

*This review is published with the permission of Research Review Service
(www.researchreviewservice.com)*

Exercise & Pregnancy in Recreational & Elite Athletes IOC Summary – Part 1

Studies Reviewed:

1. Bø K, Artal R, Barakat R, et al. Exercise and pregnancy in recreational and elite athletes: 2016 evidence summary from the IOC expert group meeting, Lausanne. Part 1 – exercise in women planning pregnancy and those who are pregnant. *British Journal of Sports Medicine* 2016; 50: 571–589.
2. Bø K, Artal R, Barakat R, et al. Exercise and pregnancy in recreational and elite athletes: 2016 evidence summary from the IOC expert group meeting, Lausanne. Part 2 – the effect of exercise on the fetus, labour, and birth. *British Journal of Sports Medicine* 2016; 50: 1297-1305.
3. Bø K, Artal R, Barakat R, et al. Exercise and pregnancy in recreational and elite athletes: 2016/17 evidence summary from the IOC Expert Group Meeting, Lausanne. Part 3 - exercise in the postpartum period. *British Journal of Sports Medicine* 2017; 51: 1516-1525.
4. Bø K, Artal R, Barakat R, et al. Exercise and pregnancy in recreational and elite athletes: 2016/2017 evidence summary from the IOC expert group meeting, Lausanne. Part 5. Recommendations for health professional and active women. *British Journal of Sports Medicine* 2018; 52: 1080-1085.

ANALYSIS

Reviewed by Dr. Ceara Higgins

Background Information

Existing guidelines pertaining to physical activity during pregnancy encourage the continuation or adoption of an active lifestyle during and following pregnancy. However, a high proportion of women do not follow these guidelines during pregnancy, increasing their risk of obesity, gestational diabetes mellitus (GDM), and other diseases and complaints. Conversely, there exists a population of enthusiastic exercisers and elite athletes who are apt to meet or even exceed these guidelines. Currently, no guidelines have been developed for these women, leaving questions about safety with high levels of exercise during pregnancy unanswered. The International Olympic Committee (IOC) has undertaken a series of meetings to develop consensus statements with three aims:

1. To summarize common conditions, illnesses, and complaints during pregnancy and after childbirth that may interfere with strenuous exercise and competition;
2. To provide recommendations for exercise training for high-level exercisers and elite athletes during pregnancy and following childbirth; and
3. To identify major gaps in the literature which may limit the ability of experts to confidently make recommendations.

This work was published in a series of five papers, four of which are summarized in this 2-part Review (Part 4 of the series dealt specifically with research recommendations, so we chose to focus on the clinical aspects in this series).

Summary:

Exercise in Women Planning Pregnancy & Those Who Are Pregnant

Preconception: Applying Current Knowledge to the Care of the Elite Athlete

Preconception care aims to optimize a woman's health and provide her with appropriate knowledge before planning and conceiving a pregnancy to help her reduce the risk of adverse health effects for herself and the fetus. This is achieved through identifying and modifying biomedical, behavioural, and social risks and is classified into four categories by the American Academy of Paediatricians and the American College of Obstetrics and Gynaecology. These include physical assessment, risk assessment, vaccinations, and counselling.

The peak age period for fertility often coincides with peak performance for many athletes. As well, high level athletes may experience impaired fertility due to relative energy deficiency in sport (RED-S). RED-S refers to impaired physiological function which may include limitations in metabolic rate, menstrual function, bone health, protein synthesis, immunological health, cardiovascular health, and other impairments caused by relative energy deficiency.

Athletes have also been shown to have a higher frequency of eating disorders, especially in weight-sensitive sports such as endurance, aesthetic, and sports with weight categories. Both anorexia nervosa and bulimia nervosa put pregnant women and their offspring at higher risk for complications such as hyperemesis gravidarum, anaemia, spontaneous abortion, preterm birth (PTB), caesarean section, and postpartum depression, as they compete for limited nutritional resources. The neonate is also at risk of having a small head or low birth weight (LBW), with some studies suggesting that these infants may have developmental disturbances persisting throughout childhood and adulthood, and are more likely to develop anxiety, depression, and substance abuse issues. Bulimia nervosa has further been associated with increased risk of vaginal bleeding, hypertension, fetal abnormalities, low Apgar scores, breech delivery, and stillbirth. Therefore, it is especially important for individuals working with pregnant athletes to be aware of the signs and symptoms of these disorders and refer appropriately. Close follow up by a team of specialists including nutritionists, maternal-fetal medicine specialists, and psychiatric specialists is also important.

Pregnancy: Anatomical and Physiological Adaptations to Pregnancy During Each Trimester

As the uterus expands, the center of gravity displaces, requiring the woman to compensate in order to avoid falling forward. This causes a progressive increase in lumbar lordosis and often an anterior rotation of the pelvis on the femur(s). Secondary to the increased lumbar lordosis, there is an increase in anterior flexion of the cervical spine and anterior rolling of the shoulders. This may be further exacerbated by breast enlargement. During the latter part of the pregnancy and the early postpartum period, significant decreases are seen in the length of the gait cycle and the step length, with a significant increase in double support time, reduction in single support time, and an increase in step width, leading to a wider stance. Due to the increase in anterior pelvic tilt, an increase in hip flexion is seen during the stance phase, an increase in knee flexion is seen during the terminal stance phase, and a general decrease in knee extension, ankle dorsiflexion and plantarflexion are also often observed. Falling has been identified as a common cause of injury in pregnant populations due to changes in balance. All of these may affect an athlete's performance and ability to participate in training and sport.

In early pregnancy the corpus luteum, placenta, and developing embryo release hormones and growth factors into the maternal system, causing a cascade of physiological changes. The cardiovascular system starts to undergo rapid, progressive, and substantial changes

aimed at ensuring blood supply to the fetus from about the fifth week of gestation. These include a reduction in vascular tone, leading to an increased resting cardiac output of about 50% compared to non-pregnant values. The heart shows increased dimensions of the ventricular cavity without any increase in wall thickness, increased aortic capacitance, and reduced peripheral vascular resistance leading to a 15-20 bpm increase in resting heart rate (HR). Stroke volume increases by about 10% by the end of the first trimester, followed by significant increases of up to 50% in maternal blood volume. Supine posture can lead to compression of the inferior vena cava causing a decrease on stroke volume, end-diastolic volume index, and left ventricular ejection time, leading to decelerations in maternal HR. Spending time motionless or exercising in a supine position may cause hypotension due to decreased venous return in 10-20% of pregnant women. Thus, if symptomatic, pregnant women should avoid the supine position.

The thoracic cage raises diaphragmatic mid-position, which decreases residual volume and expiratory reserve volume. Respiratory sensitivity to carbon dioxide increases, causing an increase in tidal volume and minute ventilation which reduces arterial carbon dioxide tension and increases arterial oxygen tension, all of which protect the fetus from acute elevations in maternal carbon dioxide. Resting oxygen uptake decreases slightly with each trimester as body mass increases and can lead to respiratory discomfort (dyspnoea) both at rest and after exertion. However, during submaximal, steady-state exercise, pregnant women generally report a reduction in perceived respiratory effort and dyspnoea.

Maternal metabolism primarily adapts to supply adequate glucose to the fetus. This is accomplished through an increase in maternal blood glucose, decrease in liver glycogen storage, elevation in liver glucose release, and increases in maternal insulin levels. All of these factors increase insulin resistance in skeletal muscle and decrease maternal utilization of glucose in the peripheral tissues. As well, this increases the amount of maternal body fat which is stored.

During fetal neural tube development (35-42 days after the last menstrual period), raising the body core temperature above 39°C (103°F) can raise the risk of neural tube defects. However, outside of this period, increases above these core temperatures should have no effect. Further, exercising at 60-70% of VO₂ max in a controlled environment for up to 60 minutes will not raise the core body temperature above 38°C. It is possible that strenuous exercise or exercising outside in hot and humid weather may increase the core temperature to unsafe levels. Thermoregulation does improve steadily during pregnancy making more strenuous exercise safer.

Nutritional requirements in pregnancy are dependent on a number of factors including gestational weight gain, pre-pregnancy weight, and energy expenditure. Elite athletes and high-level exercisers who continue training during pregnancy are likely to have higher than average energy expenditure depending on the type, frequency, intensity, and duration of their activities.

Highly conditioned athletes who exercised at a moderate-to-high intensity during and after pregnancy showed an increase in VO₂ max between 5 and 10% after pregnancy and improved anaerobic working capacity. Studies of pregnant, elite athletes showed transient fetal bradycardia when exercising at above 90% of VO₂ max. Target HR are generally given as 145-160 bpm in women from 20-29 years, 140-156 bpm in women from 30-39 years. Studies have shown that Borg's rating of perceived exertion (RPE) does not correlate strongly with HR in pregnant women. This makes target HR ranges more important for pregnant women as RPE is not accurate, making it important to directly measure HR during exercise.

While endurance training produces measurable fitness improvement during pregnancy, it is common for recreational and competitive runners to voluntarily reduce their training volume during pregnancy. There is no concern regarding running during pregnancy outside of running in extreme environmental conditions, such as high heat and humidity, or high altitude. No studies have been undertaken – however, theoretically, training at altitude during pregnancy may lead to decreased blood flow to the uterus and a decrease in fetal arterial oxygen saturation. Light-to-moderate weight training has shown no adverse effects during pregnancy. However, heavy weight training often includes the use of the Valsalva manoeuvre, which has been shown to cause a rapid increase in blood pressure and intra-abdominal pressure and may cause a temporary decrease in blood flow to the fetus. The repercussions of this are unknown. As well, the increase in intra-abdominal pressure may be harmful to the pelvic floor, resulting in increased risk of urinary or fecal incontinence or pelvic organ prolapse during or following pregnancy.

Increased levels of relaxin during pregnancy lead to greater muscle laxity and higher levels of joint instability in pregnant women. Therefore, it may be wise to avoid any specific flexibility training. As well, it is suggested that pregnant women avoid high-risk sports. These include sports with a risk of trauma or a risk of physiological harm (ex. scuba diving, where the fetus is not protected from decompression problems).

Clinical Issues in Pregnancy with a Focus on Exercising Women: Common Complaints and Diagnoses – Prevention and Treatment

Nausea is common during the first 6-12 weeks of pregnancy, with 50-80% of women experiencing some level of nausea and 50% experiencing vomiting and retching. About 1% of pregnant women experience an extreme form called hyperemesis gravidarum which involves severe and persistent vomiting, intractable vomiting leading to a weight loss of more than 5% of pre-pregnancy weight, dehydration, and electrolyte imbalance (all of which can lead to hospitalization). Due to the additional demands placed on the system when exercising, it is important to monitor women with nausea for signs of dehydration or for weight loss. It is also recommended that the urine be tested for ketones. Eating frequent, small meals and separating wet from dry intake may be helpful.

About 90% of pregnant women report fatigue. This can be affected by a number of lifestyle factors such as employment, age, etc. It is advisable to rule out severe anemia or hypothyroidism in these cases. The average prevalence of depression during pregnancy is 22.6% and can cause women to withdraw from activities they previously enjoyed and suffer from insomnia, furthering their fatigue. Postpartum, this prevalence is 20-50%. Higher levels of physical activity have been associated with lowered risk of depression, however, there is no evidence to suggest that elite athletes are less likely to suffer from depression than the general population. About 25% of women report high levels of anxiety in the first and second trimesters, with no evidence of how this number may differ in an athletic population. Most antidepressants are not contraindicated in pregnancy and cognitive behavioural therapy has been shown to be effective during pregnancy and in the postpartum period. There has also been some evidence to support the use of exercise in the prevention and treatment of depression in pregnancy and the postpartum period.

Gestational weight gain (GWG) is the amount of weight gained from conception to delivery and can be an important determinant of fetal growth. Women who gain little weight are more likely to give birth to a small (for gestational age) infant, have a preterm birth (PTB), and experience failure to initiate breastfeeding. Women who gain more than the recommended amount of weight have increased risk of GDM, hypertensive disorders, prolonged labour, caesarean section, macrosomia, large (for gestational age) infants, postpartum weight retention, and later obesity. Studies of the relationship between exercise/physical activity and GWG have shown inconsistent results, however, higher levels of physical activity pre-pregnancy have been associated with lower levels of GWG.

Pre-eclampsia is an umbrella term for a spectrum of hypertensive disorders complicated by proteinuria. These disorders affect 2-7% of women during their first pregnancy and 1.7% of multiparous women. The risk is also increased in African, African-American, and Latina women and in women with diabetes or obesity. Treatment is dependent on severity and can include induction of labour after 34 weeks or antihypertensives and corticosteroids to advance fetal lung maturity before 34 weeks. In severe cases, magnesium sulfate may also be given before and after delivery to prevent seizures. In theory, exercise may help to reduce the rate of pre-eclampsia through enhanced placental growth and vascularity, prevention and/or reduction of oxidative stress, reduction of inflammation, and correction of endothelial dysfunction. Studies have been inconclusive, but a 2014 systematic review and meta-analysis (1) showed a 40% reduction in pre-eclampsia in women who performed strenuous exercise prior to pregnancy up to 5-6 hours per week and a 21% reduction in pre-eclampsia in individuals exercising before 24 weeks gestation, with a further reduction (45%) in those exercising at high intensity. When compared to non-exercisers, women who exercised before and during pregnancy reduced their risk of pre-eclampsia by 36%. As well, women who initiated structured exercise early in pregnancy were three times more likely to prevent gestation hypertension, 1.5 times more likely to prevent excessive GWG, and 2.5 times more likely to have large for gestational age babies.

GDM now affects almost 10% of pregnancies and leaves women at a high risk for future diabetes, with about 50% of women developing type 2 diabetes within 5 years of delivery. Risk factors for GDM include obesity, older age, family history, previous history of GDM or poor obstetric outcomes, ethnicity, polycystic ovarian syndrome, and hypertension. GDM has been strongly associated with adverse pre- and post-natal outcomes and is related to long- and short-term morbidity in both mother and offspring. Lack of physical activity before and during pregnancy may lead to obesity, making it likely that high-level exercisers and elite athletes would have a reduced risk of GDM.

Pelvic girdle pain (PGP – pain between the posterior iliac crest and the gluteal fold) often arises from the musculoskeletal system in pregnancy. While it has many similar and overlapping features with low back pain (LBP), it has been shown to lead to more significant disability. About 50% of women will experience LBP and/or PGP during pregnancy, with identified risk factors including previous LBP/PGP during or after pregnancy, strenuous work, and previous trauma to the pelvis. Exercise and acupuncture have been shown to significantly reduce PGP or lumbopelvic pain, with women who reported high-impact exercise 3-5 times per week before pregnancy showing a 14% lower risk of developing severe PGP.

Pelvic floor dysfunction (PFD) includes symptoms of urinary or anal incontinence (UI/AI), pelvic organ prolapse (POP), sensory or emptying abnormalities of the lower urinary tract, defecation dysfunction, sexual dysfunction, and pelvic floor pain syndromes. Female elite athletes show high rates of UI before pregnancy with rates between 28% and 80% during sporting activities. In general, about 18.5% of women reported UI during their pregnancy, regardless of activity, with 25% of women reporting AI during their third trimester. This was most commonly flatus incontinence. Women exercising more than 8 hours per week were about 10% more likely to experience this than the general population. Pregnant women without UI who were given intensive antenatal pelvic floor muscle training were less likely to report UI up to 6 months after delivery. As greater than 30% of women have been found to be unable to perform a correct pelvic floor muscle contraction, it would be useful to provide thorough instruction on how to perform a contraction and assess pregnant women's ability to contract.

CLINICAL APPLICATION & CONCLUSIONS

These articles contain a number of important take-away points for working with elite athletes and high-level exercisers during pregnancy.

Preconception:

- Elite athletes who are trying to become pregnant should discuss issues, including their age, body weight, body composition, menstrual history, eating disorders, RED-S, and intended family size with their medical team.

- The overlap between fertile age and peak performance periods for many athletes may make family planning challenging and must be considered.
- Elite athletes with uncomplicated pregnancies should be reassured that they can continue exercising, although they may need to adjust the intensity and type of activity.
- Athletes continuing to exercise at a moderate level throughout pregnancy can expect their maximal aerobic capacity after pregnancy to be similar to their pre-pregnancy levels.
- There is evidence showing that many elite athletes are able to perform at the same or higher level after an uncomplicated pregnancy and birth.

Exercise During Pregnancy:

- In cases where there are no maternal or fetal contraindications, exercise prescription in pregnancy follows the same principles and elements as in the general population, with the distinction that pregnancy is associated with substantial anatomical, hormonal, metabolic, cardiovascular and pulmonary changes.
- Absolute contraindications to aerobic exercise during pregnancy include: hemodynamically significant heart disease, intrauterine growth restriction in current pregnancy, poorly controlled hypertension, restrictive lung disease, cervical insufficiency/cerclage, multiple gestation at risk of premature labour, persistent second or third trimester bleeding, placenta previa after 26-weeks' gestation, premature labour during the current pregnancy, ruptured membranes, pre-eclampsia/pregnancy-induced hypertension, and severe anaemia.
- Relative contraindications to aerobic exercise include: history of fetal growth restriction, miscarriage, premature birth or labour, cervical enlargement, unevaluated maternal cardiac arrhythmia, chronic bronchitis or other respiratory disorders, poorly controlled type I diabetes, extremely underweight individuals, orthopaedic limitations, and poorly controlled seizure disorders.
- Women without contraindications are encouraged to exercise regularly during pregnancy while watching for warning signs, including: vaginal bleeding, regular painful contractions, amniotic fluid leakage, dyspnoea prior to exertion, dizziness/syncope, headaches, chest pain, muscle weakness, and calf pain or swelling.
- The Physical Activity Readiness Medical Examination (ParMed-X) for Pregnancy is a useful resource for practitioners who are evaluating pregnant elite athletes and enthusiastic exercisers.

- Hyperthermia should be avoided, especially in the first trimester. Moderate exercise, at 60-70% of VO₂max, will not raise core temperature over safe levels.
- In some women, orthostatic hypotension may occur in the supine position or when standing still, especially after 28-weeks' gestation. If side effects like dizziness occur during such activities, they should be discontinued. To reduce risks, exercises normally performed supine may be modified by tilting the torso to 45-degrees or performing the exercises in side-lying, standing, or seated positions.
- A combination of exercise and hypoxia can decrease blood flow to the uterus and lead to a decrease in arterial oxygen saturation. Therefore, it is advisable to refrain from high-intensity training at altitudes > 1500-2000m in those not acclimatized.
- Country-specific nutritional recommendations should be followed by all pregnant women, with elite athletes paying special attention to adequate energy intake to achieve recommended gestational weight gain.
- When strength training, it is advisable for pregnant women to pay attention to technique and safety. If there is a feeling of muscle strain or excessive fatigue, exercises should be modified to avoid injuries.
- Strenuous strength training should be adjusted to avoid the Valsalva manoeuvre and excessive pressure on the pelvic floor. The pelvic floor muscles should be contracted before and during heavy lifting to counteract the impact of increased intra-abdominal pressure on the pelvic floor.
- Strength training of the pelvic floor muscles during pregnancy can prevent and treat urinary incontinence during pregnancy and after birth. Near maximal pelvic floor contractions, in sets of 8-12, performed three times per day on most days is recommended.
- Pelvic floor muscle training during pregnancy has been shown to reduce the length of both the first and second stage of labour with no negative influence on childbirth.
- Sports to avoid include scuba diving, due to the risk to the fetus as a result of decompression problems, and sports with a risk of direct trauma or risk of falling, although non-contact training may be continued.

Advice for Common Complaints and Diseases During Pregnancy

- Nausea, vomiting, and fatigue are common in early pregnancy and may lead to underperformance in training and competition. In cases of extreme nausea or vomiting, drug treatment may be required. Athletes should plan for more time for sleep and rest to combat fatigue.

- Adequate gestational weight gain can be used as a first line indicator of sufficient energy intake for the growth and development of the fetus.
- Pregnant recreational and elite athletes are likely at lower risk of gestational diabetes than the general population. In individuals who do develop gestational diabetes and require insulin therapy, more intense training days or competition may require a reduction in insulin dose.
- As in all pregnant women, it is important to monitor for pre-eclampsia or gestational hypertension and follow-up adequately in individuals with these conditions.
- Women with significant leg edema may benefit from treatment including compression stockings, leg elevation, and hydro-therapy.
- Pregnant women, including athletes, are at a higher risk for low back and pelvic girdle pain. Referral to a sport/women's health professional should be considered.
- There is no evidence of effective prevention or treatment options for diastasis recti abdominis during pregnancy.

STUDY METHODS

A systematic review was undertaken with a search of all available databases and a scan of existing guideline's reference lists. Each member of the working group was assigned as lead author of one or more of the topics covered and 1-3 others were assigned to review each topic. A first full consensus draft was reviewed during the 3-day IOC meeting.

STUDY STRENGTHS/WEAKNESSES

Strengths

This multi-part consensus statement fills a gap in the current recommendations for a population (enthusiastic, pregnant exercisers and athletes) that we will likely see more and more of as the population becomes more educated about the importance of exercise for their health.

Weaknesses

As with all consensus statements, these articles are based partially on the existing literature and partly on expert opinion. As with anything based upon opinion, there is the potential for unsubstantiated recommendations to be included.

Additional References:

1. Aune D, Saugstad OD, Henriksen T, et al. Physical activity and the risk of preeclampsia: a systematic review and meta-analysis. *Epidemiology* 2014; 25: 331–43.