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

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. 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, three times weekly aerobic exercise (40 – 45minutes) 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) and a partial eta squared value of 0.113. The Diastolic Blood Pressure of the pregnant women (post intervention experimental score 65.47±5.0 and control 78.19±10.72 with partial eta squared value of 0.197. Heart rate of the pregnant women decreased in the experimental group though insignificantly (experimental 89.87±6.51 and control 91.46±6.56) with partial eta squared value of 0.004. 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 with a partial eta squared score of 0.529. From the foregoing, it was concluded that there were positive changes in the cardiorespiratory fitness of exercising pregnant women leading to delivery in Rivers State.

Comment [HP1]: Researchers should describe the type and research design used in this study

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

Introduction

Comment [HP2]: In this chapter, researchers should describe what the research problem is, then reveal the prevalence of pregnant women who do not exercise and who do exercise. Then state what efforts have been made to solve the research problem and what efforts the researcher offers to solve the problem. Finally, explain what the urgency of the research is so that research needs to be done.

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). It is usually performed with music and may be practiced in a group setting led by an instructor (fitness professional), although it can be done solo and without musical accompaniment[1]. 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, obesity, osteoporosis, sarcopenia, cognitive disorders and some forms of cancer. Regardless of the specific physiological changes induced by pregnancy, which are primarily developed to meet increased metabolic demands of mother and fetus, pregnant women benefit from regular physical activity the same way as non-pregnant subjects[2].

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[3].

As more women tend to gain an excessive amount of weight during pregnancy, they also tend to retain the weight after delivery. Gaining an excessive amount of weight during pregnancy can result in obesity-associated co-morbidities, which are a major health concern. Obese women have an increased risk of fetal, neonatal and maternal morbidity; therefore, prevention of excessive weight gain during pregnancy is important for the welfare of both mother and child. Regular physical activity performed before and during pregnancy has been shown to reduce the incidence of GDM, for example, by at least 30%, depending on the amount of weekly physical activity energy expenditure and intensity of exercise [3].

Gestational hypertension is one of the leading causes of maternal morbidity and mortality. Pregnancy induced hypertension is defined as Systolic Blood Pressure (SBP) 140mmHg and Diastolic Blood Pressure (DBP) 90mmHg. Mild Pregnancy Induced Hypertension (PIH) is defined as Systolic Blood Pressure (SBP) 140 – 149mmHg and Diastolic Blood Pressure (DBP) 90 – 99mmHg [4].

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. 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 [5].

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. High blood pressure, or hypertension, in pregnancy is usually defined as 140/90 mm Hg or higher. It may cause: flushed skin, swelling of the hands or feet, headaches, shortness of breath, abdominal pain, nausea, vomiting and changes in vision. Also Low blood pressure, or hypotension, is usually defined as 90/60 mm Hg or less. It may cause: dizziness, difficulty concentrating, cold, clammy skin, blurred vision, rapid breathing, depression, sudden tiredness and extreme fatigue [5].

The symptoms of hypertension and hypotension aren't always present. The best way to know if someone has abnormal blood pressure is to take a blood pressure test. Blood pressure tests are often done at regular checkup appointments, and a doctor should perform them throughout the pregnancy. The American Heart Association 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. 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. There are several types of disorders that range in severity. 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 [6].

Hypotension, while much less common, can be directly related to pregnancy. The circulatory system expands during pregnancy to accommodate the fetus. As circulation expands, the pregnant woman might experience a small drop in blood pressure. According to the America Heart Association (2020), this is most common during the first 24 weeks of pregnancy. Still, this

amount is usually not significant enough to cause concern. Hypotension may also be caused by: dehydration, diabetes, low blood sugar, heart problems, thyroid problems, severe allergic reactions, blood loss, infection and malnutrition, particularly a lack of folic acid, B vitamins, and vitamin D [5].

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. The heart rate is one of the 'vital signs,' or the important indicators of health in the human body. The speed of the heartbeat varies as a result of physical activity, threats to safety, and emotional responses. The resting heart rate refers to the heart rate when a person is relaxed. While a normal heart rate does not guarantee that a person is free of health problems, it is a useful benchmark for identifying a range of health issues. 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[7].

The heart rate is perhaps the simplest determinant of cardiac output to visualize: the faster the heart beats, the more blood can be pumped over a particular period of time [8].The American Heart Association (AHA) (2020) recommends that exercise increases a person's heart rate to between 50 to 85 percent of the person’s maximum heart rate. Valéria and others study 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) [9].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[9].

Regular exercise during pregnancy is important for health and well-being. It can improve posture, prevent backaches, decrease fatigue, relieve stress, and build stamina needed for labor and delivery. It may also help prevent a type of diabetes that develops during pregnancy (gestational diabetes). Most aerobic, resistance, and flexibility exercises are safe during pregnancy, but because each woman and each pregnancy is different it's important to consult your doctor before starting any exercise program while pregnant [11].

Alterations in maternal physiology during pregnancy affect the physiological respect to aerobic exercise. Maternal resting oxygen consumption (VO2) and cardiac output increase during pregnancy. Heart rate (HR) becomes progressively elevated through gestation, whereas stroke volume (SV) increases until the third trimester and then declines until term, probably because of diminished venous return. Plasma volume increases earlier and to a greater magnitude than red cell volume, resulting in the 'haemodilutionalanaemia' of pregnancy and a decline in the oxygen-carrying capacity. Ventilation is greater during pregnancy because of elevated tidal volume and unchanged rate of breathing[12].

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. 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 VO2 during pregnancy are dependent on the mode of exercise. At the same workload, VO2 increases during weight-bearing exercise, but usually does not differ from postpartum values during weight-supported exercise[12].

Some recent evidence indicates that the cardiac output vs VO2 relationship for pregnant women is within the range of average values reported for non-pregnant individuals. Exercise arterial-venous oxygen difference is lower during pregnancy, suggesting that the higher cardiac output is distributed to non-exercising vascular beds. 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. Only one study has measured blood flow during exercise in pregnant women. The reported 25% decrease in uterine blood flow during supine cycle exercise in women late in gestation must be interpreted cautiously because the uterus may obstruct the vena cava in the supine position [12].

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[13].

The peak expiratory flow rate (PEFR) test measures how fast a person can exhale. The PEFR test is also called peak flow. This test is commonly performed at home with a handheld device called a peak flow monitor. For the PEFR test to be useful, you must keep continuous records of your flow rate. Otherwise you may not notice patterns that occur when your flow rate is low or decreasing. These patterns can help you prevent your symptoms from worsening before a full-blown asthma attack. The PEFR test can help you discover when you need to adjust your medication. Or it can help determine whether environmental factors or pollutants are affecting your breathing [14].

Relatively less work has been done to study pulmonary function tests. Peak expiratory flow rate especially pertaining to ventilation in pregnancy is a simple non-invasive portable method of assessment of lung function. Peak Expiratory Flow Rate (PEFR) is defined as the largest expiratory flow achieved during a maximally forced effort from a position of maximal inspiration, expressed in litres per minutes[15].

Many physiological adaptations occur during pregnancy. One such is changes in the respiratory functions and response to exercise. 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[14].

During inhalation, air travels through the nose and/or mouth into the trachea (windpipe). The trachea further divides into two tubes (bronchi) that open into the lungs. Within the lungs, the bronchi branch out into smaller tubes called bronchioles. The end of bronchioles open into little air sacs called alveoli that aid in gaseous exchange. The alveoli are surrounded by blood vessels, through which the exchange of gases, oxygen and carbon dioxide take place [13].

Indications for peak expiratory flow rate (PEFR) measurement are as follows: Monitoring of asthma, Monitoring effects of air pollutants of the respiratory system and Monitoring of chronic obstructive pulmonary disease (COPD). In recent years, there has been a great increase of knowledge derived from scientific studies regarding physical exercise during pregnancy. 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[15].

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 researcher sought to examine the changes in the cardiorespiratory fitness of exercised pregnant women in Rivers State University Teaching Hospital.

Materials and Methods

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. The research design adopted for this work was the pretest-post test experimental design.The population for this study consisted ofThree 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.

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

n = Sample Size

Effect Size = 0.53

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

$= 56.96$

$= 57$

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.

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.

Research Design

The design adopted for this research is randomized pre test-post test control group design. The differences in the pre-test and post-test values represented the impact of the ten (10) weeks aerobics training on the experimental group.

Comment [HP3]: State the type of research used and the statistical tests used to analyze the research data

Procedure for Data Collection

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. 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.

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:

Warm Up

i. Move around the gym
ii. Osn 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 45^0 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.

Exercise x – Cool Down

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

Results and Discussion

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 (x) and Standard Deviation (SD). The efficacy was tested using inferential statistics of Analysis of Covariance at 0.05 alpha level. Cohen criterion for interpretation of the partial eta value was used to interpret the effect size of the exercise on the pregnant women with 0.20 – 0.49 as small effect, 0.50 – 0.79 as medium effect and ≥0.80 as large effect [16].

Result

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, Nigeria.

Table 1: Mean and Standard Deviation on the effect of Aerobic Exercise Training on Systolic Blood Pressure among Pregnant Women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

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	

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, 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, partial eta square =.113).

Comment [HP4]: Explain what the conclusions are from the results of the analysis, researchers should not be stuck with the numbers in the table.

Table 2: One-way Analysis of CoVariance (ANCOVA) on the effect of Aerobic Exercise Training on Systolic Blood Pressure among Pregnant Women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected Model	1298.96[a]	2	649.48	13.76	.000	.311	
Intercept	2998.45	1	2998.45	63.54	.000	.510	Reject Ho
Pre-SBP	949.61	1	949.61	20.12	.000	.248	
Group	366.36	1	366.36	7.76	.007	.113	
Error	2878.48	61	47.19				
Total	1043048.00	64					
Corrected Total	4177.438	63					

a. R Squared = .311 (Adjusted R Squared = .288)

P<0.05

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, Nigeria. Furthermore, the calculated partial eta score was 0.197, indicated a small effect.

Table 3: Mean and Standard Deviation on the effect of Aerobic Exercise Training on Diastolic Blood Pressure among Pregnant Women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

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, 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 ($F(1,61)=14.95, p=0.000$, partial eta square=.197).

Table 4: One-way Analysis of CoVariance (ANCOVA) on the effect of Aerobic Exercise Training on Diastolic Blood Pressure among pregnant Women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected Model	1639.72[a]	2	819.86	16.376	.000	.349	
Intercept	1456.66	1	1456.66	29.095	.000	.323	Reject Ho
Pre-DBP	937.40	1	937.40	18.723	.000	.235	
Group	748.55	1	748.55	14.951	.000	.197	
Error	3054.03	61	50.07				
Total	356936.00	64					
Corrected Total	**4693.75**	**63**					

a. R Squared = .349 (Adjusted R Squared = .328)
P<0.05, Significant

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 the heart rate of the pregnant women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

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	

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, aerobic exercise had a non-significant effect on heart rate ($F(1,61)=.26, p=0.615$, partial eta square=.004).

Table 6: One-way Analysis of CoVariance (ANCOVA) on the effect of Aerobic Exercise Training on Resting Heart Rate among Pregnant Women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected Model	1852.18[a]	2	926.09	67.91	.000	.690	Ho
Intercept	713.89	1	713.89	52.35	.000	.462	Not
Pre-Heart Rate	1813.00	1	1813.00.	132.96	.000	.685	rejected
Group	3.48	1	3.48	.26	.615*	.004	
Error	831.81	61	13.64				
Total	527041.00	64					
Corrected Total	**2683.98**	**63**					

a. R Squared = .690 (Adjusted R Squared = .680)

p>0.05 *Not Significant

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 the exercise training had effect on the peak flow rate of the pregnant women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

Table 7: Mean and Standard Deviation on the effect of Aerobic Exercise Training on Peak Expiratory Flow Rate among Pregnant Women in Rivers State University Teaching Hospital, Rivers State, Nigeria.

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	

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, 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 sores, aerobic exercise had a significant effect on flow rate (F(1,61)=68.54,p=0.00, partial eta square=.529).

Comment [HP5]: Explain what the conclusions are from the results of the analysis, researchers should not be stuck with the numbers in the table.

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.	Partial Eta Squared	Decision
Corrected Model	316152.98[a]	2	158076.49	96.36	.000	.760	
Intercept	85078.14	1	85078.14	51.86	.000	.460	Ho
Pre-Flow Rate	74473.07	1	74473.07	45.40	.000	.427	Rejected
Group	112443.58	1	112443.58	68.54	.000*	.529	
Error	100070.45	61	1640.50				
Total	5394700.00	64					
Corrected Total	416223.44	63					

a. R Squared = .760 (Adjusted R Squared = .752)

P<0.05, * Significant

Discussion

Effect of Aerobic Exercise Training on Systolic Blood Pressure of Pregnant Women

The result of this study in Table 1 and 2 revealed a moderate effect (-4.76) of Aerobic Exercise Training on the Systolic Blood Pressure which was statistically significant at 0.05 alpha level. This clearly means that the aerobics exercise training had a considerable effect on the Systolic Blood Pressure of the pregnant women. This effect could be attributed to the ten weeks of aerobics training given to the experimental group which is different from the regular physical activity which is not geared towards achieving any bodily fitness goals. 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 [4] who investigated the effects of aerobic exercise on blood pressure during pregnancy: A case study. A 28 year primi pregnant women with complains of loss of established blood pressure control, headaches, blurred vision, night upper quadrant or epigastric pain was diagnosed to have a gestational hypertension of Systolic Blood Pressure 140mmHg and Diastolic Blood Pressure 90mmHg; with gestational age of 22 weeks. Following aerobic exercise of 30-60 minutes, two to seven (2-7) times per week during pregnancy as compared with being sedentary is associated with a significant reduced risk of gestational hypertensive disorder, gestational hypertension and caesarean delivery they concluded.Khoramand others [17] in their randomized clinical trial of seventy-two women susceptible to gestational hypertension found out following 20 – 30 minutes of walking four times a week that the incidence of complication in the 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 ($P<0.05$). The findings of this study are not in tandem with that of [18] 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. The findings of this study was also consistent with [19] who evaluated the effect of exercise during pregnancy on the risk of gestational hypertensive disorders. Electronic data bases were searched for randomized controlled trails of uncomplicated pregnant women assigned before 23 weeks to an aerobic exercise regimen or not. Women who were randomized in early pregnancy to aerobic exercise for 30 – 60 minutes, two – seven times per week had a significant lower incidence of gestational hypertensive disorders, overall gestational hypertension and caesarean delivery.Furthermore, the findings of this study conformed to the finding of [20] 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. It can be concluded that aerobic exercise is a veritable tool in controlling and managing Systolic Blood Pressure among women.

Effect of Aerobic Exercise Training on Diastolic Blood Pressure of Pregnant Women

The result of this study in Table 3 and 4 on the effect of aerobics on Diastolic Blood Pressure of pregnant women showed a moderate effect (-6.74) and statistically significant at 0.05 alpha level. This indicated that 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

Comment [HP6]: In the discussion chapter, researchers should not describe quantitative data from statistical analysis results. State what is the conclusion of the analysis, explain what the researcher's ideas are related to the conclusions of the findings accompanied by citations to support the researcher's ideas.

post-intervention score means that the Diastolic Blood Pressure was also lowered.[21] 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 in line with [18] 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. Exercise treatment reduced the Diastolic Blood Pressure to a near-significant level in his exercise group ($t = 2.34$, $df = 7$, $P = 0.052$). 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.[22] 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.

Effect of Aerobic Exercise Training on Heart Rate of Pregnant Women

The findings of this study in Table 5 on the effect of Aerobic Exercise Training in resting heart rate of pregnant women indicated a small effect. The table showed an increased post-intervention mean score of 89.87 ± 6.51 with a mean difference of -1.59 as against a pre-intervention mean score of 89.09 ± 10.04 and a mean difference of -1.81. That the post-intervention mean difference is smaller, showing that the exercise did not impact the resting heart rate of the pregnant women. Table 6 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 intervention.

Effect of Aerobic Exercise Training on the Peak Expiratory Flow Rate of Pregnant Women

The result of the study in table 7 and 8 revealed a moderate effect of 0.529 Aerobic Exercise Training on the Peak expiratory flow rate of pregnant women which was statistically significant at 0.05 alpha level. 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 studied reporting the effect of exercise on PEFR in pregnant women. Anitha and others [15] in their study of the effect of exercise on Peak Expiratory Flow Rate in pregnant women found that Peak Expiratory Flow Rate at rest was lower than that in non-pregnant women and the difference was statistically significant. After exercise, the PEFR decreased in both pregnant and non-pregnant women. The percentage decrease did not change significantly between the two groups, they concluded that although resting Peak Expiratory Flow Rate in pregnant women is less, there is not much difference in the response to exercise between the two groups.The findings of this

study are consistent with that of Bassiand others [23] on the effect of aerobic exercise on PEFR and physical fitness index in female subjects. They were assessed for height, weight, body mass index (BMI), body surface area (BSA), peak expiratory flow rate (PEFR), and physical fitness index (PFI) by Harvard step test at three different intervals: zero (0) week, six (6) weeks and ten (10) weeks. The mean values of all the parameters were compared and evaluated. There were significant changes (P<0-001) in all the parameters while comparing the baseline values at the three time intervals; an increase in peak expiratory flow rate, fall in Body Mass Index and rise in physical fitness index was seen. They concluded that any form of aerobic exercise proves to be beneficial if followed consistently. Both the groups experienced an improvement in peak expiratory flow rate, body mass index and physical fitness index (PFI).

Conclusion

Comment [HP7]: The conclusion of the researcher should describe what the findings in this study are

Participating in a planned aerobic exercise training can lead to an overall improvement in the cardiorespiratory fitness of pregnant women. This study demonstrated a significantly lower systolic and Diastolic Blood Pressure, peak expiratory flow rate. However, their heart rate did not statistically change following a ten weeks moderate intensity Aerobic Exercise Training regimen.

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

References

1. Gaston A. & Cramp A. (2013). Exercise during pregnancy: A review of patterns and determinants. *Journal of Science & Medicine in Sport.* 14, 299-305.
2. Ogunlesi T. (2005). The Pattern of Utilization of Prenatal and Delivery Services in Ilesa, Nigeria. *The international Journal of Epidemiology.* 2(2), 1-5.
3. Hui A., Back L. & Ludwig S. (2012). Lifestyle Intervention on Diet and Exercise reduced excessive gestational weight gain in pregnant women under a randomized controlled trial. *British Journal of Obstetrics and Gynaecology. 119, 70-77.*
4. Srilatha S.B and Sujatha (2019). *Effects of aerobic exercise on blood pressure during pregnancy: a case study. Research Journal of Pharmacy and Technology.* 12(12), 5749-5751.
5. American Heart Association (2020). American Heart Association recommendations for Physical Activity in Adults. Retrieved from http://www.heart.org/HEARTORG/HealthyLiving/PhysicalActivity/FitnessBasics/American-Heart-Association-Recommendations-for-Physical-Activity-in-Adults_UCM_30796_Article.jsp#.WDEHc0zjnfY
6. Endeshaw M., Abebe F., Worku S., Menber L., Assress M. & Assefa M. (2016). Obesity in young age is a risk for preeclampsia: a fertility based case-control study; Northwest Ethiopia. *British Medical Council Pregnancy childbirth* 16, 237
7. Macgrill M. (2021). What should my heart rate be? Medically reviewed by Stephens Carissa, R.N., CCRN, CPN. www.medicalnewstoday.com/articles/235710.
8. Jean-Louis, V. (2008). Understanding Cardiac output. *Crit Care*, 12 (4), 174.
9. Cohen, J. (1973). *Eta-squared and partial eta-squared in fixed factor ANOVA designs.* Educational and Psychological Measurement, 33, 107–112.

10. Valeria, M. N., Ingrid, K. B., Andrei, I. M., Paris, V., Pang, S., & Roy, J. S. (2003). Effects of three different types of exercise on blood leukocyte count during and following exercise. *Sao Paulo Med J/Paulo Med*, 121(1), 9-14.
11. Deborah, A. B., Keith, S., & George, M. H. (2004). Physiological effects of exercise. *Contin Educ AnaesthCrit Care Pain*, 4 (6), 185-188.
12. Davis C. P. (2021). *Medical definition of pregnancy. Medicinenet.com*
13. Lotgering, F. K., van Doorn, M. B., Struijk, P. C., Pool, J., &Wallenburg, H. C. (1991). Maximal aerobic exercise in pregnant women: heart rate, O2 consumption, CO2 production, and ventilation. *Journal of Applied Physiology*, 70(3), 1016-1023.
14. Radhakrishnan R. &Uttekar P. S. (2020). Medically Reviewed on 7/22/2020. Available from www.medicinenet.com
15. Anitha O. R., Smilee J., Suresh Y. &Bondade (2015). Study of effect of exercise on PEFR in pregnant women. *National journal of physiology, pharmacy and pharmacology*. 5 (2), 89.
16. Brancazio, L. R., Laifer, S. A., & Schwartz, T. (1997). Peak expiratory flow rate in normal pregnancy. *Obstetrics and gynecology*, 89(3), 383–386.
17. Khoram S., Marueh L., Maeoume P. and Marjan B. (2019). *The effect of walking on pregnancy blood pressure disorders in women susceptible to pregnancy hypertension: A randomized clinic trial. Journal of Educational Health Promotion.* 8, 95.
18. Yeo S., Steele N. M., Chang M. C., Leclaire, S. M., Ronis D. L. & Hayashi R. (2000). Effect of exercise on blood pressure in pregnant women with a high risk of gestational hypertensive disorders. *Journal of Reproductive Medicine.* 45(4), 293-8.
19. Elena R., Magro-Malosso, Gabriele S., Mariarosaria D., Tommaso, Amanda R. and Vincenzo B. (2017). Exercise during pregnancy and risk of gestational hypertensive disorders. *Available from www.obgyn.onlinelibrary.wiley.com.* 96(8), 921-931.
20. Haakstad L.A., Edvardson E. & Bo K. (2016). Effect of regular exercise on blood pressure in normotensive pregnant women. A randomized controlled trial. *Hypertension in Pregnancy* 35(2): 170-80.
21. Hinderliter, A., Sherwood, A., Gullette, E. C., Babyak, M., Waugh, R., Georgiades, A., & Blumenthal, J. A. (2002). Reduction of left ventricular hypertrophy after exercise and weight loss in overweight patients with mild hypertension. *Archives of internal medicine*, 162(12), 1333–1339.
22. Veronique A. C & Robert H. F (2005). Effects of endurance training on blood pressure, blood pressure-regulating mechanisms and cardiovascular risk factors. *Electronic publication.* 46(4): 667-675.
23. Bassi, R., Sharma, S., Sharma, A., Kaur, D,. & Kaur H. (2015) The effect of aerobic exercises on peak expiratory flow rate and physical fitness index in female subjects. *National Journal of Physiology, Pharmacy and Pharmacology*, 5 (5), 376-381.