Journal of Advanced Zoology

ISSN: 0253-7214

*Volume **44** Issue **S-3 Year 2023** Page **187:196***

Effect of Stretching Versus Aerobic Exercises on Pregnant Diabetic Women

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Article History

Received: 06 June 2023
Revised: 05 Sept. 2023
Accepted: 20 Sept. 2023

Abstract

Purpose: *This study was conducted to determine the effect of stretching versus aerobic exercises on pregnant diabetic women.* ***Subjects:*** *Sixty primigravidae and multigravidae women shared in this study. They were selected from Benha University Hospital in Benha. Their ages were ranged from 25-35 years. Their BMI was ranged from 30-35 kg/m^2. Their gestational ages were between 20-24 weeks' gestation. All pregnant women were complaining of gestational diabetes mellitus.* ***Design:*** *Design of this study was randomized controlled study. They were randomly assigned into two equal groups: Group A (stretching exercises group); It consisted of thirty pregnant diabetic women. They were treated by medical treatment, diet control and stretching exercises for 40 minutes, 3 times per week, after one hour of the main meal and insulin injection, for 12 weeks. Group B (aerobic exercises group); It consisted of thirty pregnant diabetic women. They were treated by medical treatment, diet control and aerobic exercise program in the form of walking on treadmill, at moderate intensity (60% of the maximum heart rate), for 45 minutes, 3 times per week, after one hour of the main meal and insulin injection, for 12 weeks.* ***Methods:*** *Body mass index (BMI) was assessed by weight and height scale. Fasting and postprandial blood glucose levels were assessed by using blood glucose monitoring system; fasting insulin level and HbA1C were assessed by blood analysis for each woman in both groups A and B before and after treatment.* ***Results:*** *Results of this study revealed that there was significant decrease in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level in both groups A and B after treatment. Pretreatment, there was no significant difference between both groups A and B in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level. Post treatment, there was significant difference between both groups A and B in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level (more decrease in group A).* ***Conclusion:*** *It can be concluded that both stretching and aerobic exercises during pregnancy can improve gestational diabetes mellitus by decreasing fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level, but stretching exercises are more effective than aerobic exercises.*

Keywords: *Stretching Exercises, Aerobic Exercises, Pregnancy, Gestational Diabetes Mellitus.*

1. Introduction

Being pregnant is a time in a woman's life that is frequently accompanied by a decrease in daily physical activity as well as a drop in engagement in sports and exercise **(1, 2).**

Numerous harmful health conditions, such as coronary heart disease, gestational diabetes mellitus, breast and colon cancers, are made more likely by physical inactivity. Additionally, it reduces life expectancy **(2, 3).**

There are further changes that occur during pregnancy including a decrease in regular physical activity and a lack of exercise. There are many physiological changes in the body's weight, circulatory system, hormonal, and energy balance. During pregnancy, changes in the mother's metabolism lead to an increase in insulin resistance. The rise in insulin secretion may not be enough for overcoming the rise in insulin resistance in females with inadequate beta-cell function. This results in gestational diabetes mellitus (GDM) **(2, 4).**

Regular exercise is beneficial for maternal and fetal health, preventing an excess the mother's body fat and the development of gestational diabetes mellitus **(5, 6).** Weight loss via physical exercise may protect ovarian function by increasing insulin sensitivity and improving the hormonal profile **(7, 8).**

Exercise during gestation positively affects both the pregnant woman and the fetus. The benefits of exercise for the pregnant woman include improvement of physical condition, control of body weight, shorter duration of labor, quicker recovery after childbirth, prevention of health conditions such as gestational diabetes mellitus, pregnancy-induced hypertension and preeclampsia, and reduced risks of premature birth **(6, 9).**

The benefits of exercise can be obtained through static stretching of the skeletal muscles without causing physical strain on the body, unlike with resistive and aerobic activity. It is an additional possible activity that can effectively control blood glucose levels. Since it requires little effort by the individual, it appears to be an advantageous treatment for those with reduced physical abilities. Also, it can be achieved without the need for any additional tools, facilities, or expenses **(10).** Cellular glucose uptake can be increased by passive stretching. Blood glucose levels could decrease following a program of sustained muscle stretching **(11).**

Insulin resistance, which is high in gestational diabetes mellitus, is decreased by aerobic exercise. After 12 weeks of moderate-intensity exercise training, which significantly enhances both peripheral glucose effectiveness and insulin sensitivity, it may increase insulin sensitivity **(2, 12).** Also, it was found that aerobic exercise of a moderate intensity increased the insulin response to a glucose load in late-gestational women. **(2)**.

2. Materials And Methods

Subjects

Sixty primigravidae and multigravidae women shared in this study. They were selected from Benha University Hospital in Benha. Their ages were ranged from 25-35 years. Their BMI was ranged from 30-35 kg/m^2. Their gestational ages were between 20-24 weeks' gestation. All pregnant women were complaining of gestational diabetes mellitus. Women with history of previous abortion, previous preterm birth, eating disorder or malnutrition, severe anemia, antepartum hemorrhage, premature ruptured of membranes, placenta previa, intrauterine growth restriction, pre-eclampsia or eclampsia and severe cardio-respiratory disorders were excluded from the study. The study was conducted from January 2022 to December 2022.

Design

Design of this study was randomized controlled study.

Randomization

The selected women were divided randomly by sealed envelopes into two groups of equal numbers by an independent person who took a sealed opaque envelope from a box following a numerical sequence; the envelope contained a letter indicating whether the woman would be allocated to the control and the study group.

They were randomly assigned into two equal groups: Group A (stretching exercises group); It consisted of thirty pregnant diabetic women. They were treated by medical treatment, diet control and stretching exercises for 40 minutes, 3 times per week, after one hour of the main meal and insulin

injection, for 12 weeks. Group B (aerobic exercises group); It consisted of thirty pregnant diabetic women. They were treated by medical treatment, diet control and aerobic exercise program in the form of walking on treadmill, at moderate intensity (60% of the maximum heart rate), for 45 minutes, 3 times per week, after one hour of the main meal and insulin injection, for 12 weeks.

Materials:

Informed consent form:

An informed consent form was signed from each woman in both groups (A & B) before participation in this study.

Standard weight- height scale:

It was used to measure weight and height to calculate body mass index (BMI**)** for each woman before starting the study.

Blood Glucose Monitoring System:

OneTouch, China, Model: AW 06985302A. It was used to measure blood glucose level for all women in both groups A and B before and after treatment.

Electrical Treadmill:

Motorized treadmill icon-310AM, 135 kg, made in Germany. It was used as a method of aerobic exercise training for all women in group B.

Blood analysis:

It was used to measure fasting insulin level and HbA1C for all women in both groups A and B before and after treatment.

Procedures: -

All women in both groups (A & B) were given a full explanation of the protocol of the study to increase her interest and motivation as well as, to obtain her confidence and cooperation. Consent form was signed from each woman in both groups (A & B) before participation in the study.

Evaluative procedures:

BMI assessment:

Weight and height were measured by using standard weight and height scale while the woman wearing a thin layer of clothes to calculate BMI according to the following equation:

BMI= weight/height^2 (Kg/m^2).

Fasting and postprandial blood glucose level:

Fasting and postprandial blood glucose levels were assessed for each woman in both groups A and B before and after treatment.

Fasting insulin level:

Fasting insulin level was assessed for each woman in both groups A and B before and after treatment.

HbA1C:

HbA1C level was assessed for each woman in both groups A and B before and after treatment.

Treatment procedures: -

Stretching exercises:

It was used for treatment of all women in group A. Each woman was asked to evacuate her bladder before stretching exercises to be more relaxed. Stretching exercises were given for 40 minutes, 3 times per week, after one hour of the main meal and insulin injection for 12 weeks.

Stretching program was consisted of six lower body and four upper body static passive stretches. For each stretch, the muscle was hold in the stretched position for 30 seconds, and was repeated four times. A 15 second relaxation period was separated each repeat, and a minimum 30 seconds was separated the different stretches.

For those stretches that stretched a single limb, the right limb was stretched first, and all four stretches was completed before starting on the left limb. Stretching exercises included (in the order they was applied): Seated knee flexor (bilateral), Seated knee flexor– hip adductor (bilateral), Seated hip external rotators and hip extensors (unilateral), Supine hip flexor and knee extensor (unilateral), Supine knee flexor and plantar flexor (unilateral), Seated shoulder flexors (bilateral), Seated shoulder flexors, depressors and retractors (bilateral), Seated shoulder flexors and elbow extensors (unilateral) and shoulder extensors, adductors and retractors (unilateral) **(13).**

Aerobic exercises

It was used for treatment of all women in group B. Each woman was asked to evacuate her bladder before starting aerobic exercises to be more relaxed. Aerobic exercises were given in the form of walking on treadmill, at moderate intensity (60% of the maximum heart rate), for 45 minutes, 3 times per week, after one hour of the main meal and insulin injection, for 12 weeks. 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 three stages:

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.

Second stage active stage (30 minutes) in the form of walking on the treadmill without inclination.

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.

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 **(2).**

Diet control

It was used for treatment of all women in both groups A and B. A meal plan for women with gestational diabetes mellitus includes three small to moderate sized major meals and three snacks. The total calories can be divided into nine portions. Every two portions form a major meal, and every one portion forms a snack. Another step is to divide the breakfast portion into two equal halves and consuming the portions with a 2-hour gap in between. This prevents the excessive peak in plasma glucose levels after ingestion of the total quantity of breakfast at one time and decreases 20–30 mg/dL of the postprandial plasma glucose. A decreased carbohydrate load is desirable in the breakfast meal. A bedtime snack prevents accelerated starvation and ketosis overnight **(14).**

The Dietary Reference Intakes recommend an increase in calories for pregnancy: no increase in calories in the first trimester, an additional 340 kcal/day during the second trimester, and 452kcal/day during the third trimester **(14).** All pregnant women should consume a minimum of 175 g of carbohydrates, 71 g of protein, and 28 g of fiber per day. A moderate energy restriction (1600–1800 kcal/day) is suggested only for overweight/obese women with gestational diabetes mellitus as a means of improving maternal glycaemia without impacting fetal growth or inducing maternal ketosis **(15).**

Women with gestational diabetes mellitus who are at ideal body weight during pregnancy, the caloric requirement is 30 kcal/kg/day; for those who are overweight, it is 24 kcal/kg/day; and for obese women, the caloric requirement is 12–15 kcal/kg/day of the present pregnant weight. For those women who are underweight, the caloric requirement may be up to 40 kcal/kg/day to achieve recommended weight gains, blood glucose goals, and nutrient intake. Women would generally require 1800–2400 kcal/day **(14).**

Women were advised to eat slowly (swallowing air could give a sense of bloating), drink at least 2 liters of water a day, prefer fresh foods to maintain unchanged the content of vitamins and minerals, well-cooked lean meats, roasted or steamed fish, preferably low-fat milk, cheese and yogurt, prefer complex carbohydrates such as pasta, bread, potatoes, eat eggs (no more than two a week) and eat well-washed vegetables and seasonal fruit, every day **(16).**

Women should limit coffee, tea (or prefer decaffeinated), cola drinks and chocolate because caffeine crosses the placenta and pregnant women were more sensitive to its effects. Women should avoid salt (preferring iodized salt) because of high risk of cardiovascular disease and hypertension. Prefer the iodized salt because, during pregnancy and lactation iodine requirements are greater **(16).**

Statistical analysis

The descriptive statistics inform of mean and standard deviation was calculated for all women of the study to determine the homogeneity and central deviation. Mean, standard deviation and standard error was be calculated for all variables in both groups. Independent "t" test was used also to compare between pretest and posttest in each group. Comparison was applied by student T test to compare between the independent means. A value of $p < 0.05$ was considered statistically significant.

3. Results and Discussion

Physical characteristics of women in both groups:

There was no significant difference between both groups A and B in weight, height and BMI.

Table (1): Mean values of age, height, weight and BMI of groups (A and B).

Variable	Group (A)	Group (B)	t-value	p-value	S
Age (years)	29.53 ± 3.09	28.73 ± 3.2	0.98	0.329	NS
Height (m)	1.62 ± 0.02	1.63 ± 0.03	1.48	0.147	NS
Weight (km)	84.92 ± 3.62	85.68 ± 4.18	0.76	0.451	NS
BMI (kg/m^2)	32.43 ± 1.21	32.34 ± 1.38	0.26	0.8	NS

$\overline{X}$: Mean. SD: Standard Deviation. t- value: Paired and Un-paired t- test value. p- value: Probability value. S: Significant.

Fasting blood glucose level, Post prandial blood glucose, Fasting insulin level an Hb1Ac:

Within groups

There was significant decrease in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level in both groups A and B after treatment (Table 1).

Table 1: Fasting blood glucose level, Post prandial blood glucose, Fasting insulin level an Hb1Ac within groups:

		Pre ttt	Post ttt	MD	% of improv	t-value	p-value	S
Fasting blood glucose	**Group A**	172.33 ± 10.2	136.53 ± 6.98	35.8	20.77%	35.82	0.0001	S
	Group B	176.3 ± 8.8	142.2 ± 8.73	34.1	19.34%	26.97	0.0001	S
Post prandial blood glucose	**Group A**	256.13 ± 20.52	208.6 ± 20.51	47.53	18.56%	33.29	0.0001	S
	Group B	260.33 ± 15.1	221.8 ± 14.1	38.53	14.8%	25.42	0.0001	S
Fasting insulin level	**Group A**	29.7 ± 1.92	23.13 ± 1.81	6.57	22.12%	30.87	0.0001	S
	Group B	30.47 ± 2.95	24.77 ± 2.13	5.7	18.71%	21.3	0.0001	S
Hb1Ac	**Group A**	7.72 ± 0.73	6.78 ± 0.53	0.94	12.18%	16.14	0.0001	S
	Group B	7.96 ± 0.97	7.28 ± 0.82	0.68	8.54%	15.27	0.0001	S

Between groups:

Pretreatment, there was no significant difference between both groups A and B in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level. Post treatment, there was significant difference between both groups A and B in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level (more decrease in group A) (Table 2).

Table 2: Fasting blood glucose level, Post prandial blood glucose, Fasting insulin level an Hb1Ac between groups:

		Group A	Group B	MD	% of improv	t-value	p-value	S
Fasting blood glucose	**Pre ttt**	172.33 ± 10.2	176.3 ± 8.8	3.97	–	1.61	0.114	NS
	Post ttt	136.53 ± 6.98	142.2 ± 8.73	5.67	4.15%	2.78	0.007	S
Post prandial blood glucose	**Pre ttt**	256.13 ± 20.52	260.33 ± 15.1	4.2	–	0.9	0.371	NS
	Post ttt	208.6 ± 20.51	221.8 ± 14.1	13.2	6.33%	2.9	0.005	S
Fasting insulin level	**Pre ttt**	29.7 ± 1.92	30.47 ± 2.95	0.77	–	1.2	0.238	NS
	Post ttt	23.13 ± 1.81	24.77 ± 2.13	1.64	7.1%	3.2	0.002	S
Hb1Ac	**Pre ttt**	7.72 ± 0.73	7.96 0.97 ±	0.24	–	1.07	0.291	NS
	Post ttt	6.78 ± 0.53	7.28 ± 0.82	0.5	7.37%	2.77	0.008	S

The most typical metabolic condition found during pregnancy is gestational diabetes mellitus (GDM), which is also a major public health issue. Newborn problems, such as macrosomia, hypoglycemia, and delivery trauma, have been linked to gestational diabetes mellitus and have both short- and long-term negative effects on maternal and fetal health **(17, 18, 19).** Pregnancy-related gestational diabetes mellitus increases the mother's risk of cardiovascular disease and type 2 diabetes **(19, 20).**

There are non-modifiable and modifiable risk factors associated with gestational diabetes mellitus. Age, diabetes in the family history, genetic component, and race have been identified as non-modifiable risk factors for gestational diabetes mellitus **(19, 21).** Weight, such as being overweight, obese, and gaining too much weight during pregnancy, are among the main risks linked to a high risk of gestational diabetes mellitus. These factors may be modifiable for gestational diabetes mellitus **(19, 21, 22).**

Thus, the type of diet and level of physical activity have an important effect on weight. Factors that can change, such as adopting a healthier lifestyle, are essential for preventing illnesses in public health **(19, 23).** The risk of acquiring gestational diabetes mellitus increases with inactivity and high-calorie diets **(19, 24).**

Compared to a group without exercises, a physical activity lifestyle program resulted to greater improvements in macrosomia, preterm birth rates, low birth weight rates, and mother BMI **(25, 26).** Regularly supervised exercise combined with daily brisk walks resulted in identical results to standard obstetric care in terms of the prevalence of pregnancy and birth difficulties, the requirement for pharmaceutical therapy, the percentage of body fat and body mass in the mother, as well as newborn Apgar scores **(26, 27).**

When pregnant women are normal weight and have uncomplicated single pregnancies, light-to-moderate exercise for 30 to 60 minutes, three times a week, is safe and worthy of promotion. With negative consequences like prenatal hypertension and preeclampsia, gestational diabetes mellitus and weight gain during pregnancy could be significantly decreased with this form of exercise. Additionally, exercising while pregnant is not linked to a change in the mean gestational age at delivery or a rise in the incidence of caesarean deliveries **(28).**

This study was conducted to determine the effect of stretching versus aerobic exercises on pregnant diabetic women. Sixty primigravidae and multigravidae women shared in this study. They were selected from Benha University Hospital in Benha. Their ages were ranged from 25-35 years. Their

BMI was ranged from 30-35 kg/m^2. Their gestational ages were between 20-24 weeks' gestation. All pregnant women were complaining of gestational diabetes mellitus.

They were randomly assigned into two equal groups: Group A (stretching exercises group); It consisted of thirty pregnant diabetic women. They were treated by medical treatment, diet control and stretching exercises for 40 minutes, 3 times per week, after one hour of the main meal and insulin injection, for 12 weeks. Group B (aerobic exercises group); It consisted of thirty pregnant diabetic women. They were treated by medical treatment, diet control and aerobic exercise program in the form of walking on treadmill, at moderate intensity (60% of the maximum heart rate), for 45 minutes, 3 times per week, after one hour of the main meal and insulin injection, for 12 weeks.

Body mass index (BMI) was assessed by weight and height scale. Fasting and postprandial blood glucose levels were assessed by using blood glucose monitoring system; fasting insulin level and HbA1C were assessed by blood analysis for each woman in both groups A and B before and after treatment.

Results of this study revealed that there was significant decrease in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level in both groups A and B after treatment. Pretreatment, there was no significant difference between both groups A and B in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level. Post treatment, there was significant difference between both groups A and B in fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level (more decrease in group A).

Exercise intervention had an important ability to prevent gestational diabetes mellitus and should be recommended to be administrated in pregnant women **(29).**

Results of this study agreed with **Nelson et al. (30)** who found that stretching exercises could significantly lower blood glucose in patients with Type 2 diabetes or 'at risk' for developing Type 2 diabetes. They explained their results as stretching exercises are viable activity that can help regulate blood glucose. They require little effort by the individual and appear to be an advantageous treatment for those with reduced physical capabilities. Also, they can be done without any additional equipment, facilities, or other expenses.

Also, **Solomen et al. and Park (10, 11)** found that stretching exercises resulted in significantly greater reduction in the blood glucose level in patients with Type II diabetes. This was probably due to the maintenance of a constant tension throughout the passive stretch. The tension produced, increased the metabolic activity of the muscles thereby reducing blood glucose level in subjects with diabetes mellitus.

Results of this study also agreed with **Gurudut and Rajan (31); Arsianti et al. (32) and Taheri et al. (13)** who found that passive stretching exercises are beneficial interventions in reducing fasting blood glucose level and blood glucose level immediately after exercise in type 2 diabetic patients. Also, **Mueller et al. (33)** found that stretching exercises group showed greater improvements in hemoglobin A1C values compared with those in aerobic exercises group.

Moderate stretching exercises have been shown to lower maternal glucose concentrations in women with gestational diabetes **(34).**

The results of this study supported by **Mohsenzadeh-Ledari et al. (35)** who found that stretching exercises had significantly affect on lowering gestational diabetes and weight at the end of pregnancy. Also, no intervention related complications, such as abortion, fetal loss, and preterm delivery, were observed in stretching exercises group.

Aerobic exercise is effective in controlling glucose level, HbA1c and insulin level **(36).** Aerobic exercise can help to improve insulin action and reduce the risk of gestational diabetes **(6).**

The results of this study came consistence with **Padayachee and Coombes (37)** who found that aerobic exercise has been shown to be an effective tool in glucose control which may prevent, reduce or delay the need for insulin and reduce the risk of gestational diabetes.

Results also came consistence with **Barakat et al. (38)** who found that aerobic exercise throughout pregnancy can reduce the risk of gestational diabetes and excessive maternal weight gain

Results also came consistence with **Igwesi-Chidobe et al. (39)** who found that post prandial blood glucose levels were better improved by regular supervised exercise plus daily brisk walks than routine obstetric care. Similarly, postprandial blood glucose levels were improved by a daily walking intervention in aerobic exercises.

Results also came consistence with **Xie et al. (40)** who found that the fasting blood glucose level, insulin utilization rate, and incidence of adverse pregnancy outcomes in the aerobic exercise group were lower after the intervention than before the intervention.

Findings of this study agreed with **Embaby et al. (2)** who found that moderate intensity aerobic exercise was effective in reducing fasting blood glucose and fasting insulin levels in pregnant women at high risk for gestational diabetes mellitus.

Results of this study also agreed with **Yokoyama et al. (41)** who found aerobic exercise reduces insulin resistance which is absolutely high in gestational diabetes mellitus and in type 2 diabetes mellitus. It may increase insulin sensitivity after 12-weeks' exercise training at moderate intensity which significantly increases both the peripheral glucose effectiveness and insulin sensitivity.

4. Conclusion

It It can be concluded that both stretching and aerobic exercises during pregnancy can improve gestational diabetes mellitus by decreasing fasting blood glucose level, post-prandial blood glucose level, fasting insulin level and HbA1C level, but stretching exercises are more effective than aerobic exercises.

Acknowledgments:

The authors express their gratitude to all individuals who aided in the successful completion of this project, with a special acknowledgment to the study participants.

Disclosure statement:

There were no financial interests or benefits received by any author in relation to this research.

Conflict of interest

The authors have declared the absence of any conflict of interest.

Funding:

This research received no specific grant from the public, commercial, or not-for-profit funding agencies.

Ethical approval:

This was approved by the Ethics Committee of the Faculty of Physical Therapy at Cairo University.

Consent

Prior to the commencement of the study, all participants were provided with a detailed explanation of the study's procedures and subsequently signed a consent form.

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