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# Physical Activity During Pregnancy and Postpartum: What Have We Learned?

## Overview

The development and introduction of the Physical Activity Guidelines for Americans in October, 2008 was a landmark occasion.[1] It represented the culmination, at least to this date, of decades of research that has established a variety of health benefits of physical activity for virtually everyone, regardless of age, gender, or physical capabilities. Importantly, this document included a section on the role of physical activity during pregnancy and the postpartum period. It appears that pregnant women exercise nearly to the same extent as their non-pregnant counterparts, particularly in early gestation. Using data from the 2000 Behavioral Risk Factor Survey, Evenson[2] found that more than two-thirds of pregnant women reported they participated in some type of leisure-time physical activity. Given the high prevalence of reported physical activity participation, it is important to understand the potential risks and benefits of physical activity during pregnancy for women and their offspring.

Research on physical activity among pregnant women has occurred mainly in the latter quarter of the 20th century up until today. Early research in the 1970s and 80s involved a very cautious approach and focused primarily on possible adverse effects, primarily because (a) we knew little about women's responses to exercise in general and (b) we knew even less about such responses during pregnancy. More recently, investigators have begun to focus on possible maternal and child health benefits related to physical activity participation during pregnancy. This paper will trace the development of physical activity guidelines for pregnant women, discuss leisure-time and work-related physical activity in relation to specific outcomes, and conclude with suggestions for future research.

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## ACOG Guidelines

The first US guidelines for women who chose to participate in leisure-time physical activity (LTPA) during pregnancy were published in 1985 by the American College of Obstetricians and Gynecologists (ACOG).[3] Not surprisingly, these were very conservative, and based on the limited research data available at the time. In general, the upper limit recommendation was roughly equivalent to the lower limit recommendation suggested by the American College of Sports Medicine, for adults who wished to exercise and maintain aerobic fitness.[4] Of note were the recommendations not to let maternal heart rate exceed 140 beats per minute, and to limit vigorous activity to no more than 15 minutes at a time. In addition, the ACOG authors provided a number of absolute and relative contraindications to maternal LTPA. Excessive maternal obesity and a history of extremely sedentary lifestyle were included as relative contraindications.[3] However, the authors did note that these 1985 guidelines were meant for a "general cross-section of the population." They indicated

that "a physically fit pregnant patient may tolerate a more strenuous program," opening the door for chronic exercisers to exceed the general recommendations written in the guidelines, if they received the approval of their health care providers.

As the result of over 600 published studies on LTPA and pregnancy in the nine years following the original 1985 guidelines, ACOG revised the guidelines in 1994.[5] In general, the 1994 guidelines were less restrictive than those published in 1985. The authors focused more on the broader health benefits of LTPA, indicating that "at least three days per week is preferable."[5] In addition, the 140 beats per minute heart rate restriction was removed from the document.

The most recent revision of the ACOG Guidelines occurred in 2002.[6] This document was the most progressive to date, reflecting the many studies that showed significant benefits from maternal LTPA, with little risk. Indeed, the authors suggested that pregnant women without obstetric complications should adopt the same recommendation that was written for non-pregnant women. That is, "an accumulation of 30 minutes or more of moderate exercise a day should occur on most, if not all, days of the week." While these guidelines emphasized that a wide range of recreational activities appear to be safe during pregnancy, they advised against activities with a high potential for falling or trauma such as contact sports, prolonged supine activity, and scuba diving, due to concerns for fetal health and comprised venous return of blood flow.

This historical look at exercise recommendations for pregnancy leads us back to the 2008 Physical Activity for Americans guidelines.[1] The overall statement regarding exercise during pregnancy is as follows:

> Healthy women who are not already highly active or doing vigorous-intensity activity should get at least 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic activity per week during pregnancy and the postpartum period. Preferably, this activity should be spread throughout the week.

Therefore, the most current ACOG and federal guidelines for LTPA both emphasize the importance of regular moderate intensity LTPA during healthy pregnancies. Participation in vigorous intensity LTPA during pregnancy has been studied little at the population level, thus upper limits for LTPA intensity during pregnancy do not currently exist. Instead, women who are vigorously active when entering pregnancy are encouraged to maintain their activities throughout pregnancy and postpartum, provided they remain healthy and communicate openly with their health care providers.[1]

## Recommendations for Weight Training

While literally hundreds of studies have been performed evaluating the effects of aerobic activity on pregnancy, very few studies have focused on resistance training.[7-9] It should be no surprise that this mode of activity also is mentioned only briefly in the ACOG or recent federal guidelines for LTPA during pregnancy.[1, 6] It is our belief that much of the hesitation to study this area stems from the largely unknown effect on the fetus. In theory, heavy lifting could reduce blood flow in the uterine and umbilical vessels. However, this has not been shown. In fact, two randomized controlled trials of strength training during pregnancy have reported no differences in length of gestation or birth weight between exercise and control groups.[7-9] Thus, it appears that strength training during pregnancy is not associated with premature birth or decreased birth weight, at least among healthy pregnancies.

Given that many health clubs have pregnancy exercise classes that include some sort of resistance training, it is likely that evidence of adverse effects would have shown up by now if the risk was significant. However, given the lack of more empirical data, common sense indicates that women wishing to weight train during pregnancy should work with a health care provider and/or exercise professional to develop programs that include low resistance, high repetition exercises over most of the major muscle groups. In addition, extra care should be taken to avoid supine positions as well as breath holding (Valsalva) while lifting, and women should not perform any lifts that compromise their balance.

# Leisure-Time Physical Activity and Birth Outcomes

As stated previously, early research efforts focused on the general question of "are the mother and/or fetus harmed by maternal physical activity?" Specific concerns included the possibility of abortion, fetal hypoxia, acidosis, hyperthermia,

brain damage and altered growth.[10] Many early studies were done with animals, mainly rats and sheep, to evaluate changes in uteroplacental blood flow, maternal temperature regulation, and substrate utilization. The bulk of research among humans has examined fetal heart rate, birth weight measures (i.e., changes in mean birth weight or risk of low birth weight), and risk of preterm delivery.

### *Fetal Distress*

Fetal bradycardia that continues for an extended period of time has been used as an index of fetal distress. While transient bouts of fetal bradycardia were recorded in one study following maximal cycle exercise in mid-pregnancy, investigators found that none of the women studied had any adverse events throughout the remainder of their pregnancies, and birth outcomes were unremarkable.[11] Of the very few additional studies that have included maximal aerobic exercise by pregnant women, adverse outcomes have not been reported.[12] Animal studies also have failed to document lasting changes in uteroplacental blood flow, fetal substrate delivery, or maternal temperature regulation.[10] Therefore it appears that maternal exercise does not contribute toward lasting fetal distress.

### *Birth Weight*

Early studies were concerned primarily with decreases in mean birth weight and/or increased risk of low birth weight, (2.5 kg) in relation to maternal LTPA. In the 1980s and 90s, Clapp performed a series of prospective studies on maternal exercise during pregnancy. His results showed that women who continued vigorous exercise (at least 3 days per week, 30 min per day) throughout pregnancy delivered lighter (~-300-500g) infants than those who stopped exercise earlier in pregnancy; however, none delivered low birth weight infants.[13, 14] Similarly, Bell et al.[15] found women exercising 5-7 days per week delivered significantly lighter babies (~-315g) than non-exercising controls. However, women who exercised 3-4 days per week appeared to deliver heavier babies than the control women.

In contrast, when Hatch et al.[16] prospectively studied more than 800 pregnant women, they found that "heavy exercise" (defined as >1,000 kcal/wk) was associated with significantly heavier babies (~276 g) compared to non-exercisers. In fact, there appeared to be a dose-response effect between the amount of exercise performed by the subjects, and birth weight. The findings of Hatch et al. do not necessarily conflict with the results of the earlier studies as Hatch et al.'s subjects gained more weight during gestation and had lower weekly energy expenditures than the women who delivered lighter babies in the Clapp et al. studies. Several other investigators have demonstrated no relationships between LTPA during pregnancy and mean birth weight; however, methods of LTPA assessment have varied widely.[17-19]

Recently, researchers have begun to examine possible effects of maternal physical activity on risk of macrosomia (birth weight > 4.0-4.5 kg) or large for gestational age (birth weight > 90th percentile for gestational age). Thus far, one U.S. study and two studies of Norwegian women have found that LTPA either prior to or during pregnancy was associated with decreased odds of macrosomia or large for gestational age.[20-22] However, a recent prospective cohort study among Danish women found no association between participation in sports/LTPA during the second or third trimesters of pregnancy and macrosomia.[23] Discrepancies in results may be due to underlying differences in the birth weight distributions between study populations (the Danish study had a much lower prevalence of macrosomia than the other studies) and/or to methodological differences in defining LTPA during pregnancy.

In summary, evidence for the effect of LTPA during pregnancy on birth size is conflicting. While some studies show that LTPA during pregnancy decreases mean birth weight,[13-15] others report increases in birth weight,[16] some find no effect,[17-19, 23] and others report that LTPA may decrease risk of macrosomia without increasing risk of low birth weight.[20-22] These apparently conflicting results are likely due to methodological differences in assessing LTPA, lack of or incomplete control for appropriate confounders, and variability in the choice of insufficiently active vs. completely sedentary control groups.[24, 25] However, inconsistent results might also reflect real differences in the effects of physical activity on birth size between populations of pregnant women.

While controlling for several maternal demographic characteristics, past studies have failed to account for LTPA participation *prior* to pregnancy, have measured LTPA in only one or two trimesters, or have been based on small and/or homogeneous samples. Despite these obstacles, the

majority of evidence suggests that LTPA during pregnancy decreases birth weight modestly within the normal range and may protect against giving birth to a macrosomic or large for gestational age infant, but does not contribute to increased risk of low birth weight or small for gestational age.[20-23, 24, 25] Given the inconsistencies of past research, however, more research is needed to clarify the role of LTPA on the birth weight distribution.

### *Preterm Delivery*

Fewer studies have investigated LTPA in relation to length of gestation. In 2006, a systematic Cochrane review of controlled trials concluded that data were insufficient to determine the effects of exercise on preterm delivery.[26] However, a review of observational literature found that exercise was associated with either a reduced risk or no effect on preterm delivery.[25] More recently, data from two birth cohorts (the Danish National Birth cohort and the Pelotas Birth Cohort in Brazil) found that LTPA during pregnancy was associated with a ~20-50% reduced risk of preterm delivery even after controlling for socioeconomic and body size variables.[27, 28] Thus, converging evidence suggests that LTPA is associated with a decrease in risk of preterm delivery. Future research is still needed to determine whether a minimum threshold of activity needed for a protective effect exists.

### *Risk of Preeclampsia*

Aside from birth outcomes, several researchers have examined LTPA in relation to maternal health during pregnancy. Evidence from case-control studies indicates that LTPA during pregnancy can reduce a woman's risk of preeclampsia, or pregnancy-induced hypertension, by about one third.[29-31] Similarly, two cohort studies in the U.S. and in Norway also found that LTPA either prior to[32] or during pregnancy[33] contributed towards reduced risk of preeclampsia. However, recent results from the Danish National Birth Cohort showed that women reporting 270-419 or ≥420 min/wk of LTPA in the first trimester had significantly *increased* risk of developing severe preeclampsia compared to women reporting no LTPA, while lower amounts of LTPA were not significantly associated with preeclampsia.[34]

While the bulk of evidence to date suggests that participation in LTPA during pregnancy reduces the risk of preeclampsia, results from the Danish National Birth Cohort point to the possibility of an upper threshold above which LTPA may be detrimental.[34] Future studies with careful measurement of both leisure-time and work-related physical activity at several time points in pre- and early pregnancy are needed to clarify dose-response and/or threshold effects with respect to preeclampsia risk.

### *Gestational Diabetes Mellitus*

Just as the case with individuals in the general population who suffer from type II diabetes mellitus, LTPA has been shown to be effective in the treatment of gestational diabetes mellitus (GDM). Overall, most studies indicate that exercise is a safe, and reasonably effective therapy.[35-37] More recently, researchers have focused on the role of LTPA either prior to, or during pregnancy, on GDM incidence.[38] Results are encouraging, but mixed. Dye et al.[39] showed that exercise prior to pregnancy exerts a preventive effect, primarily in obese women. Dempsey et al. showed GDM risk was lowest in women if exercise was performed both before and during pregnancy.[40] Finally, Zhang et al.[41] and Oken et al.[42] showed that risk reduction was also a function of intensity, with vigorous exercisers receiving the greatest preventive benefit. All results to date, therefore, show that LTPA is associated with reduced risk of GDM; however, the timing and dose of LTPA needed to see a beneficial effect is still unknown. A randomized controlled trial is being conducted currently to test the efficacy of an LTPA intervention among high-risk women to reduce the incidence of GDM and improve measures of insulin sensitivity.[43]

### *Weight Gain during Pregnancy and Postpartum Weight Loss*

As might be expected, physical activity during pregnancy can play a significant role in curtailing excessive weight gain during pregnancy. The Institute of Medicine has recommended ranges for gestational weight gain for underweight (28-40 lbs), normal weight (25-35 lbs), overweight (15-25 lbs), and obese women (11-20 lbs).[44] Stuebe et al.[45] showed recently that women who exercised either moderately or vigorously for 30 min per day during pregnancy were less likely to gain weight in excess of Institute of Medicine recommendations. Similar results have been found by others.[46, 47] Mottola suggests that previously sedentary women can help prevent excessive weight gain by following the new Physical Activity Guidelines for Americans recommendation of 150 minutes per week of moderate to vigorous activity.[48]

There have been several studies evaluating the role of exercise on postpartum weight loss as well, and the results are very encouraging. A cross sectional study by Ohlin and Rossner[49] showed that women who retained greater than 5 kg (11 lbs) of their pregnancy weight gain at one year postpartum were significantly less active in their leisure time. Sampselle et al.[50] had approximately 1,000 women complete a questionnaire at their six-week postpartum visit. Results showed that women with greater LTPA retained 2-3 lbs less weight at this time point compared to less active women. In addition, the women received psychological benefits such as enhanced socialization. One of the longest running evaluations of the role of LTPA and postpartum health was conducted by Rooney and colleagues.[51, 52] Given the longer time frame, their results focused on additional weight *gain*, 10-15 years later. The authors found that women who breast-fed and participated in aerobic exercise had significantly lower weight gains at 10 years follow-up. More importantly, chronic disease risk factor development (e.g., diabetes, dyslipidemia, hypertension) was related to weight gain and obesity measured at 15 years follow-up. As was the case at 10 years, women who began and continued aerobic exercise postpartum were less likely to have become obese after 15 years.

## Work-Related Physical Activity During Pregnancy

The bulk of research on work-related physical activity has centered on outcomes of birth weight and length of gestation, with particular interest in risk of low birth weight and preterm delivery. Early studies found that women employed outside the home delivered lighter infants compared to non-working women and that jobs requiring mostly standing were related to increased risk of low birth weight and preterm delivery.[53-55] Other investigators found that active-duty military status was also related to increased risk of low birth weight and preterm delivery, among other obstetrical problems.[56-58] Unfortunately none of these studies directly measured work-related physical activity, relying instead on job title classifications, and neither socioeconomic nor nutritional factors were taken into account. In contrast, when Klebanoff compared two groups of women of similar socioeconomic background (female medical residents to their classmates' non-physician wives) he found no differences in rates of adverse outcomes, suggesting that previous results may have reflected the influence of uncontrolled confounding factors.[59]

Recently, a systematic review evaluated the strength of evidence for associations among five common occupational exposures (prolonged working hours, shift work, time spent lifting, time spent standing, and heavy physical work) and risk of preterm delivery, giving birth to a small for gestational age infant, and preeclampsia.[60] A total of 53 studies published from 1966-2005 were identified with 35 reporting associations with preterm delivery, 34 on birth weight, and 9 on preeclampsia. The authors concluded that findings relating prolonged working hours (≥40 hrs/wk), shift work, standing (≥3 hrs/d) and lifting with preterm delivery were generally consistent and indicated modestly (10-30%) increased risk. In regards to risk of delivering a small for gestational age infant, the available literature indicated a majority of null relationships with all work exposures; however, study quality was generally low.[60] Only nine studies evaluated work exposures and risk of preeclampsia and findings were mixed, thus the evidence base was deemed too limited to draw any firm conclusions.

In summary, available research on work-related physical activity during pregnancy indicates few appreciable effects on birth weight but a potential increased risk of preterm delivery associated with prolonged work hours, standing, lifting, and shift work.[60] The majority of studies have relied on retrospective reports, job title categorizations, and/or non-validated scoring methods to assess work-related physical activities. In addition, few have controlled for appropriate confounders such as socioeconomic status, tobacco or alcohol consumption, nutrition, or physical activity occurring outside of work. Thus current results must be interpreted with caution and future study involving more rigorous measures is warranted.

## Leisure-Time Physical Activity During Pregnancy and Child Health

One of the latest areas of study is the effect of maternal LTPA on offspring growth and development. At present, we know that a) beginning or continuing recreational exercise during pregnancy has no identifiable acute or chronic *adverse* effects on the offspring and b) beginning or continuing recreational exercise during pregnancy appears to have some *beneficial* acute and chronic effects on the offspring.

There are few studies that have evaluated the role of LTPA during pregnancy on offspring development. In 1996, Clapp[61] found that 5-year-old offspring of women who exercised throughout pregnancy (n=20) scored higher on Wechsler intelligence test scales and tests of oral language skills compared to women who did not perform vigorous physical activity either before or during pregnancy (n=20). In addition, children of exercising mothers were lighter (~200g) and leaner (~5% fat) at birth and continued to be lighter (~1.5 kg) and leaner (~7 mm of total skinfolds) at five years of age. These results provide preliminary support that LTPA during pregnancy may have lasting effects on child body size; however, the mechanism of effect is unclear.

Investigating the effect of LTPA during pregnancy on child body size requires careful consideration of potentially confounding or modifying factors. Other pregnancy characteristics including maternal obesity, high pregnancy weight gain, smoking, and diabetes during pregnancy all increase risk for high birth weight and childhood overweight status.[62-64] Additionally, current LTPA levels of children are inversely associated with body fatness ($r = -0.52$, $p<0.01$) and active children gain significantly less body fat between 3-5 years of age compared to inactive children.[65, 66] Thus, the possible impact of maternal LTPA on child body size should be evaluated in light of the current activity level of the child as well as descriptive information on maternal body size and pregnancy conditions.

## Conclusions and Future Directions

Research to date provides evidence of beneficial health effects of LTPA during pregnancy, from a reduced risk of maternal disease and preterm delivery, to lower risk of macrosomia and possibly reduced fatness in offspring at early childhood. While these preliminary results are encouraging, the volume and quality of current research is not ideal. It is important to note that the bulk of previous research has been conducted among primarily white, middle to upper-class women. It has been shown that Non-Hispanic White race/ethnicity, nulliparity, >high school education, maternal age >25 years, not smoking, and engaging in structured exercise pre-pregnancy each are associated with increased participation in LTPA during pregnancy.[67, 68] In addition, reported barriers to LTPA during pregnancy include fatigue, lack of time, nausea, physical discomfort, lack of child care, and fear that exercise might be unsafe.[69, 70] Therefore, women who choose to engage in LTPA during pregnancy may differ from women who do not in several important ways that may impact their health status.

Future studies are needed to confirm previous reports of beneficial effects among more diverse populations. More objective means of assessing physical activity should be used, and women's health-related fitness also should be considered. In addition, multiple domains of physical activity, including leisure-time, work-related, household, and care-giving activities should be more systematically quantified and studied in relation to maternal/child health outcomes. There is great need for prospective, randomized, exercise-intervention studies that include both short- and long-term outcomes. While we have a long way to go, it is exciting to discuss these issues that were barely being considered a few decades ago.

Research indicates that health care providers should encourage their pregnant patients to be physically active during pregnancy, if there are no contraindications to do so. Such participation is not harmful to the maternal-fetal unit, and in fact, may be of great benefit to the mother both during pregnancy, and after delivery.

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