women. Overall, 26.3% of the target population had less than a high school degree, 44.1% had an annual family income of less than $30,000, and 58.2% were married or lived with a partner. Sixty-eight percent were not born in the U.S. mainland; on average, they had lived in the United States for 24.6 years (interquartile range 14–33 years).

Measures

Participant home addresses

Participant home addresses at baseline were geocoded using SAS/GRAPH version 9.3 (SAS Institute Inc., Cary, NC) geoprocessing procedures and US Census Bureau TIGER/Line Shapefiles [21]. We attempted to geocode addresses for all participants in the San Diego HCHS/SOL baseline sample (N = 4086) to maximize the sample size for macroscale attributes. At baseline, geocoded locations could not be found for 232 participants, resulting in $n = 3854$ geocoded participants (from 2042 unique addresses) for the San Diego sample, and 1684 geocoded participants (from 1084 unique addresses) for the CASAS sample (N = 1776). There were fewer unique addresses than participants because some participants resided in the same household. HCHS/SOL Visit 2 home addresses were also geocoded for 1573 CASAS sample participants; 633 reported different home addresses compared with their addresses at baseline, and these were also geocoded.

Macro-scale neighborhood environment factors

Macro-scale variables were developed to focus on 10 topical areas that have previously demonstrated associations with cardiometabolic health, physical activity, and/or psychosocial factors [22–25]. These included socioeconomic deprivation, socioeconomic advantage, residential stability, cultural environment, social disorder, walkability, greenness, recreation, transit, and environmental pollution. Table 2 details each macroscale topical area, variables included in the area, sources of data, and dates of data for baseline and Visit 2.

Table 1
Characteristics of SOL CASAS ancillary study participants by sex (N = 1776)

Characteristic	N	Overall (n = 1776)		Male (n = 578)		Female (n = 1198)	
		Mean or %	SD or SE	Mean or %	SD or SE	Mean or %	SD or SE
Unweighted statistics (SD)							
Age (y)	1776	55.3	12.80	54.2	13.58	55.8	12.38
24–34	166	9.3	—	12.4	—	7.9	—
35–44	165	9.3	—	9.7	—	9.1	—
45–54	395	22.2	—	21.3	—	22.7	—
55–64	624	35.1	—	33.7	—	35.8	—
65+	426	24.0	—	22.8	—	24.5	—
Gender (%)							
Male	578	32.5	—	—	—	—	—
Female	1198	67.5	—	—	—	—	—
Study conducted w/HCHS visit 2 (%)							
With HCHS visit 2	915	51.5	—	54.5	—	50.1	—
Separate visit	861	48.5	—	45.5	—	49.9	—
Time between HCHS Visit 2 and CASAS (mo)	861	15.1	8.45	15.3	8.40	15.0	8.48
Time between HCHS/SOL baseline and CASAS (y)	1776	6.6	0.95	6.6	0.92	6.6	0.97
Weighted statistics* (SE)							
Age (y)	1776	46.1	0.74	45.2	1.02	46.9	0.86
Age groups (%)							
24–34	166	27.3	2.60	29.5	3.65	25.3	3.16
35–44	165	20.5	2.48	20.2	3.33	20.7	2.74
45–54	395	21.7	1.75	21.4	2.66	22.0	1.97
55–64	624	17.6	1.32	17.1	1.82	18.0	1.62
65+	426	12.9	1.22	11.7	1.68	14.0	1.39
Gender (%)							
Male	578	46.7	2.15	—	—	—	—
Female	1198	53.3	2.15	—	—	—	—
Educational attainment (%)							
Less than high school	609	26.3	1.78	24.7	3.01	27.7	2.27
High school diploma	392	29.1	2.12	31.8	3.68	26.7	2.40
Greater than high school	745	44.6	2.92	43.5	3.96	45.6	3.40
Marital status†							
Single	300	28.2	2.46	32.2	4.03	24.7	2.48
Married/partner	1098	58.2	2.72	61.3	4.12	55.5	2.49
Divorced/widowed	374	13.6	1.35	6.5	1.25	19.8	2.05
Household income (%)							
≤$30,000	912	44.1	2.36	38.1	3.83	49.6	2.61
>$30,000	808	55.9	2.36	61.9	3.83	50.4	2.61
Background group							
Mexican	1672	98.2	0.57	97.0	1.20	99.2	0.28
Other	34	1.8	0.57	3.0	1.20	0.8	0.28
Preferred language (%)							
English	1428	70.3	2.35	64.8	3.56	75.2	2.54
Spanish	348	29.7	2.35	35.2	3.56	24.8	2.54
Born within the 50 states (%)							
No	1434	68.4	2.34	62.0	3.99	74.0	2.14
Yes	342	31.6	2.34	38.0	3.99	26.0	2.14
Years living in the United States‡	1433	24.6	0.66	24.6	0.88	24.6	0.69
BMI (%)							
Normal (≤24.9)	286	17.5	1.66	16.3	2.26	18.5	2.07
Overweight (25–29.9)	699	40.9	2.48	42.5	3.59	39.6	2.98
Obese (≥30)	787	41.6	2.41	41.2	3.68	41.9	2.53

With the exception of marital status, all variables were measured at HCHS/SOL Visit 2 (2014–2017).
Sample sizes vary across variables because of missing data.
SE = standard error.
* All means, SDs, standard errors, and percentages are weighted for study design and nonresponse.
† Marital status was collected at baseline.
‡ Among those who migrated to the United States.

Data for the San Diego HCHS/SOL participants with geocoded addresses at baseline (n = 3853) were obtained from a variety of sources including the U.S. Census and American Community Survey, local San Diego County government, California State government, and Landsat satellite imagery. All variables were computed in ArcGIS 10.5 (ESRI 2017, Redlands, CA) or Google Earth Engine (Google 2017, Mountain View, CA). Component variables were created for socioeconomic deprivation, socioeconomic advantage, residential stability, cultural environment, and social disorder. Walkability, transit, greenness, recreation, and pollution were generated as indexes. Participants' geocoded home locations were buffered using 800 m circular buffers. This buffer size was selected to model realistic walking distance from the home and to maximize environmental variability between participants by minimizing buffer overlap as the sample is concentrated in the southeastern part of San Diego County. Depending on the environmental variable, counts, percent area, or average values were used to extract macro environmental data for participants' home buffer areas.

Table 2
Macroscale neighborhood environment topical areas for HCHS/SOL San Diego participants at baseline and at the Visit 2–concurrent CASAS ancillary study assessment

Topical area	Variables included	Sources (baseline visit dates of data, CASAS/Visit 2 dates of data)
Socioeconomic deprivation	Education (no high school diploma); unemployment; rented housing; crowding (more than one individual per room); rent is >50% of household income; poverty; female-headed households w/ children; public health insurance; public assistance; lack of car	Census (2010, n/a) ACS (2008–2013, 2013–2017)
Socioeconomic advantage	Education (college or vocational); owned housing; median house value; households earning >$150,000/y	ACS (2008–2013, 2013–2017)
Residential stability	Population <18 y; population in same residence 1 y ago	Census (2010, n/a) ACS (2008–2013, 2013–2017)
Cultural environment	Hispanic/Latino population; Spanish-speaking population; population speaking English not well/not at all; population not born in the United States	Census (2010, n/a) ACS (2008–2013, 2013–2017)
Social disorder	Liquor stores; crime per capita; vacant housing; vacant land use	California Alcohol Beverage Control (2012, 2017) SANDAG (2011, 2016) Census (2010, n/a) ACS (2013–2017)
Walkability	Intersection density; land use mix; residential density	SANDAG (2009, 2016)
Greenness	Greenness index (Normalized Difference Vegetation Index)	Landsat (2010, 2016)
Recreation	Recreation facilities; natural features (lakes, streams, coastlines); parks; bike paths	SANDAG baseline (2008, 2009, 2010), CASAS/Visit 2 (2010, 2012, 2016)
Transit	Transit stops (bike, trolley); bike routes; pedestrian/bicycle collisions	MTS (2010, 2017) SANDAG (2009, 2016) SWIRTS (2008–2012, 2012–2016)
Pollution	Diesel particulate matter; toxic releases; hazardous waste; PM2.5 emissions; traffic congestion	CalEnviroscreen (2013, 2015)

ACS = American Community Survey; MTS = San Diego Metropolitan Transit System; n/a = not available; SANDAG = San Diego Association of Governments; SWIRTS = California Statewide Integrated Traffic Records System.

Microscale neighborhood environment factors

Microscale attributes provide complementary information to GIS-based variables on features that could affect the experience of a person being present or active in a specific environment. For example, presence and quality of sidewalks, street crossings, and bicycle facilities could affect comfort and sense of safety. Landscaping, street trees, and design of buildings reflect aesthetic features that could affect the pleasantness of being in an area. Microscale-built environments are relatively modifiable, and they can be reliably assessed with direct observation [26–28].

To assess these environmental features, we used a validated, 60-item shortened version [29] of the Microscale Audit of Pedestrian Streetscapes (MAPS) tool [27]. Observations were conducted remotely using Google Street View and Google Earth (Alphabet Inc., Mountain View, CA) along a 0.25- to 0.44-mile route from each participant's home address toward the nearest cluster of commercial destinations, including all street segments and street crossings in the route. This efficient approach assessed the specific environments most likely to be encountered by each participant when walking or biking near home. Participant addresses were approximated and assigned x and y coordinates before being mapped for MAPS assessments. The residential building closest to the coordinate point was chosen as a proximate participant address, and in some cases, multiple participants were assigned the same building. A total of 934 unique routes were assessed for a total of 1684 participants. There were fewer unique routes than unique addresses (n = 1084) because of proximity of participants' residences.

Raters were trained using a standardized protocol and required to have ≥95% agreement with the trainer before conducting observations. MAPS has documented good interrater reliability with both in-person [30] and online [31] modes. Detailed information on items, subscales, and scoring have been published [30].

For the present study, we added several items to MAPS to increase sensitivity to environmental attributes that could affect psychosocial pathways. These included items rating street lighting and visibility (i.e., porches and ground-level windows) of the pedestrian route, which were compiled into a "surveillance" subscale. Items were also added to measure the presence of billboards advertising food, tobacco or alcohol, as well as the presence of buildings with broken or boarded windows. These items were combined with existing items to form a subscale assessing negative aesthetics. Table 3 lists the subscales for each section of MAPS, along with brief descriptions of the content addressed.

Physical activity assessment

SOL CASAS participants repeated the physical activity assessment performed at the HCHS/SOL baseline visit. Before study initiation, 600 Actical accelerometers (version B-1; model 198-0200-03; Philips Respironics, Bend, OR) used at baseline were tested for data quality and function using an orbital shaker (Hoefer Red Rotor pr70; Hoefer Inc., Holliston, MA). Acticals were required to produce count values ±7.5% of three "gold standard" devices recently recalibrated by the manufacturer. Acticals that met this standard were deployed and used for up to 5 months, with up to six participants, and then retired.

Consistent with the HCHS/SOL baseline protocol [32], participants were instructed to wear the Actical on their hip for 1 week and remove the monitor only to sleep, shower, or swim. Actical data were downloaded locally and processed by the HCHS/SOL Coordinating Center using 1-minute epochs. If the initial download indicated less than three adherent days, the participant was asked rewear the monitor, and data were summarized across all valid wear time. Eighty-two participants wore the monitor twice, and three wore it three times.

Light, moderate, vigorous, and sedentary time were defined using the same procedures applied at HCHS/SOL baseline (for details, see the studies by Evenson et al., Arredondo et al., and Merchant et al. [32–34]). The definition of adherence was 3 days or more with 10 hours or more wear time, with 94% meeting these criteria in CASAS, and 86.6% including a weekend day (Table 4). Average minutes of moderate-to-vigorous physical activity per valid day is the primary physical activity analytic variable for SOL CASAS.

Participants also completed the Global Physical Activity Questionnaire, which has been shown to be reliable and valid in diverse

Table 3
Microscale Audit of Pedestrian Streetscapes: microscale neighborhood environment characteristics for SOL CASAS*

Scale	Number of items	Content*
Route		
Destinations and land use	16	Residential density; shops; public recreation
Streetscape (i.e., features of the street)	10	Transit; traffic calming; driveways, street amenities (overhangs, trash bins, benches, bike racks)
Aesthetics	8	Positive aesthetics (landscape, hardscape); negative aesthetics (building maintenance, graffiti, billboards advertising food or tobacco/alcohol†)
Overall route	Computed from subscales	Composite of destinations and land use, streetscape, and aesthetics
Segments		
Sidewalk	4	Sidewalk width and quality
Building height-setback ratio	2	Building height; building setback (i.e., distance from street)
Buffers	2	Buffer between sidewalk and traffic; street parking
Bicycle infrastructure	1	Marked bicycle facilities
Trees	3	Number of trees, shade
Surveillance†	4	Street lights; porches; ground-floor windows
Overall segments	Computed from subscales	Composite of sidewalk, building height/setback ratio, buffers, bicycle infrastructure, trees, and surveillance
Crossings		
Crosswalk amenities	5	Marked crosswalk; high visibility striping; curb extensions
Curb presence and quality	2	Curb ramp
Intersection control and signage	4	Traffic circle; pedestrian walk signals
Overall crossings	Computed from subscales	Composite of crosswalk amenities, curb presence and quality, and intersection control and signage
Cul-de-sacs		
Overall Cul-de-sacs	3	Cul-de-sac visibility; amenities (e.g., basketball hoop)
Overall		
Overall microscale	Computed from subscales	Composite of streetscape, aesthetics, segments, and crossings
Overall microscale for active transport	Computed from subscales	Composite of streetscape, segments, and crossings
Grand score	Computed from subscales	Composite of streetscape, aesthetics, segments, crossings, and destinations and land use
Grand score for active transport	Computed from subscales	Composite of streetscape, segments, crossings, and destinations and land use

Route = 0.25–0.44 mile path that originates from a pedestrian's home and heads toward the nearest likely commercial destination.
Segment = each street block along the route.
Crossing = pedestrian crossings at street intersections along the route.
Complete forms, observer manual, data dictionary, and scoring syntax can be accessed at http://sallis.ucsd.edu/measure_maps.html#MAPSABBREVIATED.
* Ratings for most features included the presence and/or number of the feature (e.g., shops), with some features being rated for quality (e.g., sidewalk quality).
† Material added for SOL CASAS.

cultural contexts [35]. The instrument assessed self-reported physical activity in the domains of work-related, transportation-related, and recreation/leisure physical activity. The latter two variables are used to provide complementary information and more specificity than total moderate-to-vigorous physical activity because an environmental attribute can have differential associations with each physical activity domain [10].

Neighborhood self-selection

To adjust for walkability-related self-selection of neighborhoods, participants completed a nine-item scale of "reasons for moving" to the current home. A measure of self-selection into a walkable neighborhood was computed by averaging ratings of three items: "desire for nearby shops and services," "ease of walking," and "closeness to recreational facilities." This measure has been used in prior studies to account for neighborhood preference [36,37].

Psychosocial pathways

HCHS/SOL participants completed an interview-assessed questionnaire battery in their preferred language (English and Spanish). SOL CASAS is examining self-reported depression symptoms assessed at baseline and Visit 2, and chronic stress burden, perceived social support, and anxiety symptoms assessed at Visit 2.

Table 4
Accelerometer data and adherence for HCHS/SOL and SOL CASAS ancillary by sex (N=1776)

	Overall (n = 1776)						Male (n = 578)						Female (n = 1198)					
	HCHS/SOL baseline (2008–2011)			CASAS ancillary (2015–2017)			HCHS/SOL baseline (2008–2011)			CASAS ancillary (2015–2017)			HCHS/SOL baseline (2008–2011)			CASAS ancillary (2015–2017)		
	N	M or %	SD	N	M or %	SD	N	M or %	SD	N	M or %	SD	N	M or %	SD	N	M or %	SD
Some wear time (%)	1700	95.7		1725	97.1		556	96.2		560	96.9		1144	95.5		1165	97.2	
≥3 Adherent days (%)	1508	84.9		1622	94.0		493	85.3		525	93.8		1015	84.7		1097	94.2	
≥3 Adherent including weekend (%)	1346	79.2		1492	86.5		443	79.7		485	86.6		903	78.9		1007	86.4	
≥3 Adherent days at both visits (%)				1409	79.3					458	79.2					951	79.4	
Wear days	1700	6.0	0.19	1725	10.1	2.90	556	6.0	0.14	560	10.1	2.88	1144	6.0	0.22	1165	10.2	2.91
Adherent days	1700	4.7	1.60	1725	6.0	2.00	556	4.7	1.66	560	6.1	2.08	1144	4.7	1.57	1165	5.9	1.97
Wear time* (h/d)	1508	14.7	2.20	1622	14.0	1.75	493	14.9	2.34	525	14.2	1.82	1015	14.6	2.12	1097	13.9	1.70

M = Mean; SD = Standard deviation.
* Wear time among adherent days.

Details about the self-report psychosocial measures can be found in Table 5.

Cardiometabolic health

Cardiometabolic variables were obtained at HCHS/SOL baseline and Visit 2 after an overnight fast and using standardized protocols and centralized assays performed at the HCHS/SOL Central Laboratory at the University of Minnesota. Additional details regarding the measurement of these variables in HCHS/SOL can be found elsewhere [6].

The primary outcome variable for SOL CASAS is a confirmatory factor analysis–derived (at baseline and Visit 2) composite of variables that comprise the metabolic syndrome [45]; specifically, waist circumference, systolic blood pressure, fasting glucose, high-density lipoprotein cholesterol (HDL-C), and triglycerides. Prior studies from HCHS/SOL demonstrated that, at baseline, the metabolic syndrome variables identified a single class of participants at elevated cardiometabolic risk [46] and formed a single latent construct, with the exception of HDL-C, which is not as relevant to classifying the metabolic syndrome in Hispanics/Latinos [47].

HCHS/SOL CASAS is also examining secondary outcomes of prevalent and incident metabolic syndrome (defined according to National Heath Lung and Blood Institute/American Heart Association criteria [6]) and prevalence and changes in individual cardiometabolic risk pathways and disorders. These indicators include (1) prevalent and incident obesity and changes in continuous measures of adiposity (body mass index, waist circumference, percent body fat); (2) prevalent and incident hypertension and changes in continuous measures of systolic and diastolic blood pressure; (3) prevalent and incident dyslipidemia and changes in continuous indicators of lipid regulation (low-density lipoprotein cholesterol, HDL-C, and triglycerides); (4) prevalent and incident diabetes and changes in continuous indicators of glucose regulation (e.g., glycosylated hemoglobin and homeostatic model assessment of insulin resistance). Additional information about assessment of these indicators can be found in prior HCHS/SOL publications (e.g., metabolic syndrome [6]; obesity and adiposity [5]; blood pressure and hypertension [9]; diabetes and glucose regulation [7]; and lipids [8]).

Statistical considerations

Statistical power

Power analyses used the simulation approach of Thoemmes et al. [48] implemented in Mplus version 7.4 [49]. Parameters for all models included a 20% attrition rate across the two time points, a design effect of 1.25 specified to account for the clustering in HCHS/SOL, an alpha level of 0.05 for two-tailed tests, and a target power of at least 80%. Effect sizes for the indirect effect (aims 1 and 2) were specified to account for 1% of the variance in both the intermediate variable and outcome variable, respectively. Given these assumptions, 1101 participants are needed to find a statistically significant mediated effect with 80% power. A similar approach was used to determine the necessary sample size to find a statistically significant interaction (aim 3) among macro- and micro-scale social and built neighborhood environmental factors in predicting a target outcome. A small effect size was defined as an interaction term accounting for an additional 1% of variance in a target outcome. Given these assumptions, 792 participants are needed to find a statistically significant interaction with 80% power. Thus, with our CASAS sample size of 1776, power for all specific aims exceeds 80%, and power is sufficient for a variety of supplementary analyses.

Primary analyses

Hypotheses are being tested using multilevel regression modeling and path analyses to test indirect effects. Models accommodate the complex survey design (stratification, clustering, and sampling weights) and control for the influence of possible confounding sociodemographic factors (e.g., sex, age, and nativity), health variables (e.g., medication use and comorbid conditions), time at address, and neighborhood self-selection. Variables significantly associated with missing data patterns are incorporated into analyses as auxiliary variables [50]. Additional information about statistical models for each study aim is shown in Table 6.

Discussion

Sociocultural and environmental factors are relevant to the epidemiology of CVD and many other chronic conditions. By incorporating different “layers” of information on these constructs, SOL CASAS provides a multidimensional perspective on potential strategies to impede the expansion of risk factors such as obesity and metabolic syndrome, which are mitigating advances made over

Table 5
Psychosocial factors examined in SOL CASAS

Construct/timing of assessment	Measure
Depression (baseline and Visit 2)	Center for Epidemiological Studies in Depression 10-item measure of depression symptoms in past week ([38]; measure shown to be reliable and valid in HCHS/SOL [39]).
Chronic stress (Visit 2)	Chronic stress burden [40,41], 8-item measure of ongoing stress of at least 6 mo duration in major life domains and degree of associated distress.
Anxiety (Visit 2)	Generalized Anxiety Disorder Scale, 7-item measure of general anxiety symptoms in the past 2 weeks [42]
Social support (Visit 2)	Interpersonal Support Evaluation List, 12-item measure of perceived availability of social support ([43]; measure shown to be reliable and valid in HCHS/SOL [44]).

Table 6
Statistical models to be tested in SOL CASAS

Aim	Analysis
Aim 1	Multilevel regression to examine changes from baseline to Visit 2 in physical activity, depression, and cardiometabolic health. Slopes (level 1) representing these outcomes modeled as random effects. Baseline neighborhood variables (level 2) used as predictors of these level 1 slopes. A multilevel indirect effects model used to determine if the environment slopes in cardiometabolic health relationship(s) are explained in part by baseline values and slopes representing changes in physical activity and depression. MacKinnon's asymmetric confidence interval used to formally test indirect effects [51].
Aim 2	Similar analyses to aim 1 used to test hypotheses of aim 2. For aim 2, variables representing the social and built environment are modeled as slopes to represent change variables (level 1) to predict changes in the slope variables physical activity, depression, and cardiometabolic health. Models test direct effects of environment in relation to these variables and indirect effects of changes in neighborhood environment variables, through physical activity and depression, to changes in cardiometabolic health.
Aim 3	This aim only includes variables assessed at Visit 2. Interaction terms, and their individual component variables, representing macro- and micro-environment variables, used as predictors of variables representing physical activity, psychosocial factors (e.g., chronic stress), and cardiometabolic health. Indirect effect models and moderated indirect effect models used to determine if the relationships between these main effect and interaction terms and cardiometabolic health are explained in part by physical activity and psychosocial factors. All follow-up tests of significant models use the procedures outlined by Edwards and Lambert [52].

the past five decades in reducing CVD incidence. Notably, this study was conducted among Hispanics/Latinos of primarily Mexican descent living in the border region of San Diego County. Hispanics/Latinos are one of the fastest growing minority populations in the United States and historically have had elevated cardiometabolic risk.

Specific strengths of SOL CASAS include unique and comprehensive measures of macro- and micro-scale neighborhood environment features among those who stayed in the same homes across 6 years or those who moved residences, objective measures of physical activity and sedentary behavior, multiple measures of psychosocial factors and cardiometabolic risk, repeat assessments across several domains allowing for longitudinal analyses, and a relatively large cohort of study participants, providing appropriate power to test multiple hypotheses. Limitations include the limited number of novel blood biomarkers to explore metabolic pathways, the study of only a single Hispanic/Latino heritage group, and limited geographic variability by restricting the study to only San Diego HCHS/SOL participants.

Recent evidence from quasiexperimental environmental intervention studies suggests that improvements in neighborhood walkability, recreational spaces, and active transport infrastructure can positively impact physical activity and health in children and adults [16,53,54]. Regeneration of deprived neighborhoods [55] and interventions that increase green spaces [56] have also been linked to improved mental health in residents. To best inform future policy and public health interventions, information is needed about the specific micro- and macro-level neighborhood factors that relate to health and the mechanisms that explain these associations. SOL CASAS is a unique collection of data that, when combined with the outcomes data being collected in the HCHS/SOL parent study, will provide novel information on how environmental factors shape cardiometabolic health through behavioral and psychosocial pathways among Hispanics/Latinos. In doing so, the study seeks to inform effective multilevel interventions targeted to improve health and reduce disparities in this large and growing U.S. population.

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