Physical Activity and Sedentary Behavior among US Hispanic/Latino Youth: The SOL Youth Study

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ABSTRACT

EVENSON, K. R., E. M. ARREDONDO, M. R. CARNETHON, A. M. DELAMATER, L. C. GALLO, C. R. ISASI, K. M. PERREIRA, S. A. FOTI, L. VAN HORN, D. C. VIDOT, and D. SOTRES-ALVAREZ. Physical Activity and Sedentary Behavior among US Hispanic/Latino Youth: The SOL Youth Study. *Med. Sci. Sports Exerc.*, Vol. 51, No. 5, pp. 891–899, 2019. **Purpose**: Physical activity and sedentary behavior among diverse Hispanic/Latino youth in the United States is not well documented. The aim of this study was to describe physical activity and sedentary behavior among a representative sample of Hispanic/Latino youth from four US communities using accelerometry and self-reported measures. **Methods**: From 2012 to 2014, 1466 Hispanic/Latino youth ages 8 to 16 yr, children of participants in the Hispanic Community Health Study/Study of Latinos, enrolled in the SOL youth. Physical activity and sedentary behavior were assessed by interview. After this, youth wore an Actical accelerometer for 1 wk. All statistical analyses accounted for the complex survey design and used sampling weights. **Results**: The accelerometer wear time adjusted mean minutes per day was: 604.6, sedentary; 178.9, light; 25.4, moderate; and 10.2, vigorous. Generally, higher levels of moderate and vigorous activity occurred among males, Mexican backgrounds, and youth age 8 to 10 yr compared with older age groups. Higher levels of sedentary behavior occurred among youth age 15 to 16 yr compared with younger age groups. The most common activities (reported, ≥1 per month) were of lower intensity, including listening to music (91.9%), homework (87.0%), riding in car/bus (84.3%), and hanging out with friends (83.4%). Common active pursuits included travel by walking (74.6%), physical education class (71.7%), running (71.4%), and recess (71.3%). **Conclusions**: Time, intensity, and type of physical activity and sedentary behavior varied among Hispanic/Latino youth. These findings can inform efforts to increase physical activity and reduce sedentary behavior among US Hispanic/Latino youth. **Key Words:** ACCELEROMETRY, ACTIVITY TYPE, ADHERENCE, HISPANIC, QUESTIONNAIRE, SELF-REPORT

The *Physical Activity Guidelines for Americans*, second edition (1), developed from a recent scientific review (2), recommended that youth ages 6 to 17 yr should engage in at least 60 min of moderate to vigorous physical activity (MVPA) daily. The guidelines recommended three types of physical activities: aerobic, muscle strengthening, and bone strengthening activities. Other countries, including Canada (3) and Australia (4), provide further guidance on sedentary behavior, such as to limit screen, sitting, and indoor time.

National surveillance of physical activity is an essential public health priority, used to monitor population trends and guide interventions (5). Surveillance of sedentary behavior is an important emerging priority due to its deleterious association with cardiovascular and cancer risk factors and other health outcomes (6). Surveillance systems assessing physical activity and sedentary behavior would ideally

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provide estimates for the largest race/ethnic groups in the population, particularly since health disparities exist across race/ethnicity. In mid-2016, Hispanics/Latinos comprised 17.8% or 57.5 million people in the US population (7); yet, only limited information is available on their physical activity and sedentary behavior. Among the Hispanics/Latinos in the United States, their diverse Hispanic/Latino background includes 63.2% Mexican, 9.5% Puerto Rican, 3.9% Cuban, 3.8% Salvadoran, 3.3% Dominican, and 2.5% Guatemalan (7). Physical activity and sedentary behavior surveillance data for specific Hispanic/Latino backgrounds are even more limited than for Hispanics/Latinos overall.

In the United States, surveillance systems for youth physical activity and sedentary behavior traditionally relies on self-report, but is known for greater inaccuracies among younger ages (8). Surveillance systems include the Youth Risk Behavior Surveillance System, the Health Behavior in School-aged Children quadrennial surveys, and the National Health and Nutrition Examination Survey (NHANES). The biennial Youth Risk Behavior Surveillance System relies exclusively on self-report and focuses on 9th through 12th grades, with optional coverage among middle school grades. The Health Behavior in School-aged Children occurs every 4 yr and includes 11-, 13-, and 15-yr-olds. The NHANES includes a wider range of youth, for example from age 6 to 17 yr for accelerometry measures collected in 2003 to 2006 and 2011 to 2014, but is unable to provide estimates beyond Mexican American background due to sampling and sample sizes. In 2012, the NHANES National Youth Fitness Survey assessed physical activity and fitness levels among youth age 3 to 15 yr, but the total sample size of 1576 was not large enough to explore findings by Hispanic/Latino backgrounds (9).

Other studies need to fill the gap in the US surveillance of physical activity and sedentary behavior among Hispanic/Latino youth, by describing population levels of these behaviors overall and by Hispanic/Latino background. In support of this, the 2014 American Heart Association position statement emphasized the importance of studying race/ethnic diversity and prevalence of cardiovascular risk factors among Hispanics/Latinos (10). The main aim of this study was to describe physical activity and sedentary behavior among US youth from diverse Hispanic/Latino backgrounds using both accelerometry and self-report methods. This included quantifying the most common types of physical activities and sedentary behaviors in which youth engaged. Secondarily, this study identified sociodemographic, health, and cultural characteristics associated with physical activity, sedentary behavior, accelerometer participation, and accelerometer wear.

METHODS

Study population. The Hispanic Community Health Study/Study of Latinos (HCHS/SOL) is a population-based cohort study designed to examine diabetes, pulmonary, and cardiovascular disease risk factors, morbidity, and mortality among adults (11). From 2008 to 2011, 16,415 self-identified Hispanic/Latino men and women age 18 to 74 yr were recruited using a two-stage probability sampling approach from randomly selected households in four US communities (Bronx, NY; Chicago, IL; Miami, FL; San Diego, CA). A previous article described the HCHS/SOL sample design, cohort selection, and participation rates among the adults (11).

The SOL youth enrolled children ages 8 to 16 yr who lived with a HCHS/SOL adult participant and were free from serious health issues (12,13). All eligible youth in a family were invited to participate between 2012 and 2014. Of 1777 eligible youth identified through screening, 1466 (82.5%) participated. The institutional review boards at all institutions involved approved the study (e.g., SOL youth centers, central laboratory, nutrition coordinating center, and coordinating center), and informed consent was obtained from all adult participants. Parents provided consent for their children to participate, and children provided either written consent or assent per the guidelines at their institution.

Accelerometry measurement. During the clinic visit, participants were asked to wear an Actical accelerometer (version B-1; model 198-0200-03) for 1 wk. All accelerometers were calibrated at Philips Respironics (Murrysville, PA) before study deployment. Participants were fitted with a belt and left the clinic visit wearing the accelerometer. They were instructed to continue to wear it above the iliac crest on the right side, the location most sensitive to vertical movement consistent with ambulation. Participants were asked to undertake their usual activities for the following week while wearing the accelerometer, and to remove it only for swimming, showering, and sleeping.

For the Actical, a microprocessor converted accelerations to a unit called "counts" over a given epoch or time period. The Actical captured accelerations in counts every 15 s, and was initialized to start recording at midnight of the day following the clinic visit. We included time from 5:00 AM to midnight for all 7 d. Nonwear was defined as consecutive zero counts for at least 90 min (window 1), allowing for short time intervals with nonzero counts lasting up to 2 min if no counts were detected during both the 30 min (window 2) upstream and downstream from that interval; any nonzero counts except the allowed short intervals were considered as wear time (14). Accelerometer "participation" was defined as returning the Actical and having any recorded wear time. "Adherence" was defined as $\geq 8\ h \cdot d^{-1}$ of wear time for ≥3 d.

Cutpoints were guided by a calibration study using the Actical among 10- to 15-yr-old youth (15). The following cutpoints were used: sedentary at 0 to 17 counts per 15 s, light at 18 to 440 counts per 15 s, moderate at 441 to 872 counts per 15 s, and vigorous at ≥873 counts per 15 s. MVPA was defined as ≥441 counts per 15 s. The number of minutes per day in each intensity were summed and averaged across adherent days, and then multiplied by 7 to obtain minutes per week for each category.

Self-reported physical activity and sedentary behavior. The SOL youth designed the physical activity questionnaire specifically for this study to complement the

accelerometry by providing type of activity. The questionnaire is available for download elsewhere (https://biolincc.nhlbi.nih.gov/studies/hchssol/). The interviewer asked youth to estimate how often they participated in each of 68 activities in the past month or week (Table, Supplemental Digital Content 1, items from the questionnaire, http://links.lww.com/MSS/B479). The response options included never, one to two times per month, one to two times per week, three to four times per week, five to six times per week, and daily. These options were converted to create a number of times/month as follows:

- Never → 0 times per month
- 1–2 times per month → 1.5 times per month
- 1–2 times per week → 4–8 times per month → 6 times per month
- 3–4 times per week → 12–16 times per month → 14 times per month
- 5–6 times per week → 20–24 times per month → 22 times per month
- Daily → 30 times per month

Additionally, youth were asked how much time per day (in hours and minutes) they spent in the following: television or video watching, computer or internet, video/computer games (nonactive), and talking on the phone or text messaging. These activities were summed to create total time (in hours per day and minutes per day) spent in screen time.

Other measures. Participants self-reported their Hispanic/Latino background, nativity (born in US mainland or not), immigrant generational status, and their preferred language (Spanish or English). Puerto Ricans were classified as foreign born for these analyses. The "other" category included those who reported more than one background.

Using standardized protocols, weight was measured to the nearest 0.1 kg on a digital scale (Tanita Body Composition Analyzer; TBF 300, Japan) and height was measured to the nearest centimeter using a wall-mounted stadiometer (SECA 222, Germany). Body mass index (BMI) was calculated and standardized to BMI percentile groups using the 2000 Centers for Disease and Prevention Growth Charts (16), with the 2016 update to better accommodate extremely high values using this program (https://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm). The BMI percentiles were grouped as follows: underweight (<5th percentile), normal weight (5th–84th percentile), overweight (85th–94th percentile), obese (≥95th percentile, BMI <35 $kg \cdot m^{-2}$ and 120% of 95th percentile), and severely obese (≥ 95th percentile, BMI ≥ 35 $kg \cdot m^{-2}$ and 120% of 95th percentile).

Statistical analysis. All statistical analyses accounted for the complex survey design (stratified and clustered) and used sampling weights. Similar to the HCHS/SOL (adult study), the SOL youth sampling weights were first adjusted by household-level and person-level nonresponse in HCHS/SOL and then in SOL youth. The nonresponse adjusted sample weights were then trimmed using the 95th percentile within each field center to reduce their variability and impact of extremely large weights, and the trimmed difference was evenly distributed among all of the nontrimmed sample weights. These were then calibrated using 18 categories (9 age groups for each year [ages 8 to 16 yr] by sex) in the target population from the 2010 US Census. Finally, these calibrated, trimmed, nonresponse adjusted sample weights were normalized using the entire youth sample. The lower level of clustering (children within a household) was accounted for in the analyses by specifying sampling with replacement for variance computations and the top-level sampling unit in SOL youth census block (17,18).

Differences in accelerometer participation and adherence were explored by sociodemographic and BMI categories using the Cochran–Mantel–Haenszel χ^2 general test of association with the Wald χ^2 statistic for nominal variables (site, Hispanic/Latino background, sex, generational status, language preference) and the Cochran–Mantel–Haenszel trend test for ordinal variables (age groups, BMI percentile groups). Significance was set at $P < 0.05$.

We estimated the mean time in accelerometer-assessed physical activity and sedentary behavior by sociodemographic and BMI categories using linear regression adjusting for accelerometer wear time. We conducted pairwise comparisons of mean values within characteristics using a Bonferroni correction for the multiple comparisons. First, we conducted an overall test for all adjusted means being equal (e.g., all adjusted means by site being equal). We used an alpha level of 0.0001 for significance given the large number of comparisons performed (i.e., seven sociodemographic and BMI characteristics for each of five accelerometer intensities, five self-reported physical activity types, and five self-reported screen time types). Only if the overall test was significant, then pairwise comparisons using an alpha level of 0.01 was performed.

Given missing accelerometer data mostly due to nonadherence, we used multiple imputation, specifically a multivariate imputation by fully conditional specification, to impute accelerometer missing values for sedentary, light, moderate, and vigorous minutes per day and an indicator for whether an adherent weekend day was included to summarize the data. We created 10 imputed complete datasets and the imputation model included sex, age group, BMI, Hispanic/Latino background, generational status, self-reported physical activity (transportation, sports, leisure but nonsports, school, household), self-reported screen time, and the strata and sampling weights to account for the complex survey design (19). After the imputation, we calculated wear time as the sum of minutes in sedentary, light, moderate, and vigorous activities. We combined the results of 10 separate analyses using Rubin's rule to account for the uncertainty in the imputation (20).

Descriptive statistics are reported for both the accelerometry and self-reported physical activity and sedentary behavior. All analyses were performed using SAS 9.3 software (SAS Institute, Cary, NC) and SUDAAN software release 11 (RTI International, Research Triangle Park, NC) was used to account for the complex survey design and sampling weights except where indicated.

RESULTS

Accelerometry participation and adherence. Among the 1466 youth, 1238 returned the accelerometer with at least some wear time. Any accelerometer participation (e.g., returning the accelerometer with some wear) differed by site, but was not different by Hispanic/Latino background, sex, age group, BMI percentile group, generational status, or language preference (Table, Supplemental Digital Content 2, comparison of those who wore and returned the Actical to those who did not, http://links.lww.com/MSS/B480).

The range of adherent accelerometer wear overall and by age and sex for each adherent day is provided in Table 1. Among the 1238 that provided at least some accelerometer wear, 1104 met the adherent criteria of ≥8 h of wear for at least 3 of the 7 d. Accelerometer adherence was lower among Puerto Rican and South American backgrounds, and was progressively lower with each successively older age group (Table, Supplemental Digital Content 3, comparison of those who provided adherent accelerometry data to those who did not, http://links.lww.com/MSS/B481). Adherence did not differ by site, sex, BMI percentile group, generational status, or language preference. The average accelerometer wear time among the adherent group was 13.7 $h \cdot d^{-1}$, and differed by site (range, 12.6–15.0 $h \cdot d^{-1}$) and Hispanic/Latino background (range, 13.1–15.1 $h \cdot d^{-1}$) (Table 2).

Accelerometry-assessed physical activity and sedentary behavior. Overall, the accelerometry wear time adjusted mean physical activity in minutes per day by intensity was: 178.9, light; 25.4, moderate; and 10.2 vigorous (Table 2). Higher levels of MVPA occurred among males, Mexican backgrounds, and youth ages 8 to 10 yr.

Overall, the wear time adjusted mean sedentary behavior was 604.6 $min \cdot d^{-1}$ (Table 2). Higher levels of sedentary behavior occurred among those 15 to 16 yr in age compared with younger age groups.

Self-reported physical activity and sedentary behavior. The most commonly self-reported activities based on reporting at least once per month were of lower intensity, including listening to music, homework, riding in car/bus, and hanging out with friends (Table 3). Common active pursuits included travel by walking, physical education class, running, and recess. These common activities were further stratified by sex/age group (Table, Supplemental Digital Content 4, common activities by sex/age group, http://links.lww.com/MSS/B482) and by Hispanic/Latino background (Table 3**)** **(**Table, Supplemental Digital Content 5, common activities by background, http://links.lww.com/MSS/B483) to reveal preferences, which generally had similar rankings.

Based on self-report, on average youth spent 475.5 $min \cdot d^{-1}$ in screen time activities including television or video watching, computer or internet, video/computer games (nonactive), and talking on the phone or text messaging (Table 4). Higher levels of screen time occurred among those from the Bronx, Dominican and Puerto Rican backgrounds, and older age groups.

DISCUSSION

The present study provides novel information about accelerometry-assessed and self-reported physical activity and sedentary behavior among US youth age 8 to 16 yr from various Hispanic/Latino backgrounds living in four US communities. This level of detail by Hispanic/Latino background cannot be currently ascertained from the US surveillance systems.

Physical activity. We found Hispanic/Latino youth 8 to 16 yr engaged in a mean of 25 $min \cdot d^{-1}$ of moderate (~3% wearing time) and 10 $min \cdot d^{-1}$ of vigorous (~1% wearing time) activity. The time spent in MVPA is well below the national guidelines of an hour or more each day (1). For context, national accelerometry data from 2003 to 2006 indicate that Mexican American youth engaged in a mean of 85, 37, and 28 $min \cdot d^{-1}$ of MVPA across ages 6 to 11 yr, 12 to 15 yr, and 16 to 19 yr, respectively (21), with no appreciable differences between 2003–2004 and 2005–2006 (22). In SOL youth, conducted 6 to 11 yr later, the amount of mean time spent in MVPA was

TABLE 1. Unweighted percentage of participants by number of adherent accelerometer days (≥ 8 h of wear), overall and by age group and sex; SOL Youth Study, 2012–2014.

			No. Adherent Days								
		n	0	1	2	3	4	5	6	7	3 or More
Full sample	Overall	1238	2.7	3.3	4.9	6.6	11.3	14.5	26.4	30.3	89.2
	Male	607	3.1	2.6	5.4	7.3	11.7	12.9	26.9	30.2	88.8
	Female	631	2.2	4.0	4.3	6.0	10.9	16.2	26.0	30.4	89.5
8–10 yr	Overall	410	1.5	1.7	3.9	6.8	9.8	14.2	28.3	33.9	92.9
	Male	202	1.5	0.5	5.0	6.9	13.9	11.9	26.2	34.2	93.1
	Female	208	1.4	2.9	2.9	6.7	5.8	16.4	30.3	33.7	92.8
11–12 yr	Overall	300	0.7	3.3	2.7	6.7	13.3	13.3	27.0	33.0	93.3
	Male	155	1.3	3.2	3.2	7.7	9.7	12.3	31.6	31.0	92.3
	Female	145	0.0	3.5	2.1	5.5	17.2	14.5	22.1	35.2	94.5
13–14 yr	Overall	310	5.2	2.9	5.8	6.8	11.9	18.4	22.9	26.1	86.1
	Male	149	5.4	3.4	6.0	7.4	9.4	17.5	25.5	25.5	85.2
	Female	161	5.0	2.5	5.6	6.2	14.3	19.3	20.5	26.7	87.0
15–16 yr	Overall	218	4.1	6.9	8.3	6.0	10.6	11.5	27.1	25.7	80.7
	Male	101	5.9	5.0	8.9	6.9	13.9	8.9	22.8	27.7	80.2
	Female	117	2.6	8.6	7.7	5.1	7.7	13.7	30.8	23.9	81.2

TABLE 2. Description of sample and adjusted mean (SE) minutes per day of accelerometry-assessed physical activity and sedentary behavior, overall and by sociodemographic, and BMI categories; SOL Youth Study, 2012–2014.

		Weighted	Wear Time	Sedentary	Light	Moderate	Vigorous	Moderate to Vigorous
	N	Percent	Mean	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Overall	1466	100	13.7	604.6 (4.4)	178.9 (2.5)	25.4 (0.6)	10.2 (0.5)	35.7 (1.0)
Site								
Bronx	422	35.9	15.0	613.7 (6.7)	171.1 (4.5)	24.9 (1.0)	9.5 (0.8)	34.4 (1.6)
Chicago	372	16.2	13.6	606.6 (7.5)	179.0 (5.8)	24.6 (1.0)	**9.0[a] (1.2)**	33.6 (2.0)
Miami	263	13.6	12.8	605.3 (5.9)	182.8 (4.4)	23.4 (1.0)	**7.8[b] (0.6)**	31.1 (1.4)
San Diego	409	34.3	12.6	593.9 (5.5)	185.5 (3.9)	27.3 (1.1)	**12.5[a,b] (1.0)**	39.8 (1.9)
Hispanic/Latino background								
Central American	112	6.0	13.7	620.9 (8.3)	168.7 (7.1)	22.3 (1.6)	7.3 (1.2)	**29.6[a] (2.5)**
Cuban	103	5.4	13.2	616.5 (6.6)	175.7 (5.6)	20.6 (1.6)	6.5 (1.0)	**27.1[b] (2.4)**
Dominican	167	12.8	15.1	617.6 (8.2)	171.5 (6.3)	22.7 (1.6)	7.4 (1.1)	**30.1[c] (2.4)**
Mexican	648	46.4	13.1	599.3 (5.2)	181.6 (3.5)	26.5 (0.8)	11.8 (0.8)	**38.3[a,b,c] (1.5)**
Puerto Rican	128	9.5	14.5	607.2 (11.1)	175.8 (8.2)	27.2 (2.0)	9.1 (1.3)	36.3 (3.0)
South American	68	4.0	13.4	608.8 (17.3)	174.6 (12.7)	24.7 (2.6)	11.2 (3.0)	35.8 (5.2)
Mixed	135	9.6	14.0	612.6 (8.2)	170.6 (7.0)	25.9 (1.8)	10.1 (1.4)	36.0 (2.8)
Other/missing	105	6.4	13.6	573.5 (12.2)	206.3 (9.2)	27.6 (2.0)	11.7 (1.4)	39.4 (3.1)
Sex								
Male	728	51.2	13.8	597.5 (5.4)	181.8 (3.9)	**27.9[a] (0.8)**	**12.0[a] (0.7)**	**39.9[a] (1.3)**
Female	738	48.8	13.5	612.1 (5.2)	175.9 (2.9)	**22.9[a] (0.8)**	**8.4[a] (0.6)**	**31.2[a] (1.2)**
Age, yr								
8–10	494	32.4	13.7	**560.9[a,b,c] (5.1)**	**215.6[a,b,c] (2.9)**	**29.4[a,b,c] (0.8)**	**13.3[a,b,c] (0.8)**	**42.7[a,b,c] (1.4)**
11–12	350	21.8	13.7	**599.3[a,d,e] (5.9)**	**186.3[a,d,e] (4.5)**	**24.1[a] (1.1)**	**9.6[a] (0.8)**	**33.7[a] (1.7)**
13–14	371	22.3	13.7	**627.0[b,d,f] (6.1)**	**160.4[b,d,f] (4.7)**	**23.3[b] (1.2)**	**8.6[b] (0.9)**	**31.9[b] (2.0)**
15–16	251	23.6	13.5	**648.4[c,e,f] (7.6)**	**139.4[c,e,f] (5.0)**	**23.3[c] (1.3)**	**8.2[c] (1.2)**	**31.5[c] (2.2)**
BMI percentile group:								
Underweight	37	2.8	14.1	599.0 (17.5)	180.3 (13.9)	27.1 (2.9)	12.8 (2.7)	39.9 (5.2)
Normal weight	712	50.4	13.7	601.6 (5.1)	179.7 (3.6)	26.4 (0.8)	11.5 (0.7)	37.8 (1.4)
Overweight	305	20.1	13.6	604.3 (7.3)	179.3 (4.7)	25.3 (1.3)	10.3 (1.1)	35.6 (2.2)
Obese	262	16.8	13.7	606.1 (6.8)	180.4 (5.5)	24.6 (1.1)	8.1 (1.1)	32.6 (2.0)
Severely obese	150	9.9	13.5	619.3 (10.1)	171.2 (7.2)	22.0 (1.7)	6.7 (1.3)	28.7 (2.7)
Generational status								
Foreign born (first generation)	305	20.5	13.4	618.9 (8.0)	167.7 (5.7)	23.4 (1.2)	9.2 (1.2)	32.6 (2.2)
US born (second generation)	913	63.1	13.5	602.0 (4.8)	181.1 (3.1)	25.6 (0.7)	10.6 (0.6)	36.2 (1.2)
US born (third + generation)	208	16.4	14.5	597.0 (7.3)	184.7 (5.4)	27.4 (1.4)	10.2 (1.0)	37.6 (2.2)
Language preference								
Spanish	287	20.5	12.9	600.0 (6.9)	181.9 (5.0)	25.8 (1.2)	11.3 (1.2)	37.0 (2.2)
English	1175	79.5	13.8	605.7 (4.6)	177.9 (2.6)	25.3 (0.6)	9.9 (0.5)	35.3 (1.0)

Accelerometry means were adjusted for wear time. All statistics accounted for the complex design and are weighted to account for probability of selection and nonresponse.
Means sharing the same superscript are significantly different (pairwise comparison $P \leq 0.01$) and highlighted in bold, except when the comparison includes background mixed or other/missing which is not meaningful. Pairwise comparisons were only conducted when the overall test was significant at an alpha level of 0.0001 given the large number of comparisons performed. Wear time differences were not statistically explored.

remarkably similar among older ages compared with NHANES Mexican American youth (43, 34, 32, and 32 min·d^{-1} for ages 8–10 yr, 11–12 yr, 13–14 yr, and 15–16 yr from Table 2). It is important to note that the type of accelerometer, and therefore the cutpoints used to define MVPA, differed between the two studies. Although the

TABLE 3. Percent of physical activities and sedentary behaviors youth reported at least once per month on the questionnaire, overall and by Hispanic/Latino background; SOL Youth Study, 2012–2014.

Activities	Overall	Central American	Cuban	Dominican	Mexican	Puerto Rican	South American	Mixed	Other/Missing
Listening to music	91.9	88.0	94.3	91.1	91.2	93.8	77.0	85.9	77.4
Homework	87.0	74.5	88.5	93.1	89.0	84.7	86.7	90.7	86.0
Riding in car/bus	84.3	93.5	94.2	72.1	82.2	84.6	82.0	80.9	74.6
Hang with friends	83.4	86.0	97.6	80.4	90.4	87.2	82.4	88.6	64.8
Travel by walking	74.6	61.7	64.4	89.2	74.8	70.8	66.7	80.2	52.9
Physical education class	71.7	66.9	86.1	76.5	71.2	72.3	67.2	72.5	78.5
Running/jogging	71.4	60.9	76.5	70.1	79.4	68.8	52.6	70.8	70.8
Recess/exercise period	71.3	63.5	64.6	70.5	76.4	76.7	76.2	58.0	87.5
Calisthenics	69.8	69.2	66.9	64.8	77.7	73.2	59.7	79.1	55.6
Indoor chores	68.8	60.7	43.5	65.5	69.6	58.7	64.4	63.1	49.3
Play catch	62.2	49.7	67.0	72.9	65.2	71.7	70.0	77.9	80.4
Shopping	61.8	57.5	59.8	58.5	61.4	53.8	52.5	58.4	61.8
Play with younger children	60.2	43.4	39.9	62.3	55.3	43.8	44.5	63.0	55.5
Walking for exercise	58.3	67.1	28.5	50.1	54.5	57.1	43.1	71.5	49.4
Reading for fun	56.5	48.8	44.8	54.6	47.6	50.2	46.9	61.4	62.1
Play with pets	55.2	50.0	43.7	54.9	53.1	71.3	49.2	56.5	53.7
Video games	53.9	69.7	66.6	68.7	55.8	64.7	67.5	66.3	71.9
Play dodge ball, kickball	52.8	53.8	73.6	58.5	58.0	53.2	63.8	53.7	74.9
Basketball	49.7	76.6	66.8	74.9	50.5	67.2	73.8	64.9	58.0
Church	49.0	55.0	37.5	49.4	50.5	42.1	56.7	41.4	49.3

The mean number of times per month are for those who reported having done the activity at least once per week (no zero counts included). All statistics accounted for the complex design and are weighted to account for probability of selection and nonresponse.

TABLE 4. Mean (SE) number of minutes per day in screen time, overall and by sociodemographic and BMI categories; SOL Youth Study, 2012–2014.

		Total Screen Time	TV/Video Watching	Computer/ Internet	Video/ Computer Games	Phone/Text Messaging
	N	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Overall	1466	475.5 (12.4)	167.1 (5.4)	113.4 (4.5)	82.5 (4.4)	114.2 (6.4)
Site						
Bronx	422	**554.6[a,b] (22.8)**	**207.2[a,b,c] (10.7)**	123.2 (8.1)	102.4 (8.7)	121.8 (12.4)
Chicago	372	**432.3[a] (18.3)**	**154.0[a] (8.2)**	109.3 (10.3)	71.9 (8.8)	101.8 (8.5)
Miami	263	492.7 (26.4)	**142.2[b] (9.3)**	120.2 (9.8)	86.4 (9.3)	149.2 (15.0)
San Diego	409	**410.1[b] (21.1)**	**142.2[c] (8.3)**	102.8 (7.4)	65.9 (6.8)	99.2 (11.3)
Hispanic/Latino background						
Central American	112	535.2 (40.1)	177.0 (25.7)	126.1 (16.5)	91.1 (16.0)	141.8 (21.6)
Cuban	103	528.1 (38.6)	152.5 (15.8)	126.0 (10.6)	76.0 (11.9)	178.4 (24.6)
Dominican	167	**589.3[a,b] (35.5)**	197.7 (13.9)	131.3 (11.6)	107.3 (15.7)	153.1 (22.6)
Mexican	648	**430.9[a,c] (16.4)**	155.3 (7.8)	108.9 (6.5)	71.0 (6.3)	97.2 (8.7)
Puerto Rican	128	**557.5[c,d] (44.3)**	215.6 (21.0)	119.3 (13.6)	102.6 (14.1)	121.8 (21.4)
South American	68	**383.8[b,d] (43.6)**	113.6 (14.8)	111.7 (17.0)	78.1 (15.2)	80.4 (18.6)
Mixed	135	491.2 (41.6)	162.2 (17.7)	108.4 (12.8)	92.4 (18.1)	129.2 (21.6)
Other/missing	105	391.7 (36.7)	166.5 (17.7)	87.3 (13.5)	73.3 (14.8)	69.8 (20.3)
Sex						
Male	728	483.0 (16.3)	175.6 (8.1)	107.0 (6.0)	**118.4[a] (7.4)**	**83.7[a] (6.7)**
Female	738	467.7 (17.2)	158.2 (6.4)	120.0 (6.1)	**45.0[a] (3.6)**	**146.2[a] (10.9)**
Age, yr						
8–10	494	**337.0[a,b,c] (14.6)**	165.5 (8.6)	**72.4[a,b,c] (5.7)**	75.7 (6.2)	**25.6[a,b,c] (3.2)**
11–12	350	**408.8[a,d,e] (22.2)**	163.6 (9.5)	**102.3[a,d,e] (6.8)**	87.9 (8.5)	**55.0[a,d,e] (8.5)**
13–14	371	**550.1[b,d,f] (22.9)**	161.5 (8.1)	**146.4[b,d] (9.3)**	87.0 (8.9)	**158.3[b,d,f] (12.0)**
15–16	251	**672.3[c,e,f] (24.7)**	178.3 (13.5)	**151.7[c,e] (10.5)**	82.6 (9.8)	**260.3[c,e,f] (18.2)**
BMI percentile group						
Underweight	37	482.9 (68.0)	198.3 (46.2)	99.3 (18.3)	111.0 (25.4)	79.5 (31.3)
Normal weight	712	469.1 (17.4)	157.6 (6.7)	106.8 (5.5)	80.2 (6.3)	125.6 (8.8)
Overweight	305	476.5 (24.6)	176.5 (13.4)	120.4 (9.9)	77.8 (10.1)	103.3 (16.4)
Obese	262	472.4 (28.3)	164.7 (11.3)	108.9 (10.2)	85.4 (10.7)	116.8 (15.6)
Severely obese	150	509.8 (36.3)	191.5 (18.1)	144.4 (18.1)	90.3 (11.2)	83.9 (11.7)
Generational status						
Foreign born (first generation)	305	502.7 (24.2)	169.9 (12.6)	123.7 (8.6)	74.9 (8.9)	135.7 (11.5)
US born (second generation)	913	467.1 (14.5)	164.2 (6.6)	112.2 (5.5)	81.0 (6.2)	111.2 (8.6)
US born (third+ generation)	208	462.9 (30.2)	170.6 (11.6)	101.1 (8.8)	92.7 (11.5)	98.9 (15.4)
Language preference						
Spanish	287	425.7 (26.1)	158.2 (11.0)	96.9 (8.2)	78.2 (10.2)	93.8 (13.8)
English	1175	487.9 (13.6)	168.7 (6.2)	117.7 (5.0)	82.9 (4.9)	120.4 (7.5)

The results from this table come only from the four screen time activities reported in minutes per day. All statistics accounted for the complex design and are weighted to account for probability of selection and nonresponse.

Means sharing the same superscript are significantly different (pairwise comparison $P \leq 0.01$) and highlighted in bold, except when the comparison includes background mixed or other/missing which is not meaningful. Pairwise comparisons were only conducted when the overall test was significant at an alpha level of 0.0001 given the large number of comparisons performed.

goal is to have comparable metrics for MVPA, the differences in accelerometer type still may contribute some error.

Both NHANES Mexican Americans (21) and this study reveal lower accelerometer-assessed MVPA among females compared with males, and a markedly lower MVPA comparing 8- to 10-yr-olds with older age groups. These age-related findings indicate a need for interventions for Hispanic/Latino youth that help maintain and promote physical activity, particularly elementary to middle school transitions (22).

Moderate to vigorous physical activity was lowest among youth of Central American, Cuban, and Dominican background, and highest among youth of Mexican and Puerto Rican background. One implication of these findings is that relying predominately on Mexican youth in US surveillance studies will miss important differences occurring among those with differing Hispanic/Latino backgrounds. If these differences hold true nationwide, then the use of Mexican youth only will overestimate the prevalence of MVPA among Latinos/Hispanics. Although our study did not detect significant differences, another accelerometry-based study of Latino/Hispanic adolescents identified Spanish language preference and non–US-born associated with higher MVPA (23). It is hypothesized that as acculturation occurs, Hispanic/Latino youth lifestyle patterns, including physical activity, become more like their US-born peers (10).

This study utilized the SOL Youth physical activity questionnaire to complement accelerometry findings by describing the most common physical activities undertaken by this ethnically diverse Hispanic/Latino population. Engaging youth in activities they potentially enjoy can help inform program development and allocation of resources directly to the activities that are engaged in and adopt. For example, the most common moderate to vigorous leisure activities reported included recess, running/jogging, and calisthenics, and sporting activities included playing catch, dodge ball, kickball, and basketball. Sixty percent of youth played with younger children, indicating the importance of family-based activities. The distribution of the types of activities, as well as the intensity, indicates the diversity of physical activity choices among this population.

Sedentary. National accelerometry data, from 2003 to 2006, found that Mexican American youth on average engaged in sedentary behavior for 5.9, 7.9, and 7.9 $h \cdot d^{-1}$ across ages 6 to 11 yr, 12 to 15 yr, and 16 to 19 yr, respectively (21). This is quite a bit lower than the time spent in sedentary behavior found in this study, where youth 8 to 16 yr recorded on average 10 h of sedentary behavior (~74% wearing time). However, the dissimilarity between the accelerometers and cutpoints used, as well as the study dates, differing proportions of immigrants, and amount of wearing time could contribute to some of these differences.

The SOL youth accelerometer findings are supported by national surveillance of high school students in 2015 that found 42% reported playing video games or used a computer for nonschool-related activities for three or more hours per day on an average school day (24). The 2012 NHANES National Youth Fitness Survey collected self-reported past month screen time from two questions on the number of hours per day spent (i) sitting and watching TV or videos and (ii) using a computer or playing games outside of school (25). Response options included less than 1, 1, 2, 3, 4, and 5 h or longer. Among 12- to 15-yr-olds, the percent reporting 2 $h \cdot d^{-1}$ or more of screen time was 77% for males and 73% for females. In the SOL youth study, the percent of 8- to 16 yr-olds reporting at least 2 $h \cdot d^{-1}$ of total screen time was even higher (92%, data not shown). However, the dissimilarities may be due to the differing ascertainment methods, particularly because the screen time behaviors could co-occur.

Adherence. A secondary aim of this study was to explore accelerometer participation and wear. Although the use of accelerometry among youth provides data free of recall bias, these benefits are attained only when the accelerometer is adequately worn. Identifying characteristics associated with accelerometry participation and wear can help account for the potential differential missing accelerometry data, for example, by using these characteristics to create inverse probability weights which allow correction for the bias of the estimates obtained by a complete-case analysis. Identifying these characteristics can also help future studies target efforts toward improving wear time. In this study, returning the accelerometer with some wear (i.e., participation) differed only by site. However, we found adherence to a minimum accelerometry wearing protocol was lower among youth of Puerto Rican and South American background, and among teenagers compared with younger ages. Lower participation or adherence has been reported among older youth compared to younger youth in studies of 11- to 14-yr-olds (26) and 9th to 12th graders (27). Past studies find adherence to be lower among participants who were male (28–30), overweight (26,29,30), or not overweight (31), but we did not identify meaningful differences by sex or weight status. Other studies also find lower adherence among youth living in neighborhoods with high deprivation or disadvantage (28,30), with lower educated mothers (29,30), with an illness or disability limiting daily activity (30), who exercised only once a week or less (30), and who reported higher weekday outdoor play (28).

We defined accelerometer adherence as wearing the accelerometer as directed by study staff according to the research protocol. The mean accelerometer wear time was 13.7 $h \cdot d^{-1}$ among adherent days, in line with studies of high school youth (12.1 $h \cdot d^{-1}$) (27). Methods exist to attempt to increase adherence with accelerometer wearing among youth, such as by providing incentives (27,32), a text message or phone reminder (32,33), showing example output of nonwear (32), completing a monitoring log (32). This study required the accelerometer to be worn at the hip. As newer studies move to the wrist or ankle, adherence should be improved (34).

Limitations. This study is subject to several limitations. First, the SOL youth physical activity and sedentary behavior questionnaire lacked psychometric testing, specifically test–retest reliability and validity. However, a recently developed surveillance questionnaire that asked about participation in similar activities in the past week had acceptable test–retest reliability and validity (35). A further limitation of the screen time questions is that sedentary behaviors could be co-occurring, such as watching television and spending time on the phone, which would not be differentiated. Second, although these data address limitations of national US surveillance, they still come from just four major metropolitan communities. However, these study sites included diverse youth from various Hispanic/Latino backgrounds recruited in a population-based sampling frame. Third, there may be unmeasured characteristics associated with participation or adherence to the accelerometer assessment that we did not measure. Moreover, our description of correlates related to physical activity and sedentary behavior was not comprehensive, and certainly omitted important intrapersonal, interpersonal, environmental, and policy factors.

Fourth, the accelerometry cutpoints assigned to define intensity levels is an estimate based on a calibration study of 10- to 15-yr-old youth. It is reassuring that other calibration studies on the Actical found similar results (36,37). Fifth, the cleaning program used to determine accelerometry nonwear for this study was developed with youth wearing the ActiGraph accelerometer (14), and it is not known whether it performs as well for the Actical. Further work is needed to define the most accurate algorithms for defining Actical wear-time. It is likely that the ideal algorithm for proprietary counts will differ between the Actical and ActiGraph, since the performance of counts varies between these accelerometers (38,39). Finally, also related to accelerometry, the use of proprietary counts does not distinguish sitting from lying posture. The Sedentary Behavior Research Network defines sedentary behavior as "any waking behavior characterized by an energy expenditure $\leq$1.5 METs while in a sitting or reclining posture" (40). Newer-generation accelerometers should be able to distinguish standing from sitting or reclining to better define sedentary behavior.

CONCLUSIONS

Levels of MVPA well below recommended amounts and excessive sedentary behavior characterized this population-based cohort of Hispanic/Latino youth from four US communities, particularly among those who were older compared with younger ages. A large proportion of the day was spent in screen time behaviors. Accelerometer-assessed MVPA differed by Hispanic/Latino background. Given our findings, coupled with national data (21,22), successful and long-lasting changes at the individual, interpersonal, environmental, and policy levels are needed to reverse the persistent drop-off of MVPA during school transitions. Interventions designed to encourage Hispanic/Latino families to continue to be physically activity and minimize sedentary behavior are needed to promote positive and lifelong health.

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