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Aerobic Training Impacts on Blood Cholesterol of Women with Gestational Diabetes

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Abstract

Gestational diabetes mellitus has been identified as a major complication of pregnancies and has remained a major cause of perinatal morbidity and mortality, as well as maternal morbidity. Lipid abnormalities significantly contribute to the increased risk of cardiovascular disease and other morbidities in diabetics. One of the benefits of regular exercise is a reduction in cardiovascular risk factors through the improvement of the lipid profile and reduction of hypertension. This study investigated the effect of aerobic training on the cholesterol level of women with gestational diabetes. Thirty-four (34) women who met the inclusion criteria for this study were randomized into Exercise and Control groups. Exercise group participated in structured exercise programme, 3 sessions a week for 8 weeks with each session lasting a maximum of 60 minutes while the Control group did not participate in any form of structured exercise programme for the period of the study. Data were collected at baseline, at 4th week and at 8th week into the exercise programme. Thirty (30) of the participants completed the study and so only their data were analysed using Repeated Measure ANOVA and Independent t-test. The result showed significant changes in the total cholesterol ($F[2, 28]$) = 268.316, $P = 0.001$), of the Exercise group compared to the control. Independent t-test used to compare the lipid profile of the Experimental and Control groups showed significant difference between the means of the 2 groups at week 4 (total cholesterol ($t(28)$ 2.164, $P = 0.039$, triglyceride [$t(28)$ 3.146 $P = 0.004$] and week 8 (total cholesterol $t(28)$ 4.596, $P = 0.001$, triglyceride $t(28)$ 5.534, $P = 0.001$) but not at baseline (total cholesterol $t(28)$ −901, $P = 0.375$, triglyceride $t(28)$ 1.612, $P = 0.118$). It was concluded that structured aerobic exercises may have positive effect on the components of lipid profile in women with gestational diabetes.

Keywords

Gestational Diabetes, Antenatal Exercise, Total Cholesterol, Aerobic Training

1. Introduction

Diabetes mellitus is a worldwide health problem predisposing to markedly increased cardiovascular mortality and morbidity [1]. Persons with diabetes have a greatly increased risk for atherosclerosis and its complications. Gestational diabetes mellitus (GDM) accounts for approximately 90% - 95% of all cases of diabetes in pregnancy [2]. The prevalence of GDM varies from 1% to 14%, in direct proportion to the prevalence of Type 2 diabetes in a given population or ethnic group [3]. Gestational diabetes mellitus has been identified as a major complication of pregnancies, affecting approximately 7% of all pregnancies [4] and has remained a major cause of perinatal morbidity and mortality, as well as maternal morbidity [5] [6]. GDM has short- and long-term implications both for the mother and child. Women with gestational diabetes are at risk of developing type 2 diabetes later in life [7]. It is obligatory for all physicians caring for pregnant women to screen, diagnose and treat them for gestational diabetes by whatsoever methods adopted [5].

Many diabetic patients have increased plasma cholesterol (including LDL-C). Additionally, glycation and oxidation of circulating LDL particles may further increase the risk for atherosclerotic disease in patients with diabetes [8]. Lipid abnormalities significantly contribute to the increased risk of cardiovascular disease and other morbidities in diabetics [8]. There is a growing body of evidence showing that hyperglycaemia and dyslipidaemia are linked to increased cardiovascular risk. It has been demonstrated that high levels of serum total cholesterol (TC), triglycerides, low density lipoprotein (LDL), very low density lipoprotein (VLDL), glycated haemoglobin (HbA1c), microalbuminuria, hypertension, low concentration of high density lipoprotein (HDL) and increased body mass index (BMI) are significantly associated with coronary heart disease.

One of the benefits of regular exercise is a reduction in cardiovascular risk factors through improvement of the lipid profile and reduction of hypertension [9]. It is now well documented that physical exercise is associated with a lowering of serum cholesterol concentrations, particularly very-low-density lipoproteins (VLDLs), and increases in high-density lipoprotein (HDL) cholesterol [10]. Another study also reported that there is also a slight decrease in low-density lipoprotein (LDL) cholesterol with exercise [11].

Studies on the mechanism by which physical training results in lower VLDL and increased HDL concentrations have shown that physically trained skeletal muscle has increased lipoprotein lipase activity compared with untrained muscle. This results in greater extraction of circulating VLDL and increased release of HDL resulting from a transfer of VLDL surface proteins to HDL particles [10]. This improvement in the lipid profile with physical training is observed with running a minimum of 10 to 12 miles per week and increases in a dose-response fashion up to distances of approximately 40 miles per week [10]. Less intensive levels of physical activity have little or no effect on lipid profiles [11].

Research has shown that the most physically active women have the lowest

prevalence of gestational diabetes mellitus (GDM) [12]. Studies on the effect of exercise on the sugar level of non-pregnant individuals have been well documented and established [13] [14] [15]. Few studies have considered the effect of exercises on the sugar level and the need for insulin therapy in pregnant women with gestational diabetes mellitus. To the best of our knowledge, no study has considered the effect of a structured exercise programme on the lipid profile of Nigerian women with gestational diabetes mellitus. This study, therefore, investigated the effect of exercise on the components of the total cholesterol of Nigerian women with gestational diabetes.

This study was considered important as exercise is cheaper and safer than drugs, and if exercise could be proven to have positive effect on the components of the lipoprotein in GDM, it may be encouraged as an adjunct therapy in the management of this condition which affects almost 7% of all pregnancies [4].

2. Methods

2.1. Subjects

This was an experimental research with a test group and a control group, designed to study the effect of aerobic exercises on the blood cholesterol of women diagnosed with gestational diabetes in their present pregnancy. The sample for the study was drawn from the population of pregnant women attending antenatal clinic at the Federal Medical Center Owerri, Imo State Nigeria, after obtaining ethical approval from the ethical committee of the hospital. The Federal Medical Centre is a tertiary healthcare centre that services the whole of Imo state, being the biggest and specialist hospital in the state.

The subjects, who were at least 24 weeks pregnant, were diagnosed with gestational diabetes mellitus with fasting blood glucose level more than 95 mg/dl or 1-h postprandial values of over 130 to 140 mg/dl range or 2-h postprandial values exceeding 120 mg/dl 17. The subjects were certified fit for exercising in pregnancy by their attending physicians and had none of the conditions contraindicating exercising in pregnancy, according to the guideline for exercising in pregnancy by ACOG [16]. These included heart disease, multiple gestation, incompetent cervix, prior preterm delivery, prior low-birth-weight infant, uterine bleeding, and chronic hypertension [17]. Forty Seven (47) subjects indicated interest and were screened using Physical Activity Readiness Questionnaire for pregnancy (Par-Med Q in pregnancy questionnaire) [18]. The questionnaire was administered to the subjects through the help of two research assistants who are trained Physiotherapists. Those that met the inclusion criteria were thirty four (34) and were asked to read and sign informed consent form after being adequately informed of the purpose and procedure of the study.

NB. This study was conducted in 2014 at the commencement of Antenatal Exercise in the hospital and part of the results on effects on the exercise on blood pressure and blood glucose have been published in other journals.

2.2. Procedures

Subjects were randomly assigned to either experimental group (17 subjects) or control (17 subjects) by picking of either A or B written on a piece of paper and folded. Those that picked A were assigned to the experimental group (17 subjects) while that picked B were assigned to the control group. The exercise group participated in the exercise programme which held every Monday, Wednesday and Friday for 8 weeks, each session lasting for a maximum of 60 minutes with 5 minutes rest intervals after every 20 minutes of exercising. Those in control group took part in no structured exercise programme during the period of the study. The serum cholesterol levels of all subjects were assessed through appropriate laboratory procedure at baseline, 4th week and 8th week of the programme.

2.3. Exercise Training Procedure

The exercise trainings were conducted 3 times a week at the Gymnasium of the Physiotherapy Department of the Federal Medical Centre, Owerri. The exercise classes were held in the mornings from 10 am to 11 am on Mondays, Wednesdays and Fridays of each week of the 8 weeks that the study lasted. The days were alternated to allow for rest and recovery.

2.4. Exercise Training

The exercise instructor demonstrated the exercises to the subjects on their first day while they watched and later joined. The exercises were carried out in group to make it more interesting and challenging. The subjects were able to draw encouragement from one another. Each exercise session started with 10 minutes warm up exercises comprising of brisk walking and jogging. The main exercise workout involved exercises to the pelvic floor muscles (Pelvic floor muscle contractions), abdominal muscles (Simple abdominal muscle contractions), back muscles (cat and camel, pelvic tilts), and muscles of the legs (ankle pump, quadriceps and hamstrings contraction etc). Breathing exercise was incorporated intermittently throughout the sessions. Stretches to the exercised muscles were done as cool down. All these exercises were performed in each session.

2.5. Table of Exercise Regimen

S/N	Exercise Types	Types of Activities	Duration
1	Warm up	On the spot jogging, brisk walking with arm swinging and stretching exercises in standing.	5 to 10 minutes
2	Aerobic	This included cardio-respiratory fitness exercises which incorporated on the spot walking, arms raising, knee raising, half-squatting, belly dancing, pelvic tilt in half squatting and free dancing to a music tone. Breathing exercise.	10 to 20 minutes
3	Strengthening exercises:	For the abdominal muscles, pelvic floor muscles, back muscle and muscles of the legs. included abdominal contraction exercises, pelvic floor muscle contraction exercises, cat and camel, straight leg raises in side lying, half-squatting and other suitable floor exercises. Breathing exercise	10 to 20 minutes
4	Cool down	This incorporates stretches for the arms, chest, side bending, quadriceps, hamstrings, feet, tendon Achilles, fingers and toes and then relaxation exercises. Breathing exercise.	5 to 10 minutes

Exercise progression: Within the first 4 weeks, the exercise intensity was maintained at the low intensity level using the Borg Scale for Rate of Perceive Exertion [17] and duration of 30 minutes, to allow the subjects to gradually adapt to the training and prevent dropping out and injuries [18]. In the last 4 weeks, the exercise intensity was increased to moderate intensity and duration of 45 to 60 minutes. This is in accordance with American College of Sports Medicine (ACSM) recommendation for exercise intensity to develop cardiovascular fitness and reduce cardiovascular disease risk factors in adults [19].

Monitoring of the exercise intensity: The rate of perceived exertion (RPE) was used throughout the exercise period to monitor the exercise intensity. This was in line with the recommendation of ACSM. The ACSM recommends that intensity should be 60% - 90% of maximal heart rate or 50% - 85% of either maximal oxygen uptake or heart rate reserve. The lower end of these ranges (60% - 70% of maximal heart rate or 50% - 60% of maximal oxygen uptake) appears to be appropriate for most pregnant women who did not engage in regular exercise before pregnancy, and the upper part of these ranges should be considered for those who wish to continue to maintain fitness during pregnancy [20]. In a meta-analysis study of exercise, ratings of perceived exertion have been found to be useful during pregnancy as an alternative to heart rate monitoring of exercise intensity [21].

2.6. Data Analysis

Out of the 34 pregnant women who met the inclusion criteria and started this study, only 30 were able to complete the study. Two subjects from the control group had preterm delivery and could not complete the study while two participants in the exercise group could not complete the exercise programme due to fluctuation in their blood pressure and advice by their Physician to stop the exercise participation.

The data of the 30 pregnant women who concluded the study were analysed and presented in this article. Descriptive statistics of means and standard deviations of the variables were computed for the participants that completed the study. Repeated measure of analysis of variance (ANOVA) was used to test the interaction between the baseline, 4th week and 8th week values of the variable. Bonferroni post hoc test was used to locate the point of difference where F is significant. Independent sample t-test is used to compare the means of the variable between the exercise and control groups at each level.

All statistical analyses were performed on an IBM compatible microcomputer, using statistical package for the social science (SPSS) (window version 15.0 Chigaco IL.USA). Differences were considered statistically significant where $P \leq 0.05$.

3. Results

The average age of subjects in the exercise group was 32.0 years and that of control group was 32.9 years (**Table 1**), making the age ranges comparable. Average

maternal height for exercise group is 1.6 m and for control 1.6 m (Table 1). Average parity for exercise group was 2 and for control group was 3 (Table 1). The gestational ages of subjects were also comparable, 26.8weeks for exercise group and 26.3 weeks for the control group.

Table 2 shows the result of the statistical analysis of the lipid profile of the exercise and control at the three stages of the study. There was an observed increase in the Mean HDL of the exercise group from 47.73 ± 0.72 at baseline to 51.13 ± 11.47 after four weeks exercise participation and a further increase to 54.87 ± 12.26 at the end of a total 8 weeks of participation in the exercises. However, the control group Mean HDL remained relatively steady, with slight decrease in values, recording 47.73 ± 9.84 at baseline, 46.87 ± 8.85 at 4th week and 46.20 ± 8.25 at 8th week. The LDL, VLDL, TChol and TG were all positively influences by the exercise as they all showed some decrease in values. The significance of these effects was determined using ANOVA and the results shown on Table 3 below.

Table 1. Characteristics of pregnant women with gestational diabetes in Imo State, Nigeria.

	Total Number	Exercise Group (n = 15)	Control Group (n = 15)
Variable	**N**	**Mean ± SD**	**Mean ± SD**
Parity	30	2.0 ± 1.5	2.7 ± 1.7
Height (m)	30	1.6 ± 0.0	1.6 ± 0.0
Age (yrs)	30	32.0 ± 3.4	32.9 ± 4.6
Gestational Age (wks)	30	26.8 ± 1.0	26.3 ± 1.0

Key: SD = Standard Deviation.

Table 2. Summary of descriptive statistics of means of the lipid profile for exercise and control groups.

Variable	Baseline		4th Week		8th Week	
	Exs (N = 15)	Control (N = 15)	Exs (N = 15)	Control (N = 15)	Exs (N = 15)	Control (N = 15)
HDL (mg/dl)	47.73 ± 10.72	47.73 ± 9.84	51.13 ± 11.47	46.87 ± 8.85	54.87 ± 12.26	46.20 ± 8.25
LDL (mg/dl)	118.40 ± 13.09	111.33 ± 14.33	103.93 ± 12.63	113.40 ± 14.12	92.27 ± 13.71	116.80 ± 15.59
VLDL (mg/dl)	25.07 ± 6.28	28.00 ± 5.88	22.00 ± 5.29	28.267 ± 5.71	18.00 ± 4.21	28.47 ± 5.97
TChol (mg/dl)	191.20 ± 16.73	186.13 ± 13.95	176.53 ± 15.74	188.33 ± 14.08	165.13 ± 17.83	192.67 ± 14.85
TG (mg/dl)	123.27 ± 26.91	139.87 ± 27.44	109.53 ± 27.00	141.47 ± 28.56	90.13 ± 20.87	142.13 ± 29.81

Table 3. Independent t-test comparing means of the lipid profiles of exercise and control groups.

Variable	Research Stage	N	Mean Difference	df	t-value	p-value
Total Cholesterol	Baseline	15	5.07	28	−0.901	0.375
	Week 4	15	11.80	28	−2.164	0.039
	Week 8	15	27.53	28	−4.596	0.001
Triglycerides	Baseline	15	−16.7	28	−1.612	0.118
	Week 4	15	−32.2	28	−3.146	0.004
	Week 8	15	−52.0	28	−15.534	0.001

4. Discussion

This research studied the effect of exercise on the blood cholesterol of pregnant women diagnosed with gestational diabetes. No differences in the components of total cholesterol, (HDL, LDL and VLDL), and triglycerides were observed at baseline but differences in the means of these variables were observed after 4 weeks and after 8 weeks of exercises (Table 2). There was observed decrease in the means of the LDL and VLDL while the HDL increased. The total cholesterol and triglycerides also decreased after the 4th Week and further decrease at 8 Weeks in the exercise group as against increase in values of these variables in the control group. Repeated Measures ANOVA was carried out to determine the significance of the observed changes and the result presented in Table 3 showed that the differences (decrease) in the means of the total cholesterol ($F[2, 28]= 268.316$, $P = 0.001$) and the triglyceride ($F[2, 28] = 77.557$, $P = 0.001$) were significant.

The Bonferroni post-hoc test was used to determine the point at which the differences in the means were significant. The result of the post-hoc test showed that there was significant difference in the total cholesterol and triglycerides levels between baseline and week 4 ($P = 0.001$) and between week 4 and week 8 ($P = 0.001$) and also between baseline and week 8 ($P = 0.001$).

Independent t-test used to compare the lipid profile of the experimental and control group showed significant difference between the means of the Exercise and Control groups at week 4 (total cholesterol ($t[28]$ 2.164, $P = 0.039$), triglyceride ($t[28]$ 3.146 $P = 0.004$) and week 8 (total cholesterol ($t[28]$ 4.596, $P = 0.001$), triglyceride ($t[28]$ 5.534, $P = 0.001$), but not at baseline (total cholesterol $t[28]$ −901, $P = 0.375$), triglyceride ($t[28]$ 1.612, $P = 0.118$) (Table 3).

The differences in means were believed to be as a result of the exercise administered on the experimental group. This is further confirmed by the no difference observed at the baseline between the Exercise and Control before the administration of the treatment (exercise) on the Exercise group.

Our study corroborates some previous studies on the effect of exercise on lipid profile, though in non-pregnant populations.

A study by Aggarwala *et al.* [22] found significant decrease in the VLDL and triglycerides in sedentary men and women following 4 weeks of aerobic training but observed that the changes in HDL, LDL and chylomicrons were not significant. They suggested that the insignificant effect could be because of small sample size and short duration of their training programme which was four weeks. In our study, the women exercised for a longer period (8weeks) and this may explain the result as shown by significant changes in all the components of total cholesterol. Gordon *et al.* [23] observed a significant reduction in serum total cholesterol of patients that attended yoga exercise as well as in those that attended conventional physiotherapy exercises in a research conducted to compare the effect of yoga and conventional physiotherapy exercises on lipid profile and oxidative stress of patients with type 2 diabetes. They found no significant

reduction in the serum total cholesterol of the control group who did not take part in exercise throughout the study period. They also observed that the concentration of VLDL in the exercise groups differed significantly from the values at baseline and after 6 months (P = 0.036). They concluded that yoga and conventional physiotherapy exercises may have therapeutic, preventive and protective effects on diabetes mellitus.

A case study by Duarte-Gardea [24] reported that lifestyle modification which included high intensity exercises reduced the LDL cholesterol of a diabetic patient from 142 mg/dl to 93 mg/dl and total cholesterol from 200 mg/dl to 146 mg/dl. Other studies also found significant increase in HDL cholesterol following exercises. However, some studies recorded no significant difference in the level of serum lipoprotein following exercises [25]. Frey *et al.* [26] noticed no significant change in the HDL-C in women after 10 weeks of training. They concluded that exercise conditioning leading to improved physical fitness in healthy women may not be associated with increments in HDL-C levels.

The increased lipoprotein lipase in adipose tissue and muscles following endurance exercises suggest that increased lipolytic rate of triglyceride-rich proteins may be an initial step in a sequence of events leading to higher plasma level of HDL-C. Triglyceride-lowering effect is an acute response with changes in cholesterol being a chronic effect of exercise. The acute triglyceride decrease seems to be due to accelerated catabolism resulting from increased LPL activity. Following exercise, there is increase in tissue insulin sensitivity which could lead to decrease VLDL synthesis [27].

Strength and Weakness of our study: Participation in antenatal exercise is not common in the environment where this study was conducted and it is a general belief that exercise could harm the woman and the unborn baby. That explains the limited number of participants who volunteered to participate in this study.

The strength of this study however lies on the consistency and commitment of the participants, especially when they were assured by their physicians of the safety of the exercises which were purely aerobic dance.

5. Conclusion

Our study observed significant decrease in the means of the LDL, VLD and triglycerides and an increase in HDL as a result of the exercise participation. No statistically significant changes were observed in the Control group. This effect may be as a result of the activities because of the activities of lipoprotein lipases in the adipose tissues and muscles which are increased by endurance exercises. It was therefore concluded that structured exercises programme may have effects on the blood cholesterol level, even in pregnant women and so may benefit women with gestational diabetes, as high lipidemia is one of the possible risks faced by this population. No adverse effect was observed from the exercise participation as the women were monitored till delivery.

It is recommended, based on the result of this study, that low to moderate intensity exercises be included as adjunct therapy for women with gestational diabetes and the exercise programme should be administered and supervised by experts in the area of Women's Health Physiotherapy or Exercise Physiologists who have training in the protocol for exercising in pregnancy. Further studies should be conducted in this area with larger number of subjects.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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