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Exercise during pregnancy and risk of late preterm birth, cesarean delivery, and hospitalizations

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Abstract

Background—Federal physical activity guidelines recommend at least 150 minutes of moderate-intensity exercise per week during pregnancy. We studied whether regular exercise during pregnancy is associated with preterm birth, cesarean delivery, and hospitalization during pregnancy.

Methods—Self-reported weekly exercise was ascertained in 3,006 women during the 3rd trimester of pregnancy. Using multivariable logistic regression, we report the relationship between regular exercise (at least 150 minutes per week) and late preterm birth, cesarean delivery, and hospitalization during pregnancy, controlling for age, race, marital status, education, poverty status, pre-pregnancy BMI weight category, gestational weight gain, and prepregnancy diabetes or hypertension.

Results—Nearly one-third of women reported meeting current federal physical activity recommendations during pregnancy. Five percent had late preterm birth, 29% had cesarean

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deliveries, and 20% reported hospitalization during pregnancy. In multivariable analysis, regular exercise during pregnancy was not associated with late preterm birth or hospitalization during pregnancy. Physical activity of 150 or more minutes/week was associated with reduced odds of cesarean delivery compared with less than 60 minutes/week, but the finding was not statistically significant (adjusted OR 0.86, 95% CI 0.69 – 1.07).

Conclusion—In the First Baby Study, physical activity was not associated with late preterm birth or hospitalizations, and may be associated with decreased odds of cesarean delivery.

Introduction and Background

In 2008, the U.S. Department of Health and Human Services released physical activity guidelines recommending that pregnant women participate in at least 150 minutes of moderate-intensity aerobic activity per week if they are not already highly active or doing vigorous intensity activity (Physical Activity Guidelines Advisory Committee, 2008). Pregnant women who habitually engage in vigorous-intensity aerobic activity or who are highly active can continue those levels of physical activity during pregnancy. These federal guidelines are in line with the American College of Obstetricians and Gynecologists (ACOG) 2002 guidelines that recommend at least 30 minutes of moderate-intensity exercise on most, if not all, days of the week in the absence of contraindications (American College of Obstetricians and Gynecologists, 2002).

These physical activity guidelines were developed due to accumulating evidence that exercise is beneficial for both the mother and fetus during pregnancy. Women who engage in at least 30 minutes of moderate physical activity per day in their last trimester of pregnancy have better cardiovascular fitness than less active women (Melzer et al., 2010). Physical activity reduces the risk of certain medical complications associated with pregnancy—specifically, physical activity is associated with a lower likelihood of hypertensive complications during pregnancy, such as preeclampsia (Martin & Brunner Huber, 2010; Saftlas, Logsden-Sackett, Wang, Woolson, & Bracken, 2004; Sorensen et al., 2003). Furthermore, prenatal physical activity is associated with reduced risk for excessive gestational weight gain (Kraschnewski et al., 2013; Stuebe, Oken, & Gillman, 2009), which leads to postpartum weight retention and long-term obesity (Amorim, Rossner, Neovius, Lourenco, & Linne, 2007; Linne, Dye, Barkeling, & Rossner, 2003; Mamun et al., 2010; Rooney, Schauberger, & Mathiason, 2005). While common belief suggests that physical activity during pregnancy could increase the risk for pregnancy complications, the federal guidelines point out that moderate-intensity activity in healthy women during pregnancy does not increase the risk of low birthweight (Gavard & Artal, 2008; Sternfeld, Quesenberry, Eskenazi, & Newman, 1995) or preterm labor (Barakat, Stirling, & Lucia, 2008; Hatch, Levin, Shu, & Susser, 1998). In fact, there may even be a decreased risk of preterm labor with greater leisure time physical activity during pregnancy (Domingues, Barros, & Matijasevich, 2008). Likewise, it has previously been observed that aerobic exercise does not negatively impact birth weight, preterm birth or neonatal well-being (Haakstad & Bo, 2011).

Exercise during pregnancy has also been shown to influence risk of cesarean delivery. For example, as early as 1962 Erdelyi found a 50% decreased risk of cesarean section among Hungarian athletes compared to non-athletes (Erdelyi, 1962). Subsequent research done by Clapp indicated that recreational athletes who continued to exercise throughout pregnancy had a lower frequency of cesarean section and vaginal operative delivery (Clapp, 1990). Moreover, Hall and Kaufmann reported that the incidence of cesarean delivery was 6.7% in women who participated in high levels of exercise compared to 28.1% in sedentary women (Hall & Kaufmann, 1987). More recent studies outside of the U.S. have also suggested that physical activity reduces the risk of operative delivery (Barakat, Pelaez, Lopez, Montejo, &

Coteron, 2012; Dumith, Domingues, Mendoza-Sassi, & Cesar, 2012). However, a larger and more recent U.S. study that included a greater proportion of overweight and obese women suggested that exercise during pregnancy was not associated with a reduced risk of cesarean delivery (Bovbjerg & Siega-Riz, 2009). Therefore, the relationship between physical activity and mode of delivery is not entirely clear, especially in a modern day population of U.S. women with significant overweight and obesity.

There are numerous known benefits of exercising during pregnancy, however the effect that prenatal exercise may have on hospitalization during pregnancy has not been well studied. Previous studies have found that the most common reasons for hospitalizations during pregnancy are preterm labor, nausea or vomiting, genitourinary complications, and hypertensive disorders (Bacak, Callaghan, Dietz, & Crouse, 2005; Bennett, Kotelchuck, Cox, Tucker, & Nadeau, 1998; Gazmararian et al., 2002). To date, few studies that have specifically investigated the relationship between exercise and pregnancy-related hospitalizations. One study of over 2,500 pregnancies in Brazil found no association between physical activity and hospitalization)(Dumith et al., 2012). Based on previous literature suggesting the health benefits of exercise during pregnancy, we hypothesized that regular prenatal exercise is associated with decreased odds of preterm birth, cesarean delivery, and hospitalizations during pregnancy.

Methods

Study Design

Data for these secondary analyses are from the First Baby Study, which is a longitudinal cohort of women having their first birth. The purpose of the parent study is to investigate the association between mode of first delivery (vaginal vs. cesarean) and likelihood of subsequent fertility. Participants were recruited between January 2009 and April 2011 through placement of study advertisements at numerous locations, such as hospitals, obstetricians' offices and clinics, ultrasound centers, childbirth education classes, and newspapers. Targeted mailings were sent to potentially eligible women obtained from marketing lists. Women were eligible to participate if they were residents of Pennsylvania, aged 18 to 35 at the time of the baseline interview, nulliparous, currently pregnant with a singleton pregnancy, and able to speak English or Spanish. Since the primary purpose of the First Baby Study is to study subsequent fertility, eligibility was limited to women 18-35 years old as women in that age range are most likely to have a subsequent child in a 3-year follow-up period. Details regarding recruitment are described elsewhere (Kjerulff et al., 2013). A total of 3,006 First Baby Study participants were recruited, consented, and completed the baseline telephone interview during the third trimester (at ≥34 weeks gestation) and 1-month postpartum interview. Birth certificate data and hospital discharge data for the mother and baby were obtained and linked to the participant interview data. The current study uses data collected at the baseline and at 1-month postpartum interviews to describe the association between prenatal physical activity and 3 outcomes—late preterm vs. full-term birth, cesarean delivery, and hospitalization during pregnancy. For the study outcome of late preterm birth, women who were enrolled in the study after 37 weeks gestation (n=608) were excluded since they were not at risk for the outcome, resulting in 2,398 women eligible for the preterm birth analysis. The First Baby Study was approved by the Institutional Review Board of the XXXXX as well as the Institutional Review Boards of participating hospitals located throughout the Commonwealth of Pennsylvania.

Definition of Variables

Outcome Variables—Late preterm birth, cesarean delivery, and hospitalization —Using birth certificate data, women were characterized as having had a late preterm birth

(34 0/7-36 6/7 weeks gestation) or a full-term birth (≥37 weeks gestation). There were no early preterm births (<34 weeks), since study inclusion required women to be at ≥34 weeks gestation at the time of the baseline interview. In the postpartum survey, women self-reported whether or not they had a cesarean delivery, which was verified by hospital discharge data. Women reported on hospitalizations that occurred during pregnancy at both the baseline and postpartum surveys. Hospitalization was defined as any self-reported hospitalization that occurred during pregnancy for any indication that did not lead to the birth of the baby. Self-reported reasons for hospitalizations were categorized into 36 categories.

Exercise during pregnancy—Physical activity items were adapted from the Leisure-Time Exercise Questionnaire (LTEQ), a validated measure of physical activity (Downs, DiNallo, & Kirner, 2008; Godin & Shephard, 1985). The LTEQ and other physical activity measures have been similarly adapted in recent years to convert metabolic equivalents (METS) to bouts and minutes of physical activity. During the baseline survey, women were asked the following 2 questions: “Since you have become pregnant, how many days per week do you engage in regular exercise behavior?” and “How many minutes per day do you engage in regular exercise behavior?” Using the responses to these questions, we calculated minutes of exercise per week. A three-level variable describing physical activity during pregnancy was created, defined as <60 minutes/week, 60-149 minutes/week, and 150 minutes/week or more.

Covariates—Covariates were chosen to reflect variables that have been demonstrated in the literature to be associated with our study outcomes, as well as other basic sociodemographic variables. Variables ascertained at the baseline interview included age group (18-24, 25-29, 30-36 years), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian, or other), marital status (married, living with partner, not living with partner, not partnered), education (high school degree or less, some college or technical school, or college graduate or higher), poverty status (poverty, near poverty, or not poverty), pre-pregnancy body mass index (BMI) category (underweight BMI <18.5 kg/m^2, normal weight BMI 18.5 – 24.9 kg/m^2, overweight BMI 25.0 – 29.9 kg/m^2, obese BMI ≥30.0 kg/m^2)(Brunner Huber, 2007), and self-reported history of diabetes or hypertension prior to pregnancy. Self-reported gestational weight gain was ascertained at the postpartum interview, defined as whether or not women exceeded the recommended amount of weight gain for prepregnancy BMI weight category (>40 lbs for underweight, >35 lbs for normal weight, >25 lbs for overweight, and >20 lbs for obese women),(IOM (Institute of Medicine) and NRC (National Research Council), 2009)

Statistical Analysis

Frequencies and percentages of the study variables were determined. Bivariate analyses were performed to test the association between the independent variables and the outcome variables using chi-square tests. We then used multivariable logistic regression to model the association between meeting physical activity recommendations during pregnancy and each of the 3 outcome variables (late preterm birth, cesarean delivery, hospitalization). In all 3 models, we controlled for basic sociodemographic variables and covariates known to be associated with the outcomes of interest as described above. The analytic sample for the logistic regression models was 2,370 for the late preterm birth model and 2,960 for the cesarean delivery and hospitalization models due to listwise deletions for missing variables. All analyses were performed using SAS Version 9.3 (SAS Institute, Inc., Cary, N.C.).

Results

The baseline characteristics of the sample are shown in Table 1. Most women were normal weight prior to pregnancy (54%), while 22% were overweight and 21% were obese prior to pregnancy. One-third of the sample was meeting the 2008 Federal Physical Activity Guidelines of at least 150 minutes of exercise per week. The bivariate relationships between physical activity level and the main outcomes are also shown in Table 1. There was no bivariate association of exercise with late preterm versus full-term birth. However, the bivariate association between physical activity and cesarean section was significant (p=0.002)—the rate of cesarean section in women who were meeting the federal physical activity recommendations during pregnancy of at least 150 minutes/week was 24.6% compared with 31.1% and 30.6% in women with 60-149 minutes/week and <60 minutes/week, respectively. There was no significant association between physical activity level and hospitalization during pregnancy in bivariate analysis.

The results of the adjusted analyses modeling the 3 outcome variables are shown in Table 2. There was no significant association between prenatal exercise and late preterm birth. The odds of late preterm birth was increased only in the oldest age group and in women with prepregnancy diabetes or hypertension.

In the multivariable model estimating cesarean delivery (Table 2), there was lower odds of cesarean delivery in women who were meeting the federal physical activity guidelines compared with women who were exercising 60 minutes/week or less (adjusted OR 0.86, 95% CI 0.69-1.07), however statistical significance was not reached. Higher odds of cesarean delivery was associated with older age, Black and Asian race, prepregnancy overweight and obesity, and having exceeded recommended gestational weight gain.

In the multivariable model estimating odds of hospitalization during pregnancy, there was higher odds of hospitalization in women who were meeting the federal physical activity guidelines compared with women who were exercising 60 minutes/week or less (adjusted OR 1.25, 95% CI 0.98-1.60), but the finding did not meet statistically significance. Reasons for hospitalization were not significantly associated with exercise frequency (results not shown). Having some college/technical school (compared with college graduate), being overweight or obese (compared with being normal weight), and having prepregnancy diabetes or hypertension were also significantly associated with increased adjusted odds of hospitalization. Women in the oldest age group (30-36 years) were less likely to report hospitalization during pregnancy.

Conclusions and Discussion

In this analysis of the First Baby Study, a large longitudinal cohort of pregnant women, we describe pregnancy-related outcomes of women who were participating in varying amounts of exercise during pregnancy. Overall, our study did not discern any statistically significant effects between amount of physical activity and the main study outcomes of late preterm birth, cesarean delivery, or hospitalization during pregnancy. However, a few trends emerged that are worth discussion. First, the rate of cesarean delivery was lowest in women meeting the federal physical activity recommendations at 24%, compared with 31% in women exercising at lower levels. While this association was attenuated and not significant (p=0.06) after adjusting for covariates such as prepregnancy weight category and gestational weight gain, the trend towards lower odds of cesarean delivery in women who exercise is worth noting. A lower odds of cesarean delivery in exercising women has been described in older studies where most women were normal weight (Clapp, 1990; Erdelyi, 1962; Hall & Kaufmann, 1987), but it was important to corroborate in a modern day sample of U.S. women with high rates of prepregnancy overweight and obesity. While the exact mechanism

by which prenatal physical activity may influence route of delivery is unclear, desire to avoid operative delivery may be motivation for women to remain active during pregnancy.

Second, although there was no significant association between physical activity level and hospitalization during pregnancy, we did not expect that there would be a trend toward greater odds of hospitalization in women who were meeting the federal physical activity guidelines of exercising at least 150 minutes per week. Further research on how physical activity during pregnancy may modify a woman's risk for hospitalization may need to be explored. In spite of the possibility of increased hospitalization, it is important to note that any increased hospitalizations that occurred did not result in increased odds of late preterm birth in women who were meeting the recommended levels of physical activity. This is an important finding, because women may avoid exercising during pregnancy due to fear of inducing preterm labor. Our findings do not support that notion. By design, all women in the First Baby Study had their baseline interview at ≥34 weeks, and therefore we were unable to determine if exercise had any association with early preterm delivery.

Of note, only one-third of our sample was meeting the federal guidelines of at least 150 minutes of physical activity per week. While this low prevalence was expected, it confirms that pregnant women are largely not conforming to recommended levels of physical activity. It has been well described in the literature that physical activity levels decline during pregnancy, especially in women who were physically active prior to becoming pregnant (Pereira et al., 2007). Unfortunately, our prior work suggests that pregnant women do not receive sufficient counseling from their prenatal care providers about recommended physical activity during pregnancy (Stengel, Kraschnewski, Hwang, Kjerulff, & Chuang, 2012).

The strength of this study is that it is a large longitudinal cohort of pregnant U.S. women with a significant proportion of overweight and obesity that is representative of the current U.S. weight distribution of pregnant women. Our study has limitations to consider. Both physical activity and hospitalizations were determined by self-report. The physical activity questions were only asked at one point in time during the third trimester of pregnancy, so we were not able to assess how the amount of physical activity may have varied throughout pregnancy. We did not assess prepregnancy physical activity, and how that may have affected the risks/benefits of exercise during pregnancy. Hospitalizations were also determined by self-report. It is therefore possible that women may have included visits to a labor and delivery unit that did not result in a true hospital admission in this count. While our analysis controlled for possible confounders, it is certainly possible that unmeasured confounders exist that were not accounted for. Participants in the First Baby Study were predominantly white, married, and educated, and thus our results may not be generalizable to more diverse populations.

Implications for Practice and Policy

There are many well-established benefits to exercising during pregnancy both to the fetus and the mother. In this study, we report no statistically significant associations between exercise during pregnancy and the odds of adverse pregnancy outcomes (i.e., late preterm birth, cesarean delivery, or hospitalization during pregnancy). However, reported levels of physical activity during pregnancy are low, and efforts to disseminate and implement the recommended guidelines are needed.

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Table 1

Baseline characteristics of pregnant women and prenatal physical activity, N= 3,006.

	Total sample N=3,006	Prenatal physical activity (minutes/week)			p-value[1]
		<60 N = 771 (25.9%)	60-149 N = 1239 (41.6%)	≥150 N = 968 (32.5%)	
Age group - years					<0.001
18 - 24	777 (25.8)	187 (24.3)	269 (21.7)	305 (31.5)	
25 - 29	1187 (39.5)	315 (40.9)	539 (43.5)	327 (33.8)	
30 - 36	1042 (34.7)	269 (34.9)	431 (34.8)	336(34.7)	
Race/Ethnicity					0.004
White, non-Hispanic	2502 (83.2)	620 (80.4)	1076 (86.8)	790 (81.6)	
Black, non-Hispanic	221 (7.4)	72 (9.3)	69 (5.6)	73 (7.5)	
Hispanic	166 (5.5)	46 (6.0)	50 (4.0)	66 (6.8)	
Asian	62 (2.1)	17 (2.2)	22 (1.8)	23 (2.4)	
Other	55 (1.8)	16 (2.1)	22 (1.8)	16 (1.7)	
Marital Status					<0.001
Married	2117 (70.4)	557 (72.2)	927 (74.9)	625 (64.6)	
Living with partner	544 (18.1)	136 (17.6)	194 (15.7)	207 (21.4)	
Not living with partner	187 (6.2)	43 (5.6)	60 (4.8)	74 (7.6)	
Not partnered	157 (5.2)	35 (4.5)	57 (4.6)	62 (6.4)	
Education					0.001
HS graduate or less	501 (16.7)	125 (16.2)	173 (14.0)	189 (19.5)	
Some college or technical school	804 (26.7)	221 (28.7)	312 (25.2)	263 (27.2)	
College graduate	1701 (56.6)	425 (55.1)	754 (60.9)	516 (53.3)	
Poverty Status					<0.001
Poverty	254 (8.5)	67 (8.7)	81 (6.5)	100 (10.4)	
Near Poverty	340 (11.3)	89 (11.6)	117 (9.5)	129 (13.4)	
Not Poverty	2403 (80.2)	612 (79.7)	1039 (84.0)	735 (76.2)	
Pre-pregnancy weight category					<0.001
Underweight	106 (3.5)	19 (2.5)	46 (3.7)	39 (4.0)	
Normal weight	1611 (53.6)	366 (47.5)	644 (52.0)	585 (60.4)	

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	Total sample N=3,006	Prenatal physical activity (minutes/week)			p-value[1]
		<60 N = 771 (25.9%)	60-149 N = 1239 (41.6%)	≥150 N = 968 (32.5%)	
Overweight	667 (22.2)	188 (24.4)	273 (22.0)	201 (20.8)	
Obese	620 (20.6)	197 (25.6)	276 (22.3)	143 (14.8)	
Exceeds recommended gestational weight gain					<0.001
Yes	1620 (54.1)	450 (58.6)	694 (56.1)	463 (48.0)	
No	1377 (45.9)	318 (41.4)	543 (43.9)	502 (52.0)	
Pre-pregnancy diabetes or hypertension					0.015
Yes	121 (4.0)	45 (5.8)	43 (3.5)	33 (3.4)	
No	2885 (96.0)	726 (94.2)	1196 (96.5)	935 (96.6)	
Late preterm birth[2]	118 (4.9)	28 (4.5)	50 (5.1)	39 (5.0)	0.826
Cesarean delivery	863 (28.7)	236 (30.6)	385 (31.1)	238 (24.6)	0.002
Hospitalization	596 (19.8)	144 (18.7)	230 (18.6)	215 (22.2)	0.069

[1] chi-square test comparing women by prenatal physical activity level.

[2] sample size for determining bivariate relationship between prenatal physical activity and late preterm birth was 2,398. A total of 608 subjects (with gestation ≥ 37 weeks at baseline) were removed before analysis.

Table 2

Logistic regressions modeling effect of prenatal physical activity on late preterm birth, cesarean delivery, and hospitalization [adjusted odds ratios (95% confidence intervals)]

	Late preterm birth N = 2,370[1]	Cesarean delivery N = 2,960[2]	Hospitalization N = 2,960[2]
Prenatal physical activity			
<60 min/wk	Reference	Reference	Reference
60-149 min/wk	1.14 (0.71 - 1.84)	1.09 (0.89 - 1.34)	1.05 (0.83 - 1.33)
150+ min/wk	1.12 (0.67 - 1.86)	0.86 (0.69 - 1.07)	1.25 (0.98 - 1.60)
Age group - years			
18 - 24	Reference	Reference	Reference
25 - 29	1.86 (0.9 - 3.83)	1.72 (1.29 - 2.30)*	0.75 (0.56 - 1.00)
30 - 36	2.29 (1.09 - 4.85)*	2.43 (1.78 - 3.31)*	0.56 (0.41 - 0.78)*
Race/Ethnicity			
White, non-Hispanic	Reference	Reference	Reference
Black, non-Hispanic	1.19 (0.50 - 2.84)	1.48 (1.03 - 2.13)*	1.21 (0.84 - 1.73)
Hispanic	0.49 (0.15 - 1.67)	1.37 (0.94 - 2.01)	0.96 (0.65 - 1.44)
Asian	0.86 (0.2 - 3.64)	1.88 (1.1 - 3.23)*	1.22 (0.62 - 2.38)
Other	1.57 (0.47 - 5.31)	0.85 (0.43 - 1.65)	0.93 (0.47 - 1.82)
Marital Status			
Married	Reference	Reference	Reference
Living with partner	0.98 (0.52 - 1.87)	1.24 (0.95 - 1.62)	1.28 (0.97 - 1.69)
Not living with partner	1.23 (0.44 - 3.43)	1.29 (0.84 - 1.97)	1.13 (0.74 - 1.72)
Not partnered	1.39 (0.52 - 3.76)	1.24 (0.80 - 1.92)	1.51 (0.99 - 2.30)
Education			
HS graduate or less	1.58 (0.78 - 3.19)	1.10 (0.81 - 1.51)	1.28 (0.92 - 1.78)
Some college or technical school	0.98 (0.59 - 1.63)	0.96 (0.77 - 1.19)	1.41 (1.10 - 1.81)*
College graduate	Reference	Reference	Reference
Poverty Status			
Poverty	0.71 (0.27 - 1.86)	1.12 (0.79 - 1.59)	1.04 (0.73 - 1.48)
Near Poverty	1.15 (0.55 - 2.39)	0.91 (0.67 - 1.25)	1.23 (0.91 - 1.66)
Not Poverty	Reference	Reference	Reference
Pre-pregnancy weight category			
Underweight	0.71 (0.21 - 2.37)	0.61 (0.35 - 1.09)	1.39 (0.86 - 2.23)
Normal weight	Reference	Reference	Reference
Overweight	1.00 (0.61 - 1.62)	1.24 (1.01 - 1.54)*	1.42 (1.12 - 1.81)*
Obese	0.64 (0.37 - 1.11)	2.11 (1.72 - 2.61)*	1.46 (1.15 - 1.86)*
Exceeds recommended gestational weight gain	0.83 (0.55 - 1.23)	1.55 (1.30 - 1.85)*	0.95 (0.78 - 1.16)
Pre-pregnancy diaabetes or hypertension	3.24 (1.71 - 6.16)*	1.27 (0.86 - 1.87)	1.72 (1.13 - 2.61)*

Models are adjusted for age group, race/ethnicity, martial status, education, poverty status, pre-pregnancy weight category, gestational weight gain, and pre-pregnancy diabetes or hypertension.

[1] A total of 608 subjects (with gestation ≥ 37 weeks) were removed before analysis. Sample size reduced from n=2,398 to n=2,370 in the logistic regression due to listwise deletions.

[2] Sample size reduced from n=3,006 to n=2,960 in the logistic regression due to listwise deletions.

* $p<0.05$