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Physical Activity and Gestational Weight Gain in Hispanic Women

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Abstract

Objective—Hispanic women have high rates of excessive and inadequate gestational weight gain (GWG) according to Institute of Medicine (IOM) guidelines. Observational studies suggest that physical activity may be associated with GWG but have been conflicting and were largely conducted in non-Hispanic white populations.

Design and Methods—We prospectively evaluated the association between physical activity and compliance with GWG guidelines, total GWG, and rate of GWG among 1,276 Hispanic participants in Proyecto Buena Salud, a cohort study in Western Massachusetts. The Pregnancy Physical Activity Questionnaire was used to assess pre, early, mid, and late pregnancy physical activity according to both intensity (i.e., sedentary, moderate, and vigorous) and type (i.e., housework/caregiving, occupational, and sports/exercise).

Results—A total of 26.9% of women gained within IOM guidelines, 21.2% had inadequate GWG, and 51.9% experienced excessive GWG. Overall, we did not observe statistically significant associations between type or intensity of physical activity during pre, early, mid, and late pregnancy and inadequate or excessive GWG, total GWG, or rate of GWG.

Conclusions—In this prospective cohort study of Hispanic women, after controlling for important risk factors, pregnancy physical activity did not appear to be associated with GWG.

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L.C.T. conceived of the topic for the manuscript, researched the literature, and drafted the manuscript. K.E.L. researched the literature and performed statistical analyses. M.S. performed data analyses. P.P. oversaw statistical analyses. C.G.S. researched the literature. G.M. confirmed gestational weight gain. All the authors read and commented on manuscript drafts and approved of the final version for submission.

Conflicts of Interest Statement

Competing interests: the authors have no competing interests.

Keywords

Exercise; Weight Gain; Pregnancy; Hispanic; Cohort; Epidemiology

Introduction

In the United States, more than 40% of pregnant women exceed the Institute of Medicine (IOM) guidelines for gestational weight gain (GWG), less than one-third meet GWG guidelines, and the remainder have inadequate GWG (1). Women with excessive GWG are at increased risk for gestational hypertension and preeclampsia (2), gestational diabetes mellitus (GDM) (3), and, in the longer term, postpartum weight retention (4). Women with inadequate GWG are at increased risk for preterm birth and small-for-gestational age offspring (5).

Studies have observed high rates of inadequate and excessive GWG among Hispanic women with, for example, 52% of overweight and 75% of obese Hispanic women having excessive GWG (6) and 19-29% of Hispanic women with inadequate GWG (7, 8, 9, 10). Recent data from the Centers for Disease Control and Prevention found that low GWG (< 15 pounds) was more common among black and Hispanic women than among non-Hispanic white women (1).

This is critical as Hispanics are the largest minority group in the U.S., with the highest birth and immigration rates of any minority group (11). Hispanics from the Caribbean islands (i.e., Puerto Ricans and Dominicans) are the 2nd largest group of Hispanics living in the U.S. (11), the fastest growing subgroup, and the largest Hispanic subgroup in the northeast U.S. (12, 13). As compared to other Hispanics, Puerto Ricans and Dominicans experience the greatest health disparities, the highest prevalence of type 2 diabetes, and exhibit more adverse behaviors such as poor nutrition (14, 15, 16).

The American Congress of Obstetricians and Gynecologists (ACOG) recommends that pregnant women, in the absence of contraindications, engage in 30 minutes or more of physical activity of at least moderate intensity on most, if not all days of the week (17). Compliance with these activity recommendations during pregnancy is low with half as many Hispanic women complying with these recommendations as compared to non-Hispanic whites (18).

The IOM has noted that existing research is inadequate to establish the characteristics of interventions that work reliably to assist women in meeting guidelines for GWG (1) and recent meta-analyses have been unable to identify the defining features of effective interventions (19, 20). Consistent with these findings, review articles have suggested that physical activity levels during pregnancy may not be sufficient to influence GWG (1, 21, 22). More recent observational studies have been conflicting, with some studies finding no association, and others suggesting that the impact of exercise on GWG was limited to late pregnancy (23) or to vigorous exercise only (24). However, the majority of these observational studies were conducted in predominately non-Hispanic white populations, measured physical activity in one trimester using tools not validated for pregnancy, and

limited their assessment to sports/exercise activities. This is of particular concern for Hispanic women for whom household/caregiving activities make up the majority of their total activity (25, 26).

Therefore, we prospectively examined the relationship between physical activity during pre, early, mid, and late pregnancy according to both intensity and type and inadequate and excessive GWG, total GWG, and rate of GWG among a cohort of prenatal care patients of Puerto Rican and Dominican descent at a large tertiary care facility. We hypothesized that activities of moderate and vigorous intensity and increasing levels of housework/caregiving, occupational, and sports/exercise activity would reduce risk of excessive GWG, and that sedentary behavior would increase risk of excessive GWG.

Methods

Study Design

Proyecto Buena Salud was based in the ambulatory obstetrical practices of Baystate Health, an integrated health system in Western Massachusetts from 2006 to 2011. Details of the study have been presented elsewhere (27). In brief, bilingual interviewers recruited patients at a prenatal care visit early in pregnancy (up to 20 weeks gestation), informed them of the aims and procedures of the study, and obtained written informed consent as approved by the Institutional Review Boards of the University of Massachusetts-Amherst and Baystate Health. Interviews were conducted in Spanish or English (based on patient preference) in order to eliminate potential language or literacy barriers.

At the time of enrollment (mean=12.4 weeks gestation), bilingual interviewers collected information on socio-demographic, acculturation, psychosocial factors, and behavioral factors in early pregnancy. Information on behavioral factors was updated in mid (mean=21.3 weeks gestation) and late (mean =30.8 weeks gestation) pregnancy. After delivery, medical records were abstracted for medical and obstetric history and clinical characteristics of the current pregnancy.

Eligibility

Eligibility was restricted to women of Puerto Rican or Dominican Republic heritage (Caribbean Islanders). Women who: 1) were themselves born in the Caribbean Islands, or 2) had a parent born in the Caribbean Islands, or 3) had at least 2 grandparents born in the Caribbean Islands were included. Additional exclusion criteria included: 1) current medications thought to adversely influence glucose tolerance, 2) multiple gestation, 3) history of diagnosis of diabetes, hypertension, heart disease or chronic renal disease, and 4) <16 years of age or over 40 years of age.

A total of 1,604 prenatal care patients were enrolled in Proyecto Buena Salud. For the purposes of the current analysis, we excluded 69 (4%) participants who experienced a miscarriage, 160 (10%) participants who did not deliver at Baystate Health, and 78 (5%) participants missing weight gain information. From the remaining group of 1,297 participants, information on physical activity during pre, early, mid- and late pregnancy was available for 1276 (98%) participants. Pre-pregnancy physical activity data was available for

1160 (91%) participants; information on early pregnancy activity was available for 868 (68%); mid pregnancy activity was available for 792 (62%); and late pregnancy activity was available for 746 (58%). Reasons for missing physical activity information included inability to locate women at the clinic or over the telephone (e.g., due to disconnected telephone) and preterm delivery.

Physical Activity

Physical activity during pre-pregnancy (1 year prior) and early pregnancy was assessed at the time of enrollment and updated during the mid- and late-pregnancy interviews using a modified version of the Pregnancy Physical Activity Questionnaire (PPAQ), a semi-quantitative questionnaire validated for use during pregnancy (28). The PPAQ evaluates participation in four domains of activities: household/caregiving, occupational, sports/exercise, and transportation. The duration of time spent on each activity was summed and multiplied by its intensity as defined by the Compendium of Physical Activities (29). Sedentary behavior was defined as (<1.5 METs), moderate-intensity activity as 3-6 METs, and vigorous activity as >6 METs. Total physical activity (total MET hrs/day) across all activity domains was also calculated. Each physical activity variable was then divided into quartiles with the highest (fourth) quartile reflecting the highest levels of activity. Due to low numbers of employed women during pregnancy, occupational activity was divided into 3 categories: unemployed, low (below the median MET-hrs/day among employed women) and high (above the median MET-hrs/day among employed women). Due to low participation in vigorous activity during pregnancy, this variable was dichotomized as any vs. none. Sedentary behavior was divided into quartiles with the highest (fourth) quartile reflecting the greatest sedentary behavior.

Women with >7.5 MET hrs/week in any activity of moderate intensity or greater (i.e., 30 minutes per day of activity at 3 METs multiplied by 5 days per week) were considered to have met the ACOG physical activity recommendations (17).

Gestational Weight Gain Assessment

Pre-pregnancy weight and height, and weight at delivery were abstracted from the medical record. If pre-pregnancy weight was missing from the medical record, it was based upon self-reported weight collected at the time of enrollment. Based on data from Phelan et al. (30), self-reported pre-pregnancy weight has a high correlation with measured weight ($r=0.95$). Total GWG was defined as the difference between maternal weight at delivery and maternal pre-pregnancy weight. We defined total GWG as either inadequate, adequate, or exceeding the 2009 IOM guidelines (1). These guidelines vary by pregravid body mass index (BMI) such that “underweight” women ($BMI < 18.5 \text{ kg/m}^2$) are advised to gain 28-40 pounds, “normal weight” women ($18.5\text{-}24.9 \text{ kg/m}^2$) are advised to gain 25-35 lbs, “overweight” women ($25.0\text{-}29.9 \text{ kg/m}^2$) 15-25 lbs, and “obese” women ($\geq 30 \text{ kg/m}^2$) 11-20 lbs. Rate of GWG was calculated as total pounds gained divided by gestational age at delivery.

Covariates

At the time of enrollment, interviewers collected information on age, education, annual household income, marital status, and living situation (i.e., with a partner/spouse). Acculturation was measured via the 10-item Psychological Acculturation Scale (PAS) (31) which measures an individual's sense of psychological attachment to and belonging within Anglo-American and Latino/Hispanic cultures. Item responses are scored on a 5-point Likert scale ranging from 1 (only Hispanic/Latino) to 5 (only Anglo/American). As a proxy of acculturation, interviewers also collected information on generation in the Continental U.S.

Alcohol consumption and cigarette smoking were assessed using questions designed by the Pregnancy Risk Assessment Monitoring System (PRAMS) (32). Depressive symptoms were assessed using the 10-item Edinburgh Postnatal Depression Scale (EPDS) available in English(33) and Spanish (34). Women with a score of ≥ 15 were considered to have probable major depression (35). Perceived stress was measured using Cohen's Perceived Stress Scale (PSS-14) which includes 14 items designed to address a person's sense of control over daily life demands (36). Trait anxiety was assessed using the Spielberger State-Trait Anxiety Inventory (STAI) which measures relatively stable individual differences in anxiety proneness and contains 20 statements about how the respondent generally feels (37).

Data Analysis

The association of sociodemographic, medical history, and behavioral and psychosocial factors with GWG guidelines (inadequate, adequate, excessive) was examined using chi-square tests. Multinomial logistic regression was used to estimate the association between each type and intensity of physical activity and GWG guidelines. Crude and adjusted odds ratios (OR) and 95% confidence intervals (CIs) were computed. Linear regression models were used to assess the relationship between physical activity type and intensity with total GWG and rate of GWG.

Fully adjusted models included factors observed to be associated GWG in the prior literature (e.g., age, BMI, and parity) (1). Confounding by other variables was assessed by evaluating changes in the ORs for physical activity when each covariate was included in the regression model. A change of 10% or greater was used as an indicator of confounding and, based on this criteria, age (continuous), pre-pregnancy BMI, parity, and smoking during pregnancy were included in all multivariable models.

Tests of trend were calculated by modeling physical activity categories as continuous linear variables (e.g., 1, 2, 3, 4). Interaction by pre-pregnancy BMI was evaluated by inspection of stratum specific ORs and by including a multiplicative interaction term in the multivariable models and assessing its statistical significance at $p < 0.05$ using likelihood ratio chi-square tests. Finally we compared participants who were missing information on early, mid-or late pregnancy physical activity to those not missing information according to covariates. Statistical analysis was conducted using SAS 9.3 software by SAS Institute Inc. (SAS Campus Drive, Cary, North Carolina).

Results

Among the 1,276 study participants, 26.9% had adequate GWG, 21.2% had inadequate GWG, and more than half of women (51.9%) experienced excessive GWG, according to IOM guidelines (Table 1). Mean GWG was 32.45 (± 17.48) lbs with a mean rate of weight gain of 0.83 (± 0.44) lbs/week. Overall the study population was young (70.6% <25 years), unmarried (88.9%), and almost half were born in Puerto Rico or the Dominican Republic (47.0%). Almost one-half of participants were overweight or obese prior to pregnancy (23.4% overweight and 21.7% obese). Women with higher levels of education, who lived longer in the US, and who were overweight prior to pregnancy were significantly more likely to have excessive GWG. In contrast, women who reported major depression and high levels of stress were significantly more likely to have inadequate GWG (Table 1).

We assessed the relationship between early pregnancy activity and GWG guidelines (Table 2). In unadjusted analysis, as well as after adjusting for age, BMI, parity, and early pregnancy smoking, women who met physical activity recommendations (ACOG) during early pregnancy were not at significantly increased risk of inadequate or excessive GWG as compared to women who did not meet physical activity recommendations. Similarly, women with the highest levels of total physical activity were not at significantly increased risk of inadequate GWG (OR=0.98, 95% CI 0.55-1.73) or excessive GWG (OR=1.24, 95% CI 0.74-2.06) as compared to women in the lowest quartile of total physical activity. We then evaluated the association between intensity of physical activity (i.e., sedentary, moderate, and vigorous) as well as type of physical activity (i.e., household/caregiving, occupational, and sports/exercise) and inadequate or excessive GWG. Again, there were no statistically significant findings for increased risk with increasing activity.

We then assessed the relationship between mid-pregnancy activity and GWG guidelines (Table 3). Similar to findings for early pregnancy activity, we again did not find significant associations between meeting physical activity recommendations during mid-pregnancy and inadequate or excessive GWG. Women with the highest levels of total physical activity were not at significantly increased risk of inadequate GWG (OR=1.06, 95% CI 0.60-1.80) or excessive GWG (OR=1.22, 95% CI 0.73-2.02) as compared to women in the lowest quartile of total physical activity. There were also no significant associations when evaluating activity according to intensity or type.

We then examined the association between late pregnancy physical activity and GWG guidelines (Table 4). Meeting physical activity recommendations were again not statistically significantly associated inadequate or excessive GWG. Women with the highest levels of total physical activity were not at significantly increased risk of inadequate GWG (OR=0.73, 95% CI 0.38-1.40) or excessive GWG (OR=0.73, 95% CI 0.44-1.22) as compared to women in the lowest quartile of total physical activity. However, as compared to unemployed women, women with the highest levels of occupational activity were less likely to have inadequate GWG (OR=0.50, 95% CI 0.30-0.84; $p_{\text{trend}}=0.01$). We observed no other significant associations for the other intensities and types of late pregnancy physical activity.

We then assessed the relationship between physical activity at each stage of pregnancy with total GWG and rate of GWG (Table 5). We did not observe statistically significant associations between meeting physical activity recommendations as well as high levels of total physical activity and GWG in early and mid-pregnancy. However women who did not meet physical activity guidelines in late pregnancy had, on average, higher total GWG (3.62 ± 1.48 , $p=0.01$) and higher rate of GWG (0.08 ± 0.04 , $p=0.03$) as compared to those who met the guidelines. We repeated this analysis according to intensity and type of physical activity and did not observe statistically significant associations (data not shown).

Finally, we did not observe associations between pre-pregnancy activity and GWG (data not shown). We also did not observe effect modification of the relationship between physical activity and GWG by pre-pregnancy BMI. Lastly, approximately 31-41% of the sample was missing information on early, mid-or late pregnancy physical activity due to failure to complete these interviews or preterm birth. Participants missing this information did not differ statistically from those not missing information in terms of age, education, income, insurance, marital status, number of children and adults in the household, generation in the U.S., alcohol consumption, cigarette smoking, BMI, or parity. However, they were more likely to prefer to speak/read English (82.3% vs. 75.0%, $p=0.003$), and be highly acculturated (>3 on the PAS; 24.3% vs. 18.8% $p=0.03$).

Discussion

In this prospective cohort of 1,276 pregnant Hispanic women, we observed that more than half of participants experienced excessive GWG; in addition, more than 20% of women had inadequate GWG. Approximately half of participants sample were either overweight or obese prior to pregnancy. Overall, we did not observe statistically significant associations between type and intensity of physical activity during pre, early, mid, and late pregnancy and inadequate or excessive GWG, total GWG, or rate of GWG. However women who did not meet physical activity guidelines in late pregnancy had, on average, higher total GWG and rate of GWG as compared to those who met the guidelines.

Our overall findings of no association between physical activity and GWG are consistent with the majority of prior studies conducted among non-Hispanic white women. As noted in the revised IOM 2009 guidelines, the level of physical activity in pregnant women may not be sufficient level to influence GWG (1). This would be expected to be particularly true for Hispanic women who overall have lower rates of physical activity as compared to non-Hispanic whites.

In the only prior study limited to Hispanic women, the Latina Gestational Diabetes Mellitus Study (10), the authors found that household/caregiving activity was inversely and sports/exercise and occupational activity were positively associated with GWG in bivariate analyses; however, these associations did not persist in multivariable analyses. In the current study, we found that women with high levels of occupational activities in late pregnancy were approximately 50% less likely to have inadequate GWG.

In one of the few prior studies to assess occupational and household activities as well as sports/exercise, Haakstad et al., conducted a prospective study among 467 Norwegian women (23). The authors did not observe associations for occupational and household activities. However, women who exercised regularly in the third trimester (defined as vigorous recreational physical activity at least 20 min once a week) had lower GWG than inactive women. Similarly, Clapp and Little (38) found that exercise in the first and second trimester was unrelated to the rate of weight gain, however those who continued exercise in the last trimester of pregnancy had a reduced rate of weight gain. In contrast, in a study among 144 pregnant women in the Netherlands, Althuisen et al. collected information at 30 weeks gestation on commuting, work, household work, and leisure time activities over the past month and found no association with absolute or excessive weight gain (39).

This study has several limitations. Given the multiple comparisons performed, we cannot rule out chance as explanation for the findings. In addition, we relied on a self-reported measure of physical activity which may have resulted in misclassification and therefore biased our results towards the null. However, due to the prospective nature of the study, reporting of physical activity should not be influenced by GWG status. In addition, unlike the majority of prior studies, we used a measure of activity validated in pregnant women and included household/caregiving and occupational activities in pre, early, mid and late pregnancy. Our assessment also integrated exercise frequency, duration and intensity of activity.

Interview completion rates declined from early to late pregnancy resulting in missing physical activity information. However, women missing this information did not differ significantly from those not missing this information in terms of important sociodemographic, behavioral, or clinical factors.

Our finding that women with high levels of occupational activity were less likely to have inadequate GWG may have been biased, in part, by differences among employed as compared to unemployed women. However, we considered a wide range of sociodemographic, medical history, and behavioral and psychosocial factors in our multivariable modeling. In addition, this finding may be due, in part, to a ‘healthy worker effect.’ Women with signs of gestational hypertension or preeclampsia are more likely to be placed on bed rest (and therefore be categorized as unemployed) and experience weight gain through edema.

In summary, in this prospective cohort study of Hispanic women, the highest levels of pregnancy physical activity were not sufficient to impact GWG. Lifestyle interventions are needed to assess whether physical activity can effectively be increased during pregnancy in this population. Such adequately powered, randomized controlled intervention studies on the potential benefits and risks of regular physical activity at various dose levels in pregnant women are critical.

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1. What is already known about this subject

- Physical activity may be associated with gestational weight gain.
- Previous findings have been conflicting.
- Previous studies were largely conducted in non-Hispanic white populations and relied on physical activity assessments which were not validated for pregnancy.

2. What this study adds

- In one of the first evaluations of this topic in Hispanic women, we observed that more than half of participants experienced excessive gestational weight gain and more than 20% of women had inadequate gestational weight gain.
- Overall, we did not observe statistically significant associations between physical activity during pregnancy and gestational weight gain.
- Findings support recent review articles which concluded that physical activity levels during pregnancy may not be sufficient to influence gestational weight gain.

Characteristics of Women According to Compliance with Institute of Medicine (IOM) Guidelines;^a Proyecto Bueno Salud, Western Massachusetts, 2006-2011

Table 1

	Total		Met GWG Guidelines		Inadequate GWG		Excessive GWG		p-value ^b
	N	%	N	%	N	%	N	%	
Total	1276	100.0	26.93		21.18		51.89		
<u>Demographic Variables</u>									
Age									
16-19	390	30.7	31.0		30.9		30.5		0.89
20-24	507	39.9	39.8		42.4		39.0		
25-30	226	17.8	18.7		16.4		17.9		
>30	147	11.6	10.5		10.4		12.6		
Educational Status									
Less than high school	559	47.2	48.7		54.6		43.4		0.008
High school or GED	402	33.9	32.9		33.1		34.8		
Some college/graduate	224	18.9	18.4		12.4		21.8		
Annual Household Income									
\$15,000	360	28.3	28.1		30.9		27.5		0.17
>\$15,000-\$30,000	180	14.2	14.3		9.7		15.9		
>\$30,000	76	6.0	6.4		4.8		6.2		
Don't know/refused/missing	654	51.5	51.2		54.6		50.4		
Marital status									
Single/divorced/separated/widowed	1023	88.9	88.1		89.8		88.9		0.83
Married	128	11.1	11.9		10.2		11.1		
Live with spouse/partner									
No	574	49.1	49.0		50.8		48.4		0.81
Yes	596	50.9	51.0		49.2		51.6		
Acculturation									
Low (<3)	890	79.3	77.1		80.7		79.7		0.55
High (3)	233	20.7	22.9		19.3		20.3		
Generation in the U.S.									

	Total		Met GWG Guidelines		Inadequate GWG		Excessive GWG		p-value ^b
	N	%	N	%	N	%	N	%	
Born in PR/DR ^c	577	47.0	49.5	53.1	43.3	0.03			
Parent born in PR/DR	578	47.1	45.3	43.5	49.5				
Grandparent born in PR/DR	72	5.9	5.2	3.5	7.2				
<u>Medical Record Variables</u>									
BMI (kg/m ²)									
<18.5 underweight	82	6.5	9.9	10.8	2.9	<.0001			
18.5-24.9 normal	615	48.4	55.6	51.3	43.6				
25-29.9 overweight	297	23.4	18.1	14.5	29.7				
>30 obese	276	21.7	16.4	23.4	23.8				
Parity									
0	526	41.5	40.1	38.3	43.5	0.38			
1	390	30.8	29.2	33.1	30.6				
2	352	27.8	30.7	28.6	25.9				
<u>Behavior and Psychosocial Variables</u>									
Cigarette smoking (pre-pregnancy)									
None	788	66.6	67.1	70.9	64.5	0.40			
10 cigarettes/day	298	25.2	23.9	22.8	26.8				
> 10 /day	98	8.3	9.0	6.3	8.7				
Cigarette smoking (early pregnancy)									
No	711	85.9	84.7	84.8	86.9	0.67			
Yes	117	14.1	15.3	15.2	13.1				
Cigarette smoking (mid pregnancy)									
No	655	88.2	84.3	85.2	91.5	0.02			
Yes	88	11.8	15.7	14.8	8.5				
Cigarette smoking (late pregnancy)									
No	656	88.6	87.8	87.3	89.6	0.70			
Yes	84	11.4	12.2	12.7	10.4				
Major depression ^d									
No	675	81.9	77.2	78.1	85.7	0.01			
Yes	149	18.1	22.8	21.9	14.3				

	Total		Met GWG Guidelines		Inadequate GWG		Excessive GWG		<i>p</i> -value ^b
	N	%	%	%	%	%	%		
Psychosocial stress									
1st quartile	210	25.2	22.3	23.0	27.4	0.01			
2nd quartile	232	27.8	28.6	22.4	29.7				
3rd quartile	201	24.1	24.3	22.4	24.7				
4th quartile	191	22.9	24.8	32.2	18.2				
Trait anxiety									
1st quartile	218	26.0	24.0	22.3	28.4	0.17			
2nd quartile	205	24.4	24.5	24.5	24.4				
3rd quartile	227	27.1	26.9	24.5	28.2				
4th quartile	189	22.5	24.5	28.8	19.0				

Numbers may not total 1276 due to missing data

^a According to 2009 Institute of Medicine (IOM) guidelines

^b *P*- values are from Chi square tests

^c Puerto Rico/Dominican Republic (PR/DR)

^d Score of 15 on the Edinburgh Postnatal Depression Scale (EPDS)

Table 2

Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for Early Pregnancy Physical Activity and Compliance with Gestational Weight Gain (GWG) Guidelines Using Multinomial Logistic Regression; Proyecto Bueno Salud, Western Massachusetts, 2006-2011.

Variable	Inadequate GWG		Excessive GWG	
	Unadjusted OR (95% CI)	Adjusted ^b OR (95% CI)	Unadjusted OR (95% CI)	Adjusted ^b OR (95% CI)
<u>Met Physical Activity Guidelines</u>				
Yes	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
No	1.33 (0.82, 2.15)	1.34 (0.82, 2.22)	1.22 (0.81, 1.84)	1.17 (0.76, 1.79)
<u>Total Physical Activity</u>				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	0.63 (0.36, 1.11)	0.63 (0.36, 1.11)	1.08 (0.68, 1.74)	1.04 (0.64, 1.68)
3rd quartile	0.65 (0.37, 1.13)	0.65 (0.37, 1.15)	1.11 (0.69, 1.79)	1.13 (0.69, 1.83)
4th quartile	0.95 (0.55, 1.66)	0.98 (0.55, 1.73)	1.22 (0.75, 1.99)	1.24 (0.74, 2.06)
<i>p</i> -trend	0.83	0.88	0.43	0.39
<u>Physical Activity by Intensity</u>				
<u>Sedentary</u>				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	1.14 (0.66, 1.98)	1.12 (0.64, 1.95)	1.46 (0.91, 2.33)	1.34 (0.83, 2.18)
3rd quartile	0.95 (0.55, 1.64)	0.93 (0.54, 1.62)	1.27 (0.80, 2.01)	1.26 (0.79, 2.01)
4th quartile	0.85 (0.49, 1.45)	0.83 (0.48, 1.45)	1.12 (0.71, 1.76)	1.06 (0.66, 1.70)
<i>p</i> -trend	0.44	0.41	0.79	0.90
<u>Moderate</u>				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	0.81 (0.46, 1.43)	0.84 (0.47, 1.48)	1.02 (0.64, 1.64)	1.08 (0.67, 1.76)
3rd quartile	0.66 (0.38, 1.14)	0.67 (0.38, 1.17)	0.75 (0.48, 1.19)	0.76 (0.47, 1.23)
4th quartile	1.00 (0.57, 1.76)	1.03 (0.57, 1.86)	1.13 (0.70, 1.83)	1.26 (0.76, 2.10)
<i>p</i> -trend	0.78	0.84	0.96	0.72
<u>Vigorous</u>				
None	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Any	0.76 (0.41, 1.41)	0.76 (0.41, 1.41)	0.89 (0.54, 1.45)	0.91 (0.55, 1.50)
<u>Physical Activity by Type</u>				
<u>Sports/Exercise</u>				
None	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Low	0.80 (0.48, 1.34)	0.80 (0.47, 1.34)	0.78 (0.50, 1.19)	0.76 (0.49, 1.18)
High	0.83 (0.53, 1.29)	0.83 (0.53, 1.30)	0.88 (0.61, 1.28)	0.84 (0.57, 1.23)
<i>p</i> -trend	0.39	0.40	0.47	0.33
<u>Household/Caregiving</u>				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	0.49 (0.27, 0.87)	0.49 (0.27, 0.89)	1.00 (0.63, 1.59)	1.07 (0.66, 1.75)
3rd quartile	0.72 (0.42, 1.25)	0.75 (0.41, 1.36)	0.98 (0.61, 1.57)	1.03 (0.61, 1.72)
4th quartile	0.86 (0.50, 1.47)	0.90 (0.49, 1.67)	0.91 (0.57, 1.47)	0.97 (0.57, 1.67)

Variable	Inadequate GWG		Excessive GWG	
	Unadjusted OR (95% CI)	Adjusted ^b OR (95% CI)	Unadjusted OR (95% CI)	Adjusted ^b OR (95% CI)
<i>p</i> -trend	0.87	0.93	0.71	0.89
Occupation				
Unemployed	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Low	0.88 (0.52, 1.48)	0.87 (0.51, 1.46)	1.04 (0.67, 1.60)	1.02 (0.65, 1.59)
High	0.89 (0.57, 1.39)	0.87 (0.55, 1.38)	1.30 (0.90, 1.89)	1.21 (0.83, 1.77)
<i>p</i> -trend	0.59	0.53	0.17	0.34

^aCompared to meeting IOM guidelines

^bAdjusted for age (continuous), body mass index, parity and smoking during early pregnancy

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Table 3

Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for Mid Pregnancy Physical Activity and Compliance with Gestational Weight Gain (GWG) Guidelines Using Multinomial Logistic Regression; Proyecto Bueno Salud, Western Massachusetts, 2006-2011.

Variable	Inadequate GWG		Excessive GWG	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI) ^b	Unadjusted OR (95% CI)	Adjusted OR (95% CI) ^b
Met Physical Activity Guidelines				
Yes	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
No	1.13 (0.67, 1.90)	1.11 (0.65, 1.92)	1.22 (0.79, 1.88)	1.15 (0.73, 1.82)
Total Physical Activity				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	1.07 (0.60, 1.93)	1.13 (0.62, 2.04)	1.85 (1.14, 3.02)	1.92 (1.16, 3.16)
3rd quartile	1.08 (0.61, 1.93)	1.13 (0.63, 2.05)	1.70 (1.05, 2.77)	1.97 (1.19, 3.27)
4th quartile	1.03 (0.60, 1.79)	1.06 (0.60, 1.80)	1.08 (0.67, 1.74)	1.22 (0.73, 2.02)
<i>p</i> -trend	0.90	0.84	0.84	0.43
<u>Physical Activity by Intensity</u>				
Sedentary				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	1.03 (0.58, 1.83)	1.06 (0.59, 1.89)	1.14 (0.71, 1.81)	1.11 (0.68, 1.80)
3rd quartile	1.36 (0.76, 2.43)	1.39 (0.77, 2.49)	1.51 (0.93, 2.44)	1.44 (0.88, 2.37)
4th quartile	1.26 (0.72, 2.21)	1.27 (0.72, 2.26)	1.10 (0.68, 1.76)	1.05 (0.64, 1.72)
<i>p</i> -trend	0.29	0.29	0.46	0.59
Moderate				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	0.75 (0.43, 1.33)	0.78 (0.43, 1.39)	1.05 (0.65, 1.69)	1.16 (0.70, 1.91)
3rd quartile	0.79 (0.44, 1.43)	0.78 (0.42, 1.43)	1.40 (0.86, 2.28)	1.54 (0.92, 2.58)
4th quartile	0.81 (0.47, 1.40)	0.79 (0.45, 1.41)	0.83 (0.51, 1.34)	0.95 (0.57, 1.57)
<i>p</i> -trend	0.50	0.45	0.72	0.92
Vigorous				
None	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Any	1.04 (0.57, 1.90)	1.02 (0.55, 1.88)	0.87 (0.52, 1.46)	0.89 (0.52, 1.52)
<u>Physical Activity by Type</u>				
Sports/Exercise				
None	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Low	0.88 (0.53, 1.46)	0.88 (0.53, 1.47)	1.33 (0.88, 2.00)	1.34 (0.88, 2.06)
High	1.09 (0.68, 1.74)	1.08 (0.67, 1.75)	1.36 (0.91, 2.02)	1.34 (0.89, 2.02)
<i>p</i> -trend	0.76	0.78	0.12	0.16
Household/Caregiving				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	0.71 (0.40, 1.25)	0.67 (0.37, 1.20)	0.79 (0.49, 1.26)	0.83 (0.50, 1.37)
3rd quartile	0.64 (0.35, 1.17)	0.63 (0.33, 1.20)	1.16 (0.72, 1.87)	1.44 (0.85, 2.43)
4th quartile	0.95 (0.55, 1.65)	0.95 (0.51, 1.76)	0.73 (0.45, 1.18)	0.95 (0.55, 1.64)

Variable	Inadequate GWG		Excessive GWG	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI) ^b	Unadjusted OR (95% CI)	Adjusted OR (95% CI) ^b
<i>p</i> -trend	0.88	0.96	0.51	0.63
Occupation				
Unemployed	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Low	0.89 (0.48, 1.66)	0.89 (0.48, 1.66)	1.00 (0.60, 1.66)	0.96 (0.57, 1.61)
High	0.97 (0.62, 1.51)	0.94 (0.60, 1.49)	1.12 (0.77, 1.63)	1.00 (0.68, 1.47)
<i>p</i> -trend	0.86	0.77	0.56	0.97

^a Compared to meeting IOM guidelines

^b Adjusted for age (continuous), body mass index, parity and smoking during mid-pregnancy

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Table 4

Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for Late Pregnancy Physical Activity and Compliance with Gestational Weight Gain (GWG) Guidelines Using Multinomial Logistic Regression; Proyecto Bueno Salud, Western Massachusetts, 2006-2011.

Variable	Inadequate GWG		Excessive GWG	
	Unadjusted OR (95% CI)	Adjusted ^b OR (95% CI)	Unadjusted OR (95% CI)	Adjusted ^b OR (95% CI)
<u>Met Physical Activity Guidelines</u>				
Yes	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
No	0.91 (0.51, 1.61)	0.95 (0.53, 1.71)	1.26 (0.82, 1.93)	1.29 (0.83, 2.00)
<u>Total Physical Activity</u>				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	0.95 (0.50, 1.78)	0.91 (0.48, 1.73)	0.91 (0.55, 1.49)	0.87 (0.52, 1.46)
3rd quartile	0.85 (0.45, 1.60)	0.86 (0.45, 1.64)	0.81 (0.50, 1.33)	0.85 (0.51, 1.42)
4th quartile	0.76 (0.40, 1.43)	0.73 (0.38, 1.40)	0.81 (0.50, 1.32)	0.73 (0.44, 1.22)
<i>p</i> -trend	0.36	0.34	0.34	0.25
<u>Physical Activity by Intensity</u>				
<u>Sedentary</u>				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	Referent
2nd quartile	0.56 (0.30, 1.03)	0.55 (0.30, 1.03)	0.92 (0.56, 1.49)	0.92 (0.56, 1.53)
3rd quartile	0.57 (0.31, 1.06)	0.55 (0.29, 1.03)	0.94 (0.58, 1.53)	0.93 (0.56, 1.50)
4th quartile	0.65 (0.36, 1.19)	0.64 (0.35, 1.18)	0.89 (0.55, 1.45)	0.91 (0.55, 1.51)
<i>p</i> -trend	0.18	0.16	0.69	0.74
<u>Moderate</u>				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	1.11 (0.60, 2.05)	1.01 (0.54, 1.89)	0.97 (0.59, 1.58)	0.87 (0.52, 1.44)
3rd quartile	0.65 (0.35, 1.22)	0.59 (0.31, 1.12)	0.69 (0.43, 1.11)	0.65 (0.40, 1.07)
4th quartile	0.91 (0.49, 1.70)	0.86 (0.46, 1.61)	0.88 (0.54, 1.43)	0.81 (0.49, 1.34)
<i>p</i> -trend	0.41	0.33	0.34	0.26
<u>Vigorous</u>				
None	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Any	1.01 (0.52, 1.97)	0.93 (0.47, 1.85)	0.95 (0.56, 1.59)	0.99 (0.58, 1.71)
<u>Physical Activity by Type</u>				
<u>Sports/Exercise</u>				
None	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Low	0.74 (0.43, 1.27)	0.70 (0.40, 1.21)	0.96 (0.64, 1.46)	0.82 (0.53, 1.26)
High	0.86 (0.52, 1.43)	0.80 (0.48, 1.34)	0.95 (0.64, 1.41)	0.81 (0.54, 1.24)
<i>p</i> -trend	0.53	0.38	0.78	0.33
<u>Household/Caregiving</u>				
1st quartile	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
2nd quartile	0.99 (0.53, 1.85)	1.03 (0.54, 1.97)	1.05 (0.65, 1.70)	1.00 (0.60, 1.66)
3rd quartile	0.84 (0.45, 1.58)	0.93 (0.48, 1.83)	0.94 (0.58, 1.51)	0.91 (0.54, 1.53)
4th quartile	0.97 (0.53, 1.79)	1.06 (0.54, 2.09)	0.83 (0.52, 1.34)	0.77 (0.45, 1.32)

Variable	Inadequate GWG		Excessive GWG	
	Unadjusted OR (95% CI)	Adjusted ^b OR (95% CI)	Unadjusted OR (95% CI)	Adjusted ^b OR (95% CI)
<i>p</i> -trend	0.82	0.93	0.38	0.31
Occupation				
Unemployed	1.00 Referent	1.00 Referent	1.00 Referent	1.00 Referent
Low	1.39 (0.69, 2.81)	1.39 (0.68, 2.84)	0.79 (0.42, 1.49)	0.71 (0.37, 1.37)
High	0.52 (0.32, 0.86)	0.50 (0.30, 0.84)	0.73 (0.51, 1.05)	0.73 (0.50, 1.06)
<i>p</i> -trend	0.02	0.01	0.09	0.09

^aCompared to meeting IOM guidelines

^bAdjusted for age, BMI, parity and smoking during late pregnancy

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Table 5

Beta Coefficients and Standard Errors (SE) for Gestational Weight Gain (GWG) on Physical Activity during Pregnancy; Proyecto Bueno Salud, Western Massachusetts, 2006-2011.

Variable	Total GWG			Rate of GWG		
	Unadjusted Beta (SE)	Adjusted ^a Beta (SE)	Adjusted ^a p-value	Unadjusted Beta (SE)	Adjusted ^a Beta (SE)	Adjusted ^a p-value
<u>Early Pregnancy</u>						
Met Physical Activity Guidelines						
Yes	Referent	Referent	Referent	Referent	Referent	Referent
No	-0.12 (1.44)	-1.33 (1.44)	0.36	0.00 (0.04)	-0.03 (0.04)	0.47
Total Physical Activity						
1st quartile	Referent	Referent	Referent	Referent	Referent	Referent
2nd quartile	3.38 (1.73)	3.35 (1.68)	0.05	0.08 (0.04)	0.08 (0.04)	0.05
3rd quartile	3.31 (1.73)	3.57 (1.69)	0.03	0.08 (0.04)	0.08 (0.04)	0.05
4th quartile	0.60 (1.73)	2.36 (1.73)	0.17	0.03 (0.04)	0.08 (0.04)	0.08
P-trend	0.75	0.17		0.55		0.10
<u>Mid Pregnancy</u>						
Met Physical Activity Guidelines						
Yes	Referent	Referent	Referent	Referent	Referent	Referent
No	1.70 (1.62)	0.36 (1.61)	0.82	0.05 (0.04)	0.01 (0.04)	0.72
Total Physical Activity						
1st quartile	Referent	Referent	Referent	Referent	Referent	Referent
2nd quartile	3.14 (1.87)	2.82 (1.79)	0.12	0.08 (0.05)	0.07 (0.05)	0.13
3rd quartile	1.91 (1.87)	3.00 (1.81)	0.10	0.04 (0.05)	0.07 (0.05)	0.14
4th quartile	0.09 (1.87)	2.03 (1.84)	0.27	-0.01 (0.05)	0.04 (0.05)	0.35
P-trend	0.87	0.27		0.72		0.36
<u>Late Pregnancy</u>						
Met Physical Activity Guidelines						
Yes	Referent	Referent	Referent	Referent	Referent	Referent
No	4.34 (1.50)	3.62 (1.48)	0.01	0.10 (0.04)	0.08 (0.04)	0.03
Total Physical Activity						

Variable	Total GWG				Rate of GWG			
	Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a	
	Beta (SE)	p-value	Beta (SE)	p-value	Beta (SE)	p-value	Beta (SE)	p-value
1st quartile	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
2nd quartile	-1.35 (1.76)	0.45	-1.80 (1.73)	0.30	-0.03 (0.04)	0.52	-0.04 (0.04)	0.36
3rd quartile	-2.35 (1.76)	0.18	-2.32 (1.74)	0.18	-0.06 (0.04)	0.19	-0.06 (0.04)	0.19
4th quartile	-2.49 (1.76)	0.16	-1.76 (1.76)	0.32	-0.06 (0.04)	0.21	-0.04 (0.04)	0.40
p-trend	0.13		0.30		0.16		0.36	

^a Adjusted for age (continuous), body mass index, parity, and smoking during pregnancy