



Improving prescription of physical exercise in prophylaxis/therapy of gestational diabetes: a survey from evidence to current recommendations

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ABSTRACT

Exercise has been proved to be safe during pregnancy and to offer benefits for both mother and fetus; moreover, physical activity may represent a useful tool for gestational diabetes prevention and treatment. Therefore, all women in uncomplicated pregnancy should be encouraged to engage in physical activity as part of a healthy lifestyle. However, exercise in pregnancy needs a careful medical evaluation to exclude medical or obstetric contraindications to exercise, and an appropriate prescription considering frequency, intensity, type and duration of exercise, to carefully balance between potential benefits and potential harmful effects. Moreover, some precautions related to anatomical and functional adaptations observed during pregnancy should be taken into consideration. This survey summarized the suggested recommendations for physical activity among pregnant women with focus on gestational diabetes.

Keywords: Guidelines, Physical Activity, Gestational Diabetes, Pregnancy.

INTRODUCTION

Gestational Diabetes Mellitus (GDM) is the most common metabolic complication of pregnancy. Its

SOMMARIO

Numerose evidenze suggeriscono che l'attività fisica è sicura in gravidanza e offre benefici sia per la madre che per il feto; inoltre, l'esercizio fisico può rappresentare un utile strumento per la prevenzione e il trattamento del diabete gestazionale. Pertanto, tutte le donne in gravidanza non complicata dovrebbero essere incoraggiate ad impegnarsi in attività fisica come parte integrante di uno stile di vita sano. Tuttavia, l'esercizio fisico in gravidanza necessita di una attenta valutazione medica per escludere controindicazioni mediche od ostetriche, e una prescrizione appropriata che tenga conto della frequenza, dell'intensità, del tipo e della durata dell'esercizio, per bilanciare con attenzione i benefici e gli effetti indesiderati potenziali. Inoltre, dovrebbero essere prese in considerazione alcune precauzioni relative ai fisiologici adattamenti anatomici e funzionali che si osservano durante la gravidanza. Questa survey riassume le raccomandazioni attualmente suggerite per l'attività fisica nelle donne in gravidanza con particolare attenzione al diabete gestazionale.

prevalence is increasing worldwide accordingly with increasing of obesity and the number of obese pregnant women⁽¹⁾. Significant evidences suggest that physical activity may represent a simple, inexpensive and useful tool for GDM prevention and treatment⁽²⁾. However, exercise

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in pregnancy needs a careful evaluation and appropriate prescription. To implement a proper prescription of exercise during pregnancy, we examined the published international guidelines for exercise in pregnancy⁽³⁻⁹⁾ complicated or not by diabetes and summarize in this survey the suggested recommendations for physical activity among pregnant women with focus on GDM.

GESTATIONAL DIABETES: SCREENING, DIAGNOSIS AND MANAGEMENT

Briefly, GDM is defined as a carbohydrate intolerance of varying degree of severity with first diagnosis during pregnancy and a natural dispelling of the hyperglycemic condition after child birth⁽⁴⁾. GDM, when undiagnosed or inadequately treated, has many detrimental consequences for the woman, the fetus and the child⁽¹⁰⁻¹⁵⁾.

Since 2011, the Italian National Health System guidelines recommend a selective screening for GDM based on risk factors. According to national guidelines, high risk women are those with previous GDM, obesity (pre-gestational BMI ≥ 30 kg/m²), fasting plasma glucose between 100 and 125 mg/dl, in the first trimester of pregnancy; while at medium risk are women aged 35 years or older, overweight (pre-gestational BMI 25-29.9 kg/m²), with family history of type 2 diabetes, previous fetal macrosomia, ethnic group at GDM high risk. Based on this stratification, in high risk women an early screening between 16th-18th gestational week was recommended, to be repeated later (24th-28th gestational week) in case of normal glucose tolerance, while in medium risk women the screening was scheduled between 24th-28th gestational week. Diagnosis of GDM is based on IADPSG/WHO 2013 criteria. (Table 1).

Table 1. Diagnostic criteria for GDM (IADPSG/WHO 2013)¹⁶.

2 hours -75 g OGTT	Glucose concentration threshold*
Fasting plasma glucose	≥ 5.1 mmol/l (92 mg/dl)
1-h plasma glucose	≥ 10.0 mmol/l (180 mg/dl)
2-h plasma glucose	≥ 8.5 mmol/l (153 mg/dl)

*One or more of these values from a 75-g OGTT must be equaled or exceeded for the diagnosis of GDM¹⁶.

The primary aim of GDM treatment is blood glucose control in order to reduce the elevated risk for short and long term complications for both mother and offspring. The approach for GDM

includes: maternal education, diet modifications, exercise, drug treatment and fetal surveillance (Figure 1).

The initial management of GDM involves diet modifications and implementation of regular physical activity. If adequate glycemic control is not been achieved, drug treatment is prescribed with the aim to reach the target maternal blood glucose levels and hence indirectly for the fetus⁽¹⁷⁻¹⁹⁾.



Figure 1. Key elements in the management of gestational diabetes.

A PHYSICAL ACTIVITY DURING PREGNANCY: BENEFITS AND RISKS

Exercise has been proved to be a beneficial therapeutic tool during pregnancy (Table 2). Recent studies showed that exercise was safe and advantageous for glucose control for women with GDM, improved cardiovascular functions (fitness, blood pressure, peripheral edema), preeclampsia prophylaxis, varicose veins and deep vein thrombosis, decreased lower back pain and had benefits on mood and psychological wellbeing; decreased risk of preterm delivery, length of labor and delivery complications; furthermore exercise has an important role in limitation of weight gain and fat retention after delivery, also improving self image⁽²⁰⁻²¹⁾. Maternal exercise has also been shown to provide significant benefits to the fetus health: increased amniotic fluid, increased in placenta viability and volume, increased vascular function, faster placenta growth and greater villous tissue, more adequate birth weight and lower risk of preterm birth, improved neurodevelopment and lower fetal body fat percentage⁽²²⁻²⁵⁾. Therefore, considering the benefits of exercise during pregnancy, it's necessary that it becomes an integral part of treatment strategies in women during pregnancy and particularly in case of pregnancy complicated by GDM.

Exercise prescription requires knowledge of the potential risks and assessment of the

Table 2. Benefits of maternal exercise

Benefits to the mother	Benefits to the foetus	Benefits to the child
<ul style="list-style-type: none"> • Improved glucose control • Decreased lower back pain • Improve cardiovascular functions • Decreased preeclampsia • Improved muscle tone • Reduced length of labour • On mood and psychological wellbeing • Improved self image • Control in weight gain • Facilitating post partum weight loss • Reduced constipation and bloating, fatigue and insomnia 	<ul style="list-style-type: none"> • Lower heart rate response to acute maternal exercise • Increased amniotic fluids • Increase in placenta viability and volume • Increase in vascular function • Faster placental growth and greater villous tissue • Higher tolerance to labour • Lower birth weights • Lower risk of preterm birth • Improved neurodevelopment and lower body fat percentage 	<ul style="list-style-type: none"> • Infants have higher behaviour regulatory ability and orientation • At the age of five children have less body fat, higher general language intelligence and oral language

physical ability to engage in various activities. As with any clinical population, there are some contraindications to exercise also in pregnancy. Moreover, some anatomical and physiological change occurring during pregnancy should be taken into account in prescribing exercise. Therefore, clinical evaluation of each pregnant woman should be conducted before physical activity is recommended and exercise programs should be tailored by appropriately trained and qualified practitioners.

Pregnant women with GDM don't need suggestions or special precautions for physical activity other than those recommended in women with normal glucose tolerance but, considering the presence of hyperglycemia, they need to take into account the recommendations for the physical activity outlined for the pre-gestational diabetes too, especially when GDM requires a pharmacological treatment that could cause hypoglycemia. Considering the lack of large cohort studies implementing exercise as treatment of GDM, the suggested recommendations have been derived from exercise guidelines in pregnancy and exercise in type 2 diabetes guidelines⁽²⁶⁻³¹⁾. Although currently there is only a GDM specific exercise prescription guideline published⁽³²⁾, we suggest to develop Italian recommendations to allow proper application of physical activity practice as an effective tool in glucose control to prevent, delay or treat GDM.

INDICATION AND CONTRAINDICATIONS TO PHYSICAL ACTIVITY DURING PREGNANCY

All women in uncomplicated pregnancy should be encouraged to engage in physical activity as part of a healthy lifestyle. [Level of evidence II, Recommendation B]

Women with complicated pregnancy have been discouraged from the practice of physical activity to avoid a worsening of the underlying disease or negative impacting both maternal and fetal outcomes. The absolute contraindications represent conditions where exercise is not recommended, while relative contraindications are conditions where the risks may outweigh the benefits of regular physical activity and should be individually evaluated (Table 3). Therefore, **clinical evaluation of each pregnant woman should be performed before physical activity is recommended.** [Level of evidence V, Recommendation B]

STARTING A NEW EXERCISE PROGRAM DURING PREGNANCY

Starting a new exercise program should be considered already in the pre-conceptual period, especially in women who are overweight-obese and/or have other risk factors for GDM (previous gestational diabetes, age > 35 years, family history for diabetes, high-risk ethnic group) in order to avoid excessive weight gain during pregnancy and prevent GDM⁽³³⁾ [Level of evidence III, Recommendation B].

Previously active women can continue the regular practice of physical exercise, as long as the pregnancy is uncomplicated, and the activity practiced meets the safety criteria in terms of type, intensity and frequency of exercise as suggested below-Table 4⁽³⁴⁾. [Level of evidence III, Recommendation B].

In sedentary women, especially those in which the gestational diabetes is diagnosed, an exercise program could be initiated in the second trimester, when the nausea, vomiting, and fatigue (sometimes intense in the first trimester) have passed and before the physical limitations of the third trimester occur. [Level of evidence VI, Recommendation C].

Table 3. Relative and absolute contraindications for the practice of physical activity during pregnancy.

Absolute	Relative
<p><i>Obstetric complications</i></p> <ul style="list-style-type: none"> • Ruptured membranes • Preeclampsia • Pregnancy-induced hypertension • Premature labour during current pregnancy • Persistent bleeding (second or third trimester) • Incomplete cervix or cerclage • Placenta previa (placental implanting into lower uterus) after 26 wk of gestation • High order multiple gestation (≥ triplets) <p><i>Medical complications</i></p> <ul style="list-style-type: none"> • Restrictive lung disease • Hemodynamically significant heart disease • Severe anaemia (Hb <10 g/dL) • Extreme morbid obesity • Extremely underweight (BMI < 12 kg/m²) • Poorly controlled seizure disorder • Poorly controlled hyperthyroidism • Poorly controlled type 1 diabetes 	<p><i>Obstetric complications</i></p> <ul style="list-style-type: none"> • History of spontaneous abortion or premature labour in previous pregnancies • Twin pregnancy after 28th week • Intrauterine growth restriction in current pregnancy • Previous spontaneous abortion • Anaemia (Hb >10 g/dL) • Twin pregnancy after 28 wk <p><i>Behaviour habits and medical complications</i></p> <ul style="list-style-type: none"> • Heavy smoking • History of extremely sedentary lifestyle • Orthopaedic limitations • Poorly controlled hypertension • Chronic bronchitis • Unevaluated maternal cardiac arrhythmia • Malnutrition or eating disorder • Obesity (BMI >40 kg/m²)

EXERCISE PRESCRIPTION DURING PREGNANCY

Consideration should be given to frequency of exercise sessions, intensity of exercise, type of exercise and its duration, to carefully balance between potential benefits and potential harmful effects. We identified in the FITT model (Frequency, Intensity, Time/duration and Type - **Table 4**) a valid tool to prescribe physical activity during pregnancy in order to prevent and treat GDM ⁽³⁵⁾.

Table 4. FITT (Frequency, Intensity, Time / duration and Type) model.

F	FREQUENCY	Begin at 3 times per week and progress to 4 times per week
I	INTENSITY	Exercise to not excessively increase the heart rate. The proper intensity is one that lets you continue the conversation while exercising (Talk Test)
T	TIME	Start from a minimum of 15 minutes per session, 3 times a week (according to an appropriate target heart rate) to a maximum of about 30 minutes per session, 4 times a week (to the appropriate heart rate).
T	TYPE	Preferably use large muscle groups (such as those that are put in motion for walking, stationary bike, swimming, aquatic exercise, low impact aerobics). Avoid the exercises with use of weights or resistance; those that can cause falls; sports at high altitude and underwater.

FREQUENCY AND DURATION

Aerobic exercise should go on for a minimum of 15 minutes per session, 3 times a week (according to an appropriate target heart rate), and should be increased gradually during the second trimester up to a maximum of approximately 30 minutes per session, 4 times to week (to the

appropriate heart rate) ⁽³⁶⁾. [Level of evidence IV, Recommendation C]. To optimize the metabolic benefits of physical activity, due to the transient improvement of insulin action and passive glucose uptake for up to 48 hours, exercise should be conducted with no more than two consecutive days between sessions.

Aerobic activity should be preceded by a short (10-15 min.) warming up and followed by a short (10-15 min.) cool-down phase that include stretching and relaxation exercises. [Level of evidence VI, Recommendation C].

Intensity

The best way to prescribe and monitor the intensity of physical activity is evaluating the heart rate based on age and the rating of perceived exertion (RPE), simultaneously.

Heart rate: In pregnancy, at rest, there is a physiological increase in heart rate from 10 to 15 beats/minute⁽³⁷⁾. **The target heart rate during exercise, depending on the age of the woman (Table 5), representing about 60-80% of peak aerobic capacity for a pregnant woman** ⁽³⁸⁾ [Level of evidence VI, Recommendation C].

Table 5. Heart Rate Intervals useful for pregnant women.

Maternal age (years)	Fitness level	Heart rate range (beats/minute)
< 20	-	140-155
20-29	Low	129-144
	Active	135-150
	Fit	145-160
30-39	Low	128-144
	Active	130-145
	Fit	140-156

Classification of perceived physical activity:

Choosing carefully the desirable heart rate, it is useful to compare it with the scale that assesses the individual's perception of physical activity (Borg's scale, Table 6)⁽³⁹⁾. **An interval between 12 and 14 is appropriate for most of pregnant women.** [Level of evidence VI, Recommendation C].

Table 6. Borg's scale of perceived physical activity

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Very very light	Somewhat light	Light	Somewhat hard	Hard	Very hard	Very hard								

Talk Test: A simple, alternative or complement system for assessing the adequacy of physical exercise intensity is represented by the "talk test": **if a woman is able to maintain a conversation during exercise means that the intensity of exercise is adequate; It should be reduced if the conversation is not possible.** [Level of evidence VI, Recommendation C].

TYPE

Exercise for the development and the maintenance of adequate physical fit in pregnant women consists of activities that improve both the cardio-respiratory (aerobic exercise, consisting of any activity that uses large muscle groups rhythmically and continuously) and musculoskeletal status (strength and flexibility exercises) [Level of evidence VI, Recommendation C].

However, some elements should be considered when prescribing physical activity during pregnancy.

A wide range of recreational activities appears to be safe for pregnant women. The safety of each sport is largely determined by the specific movements required by the exercise. **Activities with a high risk of falling or abdominal trauma should be discouraged. Activity with a high potential for physical contact (such as ice hockey, football, and basketball) or falls (horseback riding, downhill skiing, ...) can cause severe trauma to both mother and fetus and therefore should be discouraged. Scuba diving should be avoided during pregnancy, because the fetus is at risk for decompression sickness. Caution should be also in the practice of physical exercise at high altitude (> 2500 m).** [Level of evidence VI, Recommendation C].

The most popular form of aerobic activity during pregnancy is walking, however, also water exercise may be an excellent choice of exercise during pregnancy.

Precautions for exercise during pregnancy

Although it is useful to exercise all muscle groups, precautions shall be taken, in part related to anatomical and functional adaptations that are observed during pregnancy (Figure 2).

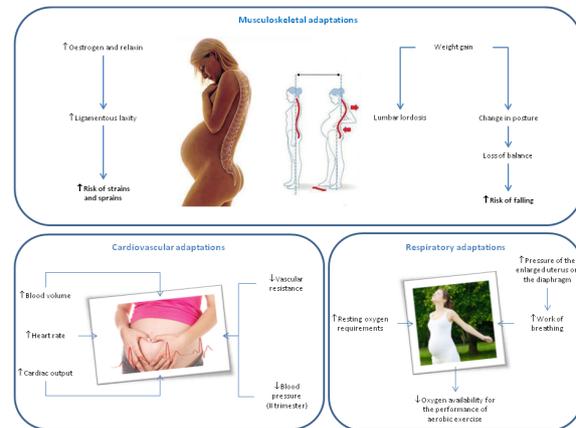


Figure 2. Anatomical and physiological adaptation during pregnancy and related potential risks during exercise.

Musculo-skeletal adaptation: The increase in weight can increase the pressure on all the joints, especially hips and knees, causing discomfort for normal joints and increase in damage in previously unstable joints. Furthermore, due to the increase of weight and abdomen, pregnant women usually develop lumbar lordosis, which leads to changes in posture, predisposing them to loss of balance and increased risk of falls. Finally, during pregnancy there is an increase of the laxity of the ligaments, due to the higher levels of estrogen and relaxin. This could predispose pregnant women to a higher risk of tearing and distortions.

Cardiovascular adaptation: Pregnancy induces an increase in blood volume, frequency and cardiac output, and a reduction in systemic vascular resistance⁽⁴⁰⁾. These hemodynamic changes seem to establish a circulatory reserve, necessary to provide nutrients and oxygen to the mother and fetus at rest and during moderate physical activity⁽⁴¹⁾. After the first trimester, the supine position results in relative obstruction of venous return and therefore decreased cardiac output. For this reason, the supine position should be avoided as much as possible during both rest and exercise. [Level of evidence VI, Recommendation C]. Furthermore, the maintenance of the motionless standing should be avoided because it is associated with a significant decrease in cardiac output.

Respiratory adaptation: Pregnancy is associated with increase of about 50% of the ventilation, increase in arterial oxygen tension, especially in the first trimester, increased uptake of oxygen and its baseline consumption⁽⁴²⁾. Because

of the increased requirement of oxygen at rest and increased work of breathing caused by the pressure exerted on the diaphragm by increased uterine volume, the availability of oxygen for the execution of aerobic exercise during pregnancy decreases.

Thermoregulation: During pregnancy, the basal metabolic rate, and thus heat production, has increased. The dissipation of excess heat generated during exercise can be a potential problem, since some studies suggest that hyperthermia (body temperature > 39°C) during the first 45-60 days of gestation can also be teratogenic in humans⁽⁴³⁾. The increase in body temperature during exercise is directly related to the intensity of exercise⁽⁴⁴⁾. If the production of heat exceeds the heat dissipation capacity, for example during exercise in hot, humid conditions or during very high intensity exercise, the temperature may further rise. The exercise should, therefore, be preferably performed in a thermo-neutral environment or under controlled environmental conditions (conditioning). [Level of evidence VI, Recommendation C]. Moreover, since during prolonged exercise the loss of fluid through sweat can impair the dissipation of heat, it must be maintained a proper hydration.

In women with gestational diabetes, especially

insulin-treated, it is necessary to minimize the risk of an episode, however rare, of hypoglycemia. Therefore, glucose self-monitoring should be recommended before and after physical exercise. If exercise is particularly prolonged, glucose monitoring should be performed also during physical activity. Moreover, if glycemia before exercise is ≤ 70 mg/dl, it is useful to posticipate the exercise after the intake of glucose and the restoration of an adequate blood glucose level. Finally, it may be important to perform physical activity after at least one hour of rapid acting insulin administration, in order to further reduce the risk of hypoglycemia.

Indication to the interruption of physical activity

Pregnant women should be asked to stop physical activity in case of occurrence of:

- Excessive shortness of breath, feeling short of breath or rapid heartbeat

- Chest pain

- Painful uterine contractions

(more than 6-8 per hour)

- Vaginal bleeding

- Any "gush" of fluid from the vagina (suggesting premature rupture of membranes)

- Dizziness or weakness

[Level of evidence VI, Recommendation C].

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