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Trajectories of objectively-measured physical activity and sedentary time over the course of pregnancy in women self-identified as inactive

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ABSTRACT

There is a need for investigations that document the *daily* course of pregnancy-related changes in PA and sedentary behavior. The purpose of this study was to describe the trajectory of PA and sedentary behavior and whether they differ among weight status in pregnant women self-identified as inactive. Eighty inactive pregnant women (8–16 weeks) were recruited from a nationwide text-message intervention. PA was measured using a Fitbit. Chi-square analyses and *t*-tests were used to analyze univariate demographic and PA variables. Mixed model-repeated measures ANOVA was used to analyze trajectory changes in *daily* PA and sedentary behavior. Light activity (beta [SE] = 2.79 [0.30], $p < .001$), active time (b [SE] = 1.62 [0.16], $p < .001$), and steps (b [SE] = 112.21 [10.66], $p < .001$) increased during the second trimester followed by a precipitous decline during the third trimester. Sedentary behavior followed an opposite pattern (b = −9.88 [1.07], $p < .001$). Overweight and obese women took significantly fewer steps/day (b [SE] = −742.37 [362.57], $p < .05$ and −855.94 [381.25], $p < .05$, respectively) than normal weight women, and obese women had less "active" minutes/day (~>3.0 metabolic equivalents; b [SE] = −12.99 [5.89], $p < .05$) than normal weight women (P's < 0.05). Women who self-identify as inactive, become more sedentary and less physically active as pregnancy progresses. This study was among the first to describe the trajectory of *daily* PA and sedentary behavior throughout pregnancy. This study may help inform health care provider and patient communication related to PA, sedentary behavior, and the time in which to communicate about these behaviors.

1. Introduction

There is considerable evidence that physical activity participation during pregnancy has beneficial effects for both the mother and fetus (Borodulin et al., 2008; Ferraro et al., 2012). For the mother, physical activity may help prevent gestational diabetes, pre-eclampsia, support healthy weight, and improve mental health (Borodulin et al., 2008; Ferraro et al., 2012). Regular physical activity may also help maintain cardiovascular fitness during pregnancy and may positively impact postpartum recovery (Evenson, 2011). Fetal benefits include reduced stress response and healthier birth weight (Mudd et al., 2013).

Current recommendations for pregnant women are based upon evidence and recommendations for healthy adults (Physical Activity Guidelines Advisory Committee Report, 2008). According to the Physical Activity Guidelines for Americans, healthy women should get at least 150 min per week of moderate-intensity aerobic activity, such as brisk walking, during and after their pregnancy. The American College of Obstetricians and Gynecologists (ACOG) recommends that pregnant women, with uncomplicated pregnancies, engage in regular physical activity (both aerobic and strength-conditioning exercises) (Physical Activity Guidelines Advisory Committee Report, 2008; American College of Obstetricians and Gynecologists, 2015) while avoiding activities such as contact sports and supine position activities after 20-week gestation.

Studies estimate that most pregnant women (>50%) do not participate in recommended physical activity despite the benefits to both the mother and fetus (Evenson et al., 2004; Harrison et al., 2011; Zhang and Savitz, 1996). Borodulin and colleagues (2008) have suggested the prevalence of pregnant women meeting physical activity guidelines varies across studies from 6% to 78% (Pereira et al., 2007; Petersen et al., 2005). There is limited data available on the relationship between weight status (i.e., normal, overweight, obese) and physical activity patterns in pregnant women (Sui, 2013). However, the CDC suggests that women and obese adults are less likely to meet physical activity guidelines (Centers for Disease Control and Prevention, 2015). One longitudinal study reported 65% of their sample of overweight and obese pregnant women met PA guidelines (i.e., 30 min of moderate to vigorous physical activity (MVPA) per day) throughout their pregnancy

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(McParlin et al., 2010). Findings from this study were limited due to small sample size and power. Furthermore, retrospective and prospective studies suggest that both self-reported leisure and occupational-related physical activities decrease throughout pregnancy (Downs et al., 2009) with the largest changes occurring during the third trimester (Borodulin et al., 2008; Evenson et al., 2004; Evenson et al., 2002; Mottola and Campbell, 2003; Poudevigne and O'Connor, 2006). However, these studies have only collected physical activity data at specific time points for a short duration (3–7 days) and haven't collected data at the daily level across trimesters.

Physical activity estimates in pregnancy are also mostly based on studies that use self-report measures of physical activity (Schmidt et al., 2006). Self-report measures have known limitations and poor reliability and validity relative to objective measures (i.e., accelerometers) (Poudevigne and O'Connor, 2006). This is especially true for measuring light and sedentary activities, which are more common activity intensity levels during pregnancy yet are not commonly observed (Borodulin et al., 2008; Schmidt et al., 2006). A few studies have used both self-reported and objective measures to quantify physical activity levels during pregnancy (Ruifrok et al., 2014). Bell et al. measured physical activity using self-report and accelerometer measures in 59 pregnant women at one time point (12-week gestation) (Bell et al., 2013). Self-reported MVPA was significantly higher (81–127 min/day) than that recorded using accelerometers (35 min/day). Oostdam et al. also found self-reported physical activity to be higher than accelerometer data in overweight and obese pregnant women (Oostdam et al., 2013).

Studies using either self-report and/or objective measures are further limited by their lack of continuous measurement of physical activity (i.e., daily across trimesters) (Bell et al., 2013). Studies using self-reported physical activity relied on single recalls of overall activity during various points throughout pregnancy (e.g., trimesters) and studies with objective measures have not tracked physical activity patterns beyond single estimates in each trimester (Schmidt et al., 2006). Additionally, the few studies that have assessed physical activity patterns in overweight and obese pregnant women lack comparison with normal weight pregnant women and differences between weight status are inconclusive (Sui, 2013; McParlin et al., 2010; Van Poppel et al., 2013). Such methods do not offer the full picture of physical activity trajectories or patterns over the course of pregnancy or by weight status. Examining how physical activity trajectories may be unique during pregnancy and weight status is important given known fluctuations over time in physical activity among non-pregnant adults (Centers for Disease Control and Prevention, 2015; Adams et al., 2013; Bassett et al., 2015), changes to priorities and demands on pregnant women's time, and rapidly changing physiological, psychological, social conditions as pregnancy develops.

There is also a scarcity of information about sedentary time in pregnant women (i.e., sitting/reclining with low energy expenditure) (Ruifrok et al., 2014; Di Fabio et al., 2015; Franks et al., 2011; Sedentary Behaviour Research Network, 2012). Sedentary time has emerged as an important and independent risk factor for chronic disease and may have negative health implications during pregnancy (Franks et al., 2011). These include gestational diabetes, hypertension and preeclampsia in the mother and low/high birth weight in the baby (Franks et al., 2011). A recent study reported pregnant women spend approximately 70% of their wake time sedentary (Di Fabio et al., 2015). However, like physical activity, the trajectory of change in sedentary time during pregnancy is undocumented.

Knowing how the progression of pregnancy affects physical activity and sedentary time over trimesters could help with the design of interventions, yet longitudinal investigations that document the course of pregnancy-related changes in physical activity and sedentary time using objective measures at frequent intervals during pregnancy does not exist (Poudevigne and O'Connor, 2006). This information could help to determine the optimal time during pregnancy in which to intervene and the appropriate intensity to improve physical and mental health outcomes. Therefore, the purpose of this observational study was to examine the trajectory of physical activity behavior and sedentary time in pregnant women self-identified as inactive, throughout the pregnancy time course (i.e., daily across trimesters and up to 40 weeks). A secondary purpose was to test whether these trajectories differed among weight status (i.e., normal, overweight, obese at entry to study).

2. Methods

This study was approved by the Institutional Review Board at a University in the Southwestern United States. Participants were women recruited for a text message intervention (i.e., Text4baby (T4b)) aimed at improving physical activity in pregnant women. The intervention is published elsewhere (Huberty et al., in review; Huberty et al., 2015) and found no intervention effects and no differences across groups (Huberty et al., 2015). Briefly, the study was a 4-arm randomized controlled trial. Specifically, participants were randomly assigned to one of four groups and stratified according to ethnicity to facilitate equal representation of minorities in each of the four groups: (a) *Standard* (three *T4b* SMS from the original content (original cT4b content included only two PA SMS across entire pregnancy) per week (M,W,F) at noon); (b) *Plus One* (three SMS; two *T4b* and one PA per week (M,W,F) at noon); (c) *Plus Six* (seven SMS; one *T4b* and six *PA* per week (Su-Sa) at noon); and (d) *Plus Six Choice* (seven SMS; one *T4b* and six PA per week (Su-Sa) at the time of day they choose).

Physical activity was measured from entry into the study (8–16 weeks pregnant) until the end of the pregnancy (36–40 weeks). Pregnant women were recruited through social media sites (e.g., Facebook, Twitter), fliers posted in health care provider offices, word of mouth, email listservs and discussion boards (e.g., BabyCenter). Interested participants were directed to an eligibility questionnaire on Qualtrics (Provo, Utah) that took three to 5 min to complete.

Women were eligible to participate if they were: 1) at least 18 years of age, 2) between 8 and 16 weeks pregnant, 3) owned a smartphone with text message capability, 4) had regular access to a computer, 5) able to speak/read/understand English, 6) resided in the United States, 7) willing to provide a cell phone number to receive text messages, 8) willing to wear a physical activity monitor throughout their pregnancy, and 9) were not meeting recommendations for physical activity (i.e., 30 min of moderate physical activity on at least five days/week) before their pregnancy or currently (Physical Activity Guidelines Advisory Committee Report, 2008). Women were ineligible if they were: 1) considered a high risk pregnancy (defined by The ACOG's Position Statement on Exercise During the Pregnancy and Postpartum Period(Artal and O'Toole, 2003)), and 2) physically limited to exercise or instructed by a physician not to participate in exercise. Recruitment took place between June and September 2014.

After eligibility was confirmed, participants were asked to sign an online consent form, complete a demographic questionnaire (e.g., age, race, ethnicity, income, education, number of chronic conditions, days of wear, and gestational age at enrollment), self-report physical activity using the Modifiable Activity Questionnaire (Kriska, 1997), and schedule a telephone intake appointment. Online consent and the demographic and physical activity questionnaire were completed using Qualtrics (Provo, Utah).

After the intake appointment, each participant was mailed a Fitbit Flex (San Francisco, CA) and instructions about how to wear and sync the monitor. Participants were instructed to wear the Fitbit throughout pregnancy (up to 40 weeks), 24 h a day (except during showers or swimming) on their non-dominant wrist. When sleeping or taking a nap, women were instructed to switch the Fitbit mode to “Sleep”. Physical activity was measured using the Fitbit device. The Fitbit has been shown to be valid measure of steps under laboratory conditions (Patel et al., 2015; Takacs et al., 2014). The Fitbit provides estimates of “sedentary”, “light”, “fairly active” and “very active” minutes as daily