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Accelerometer Adherence and Performance in a Cohort Study of US Hispanic Adults

Kelly R. Evenson[1], **Daniela Sotres-Alvarez**[2], **Yu Deng**[2], **Simon J. Marshall**[3], **Carmen R. Isasi**[4], **Dale W. Esliger**[5], and **Sonia Davis**[2]

[1]University of North Carolina - Chapel Hill, Gillings School of Global Public Health, Department of Epidemiology, Chapel Hill, NC

[2]University of North Carolina - Chapel Hill, Gillings School of Global Public Health, Department of Biostatistics, Chapel Hill, NC

[3]Department of Family & Preventive Medicine, University of California, San Diego, La Jolla, CA

[4]Albert Einstein College of Medicine, Department of Epidemiology & Population Health, Bronx, NY

[5]School of Sport, Exercise and Health Sciences, Loughborough University, Loughborough, United Kingdom

Abstract

Purpose—This study described participant adherence to wearing the accelerometer and accelerometer performance in a cohort study of adults.

Methods—From 2008-2011, 16,415 United States (US) Hispanic/Latino adults age 18-74 years enrolled in the Hispanic Community Health Study/Study of Latinos. Immediately following the baseline visit, participants wore an Actical accelerometer for one week. This study explored correlates of accelerometer participation and adherence, defined as wearing it for at least 3 of a possible days for >=10 hours/day. Accelerometer performance was assessed by exploring the number of different values of accelerometer counts/minute for each participant.

Results—Overall, 92.3% (n=15,153) had at least one day with accelerometer data and 77.7% (n=12,750) were adherent. Both accelerometer participation and adherence were higher among participants who were married or partnered, reported a higher household income, were first generation immigrants, or reported lower sitting time. Participation was also higher among those with no stair limitations. Adherence was higher among participants who were male, older, employed or retired, not US born, preferred Spanish over English, reported higher work activity or lower recreational activity, and those with a lower body mass index. Among the sample that met the adherence definition, the maximum recorded count/minute was 12,000, and there were a total of 5,846 different counts/minute. On average, participants had 112.5 different counts/minute over 6 days (median 106, interquartile range 91-122). The number of different counts/minute were

Address for Correspondence: Kelly R. Evenson, 137 East Franklin Street, Suite 306, University of NC, Gillings School of Global Public Health, Department of Epidemiology, Chapel Hill, NC 27514, kelly_evenson@unc.edu; fax: 919-966-9800; phone 919-966-1967.

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higher among men, younger ages, normal weight, and those with higher accelerometer assessed physical activity.

Conclusion—Several correlates differed between accelerometer participation and adherence. These characteristics could be targeted in future studies to improve accelerometer wear. The performance of the accelerometer provided insight into creating a more accurate non-wear algorithm.

Keywords

Actical; missingness; non-wear; physical activity; sample weights; surveillance

Introduction

An extensive literature review of studies on physical activity and health supported the 2008 United States (US) physical activity guidelines for adults (37). Recommendations included muscle strengthening activities and >=150 minutes/week of moderate aerobic activity, >=75 minutes/week of vigorous aerobic activity, or an equivalent combination of the two in episodes of at least 10 minutes. Based on these recommendations, national goals for physical activity targeted increasing population levels of moderate to vigorous physical activity (http://www.healthypeople.gov). One way to assess progress towards these goals is to use accelerometers to objectively measure physical activity, as was done in the US National Health and Nutrition Examination Survey (NHANES) starting in 2003-2006. Accelerometers measure movement through a battery powered, wearable, electronic device. More often surveillance and epidemiologic studies are incorporating accelerometry, with advances in technology and reduced costs. Accelerometry offers benefits in terms of eliminating reporting bias; however, it relies on both the participant to wear the monitor (adherence) and the device to accurately record information.

Adherence is defined in this study as wearing the accelerometer as directed by study staff according to the research protocol. As accelerometer adherence increases, the amount of missing data declines. Methods exist to attempt to increase adherence with accelerometer wearing (1, 28, 34). Identifying characteristics associated with adherence provides researchers information to develop strategies to adjust for missing data from non-participation and non-adherence in order to obtain more accurate population estimates, improvement in modeling of relationships, and assisting future studies to target efforts towards improving participation and wear of the accelerometer. Currently, the most commonly used accelerometers in surveillance and epidemiologic studies are the ActiGraph (Pensacola, FL) and Actical (Philips Respironics, Bend, OR). Both devices use a proprietary algorithm to convert accelerations to a count metric providing counts per unit of time. However, the counts between the two devices are not directly comparable, since they have different accelerometer sensors and different ways to derive and filter accelerations (17, 21).

Study protocols typically specify that the accelerometer is worn during waking hours and only removed during water activities and for sleeping. Some studies use participant-recorded logbooks to determine when the accelerometer was put on and taken off to complement the accelerometer readings (25, 32). However, logbooks place additional burden on participants

and may be incomplete. A number of studies have used a period of consecutive zero counts of varying durations to define non-wear using an automated algorithm, with some protocols allowing for a few minutes of movement during the prolonged period of zeros, for both the ActiGraph (3, 4, 10, 22, 23, 25, 27, 31, 39) and the Actical (16). To date, a consensus standard for defining non-wear has not been reached for either accelerometer.

We located only one study that explored non-wear-time algorithms using the Actical accelerometer among adults (16). Applying an accurate wear-time algorithm is important to derive precise measures of frequency and duration of physical activity at various intensity levels. Thus, the first aim of this paper was to describe the participation and adherence of wearing an accelerometer to identify those less likely to comply. The second aim of this paper was to document the performance of the Actical accelerometer. Both aims were accomplished in a large population-based cohort of Hispanic/Latino adults.

Methods

The study aims were examined using the Hispanic Community Health Study / Study of Latinos (HCHS/SOL). The population-based cohort was designed to examine diabetes, pulmonary, and cardiovascular disease risk factors, morbidity, and mortality (18). From March 2008 to June 2011, 16,415 self-identified Hispanic/Latino men and women 18-74 years were recruited and enrolled from randomly selected households in four US communities (Bronx, NY; Chicago, IL; Miami, FL; San Diego, CA). The study was approved by Institutional Review Boards at each site and informed consent was obtained from all participants.

Objective Physical Activity Measurement

During the HCHS/SOL baseline clinic visit, participants were asked to wear an Actical accelerometer (version B-1; model 198-0200-03) for one week. This Actical is an omnidirectional accelerometer, measuring 1.14″ × 1.45″ × 0.43″, weighing 16 grams, and powered by a CR2025 lithium battery. The device had 32MB of non-volatile flash memory, a sampling rate of 32 Hz, sensitive to motion from 0.05-2.0G, and a bandwidth of 0.035-3.5 Hz. A microprocessor converted accelerations to a unit called counts over a given epoch or time period. Prior studies indicate that the Actical has acceptable technical reliability for counts (9, 38). More detailed technical specifications are available elsewhere (17).

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 movements consistent with ambulation. Participants were told to undertake their usual activities for the following week while wearing the accelerometer, and to remove it only for swimming, showering, and sleeping. They were provided written instructions and a phone number to call if any questions arose. Study staff called participants a few days later to answer questions, to ensure the instructions were clear, and to remind them to wear the accelerometer. Participants returned the accelerometer using a padded pre-paid envelope. Upon receipt, staff downloaded the data and initialized the accelerometer for reuse. Participation was defined as returning the Actical and having any recorded wear time.

The Actical was programmed to capture accelerations in counts and steps in one-minute epochs. The four study sites programmed the monitor to start at varying times between 5:00am of the clinic visit day and 5:00am of the following day. To standardize, we included time for all sites beginning at 5:00am the morning following the clinic visit and truncated data at midnight on day 6 of the wear period, providing a consistent maximum 6-day wear period across all study participants. We then performed a systematic review of count patterns to identify and exclude days that indicated spurious recordings. Non-wear was defined as consecutive zero counts for at least 90 minutes (window 1), allowing for short time intervals with nonzero counts lasting up to 2 minutes if no counts were detected during both the 30 minutes (window 2) upstream and downstream from that interval; any nonzero counts except the allowed short intervals were considered as wear time (3). Adherence was defined as >=10 hours/day of wear time for at least 3 of 6 possible days of wear. The >=10 hours/day criteria is often used in other studies (36), and the 3 of 6 days was chosen to represent at least 50% of the maximum days of wear.

The intensity levels were defined as follows (5, 7, 40): vigorous >=3962 counts/minute, moderate 1535-3961 counts/minute, light 100-1534 counts/minute, and sedentary <100 counts/minute. Using the accelerometer data, we operationalized meeting the 2008 US physical activity guidelines using their terminology as (37):

- High: moderate physical activity>=300 minutes/week, vigorous physical activity >=150 minutes/week, or a combination of the two (multiplying vigorous by 2 and summing to obtain >=300 minutes/week) in >=10 minute bouts
- Medium activity: moderate physical activity 150 to <300 minutes/week, vigorous physical activity 75 to <150 minutes/week, or a combination of the two (multiplying vigorous by 2 and summing to obtain 150 to <300 minutes/week) in >=10 minute bouts
- Not meeting physical activity recommendations

Since participants contributed between 3 and 6 days of adherent accelerometer data, the physical activity guidelines were pro-rated for the proportion of a week with available data. This assumed that the remainder of days within the week had the same average level of physical activity as the adherent days.

Other Descriptive Measures

Self-reported physical activity in a typical week was assessed using the modified Global Physical Activity Questionnaire (GPAQ). The GPAQ was originally developed as a result of an international collaboration with the World Health Organization (http://www.who.int/chp/steps/GPAQ/en/index.html), with evidence of test-retest reliability (2) and concurrent validity (2, 15). The HCHS/SOL GPAQ questionnaire (available at the study website: http://www.cscc.unc.edu/hchs/) included 6 questions on work activity, 3 questions on transport, 6 questions on recreation, and 1 sitting question. We derived time spent in recreational, work, transportation, and sitting time in minutes/day. The recreational, work, and transportation variables were used to derive total time spent separately in moderate (small increases in

breathing and heart rate) and vigorous (large increases in breathing and heart rate) physical activity.

Weight was measured to the nearest 0.1 kilograms and height to the nearest centimeter. Body mass index (BMI) was calculated as weight in kilograms divided by height in squared meters and grouped into underweight (<18.5 kg/m^2), normal weight (18.5-<25 kg/m^2), overweight (25-<30 kg/m^2), and obese (>=30 kg/m^2). Annual household income, education, marital status, employment, country of birth, language preference, immigrant generational status, general health, and health limitations were obtained by interview during the clinic visit. Participants self-identified into the following groups: Central American, Cuban, Dominican, Mexican, Puerto Rican, South American, or Other. Health limitations were ascertained by self-reported health limiting them in moderate activities or in climbing several flights of stairs (response options: a lot, a little, not at all). Both questions came from SF-12 (version 2) Health Survey (QualityMetrics, 2002).

Statistical Analysis

The sample design and cohort selection has been previously described (18). Briefly, a stratified two-stage area probability sample of household addresses was selected in each of the four sites. The first sampling stage randomly selected census block groups based on Hispanic/Latino concentration and proportion of high/low socioeconomic status. The second sampling stage randomly selected households from US Postal Service registries that covered the randomly selected census block groups. Households were screened for eligibility, and Hispanic/Latino persons age 18 to 74 were selected in each household that agreed to participate. Oversampling occurred at each stage, with block groups in areas of Hispanic/Latino concentration, households associated with a Hispanic/Latino surname, and those age 45 to 74 years selected at higher rates than their counterparts. The household response rate was 33.5%. Of 39,384 individuals who were screened, selected, and met eligibility criteria, 41.7% were enrolled, representing 16,415 participants from 9872 households.

Because oversampling occurred at both stages of sample selection to increase the likelihood that a selected address yielded an eligible household, participants in HCHS/SOL were selected with unequal probabilities of selection. Hence, participants had a sampling weight which was the product of their base weight (defined as the reciprocal of the probability of selection) and three adjustments (non-response relative to the sampling frame, trimmed to handle extreme values, and calibrated to the 2010 US Census according to age, gender, and Hispanic/Latino background). The HCHS/SOL target population was defined as all non-institutionalized Hispanic/Latino adults age 18-74 years residing in the defined geographical areas (census block groups) across the four participating sites. 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.

Participation and adherence were determined overall, by sociodemographic characteristics (site, Hispanic/Latino background, site by background, age, gender, household income, education, marital status, employment, US born, immigrant generation, language preference), by health-related characteristics (BMI, general health, health limitations), and

for self-reported physical activity. Differences across groups were assessed using the Cochran-Mantel-Haenszel chi-square general test of association with the Wald chi-square statistic for nominal variables, the test for trend for ordinal variables, and the t-test for continuous variables. P-values are presented for descriptive purposes.

Descriptive statistics were calculated to evaluate the performance of the accelerometers in a variety of ways, focusing on the number of different counts/minute to understand how the accelerometer performed. Heat plots were generated to display all counts/minute among adherent participants. Descriptive statistics for the number of different values by gender, age, BMI, meeting 2008 physical activity guidelines, consecutive wear day, weekday/weekend, and number of adherent days. Since physical activity is dynamic, sustained measurements of the same values of counts/minute with the Actical may be a sign of either non-wear (for 0 counts/minute), device rounding due to precision limits, or device malfunction. Therefore, non-zero sustained counts/minute were also explored, identified when the same count value was repeated more than 10 minutes.

Results

Participation

Overall, 92.3% participants returned the accelerometer with at least some wear time. Characteristics of participants (n=15,153) were compared to non-participants (n=1262), regardless of the amount of time the accelerometer was worn (Table 1 and Table 2). Accelerometer participation was higher ($p<=0.05$) among those who were married or partnered, reported a higher household income, were first generation immigrants, were not health-limited with stairs, and reported lower sitting time. The weighted percent of participation differed by site (ranging from 86.9% in the Bronx to 96.1% in San Diego), background (ranging from 82.5% for Mixed, Other, or Missing groups to 94.8% for Mexicans), and site-background (ranging from 85.3% by South Americans in the Bronx to 96.2% by Mexicans in San Diego; data not shown; Mixed, Other, or Missing group not included). There were no notable differences in accelerometer participation by gender, age, education, employment status, US born, language preference, general health, BMI, moderate activity health limitations, physical health score, or by self-reported physical activity (moderate, vigorous, recreational, work, and transportation in minutes/day).

Adherence

Prior to assessing wear-time adherence, we excluded 232 participants whose clinic date and Actical start date differed by more than 2 days, in order to eliminate cases where the accelerometer may have been initiated on the wrong day. A systematic review of counts/minute for potential spurious recordings identified several patterns. Five participants with no recorded sedentary time on all six monitoring days were excluded. We identified 124 participants with at least one instance of any non-zero counts/minute sustained for 10 or more consecutive minutes. All occurrences happened below 200 counts/minute and most below 100 counts/minute. Upon detailed review, we excluded 3 participants for whom most of their data had the same repeated non-zero values (specifically 12 counts/minute for one participant and 13 counts/minute for two participants). After exclusions, this left a sample

size of 14,913 to assess adherence. Overall, 85.5% of this sample (12,750/14,913) met the adherence definition of >=3 days of wear for at least 10 hours/day, with 46.5% providing 6 days of adherent data, 19.5% providing 5 days, 11.5% providing 4 days, and 8.1% providing 3 days (Table 3).

Adherent participants (n=12,750) were more likely (p<=0.05) to be male, older, married or partnered, employed or retired, reported higher household income, first generation immigrants, preferred Spanish over English, have lower BMI when explored continuously, or reported higher work activity, lower recreational activity, or lower sitting time compared to those who wore the accelerometer but did not provide adherent data (Table 1 and 2). Adherence was lower (p<=0.05) among participants who were not employed and those who were US born. There were also differences by site (ranging from 76.4% Miami to 86.4% Bronx), background (ranging from 76.0% for Mixed, Other, or Missing group to 86.3% for Dominicans), and site-background (ranging from 75.3% by Central Americans in Miami to 94.0% by South Americans in the Bronx; data not shown; Mixed, Other, or Missing group not included). Adherence did not differ by education, general health, health limitations (stairs or moderate physical activities), physical health score, moderate physical activity, vigorous physical activity, or transportation physical activity.

Performance

Among the 12,750 adherent participants, the maximum count/minute was 12,000. Within the range of 0 to 12,000 values, there were 5,846 different values of counts/minute (48.7%) recorded at least once and, therefore, 6,154 values that never occurred among the adherent participants on adherent days (Figure 1). In particular, there were four values less than 200 that never occurred across all adherent days of wear (1, 2, 3, and 6 counts/minute) and some values that were much more likely to occur than others. For example, 0 counts/minute occurred 33,132,407 times (50.7% of wear) and 13 counts/minute occurred more than 100,000 times. However, 7 counts/minute occurred less than 20,000 times. For all recorded counts/minute less than 200, the mean number of different counts/minute across the monitoring period (3-6 adherent days) was 17.4 (standard deviation 9.3, median 16, interquartile range 16-17, range 13-132).

Among the 12,750 adherent participants, the mean number of different counts/minute across the full range of data during the monitoring period was 112.5 (standard deviation 64.3, median 106, interquartile range 90-122, range 14-1606) (Table 4). The different number of counts/minute was higher (p<=0.05) among men, younger ages, normal weight, participants from the San Diego site, those categorized at higher levels of physical activity, and those who were adherent all 6 days.

Discussion

Adherence

This study described participation and adherence of accelerometer wear to identify adults less likely to complete the accelerometer protocol as intended. Overall, 92.3% of the HCHS/SOL cohort returned the accelerometer with at least some wear time and 77.7% of

the HCHS/SOL cohort met the adherence definition of wearing it at least 3 of 6 days for >=10 hours/day. Participation was higher for the HCHS/SOL participants compared to the 2003-2004 NHANES sample age 6 and older (74.4% or 7176/9643) (33). In the HCHS/SOL, both accelerometer participation and adherence were higher among those who were married or partnered, reported a higher household income, first generation immigrants, or reported lower sitting times. Notably, other factors were associated with either participation or adherence, but not both. Accelerometer participation, but not adherence, was higher among those with no stair limitations. Adherence, but not participation, was higher among those who were male, older, employed or retired, not US born, preferred Spanish over English, reported higher work activity or lower recreational activity, and those with a lower BMI.

A few other studies of adults have explored factors associated with adherence of accelerometer wear, although definitions of adherence varied (7, 11, 19, 20, 33). In a nationally representative sample of Canadians, meeting the adherence definition for wearing the Actical was higher among 60-79 year olds compared to 20-39 year olds (7). NHANES data supported this pattern, finding that the ActiGraph accelerometer adherence was higher among those 60 years and older compared to other age groups (33). The investigators also found 7 of 7 days of adherence was higher among men compared to women within the same age categories (20-39, 40-59, and >=60 years). Other adult studies have found higher participation or adherence to the accelerometer protocol among older adults (19, 26), non-smokers (19, 20, 26), and those who were married (20), had higher education (11, 19, 20), higher income (11), worked or retired (19, 26), had higher self-reported health (19, 20), higher cognitive function (11), higher physical function (11), or reported more vigorous physical activity (20). The variety of correlates associated with either accelerometer participation or adherence can be used to develop strategies to adjust for missing data and help future studies target efforts towards improving participation.

Performance

Calibration studies among adults indicate cutpoint thresholds for intensity level when the Actical is positioned at the hip for sedentary (8, 24), light (5, 13), moderate (5, 12-14, 35, 38), and vigorous activity (5, 12). What has not been documented for the Actical is its performance in a large sample. For example, are the counts continuous across all intensity levels? How much variability do the counts provide? Our data were able to address these questions.

In this study, we found that the Actical counts/minute ranged from 0 to 12,000. This upper range is much lower than the plausible values of upwards of 20,000 counts/minute described by Colley et al. (6). Across this range of counts, over half (50.7%) of the values (in counts/minute) were never recorded. This might be expected at higher values, where fewer participants engage in vigorous physical activity, but we also found instances of this at lower ranges. For example, the values of 1, 2, 3, and 6 counts/minute never occurred among those with adherent data. According to the manufacturer, due to the nature of the Actical processing, counts below 100 are not as precise and often recorded using only a few values that appear repetitively rather than being truly continuous. This phenomenon can lead to

sustained repetitions of the same count that are not spurious. We also found the mean number of different counts/minute for each participant was 112.5, which is seemingly low given that this was assessed over 3 to 6 adherent days of monitoring. As expected, the number of different values was higher among those that were more physically active. Even so, the findings illustrate that due to the filtering the Actical data are not truly continuous.

Understanding the performance of the Actical accelerometer can help researchers decide on non-wear time algorithms or identify the rare cases of spurious recordings. The process to identify missing and non-adherent accelerometer data is not standardized. Some studies use logbooks to help make the determination (for example, (39)). Research to determine when the accelerometer is worn by participants, in the absence of keeping a logbook to determine on and off times, has been conducted primarily using the ActiGraph accelerometer. One study of adults recommended using a longer period of zero counts (i.e., 60 minutes) instead of shorter period of zero counts (i.e., 20 minutes) to define accelerometer non-wear (10). However, this study lacked a referent standard. Another study improved on this by comparing 3 wear-time algorithms to self-reported wear-time (39). They found that allowing for very limited interruptions during the extended period of zeros optimized accuracy. The algorithm used did not meaningfully change the prevalence of moderate to vigorous physical activity, but it did impact the prevalence of sedentary behavior. True non-wear periods shorter than 60 minutes, which commonly occur when the accelerometer was removed in the evening (particularly after 23:00), were being misclassified as wear time. The authors proposed that this bias would also impact studies of correlates or those exploring within-person changes in physical activity. Choi et al. (3) developed an improved algorithm to discriminate between wearing states based on actual wearing time while participants were observed in a whole-room indirect calorimeter.

Based on the Actical performance, we found that consecutive counts can occur over long periods of time. Thus, we may be excluding zero counts/minute that were sedentary rather than non-wear. Increasing the number of consecutive minutes of zero counts that define non-wear will keep more data and thus increase adherence. It will also increase the time spent in sedentary behavior. The key is determining what criteria to use for maximum accuracy. One study of adults 56 years and older contrasted wear from logbooks to 60, 90, 120, 150, and 180 consecutive minutes of zeros from the Actical to define non-wear (16). They found highest sensitivity and specificity using 90 and 120 consecutive counts/minute of zeros to define non-wear when compared to logbooks. Moreover, the Actical filter could be altered by the company to allow for better sensitivity at the lower end of the range of counts. A small study reported that the ActiGraph GT3X was more sensitive than the Actical to movements in non-vertical planes and at thresholds of <8000 counts/minute, but that the Actical was more sensitive above this cutpoint (30).

Limitations

Several limitations of our work should be noted. First, there may be unmeasured characteristics associated with participation, adherence, or performance of the accelerometer that we did not assess. Second, the manufacturer states that the different versions of the Actical use similar data acquisition methodology and show equivalency across counts;

however, the newer versions add features and upgrades. However, we are not aware of any published studies that explore equivalency across Actical versions. Thus, it is not known how the different versions might impact on Actical performance. Third, our data collection protocol specified a 1-minute epoch; it is not known how a shorter epoch may impact the Actical performance. Fourth, the cleaning program we used to determine non-wear for this study was developed on the ActiGraph and it is not known whether it performs as well for the Actical (3). A next useful study would be to explore accurate (gold standard) assessment of wear and non-wear of the Actical accelerometer against other cleaning algorithms.

Conclusions

Among this large cohort study of Hispanic/Latino adults, we found differences in some correlates of accelerometer participation and adherence. Studies should assess characteristics potentially associated with accelerometer participation and adherence in order to address a high percentage of missing accelerometer outcomes. For example, these characteristics could be used to create inverse probability weights which allow correction for the bias of the estimates obtained by a complete-case analysis. As accelerometers become lighter and less intrusive, participation and adherence should improve. The performance of the Actical accelerometer provides insight into creating a more accurate non-wear algorithm. Further work is needed to develop and determine the most accurate algorithms against a criterion measure to define wear-time for the Actical. It is likely that the algorithm of choice may differ by type of accelerometer, since the performance of counts varies across accelerometers (17, 21).

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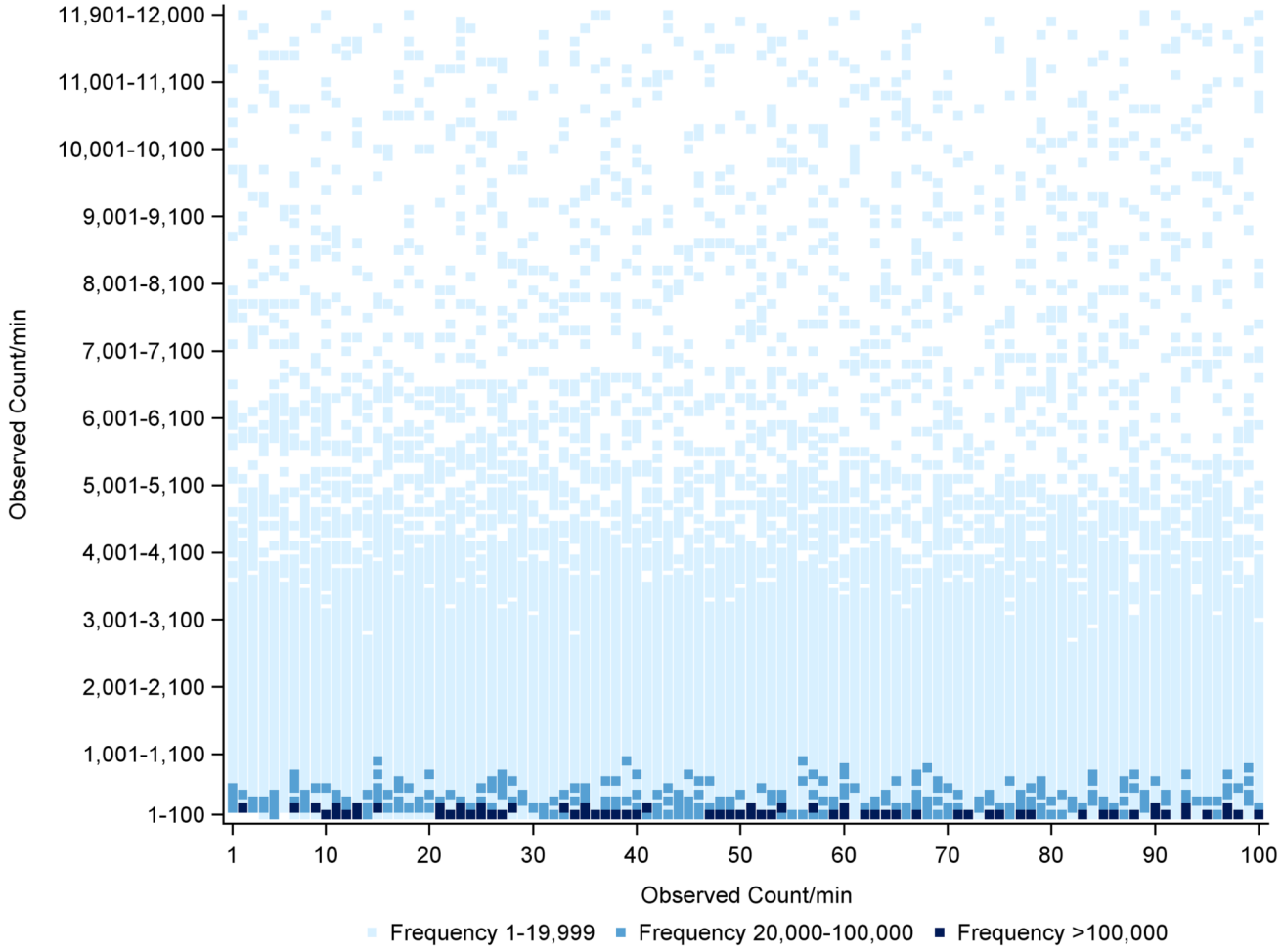

Figure 1.

Heat map for all possible counts/minute ranging from 1 to 12,000 among participants with at least 3 compliant days of accelerometer data (n=12,750); HCHS/SOL 2008-2011. The three blue colors classify the frequency (minutes*day*participants) of counts/minute into categories. The white indicates the count/minute was never recorded for any participant. The x-axis unit is in hundreds whereas the y-axis unit is in thousands. Zero counts/minute is not shown on the figure.

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Table 1

Comparison of participation in the accelerometer portion of the study and adherence to the protocol, HCHS/SOL 2008-2011

Characteristics		Weighted Percent			Weighted Percent	
	Total n	Any Participation** (n=15,153)	p value*	Total n	Adherent*** (n=12,750)	p value*
Overall	16,415	91.6		15,153	81.1	
Site:			<0.0001			<0.0001
Bronx	4,118	86.9		3,637	86.4	
Chicago	4,134	92.6		3,847	84.8	
Miami	4,077	91.7		3,738	76.4	
San Diego	4,086	96.1		3,931	78.8	
Background:			<0.0001			<0.0001
Dominican	1,473	89.9		1,340	86.3	
Central American	1,732	91.1		1,576	79.6	
Cuban	2,348	91.9		2,159	76.5	
Mexican	6,472	94.8		6,145	81.7	
Puerto Rican	2,728	88.3		2,461	83.7	
South American	1,072	89.6		986	83.7	
Mixed/Other/Missing	590	82.5		486	76.0	
Gender:			0.52			0.01
Men	6,580	91.4		6,042	82.4	
Women	9,835	91.8		9,111	80.0	
Age (years):			0.22			<0.0001
18-29	2,676	90.7		2,423	72.3	
30-44	4,025	92.2		3,727	81.1	
45-64	8,382	91.4		7,755	86.8	
65-74	1,323	93.0		1,241	88.2	
Body mass index:			0.12			0.52
Underweight	130	90.1		117	73.9	
Normal weight	3,191	92.3		2,962	80.7	
Overweight	6,116	92.7		5,679	83.0	
Obese	6,907	90.7		6,364	79.9	

Characteristics	Total n	Weighted Percent Any Participation** (n=15,153)	p value*	Total n	Weighted Percent Adherent*** (n=12,750)	p value*
Household Income:			0.01			0.05
<30,000	10,516	91.6		9,728	81.2	
>=30,000	4,877	92.4		4,534	81.9	
Don't know, refused, or missing	1,022	87.4		891	76.4	
Education:			0.18			0.29
No high school diploma or GED	6,207	92.5		5,761	82.7	
At most a high school diploma or GED	4,180	91.7		3,886	79.1	
Greater than high school or GED	5,937	91.4		5,467	81.4	
Married or Partnered:			<0.0001			<0.0001
No	7,891	90.1		7,210	79.1	
Yes	8,436	93.6		7,903	83.3	
Employment:			0.86			<0.0001
Retired or not employed	1,545	92.1		1,445	87.1	
Not retired and not employed	6,408	92.5		5,977	77.0	
Employed part time (<=35 hours/week)	2,728	91.8		2,533	82.2	
Employed full time (>35 hours/week)	5,428	91.7		5,003	84.7	
US Born:			0.30			<0.0001
No	13,479	92.1		12,500	82.6	
Yes	2,863	91.1		2,630	76.1	
Immigrant Generational Status:			<0.0001			<0.0001
First	13,221	92.0		12,257	82.7	
Second or higher	3,100	91.3		2,853	76.2	
Language Preference:			0.06			0.0007
Spanish	13,119	92.2		12,159	82.2	
English	3,296	89.7		2,994	77.9	
General Health:			0.06			0.69
Excellent	1,328	93.5		1,240	82.0	
Very Good	2,584	91.3		2,388	79.8	
Good	7,516	92.5		7,004	81.7	
Fair	4,004	90.9		3,688	81.7	

Characteristics	Total n	Weighted Percent Any Participation** (n=15,153)	p value*	Total n	Weighted Percent Adherent*** (n=12,750)	p value*
Poor	863	89.5		779	77.1	
Health Limitation - Moderate Activities:			0.40			0.73
Limited a lot	1,388	90.4		1,280	79.2	
Limited a little	2,482	92.2		2,290	82.7	
Not limited at all	12,444	92.0		11,548	81.1	
Health Limitation - Stairs:			0.04			0.52
Limited a lot	2,007	89.6		1,833	79.9	
Limited a little	3,464	91.8		3,219	83.6	
Not limited at all	10,840	92.2		10,063	80.7	

* P-value comparing the two groups from the Cochran-Mantel-Haenszel (CMH) test of general association using Wald chi-square statistics for nominal variables (e.g. site, background, etc.) and CMH trend test using Wald chi-square statistics for ordinal variables (e.g., age, body mass index, education, general health, and health limitation groups).

** Any participation was defined as returning the accelerometer with at least some wear. This sample (n=15,153) was compared against 1,262 who did not participate.

*** Adherence was defined as wearing the accelerometer for at least 10 hours/day on at least 3 of 6 possible days. This sample (n=12,750) was compared against 2,403 who wore the accelerometer but were not adherent.

Table 2

Comparison of participation in the accelerometer portion of the study and adherence to the protocol, HCHS/SOL 2008-2011

Characteristics	Total n	Overall Weighted Mean (SE)	Any Participation** Weighted Mean (SE) n=15,153	Did Not Participate Weighted Mean (SE) n=1262	p value*
Physical Activity from Questionnaire (minutes/day):					
Total moderate	16,275	94.0 (1.8)	93.3 (2.0)	101.0 (7.7)	0.35
Total vigorous	16,272	42.1 (1.3)	41.3 (1.3)	51.2 (6.8)	0.16
Total recreational	16,269	24.5 (0.8)	24.3 (0.8)	27.0 (3.3)	0.42
Total work	16,020	80.2 (2.2)	79.6 (2.3)	87.5 (8.0)	0.36
Transportation	16,239	32.6 (1.2)	32.0 (1.2)	38.7 (4.7)	0.18
Sitting time	16,199	261.6 (2.8)	260.3 (3.0)	276.6 (8.1)	0.05
Body mass index (kg/m2)	16,344	29.4 (0.1)	29.3 (0.1)	30.0 (0.4)	0.09
Age (years)	16,415	41.1 (0.2)	41.1 (0.3)	40.5 (0.7)	0.37
Aggregate physical health score	16,117	50.0 (0.1)	50.0 (0.1)	49.3 (0.4)	0.12

Characteristics	Total n	Overall Weighted Mean (SE)	Adherent*** Weighted Mean (SE) n=12,750	Not Adherent Weighted Mean (SE) n=2403	p value*
Physical Activity from Questionnaire (minutes/day)					
Total moderate	15,085	93.3 (2.0)	94.3 (2.1)	89.1 (4.7)	0.30
Total vigorous	15,083	41.3 (1.3)	41.3 (1.4)	41.3 (2.6)	1.00
Total recreational	15,079	24.3 (0.8)	23.0 (0.8)	29.6 (1.9)	0.0006
Total work	14,846	79.6 (2.3)	81.9 (2.5)	69.7 (4.4)	0.01
Transportation	15,054	32.0 (1.2)	32.0 (1.3)	32.4 (2.5)	0.86
Sitting time	15,022	260.3 (3.0)	256.4 (3.0)	277.1 (6.6)	0.002
Body mass index (kg/m2)	15,122	29.3 (0.1)	29.2 (0.1)	29.7 (0.2)	0.04
Age (years)	15,153	41.1 (0.3)	42.2 (0.3)	36.4 (0.5)	<0.0001
Aggregate physical health score	14,990	50.0 (0.1)	50.0 (0.2)	50.1 (0.3)	0.73

SE=standard error

*The p value compared the two groups using a 2-sample t-test.

**Any participation was defined as returning the accelerometer with at least some wear. This sample (n=15,153) was compared against 1,262 who did not participate.

*** Adherence was defined as wearing the accelerometer for at least 10 hours/day on at least 3 of 6 possible days. This sample (n=12,750) was compared against 2,403 who wore the accelerometer but were not adherent.

Table 3

Percentage of participants by number of adherent days wearing the accelerometer, by age group and gender; HCHS/SOL 2008-2011

			Number of Adherent Days							
Age group, years	**Gender**	**N**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>=3**
18-74	Overall	14,913	4.4	4.3	5.8	8.1	11.5	19.5	46.5	85.5
	Men	5,947	4.6	4.3	5.5	7.4	11.3	19.0	48.0	85.6
	Women	8,966	4.2	4.4	6.0	8.6	11.6	19.8	45.4	85.4
18-29	Men	1,109	7.8	7.9	7.3	11.5	12.7	17.2	35.4	76.9
	Women	1,272	9.3	8.5	9.4	12.4	15.3	16.5	28.6	72.8
30-44	Men	1,484	4.9	4.8	6.6	8.6	12.8	20.0	42.3	83.8
	Women	2,181	4.5	5.4	7.6	9.6	12.9	21.2	38.7	82.5
45-64	Men	2,887	3.4	3.1	4.6	5.5	10.3	19.7	53.4	88.8
	Women	4,750	3.0	3.1	4.5	7.5	10.4	20.1	51.4	89.4
65-74	Men	465	3.2	1.3	3.4	4.5	9.0	15.5	63.0	92.0
	Women	758	2.2	2.4	5.0	5.7	9.5	19.8	55.4	90.4

* Adherent day was defined as wearing the accelerometer for at least 10 hours/day. Adherence was defined as wearing the accelerometer at least 3 of 6 possible days. Values in this table are not weighted.

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Table 4

Different number of counts across adherent days by demographic and health characteristics; HCHS/SOL 2008-2011

	Sample size (n)	Mean (SD)	25th percentile	50th percentile	75th percentile	Minimum	Maximum	p value*
Overall	12,750	112.5 (64.3)	90	106	122	14	1,606	
Site:								<0.0001
San Diego	3,211	119.0 (58.1)	99	115	130	20	1,606	
Miami	3,367	111.4 (53.8)	93	108	122	14	1,052	
Chicago	2,919	111.5 (90.9)	82	96	112	23	1,482	
Bronx	3,253	108.2 (48.7)	89	104	119	21	946	
Gender:								<0.0001
Men	5,091	120.2 (70.2)	97	113	129	14	1,482	
Women	7,659	107.5 (59.5)	86	101	117	21	1,606	
Age group:								<0.0001
18-29	1,779	121.2 (51.5)	101	117	131	14	844	
30-44	3,042	117.2 (69.5)	95	110	125	21	1,606	
45-64	6,811	111.0 (65.9)	88	103	119	23	1,179	
65-74	1,113	95.4 (52.8)	74	90	107	23	1,052	
Body mass index:								<0.0001
Underweight	93	120.6 (60.0)	96	113	132	33	508	
Normal weight	2,498	118.1 (59.7)	94	112	128	23	902	
Overweight	4,878	115.1 (68.2)	92	108	124	30	1,482	
Obese	5,258	107.3 (62.2)	85	101	117	14	1,606	
Meeting 2008 physical activity guidelines from the accelerometer:								<0.0001
High	551	159.0 (91.6)	130	145	170	81	1,606	
Medium	1,037	137.6 (68.1)	119	129	141	71	1,187	
Not meeting recommendations	11,162	107.9 (60.7)	87	102	117	14	1,482	
Meeting 2008 physical activity guidelines from the accelerometer:								<0.0001
Yes (high + medium)	1,588	145.0 (77.7)	122	134	150	71	1,606	
By consecutive day:								n/a
1	11,360	72.5 (29.2)	55	69	84	4	547	
2	11,554	73.5 (29.4)	56	70	86	2	489	

	Sample size (n)	Mean (SD)	25th percentile	50th percentile	75th percentile	Minimum	Maximum	p value*
3	11,383	73.5 (29.3)	56	70	86	6	450	
4	11,031	73.2 (29.7)	55	70	86	3	498	
5	10,824	72.9 (29.5)	55	70	86	3	528	
6	10,402	72.6 (28.2)	55	70	85	6	485	
Number of adherent days:								0.0006
3	1,205	99.8 (49.4)	78	93	110	21	537	
4	1,713	106.9 (58.5)	85	100	116	23	788	
5	2,905	112.2 (72.8)	88	104	120	14	1,606	
6	6,927	116.3 (63.7)	95	110	126	20	1,482	
Weekends	11,328	68.5 (26.8)	53	65	80	6	471	n/a
Weekdays	12,750	74.3 (27.1)	59	71	85	11	492	n/a

n/a=not applicable; SD=standard deviation

*p value for comparison of the means; values in this table are not weighted