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The descriptive epidemiology of sitting among US adults, NHANES 2009/2010

Deirdre M. Harrington, **Tiago V. Barreira**, **Amanda E. Staiano**, and **Peter T. Katzmarzyk***
Preventive Medicine and Healthy Aging, Pennington Biomedical Research Center, USA

Abstract

Objectives—Using NHANES 2009/2010, to describe the amount of time a representative sample of the U.S. population spends sitting by age, sex, ethnicity, education, and body mass index.

Design—Cross-sectional analysis.

Methods—Participants (n = 5911, ≥20 years) self-reported demographic variables and the amount of time they spend sitting on a typical day. Body mass index was calculated from measured height and weight.

Results—Mean self-reported sitting time was 285 min/day for males and 281 min/day for females. Mexican-Americans reported sitting less than both non-Hispanic Whites and non-Hispanic Blacks (all $p < 0.0001$). Non-Hispanic White males reported sitting more than non-Hispanic Black males, while Non-Hispanic White females reported sitting more than Other Hispanic females (both $p < 0.0001$). No significant differences were found between sexes in any age group. There was a trend for increased sitting time with increasing age for females (p for trend = 0.0045), for all Mexican-American and Hispanic participants and non-Hispanic Black males (all $p \leq 0.006$) and with increasing education (p for trend <0.0001). At the College Graduate level, females reported sitting less than males ($p < 0.0001$). Obese females reported sitting more than normal weight and overweight females ($p = 0.0008$). There were no significant differences in sitting time by body mass index for males.

Conclusions—Self-reported sitting time differed by ethnicity, age group, education and body mass index but there was no overall difference by sex. These results represent the most up to date prevalence of self-reported sitting for the US adult population. Certain groups should be targeted to reduce sitting time, for example those with higher educational attainment and obese females.

Keywords

Sedentary; Self-report; Ethnicity; Body mass index

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*Corresponding author. peter.katzmarzyk@pbrc.edu (P.T. Katzmarzyk)..

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1. Introduction

Sedentary behaviors have been associated with cardiometabolic risk factors,[1–3] insulin resistance[2,4] and higher rates of mortality in adults.[5–7] Despite the emergence of the risks of sedentary behaviors, recent population prevalence of sitting time among U.S. adults have not been reported. Results from device-based (accelerometry) methods in the 2003/2004 National Health and Nutrition Examination Survey (NHANES) highlighted that the U.S. population spends the majority of their waking hours engaged in sedentary behaviors (on average 7.7 h/day).[8] Mexican-American adults have been highlighted as the least sedentary using objective and self-report data.[8,9] Internationally, the variation in sitting time across different population segments has also been highlighted. Using self-reported data collected in 20 countries, Bauman et al. reported that increasing age and greater educational attainment significantly predicted being in the highest quintile of sitting time.[10] In Australia, Proper et al. reported that sex, age and education were all associated with self-reported sitting.[11]

The aim of this paper is to describe the amount of time a representative sample of the U.S. adult population spends sitting/day using data from NHANES 2009/2010, including comparisons by age, sex, ethnicity, educational attainment, and BMI.

2. Methods

The analysis sample consisted of NHANES 2009/2010, a study of the health and nutritional status of a representative sample of the U.S. civilian non-institutionalized population (n = 10,537).[12] The National Center for Health Statistics (NCHS) research ethics review board approved the study procedures and written informed consent was obtained from all participants. For the current analysis, those <20 years (n = 4319) and those with missing values for the sitting question (n = 18) were excluded. Since a wide range of values, including implausible values, for sitting time were reported (0–1200 min/day), observations below the 5th (<60 min/day) and above the 95th percentile (>720 min/day) for sitting were excluded (n = 289). Females with a positive pregnancy test (n = 66) were not excluded from the main analysis as their mean sitting time (323 min/day) was not significantly higher than that of same aged females (312 min/day; p = 0.640). The remaining sample was 5911 adults (95.1% of eligible adults).

Participants were asked during the in-home interview: “How much time do you usually spend sitting on a typical day?” The participant reported the typical number of min/day. Although this question is similar to the sitting question in the International Physical Activity Questionnaire (IPAQ) short-form (“During the last 7 days, how much time did you usually spend sitting on a week-day/weekend day?”), which has shown acceptable validity and reliability,[13,14] to the best of our knowledge the exact question used in NHANES 2009/2010 has not been validated.

Age was self-reported at the household screening while educational attainment was self-reported in the sample person questionnaire. Age was recoded into 6 age-groups (20–29, 30–39, 40–49, 50–59, 60–69 and ≥70 years) for the purpose of this analysis. Race/ethnicity was

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queried at both the household screening and in the sample person questionnaire. If the participant answered yes to the questions “Do you consider yourself to be Hispanic or Latino?” he/she was then asked to specify the country of ancestral origin. If the participant replied no, he/she reported their race. This self-reported race and ethnicity information was recoded by the NCHS into the following classifications (that will be called ethnicity herein): Mexican-American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black and Other Race (including multi-racial). The Hispanic category represents all non-Mexican-American Hispanics.

To ascertain educational attainment, participants were asked to report their highest level of school based on the US education system. These answers were then recoded into the following five categories: Less than 9th Grade, 9th–11th Grade (includes 12th grade with no diploma), High School Grad/GED or Equivalent, Some College or Associate Degree and College Graduate or above. The following questions (yes/no answer) on intensity of daily work were asked: “Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like carrying or lifting heavy loads, digging or construction work for at least 10 min continuously?” and “Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking or carrying light loads for at least 10 min continuously?”

During the body measures component, height and weight were measured by trained technicians in the mobile examination center (MEC) using standard procedures.[15] Height was measured using a stadiometer and weight was measured using a Seca digital scale with the participant wearing an examination gown. BMI was calculated from weight and height (kg/m^2). Based on BMI, the sample was divided into normal weight (18.5–24.9), overweight (25.0–29.9) and obese (≥30.0) categories according to National Institutes of Health guidelines.[16]

The surveymeans, surveyfreq and surveyreg procedures were used in SAS® v.9.3 (SAS Institute Inc., Cary, NC, USA) to take into account the weighting for each observation and the complex survey design of NHANES. Weightings for the interview variables and the MEC exam were used to account for oversampling, survey non-response and post-stratification. Due to a skewed distribution, the sitting variable was transformed using the natural logarithm for each participant. The mean value of this log-transformed sitting variable was calculated for each group of interest and that mean was back-transformed exponentially to represent the geometric mean. The geometric means and related confidence intervals for each group were retained and are reported as the means herein. The use of the ‘contrast’ statement in the surveyreg procedure allowed custom hypothesis tests around the effects in the regression analysis (i.e. compare age groups with each other and compare ethnicity groups to each other). The log-transformed value was used in these contrasts, and the *p*-value was used to highlight differences between groups based on the log-transformed sitting values. Significance level for trends was set at ≤0.006 (8 group comparisons) and was reduced to a conservative level of ≤0.001 for multiple group comparisons.

A subset analysis was conducted to examine sitting time by BMI category. Participants with missing BMI data ($n = 207$), a BMI <18.5 kg/m^2 ($n = 86$), and females between the ages of

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20 and 44 who took a pregnancy test and had a positive pregnancy test result ($n = 66$) were not included in this comparison, which left 5552 (2717 males and 2835 females). While those with missing BMI data reported sitting more than those with full data (292 vs. 263 min/day; $p = 0.003$), no difference in age, sex or ethnicity was found.

3. Results

Of the 5911 adults (48.3% male) in the main analysis, 48.3% were non-Hispanic Whites, 18.2% were Mexican-American, 17.9% were non-Hispanic Blacks and 10.1% were Other Hispanic (see Supplementary Table 1). The 'Other' ethnicity category was relatively small (5.5%) and was excluded from all group comparisons within this paper. Males reported sitting for 285 min/day (95% confidence interval [CI], 278–292), and females reported sitting for 281 min/day (CI, 272–289). For both males and females (Table 1), Mexican-Americans reported significantly less sitting time than both non-Hispanic White (309, CI, 294–325) and non-Hispanic Blacks ($p < 0.0001$). Non-Hispanic White females reported significantly more sitting time than Other Hispanic females ($p < 0.0001$).

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No significant differences were found in mean sitting time between sexes at any age group but, when stratified by sex, differences were found between age groups. There was a trend for increased sitting time with increasing age for females (p for trend = 0.0045). However, females aged 40–49 years reported significantly less sitting time (260, CI, 247–275) compared to females aged 60–69 years (293, CI, 278–308; $p = 0.005$) and those aged ≥70 years (297, CI, 286–309; $p = 0.0006$). Males >70 years old reported sitting more than their counterparts in their 30s ($p = 0.004$). No other differences were seen between age groups in men using the $p < 0.006$ significance level. When stratified by ethnicity (Fig. 1), sitting time significantly increased with increasing age for all Mexican American and Hispanic participants and for non-Hispanic Black males (all $p \leq 0.006$).

Increasing educational attainment was related to increased time spent sitting for both sexes ($p < 0.0001$). Differences between sexes only emerged at the College Graduate or above level where females reported less time sitting than males (319 vs. 373 min/day; $p < 0.0001$). Males with a High School degree and lower reported less sitting time than males educated to the College Graduate or Above level ($p < 0.001$). Males with Some College or AA degree also had lower sitting time than males in the College Graduate or Above group ($p < 0.001$). In females, those with Less than 9th Grade education had lower sitting time than all other groups ($p < 0.001$). No significant differences were seen between males in education groups at high school education and lower (Less than 9th Grade, 9–11th Grade, High School Grad) ($p > 0.004$). No significant differences were seen between females with High School education and higher (High School Grad, Some College or AA Degree, College Graduate or Above) ($p > 0.002$). Participants who reported engaging in vigorous intensity activity at work (268 vs. 350 min/day) and engaging in moderate intensity activity at work (290 vs. 360 min/day) reported sitting less each day ($p < 0.0001$; see Supplementary Fig. 1). There were

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no sex differences (not shown) and the differences reported in also persisted when stratified by ethnicity group.

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Mean BMI for males and females was 28.8 kg/m^2 (SE 0.20) and 28.7 kg/m^2 (SE 0.15) respectively, with 35.6% of males and 35.9% of females classified as obese. Fig. 2 displays the mean time spent sitting in each BMI category. Sitting time for normal weight, overweight and obese males was 276 (CI, 258–295), 283 (CI, 269–297) and 295 (CI, 282–309) min/day, respectively. Obese females (311 min/day, CI, 295–327) reported more sitting time than both normal weight (263, CI, 251–276; $p < 0.0001$) and overweight females (261, CI, 243–281; $p = 0.0008$). There were no significant differences in sitting time by BMI for males or differences between sexes at each BMI category.

4. Discussion

Based on a recent representative sample, U.S. adults ≥20 years of age reported sitting on average 4.7 h/day. Differences based on ethnicity, age, sex, educational level and BMI existed. Mexican-Americans reported less time sitting than non-Hispanic Whites and Blacks. Variation in sitting time across age groups was seen, but typically sitting time increased across successive age-groups. Greater educational attainment was associated with more sitting time, and males with a college education reported sitting more than their female counterparts. Obese females reported sitting more than normal weight and overweight females.

In the International Prevalence Study (IPS), a representative U.S. adult sample ($n = 4671$) self-reported a median sitting time of 240 min/day[10] while in a sample of 4091 Azorean men, the median self-reported sitting time was 180 min/day.[17] In the present analysis, the median was 300 min/day. There are a number of reasons that may account for this 1 h difference between the IPS data (2002) and NHANES 2009/2010. Difference in the response rate (30.9% from the IPS[18] and 77.3% in NHANES 2009/2010[19]), questioning week-days as opposed to all days (During the last 7 days, how much time did you usually spend sitting on a weekday? from IPS[10]) or age groups (18–65 year olds in the IPS) could contribute to these differences. An alternative explanation is that there has been a secular increase in sitting time over the 7–8 year period between the two surveys.

Similar to past NHANES analysis,[8,9] we found that Mexican-

Americans were less sedentary than non-Hispanic Whites and non-Hispanic Blacks across all age groups. Differences of 15–50 min/day were found between these ethnicity groups using accelerometry (Actigraph 7164 using <100 counts/min threshold) from NHANES 2003/2004.[8] While we found larger differences between these groups (>60 min/day), it is encouraging to uncover similar trends using self-report and objective measures. Earlier analysis of the NHANES 2003/2004 found that Mexican-Americans accumulated more physical activity counts than non-Hispanic Whites and non-Hispanic Blacks,[20] which would be a reflection of total volume of physical activity and concur with these sedentary results.

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The present findings also indicated that sitting time was higher with increasing age among Mexican-Americans, Other Hispanics and non-Hispanic Black males. Matthews et al. reported a signifi-cant linear increase in sedentary behavior by age and significant sex differences at ages 20–29 and 60–69.[8] Proper et al. found differences in self-reported leisure time sitting with Australian older adults (35–65 years) sitting more than those between 20 and 34 years.[11] In contrast, Hagströmer et al. found that Swedish adults of all age groups accumulated ~7.6 h/day of 'inactivity' (Actigraph 7164 using <100 counts/min threshold),[21] and Bauman et al. found no difference in self-reported sitting when the sample was dichotomized into age groups of 18–39 years and 40–65 years.[10]

A study using the IPAQ reported significant differences in median self-reported sitting time between U.S. adults with ≤13 years of education (180 min/day) and >13 years education (300 min/day).[10] A study of Australian adults found that those with less than year 10 education (age ~ 15/16 years) spent less time sitting on weekdays and more time sitting on weekend days compared to those with tertiary qualifications.[11] We found that as educational attainment increases, sitting increases for both males and females. We can only speculate that this is due to increasingly sedentary occupations as education increases. The lack of difference between males at the three lowest educational statuses is noteworthy. It would seem that males with these levels of education (≤high school degree) tend to be involved in more manual occupations such as construction, maintenance or production[22] which involve less sitting and have higher energy expenditure than service related occupations.[23] Similarly, differences by race/ethnicity mentioned above could be due to differences in occupation with a large proportion of Hispanics involved in more active occupations such as construction and extraction type occupations.[24] As occupation data are not currently available for the NHANES sample, and the NHANES question only queries total sitting time for a typical day, we cannot establish when these differences in sitting time occur. However, we did report differences in sitting time depending on whether the participants reported both vigorous intensity and moderate intensity activity at work pointing to an occupation effect on total sitting time.

Obese females reported spending more time sitting than their normal and overweight counterparts, while males at every BMI classification reported a similar amount of sitting. Hagströmer et al. analyzed accelerometer-assessed 'inactivity' in Swedish adults based on BMI and found no difference; all BMI groups accumulated ~7.6 h/day.[21] However, the prevalence of obesity (7.2%) and the mean BMI (25 kg/m^2) in this Swedish cohort[21] were lower than the present study. Recently, Stamatakis et al. reported a difference in BMI across tertiles of self-reported and accelerometer-assessed (Actigraph GT1M using <200 counts/min and <100 counts/min thresholds) sedentary time but males and females were pooled together,[3] making sex comparisons not possible. Using both sitting on weekend days and sitting in leisure time (but not weekday sitting), Proper et al. reported increased odds of being overweight/obese as self-reported sitting time increased.[11]

The limitations of self-reported sitting time, including the cognitive challenges of accurately recalling all sitting time, have been highlighted.[9,25] In the present study, for example, 32.8% of the sample reported sitting for <3 h/day, which leaves an unlikely remainder of ~13 h/day of waking hours to engage in non-sitting activities. Nielsen U.S. data reported a mean of 5.5

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h/day of screen time in 2009/2010[26] so there is a potential for~underestimation of the exposures that contribute to total sitting time. There are known underestimations in self-reported sitting time[3] but it is unclear whether demographics or BMI bias the reporting of sitting time. Despite these limitations, self-report measures are necessary for epidemiological studies given constrained finances and the need to reduce participant burden. Self-report data require substantially less data reduction and screening than accelerometer data such that a much larger proportion of the overall sample can be retained (95.1% herein) compared with 68% who had useful accelerometry data in a past NHANES analysis.[8] The various sedentary thresholds of Actigraph models have both under- and over-estimated sedentary time, with day of the week and participant sedentary level impacting the direction and magnitude of the difference.[27–29] In the absence of any objective measure of sedentary behaviors in the most recent two NHANES waves, self-reported sitting is the only, and a valuable, alternative. Interestingly, a recent analysis found that self-reported sitting time was more related to cardiometabolic risk factors than accelerometer-estimated sedentary time.[3]

Future work should focus on comparing sitting questions to gold-stand measures of sitting in multi-racial samples. Also, investigating whether self-reported differences in sitting are due to how various population groups read and respond to the question or are the self-reported values really reflecting actual differences between groups is of value. While it must be accepted that self-reporting will differ from accelerometry-estimated sedentary time,[3] and underestimate compared to a criterion inclinometer based device,[29] perhaps a consistent magnitude of difference can be identified. For example, Stamatakis et al. found that the bottom tertile of self-reported sitting was exactly 200 min/day lower than the bottom tertile of accelerometer-estimated sedentary time.[3]

5. Conclusion

Using the most recent NHANES cycle, we have reported self-reported sitting levels of a representative sample of the U.S. population. In the absence of any objective estimate of a sedentary behavior in the 2009–2010 NHANES, these results represent the most up to date prevalence of sitting for the U.S. population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Practical implications

- Mexican American adults reported sitting the least amount of time.
- Self-reported sitting time increased with advancing age.
- Participants with more education reported sitting more.
- Females with a higher BMI (≥30 kg/m^2) reported sitting more than normal weight and overweight females, but these differences were not seen in males.

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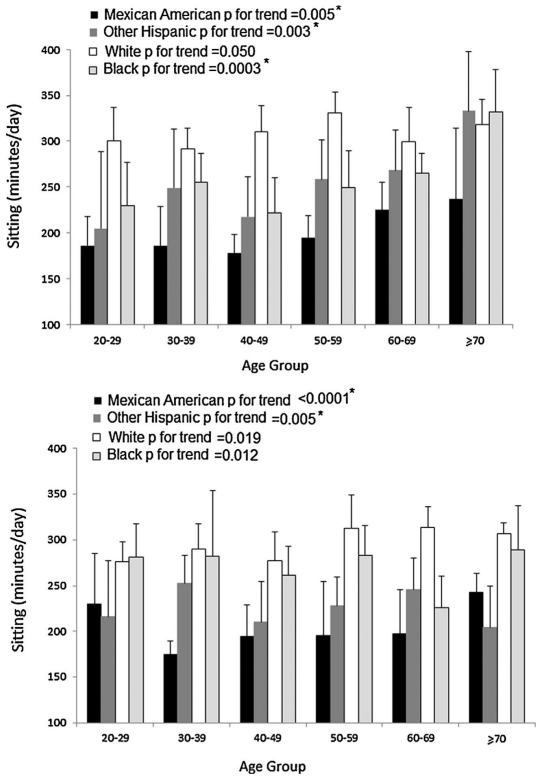

Fig. 1.

Mean (geometric mean; ±confidence intervals) self-reported sitting time for each age group stratified by ethnicity for males (top panel) and females (bottom panel). *Note*: *significant trend $p < 0.006$ across age groups.

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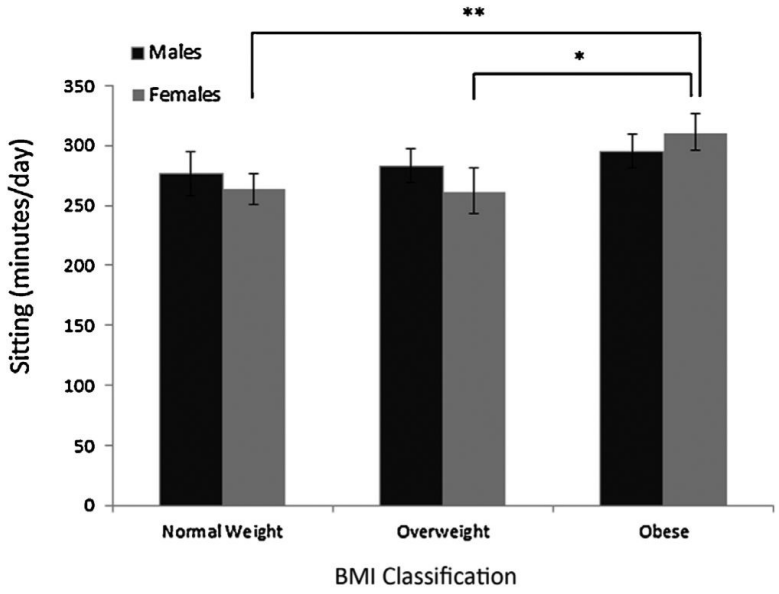

Fig. 2.

Mean (geometric mean; ±confidence intervals) time spent sitting stratified by sex and BMI.

Note: Significant differences between female BMI groups $^{**}p < 0.0001$ and $^{*}p = 0.0008$.

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Table 1

Mean (CI) of amount of time spent sitting stratified by sex and race/ethnicity group.

	All	Mexican American	Hispanic[c]	Non-Hispanic White	Non-Hispanic Black
Males	285 (278–292)	190 (179–201)[a]	235 (201–275)	309 (294–325)[a]	247 (233–261)[a]
Females	281 (272–289)	202 (187–219)[a]	227 (209–245)[b]	296 (284–308)[a,b]	271 (245–302)[a]

Note: Values with the same subscript letter are significantly different within sex group.

[a] $p < 0.0001$

[b] $p < 0.0001$

[c] represents non-Mexican-American Hispanics.