Exercise and Pregnancy

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Abstract: Recent research and updated expert guidelines for exercise during pregnancy and the postpartum period enthusiastically promote physical activity for its overall health and fitness benefits. Weight gain and hormones of pregnancy cause anatomical and physiological adaptations that affect both mother and fetus at rest and during exercise. The possibility of musculoskeletal discomfort or injury during exercise requires implementation of a prudent exercise prescription properly designed and lead by an experienced fitness professional in consult with the obstetrician. Profound hemodynamic changes help meet the demands of both the mother and growing fetus by assuring adequate circulation of oxygen and nutrients to the uterus during exercise while facilitating dissipation of an increased heat load. Changes in the respiratory system increase the volume of air breathed and more efficient gas exchange enhances oxygen availability to and carbon dioxide removal from the fetus. Fuel metabolism is altered with an increased demand for carbohydrate during exercise. Adequate intake of food to meet energy needs without excess calorie consumption resulting in unwanted weight gain and obesity requires careful monitoring. Redistribution of blood flow from the uterus to exercising muscles presents a hypothetical risk but there is no evidence of adverse pregnancy outcomes. The exercise prescription needs to be individualized and formulated with specific goals in mind. It should be determined if the woman desires only the achievement of overall health and fitness objectives, or if she wishes to pursue recreational activities and/or competitive sports. A comprehensive program includes cardiovascular, musculoskeletal and core stability training with the intensity and volume of exercise varied based on the goals and ongoing health status of each woman and her developing fetus as the pregnancy progresses. We conclude that physical activity during pregnancy has minimal risks and many potential benefits. Therefore, restrictions on exercising should only be indicated if warranted by obstetric/medical determination.

Exercise and Pregnancy

Epidemiologic, clinical and experimental studies show that physically active people enjoy better health and fitness than those who are sedentary.[1, 2] Benefits include increased longevity and reductions in the prevalence of certain cancers and cardiovascular diseases and related comorbidities such as, hypertension, hyperlipidemia, type 2 diabetes and obesity.[1-3] Women's health awareness typically increases during pregnancy and the postpartum period, and many women wish to continue an active lifestyle during the childbearing year.[4, 5]

Endurance exercise activities that are popular with pregnant women include walking/running, stationary cycling, group aerobics, and swimming, with smaller numbers of women choosing to perform strength training exercises.[4] For women who were sedentary prior to their pregnancy, the pregnancy itself may motivate them to make positive behavior changes, including increasing exercise. One reason for this is the common desire to avoid excessive weight gain during pregnancy. If the woman continues her exercise habits into the post-partum period, she may benefit from an accompanying reduction in the risk of several chronic diseases.

The major concerns regarding exercise during pregnancy are associated with the increase in oxygen and fuel requirements of exercising muscles and the increased heat production that occurs with physical activity.[3] Hypothesized risks to mother and fetus are listed in Table 1. Important considerations are the need for oxygen enriched blood flow with sufficient glucose delivery and adequate heat dissipation to prevent overheating in both the fetus and the mother. Compensatory pregnancy-related physiologic changes in the mother, combined with adaptations from exercise conditioning coupled with certain precautions, make adverse outcomes unlikely in healthy fit women experiencing uncomplicated pregnancies. Current guidelines from many expert organizations recommend that previously active women continue their exercise programs,

and previously sedentary women are increasingly encouraged to begin a safe exercise program during pregnancy.[6-9] Authorities have moved from advocating caution, to encouraging women and their physicians to consider the potential negative effects of remaining sedentary during pregnancy.[6]

Table 1. Possible Risks of Exercise in Pregnancy

Maternal	Fetal
Aggravation of pubic symphysis or posterior pelvic pain Potential musculoskeletal injury • altered biomechanical stresses and ligamentous laxity • injury related to balance changes Hypoglycemia with poor management of low intensity long duration exercise Hyperthemia	Hypoxemia Hypoglycemia Fetal distress • abnormal heart rate • decreased fetal movement Potential malformations with hyperthermia or hypoglycemia Uterine contractions from hormonal surges with exercise Blunt or penetrating trauma in high risk activities Low birth weight with excessive exercise and low nutrition

Mothers are also encouraged to resume exercise programs in the postpartum as soon as maternal health allows, and to breastfeed their babies if desired without fears of negative outcomes for mother or child.[3, 10] The postpartum period may also be an ideal time to implement modest caloric restriction along with exercise to encourage the loss of pregnancy related weight and to lower risks of obesity.[3, 10, 11] Pelvic floor exercises are encouraged as an adjunct to other exercise throughout pregnancy, and particularly during the postpartum period to decrease the risk of long term incontinence.[12, 13]

Currently, a comprehensive exercise program is recommended to healthy women with uncomplicated pregnancies. It should include aerobic conditioning, strength training for muscles put under stress during pregnancy, flexibility, balance and core stability training. Women are encouraged to combine exercise with monitoring their dietary intake to ensure adequate intake to meet caloric demand without exceeding daily requirements in order to prevent excessive weight

gain.[14, 15] Adequate carbohydrate intake is important as pregnant women utilize more carbohydrate during rest and exercise than their non-pregnant counterparts. However, complex carbohydrates are encouraged over simple carbohydrates as this is best for maternal and fetal euglycemia and body weight control.[16, 17]

BIOMECHANICAL AND ANATOMIC CONSIDERATIONS FOR EXERCISE GUIDELINES IN PREGNANCY

Pregnancy is a time of considerable physiological and biomechanical changes. Weight gain places additional stresses on the musculoskeletal system. The hormonal changes of pregnancy alter tissues, producing effects that lead to ligamentous laxity and possibly to joint instability and pain.[18-23] These effects interact with altered biomechanics and center of mass (COM) changes that potentially place women at risk of balance problems and musculoskeletal injuries and pain syndromes. Exercise that targets vulnerable musculature during pregnancy may be helpful, and entering pregnancy with strong supporting muscles can help minimize these risks.

Postural changes are an expected part of pregnancy. As body mass alters, COM will shift. However, the literature is surprisingly unclear on the exact effect of pregnancy on posture. The standard view is that there is an increase in both the lumbar lordosis and the thoracic kyphosis, but this has not consistently been found in research.[24] Some have found increased lumbar lordosis, with or without an increase in thoracic kyphosis,[20, 25-27] while others have found variations dependent on the stage of pregnancy,[28] no change,[29] or variations in the postural adaptations adopted across individuals in the studied sample.[30]

A recent analysis of posture in pregnant women[31] concluded that women usually increase their lumbar lordosis as a strategy that minimizes the anterior translation of their COM that would otherwise occur. It was also noted that women's lumbar vertebrae have evolved a pattern of dorsal wedging to protect against the load bearing stresses imposed by pregnancy and related spinal posture alterations. In that study "correcting" the lordosis produced greater translation of COM.[31] Insights from this study may help explain why changes in lordosis seen in pregnancy are not linked to back pain.[19, 27, 28] These findings also raise important questions regarding the suitability of the "postural correction" exercises so often given to pregnant women.

While the majority of research suggests that pregnancy typically results in an increase in lumbar curvature, the precise postural adaptation in an individual woman is less easy to predict. Individual postural changes during pregnancy may be related to individual pre-pregnancy spinal postural patterns, and consequently it is suggested that postural advice for pregnant women should be individualized and based on evaluation of the woman.[24]

Pregnancy also affects how women perform functional activities. Women report difficulty rising from low chairs, and the act of moving from sitting to standing shows timing alterations in this activity in the second and third trimesters.[32] The time required to rise from a chair increases as pregnancy advances, with this being most significantly lengthened when tested using shorter chair heights in the third trimester of pregnancy. Knee moment was significantly increased during later pregnancy, particularly at lower chair heights, while hip flexion remained relatively unchanged.[32] The authors suggested that women avoid low seats and use arm rests to assist in rising as pregnancy advances to minimize the risk of overloading their knee joints. The known laxity of the knee ligaments during pregnancy[19] supports the suggestion of avoiding

positions that over strain the knees, unless the woman has adequate strength in supportive muscles.

Studies of trunk movement in late pregnancy have shown decreases in spinal forward flexion and rotation in the thoraco-lumbar spine, and thoracic spine, with less alteration of pelvic segment movement.[33, 34] In late pregnancy women increased their base of support in static standing for forward and lateral flexion,[33, 34] in an apparent adaptive response to maintain stability.

Many kinematic aspects of gait during pregnancy remain surprisingly unchanged, with no significant differences in stride length, cadence or velocity.[35] Most of the women studied increased their maximum anterior pelvic tilt (although this varied among participants), maximum hip flexion and stance phase hip adduction, the latter apparently enabling them to maintain a normal base of support during walking despite a wider pelvis during pregnancy.[35] The authors concluded that the adaptations seen maintained many gait pre-pregnancy kinematic parameters but placed increased stress on hip abductors, hip extensors, and ankle plantarflexors, possibly putting these muscle groups at risk of overuse injuries.

Biomechanical effects of pregnancy interacting with hormonal changes can produce a diastasis recti abdominis (DRA). This is the separation of the two bellies of the rectus abdominis from the linea alba at the midline. A separation of more than 2 cm or 2 finger widths is considered clinically significant.[36-38] DRA is fairly common during pregnancy with reports of 34 -100% occurrence in the literature.[36, 38, 39] Resolution postpartum does not appear to be spontaneous.[38] Related loss of abdominal wall tone and mechanical inefficiency of the abdominals may then alter trunk control, postural stability, respiration, trunk mobility, visceral mobility and motility, and affect childbirth.[36, 38] Since poor trunk control has been implicated as a

prime factor leading to low back pain, maintenance and resumption of abdominal wall control and stability is crucial.

Researchers in small studies investigating the use of exercise as a protective and/or management tool for DRA during pregnancy have identified a positive relationship between participation in exercise and having no or mild DRA.[39, 40] Before prescribing exercise for a client who is pregnant or postpartum, it is important to assess the abdominal wall DRA[37, 39, 40] If clinically significant DRA is present, approximation of the two bellies of the rectis abdominis is initially required prior to performance of exercises targeting the transversus abdominis, internal and external obliques.[37, 38, 40, 41] Instruction by a health care professional versed in appropriate approximation and exercise progression for management of the DRA is recommended.

In summary, the biomechanical and anatomical alterations imposed by pregnancy may result in a number of musculoskeletal complaints. Women who enter pregnancy with a good level of fitness and strong supporting muscles may be less likely to encounter such problems. Should such problems develop they can often be managed conservatively rather than left untreated until the end of pregnancy.

CARDIOVASCULAR RESPONSES TO EXERCISE IN PREGNANCY

Pregnancy is marked by significant resting hemodynamic adaptations in the mother which influence exercise tolerance. These include increases in blood volume, heart rate, stroke volume, and cardiac output. They are primarily the result of an increase in preload and are partially compensated for by an increased venous capacity and vascularization of the uterus and placenta, accompanied by an afterload decrease caused by lowered systemic vascular resistance, particularly in the kidneys and skin.[42] The changes mean that women experience a drop in mean arterial pressure of between 5-10 mmHg during the first half of pregnancy, followed by a gradual

return to pre-pregnancy levels during the third trimester.[43] Pregnancy also causes increased red blood cell production and volume triggered by a rise in circulating erythropoietin.[42]

The combination of the cardiovascular changes results in increased blood flow and a reserve of nutrients and oxygen available to both mother and fetus that appears protective to both, at least up to moderate intensity exercise levels. Exercise conditioning itself causes favorable hemodynamic adaptations leading to increased cardiac output and oxygen extraction by exercising muscle and the placenta. The combination of pregnancy and exercise training increases VO_2 max by 5-10% .[44]

Physical activity increases heat production and raises body temperature. Hyperthermia is a concern if maternal core temperature exceeds 39.2 degrees Celsius, especially during the vulnerable first trimester.[45, 46] The increase in skin blood flow along with the increased blood volume assists in dissipating heat, and helps protect the fetus from potential thermic induced teratogenesis during exercise. Physical conditioning also improves thermoregulation and reduces risk of heat stress as long as exercise is performed in a thermoneutral environment.[44, 47]

As the gravid uterus increases in size throughout the second and third trimesters both the inferior vena cava and aorta can become compressed in the supine position causing a significant reduction in venous return, cardiac output and mean arterial pressure. Supine hypotensive disorder (SHD) which results in dizziness or syncope occurs in less than 10% of women from mid to late pregnancy.[42] Women who choose to exercise in the supine position should do so with caution and only for periods of one to three minutes without changing position. The left lateral recumbent position is usually well tolerated due to the shifting of the gravid uterus from underlying blood vessels. Swimming or water exercise in the supine or any other position does

not cause SHD.[43] Pregnant women also need to avoid standing still for long periods which may cause orthostatic intolerance.[43] Changing positions frequently will encourage venous return.

Uterine blood flow progressively increases 10 fold throughout pregnancy from 50 to 500 mL/min, the result of a decline in local vascular resistance. However, exercise causes an intermittent reduction in uteroplacental blood flow because of redistribution of blood to the skeletal muscles and skin. Although this would seem to have a negative impact on the fetus it does not appear to result in any hypoxic damage as no such cases in healthy women with uncomplicated pregnancies have been reported.[44] A prolonged reduction in uterine blood flow that exceeded 50% would be required. If this took place it would be most likely during highly strenuous or prolonged exercise in an untrained woman, or in the subpopulation of women with uteroplacental vascular insufficiency (UPVI) who are already at risk of early-onset intrauterine growth restriction.[48] In uncomplicated pregnancies in healthy women, a protective adaptation that occurs during exercise in pregnancy, particularly noted in regular running or other weight-bearing forms of exercise, is an increase in both absolute and relative villous vascular volume and cell proliferation of the placenta at term. It is speculated that this training effect may have clinical value and act to improve fetoplacental growth by enhancing placental transfer of oxygen and diffusible substrate.[49]

Since there is considerable individual variation in exercise heart rates among pregnant women, heart rates are not always a reliable measure of exercise intensity. Ratings of perceived exertion (RPE) appear to be a better method of monitoring intensity.[50] How a pregnant woman feels before, during, and after exercise seems to allow for better monitoring of her health, safety, and the quality of the workout than heart rate.[44]

PULMONARY RESPONSES TO EXERCISE IN PREGNANCY

Adaptations of the respiratory system during pregnancy enhance gas exchange and acid base balance in maternal and fetal tissues. Minute ventilation increases by nearly 50% during pregnancy primarily due to elevated progesterone which increases tidal volume largely by increasing CO_2 sensitivity of the respiratory center.[51] Resting oxygen consumption is also increased throughout pregnancy due to the rise in metabolic needs of the mother and the growing fetus. In addition, the oxyhemoglobin dissociation curve shifts slightly to the right. These changes result in a small increase in arterial oxygen tension and enhanced unloading of oxygen at the tissues while reducing CO_2 tension resulting in mild alkalosis.[42, 52] These changes enhance oxygen extraction by active muscle by active muscle and the fetus, maintain acid-base balance and facilitate exercise tolerance.[43]

Pregnancy results in feelings of dyspnea at rest in most women due in part to increased depth of breathing and to the effect of an enlarged uterus elevating the diaphragm making inspiration difficult. However, the elevated and expanded rib cage of pregnancy compensates for this and maximum breathing capacity is maintained or increased.[42, 43] Indeed, increased respiratory discomfort during submaximal, prolonged or strenuous cycle ergometer exercise did not occur from mid to late pregnancy despite substantially higher ventilation than in a nonpregnant control group.[53] Training-induced increases in ventilatory threshold and VO_2max during pregnancy improve maternal work capacity.[54]

FUEL USE DURING EXERCISE IN PREGNANCY

Although energy intake recommendations need to be individualized to each women, at the beginning of the 2nd trimester an extra 300-350 kcal per day is required to meet the metabolic needs of pregnancy and provide the growing fetus with adequate stores of energy to develop properly.[55, 56] As pregnancy progresses, metabolic rate at rest and during exercise

increases along with weight gain. From mid pregnancy to term at least 350-500 kcal additional food intake per day is required to meet energy needs and to prevent hypoglycemia during a normal exercise session, depending on duration and intensity of exercise.[44, 55, 57] Pregnant women use carbohydrate to a greater extent at rest and exercise than non-pregnant women,[43] and adequate carbohydrate intake is essential to meet caloric demands. However the type of carbohydrate ingested is also important. Eating an excess of simple high-glycemic index carbohydrates results in fetoplacental overgrowth and excessive maternal weight gain, while intake of low-glycemic index complex carbohydrates produces infants with low-normal birth weights and normal maternal weight gain.[16] Altering maternal carbohydrate in favor of complex sources may improve insulin sensitivity and lower insulin resistance.[16, 44]

The growing prevalence of obesity has resulted in an increase in obese pregnant women and an increased prevalence of gestational diabetes (GDM), preeclampsia, hypertension, adverse perinatal outcomes such as caesarean section, neural tube defects and overweight infants.[14, 42] A greater emphasis on avoidance of excessive weight gain during pregnancy is warranted as it maybe associated with lifelong weight retention.[15] Exercise results in lower weight gain during pregnancy.[14, 16, 44] Reducing caloric intake through dietary monitoring and increasing caloric expenditure through daily physical activity in the obese pregnant woman to deliberately produce an energy deficit may be warranted to improve pregnancy outcome.[14]

FETAL RESPONSES TO MATERNAL EXERCISE

There are several concerns regarding the effects of exercise on the fetus. While the risks may be low in uncomplicated pregnancies, there continue to be concerns over the theoretical risks, with researchers attempting to clarify the issues as guidelines for exercise in pregnancy become less restrictive.

One concern regarding the fetus centers on the redistribution of blood flow during exercise. Animal studies suggest that a reduction of uterine blood flow by 50% or more could lead to fetal respiratory acidosis,[58] and it is possible that sustained vigorous exercise could produce the same effect in exercising women. While this is unlikely in healthy women accustomed to exercise, it is important to emphasize that there are subpopulations of women in whom the risks are greater. In a study of women with UPVI, as determined by Doppler studies between 22 and 26 weeks gestation, 5 minute bouts of steady state cycle ergometry at only 10% and 15% of predicted work maximums produced deterioration. Four of 12 women demonstrated a transient absent end diastolic flow in the umbilical artery, but without any accompanying abnormalities noted in fetal cardiac output studies.[48] The study serves to emphasize the importance of caution in high risk populations.

Fetal heart rate is considered an indication of fetal well being, with fetal bradycardia of less than 110 bpm a response to hypoxia.[59] The usual response to submaximal exercise in the second and third trimesters has been studied, confirming that the normal response to maternal exercise of greater than 30 minutes is a mild to moderate increase in fetal heart rate.[60, 61]

In a study attempting to determine whether fetal heart rate responses to strenuous exercise could predict abnormal cardiac tracings during labor, women between 33 and 38 weeks gestation were given a graded exercise test.[62] The most common fetal cardiac response was tachycardia. This was unrelated to maternal fitness, fetal weight or maternal body mass index. There was also no link between the exercise responses and fetal distress in labor.[62]

One controlled study of women during the second and third trimesters of pregnancy found that fetal heart rate during submaximal exercise increased about 5 to15 beats per minute followed by a transient decrease immediately after exercise and a return to normal during the

exercise recovery period.[63] In this study no bradycardia was seen. It has been suggested that this effect is more likely in women who are doing maximal exercise testing than submaximal exercise bouts [60, 63] and that it is more likely after the cessation of exercise than during exercise.[60] This finding warrants emphasizing a gradual cool down after an exercise bout.

Sustained higher levels of exercise can produce brief decreases in fetal heart rate reactivity and fetal breathing movements.[60] There is also a reduction in oxygen and nutrient delivery with sustained exercise.[64] The effect of this is buffered by a fetal sympathetic response interacting with other physiologic changes to maintain fetal oxygen uptake and tissue perfusion.[64] The fetal responses to such exercise levels usually revert to normal within 30 minutes.[65]

EXERCISE, HYPERTHERMIA, AND RISK FOR MALFORMATIONS

There have been fears that hyperthermia during the first trimester of pregnancy could result in neural tube defects.[45, 46] Reviews of available research suggest that physiologic adaptations during pregnancy act to protect the fetus.[66] During pregnancy women experience an increase in resting skin temperature which, along with changes in peripheral venous tone and the increased blood volume of pregnancy, improves heat removal.[67]

Core temperature responses to sustained exercise are blunted in pregnancy[68] One recent study involving 40 pregnant women with a mean gestational age of 25.4 weeks who performed low-impact maximal exercise did not show any significant increase in core body temperature during or after the exercise sessions, and although oxygen saturation was significantly reduced in the women at maximal exercise and post-maximal exercise, no reading was below 95%.[46] The authors concluded that low-impact aerobics at about 70% of maximal heart rate is safe for healthy pregnant women with regard to hyperthermia. Another study repeatedly tested 14

women, using sub-maximal bicycle exercise tests that brought the women to 85% of age predicted maximal heart rates, beginning prior to conception and following them through pregnancy (weeks 8, 15, 22, 29 and 36 weeks gestation) and post-partum.[45] Core temperatures at submaximal workloads declined from pre-conception to post-partum, with decreased differences between peak and basal core temperature. They concluded that the thermal response to submaximal exercise during pregnancy acted to protect the fetus from thermal damage.

Caution should be used in the application of the current research. Most research has been done with women in their second and third trimesters, and much more work is needed on maternal and fetal responses to exercise during the first trimester.[69]

FETAL GROWTH, PRE-ECLAMPSIA AND BIRTH OUTCOMES

Historically there have been fears that leisure time exercise, particularly high impact exercise, increases the risk of miscarriage or preterm birth in pregnancy. Evidence is conflicting. One epidemiological study[70] suggested that there may be an effect of vigorous exercise on miscarriage early in pregnancy but suggested caution in this interpretation due to possible recall bias in their sample. Others have found no risk, and possibly an increased tendency of exercisers to have a timely rather than either a premature or delayed delivery.[71, 72]

Concern has also been expressed over the effects of long or strenuous working hours on pregnancy. These occupational exposures, where women may have limited control of activity levels, may have different effects from leisure time exercise.[73] A recent systematic review explored the effects of hypothesized hazardous work conditions (long hours, lifting, shift work, standing and heavy physical workload) on several adverse outcomes (preeclampsia, prematurity and low birth weight).[74] Limitations in the evidence base, and study variations made

interpretation difficult, preventing the authors from reaching strong conclusions. The evidence suggests there can be no more than a moderate risk increase for premature delivery (RR>1.4), less evidence for similar conclusions regarding low birth weight and insufficient evidence to reach conclusions regarding pre-eclampsia and gestational hypertension. The authors suggest that until more definitive evidence is available, women should still be advised against long working hours and physically strenuous occupational work, particularly late in pregnancy. [74]

Epidemiological studies of leisure time exercise are limited in that the measurement of exercise is extremely difficult and current epidemiologic studies are unlikely to be accurate enough in this matter to reach firm conclusions.[75] This review suggests that while the bulk of evidence suggests that physical activity in general may be protective with a possibility for harm with excessive activity, measurement issues and retrospective reporting limit conclusions. Objective measures of activity are badly needed. Studies have found conflicting results in terms of birth weight and the effect of vigorous activity.[71, 76, 77]

One recent study used accelerometry to evaluate the effect of aerobic activity on fetal growth ratio in normal uncomplicated pregnancies.[78] While all infants fell within normal ranges, fetal growth ratio was inversely associated with aerobic physical activity. However the effect was almost entirely seen in women taller than the study median height, suggesting that that the effect of aerobic activity levels on birth weight may have most impact on taller women.[78]

More specific information on the effect of exercise on neonatal size and lean body mass is becoming available and emphasizes that the relationship between leisure exercise and neonate size and composition is complex. The effect of exercise depends on the stage of pregnancy, type of exercise (intensity, duration, frequency), and interacts with diet. For an overview of the

subject in uncomplicated pregnancies the reader is referred to Clapp[16, 17, 44] who, after an extensive series of studies, and integration of other literature, makes several statements regarding the effects of exercise on neonatal outcomes (weight, length, lean body mass) in low risk pregnancies:

- sedentary women who begin a moderate intensity weight-bearing exercise program at about eight weeks gestation have improved outcomes when compared to sedentary controls; these are similar to those of physically active controls

- continuing high levels of exercise through the first half of pregnancy and then decreasing the volume in the second half is associated with increase in neonatal weight, but the extent to which this is due to fat mass or lean body mass is not clear

- continuing a high volume of exercise throughout pregnancy produces babies who are either unchanged in weight or lighter than usual, but who have maintained lean body mass and decreased fat mass

- increasing to high levels of exercise and either maintaining or increasing this in late pregnancy produces "the lightest, leanest infants with the greatest fetoplacental weight ratios" [16(p530)]

This abbreviated list serves to indicate the complexity of the effects of exercise in pregnancy, and the reader is referred to the original articles for more information and a discussion of related studies on the interacting effects of maternal diet.

It should again be emphasized that the results of studies indicating that growth retardation with exercise is not a problem in healthy women with uncomplicated pregnancies should not be extrapolated to all women or high risk populations.

BENEFITS OF EXERCISE DURING PREGNANCY FOR WOMEN

Just as in the nonpregnant individual, exercise provides a number of healthy benefits to the pregnant female. Noble goes so far as to state that the childbearing year "creates a special need for exercise."[37(p19)] In the past, exercise during pregnancy was considered controversial, with health professionals and women both focusing on the potential risks to the mother and fetus. Recently some concerns have been allayed and clearer, more encouraging exercise guidelines during pregnancy have been developed, paving the way for women to enjoy the benefits of exercise during pregnancy. Table 2 lists potential benefits of exercise in pregnancy for women. It is essential that health care providers remain aware of potential maternal and fetal risks, and particular high risk groups when providing guidelines and prescription for exercise. However, it is now suggested that women be encouraged to initiate or continue to participate in an exercise program during pregnancy in order to receive the benefits of exercise. [6-8, 43, 50, 66]

Table 2. Possible Benefits of Exercise in Pregnancy

Healthy body weight maintenance without excess fat accumulation
Maintained or improved cardiovascular fitness muscular strength and endurance, and flexibility
Decreased musculoskeletal complaints and minor discomforts of pregnancy
Improved posture and body mechanics, which may improve coordination, balance, and body awareness
Improved sleep
Prevention and treatment of problems associated with gestational diabetes, hypertension, and pre-eclampsia
Protective effects against chronic disease
Decreased risk of some forms of cancer
Decreased risk of osteoporosis
Increased respiratory function
Reinforced principles of breath awareness and relaxation
Stress reduction, improved self-image, improved mental and emotional health
Potential easing of labor with fewer complications of delivery and faster postnatal recovery
Reduced fetal stress during labor
Strong pelvic floor muscles can lower risks of incontinence and other pelvic dysfunction
Potential of carrying healthy lifestyle patterns into the postpartum period

Although the most significant physiological changes appear to occur early in pregnancy, change is occurring both to the mother and the fetus on an ongoing, daily basis.[79-81] Variation in maternal response to exercise from one day to the next should be expected and considered when prescribing exercise. Changes in body fluids, body weight and body weight distribution, COM, postural support and tone, hormonal influences, and joint stability create a theoretical moving target for maintaining controlled motion even when not exercising. Responding to these constant biomechanical changes during exercise may be challenging and requires awareness and education for safe participation.

In their most recent guidelines, ACOG stated that pregnancy offers women an important opportunity for modification of lifestyle and health behaviors.[9] There is consensus in the literature that healthy previously sedentary women can safely initiate a mild to moderate exercise regime, after medical evaluation and clearance, to promote aerobic fitness and musculoskeletal improvements[6-9, 50, 82] These women can improve or maintain their overall fitness.[82] For them the emphasis should be on a gradual increase in activity.

Women actively engaged in exercise prior to conception should be encouraged to continue participation in exercise, after medical evaluation and clearance. For these women, maintenance of pre-pregnancy fitness level should be emphasized and education provided regarding potential changes in their performance as their pregnancy progresses. Several studies have identified self-selected decreases in activity level, particularly in the third trimester and postpartum period.[4, 83-85]

For the very physically active pregnant exerciser and the pregnant elite athlete, specialized medical care is recommended, and there should be ongoing monitoring of the training program.[6, 86] These individuals should not increase their training program during pregnancy, and they should be made aware of an anticipated decline in performance as the pregnancy progresses.[6] Potential risks should be assessed, evaluated, and discussed with these women at the onset of pregnancy as well as over the course of the childbearing year.[6, 86]

As described earlier, women experience considerable biomechanical and physiological changes during pregnancy, and they often experience a variety of new aches and pains. Nobel has stated that pregnancy challenges the weaknesses one has, and often uncovers or accentuates these weaknesses.[37] Discomforts commonly experienced by pregnant women include back and pelvic pain and dysfunction, nerve compression syndromes, faulty postural sprains and strains, ligamentous strain, nausea, vomiting, and circulatory problems. It is believed that exercise can positively influence these aches and pains.[24, 37, 80, 81, 87-89] Many researchers, clinical experts and reviewers have identified a positive impact from exercise on such discomforts as low back and pelvic pain, lower extremity edema, leg cramps, fatigue, nausea, joint and ligament pain, postural strain, and improved mobility.[80, 87-95]

Insulin resistance develops in pregnancy as a response to the hormonal changes during pregnancy, perhaps having evolved as a strategy to protect the fetus during times of maternal undernourishment.[96] Unfortunately this response can pose problems in many developed countries where overnourishment is more likely than undernourishment. When women develop GDM they face a number of pregnancy and birth complications and increased risk of problems like type 2 diabetes later in life.[97]

Although more research is needed to refine parameters, physical activity, particularly vigorous physical activity, prior to and during pregnancy is associated with an approximately 50% lower risk of GDM.[96, 98-100] For women who do develop GDM, exercise has gained acceptance as an adjunctive therapy.[96, 97, 99-101] One small study that combined diet and exercise interventions in obese and morbidly obese pregnant women with GDM found that even in this population weight restriction through the use of exercise and diet can limit weight gain and result in less macrosomic neontates.[14] The authors also make the important point that pregnancy is a time when women may be more open to improving lifestyle behaviors and that these may then carry over into the postnatal period.[14]

Physically active women, particularly those who are active both before and during their pregnancies are also less likely to develop preeclampsia than their sedentary peers.[96, 97, 102-104] While it is seems clear that exercise before and during pregnancy reduces the risk of GDM, and preeclampsia, more work is needed to clarify the optimum type, intensity and frequency of exercise needed.[96]

It has long been accepted that exercise provides for significant psychological benefits including enhanced feelings of well-being, self-esteem, and overall performance in activities of daily living and occupation in the non-pregnant population. Pregnancy is a major life event and

may significantly increase stress and lead to changes in body image, anxiety, depression, fatigue, negative self-esteem and sense of well-being.[105, 106] The literature supports the postulated psychological benefits of exercise during pregnancy, including enhanced well-being, improved self-esteem, improved body image, decreased anxiety, decreased depression, and diminished fatigue. [88, 89, 105-108] Even low intensity exercise was found to be positively correlated to improved psychological well-being in the third trimester.[108] As previously noted, researchers have identified a trend of decreasing physical activity in the third trimester. It would be prudent to encourage women to maintain at least low level physical activity until the end of pregnancy to enhance psychological well-being. Additionally, Nonacs noted that a history of mood disorder and depression during pregnancy are two of the greatest risk factors for postpartum mood disorders.[109] Exercise during pregnancy may help protect against this very serious condition.

Regular physical activity is protective against excessive weight gain and allows for improved mobilization of fat. Although guidelines for weight gain during pregnancy have been described, there appear to be few studies that have evaluated the effects of exercise during pregnancy on weight gain, and outcomes for weight control following delivery.[4, 56] Prepregnant weight status and identification of appropriate weight gain ranges by pre-pregnant body weight, BMI, and fat mass during pregnancy are important factors to consider. One pilot study found that women who exercised during pregnancy had less than recommended weight gains during their pregnancy, but did not have any identifiable adverse effects on their pregnancy or fetus.[57] Others have also found that excessive weight gain increases the risk of maternal and fetal complications such as GDM, macrosomia, hypertension, and preterm delivery,[4] and that daily household and childcare activities were not enough to ward off excessive weight gain.[4] Women who retained a significant weight gain postpartum demonstrated a propensity to do so in subsequent

pregnancies.[110] Another review suggested that although exercise may improve cardiovascular fitness, it does not appear to effect the rate of postpartum weight loss unless combined with diet.[11] Some researchers have suggested that exercise during the postpartum period may have a greater impact on long-term obesity risk than exercise during pregnancy. [11, 83]

Hypothesized benefits of avoiding excessive weight gain during pregnancy include decreased length of and difficulty with labor, decreased potential discomforts and adverse biomechanical adaptations during pregnancy associated with the musculoskeletal system, decreased risk of excessive weight gain in subsequent pregnancies, and decreased risk of long-term obesity and diabetes mellitus.[11, 66, 80, 83, 96, 98-100, 104] Additionally, women with high pre-pregnant or pregnant BMI's are at increased risk for developing chronic diseases such as cardiovascular disease and diabetes mellitus in the future.[97, 111] As in the non-pregnant individual, avoidance of excessive weight gain via exercise may provide further protection against future disease status.

Pregnancy is accompanied by a necessary increase in 6-8 liters of water content, which may lead to clinically significant edema in a significant number of pregnant women.[112] Edema and poor circulation may be triggered by changes in vascular tone, renal sodium and water management, downward uterine pressure, weight gain, and hormonal changes in estrogen and progesterone.[112-114] Exercise during pregnancy has been postulated to help with symptoms. Research has identified shifts of fluid during short bouts of exercise on land, but aquatic exercise may be particularly helpful with significant effects seen with static and dynamic activity while immersed.[94, 95, 114] These include decreased discomfort, increased diuresis, and reduction of edema.[94, 95]

Although still not comprehensive, further guidelines have recently been developed for the very active pregnant women or elite athlete.[8, 86] Guidelines for these two sectors of the pregnant population need to be further clarified. Concerns for high impact sport include increased strain on already lax joints and tissues; decreased balance and coordination leading to potential falls and related risk to the fetus by falls and impacts, hyperthermia and dehydration.[8, 71, 86, 115-118]

Bo et al found no significant increase in low back pain in women who competed in elite activities.[119] Increases in maternal injury from falls and abdominal injuries have not been seen in the research, suggesting a relatively low risk, but at this point each case should be evaluated individually.[120] It has been suggested that highly trained individuals may have improved balance, improved motor control and coordination, improved overall strength, and improved ability to dissipate heat, thus, allowing these individuals to train at higher levels.

Pentinnen and Kardel suggest that elite level athletes can continue vigorous activity without harmful effects to mother or fetus.[117] Further, it may be that highly trained individuals need to continue vigorous intensities in order to maintain fitness and resume training following delivery.[116]

Some research has identified shorter and less complicated labors and improved recovery in women who remain physically active throughout pregnancy.[66] Additional hypothesized benefits of exercise include a decreased need for pain management, decreased maternal fatigue, decreased requirement of artificial rupture of the membranes, decreased need for induction and/or stimulation of labor with pitocin, decreased need for further artificial intervention secondary to abnormal fetal heart rate, decreased need for episiotomy, decreased need for forceps or cesarean section delivery.[44, 66]

GUIDELINES FOR EXERCISE PRESCRIPTION

Consensus-based guidelines for exercise during the childbearing year, including the post partum period, have been established by several organizations.[6-9, 50] These guidelines, based on a

Table 3. Absolute Contraindications to Exercise in Pregnancy

Hemodynamically significant cardiac disease
Severe systemic disease
Incompetent cervix or cerclage
Restrictive lung disease
Multiple gestation at risk for premature labor
Persistent second or third trimester bleeding
Incompetent cervix or cerclage
Pregnancy – induced hypertension, pre-eclampsia or toxemia
Uncontrolled diabetes or thyroid disease
Placenta previa > 26 weeks
Premature labor during current pregnancy
Ruptured membranes
Pregnancy – induced hypertension, pre-eclampsia or toxemia
Uncontrolled diabetes or thyroid disease
Severe intrauterine growth restriction or macrosomia

body of research that is not conclusive in all areas, should be applied with intelligent clinical reasoning and adaptation to the individual case. It is also important to remember that they are particularly tentative with regard to the elite athlete and to intense exercise in the first trimester. Relative and absolute contraindications from these guidelines are presented in Table 3 and 4.

As women are encouraged to participate in exercise during and after their pregnancy, it is necessary for them to be educated in warning signs for termination of exercise (Table 5). If it is necessary for a pregnant woman to terminate a bout of exercise, she must understand that she should be evaluated prior to resumption of physical activity. For some women, it may be necessary for them to participate in an exercise program under the supervision of a health care professional experienced in assessment, prescription, and progression of an exercise program during the childbearing year.

Table 4. Relative Contraindications to Exercise in Pregnancy (may exercise in medically supervised programs or if cleared with medical investigation)

Previous spontaneous abortion
Mild to moderate cardiovascular disorder
Mild to moderate respiratory disorder
Severe anemia
Eating disorder
Unevaluated cardiac arrhythmia
Chronic bronchitis
Diabetes mellitus
Extreme morbid obesity
Extreme underweight (BMI < 12)
History of extremely sedentary lifestyle
Mild intrauterine growth restriction in current pregnancy
Poorly controlled hypertension/pre-eclampsia
Orthopedic limitations
Poorly controlled seizure disorder
Poorly controlled thyroid disease
Heavy smoker
Twin pregnancy after 28th week
Headache
Lower extremity swelling or pain

Table 5. Warning Signs for Termination of Exercise

Vaginal bleeding
Dyspnea before exertion
Excessive shortness of breath
Dizziness or pre-syncope
Headache
Chest pain
Muscle weakness or undue fatigue
Calf pain or swelling (rule out thrombophlebitis)
Pre-term labor
Decreased fetal movement
Amniotic fluid leakage
Abdominal pain, especially in the back or pubic area
Pelvic girdle pain
Excessive increase in heart rate
Nausea
Sudden swelling in ankles, hands, or face

The same modes of exercise suitable for fitness in non-pregnant women may be considered for healthy women who are pregnant, with some precautions or exceptions regarding high risk/high contact activities (Table 6). Cardiovascular exercises should emphasize large muscle groups

while considering fall risk, and excessive stress or stain to joints, tendons, ligaments and muscles affected by pregnancy. Aquatic exercise is an exercise option for pregnant women with some unique advantages. The special properties of water, including buoyancy, hydrostatic pressure, viscosity, surface tension, hydromechanics, and thermodynamics, as well as the implications for immersion offer pregnant women a mode of exercise that addresses many of the discomforts associated with pregnancy.[88, 93-95, 121, 122] Current research suggests benefits from water immersion or aquatic exercise for edema-related discomfort in the lower extremities and labia, relief of or decrease in intensity of low back pain, improvements in strength, increased cardiovascular endurance, improved mobility, improved participation in health promoting behaviors, and improvement in psychological factors of mood, well-being, body image, decreased fatigue.[88, 94, 95, 123] No significant adverse effects on mother or fetus have been identified to date.

Although few studies exist and parameters are not well defined, resistance training and flexibility provide many benefits to the pregnant female.[9] Maintaining appropriate intra-abdominal pressures and refraining from lifting heavy resistances is prudent. Women should also be cautioned to avoid repetitive high-intensity isometric exercise. Proper breathing with resistance training to avoid Valsalva-like pressures should be highlighted. Resistance training with low weights or exercise machines through comfortable range of motion is encouraged, as this has not been associated with any safety risks.[9] For the beginner resistance machines can be used to build strength initially, but more functional exercises including the use of free weights should be implemented to integrate balance and stabilization.

Table 6. Sport Activities of Concern for Pregnant Women

High-Risk Contact Sports	Rock Climbing
Ice and Field Hockey	High-Altitude Activities
Boxing	Horseback Riding
Wrestling	Ice and In-line Skating
Football	Alpine and Water Skiing
Soccer	Board and Body Surfing
Rugby	Vigorous Racquet Sports
Competitive Basketball	Power Lifting
Gymnastics	Scuba Diving
Mountain biking	Lacrosse
Sky diving and hang gliding	

Core stabilization should be included in any strength training program. Maintaining stabilization requires facilitation of the transverses abdominis, multifidi and the pelvic floor muscles in coordination with appropriate breath patterns. Stabilization protocols have been described elsewhere.[37, 124-127] Although Pilates is currently very popular, there is a paucity of research describing the effects of Pilates for maintaining core stability in pregnant women.[128]

Despite the associated relaxation in soft tissues during pregnancy, individualized assessment of extensibility of the tissues surrounding joints should be conducted. The goal during pregnancy is for maintenance of normal tissue extensibility and joint range of motion.[9, 37, 79, 80] For any tissues lacking proper extensibility, exercise should be prescribed. Flexibility exercises typically conducted during the non-pregnant state may need to be modified to avoid excessive strain – especially for those structures attaching to the lumbosacral and pelvic region, such as the adductors, piriformis, and hamstrings.

In addition to resistance training and core stabilization, exercise focusing on the pelvic floor musculature (PFM) is important. Pregnancy, labor and delivery are critical events for pelvic floor muscles and damage to the pelvic floor plays an important role in the pathogenesis of incontinence and other pelvic dysfunctions.[12, 129-131] Correct performance of exercises to strengthen the pelvic floor and structures of support may provide protection to the structures

during pregnancy, labor and delivery. Preliminary studies have found that specific exercise programs focusing on the PFM have positive effects on increased PFM strength and pressure and decreased incidence of incontinence during pregnancy and at three months postpartum.[12, 129] Neuromuscular training with consideration of PFM coordination with abdominals is also important.[132] Fine and colleagues reported that only 64% of women were provided instruction in PFM exercise during or after delivery.[133] Methods of instruction were varied, but included instruction by a doctor or mid-wife in less than half the cases, with less than 10% of women reporting demonstration during a pelvic examination. Fine also reported that less than 1/3 of the women provided written or oral instruction could perform an "ideal" PFM contraction. Additionally, adherence was found to be problematic. Exercise recommendations, should include proper instruction of PFM exercises, assurance that women are performing correct PFM contractions, and incorporation of PFM exercises in the routines for all pregnant women.

Low back, pelvic girdle, and symphysis pubis pain and instability are not uncommon complaints during pregnancy and in the postpartum period. A variety of interventions have been described and tested for efficacy.[134-136] In examining the effectiveness of support belts versus other measures, support belts do not appear to provide superior additional benefit to exercise alone.[135, 137]

EXERCISE PROGRAMMING, TESTING AND MONITORING

In general, a "one-size-fits-all" exercise program cannot routinely be applied to all pregnant women. Individual differences in health status, physical fitness, and previous exercise experience need to be considered and require personalization of recommendations to the individual woman. The exercise program is dependent on whether the woman is a novice, an experienced exerciser, or a competitive athlete and what their current goals of physical activity

are during the current pregnancy. A pre-activity screening should be performed and medical approval obtained prior to engaging in moderate-vigorous exercise. It is recommended that the PARmed-X for Pregnancy[138] and a thorough medical health history questionnaire be completed together by the pregnant woman and her obstetric physician prior to participation in fitness testing or an exercise routine. The women who need the most thorough evaluation and detailed recommendations are beginners just starting an exercise program and competitive athletes wanting to continue to compete through all or part of their pregnancies. Previously active, healthy, fit women usually do not need to change their exercise routine until the second or third trimester, although they need to be concerned about avoiding hyperthermia during the first trimester.[44] With the increasing anatomic and biomechanical changes, women may want to consider adjusting their routines and athletes need to lower their performance expectations as the pregnancy progresses toward term.

Contraindications to exercise should be ruled out by the physician and precautions discussed. For beginners, a start date should be determined based on their previous exercise experience and pregnancy history. Novices should participate in the decision on whether to begin exercising during or following the first trimester. Ideally, sedentary women should start exercising at least 6 weeks prior to a planned conception. Developing a level of moderate to vigorous physical fitness prior to conception may be the optimum way to start a pregnancy. Unless medical or obstetric complications prevent it, pregnant women may follow the same general guidelines as the any other individual as recommended by ACSM and CDC to accumulate 30-40 minutes or more of moderate physical activity on most, if not all, days of the week.[1, 2, 50] Otherwise, a novice should begin gradually with 3 aerobic exercise sessions a week

for up to 20 minutes at low-moderate intensity.[50] Walking, stationary cycling or water-based programs are recommended for those just starting out.

Competitive athletes who prefer to continue to train hard during pregnancy should be warned by health professionals that they maybe placing themselves and the fetus at greater risk of thermoregulatory complications, falling or abdominal trauma, and compromised intrauterine growth. Although this advice is part of usual recommendations, it should be noted that there are no studies that document such occurrences.[8, 86] Several prominent sportswomen have competed successfully at an elite level well into pregnancy. It may be discriminatory and illegal to ban women from competing when pregnant.[86] Others have chosen to retire from sport during this time. The decision is largely a matter of personal choice that should be based on the latest scientific information and competent professional advice. Table 7 gives some general guidelines for exercise for elite athletes based on the cited resources.[8, 86, 116-119]

Table 7. Guidelines for Exercise for Elite Athletes

Pregnant elite athletes require specialized on-going care during pregnancy.
As pregnancy progresses, performance parameters may be adversely affected.
High level exercise may increase risk of thermoregulatory complications.
Special attention to hydration is required and fluids must be maintained.
Body weight should be assessed before and immediately after a bout of exercise. For every 1 pound of weight loss, 1 pint of fluid must be ingested and weight loss must be regained prior to next bout of exercise
Must consider additional nutritional requirements to sustain exercise and fetal growth
Intensity of training should not be increased during pregnancy
Observe warning signs for exercise termination
Competing athletes are advised to abide by governing rules regarding pregnancy of the sports organization

In those cases where exercise testing is deemed appropriate, a decision as to what tests (cardiovascular, muscular strength and endurance, flexibility and/or body composition) are to be performed should be made. Specific testing may be indicated if the exercise to be undertaken is vigorous, there is a marked increase in intensity, or a mother has suspected risks related to the

level of exercise she desires. Unless a clinical condition indicates it maximal graded exercise tests used to determine one's cardiorespiratory endurance are not routinely performed. If they are, they should be done only under the supervision of a physician, due to a potentially high-risk/benefit ratio.[50] Submaximal tests (intensity usually not to exceed 75% of predicted heart rate maximum), although less accurate in predicting aerobic capacity owing to HR variability during pregnancy, can provide a basis for fitness comparisons. Mottola[139] has developed and validated a VO_2 peak prediction equation for pregnant women based on submaximal workloads and HR. The HR during exercise tests should be compared with ratings of perceived exertion (RPE) and the woman educated on the use of the RPE scale.[140] Prescriptive HR intensity based on the HR reserve and the magnitude of HR change to increased power output are blunted or sometimes elevated during pregnancy, making prescription based on HR alone variable and less valid. Any exercise test on the treadmill or cycle ergometer should not exceed 10-12 minutes in order to reduce the time the fetus is at risk for reduced blood flow and to avoid hyperthermia. A 3 to 5 minute warm up should precede the test, and a 3 to 5 minute cool down should be incorporated to avoid lower extremity blood pooling and hypotension.

Maximal testing of strength is generally not recommended due to relaxed ligaments from gestational hormones and the possibility of increased risk of injury; submaximal resistance testing is fine. Manual strength testing of muscles that tend to be weak during pregnancy may be helpful in guiding exercise advice. These may include abdominal muscles, hamstrings, gluteals, upper back extensors, lower and middle trapezius, external shoulder rotators, serratus anterior and pelvic floor muscles. Manual flexibility testing of muscles that tend to be tight during pregnancy may also be helpful. These may include the pectorals, internal shoulder rotators, hip flexors and adductors, plantarflexors, rectus femoris, rhomboids, quadratus lumborum, lower

back extensors, levator scapulae and upper trapezius. A warm up prior to musculoskeletal testing should be emphasized to ensure safety.

If desired, body composition can be determined using anthropometric measures. Skinfold techniques can be used to provide good estimates of maternal adiposity.[141] Underwater weighing, air plethymography and bioelectric impedence methods of body fat assessment are questionable due to altered body fluid volumes. For further information on exercise testing the reader is referred to other resources.[44, 50, 142]

A report by The Maternal Weight Gain Expert Work Group convened by the Maternal and Child Health Bureau on maternal weight gain recommended that health care professionals promote strategies to help pregnant women stay within recommended weight gain ranges in order to reduce adverse perinatal outcomes both for mother and baby.[15] It has been shown that the contribution of pregnancy weight gain to body composition, body fat distribution, and the long-term risk of maternal overweight and obesity is significant, and interventions for weight management are needed. Any counseling or intervention should also include monitoring the quality of the diet. It is beyond the scope of this paper to address specific nutrition concerns during the childbirth year, but the Institute of Medicine publications may prove useful.[56, 143]

The extent of exercise monitoring should be based on the physician's assessment of risk and exercise prescription. General guidelines for women with uncomplicated pregnancies are in Table 8, and more detailed information can be located in published guidelines.[6-9, 50]

Table 8. General Guidelines for Exercise for Women with Uncomplicated Pregnancies

All healthy pregnant women are encouraged to exercise
Medical screening/clearance is necessary prior to participation in exercise
An individualized exercise program designed by an appropriate health professional is advised
Intensity, frequency, duration, and mode of exercise should be designed with regard to pre-pregnancy activity levels and interests ○ At least 30 minutes of physical activity should be performed most days of the week, with formal exercise 3-4 days per week preferred ○ Shorter bouts of exercise for 15-30 minutes are recommended for those who were previously sedentary, if well-tolerated this may be gradually increased as fitness improves ○ Regular mild to moderate exercise routines including cardiovascular (aerobic) exercise, musculoskeletal (resistance and flexibility) are preferable to intermittent activity ○ Avoid intense isometric or heavy resistance exercise ○ Prescribed exercises should not strain the pelvic floor or abdominal muscles and should avoid vigorous stretching of the hip adductors ○ The abdominal wall should be evaluated for DRA before prescription of abdominal exercise
Some guidelines have suggested a HR maximum of 155 bpm, but others now suggest use of self regulation and RPE instead
Exercise in the supine position longer than 1 to 3 minutes should be avoided after the first trimester
Prolonged stationary and positions of inversion should be avoided.
Exercise should be stopped when fatigued, or if there are any other indications suggesting need for termination
Exercise that may cause falls should be avoided and exercise routine should include safe balance exercise
Ensure adequate nutrition and hydration
Exercise should be avoided in temperature extremes or when febrile or otherwise unwell
Clothing should allow adequate cooling, and footwear should be supportive and well-fitting
Aquatic exercise should not be done in water over 32^0C
All pregnant women should be educated on benefits and risks of exercise during pregnancy with advice individualized to their particular situation

While risks of exercise may be minimal for the healthy woman experiencing a normal singleton pregnancy, she should understand the rationale behind any restrictions and be a willing partner in any monitoring and adherence to safe exercise guidelines. Therefore, teaching principles and practice of safe exercise should be viewed as an integral role of perinatal health care providers and part of a comprehensive activity program.

EXERCISE DURING THE POSTPARTUM PERIOD

Most women desire to lose weight and tone muscles in the postpartum period. Those who were previously inactive throughout pregnancy often desire to initiate a program at this time. Weight reduction can be difficult for anyone at anytime, but a new mother who is trying to return to her prepregnancy weight is also confronted with additional challenges such as, increased child care commitments, less rest and sleep, continuing household responsibilities, and possibly returning to work outside the home. To be successful, she will need the support and understanding of her family, friends, employer and medical caregiver. Experienced health professionals will be able to provide sound advice to women who wish to be active during the busy and exciting, but sometimes complicated, postpartum period. Previous research has demonstrated that maternal weight loss, even while breastfeeding, can be achieved safely and with no adverse effects through appropriate exercise and sensible dieting.[10, 37, 144, 145] Postpartum depression may also be less in those who return to physical activity, but only if the exercise itself is not stress promoting.[43]

Hammer and Hinterman[146] previously published an in-depth article that describes exercise and dietary programming to promote maternal health fitness and weight management during the postpartum period. Other practical sources of information for working out following childbirth may be found in Clapp,[44] Bing and Colman[147] and Noble.[37]

CONCLUSION

Many women wish to begin or continue an active lifestyle during the childbearing year and beyond. Those with uncomplicated pregnancies should be encouraged to pursue fitness, recreational and sporting activities as desired in consult with their health care provider and an experienced exercise professional. Available research shows that in most cases exercise is safe

for both mother and fetus and desirable health benefits are associated with remaining physically active rather than treating pregnancy as a state of confinement.

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