



## Accelerometer-measured sedentary time among Hispanic adults: Results from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL)

Gina Merchant<sup>a,i,\*</sup>, Christina Buelna<sup>b</sup>, Sheila F. Castañeda<sup>b</sup>, Elva M. Arredondo<sup>b</sup>, Simon J. Marshall<sup>a,i</sup>, Garrett Strizich<sup>c</sup>, Daniela Sotres-Alvarez<sup>d</sup>, Earle C. Chambers<sup>e</sup>, Robert G. McMurray<sup>d</sup>, Kelly R. Evenson<sup>f</sup>, Mark Stoutenberg<sup>g</sup>, Arlene L. Hankinson<sup>h</sup>, Gregory A. Talavera<sup>b</sup>

<sup>a</sup> Department of Family Medicine and Public Health, University of California, San Diego, San Diego, CA, United States

<sup>b</sup> Institute for Behavioral and Community Health, Graduate School of Public Health, San Diego State University, San Diego, CA, United States

<sup>c</sup> Department of Epidemiology and Population Health, Albert Einstein College of Medicine, Bronx, NY, United States

<sup>d</sup> Collaborative Studies Coordinating Center, Department of Biostatistics, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC, United States

<sup>e</sup> Department of Family and Social Medicine, Albert Einstein College of Medicine, Bronx, NY, United States

<sup>f</sup> Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC, United States

<sup>g</sup> Department of Public Health Sciences, University of Miami, Miami, FL, United States

<sup>h</sup> Chronic Disease Division, Chicago Department of Public Health, Chicago, IL, United States

<sup>i</sup> Center for Wireless and Population Health Systems, University of California, San Diego, San Diego, CA, United States

### ARTICLE INFO

Available online 22 October 2015

#### Keywords:

Latino  
Health disparities  
Cardiovascular health  
Sedentariness

### ABSTRACT

Excessive sedentary behavior is associated with negative health outcomes independent of physical activity. Objective estimates of time spent in sedentary behaviors are lacking among adults from diverse Hispanic/Latino backgrounds. The objective of this study was to describe accelerometer-assessed sedentary time in a large, representative sample of Hispanic/Latino adults living in the United States, and compare sedentary estimates by Hispanic/Latino background, sociodemographic characteristics and weight categories. This study utilized baseline data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) that included adults aged 18–74 years from four metropolitan areas (N = 16,415). Measured with the Actical accelerometer over 6 days, 76.9% (n = 12,631) of participants had >10 h/day and >3 days of data. Participants spent 11.9 h/day (SD 3.0), or 74% of their monitored time in sedentary behaviors. Adjusting for differences in wear time, adults of Mexican background were the least (11.6 h/day), whereas adults of Dominican background were the most (12.3 h/day), sedentary. Women were more sedentary than men, and older adults were more sedentary than younger adults. Household income was positively associated, whereas employment was negatively associated, with sedentary time. There were no differences in sedentary time by weight categories, marital status, or proxies of acculturation. To reduce sedentariness among these populations, future research should examine how the accumulation of various sedentary behaviors differs by background and region, and which sedentary behaviors are amenable to intervention.

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### Introduction

Sedentary behavior is defined as any waking activity characterized by an energy expenditure  $\leq 1.5$  metabolic equivalents (METs) in a sitting or reclining posture (Sedentary Behaviour Research Network, 2012). There is a consistent and growing body of evidence that sedentary behavior negatively impacts individuals' health independent of physical activity (Thorp et al., 2011; Wilmot et al., 2012; Prince et al., 2014; Hamilton et al., 2008). For example, a meta-analysis found that

even in studies adjusting for physical activity, there remained a 2.5 times higher risk of diabetes among the most sedentary individuals (Wilmot et al., 2012). Prolonged sedentariness is known to disrupt metabolic function, increase plasma triglyceride levels, decrease high-density lipoprotein cholesterol and insulin sensitivity (Tremblay et al., 2010), and is associated with an increased risk of cardiovascular disease (Allison et al., 2012), metabolic syndrome (Cooper et al., 2014), incident hypertension (Beunza et al., 2007), and cancer (Schmid and Leitzmann, 2014). Although there is an increased cardiometabolic risk associated with sedentariness after adjusting for physical activity (Healy et al., 2011a; Henson et al., 2013; Qi et al.), individuals who interrupt prolonged sedentary behavior with light physical activity, such as sit-to-stand transitions, have been found to have improved

\* Corresponding author.  
E-mail address: [gmerchant@ucsd.edu](mailto:gmerchant@ucsd.edu) (G. Merchant).

cardiometabolic profiles compared to those who did not (Tremblay et al., 2010; Healy et al., 2015).

Many chronic metabolic diseases linked to excessive sedentariness (e.g., diabetes) disproportionately affect Hispanic/Latinos compared to non-Hispanic Whites (Cowie et al., 2010). However, sedentary behavior research has been largely restricted to non-Hispanic Whites (Rhodes et al., 2012), with the few studies examining sedentary time in Hispanic/Latinos from the US consisting predominantly of individuals of Mexican background (De Heer et al., 2012; Matthews et al., 2008; Evenson et al., 2014). The Hispanic/Latino population residing in the US is diverse in terms of immigration, generation status, types of occupation, acculturation status, and health literacy, and should not be considered a single homogenous racial/ethnic group (Brown and Patten, 2014). Further, time spent in various sedentary behaviors may vary by background (Thompson et al., 2013), which has implications for interventions aimed at reducing sedentary behaviors among different Hispanic/Latino populations. An additional limitation of earlier work in sedentary research is that studies have relied on self-reported sedentary behavior (Healy et al., 2011b), but recalling the amount of time spent in past sedentary activities is difficult (Van Uffelen et al., 2011) and self-report surveys are subject to cultural biases (Nicaise et al., 2011).

While considering the aforementioned limitations of the extant literature, this study aimed to: (i) examine the descriptive epidemiology of accelerometer-assessed sedentary time in a large representative sample of Hispanic/Latino adults living in the US, (ii) compare the amount of sedentary time among different Hispanic/Latino groups, and (iii) compare the amount of sedentary time among Hispanic/Latino adults across sociodemographic characteristics and weight categories.

## Methods

### Study population and design

The Hispanic Community Health Study/Study of Latinos (HCHS/SOL) is a longitudinal cohort study of 16,415 Hispanic/Latino adults (ages 18–74 years) from 4 United States (US) metropolitan areas (Bronx, New York; Chicago, Illinois; San Diego, California; and Miami, Florida). Baseline information was obtained from 2008–2011. The goals of the HCHS/SOL, sample design and cohort selection have been reported in detail elsewhere (Lavange et al., 2010; Sorlie et al., 2010). The Institutional Review Board at each field center approved this study and all participants gave written informed consent.

### Sedentary-time assessment

Participants were instructed to wear the Actical version B-1 accelerometer (model 198-0200-03; Philips-Respironics Co. Inc., Bend, OR) for 6 days during waking hours. The Actical is a small, lightweight omnidirectional accelerometer worn around the waist on an elasticized belt. The Actical samples raw acceleration data at 32 Hz, which is then filtered and aggregated over a user-defined period ('epoch'). The Actical has evidence for validity to measure sedentary behavior in free-living populations (Crouter et al., 2006; Wong et al., 2011).

Participants left the clinic visit wearing the Actical and were instructed to wear it during all waking hours for seven days as they went about their usual activities, removing the Actical only for sleeping and water-based activities such as showering. To standardize across sites, the range of usable data was defined as data collected between 5:00 am the morning following the clinic visit through a maximum of six subsequent days.

Actical data were captured in one-minute epochs using the vertical axis, and raw data were filtered using a proprietary algorithm by Actical. Sedentary time was defined as the number of minutes/day spent at 0–99 counts per minute (Wong et al., 2011). Non-wear time was defined as at least 90 consecutive minutes of zero counts (Choi et al., 2011). During non-wear periods, up to 2 min of nonzero counts were

allowed provided that they were not detected in a 30-minute window upstream or downstream of the non-wear period, and recommendations put forth by Colley and colleagues were used to identify spurious data (Colley and Gorber). An adherent day was defined as at least 10 h of wear time. Participants needed to contribute >3 adherent days of 6 to be included in the analyses.

There is some evidence that time spent being sedentary varies by day of the week when assessed via self-report (Burton et al., 2012) and objective measurement (Evenson et al., 2015). In studies where sedentary behavior is objectively measured, it is often not tenable to require that a participant contribute at least one weekend day of data to be included in the analysis due to substantial data loss associated with this requirement. However, it is possible to enhance the robustness of individual, day-level estimates by separately considering how sedentary time is accumulated by day of the week. To this end, the present study created the following formula to estimate individual's daily sedentariness: ((average weekday sedentary time \* 5) + (average weekend sedentary time \* 2) / 7). If individuals did not contribute a weekend day of wear, average wear time was calculated as the average daily sedentariness based on number of days the Actical was worn. Among individuals contributing at least one weekend day of wear, there was a small but significant within-person difference with more minutes/day of sedentary time being accumulated on weekdays ( $M = 726$ ,  $SE = 1.7$ ) compared to weekends ( $M = 718$ ,  $SE = 1.9$ ;  $t(11,209) = 5.8$ ,  $P < .001$ ).

### Actical sample

Of the 16,415 enrolled participants, 1262 individuals did not return the Actical and 232 did not have a start date within one day of their clinic visit. In addition, 127 had spurious data including no sedentary time on any adherent day ( $n = 5$ ), average wear time greater than or equal to 23 h/day ( $n = 119$ ), and repeated counts indicative of device malfunction ( $n = 3$ ). A remaining 2163 were excluded because they had less than 3 days of adherent wear time, leaving a final sample of 12,631 participants.

### Socio-demographic characteristics

Socio-demographic characteristics self-reported during the baseline exam included: age, gender, Hispanic/Latino group, household income, education, marital employment, health insurance status, language preference, born in US mainland, and years residing in on the US mainland.

### Weight characteristics

Participants' height was measured to the nearest centimeter and body weight to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. BMI categories were defined as underweight (<18.5 kg/m<sup>2</sup> Thorp et al., 2011), normal weight (18.5–24.9 kg/m<sup>2</sup> Thorp et al., 2011), overweight (25.0–29.9 kg/m<sup>2</sup> Thorp et al., 2011), and obese (>30.0 kg/m<sup>2</sup> Thorp et al., 2011) (National Heart Lung and Blood Institute, 1998).

### Weight characteristics

Participants reported their usual sleep separately on weekdays and on weekends by answering the following questions: "What time do you usually go to bed?" and, "What time do you usually wake up?" Sleep duration for weekdays and weekends were derived from the two questions and average weekly sleep duration was calculated as: ((weekday sleep time \* 5) + (weekend sleep time \* 2) / 7).

Sleep data were used in the present study to estimate participants' waking day (defined as 24 h minus sleep in hours). Participants' Actical wear time was compared to their waking day to determine adherence to wear time protocols. Given the effect of device wear time on

sedentary estimates (Tudor-locke et al., 2011), it is important to determine what percent of individuals' waking day is being monitored.

### Statistical analyses

Analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC) and SPSS version 20 (IBM, Armonk, NY). Means were weighted using the product of an Actical non-response weight (to weight the results for the compliant subset back to the whole HCHS/SOL sample) and an HCHS/SOL sampling weight (to further weight the results back to the Hispanic/Latino population in the target areas).

The sampling weight accounted for bias due to differential nonresponse in the sample at the household and person levels and for cluster sampling and the use of stratification in sample selection (Lavange et al., 2010). The weights were trimmed to limit precision losses due to the variability of the weights, and calibrated to the 2010 U.S. Census characteristics by age, sex and background in each site's target population. Also, due to 22% missing Actical data (Evenson et al., 2015), analyses were further adjusted by using inverse probability weighting (Seaman and White, 2011). The inverse probability weight was created from a logistic regression model predicting compliance with device wear based on socio-demographic and weight characteristics associated with Actical compliance in this sample (Evenson et al., 2015).

The SURVEYREG procedure in SAS was used to obtain least-squared mean estimates of daily sedentary time by gender, age, background, and sociodemographic and weight characteristics. All models adjusted for wear time, field center, and the wear time by center interaction. To accurately estimate sedentary time within subgroups (e.g., gender \* age \* background) other interactions were included as appropriate. Sedentary time was adjusted for wear time because longer device wear is associated with greater sedentary time estimates (Tudor-locke et al., 2011). In the present study, the two variables were highly correlated ( $r = 0.8, P < .001$ ).

### Sensitivity analysis

To explore the impact of wear time on sedentary estimates, the sample was further restricted to participants who wore the Actical < 16 h/day, the average number of monitored hours in each adherent day for the full sample, while adjusting for the average wear time of this subsample ( $M = 13.7$  h/day). Data were also explored to assess whether differences in sociodemographic variables by field center explained the long Actical wear times observed.

### Results

Table 1 presents descriptive statistics on sociodemographic and weight characteristics of participants contributing adherent Actical data. Among the 12,631 participants contributing adherent data, 12,605 reported their ethnic background. The mean number of days the Actical was worn was 5.2 (SD 1.0) out of a possible 6 days, and 89% ( $n = 11,210$ ) had at least one adherent weekend day. The average wear time within adherent days was 16 h (SD 2.9; IQR = 14–18). Across all backgrounds, unweighted wear-time adjusted average daily sedentary time was 11.9 h (SD 3.0) and individuals spent 74% of their wear time in sedentary behaviors (11.7 sedentary hours/day/16 h of monitoring). Hispanic/Latino background was closely related to field center (e.g., most adults of Dominican (95%) and Puerto Rican (72%) background were from the Bronx) (Appendix). As has been found in previous work (Healy et al., 2008), spending more time being sedentary was associated with less light physical activity ( $r = -.3; P < .0001$ ).

### Differences by background, gender, and age

Participants spent between 71% (11.6 h; Mexican background) and 77% (12.3 h; Dominican background) of their Actical wear time being sedentary. Adults from a Mexican background were less sedentary

**Table 1**  
Sociodemographic and weight characteristics of Hispanics/Latinos by background, HCHS/SOL 2008–2011 (N = 12,605).<sup>a</sup>

Characteristic n (%) <sup>b</sup>	Mexican (N = 5192)	Puerto Rican (N = 2089)	Cuban (N = 1680)	Central American (N = 1273)	Dominican (N = 1178)	South American (N = 846)	Other/multi-ethnic <sup>c</sup> (N = 347)
Age, years							
18–34	1141 (44)	359 (35)	197 (26)	293 (43)	259 (42)	140 (32)	138 (63)
35–49	1873 (33)	605 (31)	553 (31)	435 (31)	379 (31)	315 (36)	103 (21)
50–64	1807 (18)	866 (25)	728 (26)	461 (20)	443 (21)	322 (24)	83 (11)
64–74	371 (5)	259 (9)	202 (17)	84 (6)	97 (7)	69 (8)	23 (5)
Men	1937 (47)	862 (51)	799 (52)	517 (48)	422 (39)	335 (48)	153 (46)
Annual household income							
<\$20,000	2030 (37)	973 (6)	820 (46)	617 (47)	600 (46)	363 (41)	119 (31)
\$21–50,000	2294 (43)	646 (31)	511 (30)	443 (34)	403 (36)	358 (42)	140 (45)
>\$50,000	576 (15)	288 (13)	109 (8)	75 (7)	67 (7)	74 (10)	54 (17)
Unreported	292 (5)	182 (10)	240 (16)	138 (12)	108 (10)	51 (8)	34 (7)
Education							
<High School	2346 (36)	814 (37)	392 (22)	536 (38)	502 (36)	209 (22)	85 (24)
High School grad	1320 (30)	566 (28)	475 (30)	290 (27)	242 (25)	211 (29)	65 (15)
>High School	1519 (34)	707 (35)	813 (48)	445 (35)	434 (39)	426 (48)	197 (61)
Employment							
Retired	345 (5)	458 (16)	175 (12)	76 (5)	124 (8)	59 (5)	23 (5)
Unemployed	1875 (38)	821 (45)	777 (45)	461 (37)	443 (44)	257 (33)	142 (40)
Employed ≤ 35 h/week	1023 (20)	191 (11)	204 (12)	267 (22)	167 (17)	204 (23)	56 (22)
Employed > 35 h/week	1932 (37)	571 (28)	517 (31)	465 (36)	399 (31)	313 (39)	119 (34)
Marital status							
Single	979 (28)	775 (48)	358 (26)	368 (39)	404 (47)	175 (29)	137 (51)
Married/living with partner	3276 (59)	794 (34)	912 (51)	666 (46)	499 (37)	474 (51)	140 (34)
Separated/divorced/ widow(er)	930 (12)	518 (18)	406 (23)	238 (14)	275 (16)	197 (20)	69 (15)
Foreign born <sup>d</sup>	4413 (76)	1260 (52)	1618 (93)	1218 (93)	1086 (85)	812 (94)	163 (44)
Weight status							
Underweight or healthy weight	1006 (22)	404 (21)	375 (25)	265 (24)	231 (23)	210 (28)	72 (24)
Overweight	2055 (39)	698 (33)	668 (37)	492 (39)	458 (39)	343 (41)	112 (31)
Obese	38.88 (39)	979 (45)	636 (38)	515(37)	485 (38)	292 (31)	163 (45)

<sup>a</sup> Sample sizes are unweighted.

<sup>b</sup> Percentages may not sum to 100 due to rounding.

<sup>c</sup> Other/multi-ethnic were also of Hispanic/Latino origin.

<sup>d</sup> Foreign born is defined as being born outside of one of the 50 contiguous United States.

**Table 2**  
Mean (95% CI) of sedentary time (hours/day) by Hispanic/Latino background and age, HCHS/SOL 2008–2011 (N = 12,605)<sup>a,b</sup>.

	Total			18–34			35–49			50–64			65–74		
	N	M	CI	N	M	CI	N	M	CI	N	M	CI	N	M	CI
Mexican	5192	11.6	11.5, 11.8	1141	11.4	11.2, 11.5	1873	11.0	10.8, 11.2	1807	11.6	11.4, 11.8	371	12.5	12.3, 12.7
Puerto Rican	2089	12.1	11.9, 12.2	359	11.8	11.5, 12.1	605	11.6	11.4, 11.8	866	12.0	11.7, 12.3	259	12.8	12.6, 13.1
Cuban	1680	12.2	12.1, 12.4	197	11.9	11.7, 12.2	553	11.7	11.6, 11.9	728	12.2	12.0, 12.4	202	13.0	12.8, 13.3
Central American	1273	12.1	11.9, 12.2	293	11.7	11.5, 11.9	435	11.6	11.4, 11.8	461	11.9	11.7, 12.1	84	13.1	12.7, 13.5
Dominican	1178	12.3	12.1, 12.5	259	12.1	11.9, 12.4	379	11.9	11.5, 12.3	443	12.1	11.9, 12.4	97	13.1	12.8, 13.4
South American	846	12.1	11.9, 12.3	140	11.9	11.6, 12.2	315	11.5	11.2, 11.8	322	12.1	11.8, 12.3	69	12.9	12.6, 13.3
Other/multi-ethnic <sup>c</sup>	347	12.0	11.7, 12.3	138	11.8	11.5, 12.2	103	11.6	11.3, 12.0	83	11.7	11.1, 12.2	23	12.8	11.9, 13.6

<sup>a</sup> All values are weighted for study design, calibrated using the 2010 Census population, and adjusted for Actical non-response.

<sup>b</sup> Estimates are least-square means adjusted for mean Actical wear time (15.87 h/day), field center, and field center \* wear time as well as other interactions as necessary to obtain estimates by subgroups.

<sup>c</sup> Other/Multi-ethnic were also of Hispanic/Latino origin.

than all groups with an absolute mean difference ranging from 24 min (compared to Other/multi-ethnic) to 42 min (compared to Dominican) (Table 2).

Women were more sedentary than men (Table 3) by an average of 12–30 min/day across all backgrounds except among adults of Dominican background age 18–34 years, wherein men were more sedentary by approximately 18 min/day. The difference between men and women was most pronounced among Mexican background wherein women were an average of 33 min/day more sedentary than men. Considering all groups, the largest difference in sedentary time between men and women was among those age 35–49 years (+36 min/day among women). Conversely, the smallest differences were among men and women age 65–74 years (+12 min/day among women).

Older adults were not consistently more sedentary than younger adults (Table 2). Across most background groups, men and women age 35–49 years were less sedentary than men and women age 18–34 years (Table 3). However, across all groups, time spent being sedentary was higher from ages 35–49 to 50–64 to 65–74 years.

#### Differences by sociodemographic and weight characteristics

Men and women in the highest annual household income bracket ( $\geq \$50,000$ ) were more sedentary than those in the lowest income bracket ( $\leq \$20,000$ ) by approximately 24 min/day (Table 4). Among men, having more than a high school degree was associated with more sedentary time compared to those with less than a high school

degree by approximately 24 min/day. Retired and unemployed individuals were more sedentary than employed individuals. For example, men employed  $\geq 35$  h/week were 1.2 h/day less sedentary than men who were unemployed. Sedentary time did not meaningfully differ by marital status, country of birth, years lived in the US, language preference, or weight status.

#### Sensitivity analysis

Although the primary analyses adjusted for Actical wear time, and hence accounted for the variance explained by differences in wear time between individuals, the long wear time observed in the present study influenced the sedentary time estimates. Whereas previous research among a nationally representative sample observed average accelerometer wear time of approximately 14 h/day (Matthews et al., 2008), Actical wear time in the present study was 14 to 18 h per day. Longer, versus shorter, wear time indicates favorable compliance with study protocols but excessive wear time suggests deviation from protocol such as wearing the Actical to sleep.

When comparing individuals' Actical wear time to their estimated waking day, the average wear time among individuals of Dominican and Puerto Rican background was longer than their estimated waking day. Therefore, some participants of Dominican and Puerto Rican background, or those recruited from the Bronx, may have worn their Actical while sleeping (Appendix). We contacted the measurement staff at the Bronx site and were unable to identify a systematic breach in study

**Table 3**  
Mean (95% CI) of sedentary time (hours/day) by gender, background and age, HCHS/SOL 2008–2011 (N = 12,605)<sup>a,b</sup>.

	Total			18–34			35–49			50–64			65–74		
	N	M	CI	N	M	CI	N	M	CI	N	M	CI	N	M	CI
<b>Women</b>															
Mexican	3255	11.9	11.8, 12.0	640	11.6	11.5, 11.8	1197	11.4	11.2, 11.5	1176	11.9	11.7, 12.2	242	12.7	12.5, 12.9
Puerto Rican	1227	12.2	12.0, 12.4	171	11.9	11.6, 12.2	347	12.0	11.8, 12.2	545	12.1	11.7, 12.6	164	12.8	12.5, 13.1
Cuban	881	12.3	12.2, 12.5	99	12.2	11.9, 12.4	284	12.0	11.8, 12.2	391	12.3	12.1, 12.5	107	12.9	12.7, 13.2
Central American	756	12.3	12.1, 12.4	140	11.9	11.7, 12.2	265	11.6	11.4, 11.8	304	12.0	11.8, 12.2	47	13.5	13.0, 14.0
Dominican	756	12.4	12.2, 12.6	146	12.0	11.7, 12.3	266	12.2	11.7, 12.6	281	12.3	12.0, 12.6	63	13.1	12.8, 13.5
South American	511	12.2	12.0, 12.4	64	12.0	11.6, 12.4	189	11.7	11.4, 12.0	212	12.1	11.8, 12.4	46	13.2	12.8, 13.5
Other/multi-ethnic <sup>c</sup>	194	12.1	11.7, 12.4	70	12.0	11.5, 12.4	64	11.7	11.4, 12.1	46	11.9	11.1, 12.6	14	12.8	11.8, 13.8
<b>Men</b>															
Mexican	1937	11.4	11.2, 11.5	501	11.1	10.9, 11.3	676	10.7	10.4, 10.9	631	11.3	11.1, 11.5	129	12.3	12.0, 12.6
Puerto Rican	862	12.0	11.8, 12.1	188	11.8	11.3, 12.2	258	11.3	11.0, 11.6	321	11.9	11.5, 12.2	95	12.9	12.4, 13.3
Cuban	799	12.1	11.9, 12.3	98	11.7	11.3, 12.2	269	11.5	11.3, 11.7	337	12.1	11.9, 12.4	95	13.1	12.9, 13.4
Central American	517	11.9	11.7, 12.1	153	11.4	11.1, 11.7	170	11.5	11.2, 11.9	157	11.9	11.6, 12.2	37	12.8	12.1, 13.4
Dominican	422	12.2	12.0, 12.5	113	12.3	11.9, 12.6	113	11.6	11.0, 12.2	162	12.0	11.6, 12.3	34	13.1	12.6, 13.5
South American	335	12.0	11.7, 12.2	76	11.7	11.3, 12.1	126	11.4	10.9, 11.9	110	12.1	11.7, 12.5	23	12.7	12.1, 13.3
Other/multi-ethnic <sup>c</sup>	153	11.9	11.4, 12.3	68	11.7	11.1, 12.3	39	11.6	11.0, 12.1	37	11.5	10.7, 12.3	9	12.7	11.4, 14.0

<sup>a</sup> All values are weighted for study design, calibrated using the 2010 Census population, and adjusted for Actical non-response.

<sup>b</sup> Estimates are least-square means adjusted for mean Actical wear time (15.87 h/day), field center, and field center \* wear time as well as other interactions as necessary to obtain estimates by subgroups.

<sup>c</sup> Other/multi-ethnic were also of Hispanic/Latino origin.

**Table 4**Mean (95% CI) of sedentary time (hours/day) overall, by gender, sociodemographic characteristics and weight status, HCHS/SOL 2008–2011<sup>a,b</sup>.

	Total (N = 12, 416)			Men (N = 4954)			Women (N = 7462)		
	N	M	CI	N	M	CI	N	M	CI
Annual household income									
<\$20,000	5434	12.01	11.91, 12.11	1950	11.9	11.8, 12.1	3484	12.1	12.0, 12.2
\$21–50,000	4735	12.04	11.92, 12.16	2053	11.9	11.7, 12.0	2682	12.2	12.1, 12.3
>\$50,000	1226	12.38	12.21, 12.55	642	12.3	12.1, 12.5	584	12.5	12.2, 12.7
Unreported	1011	12.09	11.94, 12.24	309	11.9	11.6, 12.1	712	12.3	12.1, 12.4
Education									
<High School	4811	12.04	11.89, 12.16	1896	11.8	11.7, 12.0	2915	12.2	12.1, 12.4
High School grad	3122	12.12	12.00, 12.24	1345	12.0	11.8, 12.2	1777	12.3	12.1, 12.4
>High School	4483	12.24	12.13, 12.36	1713	12.2	12.0, 12.3	2770	12.3	12.2, 12.5
Employment status									
Retired	1248	12.59	12.43, 12.76	520	12.6	12.4, 12.8	728	12.6	12.4, 12.8
Unemployed	4758	12.51	12.40, 12.63	1497	12.5	12.3, 12.6	3261	12.6	12.5, 12.8
Employed < 35 h/week	2106	11.82	11.66, 11.97	710	11.6	11.4, 11.8	1396	12.0	11.8, 12.2
Employed > 35 h/week	4304	11.59	11.48, 11.71	2227	11.3	11.2, 11.5	2077	11.9	11.8, 12.0
Marital status									
Single	3139	12.22	12.08, 12.35	1363	12.1	11.9, 12.3	1776	12.3	12.2, 12.5
Married/living with partner	6680	12.03	11.91, 12.14	2945	11.9	11.7, 12.0	3735	12.2	12.1, 12.3
Separated/divorced/widow(er)	2597	12.14	12.01, 12.27	646	12.0	11.7, 12.2	1951	12.3	12.2, 12.5
Country of birth and years in the US									
Born in US Mainland	1998	12.16	11.99, 12.33	872	11.9	11.7, 12.2	1126	12.4	12.2, 12.6
Foreign born and in US < 10 years	7525	12.16	12.04, 12.27	2956	12.1	11.9, 12.3	4569	12.2	12.1, 12.4
Foreign born and in US > 10 years	2893	12.07	11.92, 12.22	1126	12.0	11.7, 12.2	1767	12.2	12.1, 12.4
Language preference									
Spanish	10,120	12.09	11.96, 12.21	3959	11.9	11.8, 12.1	6161	12.2	12.1, 12.4
English	2296	12.17	12.03, 12.32	995	12.0	11.8, 12.3	1301	12.3	12.1, 12.5
Weight status									
Underweight/healthy weight	2526	12.12	11.98, 12.25	1029	12.0	11.8, 12.2	1497	12.2	12.1, 12.4
Overweight	4766	12.06	11.95, 12.18	2134	11.9	11.7, 12.0	2632	12.3	12.1, 12.4
Obese	5124	12.21	12.10, 12.32	1791	12.1	11.9, 12.3	3333	12.3	12.2, 12.4

<sup>a</sup>All values are weighted for study design, calibrated using the 2010 Census population, and adjusted for Actical non-response.<sup>b</sup>Estimates are least-square means adjusted for mean Actical wear time (15.87 h/day), field center, and field center \* wear time as well as other interactions as necessary to obtain estimates by subgroups.

protocol in terms of how participants were instructed to wear the Actical. Further, not all participants from the Bronx had excessive Actical wear time.

When the sample was restricted to participants who wore the Actical < 16 h/day, the average wear time in the present study, sedentary time for all groups was reduced by approximately 15% (Tables 5–6). Individuals of Dominican background remained the most sedentary (10.5 h/day) (Table 5), which was driven by sedentary estimates of men of Dominican background (Tables 6). Women remained more sedentary than men (Table 6). No differences in sleep duration or employment (e.g., shift work) by field center were observed (data not shown).

## Discussion

This study provides accelerometer-measured day-level estimates of time spent in sedentary behavior among an ethnically diverse sample of

Hispanic/Latino adults living in the US. The overall differences between Hispanic/Latino groups were small except for when comparing individuals of a Mexican background to those from other backgrounds. Individuals of Mexican background were less sedentary than other groups by a range of 24 min/day (Other/multi-ethnic) to 42 min/day (Dominican). This may, in part, be explained by the finding that adults of Mexican background engage in more light physical activity than individuals of other Hispanic/Latino backgrounds (Arredondo et al.; Gay and Buchner, 2014), which likely displaces a significant amount of sedentariness given the strong negative correlation between sedentary behavior and light physical activity – as observed in the present study and elsewhere (Healy et al., 2008).

Further, differences in types of employment may account for differences in sedentary time by background. For example, there is some evidence that Mexican adults residing in the United States engage in more occupational physical activity than those from other backgrounds (Gay and Buchner, 2014), which suggests that they may have less

**Table 5**Mean (95% CI) of sedentary time (hours/day) by Hispanic/Latino background and age, HCHS/SOL 2008–2011 restricted to participants with < 16 h of device wear (N = 7000)<sup>a,b</sup>.

	Total			18–34			35–49			50–64			65–74		
	N	M	CI	N	M	CI	N	M	CI	N	M	CI	N	M	CI
Mexican	3407	9.8	9.6, 10.0	745	9.5	9.2, 9.7	1233	9.3	9.1, 9.5	1177	9.9	9.6, 10.1	252	10.5	10.2, 10.8
Puerto Rican	603	10.3	10.1, 10.5	93	10.0	9.6, 10.4	178	9.8	9.5, 10.1	249	10.1	9.6, 10.6	83	11.4	11.0, 11.7
Cuban	1346	10.3	10.2, 10.5	163	10.0	9.7, 10.4	447	9.9	9.7, 10.1	586	10.3	10.1, 10.5	150	11.1	10.9, 11.4
Central American	791	10.2	10.0, 10.4	199	9.7	9.4, 10.0	271	9.8	9.5, 10.0	277	10.0	9.8, 10.3	44	11.3	11.0, 11.7
Dominican	217	10.5	10.1, 10.9	62	10.3	9.8, 10.8	62	9.8	9.1, 10.5	72	10.2	9.5, 11.0	21	11.6	11.1, 12.1
South American	458	10.2	10.0, 10.4	81	10.0	9.7, 10.4	180	9.7	9.3, 10.0	173	10.2	9.9, 10.5	24	10.9	10.5, 11.2
Other/multi-ethnic <sup>c</sup>	178	10.1	9.7, 10.5	64	9.9	9.3, 10.4	51	9.7	9.3, 10.1	47	9.8	9.1, 10.5	16	11.0	10.0, 12.0

<sup>a</sup> All values are weighted for study design, calibrated using the 2010 Census population, and adjusted for Actical non-response.<sup>b</sup> Estimates are least-square means adjusted for mean Actical wear time (13.71 h/day), field center, and field center \* wear time as well as other interactions as necessary to obtain estimates by subgroups.<sup>c</sup> Other/multi-ethnic were also of Hispanic/Latino origin.

**Table 6**  
Mean (95% CI) of sedentary time (hours/day) by gender, background and age, restricted to participants with < 16 h of device wear HCHS/SOL 2008–2011 (N = 7000)<sup>a,b</sup>.

	Total			18–34			35–49			50–64			65–74		
	N	M	CI	N	M	CI	N	M	CI	N	M	CI	N	M	CI
<i>Women</i>															
Mexican	2243	10.1	9.8, 10.3	452	9.8	9.6, 10.0	823	9.6	9.3, 9.8	795	10.2	9.8, 10.5	173	10.7	10.4, 11.0
Puerto Rican	359	10.5	10.3, 10.7	47	10.3	9.8, 10.8	104	10.2	9.9, 10.4	156	10.4	10.1, 10.7	52	11.3	11.0, 11.6
Cuban	755	10.4	10.3, 10.6	83	10.2	10.0, 10.5	247	10.1	9.9, 10.3	342	10.4	10.2, 10.6	83	11.0	10.7, 11.4
Central American	487	10.3	10.1, 10.5	99	10.0	9.7, 10.3	173	9.8	9.5, 10.0	188	10.1	9.8, 10.4	27	11.4	11.0, 11.9
Dominican	144	10.4	9.9, 10.9	38	10.1	9.4, 10.8	43	9.8	8.8, 10.8	48	10.4	9.8, 11.0	15	11.3	10.9, 11.8
South American	295	10.4	10.1, 10.6	41	10.4	10.0, 10.8	120	9.7	9.4, 10.0	115	10.1	9.8, 10.5	19	11.2	10.6, 11.7
Other/multi-ethnic <sup>c</sup>	105	10.2	9.8, 10.7	33	10.0	9.4, 10.6	33	9.8	9.4, 10.3	28	10.1	9.0, 11.1	11	11.0	9.9, 12.1
<i>Men</i>															
Mexican	1164	9.5	9.3, 9.7	293	9.2	8.8, 9.5	410	9.1	8.8, 9.3	382	9.5	9.3, 9.8	79	10.3	9.9, 10.6
Puerto Rican	244	10.1	9.8, 10.4	46	9.7	9.2, 10.2	74	9.4	8.8, 9.9	93	9.8	8.9, 10.7	31	11.4	10.8, 12.1
Cuban	591	10.2	10.0, 10.5	80	9.8	9.3, 10.4	200	9.7	9.4, 10.0	244	10.2	9.9, 10.5	67	11.2	10.9, 11.6
Central American	304	10.1	9.9, 10.3	100	9.4	9.0, 9.8	98	9.8	9.5, 10.1	89	10.0	9.5, 10.4	17	11.2	10.8, 11.7
Dominican	73	10.6	10.0, 11.1	24	10.4	9.9, 11.0	19	9.8	9.0, 10.7	24	10.1	8.9, 11.4	6	11.9	11.0, 12.7
South American	163	10.0	9.7, 10.3	40	9.7	9.2, 10.2	60	9.6	8.9, 10.3	58	10.3	9.8, 10.8	5	10.6	10.2, 11.0
Other/multi-ethnic <sup>c</sup>	73	9.9	9.3, 10.5	31	9.7	8.8, 10.6	18	9.6	8.9, 10.3	19	9.5	8.5, 10.5	5	10.9	9.1, 12.8

<sup>a</sup> All values are weighted for study design, calibrated using the 2010 Census population, and adjusted for Actual non-response.

<sup>b</sup> Estimates are least-square means adjusted for mean Actual wear time (13.71 h/day), field center, and field center \* wear time as well as other interactions as necessary to obtain estimates by subgroups.

<sup>c</sup> Other/multi-ethnic were also of Hispanic/Latino origin.

opportunity to accumulate sedentary time during the workday. Workplace sitting significantly contributes toward the accumulation of daily sedentariness. For example, on workdays, individuals with sedentary jobs walk and stand less, and accumulate more sedentary time than during their leisure time (Thorp et al., 2012).

Observed differences in sedentary time by household income, education, and employment may also be due to differences in occupational versus leisure-time sedentary behaviors. More educated Hispanic/Latino men were more sedentary than less educated men, which may be explained by type of employment (i.e., white collar jobs requiring more sitting). Higher income was also associated with more time spent being sedentary, which could similarly reflect type of employment. In contrast, being retired/unemployed was associated with more sedentary time compared to those who were employed, which may, in part, be due to leisure-time television viewing (Rhodes et al., 2012). This finding is consistent with earlier work demonstrating that unemployed individuals are more sedentary and less physically active than employed individuals, although this relationship appears to vary by gender, type of employment, health status, and day of the week (Van Domelen et al., 2011). For example, women with sedentary jobs were found to be more sedentary and less active than healthy unemployed women on weekdays (Van Domelen et al., 2011).

The present study's finding that retired/unemployed individuals are more sedentary than employed individuals is likely also partially mediated by chronic health conditions and/or age-related decline. For example, higher prevalence of coronary heart disease among men and women of Puerto Rican background and men of Cuban or Dominican background (Daviglius et al., 2012) may result in these groups accumulating more sedentary time than other groups. The finding also may reflect what is known as the "healthy worker effect," (Li and Sung, 1999) which states that employed individuals have lower morbidity and mortality, and are generally more healthy than those not employed.

Across almost all ages and Hispanic/Latino backgrounds, women were more sedentary than men. This is different than what has been found previously among a nationally representative sample of Non-Hispanic Whites and Blacks where middle age and older women were similar to or less sedentary than their male counterparts (Matthews et al., 2008). Cultural beliefs, such as believing that occupation and family duties provide sufficient amounts of physical activity (Cromwell and Berg, 2006) or that family responsibilities come before personal health (D'Alonzo, 2012), may result in Hispanic/Latino women accumulating more leisure-based sedentary time than men.

Similar to Matthews et al. (2008), the present study found that sedentary time was not higher with successive age groups. Instead, time spent in sedentary behaviors was greater among younger (18–34) compared to middle-age (35–49) adults. However, the magnitude of this difference was small and sedentary time was higher among subsequent age groups. The observed 1.3 h/day of additional sedentary time in adults between 35–49 and 65–74 is similar to estimates found in another work (Matthews et al., 2008) and is notable when considering the concomitant declines in physical activity with age (Troiano et al., 2008). Researchers have begun to investigate how to reduce sedentariness among older adults (Gardiner et al., 2012), but work has yet to be undertaken among an ethnically diverse Hispanic/Latino older adult population.

The present study did not find support for a link between overweight/obesity status and sedentary time. Whereas there is moderate support for a link between television watching/screen time and higher BMI (Thorp et al., 2011), the evidence for overall sedentary time and overweight/obesity status is weak (Rhodes et al., 2012). However, other work investigating the association between sedentariness and health in this sample found evidence that increasing time spent being sedentary is associated with cardiometabolic disease risk factors such as poor glycemic and insulin profiles (Qi et al., Kaplan R. Sedentary Behavior and Cardiometabolic Risk Factors Among US Hispanic/Latino Adults: The Hispanic Community Health Study/Study of Latinos (HCHS/SOL). Circulation.). The negative impact of sedentary time on these risk factors remained even after adjusting for physical activity, BMI, and waist-to-hip ratio (Qi et al., Kaplan R. Sedentary Behavior and Cardiometabolic Risk Factors Among US Hispanic/Latino Adults: The Hispanic Community Health Study/Study of Latinos (HCHS/SOL). Circulation.).

There was also no evidence of an association between marital status and sedentary time, which is in line with earlier work (Rhodes et al., 2012). Also, although other studies have found that acculturation indicators such as language use are related to activity levels among Hispanic/Latino adults (Banna et al., 2012; Murillo et al., 2014; Gaskins et al., 2012; Crespo et al., 2001), country of birth, years in the US, and language preference were not associated with sedentary time in the present study. These differences may be due to the fact that previous work was conducted predominantly among adults identifying as Mexican American (Banna et al., 2012; Murillo et al., 2014; Gaskins et al., 2012; Crespo et al., 2001) and/or that other studies assessed leisure-time physical activity (Gaskins et al., 2012; Crespo et al., 2001),

self-reported sedentary behavior (Banna et al., 2012; Murillo et al., 2014), or only explored television viewing among women (Banna et al., 2012).

Hispanic/Latino adults in the present study spent a larger percentage of their accelerometer wear time engaged in sedentary behaviors (74%) compared to earlier studies that described the sedentariness of Whites, Blacks, and Mexican American adults (Matthews et al., 2008). This may be explained, in part, due to the prevalence of adverse health characteristics among this sample, such as cardiovascular disease risk factors (Davignus et al., 2012), which limit mobility and/or are associated with more time spent being sedentary (Loprinzi et al., 2014). Participants in the present study were also older, and the sample size was larger than in previous work (Matthews et al., 2008). However, it is worth noting that the average monitoring period in the present study was approximately 2 h per day longer than usually observed, which must be considered when making such a comparison. Individuals spend more time being sedentary in the evening hours, which is usually when extended accelerometer wear occurs (Tudor-locke et al., 2011). Also, given that adults are sedentary for approximately half of every hour between 12 and 17 h of wear time (Tudor-locke et al., 2011), each additional hour of monitoring may increase sedentary time estimates up to 30 min.

### Strengths and limitations

This study's strengths include its large, diverse sample of Hispanic/Latino adults from four major metropolitan areas in the US. This study is the first to report on objective estimates of daily sedentariness among adults from various Hispanic/Latino backgrounds, and provides evidence indicating that these populations should not be considered homogenous. The study is also bolstered by its transparency in reporting about accelerometer data treatment (Dallal et al., 2012).

Although there is some evidence that sedentariness varies between week and weekend days (Burton et al., 2012; Evenson et al., 2015), most studies using objectively derived estimates of sedentary behavior do not take day of the week into consideration in their analyses. Requiring participants to contribute at least one weekend day of wear often results in too much data loss. The present study addressed the potential difference by day of the week by weighting the observed data. Although we expect that this provides more accurate estimates of individuals' sedentariness, it could be problematic in terms of external validity. However, given that the observed difference between weekday and weekend sedentariness was small, our weighting does not likely affect comparability with other studies.

The study is limited by the unusually long wear times observed among some adults. In particular, individuals of Dominican and Puerto Rican background, who predominately were recruited from the Bronx, had estimates of daily sedentariness that were longer than their average waking day. It is possible that some of these individuals wore their devices to sleep due to misunderstandings of the study protocol and that some of their sleep time was incorrectly classified as wear time involving very low intensity activity as opposed to non-wear. Although one way to address this would have been to exclude data based on self-reported sleep at the individual-day level, we felt this carried a potentially equally problematic bias to use self-reported "usual" sleep/wake times that may not have aligned with the days that the accelerometer was worn by the participant. Instead, to address the issue of excessive wear time, we conducted a sensitivity analysis, which involved restricting the sample to only those who wore the Actical < 16 h/day (i.e., the average daily monitoring period). Although the smaller sample sizes in this restricted analysis are limited, due to the fact that Actical wear time is associated with various sociodemographic characteristics (e.g., higher household income) (Evenson et al., 2015), we recommend that the sedentary estimates derived from the restricted sample be used when making comparisons to other work given that this monitoring period more closely aligns with other studies.

Though long Actical wear among some individuals may be a limitation, the favorable participant compliance with accelerometer wear across all adults in this sample was closer to a full waking day compared to other work, suggesting that the sedentary time estimates presented here may be more representative of daily sedentariness than studies with shorter observation periods (Tudor-locke et al., 2011; Katapally and Muhajarine, 2014; Herrmann et al., 2013).

Finally, this study is limited in that it is cross-sectional and does not describe sedentary behavior patterns across time, nor does it provide insight as to which sedentary behaviors adults were engaged in during their waking day.

### Conclusions

The present study provided objective estimates of daily sedentary time among a diverse population of Hispanic/Latino adults. Adults of Mexican background were found to be the least sedentary, highlighting that individuals from different Hispanic/Latino backgrounds should not be considered a homogenous population.

In line with earlier work, being employed and having higher education was associated with more time spent being sedentary. Hispanic/Latino background may interact with type of occupation and other socioeconomic factors to influence how daily sedentary time is accumulated. Future work should explore how Hispanic/Latino adults from diverse backgrounds similarly/differently accumulate sedentary time throughout the waking day as well as how daily sedentary behavior, physical activity, and sleep varies across groups. This will assist our understanding of how interindividual variance in the movement continuum (Tremblay et al., 2010) affects health outcomes, such as diabetes, that disproportionately affect Hispanic/Latino adults residing in the US (Cowie et al., 2010).

### Funding sources

The Hispanic Community Health Study/Study of Latinos was supported by contracts from the National Heart, Lung, and Blood Institute (NHLBI) to the University of North Carolina (N01-HC65233), University of Miami (N01-HC65234), Albert Einstein College of Medicine (N01-HC65235), Northwestern University (N01-HC65236), and San Diego State University (N01-HC65237). The following Institutes/Centers/Offices contribute to the HCHS/SOL through a transfer of funds to the NHLBI: National Center on Minority Health and Health Disparities, the National Institute of Deafness and Other Communications Disorders, the National Institute of Dental and Craniofacial Research, the National Institute of Diabetes and Digestive and Kidney Diseases, the National Institute of Neurological Disorders and Stroke, and the Office of Dietary Supplements. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

### Conflict of interest statement

The authors declare that there are no conflicts of interest.

### Transparency document

The Transparency document associated with this article can be found, in the online version.

### Acknowledgments

The authors thank the staff and participants of HCHS/SOL for their important contributions. A complete list of staff and investigators has been provided by Sorlie P., et al. in *Ann Epidemiol.* 2010;20:642–649 and is also available on the study website <http://www.csc.unc.edu/hchs/>.

## Appendix A

Table A1

Actual wear time and waking day descriptive statistics (hours/day) by Hispanic/Latino Background, HCHS/SOL 2008–2011 (N = 12,605).

	Mexican (N = 5192)	Puerto Rican (N = 2089)	Cuban (N = 1680)	Central American (N = 1273)	Dominican (N = 1178)	South American (N = 846)	Other/multi-ethnic <sup>a</sup> (N = 347)
Wear time, M (SD)	15.4 (2.6)	17.6 (2.8)	14.5 (2.3)	15.5 (3.0)	18.2 (2.5)	16.0 (2.8)	16.3 (3.0)
Participants with > 20 h of wear, n (%) <sup>b</sup>	430 (6)	494 (16)	66 (2)	149 (7)	309 (20)	89 (7)	59 (9)
Sleep time, M (SD)	8.0 (1.3)	7.7 (1.6)	7.9 (1.4)	7.9 (1.3)	7.8 (1.5)	7.7 (1.3)	7.8 (1.5)
Estimated waking day <sup>c</sup>	16	16.3	16.1	16.1	16.2	16.3	16.2

<sup>a</sup> Other/multi-ethnic were also of Hispanic/Latino origin.<sup>b</sup> All values are weighted for study design, calibrated using the 2010 Census population, and adjusted for Actical non-response.<sup>c</sup> Estimated waking day is 24 h – sleep time in hours.

Table A2

Sample size distribution, n (%) overall and by Hispanic/Latino Background and Field Center, HCHS/SOL 2008–2011 (N = 12,605)<sup>a,b</sup>.

Field center	Total (N = 12,605)	Mexican (N = 5192)	Puerto Rican (N = 2089)	Cuban (N = 1680)	Central American (N = 1273)	Dominican (N = 1178)	South American (N = 846)	Other/multi-ethnic <sup>c</sup> (N = 347)
Bronx	3154 (25)	160 (8)	1394 (72)	36 (2)	166 (19)	1110 (95)	152 (25)	136 (42)
Chicago	3316 (26)	1959 (26)	598 (21)	21 (1)	342 (14)	21 (0.7)	302 (20)	73 (11)
Miami	2905 (23)	32 (1)	67 (5)	1616 (97)	718 (63)	45 (4)	355 (51)	72 (27)
San Diego	3230 (26)	3041 (64)	30 (2)	7 (0.4)	47 (4)	2 (0.4)	37 (4)	66 (21)

<sup>a</sup> All values are weighted for study design, calibrated using the 2010 Census population, and adjusted for Actical non-response.<sup>b</sup> Other/multi-ethnic were also of Hispanic/Latino origin.<sup>c</sup> Percentages may not sum to 100 due to rounding.

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