



Changes in the Cardiorespiratory Fitness of Exercised Pregnant Women Leading to Delivery

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Substantial proportion of women stop exercising after they discover they are pregnant, and only few begin participating in exercise activities during pregnancy. The adoption or continuation of a sedentary lifestyle during pregnancy may contribute to the development of certain disorders. In view of the global epidemic of sedentary behaviour and obesity-related pathology, prenatal physical activity was shown to be useful for the prevention and treatment of these conditions. The aim of this study was to investigate the changes in the cardiorespiratory fitness of exercising pregnant women in Rivers State University Teaching Hospital. This original research article is designed using randomized pre test-post test control group. The differences in the pre-test and post-test values represented the impact of the ten (10) weeks aerobics training on the experimental group. Sixty-four pregnant women who completed the study were simply randomized into experimental (n=38) and control (n=26) groups and their pre-intervention values of systolic blood pressure, diastolic blood pressure, peak expiratory flow rate and resting heart rate were taken and recorded. A ten week,

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three times weekly aerobic exercise (40 – 45 minutes) training was administered on the experimental group. A post-intervention score was also taken from all participants and the data analyzed using mean and standard deviations. Analysis of covariance was used to determine the changes at 0.05 alpha level. Results showed the Aerobic Exercise Training impacted – Systolic Blood Pressure of pregnant women (experimental 125.47±78.05 and control 130.23±8.92). The Diastolic Blood Pressure of the pregnant women (post intervention experimental score 65.47±5.0 and control 78.19±10.72. Heart rate of the pregnant women decreased in the experimental group though insignificantly (experimental 89.87±6.51 and control 91.46±6.56). The expiratory peak flow rate increased from 261.58±80.39 to 329.74±66.07 and in the control group 203.85±66.07 to 204.62±22.84. From the foregoing, it was concluded that there were positive changes in the cardiorespiratory fitness of exercising pregnant women leading to delivery.

Keywords: Aerobics; systolic blood pressure; diastolic blood pressure; resting heart rate; peak expiratory flow rate.

1. INTRODUCTION

“Aerobics is a form of physical exercise that combines rhythmic movements with stretching and strength training routines with the goal of improving all elements of fitness (flexibility, muscular strength, and cardio-vascular fitness)” [1,2]. “Regular physical activity is associated with improved physiological, metabolic and psychological parameters, and with reduced risk of morbidity and mortality from diseases such as cardiovascular disease, hypertension, diabetes mellitus” [3,4], “obesity, osteoporosis, sarcopenia, cognitive disorders and some forms of cancer. Regardless of the specific physiological changes” [5] “induced by pregnancy, which are primarily developed to meet increased metabolic demands of mother and fetus” [5-9], “pregnant women benefit from regular physical activity [10] the same way as non-pregnant subjects” [9].

“In need of advice and support from health professionals concerning exercise and healthy lifestyle, it is shown that among women mainly having a sedentary level of leisure-time physical activity before pregnancy, only one in four increased their activity during pregnancy” [11].

“Regular aerobic exercise is an important component for the maintenance of overall health. Exercise is especially important in pregnancy, as women of childbearing age are at increased risk of gestational diabetes mellitus (GDM), which has been strongly linked with obesity” [4,12].

Gestational hypertension [13] “is one of the leading causes of maternal morbidity and mortality” [14,15]. “Pregnancy induced hypertension is defined as Systolic Blood Pressure (SBP) 140mmHg and Diastolic Blood

Pressure (DBP) 90mmHg. Mild Pregnancy Induced Hypertension [16] (PIH) is defined as Systolic Blood Pressure (SBP) 140 – 149mmHg and Diastolic Blood Pressure (DBP) 90 – 99mmHg” [13].

“According to the American Heart Association (AHA), a normal blood pressure reading is 120/80 mm Hg and below. Readings below 90/60 mm Hg indicate low blood pressure, or hypotension. Readings above 140/90 mm Hg in pregnancy indicate high blood pressure, or hypertension” [16-18]. “Hypertension is seen far more often in pregnancy than hypotension. About 10 percent of all pregnancies in the United States are complicated by high blood pressure issues” [18]. “An abnormal blood pressure during pregnancy is a cause for concern. Both the pregnant woman and the baby may be at an increased risk of health complications of hypertension” [19-21]. “It may cause: flushed skin, swelling of the hands or feet, headaches, shortness of breath, abdominal pain, nausea, vomiting and changes in vision. Conversely, hypotension in pregnancy may cause: dizziness, difficulty concentrating, cold, clammy skin, blurred vision, rapid breathing, depression, sudden tiredness and extreme fatigue” [18].

“The American Heart Association (2020) estimates that 1 out of every 3 American adults has hypertension. In pregnancy, hypertension can be classified into two main categories: chronic hypertension and hypertension related to pregnancy” [14,22]. “Chronic hypertension refers to high blood pressure that was present before pregnancy. High blood pressure disorders related to pregnancy generally develop after the first 20 weeks of pregnancy” [3]. “There are several types of disorders that range in severity” [23-25]. “A 2016 review published in Integrated

Blood Pressure Control Trusted Source suggests that age, obesity, and underlying health problems seem to contribute to these conditions. Though these conditions usually go away after birth, the risk of getting hypertension in the future is much higher if the pregnant woman develops any of them" [14].

"The heart rate measures the number of times per minute that the heart contracts or beats. It is the number of times the heart beats in the space of a minute. A normal heart rate is between 60 and 100 beats per minute (bpm). Resting heart rate averages 60 to 80 beats/min in healthy adults" [12,26-29].

"Valéria and others showed that exercise induced a substantial increase in heart rate which indicate that immediately after exercise, the response was greatest for peak aerobic exercise (180 ± 6 beats/min), somewhat less for prolonged exercise (149 ± 7 beats/min), and even less for the resistance exercises (123 ± 11 beats/min)" [30]. "Heart rate increases to about 90% of their maximum values during strenuous exercise and cardiovascular function is the limiting factor for oxygen delivery to the tissues" [10]. "Heart rate increases proportionately with workload until heart rates close to maximal are attained" [28-30].

Some recent evidence indicated that the cardiac output vs VO_2 [26,31,32] relationship for pregnant women is within the range of average values reported for non-pregnant individuals [33,34]. "Exercise arterial-venous oxygen difference is lower during pregnancy, suggesting that the higher cardiac output is distributed to non-exercising vascular beds" [33,34]. "The data are limited but suggest that the perfusion of exercising muscle is unchanged during pregnancy and that the major haemodynamic change is an augmented cardiac output so that blood flow to the uterus and fetus is not compromised" [34]. "One study that measured blood flow during exercise in pregnant women reported 25% decrease in uterine blood flow during supine cycle exercise" [35].

"Peak expiratory flow rate (PEFR) is the maximum flow rate generated during a forceful exhalation, starting from full lung inflation. PEFR primarily reflects large airway flow and depends on the voluntary effort and muscular strength of the patient" [36,37,32].

Relatively less work has been done to study pulmonary function tests [15]. "Peak expiratory

flow rate especially pertaining to ventilation in pregnancy is a simple non-invasive portable method of assessment of lung function" [36,38].

Many physiological adaptations occur during pregnancy [39-43]. One such is changes in the respiratory functions and response to exercise [44-47]. Many studies have been conducted on changes in peak expiratory flow rate (PEFR) in pregnancy, but there are only few studies reporting the effect of exercise on PEFR in pregnant women [36].

"In recent years, there has been a great increase of knowledge derived from scientific studies regarding physical exercise during pregnancy" [10]. "This reflects the need to clarify the effects for mother and fetus, as some women of childbearing age report exercising and may continue their exercise practice during pregnancy, whereas other sedentary women may start this practice only during pregnancy" [36].

"The acute and chronic (training) responses to aerobic exercise during pregnancy have not been thoroughly investigated. Specifically, the effect of gestational age, maternal activity status, and type, duration and intensity of exercise on maternal cardiovascular response have only recently begun to be explored" [33]. "During pregnancy cardiac output during submaximal exertion increases above values in non-pregnant women, except perhaps late in gestation. Both heart rate and stroke volume contribute to the elevated cardiac output. Changes in submaximal exercise VO_2 during pregnancy are dependent on the mode of exercise" [46,47]. "At the same workload, VO_2 increases during weight-bearing exercise, but usually does not differ from postpartum values during weight-supported exercise" [32].

"Only a few studies have identified the frequency, duration, and type of recreational physical activities performed during pregnancy. In a cross-sectional study from the 1988 National Maternal and Infant Health Survey, 42% of women reported exercising during pregnancy and half of these women exercised for more than six months" [48]. "Walking (43%), swimming (12%), and aerobics (12%) were the most frequent activities. In a Washington case-control study of 386 women from 1998 to 2000, 61% of pregnant women participated in some regular physical activity" [4].

However, a substantial proportion of women stop exercising after they discover they are pregnant,

and only few begin participating in exercise activities during pregnancy. It is thus in this light that the researchers sought to examine the changes in the cardiorespiratory fitness of exercised pregnant women leading to delivery in a tertiary health facility in South-South, Nigeria.

2. MATERIALS AND METHODS

2.1 Materials: Participants

The population for this study consisted of pregnant women who attended antenatal clinic at the Obstetrics and Gynaecology (O & G) Department of the Rivers State University Teaching Hospital, Port Harcourt, South-South, Nigeria. The research design adopted for this work was the randomized pre test-post test control group design. The population for this study consisted of Three Hundred and Eighteen (318) pregnant women (age range 19 – 43years) who were registered at the O&G departments of the hospital (parity 1 – 4) in the months of December 2020 and January, 2021. Seventy-Eight (78) pregnant women willingly volunteered for study following a health promotion talk / sensitization at the Obstetrics and Gynaecology Department but Sixty-Four (64) completed the study. They were randomly assigned to experimental (n=38) and control (n=26) groups using the simple randomization method of tossing a coin.

The sample size for the study was determined using sample size determination for randomized controlled test [49].

$$n = 16 \left[\frac{1}{\text{Effect Size}} \right]^2$$

n = Sample Size

Effect Size = 0.53

$$n = 16 \left[\frac{1}{0.53} \right]^2$$

= 56.96
= 57 (approx.)

2.2 Instruments

1. The TLC Electronic Blood Pressure Monitor (BL-B918, AMeric Amer Kabbani General Trading Sp.z.o.o POLAND) was

used to measure the blood pressure and Heart rate of the study participants.

2. Peak flow rate meter Cat. No. 43602 NHS EN ISO 23747, Model 4300 (Vitalograph, Ennis, Ireland) was used to measure the peak flow of the participants.

2.3 Methods: Inclusion and Exclusion Criteria

The inclusion criteria for this study was that the age of pregnancy not more than Twenty-Six (26) weeks at the commencement of the study. This was to enable the participants conclude the study while still pregnant and that there was no history of cardiovascular diseases among the participants which could endanger them and their fetus(es).

The exclusion criteria for this study were pregnant women with other medical conditions such as cervical incompetence, placenta previa, multiple pregnancies and all pregnant women on bed rest.

2.4 Research Design

The design adopted for this research is randomized pre test-post test control group design.

We did not anticipate any risks as there are no known risks of moderate Aerobic Exercise Training from literature. However, the volunteers were educated on the procedures of the study and willingly decided to sign the consent form. They were also told that should they have any unfavourable experiences, they were free to discontinue from the training. Moreso, each participant was under the watchful eyes of her consultant obstetricians. Also, there were no cost burdens on the participants throughout the training period.

2.5 Procedure for Data Collection

The participants were volunteers who were randomly assigned into two groups – the experimental (n=38) and control (n=26) groups.

All participants went through the rigors for obtaining the baseline data of Name, age, pregnancy age, how many pregnancies previously and occupation. Also the variables – percentage body fat, mid upper arm circumference and hand grip strength were measured using their various instruments and their results recorded.

The TLC Electronic Blood Pressure Monitor was used to assess the systolic and Diastolic Blood Pressure of all participants as well as their heart rate with measurement taken from the left arm, keeping the cuff at heart level in an upright sitting position.

Each pregnant woman was given the Peak Flow Rate Meter, they were asked to take a deep breath in. Following this, they were instructed to blow into the mouthpiece as quickly and as hard as possible. This was done three (3) times and the highest of the three (3) scores recorded in L/min.

2.6 The Training Protocol

Then the exercise protocol was carried out thrice weekly in the physiotherapy gymnasium of the physiotherapy department of the Rivers State University Teaching Hospital, Port Harcourt. The exercise lasted for about 40 – 45 minutes each session. At the end of the ten (10) weeks, a post-test data was obtained from both the experimental and control groups.

The training protocol used for this study was researcher-designed but followed the recommendations of the American College of Sports Medicine (ACSM), 2014. The class of pregnant women were instructed to perform the following:

2.7 Warm Up

- i. Move around the gym
- ii. On a spot, Swing arms forwards & backwards x 5
- iii. Side and Upward Swings x 5
- iv. Put hands on waist and rotate slowly x5
- v. Hold unto the parallel bars, Swing right legs forward and backwards x 5
- vi. Then Swing the Left also x5

Exercise i: Hopping on the spot slowly for 2 minutes

Exercise ii: Alternate leg raises in standing (at least 6" above the floor) x 5 each leg

Exercise iii: Reach out to something far above your height (can use chalk as marker) tip-toe x 5

Exercise iv: With clenched fist and outstretched arms, swing arms beyond your frontal midline x5 each hand.

Exercise v: In sitting on an armless chair with a (1.5 kg wt), swing arms from the back mode to above your heads and return x 10.

Exercise vi – in Sitting

Head/ Neck Movements

- i. Forward looking, bring your chin to touch your chest and return x 5
- ii. Forward looking, look up to see a bit beyond the centre of your head and return x 5
- iii. Forward looking, turn your head/neck to the right as far as you can go and return x 5
- iv. Forward looking, turn your head/Neck to the left as far as you can go and return x 5

Exercise vii – in Lying

Supine (Face up)

- i. With both legs together, separate them as far possible as you can go and return x 5.
- ii. Alternate Straight leg raises to about 45⁰ above the floor 5 x each (in the last 5wks, increase to 10 x each leg)
- iii. Bicycling in the air (better done with the rhythm of a metronome) for 2 – 3 minutes.

Exercise viii – Side Lying

- i. Right side lying: raise the left leg from the hip x5
- ii. Left side lying: raise the right leg from the hip x5

(In the last 5wks, increase to 10 x each leg)

Exercise ix – Kegels

Still lying on your left side, try and hold back as if trying to prevent urine/faeces from coming out, hold it to the count of 10; rest for 1 minute, and hold again to the count of 15.

2.8 Cool Down

- i. Gentle Spot hopping, while raising and dropping both upper limbs.
- ii. Deep breathing exercises

3. RESULTS AND DISCUSSION

3.1 Data Analysis

All statistical analyses were done using Statistical Package for Social Science (SPSS) for windows version twenty-One (21). Data were analyzed using descriptive statistics such as Mean (\bar{x}) and Standard Deviation (SD). The efficacy was tested using inferential statistics of Analysis of Covariance at 0.05 alpha level.

3.2 Results

The results of the study in Table 1 revealed that the participants in the experimental group had a pre-test mean score of 117.44 ± 11.72 with a mean difference of 0.29. Following the exercise training, the experimental group mean score was 125.47 ± 7.05 with a mean difference of -4.76 when compared with the control group. This shows the extent of impact the aerobics training had on the Systolic Blood Pressure of the pregnant women in Rivers State University Teaching Hospital, Rivers State, South-South, Nigeria. It is therefore concluded that since mean difference is lower and in the negative direction, it can be safely adduced that the aerobic exercise reduced the systolic blood pressure of the pregnant women.

In Table 2, a One-way between groups Analysis of CoVariance (ANCOVA) was conducted to compare the effect of Aerobic Exercise Training on Systolic Blood Pressure among pregnant women in Rivers State University Teaching Hospital, Rivers State, South-South, Nigeria. The dependent variable consisted of scores of Systolic Blood Pressure after the intervention. The participants' systolic score on the pre-intervention was used as the covariate. Preliminary checks were conducted to ensure that there was no violation of the assumptions of

normality, linearity, homogeneity of variance, homogeneity of regression slope and reliable measurement of covariance. After adjusting for pre-intervention Systolic Blood Pressure reading, aerobic exercise had a significant effect on Systolic Blood Pressure ($F(1,61) = 7.76, p = 0.007$). This leads to the conclusion that the aerobic exercise has a significant impact on the systolic blood pressure of the pregnant women.

The results of the study in Table 3 showed that the pre-test experimental values had a mean score of 65.47 ± 8.12 and a mean difference of 0.44 when compared with the control. Following the ten (10) weeks Aerobic Exercise Training, the experimental mean value was 65.47 ± 5.50 and the control group was 78.19 ± 10.72 with a mean difference of -6.74. the values of the mean difference between the pre-test and post-test is remarkable, which means that the exercise training impacted the Diastolic Blood Pressure of pregnant women in Rivers State University Teaching Hospital, Rivers State, South-South, Nigeria. Furthermore, the calculated partial eta score was 0.197, indicated a small effect. It is therefore concluded that since mean difference is lower and in the negative direction, it can be safely posited that the aerobic exercise reduced the diastolic blood pressure of the pregnant women.

Table 1. Mean and Standard Deviation on the effect of Aerobic Exercise Training on Systolic Blood Pressure among Pregnant Women

Systolic Blood Pressure	GROUP	N	MEAN	SD	Mean difference
Pre intervention	Experimental	38	117.44	11.72	0.29
Pre intervention	Control	26	117.154	6.67	
Post intervention	Experimental	38	125.47	7.05	-4.76
Post intervention	Control	26	130.23	8.92	

Table 2. One-way Analysis of CoVariance (ANCOVA) on the effect of Aerobic Exercise Training on Systolic Blood Pressure among Pregnant Women

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1298.96 ^a	2	649.48	13.76	.000
Intercept	2998.45	1	2998.45	63.54	.000
Pre-SBP	949.61	1	949.61	20.12	.000
Group	366.36	1	366.36	7.76	.007
Error	2878.48	61	47.19		
Total	1043048.00	64			
Corrected Total	4177.438	63			

P<0.05

Table 3. Mean and Standard Deviation on the effect of Aerobic Exercise Training on Diastolic Blood Pressure among Pregnant Women

Diastolic Blood Pressure	Group	N	Mean	SD	Mean difference
Pre intervention	Experimental	38	65.4737	8.12316	.44
Pre intervention	Control	26	65.04	6.88	
Post intervention	Experimental	38	65.4737	5.50	-6.74
Post intervention	Control	26	78.19	10.72	

In Table 4, a One-way between groups Analysis of CoVariance (ANCOVA) was conducted to compare the effect of Aerobic Exercise Training on Diastolic Blood Pressure among pregnant women in Rivers State University Teaching Hospital, Rivers State, South-South, Nigeria. The dependent variable consisted of readings of Diastolic Blood Pressure after the intervention. The participants' Diastolic Blood Pressure reading on the pre-intervention was used as the covariate. Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variance, homogeneity of regression slope and reliable measurement of covariance. After adjusting for pre-intervention Diastolic Blood Pressure reading, aerobic exercise had a significant effect on Diastolic Blood Pressure ($F(1,61) = 14.95, p=0.000$). It is therefore concluded that the aerobic exercise has a significant effect on the diastolic blood pressure of the pregnant women.

The results of the study in Table 5 indicated that the experimental group had a mean score of 89.08 ± 10.04 , with a mean difference of -1.81 when compared with the control group at pre-test. Following the exercise training intervention, the experimental group mean score was 89.87 ± 6.51 and a mean difference of -1.59 when compared with the control group with a mean score of 91.46 ± 6.56 . The post-test intervention mean difference is less than the pre-test difference, hence the intervention did not have an effect on the heart rate of the pregnant women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

In Table 6, a One-way between groups Analysis of CoVariance (ANCOVA) was conducted to compare the effect of Aerobic Exercise Training on heart rate among pregnant women in Rivers State University Teaching Hospital, Rivers State, Nigeria. The dependent variable consisted of readings of heart rate after the intervention. The participants' heart rate reading on the pre-

intervention was used as the covariate. Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variance, homogeneity of regression slope and reliable measurement of covariance. After adjusting for pre-intervention heart rate reading, it was concluded that aerobic exercise had a non-significant effect on heart rate ($F(1,61) = .26, p=0.615$) of the participants.

The results of the study in Table 7 revealed that at pre-test, the mean value for the experimental group was 261.58 ± 80.39 with a mean difference of 57.73 when compared with the control group with a mean of 203.85 ± 21.92 . At post-test, the experimental group mean score was 329.74 ± 66.07 and a mean difference of 125.12 when compared with the control group with a mean score of 204.62 ± 22.84 . The post intervention mean score was higher here, so we concluded that the exercise training had effect on the peak flow rate of the pregnant women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

In Table 8, a One-way between groups Analysis of CoVariance (ANCOVA) was conducted to compare the effect of Aerobic Exercise Training on Flow Rate among pregnant women in Rivers State University Teaching Hospital, Rivers State, South-South, Nigeria. The dependent variable consisted of readings of flow rate after the intervention. The participants' flow rate on the pre-intervention was used as the covariate. Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variance, homogeneity of regression slope and reliable measurement of covariance. After adjusting for pre-intervention flow rate scores, aerobic exercise had a significant effect on flow rate ($F(1,61) = 68.54, p=0.000$). We concluded therefore that the aerobic exercise had a significant impact on the peak expiratory flow rate of the pregnant women.

Table 4. One-way Analysis of CoVariance (ANCOVA) on the effect of Aerobic Exercise Training on Diastolic Blood Pressure among pregnant Women

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1639.72 ^a	2	819.86	16.376	.000
Intercept	1456.66	1	1456.66	29.095	.000
Pre-DBP	937.40	1	937.40	18.723	.000
Group	748.55	1	748.55	14.951	.000
Error	3054.03	61	50.07		
Total	356936.00	64			
Corrected Total	4693.75	63			

P<0.05, Significant

Table 5. Mean and Standard Deviation on the effect of Aerobic Exercise Training on Resting Heart Rate among Pregnant Women in Rivers State University Teaching Hospital, Rivers State, Nigeria

Heart Rate	Group	N	MEAN	SD	Mean difference
Pre intervention	Experimental	38	89.0789	10.04	-1.81
Pre intervention	Control	26	90.89	6.39	
Post intervention	Experimental	38	89.8684	6.51	-1.59
Post intervention	Control	26	91.46	6.56	

Table 6. One-way Analysis of CoVariance (ANCOVA) on the effect of Aerobic Exercise Training on Resting Heart Rate among Pregnant Women

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1852.18 ^a	2	926.09	67.91	.000
Intercept	713.89	1	713.89	52.35	.000
Pre-Heart Rate	1813.00	1	1813.00	132.96	.000
Group	3.48	1	3.48	.26	.615*
Error	831.81	61	13.64		
Total	527041.00	64			
Corrected Total	2683.98	63			

p>0.05 *Not Significant

Table 7. Mean and Standard Deviation on the effect of Aerobic Exercise Training on Peak Expiratory Flow Rate among Pregnant Women

Flow Rate	Group	N	MEAN	SD	Mean difference
Pre intervention	Experimental	38	261.58	80.39	57.73
Pre intervention	Control	26	203.85	21.92	
Post intervention	Experimental	38	329.74	66.07	125.12
Post intervention	Control	26	204.62	22.84	

Table 8. ANCOVA on the effect of Aerobic Exercise Training on Peak Expiratory Flow Rate among Pregnant Women in Rivers State University Teaching Hospital, Rivers State, Nigeria

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	316152.98 ^a	2	158076.49	96.36	.000
Intercept	85078.14	1	85078.14	51.86	.000
Pre-Flow Rate	74473.07	1	74473.07	45.40	.000
Group	112443.58	1	112443.58	68.54	.000*
Error	100070.45	61	1640.50		
Total	5394700.00	64			
Corrected Total	416223.44	63			

P<0.05, * Significant

3.3 Discussion

Hypertensive disorders of pregnancy are an important cause of severe morbidity, long-term disability and death among mothers and their babies [50]. The aerobic training exercise acted as a moderator of the blood pressure of the participants in the experimental group. The findings of this study are in consonance with the findings of Srilatha & Siyathat [13] who investigated the effects of aerobic exercise on blood pressure during pregnancy. Khoram et al. in their randomized clinical trial of seventy-two women susceptible to gestational hypertension found out that the incidence of complication in their experimental group was significantly lower than the control group ($P < 0.05$). Moreover, Diastolic Blood Pressure in the experimental group were significantly lower than the control group ($P < 0.05$) [35]. This study falls in line with this present one and relate closely with the results of the blood pressure changes. The findings of this study was also consistent with [41] who evaluated the effect of exercise during pregnancy on the risk of gestational hypertensive disorders. Furthermore, the findings of this study conformed to the finding of [42] who investigated the effect of regular exercise on blood pressure in normotensive pregnant women following 12 weeks of aerobic exercise. They concluded that aerobic exercise reduced resting Systolic Blood Pressure in healthy inactive pregnant women. The findings of this study are not in tandem with that of [40] who prospectively sought to determine whether moderate exercise during pregnancy lowers blood pressure in a randomized controlled trial, with all subjects having a history of mild hypertensive disorders and a family history of hypertensive disorders. These subjects visited the laboratory three times a week for ten weeks to perform 30minutes of exercise at rating of perceived exertion level B. Here, Systolic Blood Pressure (SBP) did not change significantly. It can be concluded that aerobic exercise is a veritable tool in controlling and managing Systolic Blood Pressure among women.

The Aerobic Exercise Training program had an effect on the Diastolic Blood Pressure of the pregnant women. The negativity in the mean difference of the post-intervention score means that the Diastolic Blood Pressure was also lowered which is in line with [43] who posited that weight loss was an important factor in mitigating the left ventricular hypertrophy. This is to say that, regular physical activities make the heart

stronger and so can pump more with less effort making the heart work less to pump blood thereby reducing the force in the arteries resulting to a lowered or normalized Diastolic Blood Pressure. The findings of this study is also in line with [40] who observed that the Diastolic Blood Pressure of his exercise group decreased by 3.5mmHg while that of the control group increased by 1.1mmHg. Thus the pre-post changes in Diastolic Blood Pressure differed by 4.6mmHg between groups. This study detected a strong trend that ten weeks of moderate exercise lowered the Diastolic Blood Pressure among pregnant women at risk of hypertension disorders. The reductions were probably due to the effect of exercise training as also seen by [44] who studied the effects of endurance training on blood pressure, blood pressure-regulating mechanism and cardiovascular risk factors. These researchers found a reduction in resting blood pressure which was more pronounced in the hypertensive study group, and concluded that aerobic endurance training decreases blood pressure through a reduction of vascular resistance thereby conforming to the results of this study.

The findings revealed that there was no significant effect of the aerobic exercise on the heart rate of pregnant women. This could be explained by the fact that the exercise was really not a strenuous one in the cardiovascular system of the pregnant women. They were simply not exerted and so maintained a fairly same resting heart rate in the 10 weeks all through the intervention. This is not in consonant with [32] whose work on maximal aerobic exercise in pregnant women: heart rate, O_2 consumption, CO_2 production and ventilation revealed that maximal heart rate was slightly lower throughout pregnancy. Also, the study is not in agreement with [51,52] who showed a lower resting heart rate following aerobic exercise.

The enormous difference between the pre and post mean differences is undoubted the result of the effectiveness of the exercise training in boosting the lung capacity of the exercised pregnant women. Despite the increasing volume of their abdominals with advancing gestation, they were still able to turn out a peak flow rate that is statistically significant when compared with the control. Many studies have been conducted on changes in peak expiratory flow rate (PEFR) in pregnancy, but there are only few studies reporting the effect of exercise on PEFR in pregnant women [36].

4. CONCLUSION

Aerobic exercise has a significant impact on the systolic and diastolic blood pressure as well as the peak expiratory flowrate of the pregnant women. Conversely, there was no significant change on the heart of the exercised pregnant women.

Succinctly, it was noted that aerobic exercise regimen resulted in a significant improvement in the cardiorespiratory fitness of the pregnant women.

CONSENT AND ETHICAL APPROVAL

Ethical approval was granted by the Research Ethics Committee of the Rivers State University Teaching Hospital, Port Harcourt, Rivers State, Nigeria (RSUTH / REC / 2021048). Informed consent was also obtained from the participants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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