Exercise in Pregnancy

David Olson,[1] Robby S. Sikka,[2] Jacob Hayman,[1] Melissa Novak,[1] and Christina Stavig[1]
[1]Broadway Family Medicine Clinic, Minneapolis, MN; [2]TRIA Orthopaedic Center, Minneapolis, MN

Downloaded from http://journals.lww.com/acsm-csmr by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 08/19/2023

OLSON, D., R.S. SIKKA, J. HAYMAN, M. NOVAK, and C. STAVIG. Exercise in pregnancy. *Curr. Sports Med. Rep.*, Vol. 8, No. 3, pp. 147–153, 2009. *A greater number of women are choosing to exercise in pregnancy as the recommendations by the American College of Obstetrics and Gynecology (ACOG) and other organizations have changed in recent years. Exercise during pregnancy can be beneficial to the health of the fetus and mother. Physicians should be aware of the contraindications to exercise, the warning signs to terminate exercise, and the latest recommendations by the ACOG. In the absence of contraindications, the authors believe that physicians should help to develop a reasonable exercise protocol for women based upon their previous activity levels. It is incumbent upon physicians to be aware of the unique physiologic factors present during pregnancy that may predispose women to injuries. Treatment of injuries sustained during pregnancy must balance the risks to both the mother and fetus.*

INTRODUCTION

The female body undergoes many metabolic, biochemical, and physiologic changes during pregnancy. These changes create a milieu that is advantageous for the maintenance of pregnancy and the post-partum period. Pregnant women often request information about how their body will change and ways to remain active and healthy. This article describes the physiologic changes inherent during pregnancy. We review the most recent recommendations for exercise in pregnancy and the associated risks of exercise to the mother and fetus. It is recognized that exercise in pregnancy has beneficial effects. However, a Cochrane review in 2006 suggests that the available studies were too small, flawed, and inconsistent in their methodology and outcome measures to support a recommendation. They further note that women who exercised regularly during pregnancy subjectively improved their body image and maintained or improved their physical fitness. No other benefits (or risks) were supported by the currently available studies. Parameters studied include mode of delivery, length of labor, growth parameters, preterm birth, and Apgar scores. The Cochrane review highlights the need for more studies examining the impact of exercise upon pregnancy (35). However, recent research suggests that positive effects include potential risk reduction for development of gestational diabetes and pregnancy-induced hypertension, decrease in postpartum depression symptoms, and a decreased incidence of urinary incontinence and preeclampsia, and no increased risk of preterm birth (1,8,13,28, 29,31,36). Despite methodological pitfalls in the studies published, the evidence does suggest a benefit of exercise in pregnancy. This article is meant to augment the conversation between doctors and their pregnant patients with regards to exercise during pregnancy.

GUIDELINES

The U.S. Centers for Disease Control and Prevention (CDC) and American College of Sports Medicine (ACSM) recommend that nonpregnant individuals participate in moderate exercise for 30 min or on most, if not all, days of the week (2). In January 2002, the American College of Obstetricians and Gynecologists (ACOG) published their most recent recommendations for exercise in pregnancy. ACOG recommends that in the absence of either medical or obstetrical complications (Table 1) (1), pregnant women should participate in 30 min or more of moderate intensity exercise on most, if not all, days of the week (1). The ACOG recommends that a thorough clinical evaluation of each pregnant woman be conducted before recommending an exercise program. In the absence of contraindications (Table 1) (1), regular, moderate intensity exercise is advised. Women should be counseled for warning signs of when to stop exercise (Table 2) (1). Routine prenatal care is sufficient to monitor an exercise program (1).

When prescribing an exercise program, consideration should be given to the type and intensity of exercise (4). Women should consider avoiding activities with a high risk of falling or trauma (Table 3) (5). Sports to be avoided include ice hockey, soccer, basketball, gymnastics, horseback riding, downhill skiing, and vigorous racquet sports. Scuba diving should be avoided due to an increased risk of fetal

Address for correspondence: Robby S. Sikka, M.D., TRIA Orthopaedic Center, 8100 Northland Drive, Minneapolis, MN 55431 (E-mail: sikka@usc.edu).

1537-890X/0803/147–153
Current Sports Medicine Reports
Copyright © 2009 by the American College of Sports Medicine

Copyright © 2009 by the American College of Sports Medicine. Unauthorized reproduction of this article is prohibited.

TABLE 1. Guidelines for exercise in pregnancy.

Absolute Contraindications to Exercise	Relative Contraindications to Exercise
Incompetent cervix	Extreme underweight (body mass index < 12) or maternal eating disorder
Intrauterine growth restriction	Maternal cardiac arrhythmia or cardiovascular disorder
Multiple gestations (>triplets)	Mild to moderate respiratory disorder
Persistent second or third trimester bleeding	Previous spontaneous abortion
Placenta previa after 25–28 wk of gestation	Severe anemia (Hgb < 100 $g \cdot L^{-1}$)
Preeclampsia	Twin pregnancy after 28 wk of gestation
Pregnancy-induced hypertension	Poorly controlled hypertension
Premature labor during current or prior pregnancy	Poorly controlled Type I diabetes
Premature rupture of membranes	History of extreme sedentary lifestyle
Risk of premature labor	Orthopedic limitations
	Extreme morbid obesity
	Poorly controlled seizure disorder or hypothyroidism
	Other significant medical condition

Downloaded from http://journals.lww.com/acsm-csmr by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 08/19/2023

decompression sickness. An inability of fetal pulmonary circulation to filter bubble formation is thought to be the cause (11). ACOG recommends that women who plan to exercise at altitudes of 6000 feet or greater should be made aware of signs of altitude sickness, for which they should stop exercise, descend from altitude, and seek medical attention. Women should avoid exercises where they will be in the supine position or exposed to prolonged motionless standing (1). Recommended exercises in pregnancy include walking, hiking, jogging/running, aerobic dance, swimming, cycling, rowing, cross-country skiing, and dancing. The type of exercise should be individualized to the patient after risks and benefits have been discussed, and participating in certain sports such as Nordic skiing may require skill development to reduce the risk of injury (1). Athletes participating in NCAA or professional sports often continue to participate in sports during the early phases of pregnancy, but should be made aware of the risks and benefits of continued participation in high-level sports and should be monitored closely.

The intensity of exercise in pregnancy is a difficult parameter to prescribe. The CDC-ACSM definition of moderate intensity exercise is defined as 3–5 metabolic equivalents (METS) *or* the equivalent of a brisk walk (1). Although there is no evidence for the exact amount of time a pregnant woman should exercise, Artal and O'Toole have recommended two 15-min periods for better monitoring of thermoregulatory and energy balance needs (4).

The ACOG guidelines also comment on exercise for competitive athletes. Competitive athletes tend to maintain more strenuous training schedules throughout pregnancy. These athletes tend to want to resume high-intensity exercise more quickly postpartum. Two major concerns regarding exercise in the competitive athlete are: 1) the effects of exercise upon competitive ability, and 2) the effects of more strenuous training and competition upon pregnancy and the fetus. As pregnancy progresses, athletic performance tends to decline. The physical demands of high-intensity training should be balanced with close monitoring of body temperature, hydration status, and weight. These patients should be seen more frequently than their routine prenatal visits (1).

Postpartum resumption of physical activity is an individualized process. There are no studies indicating that rapid resumption of activities has adverse outcomes. However, because postpartum women have a degree of deconditioning, gradual resumption of exercise is advised. It should be emphasized that return to physical activity after pregnancy has been associated with decreased incidence of postpartum depression if the exercise is felt to be stress relieving (1,13,34).

Physiology

Many anatomic and physiologic changes occur during pregnancy. Anatomically, the heart is displaced cephalad and laterally within the chest cavity, causing apical beats to be palpated more laterally on the chest wall. This displacement may be seen as a shift in axis on electrocardiograhy (EKG) interpretation and may result in radiographic findings of cardiomegaly. Through increasing heart rate and stroke volume by up to 1.5 $L \cdot min^{-1}$, the pregnant woman increases uteroplacental circulation. Cardiac output may increase up to 40% by as early as 24 wk of gestation. After 30 wk of gestation, cardiac output is greatly influenced by body position; specifically, the recumbent position may decrease the cardiac output. This is the reasoning behind advising expectant mothers to lie on their left side, rather than on their back. There is a small drop in systemic blood pressure during the second trimester. This is due to a combination of expanding

TABLE 2. Warning signs to terminate exercise.

Warning Signs to Terminate Exercise While Pregnant
Vaginal bleeding
Dyspnea prior to exertion
Dizziness
Headache
Chest pain
Muscle weakness
Calf pain or swelling
Preterm labor
Decreased fetal movements
Amniotic fluid leakage

Copyright © 2009 by the American College of Sports Medicine. Unauthorized reproduction of this article is prohibited.

TABLE 3. Sports recommendations.

Low-Risk Sports	High-Risk Sports
Swimming	Road cycling
Running	Downhill skiing or waterskiing
Aerobics	Court sports (*e.g.*, basketball, tennis)
Dance	Scuba diving
Spinning or cycling	Horseback riding
Walking	Soccer
Cross-country skiing	Ice hockey
Light weight training	Gymnastics
Yoga/Pilates	Martial arts
Rowing	

Downloaded from http://journals.lww.com/acsm-csmr by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 08/19/2023

uteroplacental circulation and decreased systemic vascular resistance (17,44).

Pregnant women commonly have functional heart murmurs, seen in up to 90% of pregnant women. These murmurs are multifactorial in origin, resulting from the hyperdynamic state seen in pregnancy. This also results in an increase in the incidence of premature atrial and ventricular contractions. Blood volume increases 40%–45% in pregnancy and is required for adequate tissue perfusion. This is achieved by an increase in the number of erythrocytes. Red blood cell mass can increase up to 33%. As a consequence, there are increased iron requirements during pregnancy, mainly in the latter period. Most women are unable to meet these requirements with diet alone. Thus iron supplementation is advised. It is known that pregnancy commonly results in an anemic state. It is not uncommon for a pregnant female to have hemoglobin levels of 12.5 $m \cdot dL^{-1}$. Commonly, a leukocytosis is seen during pregnancy, with a predominance of polymorphnuclear neutrophils (PMNs). These values may be as high as 25,000 during labor. Clotting factors commonly are elevated, increasing the risk for thrombotic events. All clotting factors, except XI and XIII, are increased in pregnancy resulting in an elevated erythrocyte sedimentation rate (ESR) (17,37,44).

During pregnancy, elevated levels of progesterone decrease CO_2 via hyperventilation and increased tidal and minute volumes. Minute ventilation increases 50%, and oxygen consumption increases by 15%–20%. Tidal volume can increase 35%–50%, while total lung capacity decreases 4%–5% as a result of increasing dead volume. Progesterone increases capillary dilation, causing the common nasal congestion seen in pregnancy, as well as congestion of the entire nasopharynx, trachea, and bronchi (17,44).

There is an increase in length and weight of the kidneys during pregnancy. Progesterone causes dilation of renal pelvices and ureters. This contributes to the increased risk of urinary tract infections (UTI), hydronephrosis, and hydroureter during pregnancy. There is an increase in the glomerular filtration rate (GFR) of 50% without a subsequent increase in urine output. This can cause increased glycosuria, as well as decreased ability to reabsorb filtered glucose. The bladder is displaced cephalad and flattened, contributing to increased urinary frequency. Urinary incontinence is frequently seen because of increased pressure on and displacement of the bladder.

Elevated levels of human chorionic gonadotropin (hCG) increase appetite, salivation, nausea, and vomiting, some of the symptoms women experience early in pregnancy. Levels of motilin decrease, thereby slowing peristalsis in the gut, increasing transit time and decreasing absorption of water. An increase in gastrin lowers stomach pH and increases stomach mucus production. An increased risk of reflux during pregnancy is secondary to a decrease in esophageal peristalsis, slowed gastric emptying, and relaxation of the lower esophageal sphincter (17,44).

Estrogen stimulates hepatocytes to increase thyroid-binding globulin. This leads to an apparent increase in free thyroid hormone levels, while systemic levels remain normal. Moderate thyroid enlargement is seen in some women. The placenta produces corticotropin releasing hormone (CRH), increasing adrenocorticotropin hormone (ACTH), and subsequently cortisol and aldosterone. This can contribute to water retention and edema. The placenta's production of progesterone increases insulin resistance and potentially insulin requirements. The stretch placed on the abdominal wall may result in diastasis recti, or separation of the abdominal wall muscles (17,44).

In animal studies, exposure to chronic supraphysiologic levels of estrogen has led to changes in collagen synthesis and decreased fibroblast proliferation, decreasing the tensile strength of the native anterior cruciate ligament (ACL) (19). The etiology of noncontact ACL injuries is complex and multifactorial, meriting further investigation. Hart *et al.* reported an increase in medial collateral ligament (MCL) laxity in primigravid rabbits (26), and Blecher and Richmond reported on transient ACL laxity in a pregnant athlete who had undergone ACL reconstruction 1 yr prior to pregnancy (9). Woodhouse *et al.* found in a study of rat ligaments that the administration of reproductive hormones designed to simulate typical oral contraception in humans alters the mechanical properties of the rat ACL (48). Further research is needed to understand the effects of the hormonal milieu of pregnancy and its effects upon ligamentous laxity.

Specific Sport Recommendations

Stationary cycling

Stationary upright cycling is a low-impact, non–weight-bearing sport recommended by both the Society of Obstetricians and Gynecologists of Canada (SOGC) and ACSM. Studies indicate that fetal heart rate (FHR) and maternal temperature are not negatively affected. However, there may more variability of FHR and maternal temperature with higher intensity and longer duration exercise. No negative fetal outcomes have been reported (43). Data have shown that cycling for 30 min at a maternal heart rate around 140 bpm or exercising for 15 min at a rate of 155 bpm has not negatively affected woman or fetus (43). Research is currently ongoing examining the impact of higher level cycling seen in Spinning. However, no published research is available at present (13).

Copyright © 2009 by the American College of Sports Medicine. Unauthorized reproduction of this article is prohibited.

Swimming

Swimming, an optimal exercise during pregnancy due to buoyant effects and the thermally conductive properties of water, has been recommended by ACOG, SOGC, and ACSM. Studies indicate that baseline fetal heart rate may be less affected by swimming than cycling (24).

Walking

Many women use walking as a primary means of exercise throughout pregnancy. It is recommended during pregnancy by ACOG, SCOG, and ACSM. Walking has been shown to be safe and increases maternal sense of well-being and decreases physical complaints. Additionally, walking has not been shown to have a negative effect upon maternal weight gain or upon labor outcomes (13).

Weight training

Conditioning exercises and physical therapy to help maintain posture and prevent low back pain have been recommended by ACOG. There have been no reports of adverse effects with light to moderate weight training with free weights or weight machines (7,13). Some studies have indicated that strength and flexibility are actually improved with these activities (13). Further, moderate strength conditioning has been shown to be safe in a healthy pregnancy with no obvious positive or negative effects (7). It has been found that there are minimal fetal heart rate changes from baseline and that fetal wakefulness is actually increased (13). Studies indicate that with rest periods between sets, healthy pregnant women may use strength training as a form of exercise (2). Weight training in the supine position late in gestation should be avoided because venous return to the heart can be compromised (7,13).

Scuba diving

Scuba diving has been classified as a high-risk sport and has not been endorsed by ACOG (1). Clapp suggested scuba diving can be safe if women limit their dives to less than 30 ft, as the risk for air embolism is low at this depth, and if repeated dives are avoided (13). It also is noted that those who dive frequently and professionally are at three to six times greater risk for spontaneous abortion, intrauterine growth restriction (IUGR), and fetal malformation. ACOG has not yet changed their position on this activity (13).

High altitude exercise

There are few data on exercise at high altitudes. There are few reported cases of injury with high-altitude exercise such as skiing, hiking, mountain biking, and running (3,13, 32,42). It is known that pregnancy complications such as low birth weight occur at a higher rate at altitudes above 10,000 ft (13). SOGC has suggested women modify or avoid mountain climbing all together. One study reported on cycling with short bursts of moderate to high intensity at altitude levels of 6000 and 7300 ft without injury to woman or fetus (3,13,32,42).

Sports with abdominal trauma risk from contact or falling

These sports include, but are not limited to, downhill skiing, waterskiing, horseback riding, road cycling, surfing, court sports (basketball, racquet sports), ice hockey, soccer, and gymnastics. Traditionally, pregnant women have been discouraged from participating in sports that could potentially cause abdominal trauma from contact or falling. However, there have been no studies found to indicate adverse outcomes in women participating in these sports (13). Although unsupported in the literature, there have been suggestions that because of ligament laxity, women could be at an increased risk for falls (13,23). ACOG has recommended against surfing or waterskiing at any time. SOGC has suggested that downhill skiing be modified or avoided and water skiing be avoided altogether. ACOG has suggested alpine skiing on "safe slopes." One retrospective study in a cohort of women playing multiple sports reports that the overall risk of abdominal injury to all women (not limited to pregnant women) is very low (23).

Running

Running often becomes uncomfortable later in gestation. Jogging traditionally has been a supported activity by ACOG (1). A study from 2004 indicates that running and other weight-bearing activities can actually enhance placental growth, which indicated a healthy pregnancy outcome (8). Clapp found that women who continued to exercise throughout pregnancy have maintained their training regimens and level of fitness well above indices of cardiovascular risk, and their risk level is well below those present in both the general populace and women who temporarily stopped exercise during pregnancy (12). There also have been numerous case reports of women able to participate in marathons early in pregnancy.

Exercise and Pregnancy-Related Complications

Several theoretical complications may result from exercise during pregnancy. These may result in fetal malformations or poor outcomes to the woman or fetus. Complications may arise from increased maternal core body temperature, change in uterine blood flow and fetal nutrient supply, hormonal impact on ligamentous laxity, soft tissue swelling, or the induction of preterm labor. Consideration of treatment of these complications must balance the risks and benefits to both woman and fetus. It also should be noted that the incidence of meconium, abnormal fetal heart rates, cord entanglement, and low Apgar scores are all reduced in those who continue to exercise through pregnancy (3).

Temperature regulation during exercise has drawn considerable attention since the deaths of several high profile athletes during training. Additionally, several animal studies have linked hyperthermia to congenital malformations of the fetus (38). Milunsky *et al.* reported neural tube defects associated with women who regularly used hot tubs during pregnancy (40). This potentiated the theory that increases in core body temperature during exercise may have teratogenic effects. In active nonpregnant women, exercise can elevate body temperature above 103°F, 39.2°C. Artal *et al.* recommended that core body temperature should not rise more than 1.5°C above resting temperature or above 38.9°C during exercise (6). This was based upon data that reported that the majority of defects occurred from fever, infection, or isolated incident by hot tub exposure resulting in temperatures above 38.9°C. Of note, sauna exposure does not appear

Downloaded from http://journals.lww.com/acsm-csmr by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 08/19/2023

Copyright © 2009 by the American College of Sports Medicine. Unauthorized reproduction of this article is prohibited.

to increase maternal core temperature above 38.1°C, and 90% of Finnish women who regularly visited a sauna did not show a higher incidence of malformations (46,47).

Jones *et al.* studied women running 3 miles or more, four times per week, at a 10 min·mile^{-1} pace. In this group, the mean maximum core temperature did not change during pregnancy, and no change in vaginal temperature occurred during or after exercise (30). Other studies show that women appear well protected against hyperthermia even during prolonged exercise when the intensity is low (16,30,32). However, nearly all studies have been performed in women who trained prior to the study, and no prospective trials exist evaluating the risk of elevated temperatures (46). Nonetheless, no human study has elicited an increase of more than 1.1°C in maternal core temperature during pregnancy in response to exercise (38).

During exercise, it is theorized that decreased splanchnic blood flow may result from exercise. This could compromise uterine or umbilical artery blood flow. However, research using Doppler ultrasound has shown that there are no changes in either artery's perfusion (22). Further study is needed to examine the effects of exercise upon uterine blood flow in sedentary women. Many studies document an increase in fetal heart rate during maternal exercise (32). Whether this change is due to distress or a response to maternal catecholamine release is unclear. Some studies have shown a percentage of fetuses that have bradycardia in response to maternal exercise, and another study showed 1% had decelerations (33). Episodes of bradycardia resolved within 2 min and were not thought to be substantial enough to result in fetal hypoxia, and there were no adverse birth outcomes (32,33).

Utilization of glucose is another potential concern for the fetus, as some studies have shown that maternal glucose can fall during exercise and may result in decreased neonatal fat mass (13,14). However, no studies have shown an actual decrease in fetal growth during exercise, as there is likely increased glucose delivery after exercise, and women who exercise may have an increased placental size (32). Regular aerobic exercise with proper warm-up and cool-down has been shown to lower fasting and postprandial glucose concentrations in several small studies of previously sedentary individuals with gestational diabetes mellitus (GDM) (39). Further research also is needed to improve our understanding of how gestational diabetes is impacted by exercise, and if it may decrease the risk of GDM.

Increased ligamentous laxity commonly is seen in pregnancy and is thought to be related to the effects of estrogen and relaxin (19,38,44,45). Dragoo *et al.* reported that specific relaxin receptors are present in the ACL of nonpregnant female subjects and that ACL relaxin receptors were not present in males (19). Lower back pain and pelvic pain are commonly associated with this hormonal change. Hyperlordosis of pregnancy is associated with ligamentous laxity and is potentiated by the gravid uterus increasing forward rotation of the pelvis. Pubic symphisis pain is caused by widening of the pubic symphisis caused in part by the effects of relaxin and can cause tenderness and pain over the pubic symphisis. Rupture of the pubic symphisis is a rare complication. Treatment of this is generally conservative. Consideration of operative intervention was only recommended for patients with a symphyseal diastatsis of >4.0 cm (10). Low back pain is reported by upwards of 50% of pregnant women and is associated with increased ligamentous laxity; which contributes to altered biomechanics, further increasing strain and lumbar lordosis. Pain is often exacerbated with weight bearing and activity. Sitting, rest, and recumbency often ameliorate symptoms, and good results have been seen following acupuncture and use of a pelvic binder (10,45). Careful monitoring of women who become pregnant within a few months of ACL reconstruction is recommended (9).

Studies have failed to show increased musculoskeletal injury rates during pregnancy, likely because of decreased participation in contact, pivoting, and jumping activities later in pregnancy when ligamentous laxity is greatest (10,18, 44,45). Pool and low-impact exercises are less likely to result in ligamentous injuries, in spite of increased laxity, and have been reported to result in good outcomes in low back pain. The medication of choice for pain is typically acetaminophen, as nonsteriodal antiinflammatory drugs (NSAIDs) can cause premature closure of the ductus arteriosus and are contraindicated in pregnancy.

The relationship between exercise during pregnancy and birth weight is unclear. Several studies have shown no relationship between birth weight and physical activity (44). However, Clapp *et al.* found that recreational athletes who exercised 6 d·wk^{-1} for at least 1 h had shorter lengths of gestation, and lighter babies compared with those women who stopped exercising after Week 28 (15). Other studies have shown that women who exercised heavily during pregnancy have delivered heavier babies compared with nonexercisers (27). Overall it appears there is some evidence to suggest that pregnant women engaging in frequent exercise tend to have lighter babies; however this does not seem to predispose to low-birth weight babies (<2500g). There is further evidence to suggest that offspring born to recreational athletes have lower body fatness compared with offspring of sedentary women (44).

Soft tissue swelling is common in the second and third trimesters and is reported by approximately 80% of pregnant women. In 2%–25% of women this manifests as carpal tunnel syndrome (CTS). Elevated prolactin, fluid retention, and hand positioning during nursing may worsen symptoms. Dequervain's Tenosynovitis and Meralgia parasthetica, neuropathy of the lateral femoral cutaneous nerve, are often seen. Symptoms from nerve compression syndromes typically resolve after pregnancy and are treated conservatively (10,45). More than 80% of women had good relief of symptoms using night splints in CTS, and steroid injections are useful in patients with recalcitrant symptoms (21). Similar treatments are recommended for Dequervain's patients. For patients with meralgia parasthetica, loose-fitting clothes, positional changes, and activity modification often relieve symptoms (10,45).

Although rare, transient changes in cortisol and clotting factors can lead to femoral head osteonecrosis in pregnancy. This commonly is encountered in late pregnancy and after delivery. These women typically present with antalgic gait, pain at rest, and painful range of motion. It usually is treated with restricted weight bearing, and surgery typically is

Copyright © 2009 by the American College of Sports Medicine. Unauthorized reproduction of this article is prohibited.

Downloaded from http://journals.lww.com/acsm-csmr by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 08/19/2023

TABLE 4. Recommendations.

Previously Sedentary	Moderately Active	Elite Athlete
Start with 15 min of exercise, 3 d·wk^{-1}	Start with 30 min of exercise, 4 d·wk^{-1}	Start with 30 min of exercise, 4 d·wk^{-1}
Aerobic exercise, 65%–75% of maximum heart rate	Aerobic exercise, 65%–85% of maximum heart rate	Aerobic exercise, 75%–85% of maximum heart rate
Walking	Running	Continuation of previous sports should be discussed with coach/trainer/physician and should be adjusted based upon previous activity level
Swimming	Cycling/Spinning	Taper down or modify protocol in third trimester
Aerobics	Aerobics	May return to competition within 4–6 wk of delivery depending upon method
Stationary cycling	Swimming	Avoid trauma and avoid cutting sports after first trimester
Goal 30 min, 4 d·wk^{-1}	Goal 30 min, 5 d·wk^{-1}	Goal 30–40 min, 6–7 d·wk^{-1}

avoided until after delivery (25,41). Additionally, transient osteoporosis of pregnancy should be suspected in any patient with an antalgic gait and complaints of pain with activity, with minimal pain at rest. It usually presents in the third trimester, and plain anteroposterior (AP) radiographs with appropriate shielding often show diffuse osteopenia of the pelvis. Magnetic resonance imaging (MRI) may show high-intensity signal in the bone marrow on T2 images. Standard treatment involves protected weight-bearing and usually results in a self-limited course with no long-term sequelae. The use of calcitonin is controversial as it may shorten the duration of symptoms; however, bisphosphonate exposure during gestation may lead to decreased fetal bone growth. Failure to diagnose transient osteoporosis could lead to fracture. Serial exams are important to distinguish between these conditions (36). The clinician should try to avoid unnecessary radiographs as hip pain is common in pregnancy (25,41).

Concerns regarding exercise in pregnancy causing preterm labor are based upon the theory that decreased blood flow to the uterus and hormonal response to exercise may cause contractions. In studies using tocodynometry immediately after exercise, no increase in uterine activity was noted, and prospective studies have failed to show an increase in preterm delivery associated with exercise (32). These studies were complicated by confounding factors, but further studies have shown that women who exercise are at decreased risk for preterm delivery (14,27,32).

Further research is needed to clarify the effects of exercise on birth weight, preeclampsia, and hypertension of pregnancy. Recent reports suggest that exercising at levels greater than the current guidelines may increase the risk of preeclampsia. One study reported that jogging more than 75 min·wk^{-1} more than doubled the risk of preeclampsia. This study reports that increased exercise levels beyond this further raised the risk of preeclampsia (36). Further prospective studies may help clarify the actual change in risk for patients who exercise beyond the guidelines.

CONCLUSION

In summary, cardiovascular benefits of exercise are the same for pregnant women as they are for nonpregnant women. Exercise in morbidly obese women may have a preventative effect upon development of gestational diabetes. All pregnant women should be evaluated for medical and/or obstetrical contraindications before beginning an exercise regimen. Recreational and competitive athletes with uncomplicated pregnancies should remain active. They should be monitored by regular prenatal visits unless participating in high-intensity exercise. Sedentary individuals without contraindications should be encouraged to begin exercising for the health benefits. Women with a history of or risk for preterm labor or fetal growth restriction should be advised to reduce their activity in the second and third trimesters. Women participating in higher-intensity sports should be monitored more closely.

References

1. American College of Obstetricians and Gynecologists Committee Opinion Number 267. *Exercise During Pregnancy and the Postpartum Period*. Washington, DC: The American College of Obstetricians and Gynecologists; January 2002.
2. American College of Sports Medicine. *ACSM's guidelines for exercise testing and prescription*. 6th ed. Philadelphia: Lippincott, Williams and Wilkens, 2000.
3. Artal R, Fortunato V, Welton A, et al. A comparison of cardiopulmonary adaptations to exercise in pregnancy at sea level and altitiude. *Am. J. Obstet. Gynecol.* 1995; 172(4):1170–8.
4. Artal R, O'Toole M, White S. Guidelines of the American College of Obstetrics and Gynecologists for exercise during pregnancy and the postpartum period. *Br. J. Sports Med.* 2003; 37:6–12.
5. Artal R, Sherman C. Exercise during pregnancy: safe and beneficial for most. *Phys. Sports Med.* 1999; 27:51–8.
6. Artal R, Wiswell RA, Drinkwater BL, et al. *Exercise in pregnancy: Hear stress and pregnancy*. Philadelphia: Lippincott Williams & Wilkins, 1991.
7. Avery ND, Stocking KD, Tranner JE, et al. Fetal Responses to Maternal Strength Conditioning Exercises in late Gestation. *Can. J. Appl. Physiol.* 1999; 24(4):362–76.
8. Bergmann A, Clapp JF, Zygmunt M. Running Throughout Pregnancy: Effect on Placental Villous Vascular Volumes and cell Proliferation. *Placenta.* 2004; 25:694–8.
9. Blecher AM, Richmond JC. Transient laxity of an anterior cruciate ligament reconstructed knee related to pregnancy. *Arthros.* 1998; 14(1): 77–9.
10. Borg-Stein J, Dugan SA, Gruber J. Musculoskeletal aspects of pregnancy. *Am. J. Phys. Med. Rehab.* 2005; 84(3):180–92.
11. Camporesi EM. Diving and pregnancy. *Semin. Perinatol.* 1996; 20: 292–30.
12. Clapp JF. Long-term outcome after exercising throughout pregnancy: fitness and cardiovascular risk. *Am. J. Obstet. Gynecol.* 2008; 199(5): 489.e1–489.e6.
13. Clapp JF. Exercise during pregnancy: An Update. *Clin. Sports Med.* 2000; 19:273–86.
14. Clapp JF, Capeless EL. Neonatal morphometrics after endurance exercise during pregnancy. *Am. J. Obstet. Gynecol.* 1990; 163(6): 1805–11.
15. Clapp JF, Dickstein S. Endurance exercise and pregnancy outcome. *Med. Sci. Sports Exerc.* 1984; 16:556–62.

Downloaded from http://journals.lww.com/acsm-csmr by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 08/19/2023

Copyright © 2009 by the American College of Sports Medicine. Unauthorized reproduction of this article is prohibited.

16. Clapp JF 3rd, Wesley M, Sleamaker RH. Thermoregulatory and metabolic responses to jogging prior to and during pregnancy. *Med. Sci. Sports Exerc.* 1987; 19:124–30.
17. Cunningham F, Leveno KJ, Bloom SL, et al. *Williams Obstetrics 21st Edition*. McGraw-Hill: Medical Publishing Division. 2001; 109–95.
18. Davies GAL, Wolfe LA, Mottola MF. Joint SOGC/CSEP Clinical Practice Guideline: Exercise in pregnancy and the postpartum period. *Can. J. Appl. Physiol.* 2003; 28(3):329–41.
19. Dragoo JL, Lee RS, Benhaim P, et al. Relaxin Receptors in the Human Female Anterior Cruciate Ligament. *Am. J. Sports Med.* 2003; 31(4):577–83.
20. Duncombe D, Skouteris H, Wertheim EH, et al. Vigorous Exercise and Birth Outcomes in a Sample of Recreational Exercisers: A Prospective Study Across Pregnancy. *Obstet. Gynec. Surv.* 2006; 61(11):699–701.
21. Ekman-Ordeberg G, Sälgebeck S, Ordeberg G. Carpal tunnel syndrome in pregnancy. A prospective study. *Acta. Obstet. Gynecol. Scand.* 1987; 66:233–5.
22. Ertan AK, Schanz S, Tanriverdi HA, et al. Dopper examinations of fetal and uteroplacental blood flow in AGA and IUGR fetuses before and after maternal physical exercise with the bicycle ergometer. *J. Perinat. Med.* 2004; 32(3):260–5.
23. Finch CF. The risk of abdominal injury to women during sport. *J. Sci. Med. Sport.* 2002; 5(1):46–54.
24. Watson WJ, Katz VL, Hackney AC, et al. Fetal Responses to Maximal Swimming and Cycling Exercise During Pregnancy. *Obstet. Gynec.* 1991; 77:382–6.
25. Guerra JJ, Steinberg ME. Distinguishing transient osteoporosis from avascular necrosis of the hip. *J. Bone. Joint. Surg.* 1995; 77:616–24.
26. Hart DA, Reno C, Frank CB, Shrive NG. Pregnancy affects cellular activity, but not tissue mechanical properties, in the healing rabbit medial collateral ligament. *J. Ortho. Res.* 2005; 18(3):462–71.
27. Hatch MC, Shu XO, MacLean DE, et al. Maternal exercise during pregnancy, physical fitness, and fetal growth. *Am. J. Epidemiol.* 1993; 137:1105–14.
28. Hegaard HK, Hedegaard M, Damm P, et al. Leisure time physical activity is associated with a reduced risk of preterm delivery. *Am. J. Obstet. Gynec.* 2008; 198(2):180.e1–180.e5.
29. Jeffreys R. The Pregnant Exerciser: An Argument for Exercise as a means to Support Pregnancy. *ACSM Certified News.* 2005; 15(3):4–6.
30. Jones RL, Botti JJ, Anderson WM, Bennett NL. Thermoregulation during aerobic exercise in pregnancy. *Obstet. Gynecol.* 1985; 65:340–5.
31. Juhl M, Andersen PK, Olsen J, et al. Physical Exercise during Pregnancy and the Risk of Preterm Birth: A Study within the Danish National Birth Cohort. *Am. J. Epidem.* 2008; 167(7):859–66.
32. Kelly AKW. Practical Exercise Advice During Pregnancy. *Phys. Sportsmedicine.* 2005; 33(6):24–30.
33. Kennelly MM, McCaffrey N, McLoughlin P, et al. Fetal Heart Rate response to strenuous maternal exercise not a predictor of fetal distress. *Am. J. Obstet. Gynec.* 2002; 187(3):811–5.
34. Koltyn KF, Schultes SS. Psychological effects on an aerobic exercise session and a rest session following pregnancy. *J. Sports Med. Phys. Fit.* 1997; 37:287–91.
35. Kramer MS, McDonald SW. Aerobic exercise for women during pregnancy. *Cochrane Database Syst. Rev.* 2006;(1):CD000180.
36. Madsen M, Jorgensen T, Jensen ML, et al. Leisure time physical exercise during pregnancy and the risk of miscarriage: a study within the Danish National Birth Cohort. *Br. J. Obstet. Gynecol.* 2007; 114(11):1419–26.
37. Marik P, Plante LA. Venous Thromboembolic Disease and Pregnancy. *New. Engl. J. Med.* 2007; 359:2025–33.
38. McMurray RG, Mottola MF, Wolfe LA, et al. Recent advances in understanding maternal and fetal responses to exercise. *Med. Sci. Sports Exerc.* 1993; 25:1305–21.
39. Metzger BE, Buchanan TA, Coustan DR, et al. Summary and Recommendations of the Fifth International Workshop-Conference on Gestational Diabetes Mellitus. *Diabetes Care.* 2007; 30:S251–60.
40. Milunsky A, Ulcickas M, Rothman KJ, et al. Maternal heat exposure and neural tube defects. *JAMA.* 1992; 268(7):882–5.
41. Montella BJ, Nunley JA, Urbaniak JR. Osteonecrosis of the Femoral Head Associated with Pregnancy. A Preliminary Report. *J. Bone Joint Surg.* 1999; 81:790–8.
42. Niermeyer S. The pregnant altitude visitor. *Adv. Exp. Med. Biol.* 1999; 474:65–77.
43. O'Neill ME. Maternal rectal temperature and fetal heart rate responses to upright cycling in late pregnancy. *Br. J. Sports Med.* 1996; 30: 32–5.
44. Pivarnik JM, et al. Athletes and Pregnancy. *Clin. Obstet. Gynec.* 2003; 46(2):403–14.
45. Ritchie JR, et al. Orthopaedic considerations during pregnancy. *Clin. Obstet. Gynec.* 2003; 46(2):456–66.
46. Soultanakis-Aligianni HN. Thermoregulation during exercise in pregnancy. *Clin. Obstet. Gynec.* 2003; 46(2):442–55.
47. Vaha-Eskeli K, Erkkola R, et al. The sauna and pregnancy. *Ann. Clin. Res.* 1988; 20:279–82.
48. Woodhouse E, Schmale GA, Simonian P, et al. Reproductive hormone effects on strength of the rat anterior cruciate ligament. *Knee Surg. Sports Traumat. Arthros.* 2007; 15(4):942–6.

Downloaded from http://journals.lww.com/acsm-csmr by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 08/19/2023

Copyright © 2009 by the American College of Sports Medicine. Unauthorized reproduction of this article is prohibited.