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Exercise During Pregnancy: Current State of the Art

SUMMARY

Women should be encouraged to become fit before they become pregnant. During pregnancy, those who were accustomed to aerobic exercise before pregnancy can probably continue their sports involvement throughout pregnancy, at the same perceived level of exertion. Weight training and calisthenics are advisable during pregnancy, even for those who never practised them before. Pregnant women should avoid high intensity, prolonged duration, hyperthermia, dehydration, abdominal trauma, and low oxygen availability in exercise. (*Can Fam Physician* 1989; 35:1675–1680.)

RÉSUMÉ

Il faudrait inciter les femmes à être en bonne condition physique avant de devenir enceintes. Celles qui pratiquaient des exercices aérobiques avant la grossesse peuvent probablement poursuivre leurs exercices tout au long de la grossesse, avec le même niveau d'effort que celui pratiqué antérieurement. Les exercices à l'aide de poids et les exercices d'assouplissement sont recommandés pendant la grossesse, même pour celles qui ne s'y sont jamais adonnées auparavant. Les femmes enceintes devraient cependant éviter les exercices de forte intensité, d'une durée prolongée, ceux qui engendrent l'hyperthermie, la déshydratation, les traumatismes à l'abdomen et une mauvaise oxygénation.

Key words: obstetrics, physical fitness, pregnancy

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OBSTETRICS WAS once an art, but now it has become a science. At one time it seemed reasonable and acceptable to advise all pregnant women to rest as much as possible and to avoid strenuous exertion. That advice no longer seems reasonable or acceptable. Many women are required to remain physically active for financial, social, or personal reasons, and many others choose an active lifestyle because they like it and have grown accustomed to it.

When it seemed appropriate to recommend avoidance of exertion to all pregnant women, very few women were competitive or recreational athletes. Many women now engage in regular exercise programs, however, and need honest advice about the benefits and risks associated with their habits.

Oxygen consumption increases throughout pregnancy, as more work is performed by many parts of a gravid body. A physically fit body is better able to meet the demands of pregnancy. Erkkola and Rauramo[1] measured pH and lactic acid levels in the maternal radial artery, the umbilical artery, and the umbilical vein. They found higher maternal and fetal pH levels in the more fit women. They found lower lactic acid levels in the more fit women following a standard work load and lower lactic acid levels in the umbilical vessels of the more fit women following delivery.

These data demonstrated that physical fitness enables a pregnant woman to perform work with less effort. Thus, physical fitness is desirable. The question that remains to be answered is: how much exercise can a pregnant woman safely perform in each session to achieve and maintain physical fitness without endangering her fetus?

Effects of Exercise

As physicians, we have several concerns about exercise during pregnancy: blood distribution, maternal temperature, nutrition, potential trauma, metabolism, and hormonal changes. Little is known about the last two, which will not be discussed in this article.

Blood Distribution

During exercise, blood flow to exercising skeletal muscle increases, while blood flow to most abdominal organs (i.e., splanchnic blood flow) decreases.[2] The quantity of blood diverted to exercising skeletal muscle and away from internal organs is directly proportional to the intensity of the exercise.[3] From these studies in humans, we can predict that, at high intensities of exercise in pregnant women, uterine blood flow will decrease. Lotgering and associates[4] have demonstrated in sheep that uterine blood flow is inversely proportional to maternal heart rate, which correlates with work intensity.

Morris and colleagues[5] have studied effective uterine blood flow during normal and pre-eclamptic pregnancies (in humans), and they have found a decrease in effective uterine blood flow during moderately intense supine cycling. Since the supine position itself can decrease uterine blood flow as a result of decreased cardiac output from decreased venous return due to inferior vena caval compression, it is unclear whether the observed decrease in uterine blood flow resulted from the exercise, the supine position, or both.

In studying the effect of exercise on the distribution of uterine blood flow in pregnant ewes, Curet and colleagues[6] found that total uterine blood flow was unchanged following exercise, but the distribution was altered in favour of the placenta. Also studying sheep, Clapp[7] found that, with exercise to exhaustion, the rate of both uterine and umbilical blood flow fell, but uterine and umbilical oxygen uptakes were unchanged. He found that the increase in maternal heart rate correlated directly with the decrease in uterine blood flow. He also found that significant exercise stress was always associated with significant maternal hyperthermia and respiratory alkalosis, both of which have been shown to result in decreased uterine perfusion.

Although heart rate and uterine blood flow have been shown to be inversely related in exercising sheep, it is very difficult, on the basis of these sheep data, to recommend any specific maternal heart rate as a safe upper limit for exercising humans. Maternal heart rate varies widely throughout pregnancy, and the heart rate response to exercise probably varies even more. It is probable that any specific maternal heart rate may be too high for some women to be exercising safely and may not be high enough for other women to be achieving a training effect (cardiovascular fitness).

A recent study of humans by Carpenter and associates[8] has shown, however, that fetal bradycardia is much more likely to follow exercise that exceeds 67% of maximum oxygen uptake and that this workload corresponded to a maternal heart rate exceeding about 150. Thus, if any safe limit can be suggested on the basis of existing data, it is probably a heart rate of 150. More work is needed, though, for confirmation and clarification.

Maternal Temperature

Another serious concern regarding the safety of prenatal exercise is maternal temperature. Hyperthermia can occur during exercise, and maternal hyperthermia may endanger the fetus. Pleet and associates[9] have described 24 neonatal cases of central nervous system defects and facial dysmorphogenesis following episodes of maternal hyperthermia that occurred between four and 14 weeks of gestation. None of these episodes occurred in association with exercise.

Maternal hyperthermia, however, can occur during exercise[10] or sauna or hot tub exposure.[11] The time of greatest danger appears to be before the neural groove has closed, an event that takes place at 23 to 28 days of gestation. Lotgering and colleagues[12] have demonstrated, in sheep, that fetal temperature exceeds maternal temperature following 10 to 40 minutes of maternal exercise and that the fetal temperature can remain higher than the maternal temperature for longer than 60 minutes after cessation of exercise. Jones and associates[13] have reported normal maternal temperatures during and following moderate exercise.

To date, no one has reported maternal hyperthermia in association with exercise, nor has anyone documented any congenital anomalies caused by maternal exercise. It is unlikely, for ethical reasons, however, that a scientific study can determine the safe upper limit of maternal core temperature. Thus, it seems prudent to recommend avoidance of hyperthermia during exercise.

Nutrition

In caring for pregnant women who exercise, we must also be concerned about nutrition, for the pregnant woman must supply enough calories and nutrients for herself, her fetus, and her exercise. Both pregnancy and exercise increase caloric requirements. Pregnancy, but not exercise, increases requirements for protein. Neither pregnancy nor exercise increases requirements for fat.

To meet the increased caloric requirements of pregnancy and exercise, carbohydrate intake should increase for both pregnancy and exercise. Requirements for most vitamins and minerals are increased for pregnancy. Requirements for very few vitamins and no minerals are increased for exercise; only thiamine, niacin, riboflavin, and pantothenic acid are dependent upon energy expenditure. Water intake should be increased for exercise, although not for pregnancy. Fluid intake should be increased to offset fluid lost in perspiration. Pregnant exercisers should be particularly attentive to fluid intake because dehydration augments the thermogenic effects of exercise.

Of the minerals needed in greater quantities during exercise, both iron and calcium deserve special mention. Most pregnant women should take iron supplements, regardless of whether they exercise. Both pregnancy and training cause a greater increase in plasma volume than in erythrocyte mass, resulting in hemodilution. Thus, hematocrit levels can be expected to fall during pregnancy and during training. It is likely that pregnant exercisers experience more hemodilution than would be expected for sedentary pregnant women, but this has not been studied to date.

Calcium also requires special mention because of its role in maintaining bone density and because of the susceptibility of many women to developing osteopenia and osteoporosis. Although the fetus tends to drain calcium from the mother, multiparous women have a lower risk of developing osteoporosis than nulliparous women.

Calcium intake is only one of many factors that affect bone density,

though, and the lower risk of osteoporosis among multiparous women may be related to the weight-bearing exercise every woman does during and after pregnancy, as she carries extra and increasing weight continuously during pregnancy and then carries her infant intermittently after birth. This suggestion remains speculative and worthy of further investigation. Most pregnant and lactating women should ingest 1500 to 2000 mg of calcium daily, from a combination of dietary and supplemental sources.

Fetal Well-Being

The most reliable parameters used to assess and monitor fetal well-being are fetal heart rate and fetal growth; the latter may be estimated on the basis of both maternal weight gain and fetal size, assessed by palpation or sonography.

Heart Rate

Several investigators have monitored fetal heart rate before, during, and after exercise. Collings and Curet[14] have described normal fetal heart rates following moderate maternal exercise. Several investigators[15–17] have reported fetal bradycardia during maternal exercise, when measured by Doppler ultrasound. We have found Doppler ultrasound measurements to reflect motion artifact during maternal exercise,[18] and we have found two-dimensional M-mode echocardiography to assess with greater accuracy the fetal heart rate during maternal exercise.[19]

Carpenter and associates[8] have subjected 45 pregnant women to a total of 79 maximal exercise tests and 85 sub-maximal tests. Three episodes of fetal bradycardia occurred in association with sub-maximal exertion: one before exercise, one during a vasovagal hypotensive episode during exercise, and one following exercise. Fifteen episodes of fetal bradycardia occurred following maximal exertion; in most cases, onset occurred within two minutes after cessation of maximal exertion and termination occurred within a few minutes after onset of bradycardia. Three of these episodes of bradycardia lasted longer than nine minutes, however. These important data indicate that it is prudent to advise pregnant women to avoid maximal exertion when they exercise.

It is interesting that 15 bradycardic episodes followed cessation of maximal exertion, while none occurred during the maximal exertion. Perhaps this fact can be attributed to the hemodynamic changes associated with acute exercise during pregnancy. Morton and colleagues[20] have shown that heart rate, stroke volume, and cardiac output all decrease sharply following cessation of exercise. It may be that a combination of decreased uterine perfusion during strenuous exercise and decreased cardiac output immediately following strenuous exercise predisposes some women to acute, transient placental insufficiency, which leads to the observed fetal bradycardia. This suggestion remains speculative.

Trauma

It seems prudent to recommend avoidance of sports that pose risks of abdominal trauma because of potential dangers of fetal trauma or of premature placental separation. These risks remain theoretical, however, and have not been reported in association with exercise to date.

Pregnancy Outcome

Pregnancy outcome can be assessed best by reports of perinatal morbidity and mortality, by birth weight, and by neonatal growth and development. Wilson and Gisolfi[21] have reported higher litter mortality in rats trained during pregnancy, regardless of pre-pregnancy training. Certainly, there are differences among animal species in their responses to exercise during pregnancy, and it remains unclear whether conclusions about humans can be drawn from any of the animal species that have been studied. Nevertheless, it remains disappointing that pre-pregnancy training did not provide protection from adverse outcome, at least in this study.

Obstetricians routinely monitor maternal weight gain throughout pregnancy and advise most women to gain a total of 20 to 35 lbs (9 to 16 kg) by term. It is unclear whether different guidelines are appropriate for exercisers. Clapp and Dickstein[22] have reported lower maternal weight gain, infant birth weight, and gestational length in women who exercised before and throughout pregnancy, compared with women who were sedentary before and throughout pregnancy; they reported greater maternal weight gain, infant birth weight, and gestational length in women who had exercised before pregnancy and during part of pregnancy but stopped voluntarily by the 28th gestational week, compared with sedentary control subjects.

The differences in gestational length among these three groups were not sufficient to account for the observed differences in maternal weight gain or infant birth weight. It is probable that women who continue exercising add less fat than do sedentary women and that exercisers add more fat after cessation of exercise than they would have added if they had not exercised previously. These differences in maternal weight gain or infant birth weight have yet to be shown to be important.

Recommendations

Based on what is known about the effects of exercise during pregnancy, several recommendations can be made. First, women should become fit before becoming pregnant, in order to best prepare for the increased work load of pregnancy, labour, and delivery. Women who are accustomed to aerobic exercise can probably continue their customary sports activity throughout pregnancy, as long as no medical or obstetrical complications arise. Aerobic sports include those that are performed continuously at a sustained elevated heart rate, such as running, brisk walking, stationary bicycling, swimming, aerobic dancing, and cross-country skiing. Aerobic exercise should be carried out at a comfortable pace, preferably no greater than the perceived intensity to which the woman was accustomed, and probably at a pace at which she can carry on a conversation.

I recommend judging the pace by perceived exertion, rather than heart rate, which varies so widely and which may be misleading. Women who were unaccustomed to aerobic exercise before becoming pregnant should practise no physical activity more vigorous than brisk walking. Because the safe duration of aerobic exercise has not been determined and because of the potential risks of decreased uterine blood flow and maternal hyperthermia associated with prolonged aerobic exercise, I recom-

mend limiting such exercise to a maximum of 30 minutes in each session.

Aerobic exercise is contraindicated for women with certain conditions, such as premature labour, ruptured membranes, multiple gestation, incompetent cervix, cardiac disease, growth retardation, or other obstetrical and medical complications. Those who find certain forms of aerobic exercise physically uncomfortable may choose other sports instead. For example, some women may find the bouncing movements of running or aerobic dancing uncomfortable. Although no medical reasons have been shown for avoidance of these activities, those who find them uncomfortable may choose to avoid them.

Even for women who never exercised before, weight training is advisable and calisthenics are acceptable. Weight training (lifting weights or using resistance machines, such as Nautilus) strengthens muscles and bones. Many pregnant women experience low back pain and other types of muscular aches due to the added weight of pregnancy, the altered centre of gravity, and muscles that are not strong enough to meet these demands.

Some of these pains can be prevented or reduced by strengthening muscles. The most effective way to strengthen muscles is by contracting them against resistance (i.e., weight training). Weight training is contraindicated for those with cardiac disease or musculoskeletal injuries. Musculoskeletal injuries should be permitted to heal before being stressed.

The term "calisthenics" may refer to different types of exercise. Usually, though, it includes stretching exercises. Exercises that stretch muscles are safe for all pregnant women, even if they never exercised before. Stretching helps to promote flexibility by preventing the shortening that often occurs as muscles heal following exertion. Stretching exercises are performed most safely when practised after muscles have been warmed by exercising.

In order to avoid maternal hyperthermia, I recommend that pregnant exercisers check their temperatures, rectally, at the end of a routine exercise session in early pregnancy (i.e., at the end of an exercise session that is representative of a routine session in intensity and duration). If the rectal temperature is 101°F (38.3°C) or less, the woman can assume that the intensity and duration of her exercise do not promote dangerous hyperthermia, and she can confidently exercise at the same intensity and duration throughout pregnancy (without monitoring her temperature again).

If her rectal temperature in this situation exceeds 101°F (38.3°C), she should follow several measures to reduce her heat accumulation during exercise. Such measures should include wearing looser, lighter clothing, exercising at a cooler time of day, ingesting more fluids, exercising at a lower intensity, or exercising for a shorter duration. She should recheck her temperature after modifying her routine.

I recommend avoiding saunas and hot tubs during pregnancy. Women who insist on using saunas or hot tubs during pregnancy should limit each exposure to 10 minutes or less.

It is difficult to recommend any different pattern or amount of weight gain for exercisers compared to the general population. Those who continue exercising throughout pregnancy, however, may be expected to gain slightly less weight than the norm, while those who previously exercised and subsequently stopped during pregnancy may be expected to gain slightly more weight than the norm. When following women during the course of a pregnancy, it is necessary to ask about their exercise habits and eating habits in order to assess their weight gain properly.

Pregnant exercisers should take the same vitamin and mineral supplements recommended for sedentary women. Additional calories are needed for exercise, but no additional vitamin or mineral supplements are needed. Pregnant exercisers should strive for good hydration, probably by ingesting even more fluids than would be suggested by thirst alone.

Sports that impose a potential risk of abdominal trauma should be avoided, as well as high-altitude sports (which may lead to inadequate oxygen availability). Scuba and deep sea divers should probably limit dives to a depth of one atmosphere.

Women who experience pain, bleeding, rupture of membranes, or absence of fetal movement should stop exercising and should not resume exercising until it has been determined that they can do so safely.

Conclusion

Women who are accustomed to regular exercise can probably continue exercising safely throughout pregnancy, as long as they are attentive to several concerns. Those who continue exercising throughout pregnancy may benefit from the improved fitness that would be expected among regular exercisers. Although such fitness is desirable, it remains to be shown how much exercise in each session is safe to attain and maintain cardiovascular fitness without endangering the fetus. ■

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