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Association Between Change in Maternal Physical Activity During Pregnancy and Infant Size in a Sample Overweight or Obese Women

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Abstract

Physical activity (PA) naturally declines during pregnancy and its effects on infant size are unclear, especially in overweight or obese pregnancies, a low-active subpopulation that tends deliver heavier infants. The objective of this study was to evaluate changes in prenatal PA and infant birthweight in a group of overweight or obese pregnant women. We employed a prospective analysis using data from a randomized controlled exercise trial (2001 to 2006) in sedentary, overweight or obese pregnant women in Michigan. Women with complete data on peak oxygen consumption, daily PA (via pedometers) and birthweight were included in the analyses. Change in PA was estimated via repeated measures analyses, and then its influence on infant birthweight was assessed via linear regression. Eighty-nine pregnant women were included and considered low-active (6,579.91 ± 2379.17 steps/day). PA declined from months 4 to 8 (−399.73 ± 371.38 steps$\cdot$day$^{-1}\cdot$month^{-1}). Analyses showed that the decline in PA (β= −0.28 g, 95%CI: −0.70, 0.25 g, p=0.35) was not associated with birthweight. The findings of this study demonstrated that the decline in maternal PA during mid- to late-pregnancy, in overweight or obese women, was unrelated to infant birthweight. Future investigations should employ rigorous measurements of PA and infant anthropometry in this subpopulation.

Keywords

Prenatal exercise; macrosomia; obesity; cardiorespiratory fitness

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Introduction

Pregnancies complicated by overweight or obesity, an ever-growing subpopulation, often result in the delivery of heavier infants (Ehrenberg, Mercer, and Catalano 2004). Concerningly, higher weight at birth predisposes infants to altered growth trajectories, potentially increasing the risk of overweight or obesity across the lifespan (Archer 2015; Archer and McDonald 2017). Collectively, studies demonstrate that sufficiently-active lifestyles (150 minutes of moderate intensity physical activity [PA]) positively influence infant birthweight (Bisson et al. 2016; Wiebe et al. 2015; Davenport et al. 2018), however, this observation is restricted to normal weight pregnant women populations. Limited studies show null effects of prenatal PA on BW in the overweight or obese subpopulation (Kong et al. 2014; Phelan et al. 2011; Polley, Wing, and Sims 2002).

More importantly, research demonstrates that PA declines throughout pregnancy, most precipitously in the 3rd trimester. Reductions in prenatal PA may negatively affect infant size, given the adverse metabolic effects augmenting fetal nutrient supply (Archer 2015; Archer and McDonald 2017). Only one study, to our knowledge, demonstrated that declines in PA during mid-to-late pregnancy resulted in the delivery of heavier and fatter infants (Clapp III et al. 2002). This observation is particularly important for the overweight or obese pregnant population as these women live low-active lifestyles (Huberty et al. 2016; Renault et al. 2012) and tend to gain excessive weight in pregnancy potentially exacerbating their decline in PA, and further increasing their risk of delivering heavier infants (Lau et al. 2014; O'Dwyer et al. 2013; Siega-Riz et al. 2009)

No prospective studies have evaluated the influence of the natural decline in prenatal PA on infant birthweight in overweight or obese pregnancies. In addition, no studies examined the potential modifying effect of maternal cardiorespiratory fitness (CRF) on this relationship. Higher levels of maternal CRF may protect against the negative effects of decreasing levels of PA on infant birthweight. Thus, the primary purpose of this study was to describe the relationship between changes in physical activity in mid-to-late pregnancy and infant birthweight in a sample of overweight or obese pregnant women. A secondary purpose of this study was to evaluate the potential modifying effect of maternal cardiorespiratory fitness on this relationship.

Materials and Methods

Study Design

The present study employed a prospective design using data from a five-year randomized exercise comparative trial (RCT). The parent study aimed to assess the effects of prenatal moderate intensity exercise on the incidence of preeclampsia during its pathological processes (e.g., oxidative stress) among sedentary pregnant women with a previous history of preeclampsia. The secondary purpose of the parent study was to assess the effects of exercise on gestational weight gain and birth outcomes (Yeo 2006).

Participant Eligibility & Recruitment

In the parent study, pregnant women were recruited from nine prenatal clinics via nurses in Michigan from November 2001 to July 2006. Women were eligible for this study if they 1) were less than 14 weeks gestation, 2) had a history of preeclampsia, 3) were 'low-fit' VO_{2peak} (≤ 50^{th} percentile) and 4) lived a low-active or expended < 840 kcals per day during physical activities. Women with chronic hypertension or pre-gestational diabetes, medical limitations inhibiting participation in exercise, lack of physician clearance to exercise or unable to effectively communicate with research staff (e.g., low mental acuity) were excluded. While the parent study did not impose a restriction on body mass index, 81.2% of the sample was classified as overweight or obese. The Institutional Review Boards at all clinical sites and the University of Michigan approved the study protocols.

Randomization & Intervention Groups

Two-hundred and ten pregnant women expressed interest in participating in the parent RCT; 41% (n=86) did not meet the eligibility criteria. From 14 to 17 weeks of gestation, pregnant women participated in 'run-in' period to screen for poor adherence, during which surveys, a cardiorespiratory fitness test and medical record review were performed. The remaining 124 pregnant women were randomly assigned to an exercise program (n=64) or a stretching program (n=60). The exercise program recommended that the women walk for 40 minutes, five times per week at moderate intensity (55–69% of heart rate reserve). In the stretching program, participants were instructed to mimic the movements of a stretching video of equivalent frequency and duration as the exercise program. More details on the exercise and stretching programs of the RCT can be found elsewhere (Yeo 2006). For the purposes of the present study, participant data were pooled and group allocation was controlled for in the analyses.

Outcome and Exposure

Infant Birthweight—Infant birthweight, in grams, was the primary dependent variable. Birthweight was defined as the weight of the infant at the time of delivery. The data on birthweight was extracted from the mother's medical records.

Change in Physical Activity—Physical activity was recorded daily using a pedometer (Digiwalker SW200), previously documented valid and reliable measurement of PA in pregnant women(Conway et al. 2018) from week 18 of gestation until delivery. Participants wore the pedometer, attached via an elastic belt, directly above the right hip during waking hours. Participants removed the pedometer during any water-based activities (e.g. showering). In addition, participants kept a daily record of their total daily step counts throughout their prenatal period. Daily steps were collapsed into four-week periods that corresponded to the months of pregnancy: month 4 (18 – 21 weeks), month 5 (22 – 25 weeks), month 6 (26 – 29 weeks), month 7 (30 – 33 weeks), and month 8 (34 – 37 weeks).

Because nearly 60% of data on daily step counts were missing in the 9^{th} month of pregnancy (38 – 41 weeks), likely due to variability in delivery, these data were excluded from the analysis. Prenatal PA was expressed as $steps \cdot day^{-1} \cdot month^{-1}$. We did not employ any exclusionary protocols for the PA data. The number of steps accumulated in pregnancy ranged from 1 to 16,503 steps per day. Change in prenatal physical activity was determined using individual trajectories in PA across the prenatal period (i.e. time) [see Statistical Analysis].

Cardiorespiratory Fitness—Cardiorespiratory fitness defined as peak oxygen consumption ($\dot{V}O_{2peak;}$ ml $O_2 \cdot kg^{-1} \cdot min^{-1}$) was estimated via a submaximal treadmill test at 17 and 28 weeks of gestation. The treadmill exercise test followed the Cornell Exercise protocol, a modified version of the Bruce Protocol treadmill test. Participants walked on a treadmill for eight, two-minute stages with progressive increments speed and grade. Heart rate, blood pressure, fatigue, oxygen consumption, carbon dioxide production and minute ventilation were assessed at rest and continuously during the exercise test using a portable indirect calorimeter (VO2000, Medical Graphics Corporation, Minneapolis, MN). This device has been previously validated in a sample of sedentary pregnant women (Yeo et al. 2005).

Although CRF is shown to remain stable in pregnancy, in this sample the change in CRF levels between 17 and 28 weeks of gestation was quite variable, possibly attributable to physiological differences in women with a previous history of preeclampsia and/or the physiological alterations occurring in pregnancy. Consequently, any change in CRF may not be reflective of a ‘real’ change in CRF but merely a change in pregnancy-related physiology. As such, CRF at 17 weeks of gestation was used to provide an estimate of the average level of CRF in early pregnancy.

Maternal and Infant Characteristics—Several maternal and infant characteristics that may affect birthweight, PA and/or CRF were included as potential covariates. Maternal and infant characteristics included the following: age, weight gain (17 – 18 weeks of gestation), gestational age and group allocation. Maternal age (in years) and gestational age (in weeks) were extracted from the participants’ medical records.

Gestational weight gain was calculated using the difference in weight, objectively measured, at 17 and 28 weeks of gestation. Weight gained from early to mid-to-late pregnancy was used instead of total GWG (i.e., pre-pregnancy to birth) because 1) it is prone to less error than self-reported pre-pregnancy weight, 2) on average, little weight is gained in early pregnancy, and 3) weight gained in the last trimester is mostly attributed to fetal weight. However, since the use of total GWG is ubiquitous, we calculated total GWG and compared its influence on the regression models. The calculation of total GWG required the use of multiple imputation (PROC MI in SAS v. 9.4) as nearly 40% of data for ‘weight at delivery’ was missing. The influence of these measures on the regression coefficients and standard errors regression models did not appreciably differ (data not shown), as such, we elected to use mid-to-late pregnancy GWG.

Statistical Analyses

Group differences in the maternal and infant characteristics between the exercise and stretching programs were determined using Student’s t-test and Pearson Chi-square tests. For the main analyses, we performed two multiple linear regression models to determine: 1) the effects of change in maternal PA in mid-to-late pregnancy on infant birthweight and 2) the modifying effect of CRF on this association. Change in PA in the prenatal period was determined using individual trajectories in PA across time (gestation). We performed a random intercept and slope mixed model with repeated measures to estimate intercepts and slopes of each participant. These estimates were then created as individual variables with the intercept acting as a ‘baseline measure of PA’ and the slope representing the ‘change in PA’ across the prenatal period.

For each regression analysis, infant birthweight and change in maternal PA served as the primary dependent and independent variables, respectively. In the second main analyses, the modifying effect of CRF was assessed with an interaction term between CRF and change in PA. Assumptions of linear regression were examined and were satisfactory. Following this, unadjusted linear regression models were performed first, followed by a sequential inclusion of covariates. Model selection was guided by multiple factors including: goodness of fit (using AIC), existing scientific literature and impact on the magnitude of the regression coefficients of the main predictor variable. All analyses were conducted using SAS analytical software version 9.4 (Cary, North Carolina) and the significance level was set *a priori* at $\alpha = 0.05$. Change in prenatal PA (steps $\cdot$ day^{-1} $\cdot$ month^{-1}), CRF (ml $O_2 \cdot kg^{-1} \cdot min^{-1}$), GWG (kg), age (years), gestational age (weeks) were treated as continuous. Group allocation was treated as a dichotomous variable; the stretching program served as the referent group.

Analytical Sample—Due to the documented significant impact on infant birthweight and physician-ordered restrictions on PA, women diagnosed with preeclampsia (n=13; 10.5%) or gestational diabetes mellitus (n=10; 8.1%) were excluded from the analyses. Of the remaining 101 participants, 12 were excluded due to missing data as women with complete data on infant birthweight, maternal PA in pregnancy and cardiorespiratory fitness were included in the analyses. For PA, one woman who reported no PA across the entire prenatal measurement period was excluded. In total, 89 of the 124 eligible pregnant women were used in the analyses. To assess the possibility of selection bias, we compared the differences in demographics, pregnancy-related and behavioral characteristics of women with and without complete data. We found no significant differences between these groups, thus providing some evidence that excluding these women may not result in biased estimates.

Results

At 17 weeks of gestation, the average participant was 32 years old with a BMI classified as overweight/obese (BMI: 29.97 ± 7.14 kg/m^2) (Table 1). On average, women delivered full-term, normal weight infants (gestational age: 38.64 ± 1.88 weeks; birthweight: 3477.48 ± 577.48g). The average weight gained in mid-pregnancy (17 to 28 weeks) was approximately 6.5 kilograms. Roughly 15% of infants were born macrosomic (>4000g), nearly double the prevalence in the United States (~8%) (Martin et al. 2015). Only 4% of infants delivered were low-birthweight (<2500 g). Women in this sample were considered ‘unfit’ with an average VO_{2peak} of 19.85 ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ (SD 3.35).

In addition, these women accumulated, on average, 6600 steps per day, suggesting participation in a ‘low active’ lifestyle (Tudor-Locke and Bassett 2004) (Table 2). In addition, during every month of pregnancy, PA decreased, on average, by nearly 400 steps per day. As expected, maternal PA declined from month 4 (18 – 22 weeks) to month 9 (38 – 41 weeks), with women accumulating on average 7227.7 (± 2618.5) steps$\cdot$day^{-1} and 5848.5 (± 2778.9) steps$\cdot$day^{-1}), respectively. Additionally, this table shows that the number of pregnant women recording their daily PA declined as well, most precipitously in the last month of pregnancy.

Change in prenatal PA was not significantly associated with infant birthweight (β= −0.28 g, 95%CI: −0.70, 0.25 g, p=0.35), after adjusting for maternal age, gestational age, weight gain, and group allocation (Table 3). The interaction between CRF and change in PA was not significantly associated with infant birthweight (β= 0.04 g, 95%CI: −0.06 g, 0.14 g, p=0.697), after adjusting for maternal age, gestational age, weight gain, and group allocation (Table 4).

Discussion

The primary finding of this study was that, in overweight or obese women, the decrease in maternal physical activity from mid- to late-pregnancy was unrelated to infant birthweight. This study was unique in that it was, to our knowledge, the first to prospectively follow women from mid- to late-pregnancy and evaluate the association between change in physical activity and infant birthweight. Further research is necessary in this group as these women are predisposed to excessive weight gain, low levels of PA and poor metabolic health, all of which are posited to be risk factors for the delivery of larger neonates.

A potential explanation for the null association between the change in maternal PA and infant birthweight is the small magnitude in the change in PA from mid-to late-pregnancy. In this study, a very modest reduction in maternal PA was observed likely consequent to the low active lifestyle led by these women, potentially demonstrating a floor effect. At 17 weeks of gestation (i.e. baseline) this sample of women accumulated nearly 6600 steps$\cdot$day$^{-1}\cdot$month^{-1}, which is reflective of low activity. A majority (~5000 – 7000 steps) of these daily step counts were likely the results of everyday activities of daily living [ADLs] (Tudor-Locke et al. 2011). The remainder potentially represented leisure time physical activity. Considering the necessity of the engagement in ADLs, PA attributed to ADLs likely did not change significantly during pregnancy. As such, the decrements in PA documented in this study were likely consequent to reductions in leisure-time physical activity (Gaston and Cramp 7). On average, the women in this sample decreased their daily steps by approximately 400 steps per month (−399.73 ± 371.38 steps) from the 4th month to the 8th month of pregnancy. Over a 5-month period, this corresponds roughly to a 2,000-daily step decrement. This change is consistent with previous studies. For example, Renault et al. (2012) assessed physical activity via pedometers and found an 1,850-step decrement in steps per day from 13 weeks to 36 – 38 weeks of gestation in obese women (Renault et al. 2012). The small magnitude of the decrement in maternal PA found in this study was likely insufficient to influence fetal energy supply and birthweight, thereby precluding our ability to detect an association.

In support of this interpretation, Clapp et al. (2002) evaluated the effects of various doses of prenatal physical activity in normal weight women on infant size (Clapp III et al. 2002). They found that women who decreased their PA delivered heavier, fattier neonates reflected by higher birthweight and greater amounts of adipose tissue compared to women who maintained or increased their PA throughout the prenatal period. The considerable decrement in PA likely altered fetal energy supply, especially in the 3^{rd} trimester. This is consequent to the reduction in the maternal skeletal muscle demand for energy, thus increasing energy availability to the fetus (Mujika and Padilla 2000). The decrement in PA experienced by these women was 200 minutes per week, a markedly greater reduction in the levels of PA relative to the 400-daily step per month decline exhibited in the present study. As such, a larger decrement in prenatal PA may have been necessary to affect infant size.

Another unique aspect of this study was the examination of the moderating effect of maternal cardiorespiratory fitness on the relationship between the change in maternal PA during pregnancy and birthweight. Cardiorespiratory fitness is an indicator of habitual physical activity (Caspersen, Powell, and Christenson 1985) (7). In addition, given the strong metabolic effects of physical activity (Shojaee-Moradie et al. 2007), we posited that maternal CRF may attenuate the potential adverse effects (i.e. reduced metabolic health) related to reductions in prenatal PA (Bergouignan et al. 2013) on neonate size. The findings of the aforementioned study of Clapp et al. (2002) support this hypothesis. The women in that study were previously active and subsequently possessed optimal levels of cardiorespiratory fitness. Despite the increased birthweight and adipose tissue among neonates born to the women who decreased their prenatal PA during the prenatal period, the birthweight and tissue composition of these neonates were still within the normal range (Catalano et al. 1992). This may indicate that higher levels of PA and thus, CRF in the preconception period may have protected the neonate from overgrowth in spite of a decline in maternal PA during pregnancy. In this study, however, we observed that maternal cardiorespiratory fitness does not moderate the relationship between the decline in maternal PA in the prenatal period and infant birthweight.

A possible explanation for the null observation regarding the moderating effects of maternal cardiorespiratory fitness is low variability. Previous studies assessing CRF levels in pregnancy observed low variability among the overweight or obese subpopulation. Davenport et al. (2008), assessed the CRF of overweight and obese pregnant women and found the average CRF, expressed as peak oxygen consumption, of 21.6 ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ (± 3.8 ml $O_2 \cdot kg^{-1} \cdot min^{-1}$) (Davenport et al. 2008). The average value and variability (i.e. standard deviation) is lower in comparison to those found in an anthropometrically diverse sample of pregnant women by Mottola et al. (2006). These authors found an average CRF of 23.7 ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ and SE of 5.0 ml $O_2 \cdot kg^{-1} \cdot min^{-1,}$ (Mottola et al. 2006). The lower levels of CRF found in the former study are similar to those found in the present study (VO_{2peak}: 19.85 ± 3.35 ml $O_2 \cdot kg^{-1} \cdot min^{-1}$). The low variability in CRF found in this study may be due to the low-active lifestyles led by these women. Habitual PA is a strong predictor of CRF and as such, the low levels of PA found among this sample of women likely resulted in low levels and variability of CRF. In addition, the combination of limited variability in maternal CRF and the small magnitude of the change in PA during pregnancy may have precluded our ability to detect a moderating effect (Rosenthal and Rosenthal 2011).

This study has strengths and limitations. Importantly, to our knowledge, this is the first study to examine the association between the changes in maternal physical activity in mid-to-late pregnancy and infant birthweight in a sample of overweight or obese pregnant women. Moreover, it may be the first to assess the potential moderating effect of maternal cardiorespiratory fitness on this relationship. An additional strength of this study is the longitudinal measurement of physical activity in the prenatal period. This evaluation allowed us to account for the natural changes in PA from mid-to-late pregnancy and led to a more accurate estimation of its relationship with infant birthweight. Lastly, the use of objective assessments increased the precision of the measurement of physical activity and cardiorespiratory fitness (Conway et al. 2018). In addition to these significant strengths, this study has limitations. First, only PA in mid-to-late pregnancy was observed. Thus, any changes occurring prior to 17 weeks of gestation were missed, potentially resulting in a less accurate representation of the changes in PA during pregnancy. Second, the sample size for this study was small (n=90) possibly limiting our ability to detect an association, especially a moderating effect. Third, we did not consider other behaviors that have been documented to influence PA and infant size, including maternal diet (Grieger and Clifton 2014) and maternal occupation type. Fourth, while birthweight is the most widely used measure of infant size, it fails to provide information on the tissue composition of the neonate, which is important to future health risks (Goodpaster et al. 1997).

In conclusion, this study demonstrated that the decline in maternal PA during the prenatal period was unrelated to birthweight, among overweight or obese pregnant women with a history of preeclampsia. In addition, we observed that maternal CRF did not exert a moderating effect on this relationship. In spite of these null observations, this study contributes to this rapidly growing area of research in an understudied and important subpopulation. Several recommendations are suggested to address the limitations of this study. First, the employment of sampling strategies aimed to increase the variability in PA and CRF (i.e. purposive sampling) are encouraged. Second, the use of objective assessments of PA that measure PA intensity (e.g. accelerometers) are recommended given the strong relation between PA intensity and metabolic health. Third, maternal metabolic biomarkers, such as glycemic and lipidemic control, should be assessed given that these parameters are considered the underlying mechanisms to excessive fetal growth and are often ignored in studies. Lastly, more precise measurements of infant anthropometry are needed (i.e. lean and fat mass).

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Table 1.

Sample characteristics of pregnant women, by total and intervention group

	Total (n=90)			Exercise (n=49)			Stretching (n=41)		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Demographics									
Age (y)	90	32.3	4.7	49	32.5	4.4	41	32.1	4.9
Weight (kg)	90	80.4	18.7	49	79.9	19.1	41	81.0	18.4
Height (m)	90	1.6	0.1	49	1.6	0.1	41	1.6	0.1
Body Mass Index (kg/m^2)	90	30.0	7.1	49	29.7	7.5	41	30.3	6.8
Pregnancy-Related									
Gestational Age (weeks)	90	38.6	1.9	49	38.5	2.0	41	38.8	1.7
Gestational Weight gain *	90	6.5	3.6	49	6.0	2.9	41	7.0	4.2
Birthweight (g)	90	3477.5	577.5	49	3475.5	613.4	41	3479.9	538.6
Macrosomia (%)	90	15.4	-----	49	14.0	-----	41	16.7	-----
Behavioral ¥									
CRF	90	19.8	3.4	49	20.0	3.1	41	19.7	3.6
Physical Activity	89	6588.7	2416.6	49	7801.4 **	2236.4	40	5103.1	1706.0
Change in PA	89	−399.7	371.4	49	−470.6 **	374.1	40	−312.9	353.4
No. Days Monitored	89	114.2	32.6	49	114.6	32.6	40	113.6	32.96

Note:

* Gestational weight gain represents weight gain during 17 weeks and 28 weeks of gestation (corresponding to participant laboratory visits).

** denotes significant between-group differences ($p<0.0001$).

¥ PA data on one participant was removed as no data on PA were available, however all other pertinent data were available. CRF was expressed as ml $O2 \cdot kg^{-1} \cdot min^{-1}$. Physical activity was expressed as $steps \cdot day^{-1} \cdot month^{-1}$

Table 2.

Maternal patterns of average physical activity (steps·day^{-1}) from mid-to-late pregnancy, by group

		Total		Exercise		Stretch	
		Mean	SD (range)	Mean	SD (range)	Mean	SD (range)
Gestation*	N						
Month 4	87	7227.7	2618.5 (2426.6–16503.2)	8726.3	2246.8 (4369.2–16503.2)	5465.5	1809.3 (2426.6–9922.4)
Month 5	86	7093.6	2679.5 (1987.8–17526.3)	8333.6	2574.2 (3763.6–17526.3)	5599.2	1960.9 (1987.8–9867.11)
Month 6	85	6614.4	2551.1 (1705.9–15788.6)	7852.6	2412.9 (4020.7–15788.6)	5082.9	1783.3 (1705.9–8140.1)
Month 7	84	6135.2	2618.1 (186.7–15627.4)	7407.9	2466.9 (3400.7–15627.4)	4666.7	1947.7 (186.7–8260.2)
Month 8	75	5797.2	2521.4 (598.6–14033.9)	6814.8	2408.4 (1915.0–14033.9)	4569.9	2094.5 (598.6–8517.6)
Month 9	37	5848.5	2778.9 (1302.0–14133.5)	6666.4	3121.9 (1858.0–14133.5)	4886.3	1995.3 (1302.00–8315.0)

Note:

*The weeks of gestation that correspond to each month of pregnancy are as follows: Month 4 (18 – 21 weeks), Month 5 (22 – 25 weeks), Month 6 (26 – 29 weeks), Month 7 (30 – 33 weeks), Month 8 (34 – 37 weeks) and Month 9 (38 – 41 weeks).

Table 3.

Adjusted linear regression coefficients assessing the association between change in prenatal PA and infant birthweight, in grams

	Parameter Estimates		
Predictors	**β**	**SE**	**p-value**
Primary Exposures			
PA Change †	-0.227	0.234	0.3462
Covariates			
Baseline PA *	0.017	0.029	0.5512
Maternal Age (y)	5.24	12.00	0.6637
Gestational Age (weeks)	156.17	30.32	<0.0001
Gestational weight gain **	18.31	16.02	0.2565
Group Allocation ***			
Exercise	-44.46	135.23	0.7431

Note:

† Change in PA is represented by individual trajectories (slopes) of PA from months 4 to 8 of pregnancy (See Methods section).

* Baseline PA is represented by the intercepts of individual trajectories of PA (See Methods section).

** Gestational weight gain represents weight gained during 17 weeks and 28 weeks of gestation (corresponding to participant laboratory visits).

*** Stretching group is referent. Physical activity was expressed as steps·day^{-1}·month-^{1}.

Table 4.

Adjusted linear regression coefficients assessing the modifying effect of CRF on the association between change in prenatal PA and infant birthweight, in grams

	Parameter Estimates		
Predictors	**β**	**SE**	**p-value**
Primary Exposures			
PA Change	−0.98	1.01	0.3355
CRF	10.08	25.94	0.6987
CRF*PA change	0.040	0.051	0.4333
Covariates			
PA Intercept *	0.023	0.030	0.4473
Maternal Age (y)	5.46	12.12	0.6538
Gestational Age (weeks)	152.29	31.01	<0.0001
Gestational weight gain **	18.22	16.39	0.2695
Group Allocation ***			
Exercise	−61.75	137.94	0.6556

Note: Change in PA is represented by individual trajectories (slopes) of PA from months 4 to 8 of pregnancy (See Methods section).

* Baseline PA is represented by the intercepts of individual trajectories of PA (See Methods section).

** Gestational weight gain represents weight gained during 17 weeks and 28 weeks of gestation (corresponding to participant laboratory visits).

*** Stretching group is referent. CRF was expressed as ml $O2 \cdot kg^{-1} \cdot min^{-1}$. Physical activity was expressed as $steps \cdot day^{-1} \cdot month\text{-}^{1}$.