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Sedentary behavior patterns in non-pregnant and pregnant women

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ABSTRACT

Sedentary behavior has been associated with adverse health outcomes among pregnant women; however, few studies have characterized sedentary behavior patterns in this population. We described patterns of accelerometer-determined indicators of sedentary behavior among a national sample of US pregnant ($n = 234$) women and non-pregnant ($n = 1146$) women participating in the NHANES 2003-06 cycles. We included women with ≥4 days of accelerometer wear of ≥10 h/day. A count threshold of <100 cpm was used to describe sedentary behavior as: 1) total accumulated sedentary time by bout length categories; 2) accumulated sedentary time within discrete bout length categories; 3) mean, median, and usual bout length; and 4) and bout frequency. Both non-pregnant and pregnant women spent up to 60% of their accelerometer wear time in sedentary behavior depending on the minimum bout threshold applied. Sedentary time was higher among pregnant women compared to non-pregnant women when lower bout thresholds (i.e. 10 min or less) were applied. The majority of total sedentary time was accumulated in bouts lasting <10 min. The women averaged less than two prolonged sedentary bouts (i.e., ≥30 min) per day, which accounted for nearly 20% of total accumulated sedentary time. When applying a minimum threshold of at least 15 min, sedentary time increased across pregnancy trimesters, while sedentary time was similar across trimesters when using lower thresholds. These findings provide the first characterization of accelerometer-determined indicators of sedentary behavior in pregnant women. The minimum bout threshold applied influenced estimates of sedentary time and patterns sedentary time accumulation across pregnancy trimesters.

1. Introduction

Sedentary behavior is often characterized as behaviors with low energy expenditure and sitting (Owen et al., 2009). Recently, studies have found that sedentary behavior is associated with cardio-metabolic risk factors and mortality independent of moderate-to-vigorous intensity physical activity in non-pregnant populations (Thorp et al., 2011; Yates et al., 2012; Allison et al., 2012; Tremblay et al., 2010; Healy et al., 2011). Among pregnant women, sedentary behavior has been associated with an increased risk for abnormal glucose tolerance, gestational diabetes, and preeclampsia (Saftlas et al., 2004; Gollenberg et al., 2010; Leng et al., 2016). Unfortunately, few studies have sought to describe patterns of sedentary behavior among pregnant women. In the few studies that have, sedentary behavior was estimated by summing every minute of accelerometer wear registering fewer than 100 counts (Evenson and Wen, 2011). While this approach is common in epidemiological studies, recent research suggests it may be important to consider the bout length in which the sedentary time was accumulated (Kang and Rowe, 2015). For example, Kim et al. examined the association of sedentary behavior accumulated in varying bout lengths with cardiovascular risk factors in US adults (Kim et al., 2015). The authors found that sedentary time accumulated in bouts of ≤5 min were associated with lower levels of cardiovascular risk factors while sedentary time accumulated in bouts of ≥10 min were associated with higher levels of these factors.

In addition to considering bout length, studies suggest that the patterns of sedentary behavior bout frequency are also important (Healy et al., 2011; Larsen et al., 2014; Dunstan et al., 2012). For example, Healy et al. found that individuals that had few breaks in sedentary time had a worse cardio-metabolic profile than people that had many breaks (Healy et al., 2011). Thus, there are several indicators of sedentary

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behavior that can be considered, but most studies only describe the total duration of sedentary behavior and none have been conducted among pregnant women (Diaz et al., 2016; Shiroma et al., 2013). Describing other indicators of sedentary behavior can inform the development of sedentary behavior interventions which may aim to target different sedentary endpoints in this particular population. The purpose of this manuscript was to describe patterns of sedentary behavior among a sample of US non-pregnant and pregnant women by trimester of pregnancy.

2. Methods

2.1. Study population

NHANES is a cross-sectional observational study of non-institutionalized U.S. residents conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention. NHANES uses a stratified, multistage probability sampling design to obtain a nationally representative sample of the US population (National Center for Health Statistics. Survey Design Factors Course, 2011). It oversamples minority subpopulations, including pregnant women during the 2003–2006 cycles, so that nationally representative estimates of the health of these sub-populations can be generated. The NCHS Research Ethics Review Board approved the NHANES protocol, and informed consent was obtained from all participants at the time of household interview.

During NHANES, women who participated in physical examinations and laboratory tests at a mobile examination center (MEC) completed the computer-assisted questionnaire about their reproductive health. Women that self-reported being pregnant were asked the month of pregnancy to determine their trimester.

The current analysis was limited to women aged between 18 and 43 years, in the NHANES 2003–2004 and 2005–2006 study cycles. The final sample included 1146 were non-pregnant and 38, 102, and 94 women in their first, second, and third trimester of pregnancy, respectively, at the time of the interview.

2.2. Sedentary behavior assessment

In the NHANES 2003–2004 and 2005–2006 study cycles, participants with no physical disorders were provided with an ActiGraph accelerometer (model: 7164; ActiGraph, LLC, Pensacola, FL) to wear on the right hip during waking hours for seven consecutive days, removing it only for bathing or water-based activities. The accelerometer was attached to an elastic belt and set to record the magnitude of accelerations in the vertical axis in 60-second epochs. We used the Troiano algorithm to screen for non-wear (Troiano et al., 2008). After removing non-wear periods for each day, sedentary behavior was operationalized as accumulated time <100 counts per minute (cpm) (Troiano et al., 2008), a threshold previously used in studies involving general adult and pregnant populations (Evenson and Wen, 2010; Kim and Chung, 2015). For example, activities such as sitting or standing with little movement would likely accumulate <100 cpm. Participants were included if they had ≥4 days with ≥10 h of wear per day.

To describe accumulated patterns of sedentary time, indicators of sedentary behavior were described as 1) total accumulated sedentary time by bout length categories; 2) accumulated sedentary time within discrete bout length categories; 3) bout length, and 4) and bout frequency. For all sedentary indicators, weekly estimates were used in analysis and computed as the average across the number of valid wear days.

Total accumulated sedentary time by bout length categories was calculated as the sum of sedentary time accumulated in various bout lengths (i.e., ≥1, ≥5, ≥10, ≥15, ≥20, ≥25, and ≥30) reported in average minutes per day and as an average percentage of accelerometer wear time per day.

Accumulated sedentary time within discrete bout length categories was calculated for the following categories: 1–4, 5–9, 10–14, 15–19, 20–24, 25–29, and ≥30 in both average minutes per day and as an average percentage of total sedentary time per day.

Bout length was described as mean, median, and "usual" bout length. We used a technique proposed by Chastin & Granat called sedentary bout half-life ($W_{50\%}$), to calculate "usual" bout length. The methods for calculating sedentary half-life are described in more detail elsewhere (Chastin and Granat, 2010). In brief, sedentary half-life is a function of total sedentary time and bout length. Specifically, it indicates the bout length in which half of total sedentary time is accrued, thereby providing information on *how* sedentary time is accrued (e.g. prolonged bouts versus small bouts). Higher half-life values indicate the accumulation of sedentary time in prolonged bouts.

Bout frequency was described as the total number bouts per day within discrete bout lengths of increasing duration (i.e., 1, 2–4, 5–9, 10–14, 15–19, 20–24, 25–29, and ≥30). Bout frequency provides similar information as sedentary breaks (Kim et al., 2015), however bout frequency may better inform intervention strategies (e.g. targeting total duration or prolonged bouts).

Lastly, coefficient of variations were used to examine the day-to-day variability of indicators of sedentary behavior outlined above, using the daily estimates, across all valid days of wear.

2.3. Covariates

Information on age, race/ethnicity, education, and income was collected through self-report during the household interview. Race/ethnicity data were self-reported and participants were classified as non-Hispanic white, non-Hispanic black, Hispanic, or other (includes multi-racial). Current smoking was defined as a serum cotinine level ≥3 mg/dL. Annual household income was categorized as <$35,000, $35,000 to <$65,000, ≥$65,000, or unknown/missing. Education level was categorized as less than high school, high school diploma or GED, and greater than high school. Parity was determined based on the self-reported number of live births and categorized as 0, ≥1, or unknown/missing. To provide information on pregnancy history, adverse pregnancy outcomes were determined by the self-reported history of low birth weight babies (<5.5 g) or preterm births (<37 weeks gestation) and categorized as 0, ≥1, or an unknown/missing.

2.4. Statistical analysis

The complex survey design used for NHANES data collection was incorporated into all data analysis using the "svy" command in STATA 14.0 (StataCorp LP: College Station, TX) using the appropriate strata clustering and weighting. We used an adjusted survey weight to account for non-compliance with the accelerometer component using R package "nhanesaccel" (Van Domelen et al., 2013). Descriptive characteristics included frequencies and percentages for categorical variables and means and standard deviations for continuous variables. Chi-square or analysis of variance tests were used to compare socio-demographic characteristics between non-pregnant women and in pregnant women by trimester. For the main analysis, multivariate linear regression was used to compare each sedentary behavior pattern between non-pregnant and pregnant women. Next, we tested for linear trends across trimester of pregnancy. All analyses were age-adjusted. For the analysis comparing mean minutes of sedentary behavior across the four groups, we additionally adjusted for total accelerometer wear time. All statistical significance tests were two-sided with the familywise type I error level set at $p < 0.05$.

3. Results

Overall, the sample was young, with pregnant women on average four years younger than non-pregnant women (27.5 years vs.