# Physical Activity and Mood during Pregnancy

MELANIE S. POUDEVIGNE[1], and PATRICK J. O'CONNOR[2]

[1]*Clayton State University; Health Care Management, Morrow, GA; and* [2]*University of Georgia, Exercise Science Department, Athens, GA*

**ABSTRACT**

POUDEVIGNE, M. S., and P. J. O'CONNOR. Physical Activity and Mood during Pregnancy. *Med. Sci. Sports Exerc.*, Vol. 37, No. 8, pp. 1374–1380, 2005. **Purpose:** To compare three physical activity (PA) measures in pregnant women and examine mood correlates of physical activity changes during pregnancy. **Methods:** A sample of 12 pregnant women (PW) was recruited during their first trimester and 12 nonpregnant women (NPW) (baseline age = 30.7 ± 4.4 yr) were matched to the PW (29.8 ± 4.2 yr). Once monthly, for seven consecutive months, total weekly energy expenditure (TWEE) was assessed using a physical activity diary (PAD) and a recall interview (PAR). Accelerometers were worn for 3 d each month. Mood was also assessed. A two-factor mixed-model ANOVA was used to analyze the data (2 groups [PW vs NPW] × 7 times across pregnancy). **Results:** Mean PAR TWEE and daily mean MTI counts were positively and moderately correlated with mean PAD TWEE (PW: r = 0.40 and NPW: r = 0.50, $P < 0.001$). The MTI counts decreased significantly in PW by 23% from gestational weeks 12 to 36 compared with a 5% decrease in NPW. Fatigue and vigor scores improved from gestational weeks 12 to 16 and worsened from weeks 32 to 36 in PW. Changes in PA were not correlated to changes in mood in either group. **Conclusions:** The results provide some evidence for the validity of the 7-d PAR and accelerometer as measures of physical activity in pregnancy. Healthy women who maintain an above average level of physical activity during the second and third trimesters can enjoy mood stability. **Key Words:** ACCELEROMETER, DIARY, RECALL, SELF-WORTH

Many women reduce their physical activity during pregnancy. Evidence for this statement stems from common clinical practices, such as the recommendation of bed rest for approximately 20% of pregnant women, and both retrospective and prospective studies. For example, a retrospective survey of 9953 pregnant women found that the percent of the sample who reported exercising for 30 min or more at least three times per week changed from 55% before pregnancy to 42% after pregnancy. This change was observed despite 7% of the women who were inactive before pregnancy becoming active during pregnancy (27).

One weakness of the available evidence regarding changes in physical activity during pregnancy is the crude recall methods that typically have been used to assess physical activity. Most studies with pregnant women have used physical activity measures with no published evidence of their reliability or validity despite the likelihood that the accurate assessment of physical activity is more difficult in pregnant women (23). Studies that have used established physical activity measures often have been characterized by other limitations, including infrequent assessments (e.g., only one to two consecutive days of activity measured only two to three times during pregnancy) and a failure to employ nonpregnant controls (5,9,12,23,26). Only one study has compared several methods for measuring physical activity in pregnant women (23). Pregnancy is associated with increased psychological distress for many women, including increased anxiety, depression, and fatigue. A prospective investigation of more than 14,000 pregnant women found that depression symptom scores were higher at 18 and 32 wk of pregnancy than at 8 wk and 8 months postpartum (7). A prospective study of 117 pregnant women found that symptoms were most common during the third trimester and 97% of the women reported fatigue at some point during their pregnancy (28).

Given the known links between inactivity and reduced mental health, a relationship between pregnancy-related reductions in physical activity and psychological distress is plausible. Only a small number of investigations have examined the relationship between changes in physical activity during pregnancy and changes in mood. These studies found that low physical activity was associated with higher scores on anxiety (5,9), depression (5,12) and fatigue scales (26). Conclusions from these investigations are tempered by methodological limitations such as the absence of control groups or the failure to use physical activity measures with supportive validity evidence.

The primary purposes of this prospective investigation were to describe physical activity patterns during the second and third trimester of pregnancy using three different, established measures and make comparisons among the measures. A secondary purpose was to learn whether the changes in physical activity during pregnancy were associated with changes in mood. The research was designed to extend the current literature by making frequent (monthly) assessments, by measuring physical activity using three

Address for correspondence: Mélanie S. Poudevigne, Ph.D., Clayton State University, Office of Health Care Management, 5900 North Lee St., Morrow GA 30260; E-mail: mpoudevigne@yahoo.com.
Submitted for publication September 2004.
Accepted for publication March 2005.

0195-9131/05/3708-1374/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/01.mss.0000174907.27818.ff

commonly used instruments, and by comparing the findings to a group of nonpregnant women controls. It was hypothesized that: 1) there would be a moderate positive correlation between energy expenditure assessed with a criterion measure of physical activity (7-d diary) and energy expenditure estimated using a seven day physical activity recall, and that this relationship would be stronger for the controls than for pregnant group; 2) there would be positive correlations of weak-to-moderate strength between both these measures and an objective measure of physical activity (i.e., acceleration counts), and that these relationships would be stronger for the controls than the pregnant group; 3) the moods of anxiety, depression, fatigue, and vigor would worsen at the end of pregnancy compared with both the beginning of the second trimester and to controls; and 4) moderate associations would be found between changes in physical activity and changes in mood.

## METHODS

### Recruitment

Potential participants were recruited through newspaper announcements, by flyers placed at women clinics and obstetricians offices, and at maternity-related businesses. Pregnant participants were required to be healthy women without a complicated pregnancy who were between the ages of 18 and 40, and who were able to read and understand English. Women were recruited into the study during their first trimester. All participants provided written informed consent after reviewing a document that had been approved by the human research review committee at the University of Georgia. Each woman was given $70 for her time.

A total of 30 pregnant women inquired about the study and 18 completed the first testing session. The reasons expressed by the 12 women who did not engage in the study included distance to the laboratory, time commitment required, and inadequate monetary or other incentives. No data were obtained from these women. After the first testing session, six women dropped out, two because of relocation and four because of the time demands (primarily with the diary). After the remaining group of 12 pregnant participants completed all the testing sessions, a group of 12 age- ($\pm$ 2 yr), height- ($\pm$ 5 cm), weight- ($\pm$ 2.5 kg), and race-matched nonpregnant/nonlactating control women were recruited. The mean age (SD) at enrollment was 29.8 yr (4.2) for the pregnant group and 30.7 yr (4.4) for the controls. The mean baseline weight (SD) was 68.9 kg (11.9) for the pregnant group and 66.5 kg (13.5) for the controls. Forty two percent of the pregnant group was parous, with a median parity of one (range, 0–3). Ten women worked throughout their pregnancy. Ninety-two percent of the pregnant women took prenatal vitamins and 42% of the controls took birth control pills. Eighty five percent of the participants in each group were white. None of the participants took psychiatric medication or was a competitive athlete.

### Power Analysis

Thirteen subjects per group provided *a priori* statistical power of 0.80 for testing the presence of a large interaction effect ($d = 1.1$) using a mixed model with two groups (pregnant vs nonpregnant) and seven repeated trials (24; Table 3). This calculation assumes a correlation between repeated trials of 0.90 and a two-sided test at an alpha of 0.05. Because hypothesis 3 was one-sided, 12 participants per group provided an *a priori* power of at least 0.80.

### Procedures

Physical activity, body weight, and mood were measured at gestational weeks 12, 16, 20, 24, 28, 32, and 36. The women were asked to refrain from eating, drinking caffeine, and exercising for at least 2 h before coming to the laboratory. Also, the women were asked to not deviate from their normal activities of daily living.

### Measurements

Demographic information was collected at the beginning of the study. Weight was measured at each time point using a double balance beam scale. Physical activity was measured using a 7-d diary, a 7-d physical activity recall, and 3 d of motion sensor recordings.

**Physical activity diary.** A diary of daily physical activities was obtained for seven continuous days before each laboratory testing session using the 3-d physical-activity record method (2). With this method the day is divided into 96 periods of 15 min each. For each 15-min period, the participants indicated the dominant physical activity performed. An activity card was provided that gave examples of activities of different intensities divided into nine categories. When a participant completed an activity that was not listed, she was instructed to apply the categorical value that seemed closest in intensity. Uncertainties were reported to the study coordinator for proper classification at the time of the next laboratory visit. Administration of the diary and calculation of estimated energy expenditure followed Bouchard et al. (2). Before actual data collection, each woman practiced completing the diary until she became proficient with it. Estimated energy expenditure using this diary has been found to be in close agreement with doubly labeled water. Energy expenditure estimates from this diary have been found to be significantly correlated (r range from 0.24 to 0.86) with other measures of energy expenditure based on questionnaires and accelerometry (21). The diary was considered to be the criterion measure of physical activity in this investigation.

**Physical activity recall.** An interviewer-administered 7-d physical activity recall was used to assess physical activities performed during the week preceding each testing session (1). Participants were asked to estimate the number of hours spent each day (starting with the current day and working backwards) in sleep, moderate, hard, and very hard physical activities. Any time not accounted for by these activities was categorized as light activity. Details of the

interview procedures and the methods used to estimate energy expenditure from the physical activity reports have been described elsewhere (13). The 7-d physical activity recall is one of the most commonly used measures of physical activity. Energy expenditure estimates from the 7-d recall have been found to be significantly correlated ($r = 0.20–0.86$) with other measures of energy expenditure based on diary, questionnaire, heart rate, acceleration count, and doubly labeled water data (1,6,19,21).

**Motion sensor.** The MTI® accelerometer (Manufacturing Technology Inc., Fort Walton Beach, FL) was used to obtain an objective measure of physical activity. The MTI is a uniaxial piezo-electric accelerometer. Accelerations are measured within the range of human movements and converted to counts. One count is equivalent to 16 $mg \cdot s^{-1}$. The MTI counts have been found to be highly correlated ($r > 0.85$) to the speed of both treadmill walking and running as well as oxygen consumption during walking (3,8).

The MTI was worn on the left hip, clipped to a waist band. Participants were instructed to remove it while swimming or showering. The participants were instructed to wear the MTI for two weekdays and one weekend day from the time they woke up to the time they went to bed. If the MTI record revealed that these instructions were not followed the participant was asked to wear the MTI for three additional full days, including one weekend day, to minimize missing data. Three women were asked to wear the device again. MTI counts were recorded and stored every minute. The number of counts recorded each day was totaled and divided by the number of minutes the MTI was worn each day to yield a daily average number of counts per minute. The criterion physical activity measure from the MTI was the 3-d mean of the daily average counts per minute.

**Mood.** Mood was measured using the 65-item Profile of Mood States (POMS) questionnaire. The POMS measures six mood states: tension, depression, anger, vigor, fatigue, and confusion (15). The POMS was used in this study because it is among the most accepted and widely used measures of mood available and it has extensive evidence supporting its reliability and validity (17), including data from large samples of pregnant women (25). The participants described how they had been feeling "during the past week including today" by rating the intensity of their feeling using five categories: "not at all," "a little," "moderately," "quite a bit," and "extremely." There is a large body of factor analytic, correlational, and experimental evidence supporting the idea that scores from this questionnaire can be interpreted as six separate measures of transitory mood states (15,16). For example, in a sample of 400 adults, the POMS scores correlated highly ($r = 0.54–0.70$) with corresponding visual analog mood scales (16). Completion of this questionnaire took 10 min.

### Statistical Analysis

Data were entered into two spreadsheets by two separate investigators. Comparing the two spreadsheets facilitated the identification of data entry errors.

The control group had no missing data. A small amount of data was missing for the pregnant group primarily because of a failure to attend one of the seven testing days. Missing data from the pregnant group involved five of 252 daily MTI records and three of 84 7-d recall, physical activity diary, and mood measures. Missing data were estimated by interpolation from scores obtained during the testing session before or after (or both) the testing session from which the data were missing.

Statistical analyses were conducted with SPSS Statistical Software version 11.5 (SPSS Inc., Chicago, IL). The assumptions for analysis of variance were tested; normality and independence assumptions were met. When sphericity was not met, degrees of freedom were adjusted using the Huynh–Feldt adjustments. A box plot analysis revealed no outliers for any variable. For hypothesis 1 and 2, Pearson correlations were computed with the pregnant and control groups separately (12 participants per group $\times$ 7 trials = 84 data points). Hypothesis three was tested using a mixed-model ANOVA, with repeated measures on the time factor. A significant group and time interaction was hypothesized. For hypothesis four, Spearman correlations were performed on the changes in physical activity between weeks 16 and 36 and the corresponding changes in the four measures of mood, which the literature suggests change with pregnancy (anxiety, depression, vigor and fatigue). Spearman rank–order correlations were used as a nonparametric measure of association based on the rank of the data values because the change scores were not normally distributed, even after log transformation.

## RESULTS

**Physical activity.** Table 1 reports body weight data and the time spent both sleeping and in different intensities of physical activities based on the 7-d recall. No significant group main effects or group $\times$ time interactions were found for any of the variables regarding sleep or time spent in different intensities.

Figure 1 illustrates the relation between energy expenditure estimated with the diary and recall methods. Group and time main effects and group $\times$ time interactions were not statistically significant for either the diary or the recall method. Averaged across the seven testing sessions, the recall method underestimated (insignificantly) energy expenditure by an average of 37 $kcal \cdot kg^{-1} \cdot wk^{-1}$ for the pregnant women, and 23 $kcal \cdot kg^{-1} \cdot wk^{-1}$ for the controls. Figure 2 shows a scatterplot of the relationship between diary and recall estimates of energy expenditure. The correlation between the diary and recall estimates of energy expenditure for pregnant women was $r = 0.41$ ($N = 84$). The correlation between the diary and recall estimate of energy expenditure for the controls was $r = 0.52$ ($N = 84$).

The pregnant group wore the physical activity monitors for an average of 14.1 h across the seven testing sessions (group mean range 13.6–14.5). The controls wore the physical activity monitors for an average of 15.1 h across the seven testing sessions (range of 14.6–16). Figure 3 shows

TABLE 1. Body weight and weekly duration (h ± SD) in sleep, light, moderate, hard, and very hard physical activity intensities in 12 pregnant and 12 nonpregnant women during gestational weeks 12–36.

| | Gestational Week | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
|---|---|---|---|---|---|---|---|---|
| Sleep | Nonpregnant women | 54 ± 6 | 57 ± 5 | 57 ± 5 | 56 ± 6 | 60 ± 10 | 53 ± 4 | 53 ± 7 |
| | Pregnant women | 60 ± 5 | 60 ± 5 | 59 ± 5 | 57 ± 4 | 59 ± 6 | 58 ± 5 | 58 ± 5 |
| Light activities | Nonpregnant women | 106 ± 10 | 102 ± 10 | 101 ± 9 | 105 ± 7 | 99 ± 12 | 105 ± 9 | 103 ± 13 |
| | Pregnant women | 100 ± 7 | 95 ± 7 | 100 ± 7 | 103 ± 9 | 96 ± 7 | 97 ± 10 | 102 ± 8 |
| Moderate activities | Nonpregnant women | 5.5 ± 7.4 | 7.5 ± 9.7 | 8.5 ± 8.8 | 5.0 ± 4.8 | 7.0 ± 6.2 | 8.75 ± 9.0 | 11.0 ± 13.8 |
| | Pregnant women | 7.5 ± 6.6 | 10.5 ± 8.4 | 8.0 ± 6.2 | 7.75 ± 9.5 | 12.5 ± 6.4 | 11.25 ± 9.8 | 8.0 ± 8.1 |
| Hard activities | Nonpregnant women | 1.1 ± 1.7 | 1.4 ± 2.0 | 0.67 ± 1.1 | 0.71 ± 0.9 | 0.77 ± 1.2 | 1.4 ± 4.9 | 0.90 ± 1.6 |
| | Pregnant women | 0.87 ± 0.67 | 0.85 ± 0.84 | 0.83 ± 0.11 | 0.84 ± 0.97 | 0.86 ± 0.80 | 0.84 ± 0.73 | 0.82 ± 0.13 |
| Very hard activities | Nonpregnant women | 0.40 ± 0.54 | 0.33 ± 0.65 | 0.46 ± 0.86 | 0.31 ± 0.50 | 0.54 ± 1.72 | 0.27 ± 0.62 | 0.19 ± 0.47 |
| | Pregnant women | 0.50 ± 0.14 | 0.42 ± 0.81 | 0.25 ± 0.59 | 0.08 ± 0.29 | 0.08 ± 0.29 | 0.06 ± 0.15 | 0.00 ± 0.00 |
| Body weight | Nonpregnant women | 66.5 ± 13.5 | 66.5 ± 13.2 | 66.3 ± 13.0 | 66.1 ± 12.8 | 66.0 ± 13.8 | 66.0 ± 13.4 | 66.0 ± 13.9 |
| | Pregnant women | 68.9 ± 11.9 | 70.1 ± 11.6 | 70.3 ± 11.9 | 72.8 ± 12.7 | 74.7 ± 12.8 | 76.3 ± 13.2 | 78.8 ± 13.5 |

the averaged daily MTI counts across time for the pregnant and nonpregnant groups. A mixed-model two-way ANOVA on counts per minute showed insignificance for the group × time interaction and for the main effect for group. The main effect for time was significant ($F = 2.51$; $df = 4.6, 101.0$; $P = 0.039$; $\eta^2 = 0.10$). Univariate analysis showed a significant difference in the time factor for the pregnant women ($F = 2.60$; $df = 6.66$; $P = 0.025$, $\eta^2 = 0.19$). A series of paired *t*-tests showed differences in time for the pregnant group between sessions 1 and 6 ($P = 0.038$), 2 and 6 ($P = 0.035$), 2 and 7 ($P = 0.032$), 4 and 6 ($P = 0.025$), and 4 and 7 ($P = 0.042$). The level of MTI activity counts decreased by 23% in the pregnancy group and 5% in the controls between gestational weeks 12 and 36. Figure 4 shows a scatterplot of the relationship between energy expenditure estimated from the diary and physical activity measured by MTI counts. The correlation between these two variables for the pregnant group was r = 0.41 and for the controls was r = 0.50. The correlation between the MTI counts and energy expenditure estimated from the seven day recall was r = 0.23 for the pregnant group and r = 0.30 for the controls.

**Mood.** The mood data are provided in Table 2. No significant group main effects or group × time interactions were found for any of the mood variables. A significant time main effect was found for the moods of fatigue ($F = 4.3$; $df = 4.4; 97.4$; $P = 0.002$; $\eta\,(2) = 0.16$) and vigor ($F = 3.56$; $df = 6, 132$; $P = 0.003$; $\eta\,(2) = 0.14$). For the pregnant women the largest changes in fatigue and vigor occurred during weeks 12–16 and weeks 32–36. Fatigue decreased and vigor increased from weeks 12 to 16. Fatigue increased and vigor decreased from weeks 32 to 36. The controls showed similar changes in fatigue scores during these weeks. In general, Spearman correlations between changes in physical activity and mood were not significant for the pregnant or control groups (range from r = −0.55 to 0.35; the highest negative correlation was between fatigue and physical activity assessed by recall).

## DISCUSSION

This study compared three different methods for assessing physical activity in a group of pregnant women because methods for measuring physical activity rarely have been validated in pregnant women.

No prior studies of pregnant women have compared estimates of energy expenditure from a physical activity diary to the 7-d recall. The range of mean weekly energy expenditure values from both the diary and recall methods for the pregnant and control women in this study were consistent with prior studies of nonobese adult women in which weekly energy expenditures of 250–305 kcal·kg$^{-1}$·wk$^{-1}$ have been reported using doubly labeled water and indirect calorimetry (20). Weekly energy expenditures of a similar range (230–300 kcal·kg$^{-1}$·wk$^{-1}$) also have been reported

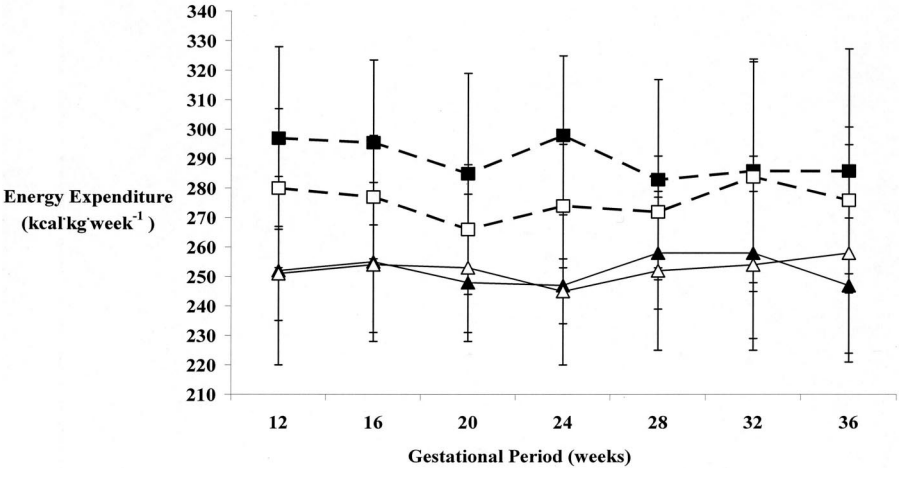


**FIGURE 1—Seven-day diary and 7-d recall estimates of energy expenditure (mean ± SD) in 12 pregnant women during gestational weeks 12–36 and 12 nonpregnant controls. Pregnant women diary, *closed square*; nonpregnant diary, *open square*; pregnant women recall, *closed triangle*; nonpregnant women recall, *open triangle*.**

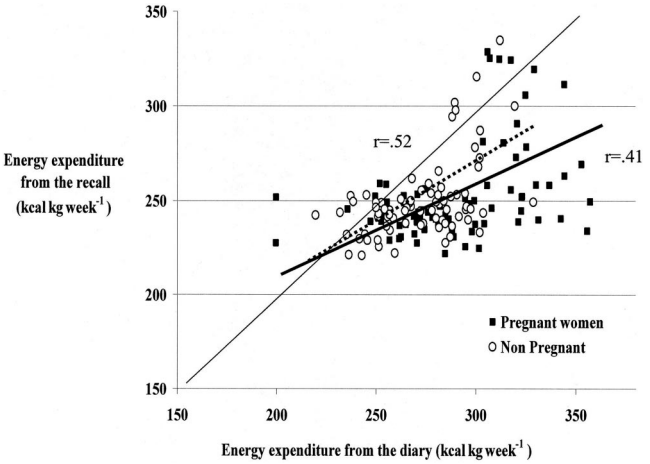


**FIGURE 2—The relationship between weekly energy expenditures from the diary and the recall in 12 pregnant women at gestational weeks 12–36 and 12 nonpregnant women. Pregnant women, *closed square/solid line*; nonpregnant women, *open circle/dashed line*.**

for college students and community samples using the 7-d recall (1,6).

The 7-d recall results showed that the pregnant group, on average, was as active during their second and third trimesters as 566 nonpregnant women (25–34 yr old) who participated in a large community study (252 vs 256 kcal·kg$^{-1}$·wk$^{-1}$, respectively) (1). Nonetheless, weekly energy expenditure was underestimated to a small and insignificant degree with the 7-d recall compared with the diary by 37 kcal·kg$^{-1}$·wk$^{-1}$ in the pregnant group. This underestimate was 14 kcal·kg$^{-1}$·wk$^{-1}$ greater than the underestimate found for the control group (23 kcal·kg$^{-1}$·wk$^{-1}$). Inaccuracies in memory represent a plausible explanation for this small underestimation of energy expenditure with the recall method. The recall required the women to rely on their memory of activities performed during the prior week. The women may have forgotten certain physical activities, especially short duration, moderate intensity, or infrequent activities performed at the beginning of the recall period. Irwin and Ainsworth (10) suggested that the estimation of total energy expenditure from the 7-d recall was more variable than from the 7-d diary in a study of 24 males because the 7-d recall overestimated by 68 kcal·kg$^{-1}$·wk$^{-1}$ compared with the 7-d diary. Conversely, Richardson and colleagues (19) reported that the 7-d recall underestimated total energy expenditure compared to the diary by 21 kcal·kg$^{-1}$·wk$^{-1}$ in 50 women of child-bearing age. Prior studies with nonpregnant samples suggest that the 7-d recall is most accurate in distinguishing activity extremes (6).

The 7-d recall method resulted in weekly energy expenditure values for pregnant women that were moderately correlated with the criterion diary method ($r = 0.52$), and this correlation was similar to that found for the nonpregnant control group ($r = 0.40$). Correlations of both similar (11) and higher (6) magnitude have been reported in studies of nonpregnant samples. An examination of the scatterplot of the relationship in this study (i.e., Fig. 2) reveals that the slopes of the regression lines appear to differ for the pregnant compared with the control group. A statistical test for a difference in the slopes of these regression lines was not performed because one of the assumptions underlying the test (independence) could not be met. Nonetheless, the regression lines appear to show greater underestimation of energy expenditure associated with higher physical activity in the pregnant compared to the control group.

The 7-d recall method resulted in weekly energy expenditure values for pregnant women that were weakly correlated with the accelerometer counts ($r = 0.23$), and this correlation was similar to that found for the nonpregnant control group ($r = 0.30$). Correlations of higher magnitude have been reported in studies of nonpregnant samples

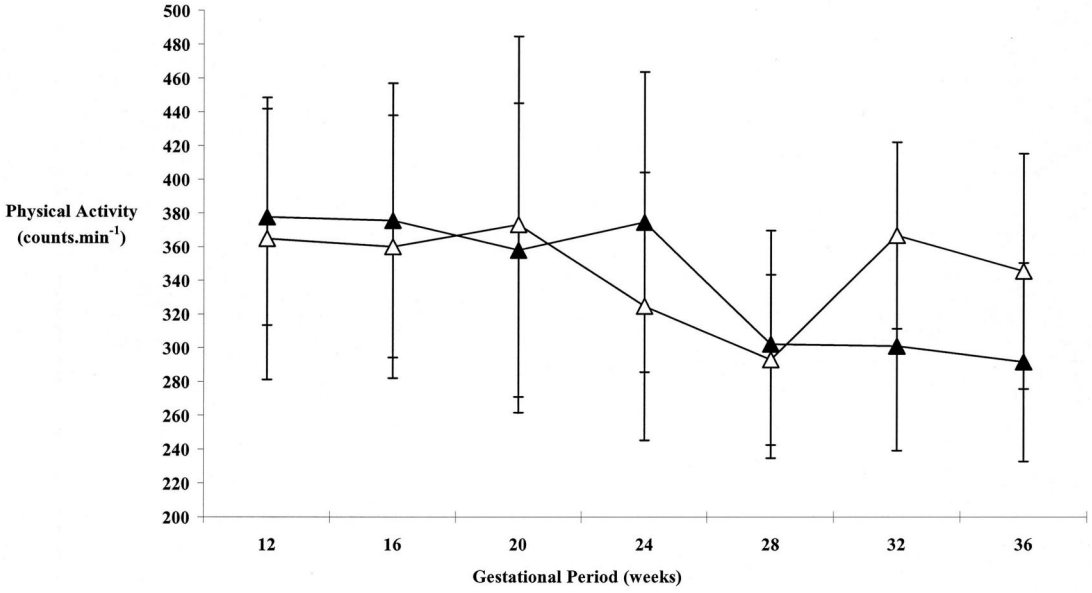


**FIGURE 3—Physical activity in the 12 pregnant women during gestational week 12–36 and 12 nonpregnant women controls. Data are expressed in average daily acceleration counts per minute (mean ± SD). Pregnant women, *closed triangle*; nonpregnant women, *open triangle*.**

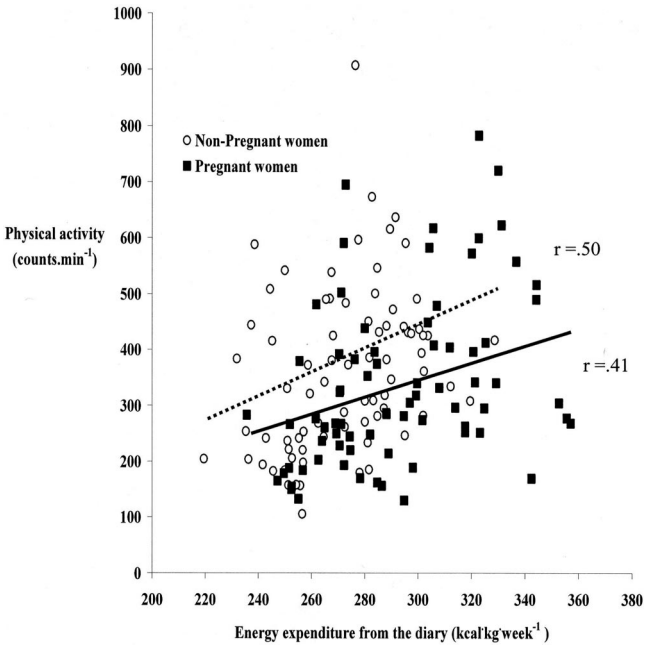


**FIGURE 4—The relationship between weekly energy expenditure from the diary and the three day mean MTI counts per minute in 12 pregnant and 12 nonpregnant women at gestational weeks 12–36. Pregnant women, *closed square/solid line*; nonpregnant women, *open circle/dashed line*.**

(11,22). These lower correlations might be explained by a smaller range of activity counts in the present sample.

No prior studies of pregnant women have compared a physical activity diary to acceleration counts measured by the MTI. An examination of the scatterplot of the relationship between the diary and MTI data in this study (i.e., Fig. 3) reveals that the slopes of the regression lines appear to differ for the pregnant compared with the control group, but no appropriate statistical test of the difference in slopes could be conducted because all the required assumptions could not be met. For the pregnant women, acceleration counts were moderately correlated with the criterion diary method ($r = 0.50$), and this correlation was similar to that found for the nonpregnant control group ($r = 0.41$). Correlations of similar magnitude have been reported in studies of nonpregnant samples using the MTI (22). One study of 28 habitually active pregnant women reported higher correlations ($r = 0.68–0.76$) between energy expenditure during pregnancy estimated from 2-d of Caltrac® acceleration counts and 2-d of diary records (23). It is potentially worth noting that the present sample of pregnant women showed a 23% decrease in MTI counts from weeks 12 to 36 compared with a 5% decrease in the controls, and that this decrease was not observed with the diary or recall methods. This suggests that the MTI may be more sensitive to changes in physical activity during pregnancy compared to the recall and diary, but it is also possible that this may represent sampling bias, considering that only 3 d of MTI data were obtained, whereas 7 d of data were obtained with the other methods.

TABLE 2. Monthly mood measured by the Profile of Mood States (mean ± SD) in 12 pregnant and 12 nonpregnant matched women.

| | Gestation Week | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
|---|---|---|---|---|---|---|---|---|
| POMS-Vigor | Nonpregnant | 15.4 (4.8) | 16.5 (6.1) | 18.1 (5.3) | 16.3 (5.2) | 15.3 (6.4) | 15.4 (5.7) | 15.7 (6.8) |
| | Pregnant | 11.8 (5.0) | 16.6 (8.1) | 18.1 (7.2) | 16.7 (7.8) | 16.1 (6.8) | 17.4 (7.6) | 15.5 (7.7) |
| POMS-Fatigue | Nonpregnant | 9.4 (5.9) | 5.8 (4.2) | 6.5 (4.7) | 7.3 (5.8) | 5.3 (4.1) | 5.1 (4.5) | 6.7 (5.9) |
| | Pregnant | 11.9 (7.1) | 5.9 (6.2) | 5.7 (5.2) | 7.3 (5.9) | 8.0 (5.8) | 8.1 (5.8) | 10.3 (6.8) |
| POMS-Depression | Nonpregnant | 7.6 (9.7) | 4.4 (5.6) | 5.8 (7.6) | 5.8 (6.4) | 5.0 (6.1) | 6.2 (8.5) | 5.0 (6.8) |
| | Pregnant | 4.0 (5.1) | 3.8 (7.9) | 4.2 (9.2) | 2.6 (6.3) | 2.7 (4.5) | 2.3 (5.1) | 2.0 (2.5) |
| POMS-Tension | Nonpregnant | 10.0 (7.7) | 6.2 (4.0) | 7.8 (5.2) | 8.5 (6.0) | 6.5 (5.0) | 7.1 (5.8) | 5.8 (4.8) |
| | Pregnant | 5.4 (3.1) | 5.0 (5.0) | 5.2 (6.1) | 6.6 (7.4) | 5.5 (5.6) | 5.1 (4.6) | 6.0 (4.5) |

**Mood.** The mean anxiety and depression scores for the pregnant group throughout the study were approximately one standard deviation lower than norms for college women (15). This observation is consistent with the common finding of positive mood states among physically active nonpregnant groups (18). This finding was inconsistent with our predictions that anxiety and depression scores would increase as pregnancy moved toward the end of the third trimester. Several factors may have contributed to these results including the level of physical activity of the pregnant group (5), freedom from health problems enjoyed by the pregnant women, strong social support that the participants anecdotally reported receiving, small sample bias, and different instruments used to measure mood. For example, the POMS scales focus on the intensity of mood symptoms, whereas scales used to measure depression in other studies focus on the frequency of mood symptoms (7).

At the outset of the study, vigor and fatigue scores were not as positive compared to norms as anxiety and depression scores. The fatigue scores were above the college norms and vigor scores were approximately 0.5 standard deviations below normal. This observation is inconsistent with prior studies of physically active groups who show lower than normal scores on anxiety, depression, and fatigue and higher than average scores on vigor (18). The results suggest pregnancy-related disturbances in fatigue and vigor scores at the outset of the study (i.e., week 12: the end of the first trimester and the beginning of the second trimester). The improvement in fatigue and vigor scores from weeks 12 to 16 are consistent with reports that fatigue and other mood states often improve as pregnant women move into their second trimester (14). Vigor and fatigue scores did worsen to a small extent at the end of the third trimester from weeks 32 to 36, but the magnitude of these effects were not as large as were expected based on prior investigations (4). It is possible that the above average level of physical activity in the pregnant group attenuated late pregnancy-related fatigue and loss of energy, but the design of this investigation does not permit such a conclusion.

**Relationships between changes in physical activity and mood.** Moderate, positive correlations between changes in physical activity and changes in mood were hypothesized. These hypotheses were not supported. The generally small changes in physical activity and mood prevented a strong test of the hypothesized relationships. Thus, examining relationships between pregnancy-related physi-

cal activity and psychological states remains a potentially fruitful area of inquiry.

It may be useful for readers to bear in mind several key limitation of the present study. The study involved a relatively small sample of self-selected participants. Thus, the findings may not generalize to other samples of pregnant women, perhaps especially those from other socioeconomic or ethnic backgrounds, because our sample consisted mostly of middle-class Caucasian women. Also, the sample size did not eliminate the possibilities for small sample bias in the results or Type II errors associated with multiple contrasts. Nonetheless, the results provide some evidence for the validity of the 7-d physical activity recall and MTI accelerometer as measures of physical activity in pregnancy, methods that are less burdensome than physical activity diaries. Healthy women who maintain an above average level of physical activity during the second and third trimester of pregnancy can enjoy mood stability.

The authors express their thanks to the participants. Special appreciation is extended to Susan Marie Gisler and John Andrew Goldsmith for their assistance with testing the study participants.

The University of Georgia's College of Education provided financial support for this study.

## REFERENCES

1. Blair, S. N., W. L. Haskell, P. Ho, et al. Assessment of habitual physical activityby a seven-day recall in a community survey and controlled experiments. *Am.J. Epidemiol.* 122:794–804, 1985.
2. Bouchard, C., A. Tremblay, C. Leblanc, G. Lortie, R. Savard, and G. Theriault. A method to assess energy expenditure in children and adults. *Am. J. Clin. Nutr.* 37:461–467, 1983.
3. Brage, S., N. Wedderkopp, P. W. Franks, L. B. Andersen, and K. Froberg. Reexamination of validity and reliability of the CSA monitor in walking and running. *Med. Sci. Sports Exerc.* 35:1447–1454, 2003.
4. Chien, L.Y., and Y. L. Ko. Fatigue during pregnancy predicts caesarean deliveries. *J. Adv. Nurs.* 45:487–494, 2004.
5. DaCosta, D., N. Rippen, M. Dritsa, and A. Ring. Self-reported leisure time physical activity during pregnancy and relationship to psychological well-being. *J. Psychosom. Obstet. Gynaecol.* 24: 111–119, 2003.
6. Dishman, R.K., and M. Steinhardt. Reliability and concurrent validity for a 7-d recall of physical activity in college students. *Med. Sci. Sports Exerc.* 20:14–25, 1988.
7. Evans, J., J. Heron, H. Francomb, S. Oke, and J. Golding. Cohort study of depressed mood during pregnancy and after childbirth. *Br. Med. J.* 323:257–260, 2001.
8. Freedson, P. S., E. Melanson, and J. Sirard. Calibration of the Computer Science and Applications, Inc. accelerometer. *Med. Sci. Sports Exerc.* 30:777–781, 1998.
9. Goodwin, A., J. Astbury, and J. McMeeken. Body image and psychological well-being in pregnancy. A comparison of exercisers and non-exercisers. *Aust. N. Z. J. Obstet. Gynaecol.* 40:443–447, 2000.
10. Irwin, M. L., B. E. Ainsworth, and J. M. Conway. Estimation of energy expenditure from physical activity measures: determinants of accuracy. *Obes. Res.* 9:517–25, 2001.
11. Johansen, K. L., P. Painter, J. A. Kent-Braun, et al. Validation of questionnaires to estimate physical activity and functioning in end-stage renal disease. *Kidney Int.* 59:1121–1127, 2001.
12. Koniak-Griffin, D. Aerobic exercise, psychological well-being, and physical discomforts during adolescent pregnancy. *Res. Nurs. Health* 17:253–263, 1994.
13. Kriska, A. M., and C. J. Carpensen. Introduction to a collection of physical activity questionnaires. *Med. Sci. Sports Exerc.* 29:S5–S9, 1997.
14. Lee, K.A., and M. Zaffke. Longitudinal changes in fatigue and energy during pregnancy and the postpartum period. *J. Obstet. Gynecol. Neonatal. Nurs.* 28:183–191, 1999.
15. McNair, D.M., M. Lorr, and L. F. Droppleman. *Profile of Mood States Manual.* San Diego, CA: Education and Industrial Testing Services, 1981, pp. 1–29.
16. Nyenhuis, D. L., C. Yamamoto, T. Luchetta, A. Terrien, and A. Parmentier. Adult and geriatric normative data and validation of the Profile of Mood States. *J. Clin. Psychol.* 55:79–86, 1999.
17. O'Connor, P. J. Evaluation of four highly cited energy and fatigue mood measures. *J. Psychosom. Res.* 57:435–441, 2004.
18. Raglin, J. S. Psychological factors in sport performance: the Mental Health Model revisited. *Sports Med.* 31:875–890, 2001.
19. Richardson, M. T., B. E. Ainsworth, D. R. Jacobs, and A. S. Leon. Validation of the Stanford 7-day recall to assess habitual physical activity. *Ann. Epidemiol.* 11:145–153, 2001.
20. Rush, E. C., L. D. Plank, and W. A. Coward. Energy expenditure of young Polynesian and European women in New Zealand and relations to body composition. *Am. J. Clin. Nutr.* 69:43–48, 1999.
21. Sallis, J. F., W. L. Haskell, P. D., Wood, et al. Physical activity assessment methodology in the Five-City Project. *Am. J. Epidemiol.* 121:91–106, 1985.
22. Sirard, J. R., E. L. Melanson, L. Li, and P. S. Freedson. Field evaluation of the Computer Science and Applications, Inc. physical activity monitor. *Med. Sci. Sports Exerc.* 32:695–700, 2000.
23. Stein, A. D., J. M. Rivera, and J. M. Pivarnik.. Measuring energy expenditure in habitually active and sedentary pregnant women. *Med. Sci. Sports Exerc.* 35:1441–1446, 2003.
24. Tran, Z. V. Estimating sample size in repeated measures analysis of variance. *Meas. Phys. Educ. Exerc. Sci.* 1:89–102, 1997.
25. Tunis, S. L., M. S. Golbus, K. L. Copeland, B. A. Fine, B. J. and Rosinsky, L. P. Seely. Patterns of mood states in pregnant women undergoing chorionic villus sampling or amniocentesis. *Am. J. Med. Genet.* 37:191–199, 1990.
26. Wallace, A. M., D. B. Boyer, A. Dan, and K. Holm. Aerobic exercise, maternal self-esteem and physical discomforts during pregnancy. *J. Nurse Midwifery* 31:255–262, 1986.
27. Zhang, J., and D. A. Savitz. Exercise during pregnancy among US women. *Ann. Epidemiol.* 6:53–59, 1996.
28. Zib, M., L. Lim, and W. A. Walters. Symptoms during normal pregnancy: a prospective controlled study. *Aust. N. Z. J. Obstet. Gynaecol.* 39:401–410, 1999.