JOURNAL OF WOMEN'S HEALTH
Volume 15, Number 8, 2006

Physical Activity Patterns during Pregnancy in a Diverse Population of Women

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ABSTRACT

***Background*: Participation in physical activity during pregnancy may reduce the risk of gestational diabetes mellitus and preeclampsia and help prevent excess maternal weight gain. However, studies describing patterns and correlates of activity during pregnancy are sparse. The purpose of this cross-sectional study was to describe total physical activity (household/caregiving, occupational, leisure, sports/exercise, and transportation) and correlates of total physical activity in a racially and economically diverse sample of 233 prenatal care patients.**

***Methods*: Bilingual interviewers administered three 24-hour physical activity recalls among women in the first trimester (11%), second trimester (36%), and third trimester (53%) of pregnancy.**

***Results*: Median total energy expenditure (MET-hours/day) was similar among women in the first and second trimesters (33.4 and 33.8 MET-hours/day, respectively) and was slightly, but not statistically significantly, lower among women in the third trimester (32.6 MET-hours/day). Moderate intensity activity followed a similar pattern, being statistically significantly lower among women in the third trimester; vigorous intensity activity was low among women in each trimester of pregnancy. In terms of activity type, household/caregiving activity was the largest contributor to both total and combined moderate and vigorous intensity energy expenditure among women in each trimester, constituting 24%–40% of total energy expenditure. Overall, total energy expenditure was highest in white non-Hispanic women and positively associated with increasing education and a history of previous live births ($p < 0.01$).**

***Conclusions*: Results from this study highlight the importance of including household/caregiving and occupational activities in addition to sports/exercise activities in the assessment of total energy expenditure during pregnancy.**

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This work was supported by the National Institutes of Health/National Institute for Child Health and Human Development HD39341.

INTRODUCTION

A growing body of literature suggests that healthy and well-nourished women can safely participate in most forms of physical activity during pregnancy.[1] Indeed, physical activity during pregnancy may reduce the risk of gestational diabetes mellitus[2–5] and preeclampsia,[6,7] and help prevent excess maternal weight gain.[8] These potential benefits are reflected in the latest guidelines of the American College of Obstetricians and Gynecologists (ACOG), which recommend that women without medical or obstetrical complications accumulate 30 minutes or more of moderate intensity activity on most, if not all, days of the week.[1]

Sparse data are available, however, concerning patterns of physical activity among pregnant women. The majority of studies measuring physical activity levels in pregnancy have been limited by (1) measurement of leisure time physical activity or exercise only, (2) a focus on vigorous intensity activity, (3) the use of measurement tools that fail to assess the frequency, intensity, and duration of activities, or (4) reliance on recall of physical activity after delivery.[9–14] To our knowledge, studies to date have not measured total energy expenditure (household/caregiving, occupational, leisure, sports/exercise, and transportation) during pregnancy. In addition, few studies have identified correlates of physical activity during pregnancy, essential for targeting interventions designed to increase participation in physical activity during pregnancy.

The current study extends the prior literature by describing patterns and correlates of total physical activity (household/caregiving, occupational, leisure, sports/exercise, and transportation) in a racially and economically diverse sample of prenatal care patients.

MATERIALS AND METHODS

Study design and population

Data for this cross-sectional study were collected as part of a larger study designed to develop a pregnancy physical activity questionnaire.[15] Prenatal care patients in each trimester of pregnancy were recruited during the same time period (1 year) at a large tertiary care hospital in western Massachusetts in 2000. Women were considered ineligible if they had any of the following characteristics: insulin-dependent diabetes, hypertension or heart disease, chronic renal disease, multiple gestation pregnancy, or <16 or >40 years of age. A total of 250 patients from the first, second, and third trimesters combined agreed to participate and fulfilled the eligibility criteria. The study was reviewed and approved by the Human Subjects Committee of the University of Massachusetts at Amherst and the Institutional Review Board of Baystate Medical Center, and each woman completed a written informed consent document prior to her participation.

Assessment of physical activity

Bilingual (English/Spanish) interviewers used standardized open-ended forms to record a detailed description of each activity performed by participants during a 24-hour period beginning at 12:00 midnight the previous day. Follow-up interviews were conducted approximately 1 week later to obtain 24-hour recalls for the 2 previous days (ensuring that 1 of the days was a weekend day). The concurrent validity of the 24-hour physical activity recall method in women, using physical activity diaries as the comparison measure, has been previously reported as $r = 0.54$ for household activity, $r = 0.74$ for occupational activity, and $r = 0.68$ for leisure time physical activity.[16]

An activity-specific intensity code from the Compendium of Physical Activities was assigned to each activity episode recorded in the 24-hour recall.[17] The Compendium of Physical Activities is a comprehensive list of physical activities with corresponding estimates of intensity in metabolic equivalent task units (METs), where 1 MET is equal to the energy expended during quiet sitting. The number of minutes spent in each reported activity was multiplied by its MET intensity and summed to calculate total daily energy expenditure. Energy expenditure values were averaged across the multiple physical activity recalls completed within the trimester. Average energy expenditure was also calculated within categories of activity intensity and type. Intensity categories were sedentary (<1.5 METs), light (1.5–2.9 METs), moderate (3.0–6.0 METs), and vigorous (>6.0 METs) and were based on the Centers for Disease Control and Prevention-American College of Sports Medicine (CDC-

ACSM) position statement,[18] modified to distinguish sedentary from light intensity activity. Specifically, the sedentary activity category included reading, writing, television viewing, and sleeping. Categories of types of activity were household/caregiving (includes self-care, housework, gardening, child care), occupational (includes occupational sitting, driving, standing, walking with or without a load, and manual labor), leisure (includes computer use, reading, television viewing, games), sports and exercise, transportation (includes riding in auto or bus, driving, walking for transportation), and sleep.

Covariate assessment

Interviewers collected information on a number of sociodemographic variables using a structured form including age, income, education, maternal place of birth, and language preference. Race/ethnicity was classified based on self-report of race and Hispanic origin. Self-reported prepregnancy weight, height, and parity (defined as number of live births) were also obtained. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared.

Data analysis

All analyses were completed using the Statistical Analysis System (SAS Institute, Cary, NC) version 9.1. Mean, median, and interquartile energy expenditure values were calculated by both activity type and intensity across trimesters and across categories of age, race/ethnicity, education, income, parity, and prepregnancy BMI. The statistical significance of differences in estimates across trimesters was assessed using the Kruskal-Wallis test of rank-order differences.

Using logistic regression, we calculated odds ratios (ORs) and 95% confidence intervals (CI) for a high level (defined as the top quartile of trimester-specific energy expenditure) of combined moderate/vigorous energy expenditure, total energy expenditure, and type-specific energy expenditure. Multivariate logistic regression was used to statistically adjust for covariates found to be statistically significantly associated with a high level of activity in unadjusted models at $p < 0.05$. Tests of trend were calculated by modeling ordinal subject characteristics as continuous variables (i.e., 1, 2, 3). Effect modification by trimester of pregnancy was evaluated by inspection of stratum-specific ORs as well as by evaluating significance of interaction terms via chi-square likelihood ratio tests.

RESULTS

A total of 445 physical activity recalls were completed by 250 participants, with an average of 1.8 ± 0.9 recalls obtained from each woman. Approximately 52% of women in the first trimester, 53% of women in the second trimester, and 34% of women in the third trimester completed two or more physical activity recalls, with the majority of these women (80% in first trimester, 85% in second trimester, 84% in third trimester) completing three recalls. Of the recalls obtained, 93% were considered complete (at least 20 hours of information), with no differences observed in completion rates among women in different trimesters. Overall, 31 recalls from 17 participants were deemed incomplete and were excluded, resulting in a final sample size of 233 women. Eleven percent of women were in the first trimester, 36% were in the second trimester, and 53% were in the third trimester. Participants recorded an average of 16.5 ± 5.7 activities per day (range 5–35). Overall, 115 distinct physical activities listed in the Compendium of Physical Activities were reported.

Participants ranged in age from 16 to 39 years, with a mean age of 26.2 years (Table 1). Overall, more than one half of women were white non-Hispanic (54.0%), 28.5% were Hispanic, and 14.5% were African American. Over half of women reported a high school education or less (54.9%), and approximately one quarter of participants (29.0%) reported an annual household income of <\$15,000. Based on prepregnancy BMI values, 45.1% of women overall were classified as overweight or obese. With the exception of a higher proportion of Hispanic women in the third trimester, the distribution of participant characteristics did not differ significantly across trimesters.

Median total energy expenditure (MET-hours/day) was similar between women in the first and second trimesters (33.4 and 33.8 MET-hours/day, respectively) but was slightly, although not statistically significantly, lower among women in the third trimester (32.6 MET-hours/day) (Table 2). Significantly lower levels of sedentary intensity energy expenditure were reported by women in the second trimester of

TABLE 1. DESCRIPTIVE CHARACTERISTICS OF STUDY PARTICIPANTS, BY TRIMESTER OF PREGNANCY

Characteristic	*First trimester* (n = *25)* %	*Second trimester* (n = *84)* %[a]	*Third trimester* (n = *124)* %[b]	p *value*[c]
Age, years				
16–19	8.0	9.9	21.5	0.12
20–24	32.0	34.6	25.6	
25–29	36.0	22.2	29.8	
30–39	24.0	33.3	23.1	
Race/ethnicity				
African American	20.0	19.5	9.9	0.001
Hispanic	16.0	14.6	40.5	
White	60.0	61.0	47.9	
Other	4.0	4.9	1.7	
Education				
<High school	28.0	17.1	24.8	0.64
High school graduate	28.0	36.6	30.6	
Some tertiary education	44.0	46.3	44.6	
Annual household income				
<$15,000	20.0	25.6	33.1	0.31
$15,000–30,000	24.0	24.4	14.9	
$>30,000	40.0	39.0	33.1	
Don't know/refused	16.0	11.0	19.0	
Previous live births				
0	44.0	45.1	41.4	0.68
1	20.0	31.7	30.2	
≥2	36.0	23.2	28.4	
Prepregnancy BMI				
<25.0	64.0	59.2	50.0	0.67
25.0–29.9	24.0	26.3	31.6	
≥30.0	12.0	14.5	18.4	

[a]Denominator excludes missing values for age [n = 3 (3.6%)], race, education, income, parity [n = 2 (2.4%)], BMI [n = 8 (9.5%)].

[b]Denominator excludes missing values for age, race, education, income [n = 3 (2.4%)], parity [n = 8 (6.5%)], BMI [n = 10 (8.1%)].

[c]Fisher exact probability test of differences across trimesters.

pregnancy, and light intensity energy expenditure was higher among women in the second and third trimesters, although these differences were not statistically significant. Median moderate intensity energy expenditure was similar among women in the first and second trimesters (2.3–2.5 MET-hours/day) but substantially lower among women in the third trimester (0.8 MET-hours/day) (p = 0.03). Participation in vigorous intensity activity was low among women in each trimester of pregnancy, with no more than 8% of women in a given trimester reporting any vigorous activity.

In terms of type of activity, the highest median levels of energy expenditure in each trimester were spent in household and caregiving activities (Table 2). Median household/caregiving energy expenditure was lower among women in the first trimester (6.8 MET-hours/day) compared with women in the third trimester women (12.5 MET-hours/day) ($p < 0.01$). Occupational activity was the only other type of activity that differed substantially between women in different trimesters, with women in the first trimester reporting a median of 6.4 MET-hours/day compared with 0.0 MET-hours/day reported by women in the last two trimesters of pregnancy ($p < 0.01$). These differences were predominantly due to the higher proportion of early pregnancy women who were employed (60% in the first trimester) compared with women in later pregnancy (33% in the third trimester).

We then calculated the percent contribution of specific activities to total energy expenditure (Table 3). Household/caregiving and occupational activity were the largest contributors to total energy expenditure, although their relative contribution varied substantially across women in different

Table 2. Mean and Median (25th and 75th Percentiles) Energy Expenditure among Pregnant Women by Activity Intensity, Type, and Trimester

	First trimester (n = *25*)			*Second trimester* (n = *84*)			*Third trimester* (n = *124*)			
	Mean[a]	*Median*[a]	*25th, 75th percentile*	*Mean*[a]	*Median*[a]	*25th, 75th percentile*	*Mean*[a]	*Median*[a]	*25th, 75th percentile*	p *value*[b]
Total energy expenditure	33.0	33.4	28.7, 36.0	35.0	33.8	31.1, 39.1	33.3	32.6	29.5, 36.6	0.08
By activity intensity										
Sedentary	14.4	15.1	12.0, 17.4	12.7	12.4	10.2, 15.0	13.8	14.1	11.1, 16.4	0.04
Light	13.3	11.7	8.2, 18.2	16.6	17.2	11.2, 20.9	16.5	15.7	11.2, 21.6	0.09
Moderate	5.1	2.3	0.0, 3.8	5.3	2.5	0.0, 7.1	2.9	0.8	0.0, 3.5	0.03
Vigorous	0.1	0.0	0.0, 0.0	0.3	0.0	0.0, 0.0	0.2	0.0	0.0, 0.0	0.96
By type of activity										
Household/caregiving	7.8	6.8	3.0, 11.9	12.5	9.7	6.7, 17.7	13.2	12.5	8.0, 16.8	<0.01
Occupational	8.4	6.4	0.0, 12.4	6.1	0.0	0.0, 10.3	3.6	0.0	0.0, 5.9	<0.01
Leisure	6.4	5.8	3.9, 8.0	5.3	5.0	3.6, 6.9	6.1	6.0	3.5, 8.1	0.21
Sports/exercise	0.2	0.0	0.0, 0.0	0.9	0.0	0.0, 0.0	0.3	0.0	0.0, 0.0	0.30
Transportation	1.5	1.3	0.5, 2.3	2.0	1.6	0.8, 3.1	1.8	1.4	0.7, 2.5	0.22
Sleep	8.7	8.1	7.0, 10.9	8.2	7.9	7.2, 9.2	8.5	8.5	7.4, 9.4	0.29

[a]MET-hours/day.
[b]Kruskal-Wallis test of differences in ranks.

Table 3. Percent of Total and Moderate/Vigorous Energy Expenditure (MET-hours/day) among Pregnant Women Accounted for by Type of Activity According to Trimester

	First trimester (n = 25) %	*Second trimester* (n = 84) %	*Third trimester* (n = 124) %
Total energy expenditure[a]	100.0	100.0	100.0
Household/caregiving	23.8	35.8	39.6
Occupational	25.4	17.4	10.3
Leisure	19.3	15.1	18.3
Sports/exercise	0.6	2.6	0.9
Transportation	4.6	5.7	5.4
Moderate and vigorous energy expenditure[b]	100.0	100.0	100.0
Household/caregiving	22.0	36.9	64.5
Occupational	72.1	44.6	26.3
Leisure	2.1	3.9	2.4
Sports/exercise	3.8	14.6	6.8

[a]Sleep accounted for the remaining 23%–26% of total energy expenditure across trimesters.
[b]Mean transportation-related moderate/vigorous energy expenditure was zero across all trimesters.

trimesters, likely due to the noted differences in employment status. For example, the contribution of household/caregiving activity to total energy expenditure was lowest in first trimester women (23.8%) and highest in third trimester women (39.6%), whereas the relative contribution of occupational activity followed an opposite pattern, being highest among women in the first trimester (25.4%) and lowest among women in the third trimester (10.3%). The proportion of total energy expenditure attributable to leisure and sports/exercise activity was relatively consistent among women in different trimesters. Because prior studies have often observed health benefits for higher intensity activities during pregnancy,[5,7,8,19] we also calculated the percent contribution of each type of activity to total moderate and vigorous intensity activity (Table 3). Again, household/caregiving and occupational activity were the largest contributors to moderate and vigorous intensity activity during pregnancy, with the relative contribution of household/caregiving activity being substantially higher among women in their last trimester compared with women in their first trimester (64.5% vs. 22.0%).

We then identified participant characteristics associated with achieving a high level of moderate and vigorous energy expenditure, defined as being in the top quartile of energy expenditure for a given trimester (Table 4). In unadjusted analyses, increasing age ($p_{\text{trend}} = 0.04$) and level of education ($p_{\text{trend}} < 0.001$), white non-Hispanic ethnicity, and having one or more live births were statistically significantly associated with having a high level of moderate and vigorous energy expenditure. Following adjustment for other covariates, women in younger age categories were at increased, but not statistically significant, odds for a high level of moderate and vigorous energy expenditure. In addition, although point estimates of the association between race/ethnicity and a high level of moderate and vigorous energy expenditure remained unchanged, associations were no longer statistically significant following adjustment for other covariates. Correlates of a high level of total energy expenditure were comparable with those observed for moderate and vigorous intensity activity. Effect modification by trimester of pregnancy was not observed.

Associations between participant characteristics and a high level of energy expenditure were also calculated for each type of activity (Table 5). Having one or more previous live births was most strongly associated (OR 11.6, 95% CI 4.1, 32.3) with a high level of household/caregiving energy expenditure. Compared with white non-Hispanic women, Hispanic (OR 0.3, 95% CI 0.1, 0.8) and African American (OR 0.2, 95% CI 0.1, 0.8) women were less likely to be classified as having a high level of household/caregiving energy expenditure. The odds of having a high level of occupational energy expenditure significantly increased ($p_{\text{trend}} = 0.04$) with level of education but was decreased in Hispanic compared with white non-Hispanic women and in women with one or more previous live births. The likelihood of having high levels of leisure activity, which primarily consisted of sedentary and light intensity activities, was higher in both Hispanic and African American women, as well as in women with less than a tertiary

TABLE 4. UNADJUSTED AND MULTIVARIATE ADJUSTED ORs AND 95% CIs FOR ASSOCIATION BETWEEN PARTICIPANT CHARACTERISTICS AND HIGH LEVEL[a] OF ENERGY EXPENDITURE (MET-HOURS/DAY) DURING PREGNANCY

	Moderate and vigorous energy expenditure		*Total physical activity energy expenditure*	
Characteristic	*Unadjusted OR (95% CI)*	*Adjusted[b] OR (95% CI)*	*Unadjusted OR (95% CI)*	*Adjusted[b] OR (95% CI)*
Age, years				
16–19	0.2 (0.1, 0.8)	1.4 (0.3, 7.0)	0.1 (0.0, 0.6)	0.8 (0.1, 5.0)
20–24	0.7 (0.3, 1.5)	2.0 (0.7, 5.6)	0.5 (0.2, 1.1)	1.4 (0.5, 3.7)
25–29	1.1 (0.5, 2.4)	1.9 (0.8, 4.6)	1.0 (0.5, 2.2)	1.6 (0.7, 3.9)
30–39	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
p value for linear trend	0.04	0.32	0.001	0.79
Race				
White non-Hispanic	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Hispanic	0.4 (0.2, 0.8)	0.4 (0.2, 1.1)	0.3 (0.1, 0.6)	0.3 (0.1, 0.8)
African American	0.3 (0.1, 0.8)	0.3 (0.1, 1.1)	0.5 (0.2, 1.3)	0.8 (0.3, 2.4)
Education				
<High school	0.3 (0.1, 0.7)	0.3 (0.1, 0.9)	0.1 (0.0, 0.4)	0.2 (0.1, 0.7)
High school graduate	0.3 (0.1, 0.6)	0.3 (0.1, 0.8)	0.3 (0.2, 0.7)	0.4 (0.2, 1.0)
Some tertiary education	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
p value for linear trend	<0.001	0.01	<0.001	<0.01
Annual household income				
<$15,000	0.6 (0.3, 1.3)	2.1 (0.7, 6.4)	0.5 (0.2, 1.0)	1.4 (0.5, 4.1)
$15,001–30,000	0.9 (0.4, 1.9)	2.5 (0.9, 7.0)	0.8 (0.3, 1.7)	1.8 (0.6, 5.0)
$>30,000	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Don't know/refused	0.4 (0.1, 1.1)	1.0 (0.3, 3.6)	0.4 (0.2, 1.1)	0.8 (0.2, 2.9)
p value for linear trend[c]	0.21	0.34	0.05	0.37
Previous live births				
0	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
≥1	2.5 (1.3, 4.8)	2.8 (1.4, 6.0)	2.9 (1.5, 5.7)	3.9 (1.8, 8.5)
Prepregnancy BMI, kg/m^2				
<25.0	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
25.0–29.9	0.5 (0.2, 1.1)	0.5 (0.2, 1.2)	0.5 (0.2, 1.0)	0.6 (0.2, 1.4)
≥30.0	2.0 (0.9, 4.3)	2.3 (0.9, 5.9)	1.0 (0.4, 2.3)	0.8 (0.3, 2.3)
p value for linear trend	0.35	0.27	0.51	0.50

[a]In the top quartile of trimester-specific energy expenditure.
[b]Adjusted for age, race, education, and previous live births.
[c]"Don't know/refused" category excluded.

level of education. Participant characteristics were not significantly associated with sports/exercise energy expenditure. Prepregnancy BMI was not associated with high levels of any type of energy expenditure for any activity type.

DISCUSSION

In this cross-sectional study of total physical activity during pregnancy, we found that activity intensity and type varied significantly across women in different trimesters of pregnancy. Mean energy expenditure in moderate intensity activity, which was similar between women in the first and second trimesters, was approximately 45% lower among women in the third trimester. Alternatively, mean household/caregiving energy expenditure was markedly higher among women in later pregnancy and was the most important constituent of moderate/vigorous activity expenditure during pregnancy.

Increasing education and having a previous live birth were associated with high levels of total, as well as combined moderate and vigorous, energy expenditure. However, when associations were examined by type of activity, a higher level of education was primarily associated with increased occupational energy expenditure, whereas parity was strongly and positively associated with household/caregiving energy expenditure and negatively associated with occupational energy expenditure. Compared with white non-Hispanic women, both Hispanic and African American women were less likely to have high levels of moderate and vigorous intensity energy expenditure.

Table 5. Multivariate Adjusted ORs and 95% CIs for Association between Participant Characteristics and High Level[a] of Type-Specific Energy Expenditure (MET-hours/day) during Pregnancy

Characteristic	*Household/caregiving adjusted*[b] *OR (95% CI)*	*Occupational adjusted*[b] *OR (95% CI)*	*Leisure adjusted*[b] *OR (95% CI)*	*Sports/exercise adjusted*[b] *OR (95% CI)*
Age, years				
16–19	0.4 (0.1, 2.4)	1.0 (0.2, 4.4)	0.4 (0.1, 1.4)	0.7 (0.1, 3.1)
20–24	0.9 (0.3, 2.8)	1.3 (0.5, 3.5)	0.6 (0.2, 1.7)	0.6 (0.2, 1.8)
25–29	1.6 (0.6, 4.0)	1.6 (0.7, 3.7)	0.6 (0.2, 1.6)	0.2 (0.1, 0.7)
30–39	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
p value for linear trend	0.43	0.82	0.20	0.54
Race				
White non-Hispanic	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Hispanic	0.3 (0.1, 0.8)	0.4 (0.2, 1.0)	2.2 (1.0, 5.1)	0.5 (0.1, 1.4)
African American	0.2 (0.1, 0.8)	0.8 (0.3, 2.2)	2.4 (1.0, 5.9)	0.8 (0.2, 2.4)
Education				
<High school	1.0 (0.3, 3.3)	0.3 (0.1, 1.1)	2.4 (0.9, 6.5)	0.9 (0.2, 3.4)
High school graduate	0.9 (0.4, 2.4)	0.5 (0.2, 1.2)	2.4 (1.1, 5.5)	0.9 (0.3, 2.5)
Some tertiary education	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
p value for linear trend	0.97	0.04	0.07	0.82
Annual household income				
<$15,000	1.1 (0.3, 3.3)	0.6 (0.2, 1.7)	0.7 (0.3, 2.0)	0.8 (0.2, 2.9)
$15,001–30,000	0.8 (0.2, 2.6)	1.9 (0.7, 5.0)	0.3 (0.1, 0.9)	1.0 (0.3, 3.3)
$>30,000	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Don't know/refused	1.1 (0.3, 3.8)	0.4 (0.1, 1.7)	0.9 (0.3, 2.8)	0.7 (0.2, 2.6)
p value for linear trend[c]	0.94	0.35	0.36	0.95
Previous live births				
0	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
≥1	11.6 (4.1, 32.3)	0.5 (0.3, 1.0)	0.6 (0.3, 1.1)	0.7 (0.3, 1.6)
Prepregnancy BMI, kg/m^2				
<25.0	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
25.0–29.9	0.9 (0.4, 2.3)	0.7 (0.3, 1.5)	0.7 (0.3, 1.7)	1.0 (0.4, 2.6)
≥30.0	1.8 (0.6, 5.2)	0.4 (0.2, 1.3)	1.4 (0.5, 3.6)	0.6 (0.2, 2.2)
p value for linear trend	0.37	0.11	0.74	0.55

[a]In the top quartile of trimester-specific energy expenditure.
[b]Adjusted for age, race, education, and previous live births.
[c]"Don't know/refused" category excluded.

Taken together, household/caregiving and occupational activity comprised approximately 49%–53% of total energy expenditure and 81%–94% of moderate/vigorous energy expenditure during pregnancy, depending on the trimester. The relative contribution of household/caregiving activity to both total and moderate/vigorous energy expenditure was highest among women in later pregnancy, and the contribution of occupational activity was highest among women in earlier pregnancy. This may be due, in part, to reduced participation in occupational tasks in later pregnancy. Sports/exercise activity, which has been the focus of most prior studies of pregnancy physical activity, contributed very little to total energy expenditure and only modestly to moderate/vigorous energy expenditure. These results are in general agreement with two prior studies conducted in nonpregnant populations.[20,21]

Prior studies of physical activity have focused largely on correlates of sports/exercise during pregnancy and have identified increasing level of income,[11,14] younger[12–14] or older[11] age, and nulliparity[11,12,14] as factors associated with increased participation. Consistent with previous studies, women in the current study who had higher levels of income, were nulliparous, and were white non-Hispanic were more likely to have a high level of sports/exercise energy expenditure. In addition, older rather than younger women were most likely to have high levels of sports/exercise participation. These findings, however, were not statistically significant likely because of the low prevalence of sports/exercise participation in the current study.

To our knowledge, prior studies have not reported the correlates of household or occupational physical activity among pregnant women. However, in a sample of 2636 nonpregnant female members of a large health maintenance organization aged 20–65 years, Sternfeld et al.[22] observed significant associations between the number of children under the age of 5 years, Hispanic ethnicity, and older age and a high level of participation in household/caregiving activity. Consistent with these findings, in the current study, we observed a positive association between parity and household/caregiving activity. However, we did not observe consistent associations for age and, in contrast to Sternfeld et al., observed that Hispanic women were less, as opposed to more, likely to participate in household/caregiving activities compared with white non-Hispanic women. Discrepancies in findings may be due to the pregnant state of the study population or, in part, to the heterogeneity of the Hispanic population. In the current study, Hispanic women were predominantly Caribbean Islanders (e.g., Puerto Ricans and Dominican Republicans) as opposed to Mexican Americans in the study by Sternfeld et al.[22]

In terms of occupational activity, Sternfeld et al.[22] found that having a high school level of education or less was associated with higher levels of occupational activity among nonpregnant women. In contrast to these findings, we observed a positive association between increasing education and occupational activity. However, Sternfeld et al. restricted the analysis of occupational activity to those employed. Given the high proportion of unemployed women in our sample, our observation of a positive association between education and occupational activity may simply reflect an increased likelihood of remaining employed during pregnancy among those with higher levels of education.

This study has several limitations. The reduced sample sizes in the first and second trimesters limited our power to make inferences regarding differences in activity levels between trimesters of pregnancy. For example, the lack of observed differences in total activity levels between women in different trimesters may have been due to the smaller numbers of women in the first and second trimesters. However, for those activity domains for which we did observe statistically significant differences between trimesters, in spite of small sample sizes (i.e., for moderate, sedentary, household, and occupational activities), we can be reasonably confident that these differences were not due to chance. Another study limitation stems from the complexity of physical activity behavior, such as the day-to-day variability in activity patterns and between-person variation in the intensity at which activities are performed, which make it difficult to accurately measure physical activity in free-living humans. However, by recording the previous day's activities during the pregnancy, as opposed to relying on recall after delivery, inaccuracies caused by memory error were likely reduced. Study interviewers were trained to use memory cues to elicit more precise information and ensure the completeness of each recall. Finally, the open-ended nature of the 24-hour recall helps to ensure that important physical activities are not missed; this is particularly important for a population, such as pregnant women, whose activity habits have not been well characterized. Nonetheless, imprecision in physical activity assessment, especially for women who did not complete multiple recalls, likely led to an attenuation of our findings.

The cross-sectional nature of the study design precluded prospectively following individual participants over the course of pregnancy, and we were, therefore, unable to assess longitudinal trends over pregnancy. Because of this study design, trimester differences in physical activity could be due to differences in participant characteristics. For example, although most self-reported characteristics were similar between women in different trimesters, a significantly higher proportion of women in the third trimester were of Hispanic ethnicity. In general, however, relative differences in trimester-specific estimates of physical activity were similar when examined within categories of race/ethnicity (data not shown), although these differences may not have been statistically significant because of the reduced sample sizes.

Participants in this study were healthy women of diverse socioeconomic and racial/ethnic backgrounds who received prenatal care while undergoing a singleton pregnancy. Care should be taken in generalizing results to pregnant women not receiving prenatal care.

CONCLUSIONS

To our knowledge, this is the first study to examine the frequency, intensity, and duration of total physical activity during pregnancy. Physical activity patterns in this economically and racially diverse sample of pregnant women varied significantly between women in different trimesters. Mean energy expenditure in moderate intensity activity and occupational activity was lower in women in later trimesters, whereas household/caregiving energy expenditure was higher. Overall, total energy expenditure was highest in white non-Hispanic women and positively associated with increasing education and a history of previous live births. Correlates of energy expenditure varied significantly between different types of activity, with a history of previous live birth strongly and positively associated with household/caregiving energy expenditure but negatively associated with occupational energy expenditure. Results from this study highlight the importance of including household/caregiving and occupational activities in addition to sports/exercise activities in the assessment of total energy expenditure during pregnancy.

ACKNOWLEDGMENTS

We are grateful to Christine Judge, J. Bianca Erickson, Larissa Brunner, Dr. James Fordyce, Erin DeWaard, Anush Yousefian, and Rachel Hecksher for their assistance with data collection and analysis.

REFERENCES

1. ACOG Committee Obstetric Practice. ACOG committee opinion. number 267, January 2002: Exercise during pregnancy and the postpartum period. Obstet Gynecol 2002;99:171.
2. Dempsey JC, Butler CL, Sorensen TK, et al. A case-control study of maternal recreational physical activity and risk of gestational diabetes mellitus. Diabetes Res Clin Pract 2004;66:203.
3. Dempsey JC, Sorensen TK, Williams MA, et al. Prospective study of gestational diabetes mellitus risk in relation to maternal recreational physical activity before and during pregnancy. Am J Epidemiol 2004;159:663.
4. Dye TD, Knox KL, Artal R, Aubry RH, Wojtowycz MA. Physical activity, obesity, and diabetes in pregnancy. Am J Epidemiol 1997;146:961.
5. Solomon CG, Willett WC, Carey VJ, et al. A prospective study of pregravid determinants of gestational diabetes mellitus. JAMA 1997;278:1078.
6. Saftlas AF, Logsden-Sackett N, Wang W, Woolson R, Bracken MB. Work, leisure-time physical activity, and risk of preeclampsia and gestational hypertension. Am J Epidemiol 2004;160:758.
7. Sorensen TK, Williams MA, Lee IM, Dashow EE, Thompson ML, Luthy DA. Recreational physical activity during pregnancy and risk of preeclampsia. Hypertension 2003;41:1273.
8. Clapp JF 3rd, Little KD. Effect of recreational exercise on pregnancy weight gain and subcutaneous fat deposition. Med Sci Sports Exerc 1995;27:170.
9. Hinton PS, Olson CM. Predictors of pregnancy-associated change in physical activity in a rural white population. Matern Child Health J 2001;5:7.
10. Mottola MF, Campbell MK. Activity patterns during pregnancy. Can J Appl Physiol 2003;28:642.
11. Ning Y, Williams MA, Dempsey JC, Sorensen TK, Frederick IO, Luthy DA. Correlates of recreational physical activity in early pregnancy. J Matern Fetal Neonatal Med 2003;13:385.
12. Zhang J, Savitz DA. Exercise during pregnancy among U.S. women. Ann Epidemiol 1996;6:53.
13. Evenson KR, Savitz DA, Huston SL. Leisure-time physical activity among pregnant women in the U.S. Paediatr Perinat Epidemiol 2004;18:400.
14. Petersen AM, Leet TL, Brownson RC. Correlates of physical activity among pregnant women in the United States. Med Sci Sports Exerc 2005;37:1748.
15. Chasan-Taber L, Schmidt MD, Roberts DE, Hosmer D, Markenson G, Freedson PS. Development and validation of a pregnancy physical activity questionnaire. Med Sci Sports Exerc 2004;36:1750.
16. Matthews CE, Freedson PS, Hebert JR, Stanek EJ 3rd, Merriam PA, Ockene IS. Comparing physical activity assessment methods in the seasonal variation of blood cholesterol study. Med Sci Sports Exerc 2000;32:976.
17. Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: An update of activity codes and MET intensities. Med Sci Sports Exerc 2000;32:S498.
18. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA 1995;273:402.
19. Rudra CB, Williams MA, Lee IM, Miller RS, Sorensen TK. Perceived exertion during prepregnancy physical activity and preeclampsia risk. Med Sci Sports Exerc 2005;37:1836.
20. Brownson RC, Eyler AA, King AC, Brown DR, Shyu YL, Sallis JF. Patterns and correlates of physical activity among U.S. women 40 years and older. Am J Public Health 2000;90:264.
21. Centers for Disease Control and Prevention (CDC). Prevalence of physical activity, including lifestyle activities among adults—United States, 2000–2001. MMWR 2003;52:764.
22. Sternfeld B, Ainsworth BE, Quesenberry CP. Physical activity patterns in a diverse population of women. Prev Med 1999;28:313.

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