

**ORIGINAL ARTICLE****Insulin Sensitivity and Plasma Glucose Response to Aerobic Exercise in Pregnant Women at Risk for Gestational Diabetes Mellitus****Heba Embaby<sup>1,2</sup>, Enas Elsayed<sup>1,3</sup>, Mohamed Fawzy<sup>1</sup>****ABSTRACT**

**BACKGROUND:** Gestational diabetes mellitus (GDM) is one of the common complications that occur during pregnancy. Early intervention is essential to prevent the development of the disease in the non-pregnant state but also helpful in preventing the occurrence of GDM. The aim of the study was to assess the effect of aerobic exercises on insulin sensitivity and fasting plasma glucose level in pregnant women with risk for gestational diabetes mellitus.

**MATERIALS AND METHODS:** Forty multigravidae women between 20-24 weeks of gestation with risk for GDM were randomly selected (age range was 25-35 years), body mass index ranged from 30-35 kg/m<sup>2</sup>. Women were divided into two equal groups: intervention group (A), which followed an aerobic exercise program in the form of walking on treadmill, three times weekly until the end of 37 weeks of gestation in addition to diet control. Control group (B) which received diet control with usual care given by obstetricians and midwives. Evaluation of the women in both groups was carried out before and after treatment program through assessment of fasting blood glucose and insulin levels.

**RESULTS:** There was a highly statistically significance decrease in fasting blood glucose level, fasting insulin level in both groups where the p value was 0.0001 favoring group (A).

**CONCLUSION:** Moderate intensity of aerobic exercises were effective in reducing fasting blood glucose level and fasting insulin level in pregnant women with risk for gestational diabetes mellitus.

**KEYWORDS:** Aerobic exercise, Blood glucose level, Insulin level, Pregnancy, Maternal diabetes

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**INTRODUCTION**

There is evidence that physical inactivity increases the risk of a lot of adverse health problems, including coronary heart disease, type 2 diabetes, breast and colon cancers. It also shortens life expectancy (1). Pregnancy is a period in the life of women that is often associated with decreased daily physical activity and decreased participation in sports and exercise (2). In the first few weeks of pregnancy, maternal carbohydrate metabolism is affected by a rise in maternal levels of estrogen and progesterone that stimulates pancreatic  $\beta$ -cell hyperplasia and insulin secretion. As pregnancy progress, pancreatic islet cell hypertrophy

continues and there is an increased insulin response to glucose or meal stimulation. The overall effect of the metabolic changes during pregnancy is diabetogenic (3).

Ning et al (4) reported that 23% of previously active women ceased to engage in exercise completely during pregnancy. Factors that might influence the level of physical activity during pregnancy are, for instance, early pregnancy symptoms, such as nausea and fatigue or the perception that physical activity during pregnancy is risky to maternal or fetal health (3). In the absence of either medical or obstetric complications, the American College of

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Obstetricians and Gynaecologists (ACOG) recommended 30 minutes or more of moderate exercise on most, if not all, days of the week for pregnant women.

A reduction in daily physical activity levels and lack of exercise is not the only change during pregnancy. Many physiological changes occur in the body weight, the vascular system, and in the hormonal and energy balance. Shifts in maternal metabolism result in an increased insulin resistance during pregnancy. In women with a suboptimal beta-cell function, the increase in insulin secretion may not be sufficient to compensate the increased insulin resistance. This results in gestational diabetes mellitus (GDM) (5). It is defined as carbohydrate intolerance of varying degrees of severity with onset or first recognition during pregnancy and disappearance after pregnancy. It is associated with an increased maternal risk for other pregnancy-related complications, such as pre-eclampsia, postpartum hemorrhage, and with an increased risk for developing type 2 diabetes after pregnancy. It also puts the infant at risk, since gestational diabetes is associated with an increased risk for macrosomia, jaundice and birth trauma. Later in life, children of gestational diabetic mothers have an increased risk for obesity, abnormal glucose tolerance, and type 2 diabetes (6).

The importance of regular physical activity for glycemic control in women with GDM has already been shown repeatedly. The increased insulin resistance normally occurring during pregnancy can be reduced by increased levels of moderate intensity daily physical activity (7-8). Jovanovic-Peterson et al (9) found that glycaemic control in women with GDM was improved after treatment with an exercise program, similar to improvements obtained with pharmacological therapies (10-11). However, most of these trials studied the effects of a short term exercise program (i.e. a single bout or only several weeks). Studies on longer lasting exercise programs, especially those continuing into the third trimester of pregnancy, are currently lacking. Furthermore, most studies concerned the treatment, and not the prevention of GDM.

Only case-control and cohort studies are available as evidence for a positive effect of regular physical activity and exercise in the prevention of GDM (12-13). However, there are

no reasons to suggest that the underlying mechanisms for GDM are any different than for type 2 diabetes mellitus in non-pregnant women. Daily physical activity and/or exercise have been shown to be effective in the prevention of type 2 diabetes in high-risk adults (14). Therefore, based on the literature, increasing daily physical activity or participation in aerobic exercise program during pregnancy may be an effective strategy for the prevention of GDM.

## MATERIALS AND METHODS

A randomized clinical trial study design was used for the purposes of the current study. Forty consecutive multigravide pregnant women at increased risk for GDM were included in the study. They were randomly selected from the out-patient clinic of obstetrics at Kasr El-Ainy University Hospital, Faculty of Medicine, Cairo University, during the period from July 2014 to February 2015. The women were randomly allocated equally to control and intervention groups and were followed for about four months (the remaining duration of the pregnancy); from 24 weeks until 37 weeks of gestations (the period related to the peak effect of the diabetogenic pregnancy hormones) (15).

Women included in the study were at 24<sup>th</sup> week of pregnancy, over 25 years of age, multigravide, physically active, at increased risk for GDM due to obesity (BMI  $\geq$  30) and had at least one of the following three characteristics: history of macrosomia, history of abnormal glucose tolerance during previous pregnancy and first grade relative with DM type 2 (16-17). Hypertension (systolic pressure  $>$  160 mmHg and/or diastolic pressure  $>$  100 mmHg), GDM, use of the medication that affects insulin secretion, serious pulmonary disease, cardiac, renal impairment and malignancy were the exclusion criteria.

Written informed consent was obtained from all study participants after explanation of the aim of the study and its procedures. The study protocol was approved by the Faculty of Physical Therapy Research Ethics Committee, Cairo University.

**Assessment:** Fasting blood glucose and insulin levels were measured by expert specialist before and after intervention period from 24<sup>th</sup> to 37<sup>th</sup> weeks of pregnancy. The average of three readings was calculated for each variable.

## Intervention

**Group (A):** Women completed program on three days/week during the remaining duration of the pregnancy; each session lasted for 45 minutes. The program consisted of moderate intensity aerobic exercises, under supervision of a trained physiotherapist.

### Exercise training program on the treadmill:

Women was instructed to take breakfast one hour before starting session and empty bladder to be relaxed. During the exercise, a woman was taught to palpate the uterus for contractions and to stop the exercise if contractions occurred. The exercise session was divided into: First stage-warming up for 10 minutes in the form of walking in place to prepare the skeletal muscles, the heart and the lungs for the exercise training, and second stage-active stage (30 minutes) in the form of walking on the treadmill without inclination. The pregnant women were asked to stand on treadmill grasped the handle so the heart rate appeared on the screen then the pregnant women started to walk at steady of speed at 0.7km / hour and increase the speed till reaching 60% of the maximum heart rate (220-age in years). The heart rate was measured through pulsometer attached to the patient's ear. The third stage involved cooling down for 5 minutes of walking on the treadmill by decreasing the speed gradually, at 40% for maximum heart rate, to return the heart rate to its pre-exercise level. The program was carried out according to the guide of the American College of Obstetricians and Gynecologists (18-19) to maintain a safe and healthy program.

Warning signs to terminate exercise were vaginal bleeding, dyspnea, dizziness, headache, chest pain, muscle weakness, calf pain or swelling, preterm labor, decreased fetal movement, and amniotic fluid leakage (18). Women in the intervention group were treated as usual for GDM or other complications during pregnancy.

**Group (B):** The control group received traditional care given by obstetricians and midwives. They were followed closely for health status and their embryos in addition to diet control. For women who developed GDM during the study, usual dietary advice and insulin treatment were given.

**Statistical analysis:** The collected data were statistically analyzed by using SPSS (version 16). Paired and unpaired t-tests were used to compare within and between the studied groups respectively. Data were presented as means and standard deviations and were considered significant at  $p \text{ value} \leq 0.05$ .

## RESULTS

General characteristics of the participants are summarized in Table 1.

Table 1: Physical characteristics of the participants in both groups (A and B) before intervention.

	Group (A)	Group (B)
	Mean±SD	
Age	28.25±2.5	30.2±5.2
BMI	29.15±1.4	28.22±1.1

### Fasting blood glucose level

**Intervention Group (A):** The mean value of fasting blood glucose level before 24 weeks gestations and at 37 weeks gestations were (6.45±0.91, 4.26±0.67) respectively. Comparison between before 24 weeks gestations and at 37 weeks gestations showed a highly significant decrease ( $p < 0.0001$ ) in fasting blood glucose level.

**Control Group (B):** The mean value of fasting blood glucose level before 24 weeks gestations and at 37 weeks gestations were (6.55±0.95, 5.07±0.54) respectively. Comparison by using paired t-test between before 24 weeks gestations and at 37 weeks gestations showed a statistically highly significant decrease ( $p < 0.0001$ ) in fasting blood glucose level (Table 2 and Figure 1).

Table 2: Comparison between mean values of fasting glucose (mmol/l) before and after intervention in groups (A) and (B)

	Group (A)	Group (B)	
	(Mean $\pm$ SD)		<i>p</i>
pre	6.45 $\pm$ 0.91	6.55 $\pm$ 0.95	0.750
Post	4.26 $\pm$ 0.67	5.07 $\pm$ 0.54	0.0001*
<i>p</i>	0.0001*	0.0001*	

\*Significant

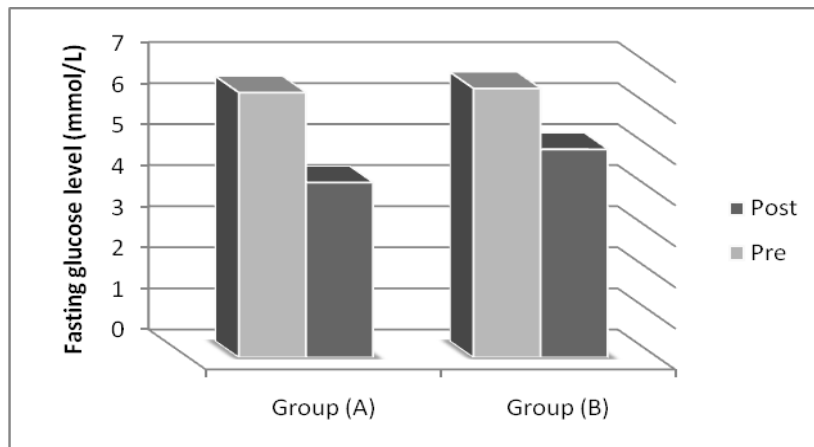


Figure 1: Mean values of fasting glucose level before and after intervention in groups (A) and (B)

### Fasting insulin level

#### Intervention Group (A)

The mean value of fasting insulin level before 24 weeks gestations and at 37 weeks gestations was (16.31 $\pm$ 0.85, 10.59 $\pm$ 1.10) respectively. Comparison by using paired t-test between before 24 weeks gestations and at 37 weeks gestations showed a statistically highly significant decrease ( $p < 0.0001$ ) in fasting insulin level.

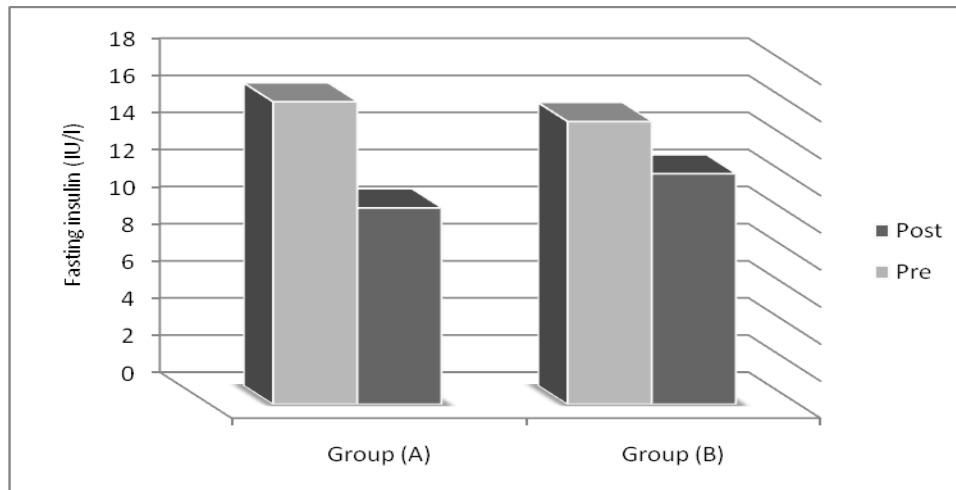
#### Control Group (B)

The mean value of fasting insulin level before 24 weeks gestations and at 37 weeks gestations was (15.25 $\pm$  2.31, 12.43 $\pm$ 1.44) respectively. Comparison between before 24 weeks gestations and at 37 weeks gestations showed a highly significant decrease ( $p < 0.0001$ ) in fasting insulin level (Table 3 and Figure 2).

Table 3: Comparison between mean values of fasting insulin (IU/l) before and after intervention in groups (A) and (B)

	Group (A)	Group (B)	
	(Mean $\pm$ SD)		<i>p</i>
pre	16.31 $\pm$ 0.85	15.25 $\pm$ 2.31	0.061
Post	10.59 $\pm$ 1.10	12.43 $\pm$ 1.44	0.0001*
<i>p</i>	0.0001*	0.0001*	

\*Significant



**Figure 2:** Mean values of fasting insulin level before and after intervention in groups (A) and (B)

## DISCUSSION

The benefits of preventing or delaying the onset of type 2 diabetes among non-pregnant individuals have been reported repeatedly; therefore, physical activity may have the potential for preventing GDM and related adverse health outcomes (20). Preventive strategies for women at risk for GDM are therefore of great importance to prevent the occurrence of GDM, and perhaps also diabetes in later life. The prevention of GDM is also relevant for the children, since it also puts the infant at risk. Gestational diabetes is associated with increased risk for macrosomia, jaundice and birth trauma. Later in life, children of gestational diabetic mothers have an increased risk for obesity, abnormal glucose tolerance and diabetes (6).

Several studies have examined exercise programs for women with high risk for GDM. The duration of the exercise program should be 45 minutes, and a meal should be consumed 1-3 hours before the exercise. Higher levels of insulin sensitivity are associated with improved metabolic profile; endurance training may preferentially improve glucose effectiveness (21-22).

Aerobic exercise reduces insulin resistance which is absolutely high in GDM and in type 2 DM. It may increase insulin sensitivity after 12-weeks' exercise training at moderate intensity which significantly increases both the peripheral glucose effectiveness and insulin

sensitivity (23). It was also Found that the insulin response to a glucose load is improved in late gestational women by a single bout of moderate intensity exercise (24).

Kahn (25) reported that exercise appears to be effective in normalizing GT only in patients who still have an adequate capacity to secrete insulin, and in whom insulin resistance is the major cause for abnormal GT. The amount of exercise required to normalize GT in such patients appears to be within the range of 25 to 35 km per week of running, or a comparable amount of another form of exercise, performed on a regular basis. On the contrary, the results of this study disagreed with the findings of Avery and Walker (10) who conducted an exercise program with randomly assigned 34 women with GDM and fasting hyperglycemia. The exercise group cycled for 45 minutes, three times a week, at 50% vo<sub>2</sub> max. No differences were found for infant birth weights and Apgar scores or mean of weekly maternal blood glucose levels. Finally, it can be concluded that moderate intensity aerobic exercise was effective in reducing fasting blood glucose and fasting insulin levels in pregnant women at high risk for GDM. However, diet control and traditional care were also effective in reducing fasting glucose and insulin levels as shown in the control group but to a lesser extent than aerobic exercises.

Psychological status of the pregnant women like anxiety and stress during the study period might be considered one of the limitations of the study.

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