Baby Steps: Pedometer-Determined and Self-Reported Leisure-Time Exercise Behaviors of Pregnant Women

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Abstract

Background. Research examining women’s pregnancy physical activity (PA) behaviors with objective measures is scant. Therefore, two studies were conducted to determine the feasibility of pregnant women wearing pedometers and to examine women’s self-reported and objectively measured PA behaviors.

Methods. Participants were pregnant women (Study 1 N = 50, Study 2 N = 30) who completed the Leisure-Time Exercise Questionnaire (LTEQ) and wore a Yamax pedometer for three consecutive days during free-living at 20- and 32-weeks gestation.

Results. As predicted in Study 1, we found: (a) 100% participant agreement in wearing the pedometer, and (b) LTEQ min and pedometer-determined indices classified 67-86% of the participants as insufficiently active at 20-weeks gestation. In Study 2, as hypothesized: (a) mean steps/day, LTEQ Total, Strenuous, and Mild min of PA were positively associated at 20- and 32-weeks gestation; (b) mean steps/day and LTEQ Strenuous min significantly declined from 20- to 32-weeks gestation, and (c) more women were classified as sedentary and low-active at 32-weeks (73%) compared to 20-weeks gestation (50%).

Conclusions. These findings are consistent with previous epidemiological evidence documenting the decline in women’s PA behaviors across the trimesters. They also illustrate that pedometer-determined indices may be a useful tool facilitating PA adoption and maintenance during pregnancy.

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Considerable evidence documents that women, at all ages, are at increased risk of sedentary and low physical activity (PA) lifestyles compared to men.\textsuperscript{1,2} In particular, pregnant women are one subpopulation of women who are at even greater risk of sedentary behavior due to the specific physical (e.g., weight gain, nausea), psychological (e.g., mood disturbances), and environmental (e.g., prenatal care responsibilities) demands of this time.\textsuperscript{3-6} This is concerning because low prepregnancy and pregnancy PA is associated with prenatal complications such as gestational diabetes,\textsuperscript{7} preeclampsia,\textsuperscript{8} and excessive weight gain.\textsuperscript{9} Thus, pregnant women without obstetric complications are encouraged to meet the current guidelines of at least 30 min of moderate-intensity PA on most, if not all, days of the week.\textsuperscript{10,11} However, women’s pregnancy PA behaviors are poorly understood, thus, warranting research in this area.

Although regular PA offers numerous health benefits to pregnant women, there is some epidemiological evidence from the Behavioral Risk Factor Surveillance System (BRFSS) data to suggest that most pregnant women are inactive during this time.\textsuperscript{12} Also, Petersen and colleagues\textsuperscript{13} examined the trends in women’s pregnancy PA behaviors from 1994-2000, and found that: (a) pregnant women engaging in no PA decreased slightly from 36\% (1994) to 33\% (2000); (b) 10\% of women from 1994-2000 met the moderate-intensity PA guidelines; (c) less women met the vigorous PA guidelines in 2000 (6\%) than in 1994 (9\%); and (d) nonpregnant women were more likely than pregnant women to meet the PA guidelines. These data, however, are based on crude PA measures involving long-term retrospective recall, and thus, the reliability of these estimates is unknown.\textsuperscript{14}

Limited research has longitudinally examined women’s pregnancy PA behaviors with
well-established and validated PA measures, and we located only one study to date that has documented the trimester-specific changes in women’s PA patterns. Hausenblas and Symons Downs\textsuperscript{15} used the Leisure-Time Exercise Questionnaire to longitudinally examine women’s mild, moderate, and strenuous PA behaviors across pregnancy and they found that only 17%, 14%, and 8% of women were meeting the PA guidelines of at least moderate-intensity PA in the first, second, and third trimesters, respectively. Furthermore, researchers\textsuperscript{12-15} have documented that the preferred mode of PA during pregnancy is walking. Because walking is a typical and low intensity PA, most people have difficulty recalling how much they walk. Thus, it is unclear if the current prevalence estimates of pregnancy PA reflect the challenges that women may have in recalling their walking behaviors. Consequently, there is a need for research that examines women’s pregnancy PA behaviors with objective measures such as pedometers to determine the accuracy of their self-reported PA. This research, however, is limited in size and scope.

In a recent review\textsuperscript{14} of 32 PA and pregnancy studies, only 2 included accelerometers, and no studies included pedometers. We’ve located only two studies that have assessed women’s pregnancy PA behaviors with pedometers.\textsuperscript{16,17} These studies, however, are limited by methodological (e.g., no reliability or validity estimates of the pedometer used)\textsuperscript{16} and conceptual (e.g., no discussion of how the pedometer steps accumulated were related to current PA guidelines) issues.\textsuperscript{17} We did locate one study\textsuperscript{18} documenting that women averaged about 6,200 step counts/day, which is considered to be low-active (e.g., Tudor-Locke & Bassett, 2004); however, this study was conducted with postpartum rather than pregnant women. There is an important need for research examining women’s pregnancy PA behaviors with standardized self-report and objective measures to better understand the true estimates of their PA behaviors and how these true estimates relate to maternal health outcomes.
Therefore, we conducted two studies to examine women’s self-reported and objectively measured free-living PA behaviors. The purposes of Study 1 were to determine the feasibility of pregnant women wearing a pedometer during pregnancy and to examine the frequency of women meeting current PA guidelines based on self-reported PA min and pedometer steps at 20-weeks gestation. Consistent with previous exercise and pregnancy research\textsuperscript{19,20} and because the second trimester is often the time in which many women feel most comfortable (e.g., overcome nausea and vomiting often associated with the first trimester), we chose the 20-week gestational period for this feasibility study. We hypothesized that most of the pregnant women would be willing to wear the pedometer and they would be classified as insufficiently active at 20-weeks gestation according to the current PA guidelines\textsuperscript{10,11} and pedometer-determined indices established by Tudor-Locke and Bassett.\textsuperscript{21} The purposes of Study 2 were to replicate the self-reported and pedometer-determined PA prevalence findings from Study 1 and to prospectively examine the change in women’s self-reported and pedometer-determined PA from 20- to 32-weeks gestation. Based on previous research\textsuperscript{4,5,12,18} we hypothesized that: (1) women’s self-reported PA and pedometer steps at 20- and 32-weeks gestation would be positively associated, (2) both self-reported PA min and pedometer steps would be lower at 32-weeks compared to 20-weeks gestation, and (3) women would also be classified as insufficiently active at 32-weeks gestation by self-reported and pedometer-determined PA indices.

**Study 1**

**Method**

**Participants**

Participants were second trimester pregnant women \((N = 50, M \text{ age} = 29.92, SD = 4.05\text{ years})\) recruited from a local medical clinic and newspaper advertisements in Central
Pennsylvania. The women were mostly Non-Hispanic White (85.5%), followed by Asian American (5.3%), Hispanic American (2.8%), African American (1.4%), and not-reported (5%). Women were also mostly married (78.6%), had a college education or higher (85.1%), had a family income of $40,000 or higher (55.7%), and were working at least part-time (60.1%). The mean body mass index of the participants at 20 weeks gestation was 26.7 kg/m$^2$ ($SD = 6.21$).

**Measures**

The Physical Activity Readiness Medical Examination for Pregnancy$^{22}$ assessed a woman’s readiness for PA and it includes detailed information on safe activities and precautions for exercising during pregnancy. The PARmed-X for Pregnancy was used as a safety screening to determine participant eligibility.

The Health History Questionnaire was developed for this study and it assessed women’s demographic information (i.e., age, race, family income, height and weight to calculate BMI), health status (i.e., disease status, health problems), and pregnancy history (e.g., gestational age, contraindications to exercise during pregnancy).$^{10}$

The Leisure-Time Exercise Questionnaire (LTEQ)$^{23}$ was used to assess the participants’ self-reported exercise behaviors at 20-weeks gestation as an indicator of whether pregnant women were meeting the current PA guidelines.$^{10,11}$ The LTEQ assesses the rate of strenuous (e.g., running), moderate (e.g., brisk walking), and mild PA (e.g., easy walking) that is done for at least 15-min during leisure-time in the past week. A composite score for min of PA per week was calculated by multiplying the intensity level by 15-min for each bout reported [i.e., total LTEQ min = (strenuous bouts*15) + (moderate bouts*15) + (mild bouts*15)]. Women who reported at least 120 min/week (i.e., at least 4 days of 30 min/day) of mild, moderate, and strenuous PA were classified as meeting the current PA guidelines, or “sufficiently active”;
whereas women who were under this threshold were classified as “insufficiently active.” The LTEQ is a reliable and valid PA measure\textsuperscript{24} and it has been used in previous research with pregnant women.\textsuperscript{15}

The \textit{Yamax Digiwalker SW-701 Pedometer} (Yamax Corporation, Tokyo, Japan) was used in the present study to assess the number of free-living steps/day women accumulated for three consecutive days at 20-weeks gestation. This small and lightweight pedometer is worn on a belt around the waist. This pedometer has yielded acceptable accuracy (correctly counting number of steps and distances walked), reliability (high inter-instrument agreement) and validity.\textsuperscript{25-27} Previous research has documented the accuracy of Yamax pedometers with adult populations during free-living conditions\textsuperscript{27,28} and in women over time.\textsuperscript{29} Prior to use, all pedometers were checked for accuracy with a walking test.\textsuperscript{30}

\textit{Pedometer Feasibility}. An author-developed instrument was used to assess women’s thoughts and beliefs about wearing a pedometer during pregnancy. Women were asked to self-report in open-ended statements how much they knew about the pedometer, how they felt about wearing it, and if they had any reservations or fears about wearing it for the next three days.

\textit{Design and Procedure}

Approval to conduct this study was obtained by the University’s Institutional Review Board and General Clinical Research Center’s (GCRC) advisory committee. Participants were recruited from a local obstetrics and gynecology office using an informational letter about the study. Interested women ($n = 42$) provided their contact information and the second author contacted them by phone to determine their eligibility (i.e., healthy pregnant women, ages 18-45, no contraindications to exercising during pregnancy).\textsuperscript{10} Women were also recruited through advertisements in local newspapers ($n = 8$). Interested women were given a contact number to
call and a member of the research team determined their eligibility over the phone. To participate in the study, women needed written approval from their physician or nurse midwife (100% of the women had consent to participate). Women visited the GCRC where they completed the informed consent form, PARmed-X for Pregnancy, and the LTEQ. They were then asked to wear the Yamax pedometer and waist belt according to standard procedures (i.e., over midline of right thigh) for the next three consecutive days during waking hours (excluding bathing and water activities). Women were also given an instruction sheet with pictures of the belt and a contact phone number for questions or problems. The pedometers were retrieved on the fourth day by a member of the research team.

**Pedometer Data Treatment**

All data screening, manipulation, and analyses were conducted using Microsoft Excel 2003 (Microsoft Corporation, Redmond, WA) and SPSS Data Analysis Version 15.0 (SPSS Inc, Chicago, IL). Pedometer data were screened for outliers based on criteria proposed by Rowe and colleagues. Frequencies were run on the data to identify outliers. There were no issues with unreasonably high pedometer steps, however, five participants had extremely low step counts (i.e., range: 54-186). One-way ANOVA and Chi Square analyses were used to examine differences in demographic characteristics between the women who remained in the study and the five participants who had low step counts. No significant group differences were observed for age, BMI, race, marital status, education, or family income ($p's > .05$). A decision was then made to delete these scores and treat these cases as missing data. Because only three days of pedometer data were collected, we chose not to use mean replacements on these data but rather to omit these cases from the pedometer analyses. The intraclass correlation coefficient for three days of pedometer data ($N = 45$) at 20-weeks gestation was $r = .70$. The step data are presented
Results and Discussion

A content analysis was conducted on the women’s responses to determine pedometer feasibility. The most common issue with the pedometer was proper placement (56%) followed by instructions for resetting steps (44%), when to wear it (e.g., day vs. night; 28%), and whether the pedometer could harm the fetus (16%). After the women were given information on the pedometer’s history, told how to properly wear and use it, and received assurances from the research team that it was not harmful to the participant or her fetus, 100% of the women agreed to wear the pedometer for the 3-day assessment and 0% had reservations about their participation. These findings illustrate the feasibility and acceptability of using pedometers to assess women’s PA behaviors in pregnancy.

Means, standard deviations, and frequencies were used to determine the proportion of pregnant women meeting self-reported PA and pedometer-determined prevalence rates at 20-weeks gestation. Based on the total LTEQ min (i.e., at least 120 min of PA/week), only 33.3% (n = 15; M = 176.53, SD = 91.06 total min/week; M = 98.07, SD = 76.14 mild min/week; M = 60.00, SD = 38.24 moderate min/week; M = 18.46, SD = 26.80 strenuous min/week) of the participants were classified as sufficiently active (meeting the PA guidelines). Most of the participants (66.7%, n = 15; M = 61.15, SD = 29.06 total min/week; M = 21.34, SD = 20.51 mild min/week; M = 28.85, SD = 26.80 moderate min/week; M = 10.96, SD = 21.02 strenuous min/week) were classified as insufficiently active (not meeting the PA guidelines).

Mean steps/day was used to classify the participants by the pedometer-determined categories of: sedentary (< 5,000 steps/day), low active (5,000-7,499 steps/day; 34.9%), somewhat active (7,500-9,999 steps/day; 27.9%), and active (10,000+ steps/day; 13.9%).
expected, the participants were mostly sedentary (23.3%; $M$ steps = 3,410, $SD$ = 1,363) and low active (34.9%; $M$ steps = 6,310, $SD$ = 731), followed by somewhat active (27.9%; $M$ steps = 8,719, $SD$ = 616), and active (13.9%; $M$ steps = 13,375, $SD$ = 3,705). The proportion of women classified as insufficiently active (sedentary, low active, and somewhat active) by the pedometer-determined indices (86.1%) was significantly higher than the proportion of women classified as insufficiently active (not meeting recommendations) by the self-reported measure (66.7%), $\chi^2 (1) = 22.34, p < .001$.

Consistent with previous research\textsuperscript{4,5,12,18} pregnant women were mainly insufficiently active in their second trimester as illustrated by both self-report and pedometer-determined indices. Interestingly, the pedometer-determined indices classified more women as insufficiently active than the self-report measure. It is possible that the pedometer-determined indices provide a more accurate assessment of women’s PA behaviors during this time compared to the self-report measure. However, due to the scant research examining women’s pregnancy PA behaviors with pedometers, we aimed to confirm these findings by conducting a second study for replication. In addition, because we established the feasibility and acceptability of pregnant women wearing the pedometer in the first study, we now wanted to obtain a prospective assessment of women’s pregnancy PA behaviors across the second and third trimesters. Consistent with previous exercise testing protocols in pregnancy,\textsuperscript{19,20} we used the 32-week gestational period to obtain the additional third trimester assessment.

**Study 2**

**Method**

**Participants**

The participants were pregnant women ($N = 30$, $M$ age = 31.0 years, $SD$ = 4.05) recruited
from a medical clinic in Central Pennsylvania. The women were 100% Caucasian and college-
educated or higher, mostly middle-high income (80% earning $40,000 or higher), 93% married, and 90% pregnant with their first child. The mean body mass index of the participants at 20-
weeks gestation was 25.1 kg/m\(^2\) (SD = 5.2) and at 32-weeks gestation it was 26.5 kg/m\(^2\) (SD = 5.41).

**Measures**

The same measures as described above in Study 1 were used for Study 2. The LTEQ\(^{23}\) was used to assess the participants’ self-reported min of total, mild, moderate, and strenuous PA and the *Yamax Digiwalker SW-701 Pedometer* was used to assess their steps at both the 20- and 32-weeks gestation time points.

**Design and Procedure**

The University’s Institutional Review Board and the GCRC’s advisory committee provided approval to conduct this study. Women were recruited from an obstetric and gynecology office using an informational letter about the study (N = 37). Interested women provided their contact information, and the second author contacted them by phone to determine their eligibility.\(^{10}\) To participate in this study, women needed written approval from their physician (100% of the participants had approval at both 20- and 32-weeks gestation). At both time points, women completed the PARmed-X for Pregnancy and LTEQ at home and then brought their surveys with them to the GCRC where they completed the informed consent form and participated in a walking treadmill protocol (results discussed elsewhere).\(^{33}\) Following this treadmill test, women were asked to wear the pedometer for three consecutive days in their free-
living environment and asked to follow the same standardized pedometer protocol as in Study 1.\(^{31}\) The pedometers were retrieved on the fourth day by the second author.
Pedometer Data Treatment

The same data treatment procedures were followed as in Study 1. Frequencies run on the implausible step counts revealed that two participants had extremely low step counts (i.e., 42, 198) and five participants had missing data for either the 20- or 32-week assessments. One-way ANOVA and Chi Square analyses were used to examine differences in demographic characteristics between the women who remained in the study and the seven participants with low steps or missing data. No significant group differences were observed for age, BMI, race, marital status, education, or family income ($p$’s > .05). Thus, the seven participants were removed from the main analyses. Intraclass correlation coefficients were calculated for three days of pedometer data ($N = 30$) at 20- ($r = .70$) and 32-weeks ($r = .77$) gestation. The step data are presented as daily steps and mean steps/day, representing the average of the three days of pedometer data.

Results

Pearson correlations were used to examine the associations among the LTEQ variables and pedometer steps at 20- and 32-weeks gestation (see Tables 1 and 2). As expected, there were significant positive correlations among the 20- and 32-week variables. The 20-week mean steps/day was positively correlated with the 20-week LTEQ Moderate min. At both 20- and 32-weeks, LTEQ Total min was positively correlated with LTEQ Moderate min and LTEQ Mild min. Similarly, LTEQ Moderate min was positively correlated with LTEQ Mild min at both time points. Also, the 20-week mean steps/day was positively correlated with the 32-week mean steps/day, LTEQ Total min, and LTEQ Mild min. The 20-week LTEQ Total min was positively correlated with the 32-week Total LTEQ min and the LTEQ Mild min. The 20-week LTEQ Strenuous min was positively correlated with the 32-week Strenuous Min. The 20-week LTEQ...
Moderate min was positively correlated with the 32-week LTEQ Total min and LTEQ Mild min. Similarly, the 20-week LTEQ Mild min was positively correlated with the 32-week LTEQ Total min and LTEQ Mild min.

Descriptive statistics were used to examine the mean and standard deviation values of the variables at 20- and 32-weeks, and a repeated measures analysis of variance (ANOVA) was used to examine differences in the study variables across time (see Table 3). As predicted, the mean steps/day was significantly lower at 32-weeks gestation ($M = 5,426$, $SD = 2,687$) than at 20-weeks gestation ($M = 7,304$, $SD = 2,297$), $p < .05$. In partial support of the hypothesis, LTEQ Strenuous min was significantly lower at 32-weeks ($M = 6.60$, $SD = 5.02$) compared to 20-weeks gestation ($M = 15.00$, $SD = 10.53$). No time differences were observed for LTEQ Total, Moderate, or Mild min. Although not significant, it is interesting to note that while the mean scores for LTEQ Total and LTEQ Mild min were higher at 20- than 32-weeks, the LTEQ Moderate min was actually higher at 32-weeks compared to 20-weeks gestation.

To replicate the findings from Study 1, we used the same self-reported PA (LTEQ Total min of 120 min of PA; at least 4 days of 30 min/day)$^{10,11}$ and pedometer-determined indices (i.e., sedentary = $< 5,000$ steps/day; low active = 5,000-7,499; somewhat active = 7,500-9,999; and active = 10,000+) $^{21}$ to examine the proportion of women meeting activity guidelines. Based on the LTEQ Total min of PA, 56.7% of women were not meeting PA guidelines at 20-weeks and 63.3% were not meeting guidelines at 32-weeks, whereas 33.3% and 26.7% of women were meeting PA guidelines at 20- and 32-weeks gestation, respectively. No significant differences in PA classification were observed from 20- to 32-weeks. Based on the pedometer-determined indices at 20-weeks gestation, participants were classified as sedentary (16.7%), low active (33.3%), somewhat active (40.0%), and active (10.0%). At 32-weeks, the classifications were
sedentary (56.7%), low active (16.7%), somewhat active (23.3%), and active (3.3%; see Figure 1). As predicted, significantly more women were classified as sedentary and low active at 32-weeks gestation compared to 20-weeks gestation, $\chi^2 (1) = 4.46$, $p = .03$. From 20- to 32-weeks gestation, 56.7% of the participants decreased their pedometer-determined category, 33.3% sustained their PA category, and 10.0% increased their PA category.

Discussion

The purposes of Study 2 were to replicate the self-reported PA min and pedometer-determined PA prevalence findings from Study 1, and to prospectively examine the change in women’s self-reported and pedometer-determined PA from 20- to 32-weeks gestation. In general, the findings from Study 2 confirmed those observed in Study 1, and they illustrated that overall, women’s PA behaviors declined from the second to the third pregnancy trimesters. The pedometer-determined indices appeared to classify more women as sedentary and low-active than the self-reported LTEQ min. Several findings warrant further discussion.

In partial support of our hypothesis, some of the LTEQ and pedometer-determined measures were positively associated. As expected, mean steps/day was positively associated with LTEQ Moderate min at 20-weeks. However, mean steps/day was not associated with the LTEQ Total, Strenuous, or Mild min at 20-weeks, and none of the correlations were significant at 32-weeks. These findings suggest that mean steps/day is mostly associated with pregnant women’s min of moderate-intensity exercise in the second trimester only. This finding is not surprising considering that the second trimester is the time period in which most pregnant women feel “good enough” to engage in moderate-intensity exercises (e.g., typically out of the first trimester nausea and vomiting, and not yet experiencing the increasing discomfort of the third trimester).

Interestingly, the 20-week mean steps/day were positively associated with the 32-week mean
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steps/day, LTEQ Total min, and LTEQ Mild min. This finding suggests that women with higher mean steps/day in the second trimester are more likely to engage in total leisure-time exercise behaviors in the third trimester. However, these findings should be interpreted with caution. Because the 20-week mean steps/day was moderately associated with women’s 32-week mild exercise (and not moderate or strenuous exercise), it is likely that the mild activity is mainly responsible for the overall LTEQ score. Thus, the women likely to engage in moderate-intensity activities (e.g., brisk walking, easy jogging) in the second trimester are likely shifting to more mild-intensity activities (e.g., easy walking) in the third trimester. Also, our findings clearly demonstrate that women’s overall PA declined from 20- to 32-weeks gestation.

For example, women had significantly fewer mean steps/day and min of strenuous leisure-time exercise in the third trimester compared to the second trimester, which is consistent with previous research.\(^4,5,12,17\) The fact that this decline in PA was observed with both the objective and self-reported PA measures suggests that this is not the result of measurement error or participant bias (e.g., poor participant retrospective recall or underreporting time spent in PA), but rather, these findings are more likely reflective of the true nature of women’s PA patterns during pregnancy. The psychological (e.g., increased anxiety) and physiological (e.g., increased body weight) changes that pregnant women experience are exacerbated as the pregnancy nears full term and likely adds to this PA reduction. Thus, it is no surprise that women’s overall strenuous PA declined from 20- to 32-weeks gestation. However, it is interesting that their overall steps also declined. The exercise recommendations\(^10,11\) advise that women engage in moderate PA (e.g., brisk walking) throughout their pregnancy. For most women, brisk walking is an activity that can and should be sustained in pregnancy all the way to delivery. From a PA promotion perspective, it is important to emphasize the safety and benefits of moderate-intensity
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PA, and encourage all pregnant women without obstetric or medical complications to engage in at least 30 min of daily moderate-intensity activities such as brisk walking.

Poudevigne and O’Connor suggested that a decline in PA over pregnancy may also reflect a general shift in the types of PA that women choose to do as they become “more” pregnant. For example, a decrease in exercise intensity and duration may occur as women shift away from more difficult types of PA (e.g., running, sports) to those activities that are more comfortable and safe from injury (e.g., walking, swimming). Our findings confirm this suggestion, with the moderate, positive association between women’s 20-week mean steps/day and 32-week min of mild leisure-time exercise behavior. They may also decrease their overall household activities and spend more time resting and preparing for the impending labor. In the current study, although there were no significant differences in leisure-time moderate or mild PA min from 20- to 32-weeks, it is important to note that a nonsignificant trend in the opposite direction was observed for moderate PA min such that more time was spent in moderate PA at 32-weeks compared to 20-weeks gestation. However, regardless of the change in the self-reported PA behaviors, women still had less mean steps/day in the third compared to the second trimester. These data are based on one cohort of women and thus, this could be indicative of a response bias as well. Future research is needed examining women’s pregnancy PA behaviors using both objective and self-reported PA measures across the pregnancy trimesters to confirm our findings.

Consistent with our hypothesis and Study 1 findings, most of the women in Study 2 were classified as low-active and sedentary according to the pedometer-determined indices. More specifically, 50% and 73% of the women were classified as sedentary and low-active at 20- and 32-weeks, respectively. These findings are similar to previous research using pedometers among
nonpregnant women.\textsuperscript{35} Interestingly, although women’s 20-week mean steps/day of about 7,300 steps is considered to be within the healthy range, their 32-week mean steps/day of about 5,400 steps is considered to be within the range of steps for individuals living with disabilities and chronic illnesses.\textsuperscript{30} This is concerning because the ACOG\textsuperscript{10} guidelines suggest that healthy pregnant women should be meeting PA guidelines\textsuperscript{11} to achieve health benefits, however, only 10\% and 3\% of women in this study were meeting PA guidelines at 20- and 32-weeks, respectively. It is important to note that none of the women in this study had medical or obstetric complications (i.e., put on medical restrictions) that may otherwise explain the significant step drop in the third trimester.

Moreover, examination of the participant-specific pedometer step categories\textsuperscript{21} indicated that 57\% of the participants decreased their pedometer category from 20- to 32-weeks, while 33\% sustained their category, and 10\% increased their category. These preliminary data suggest that regardless of the type and intensity of leisure-time PA that women may choose (e.g., running vs. walking), most of the women did not have enough steps to maintain their PA category. Future research is needed to replicate these study findings and to determine if pregnancy-specific pedometer-determined categories are warranted. From a practical perspective, using these categories may be an easy and effective way nurses and doctors to promote PA during pregnancy with their obstetric patients. That is, it may be easier for pregnant women to track their PA with a pedometer and set a goal to maintain a “somewhat active” PA category over the course of the pregnancy rather than attempt to determine if they have accumulated enough min of moderate-intensity PA to be sufficiently active. Future research is needed to test this assumption.

To our knowledge, this is the first study to examine women’s PA behaviors with both pedometer-determined and self-reported PA behaviors during pregnancy. Our findings suggest
that regardless of the type of PA measure that was used, women decreased their PA from 20- to 32-weeks gestation, and they were classified as sedentary and low-active according to both self-reported PA min and pedometer-determined indices in the second and third trimesters. However, it does appear from our findings that the pedometer-determined indices classified more women as sedentary and low-active compared to the self-reported PA min.

Despite the contributions of our study to the literature in this area, there are nonetheless study limitations. We did not obtain a recall of PA to better identify the types of PA that women were doing (e.g., household, occupational, pregnancy-specific activity, etc). This type of assessment should be included in future research to better understand the association between overall steps patterns and types of PA. For example, recent work by Chasan-Taber and her colleagues\textsuperscript{36} to develop the Pregnancy Physical Activity Questionnaire may help researchers better understand the specific types of PA that pregnant women engage in and how these behaviors relate to objectively measured pedometer steps. Also, while the samples from Study 1 and Study 2 were homogenous which improves the replication of the study findings, the participants were mostly non-Hispanic White and middle-to-upper class; thus, limiting the generalizability of the study findings to more diverse populations. Moreover, we have also located no previous studies examining the issue of pedometer accuracy with pregnant populations. However, Crouter and colleagues,\textsuperscript{37} found that the accuracy of spring-levered pedometers, such as the Yamax pedometers used in the current study, can be influenced by tilt angle, waist circumference, and BMI. These factors resulted in Yamax undercounting actual steps, and tilt angle appeared to have the greatest impact on Yamax accuracy. Pedometer tilt angle was not measured in this study, but the combined evidence of the self-reported decreases in PA, and the systematic approach to examining outliers provides evidence that these results
cannot be attributed solely to pedometer error. Also, reliability of pedometer data increased from 20- to 32-weeks. This supports existing data which suggests that more active populations have higher day-to-day pedometer-measured variability than free-living sedentary clinical populations. Nevertheless, future studies employing spring-levered pedometers with pregnant women are advised to measure pedometer tilt angle using the method outlined by Crouter et al. 37

In conclusion, the accumulating evidence from epidemiological, longitudinal, and cross-sectional research suggests that pregnancy is a critical event in women’s lives that may further promote a sedentary lifestyle. There is a need for research aiming to promote PA during this time. From a practical perspective, the Tudor-Locke and Bassett 21 pedometer indices may be a useful tool for healthcare professionals working with pregnant populations to promote and/or maintain PA levels throughout pregnancy.
Author Note

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References


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2005;33:141-149.


Table 1

*Study 2 Pearson Correlations at 20-Weeks (Top) and 32-Weeks (Bottom) Gestation*

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<th>LTEQ Total Min</th>
<th>LTEQ Strenuous Min</th>
<th>LTEQ Moderate Min</th>
<th>LTEQ Mild Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Steps/Day</td>
<td>.24</td>
<td>.00</td>
<td>.35*</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>.00</td>
<td>.04</td>
<td>.19</td>
<td>.13</td>
</tr>
<tr>
<td>LTEQ Total Min</td>
<td>.10</td>
<td>.81**</td>
<td>.92**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.02</td>
<td>.67**</td>
<td>.88**</td>
<td></td>
</tr>
<tr>
<td>LTEQ Strenuous Min</td>
<td>-.33</td>
<td>-.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.06</td>
<td>-.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTEQ Moderate Min</td>
<td></td>
<td></td>
<td>.66**</td>
<td>.51**</td>
</tr>
</tbody>
</table>

*Note. Mean steps/day = average of 3 days of pedometer steps; LTEQ = Leisure-Time Exercise Questionnaire.*

* = p < .05, ** = p < .001.
Table 2

*Study 2 Pearson Correlations of the Variables at 20-Weeks Gestation with the Variables at 32-Weeks Gestation*

<table>
<thead>
<tr>
<th>20-Week Variables</th>
<th>Mean Steps/Day</th>
<th>LTEQ Total Min</th>
<th>LTEQ Strenuous Min</th>
<th>LTEQ Moderate Min</th>
<th>LTEQ Mild Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-Week Variables</td>
<td>Mean Steps/Day</td>
<td>.41*</td>
<td>.02</td>
<td>.26</td>
<td>.12</td>
</tr>
<tr>
<td>LTEQ Total Min</td>
<td>.35*</td>
<td>.72**</td>
<td>.05</td>
<td>.60**</td>
<td>.66**</td>
</tr>
<tr>
<td>LTEQ Strenuous Min</td>
<td>.04</td>
<td>.06</td>
<td>.83**</td>
<td>.33</td>
<td>.20</td>
</tr>
<tr>
<td>LTEQ Moderate Min</td>
<td>.18</td>
<td>.27</td>
<td>-.11</td>
<td>.23</td>
<td>.27</td>
</tr>
<tr>
<td>LTEQ Mild Min</td>
<td>.35*</td>
<td>.66**</td>
<td>-.29</td>
<td>.56**</td>
<td>.69**</td>
</tr>
</tbody>
</table>

*Note.* Mean steps/day = average of 3 days of pedometer steps; LTEQ = Leisure-Time Exercise Questionnaire.

* = $p < .05$, ** = $p < .001$. 
Table 3

*Study 2 Mean (M), Standard Deviation (SD), and Repeated Measures ANOVA Results*

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>W</th>
<th>F^a</th>
<th>p</th>
<th>η^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Steps/Day</td>
<td>.67</td>
<td>14.21</td>
<td>.001</td>
<td></td>
<td>.33</td>
<td></td>
</tr>
<tr>
<td>20 weeks</td>
<td>7,304</td>
<td>2,297</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>32 weeks</td>
<td>5,426</td>
<td>2,687</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTEQ Total Min</td>
<td>.99</td>
<td>0.25</td>
<td>.61</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 weeks</td>
<td>1006.80</td>
<td>92.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 weeks</td>
<td>100.20</td>
<td>80.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTEQ Strenuous Min</td>
<td>.72</td>
<td>9.33</td>
<td>.01</td>
<td>.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 weeks</td>
<td>15.00</td>
<td>10.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 weeks</td>
<td>6.60</td>
<td>5.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTEQ Moderate Min</td>
<td>.91</td>
<td>2.46</td>
<td>.13</td>
<td>.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 weeks</td>
<td>36.34</td>
<td>34.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 weeks</td>
<td>51.92</td>
<td>31.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTEQ Mild Min</td>
<td>.99</td>
<td>0.05</td>
<td>.83</td>
<td>.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 weeks</td>
<td>56.53</td>
<td>42.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 weeks</td>
<td>54.23</td>
<td>52.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* \(^a\) = df (1, 35); W = Wilks’ Lambda, η^2 = eta squared; Mean steps/day = average of 3 days of pedometer steps; LTEQ = Leisure-Time Exercise Questionnaire.
Figure Caption

*Figure 1.* Study 2 classification of participants by pedometer-determined indices at 20- and 32-weeks gestation.
Pregnancy, Physical Activity, Pedometer

20-weeks gestation

- Sedentary: 10.0%
- Low Active: 33.3%
- Somewhat Active: 40.0%
- Active: 16.7%

32-weeks gestation

- Sedentary: 3.3%
- Low Active: 16.7%
- Somewhat Active: 23.3%
- Active: 56.7%