

CHAPTER 26

Exercise Considerations Before, During, and After Pregnancy

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INTRODUCTION

Over the past decade, there has been an increased interest in the topic of physical activity during pregnancy. This is likely due to the increasing number of studies that have shown what benefits exercise can have during this unique time in a woman's life. Physicians and patients often express uncertainty regarding physical activity during pregnancy out of concern for the safety of both the mother and fetus. Previous studies have shown that physical activity is not associated with critical outcomes such as miscarriage, neonatal death, preterm birth, or birth defects.¹ The dramatic rise in obesity, hypertension, and diabetes over the past few decades is well-documented in the literature. Subsequently there has been a similar increase in pregnancy complications such as gestational diabetes, gestational hypertension, and preeclampsia.¹ For this reason, there is an emphasis on using physical activity to help decrease the risk of these complications and optimize maternal-fetal health during pregnancy.¹

Pregnancy no longer needs to be thought of as a time to cease all activity, and it is important to counsel patients that there can be more complications by not exercising. Exercise throughout all three trimesters of pregnancy is safe, does not lead to an increase in major complications, and improves overall pregnancy outcomes.⁵ While the benefits almost always outweigh the risks for the general pregnant population, it is important to be aware of contraindications and to know when to refrain from certain activities. The goal of this chapter is to discuss the specific considerations and recommendations for exercise during pregnancy and the peripartum period based on the most updated guidelines, explain how the physiologic changes throughout pregnancy may impact the ability to perform physical activity, and describe appropriate precautions to take before engaging in physical activity.

PATHOPHYSIOLOGY

Pregnancy has a profound effect on multiple body systems, and the subsequent physiologic adaptations can be a large factor in determining the level of participation in physical activity for a pregnant woman. In the section, we will discuss the relevant adaptations and physiologic changes during pregnancy.

Anatomic/Musculoskeletal Considerations

There are various anatomic changes that occur throughout pregnancy that may affect a woman's ability to participate in certain activities or sports, of which the most obvious and noticeable is gestational weight gain. For a female with a normal prepregnancy body mass index (BMI) (18.5–24.9 kg/m²), the optimal weight gain is between 25 and 35 pounds, with an average of 1 pound per week in the second and third trimesters.⁷ Increased mass may transfer significant force across the larger weight-bearing joints such as the knees and hips.⁴ Over time, this may cause discomfort and limit the ability to participate in activities or sports requiring full load bearing, such as running.

Throughout pregnancy, both the expanding uterus and enlarging breasts will displace the center of gravity. Increased lumbar lordosis and subsequent anterior pelvic rotation on the femur occur in pregnancy, changing a woman's center of gravity.³ This is important for activities that require optimal balance such as cycling on a nonstationary bike or walking on uneven ground.¹

Finally, ligamentous laxity increases throughout pregnancy, secondary to the effects of increased levels of estrogen and relaxin, which can predispose a female to joint instability and the theoretic risk of increased strains and sprains.^{3,4,6}

Hemodynamic Adaptations

Significant hemodynamic changes occur during pregnancy, including increased cardiac output, increased

resting heart rate, increased stroke volume, and decreased systemic vascular resistance.^{3,4} Cardiac output may increase by as much as 50% in the third trimester.^{3,9} These changes are to supply sufficient blood to the placenta and the growing fetus.^{3,8} During exercise, there can be up to a 50% decrease in splanchnic blood flow and subsequently blood flow to the uterus, as blood is redirected to the exercising muscles.¹³ This raises the hypothetical risk of fetal hypoxemia during exercise, which has been the subject of multiple reports. However, flow velocity profiles in the fetal aorta and umbilical circulation in various studies resulted in contradictory and inconclusive results.^{4,14,15} At this time, the general consensus is that an increase in fetal heart rate between 10 and 30 beats per minute (bpm) over baseline during maternal exercise does not have a negative sequela on the fetus and that overall fetal injuries are unlikely during a normal uncomplicated pregnancy.⁴

An important consideration is the effect of supine positioning on the fetus, both at rest and during exercise. Primarily after the first trimester, compression of the inferior vena cava by the enlarged uterus reduces cardiac output.^{3,4} A similar phenomenon has been seen with motionless standing for prolonged periods, which leads to decreased venous return and a subsequent increased risk of hypotension.^{10–12} For this reason, it is best to assume a right or left lateral side lying position and avoid motionless standing as pregnancy progresses, especially if one is experiencing hypotensive episodes. Equally important is avoiding supine exercises such as bench press or sit-ups.

Respiratory Adaptations

Along with the cardiovascular adaptations during pregnancy, significant respiratory changes occur. As the uterus enlarges, the diaphragm displaces superiorly, which ultimately causes a profound increase in tidal volume and subsequently minute ventilation, decreasing arterial carbon dioxide.^{3,4,16} All these adaptations protect the fetus from an acidic environment, which may significantly affect the function of various organ systems, such as the cardiovascular and central nervous systems, ultimately lowering APGAR (appearance, pulse, grimace, activity, and respiration) scores.

The pressure of the enlarged uterus on the diaphragm causes a decrease in oxygen availability and thereby increased work of breathing and feelings of respiratory discomfort late in pregnancy.^{3,4} In response to increased oxygen requirements of the fetus, there are mild increases in tidal volume and oxygen

consumption in pregnant women. To meet the greater oxygen demand during physical activity, pregnant women will have an increase in respiratory frequency and oxygen consumption with just mild exercise.^{3,4,13,16} Studies have demonstrated that during pregnancy, the subjective effort to perform aerobic exercise is increased and maximum voluntary exercise performance is decreased.^{3,4,13}

Thermoregulatory Adaptations

Metabolic rate increases throughout pregnancy subsequently increasing heat production.^{4,13} In the first trimester, core temperatures above 39°C (103°F) should be avoided because of an increased risk of neural tube defects.^{3,4,13} In the second and third trimesters, thermoregulatory control improves, during which fetal temperature is maintained approximately 1°C above maternal core temperature, due to fetoplacental metabolism.^{3,4,13} Core temperature does not increase significantly with steady-state moderate exercise, which is approximately 60%–70% $\text{VO}_{2\text{max}}$.^{3,4} It is critical that heat dissipation remains greater than heat production to protect the fetus and ensure adequate uterine blood flow. For this reason, exercising in hot, humid environments or engaging in strenuous and high-intensity activities should be avoided.³

BENEFITS OF EXERCISE IN PREGNANCY

Exercise during pregnancy has been shown to have immense cardiac, metabolic, and mental health benefits. According to the 2019 Canadian guidelines for physical activity in pregnancy, there is a strong recommendation for all females without contraindications to be physically active throughout pregnancy.¹ Contraindications will be discussed in another section of this chapter. Contrary to certain myths that have prevailed over the years, recent research has shown that there is no association between physical activity and increased risk of miscarriage, preterm birth/rupture of membranes, low birth weight, congenital defects, neonatal death, hypoglycemia, or birth complications.^{1,30} Some of the many maternal benefits of physical activity during pregnancy include reduced risk of gestational diabetes, gestational hypertension, preeclampsia, and excessive gestational weight gain.¹ There has also been shown to be a reduced risk of cesarean and assisted vaginal delivery.^{1,27} Another very important benefit of exercise during pregnancy is the reduction of prenatal depressive symptoms, as well as reduction of stress and anxiety and feelings of overall improved quality of life.^{1,28,29}

GENERAL RECOMMENDATIONS

Similar to the general population, females without contraindications to exercise should aim for 150 min of moderate intensity exercise per week, accumulated over a minimum average of 3 days per week.^{1,17} It is best however to be active daily, if possible. Unfortunately, less than 15% of pregnant women achieve the goal of 150 min of moderate intensity activity per week.¹ Intensity can best be assessed via the “talk test.” Moderate-intensity exercise raises the heart rate enough that an individual is still able to carry on a conversation but would not be able to sing a song.^{1,21} Examples of moderate-intensity exercises include resistance training, brisk walking, stationary cycling, and water aerobics.¹ Heart rate ranges have also been established by the American College of Sports Medicine and the Canadian Guidelines to help better define moderate-intensity activity, based on age, fitness level, and BMI (Table 26.1).^{17,34,38}

There remains a paucity of information related to the effects of more vigorous activity levels during pregnancy, which is challenging for medical professionals caring for elite athletes and high-intensity recreational athletes. A study revealed vigorous intensity exercise during the third trimester in uncomplicated pregnancies did not result in increased poor birth outcomes.¹⁸ Studies are still limited on vigorous intensity activity in the first and second trimesters and primarily consist

of media reporting on high-profile athletes.¹⁸ It is of utmost importance for any female who wishes to exercise, especially at a high intensity, to have a conversation with a trained medical professional to individualize her exercise program during pregnancy.

EXERCISE PRESCRIPTION

With any exercise prescription and fitness counseling, the main factors that should be discussed are frequency, intensity, time, and type of exercise. The same concepts apply to pregnant women as with the general population; however, the provider must be aware of the contraindications of exercise during pregnancy. In this section, the focus will be on the different types of exercise that can be done safely in pregnancy. In general, a combination of aerobic and resistance exercises has shown greater benefit than just aerobic exercise alone and adding yoga and/or stretching may provide added benefits.¹

FIRST STEPS AND HOW TO START EXERCISING DURING PREGNANCY

Given all the benefits of exercise during pregnancy are previously discussed, it is important to know appropriate resources and how to safely engage in an exercise program during pregnancy for females who may be naïve to routine physical activity. A resource for both clinicians and pregnant women is *PARmed-X for Pregnancy*, also known as the Physical Activity Readiness Medical Examination (available through the Canadian Society for Exercise Physiology’s (CSEP) website at www.csep.ca/forms.asp). *PARmed-X for Pregnancy* was established by CSEP and has since been adopted by other institutions to help medical professionals provide individualized counseling to their patients on exercise during pregnancy.^{1,34} Further research is still needed on the effects of high-intensity activity during pregnancy, but it can be said with confidence that unless there are contraindications, all pregnant women should be engaging in moderate-intensity physical activity most days of the week.^{4,17,33}

Aerobic Exercises

Aerobic exercises that are advisable in pregnancy include those that focus on the larger muscle groups and those in which intensity is easily modified based on the goal heart rate or the talk test, as mentioned in the section General Recommendations. Brisk walking, jogging, swimming, cycling, rowing, dancing, and cross-country skiing are all examples of aerobic activities that one can partake in while pregnant.⁴ Again,

TABLE 26.1
Heart Rate Ranges Defining Moderate-Intensity Activity, Based on Age, Fitness Level, and BMI.

HEART RATE RANGES FOR PREGNANT WOMEN		
Maternal Age (Years)	Fitness Level or BMI	Heart Rate Range (beats/min)
Less than 20	—	140–155
20–29	Low	129–144
	Active	135–150
	Fit	145–160
	BMI >25 kg/m ²	102–124
30–39	Low	128–144
	Active	130–145
	Fit	140–156
	BMI > 25 kg/m ²	101–120
>40	<i>No written guidelines due to insufficient information</i>	

Target heart rate ranges were derived from peak exercise tests in medically prescreened low-risk pregnant females (established by the American College of Sports Medicine and the Canadian Guidelines). *BMI*, body mass index.

this must be catered to each patient and pregnancy based on individual risk factors, previous experience, and preferences.

Strength Training

Overall, there is much less evidence with regard to strength training, especially heavy lifting, during pregnancy. Based on findings from recent studies, lower weights and higher repetitions did not have negative impacts on pregnancy outcomes.^{4,19,22,23} Although evidence is lacking regarding heavier weight strength training or Olympic lifts, it is advisable to refrain from any lifts that require a Valsalva maneuver. The Valsalva maneuver increases intra-abdominal pressure and in turn hypothetically reduces blood flow and oxygen supply to the fetus, in addition to the potential of damaging pelvic floor muscles.^{2,4,20} Pelvic floor muscle training, if done correctly, has been shown to treat and prevent urinary incontinence both during pregnancy and after delivery. Females should aim to perform these exercises at least three times per day on most days of the week for the greatest benefit.^{2,31} It may be prudent to avoid heavy lifts or physical strain during the 6–9 days after estimated ovulation; limited evidence has shown a slightly increased risk of miscarriage during this time of implantation.²⁶ If done in the appropriate manner, weight lifting during pregnancy can have beneficial effects on the mother without negatively impacting the health of the baby.

Flexibility

Recent studies have shown that prenatal yoga is a promising treatment for maternal depression, providing beneficial effects on maternal comfort during labor, as well as reduced stress, reduced anxiety, and overall improved quality of life.^{24,25} Increased ligamentous laxity during pregnancy causes pelvic instability and misalignment of the spine, which can result in pain and discomfort. Maintaining flexibility during pregnancy enables a female to adapt effectively, efficiently, and safely to pregnancy-associated changes in alignment, joints, tendons, and ligaments. Stretching during pregnancy should focus on maintaining a normal range of motion required for activity, stretching the muscle belly rather than at the tendon or ligament, and performing stretches in a slow and controlled manner for maximum effectiveness.⁴

CONTRAINDICATIONS TO EXERCISE DURING PREGNANCY

Although the benefits of exercise during pregnancy far outweigh the risks, this primarily applies to

uncomplicated pregnancies. It is essential to be aware of both relative and absolute contraindications, as well as warning signs for when to stop exercising. For this reason, there is a need to emphasize individualized exercise programs for each patient and have a discussion regarding risks and benefits. **Table 26.2** has been adopted by the 2019 Canadian guidelines for exercise in pregnancy and outlines the absolute and relative contraindications. **Table 26.3** demonstrates the warning signs to terminate exercise during pregnancy, as detailed by the American College of Obstetricians and Gynecologists (ACOG).

HIGH-RISK SPORTS TO AVOID

It is advised to avoid contact sports with an increased risk of blunt abdominal trauma during pregnancy; this includes but is not limited to boxing, soccer, basketball, ice hockey, wrestling, and football.⁴ Additionally, sports with an increased risk of falls such as skiing (downhill and water), horseback riding, gymnastics, and ice skating should be avoided because of changes in the center of gravity as pregnancy progresses.^{1,13} Scuba diving should be avoided throughout pregnancy, as this places the fetus at an increased risk of decompression sickness and gas embolism.^{1,32}

ALTITUDE TRAINING

Exercising at altitudes less than 2500 m (8200 feet) has not been shown to have any adverse effects on the fetus in an otherwise uncomplicated pregnancy.^{1,4,32} Exercising at altitudes over 2500 m carries a hypothetical risk of hypoxia and decreased uteroplacental perfusion, especially in those who are not acclimatized or who have high-risk pregnancies.^{2,32} Uncomplicated pregnant women who are not acclimatized should limit exercise to altitudes less than 2000 m (6500 feet).²

EXERCISE CONSIDERATIONS DURING THE POSTPARTUM PERIOD AND RETURN TO SPORT

Similar to exercise prescriptions during pregnancy, returning to sport during the postpartum period must be individualized and the exact time to return is influenced by several factors. It is important for patients to be aware that regardless of prior activity level, resumption of activity after pregnancy should be gradual and should progress along a continuum. Return to sport can begin as soon as it is medically and physically safe, which is variable, and often depends on the type of delivery (cesarean section, instrumental delivery, or

TABLE 26.2
Contraindications to Exercise During Pregnancy.

Absolute Contraindications	Relative Contraindications
<ul style="list-style-type: none"> • Ruptured membranes, premature labor 	<ul style="list-style-type: none"> • Recurrent pregnancy loss
<ul style="list-style-type: none"> • Unexplained persistent vaginal bleeding 	<ul style="list-style-type: none"> • History of spontaneous preterm birth
<ul style="list-style-type: none"> • Placenta previa after 28 weeks gestational age 	<ul style="list-style-type: none"> • Gestational hypertension
<ul style="list-style-type: none"> • Preeclampsia 	<ul style="list-style-type: none"> • Symptomatic anemia
<ul style="list-style-type: none"> • Incompetent cervix 	<ul style="list-style-type: none"> • Malnutrition
<ul style="list-style-type: none"> • Intrauterine growth restriction 	<ul style="list-style-type: none"> • Eating disorder
<ul style="list-style-type: none"> • High-order multiple pregnancy (i.e., triplets) 	<ul style="list-style-type: none"> • Twin pregnancy after 28th week
<ul style="list-style-type: none"> • Uncontrolled type I diabetes, uncontrolled hypertension, or uncontrolled thyroid disease 	<ul style="list-style-type: none"> • Mild/moderate cardiovascular or respiratory disease
<ul style="list-style-type: none"> • Other serious cardiovascular, respiratory, or systemic disorders 	<ul style="list-style-type: none"> • Other significant medical conditions

TABLE 26.3
Warning Signs to Discontinue Exercise in Pregnancy.

<ul style="list-style-type: none"> • Vaginal bleeding
<ul style="list-style-type: none"> • Regular painful contractions
<ul style="list-style-type: none"> • Amniotic fluid leakage
<ul style="list-style-type: none"> • Dyspnea before exertion
<ul style="list-style-type: none"> • Dizziness
<ul style="list-style-type: none"> • Headaches
<ul style="list-style-type: none"> • Chest pain
<ul style="list-style-type: none"> • Muscle weakness affecting balance
<ul style="list-style-type: none"> • Calf pain or swelling

vaginal delivery), extent of damage to the pelvic floor muscles, or any type of incision that may have been made.⁴

Low-impact endurance training such as brisk walking or cross-country skiing can begin soon after birth, as this does not place excessive pressure on the healing pelvic floor muscles.² Higher impact endurance training as well as strength training should be resumed in a step-by-step manner, initially focusing on regaining pelvic floor muscle strength.² Following strengthening of the pelvic floor, emphasis should be on core strengthening, specifically the abdomen and back.² If a female exercised at a moderate- to high-intensity level during pregnancy, she can expect her VO_2max to return to pre-pregnancy levels, or possibly even increase.²

BREASTFEEDING

Breastfeeding and return to exercise are also important topics. The World Health Organization recommends breastfeeding for at least the first 6 months of pregnancy due to the numerous benefits for both mother and infant.³⁵ For mothers who want to engage in moderate- to high-intensity activity post partum, it is best to nurse just prior to exercise.^{2,4} This will allow for increased comfort from decreased engorgement, as well as decreased risk of acidity in breast milk, as lactic acid builds with prolonged exercise.⁴ While some mothers may be concerned about reduced production of breast milk with increased activity, some studies show performing high-volume aerobic exercises during breastfeeding resulted in both slightly greater quality and quantity of breast milk.^{36,37}

CONCLUSIONS

Pregnancy is a critical time in a woman's life and is characterized by numerous physiologic and anatomic changes. Physical activity is highly beneficial during pregnancy and is recommended for all patients with uncomplicated pregnancies. Engaging in physical activity has shown a variety of benefits for the mother and the fetus, including reduced risk of gestational hypertension, gestational diabetes, and preeclampsia, as well as a reduction in prenatal depressive symptoms, all without increasing adverse effects. Exercise programs should be tailored to each pregnancy based on patient-specific risk factors and should include a combination of aerobic and resistance training for

maximum benefit. It is important as healthcare providers and medical professionals to reassure our pregnant patients that not only will exercise improve overall health but also it has been shown to improve pregnancy outcomes.

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