



## Research Article

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# Changes in white blood cell, red blood cell and platelet parameters following short term aerobic exercise in students of Nnamdi Azikiwe University, Nigeria

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## Abstract

**Background:** Haematological changes have been associated with physical activity (exercise) and these changes have been found to involve leucocytes, red blood cells and thrombocytes depending on variables such as the duration and intensity of the exercise. **Objective:** This experimental pre-post test study was designed to assess the changes in white blood cell, red blood cell and platelet parameters following short term exercise. **Method:** A total of 30 participants with an average age of  $23.8 \pm 1.98$  years participated in the standard treadmill exercise (Bruce protocol) for 30 minutes on voluntary basis. Blood samples were collected from the subjects before exercise, immediately after exercise and 24 hours after exercise. Hematological parameters were analyzed using hematology auto-analyzer. Height, weight, body mass index and blood pressure of the participant were measured. Ethical approval was obtained from the Ethics committee of Faculty of Health Sciences and Technology and informed consent of the participants were obtained. Statistical Package for Social Sciences version 21 was used for statistical analysis. **Results:** The platelet count significantly increased post-exercise compared to pre-exercise and decreased 24hours post-exercise compared to post-exercise value. Conversely, the Platelet distribution width (PDW) significantly decreased at post-exercise compared to pre-exercise, and significantly increased at 24hours post exercise compared to post-exercise value. Moreover, there was a significant increase in Mean platelet volume (MPV) at 24hours post-exercise compared to post exercise and a significant decrease in Plateletcrit (PCT) at 24hours post-exercise compared to post-exercise. At post-exercise and 24hours post-exercise, the total lymphocyte count was significantly higher in females while the granulocyte count was significantly higher in males. Also at 24 hours post exercise the MCHC was significantly higher in females compared to males. At post-exercise, there was a significant positive correlation between BMI and MCH ( $r=0.512$ ,  $P=0.004$ ) and BMI and MCHC ( $r=0.553$ ,  $P=0.003$ ) while there was a significant negative correlation between BMI and MPV ( $r=-0.367$ ,  $P=0.046$ ). **Conclusion:** Short term exercise causes significant alterations in platelet parameters than other hematological parameters.

**Keywords:** Exercise, Platelets, Red blood cell, White blood cells.

## INTRODUCTION

Exercise can be defined as any bodily activity that enhances or maintains physical fitness and overall health and wellness [1]. It could involve part or entire body. It is essential for the maintenance of the various organs and tissues at optimal level especially at regular and moderate rate [2] and could be recommended as a remedy for some disease conditions [3]. Frequent and regular physical exercise is known to boost the immune system and may help to prevent "diseases of affluence" such as cardiovascular disease, type 2 diabetes, and obesity [2, 4]. However, its implementation and intensity should be so that its side effects are reduced [5]. Aerobic exercise (which can also be referred to as cardio) is physical exercise of low to high intensity that depends primarily on the aerobic energy-generating process [6]. Examples of aerobic exercise include cycling, rowing, running, brisk walking, hiking, swimming, playing tennis, skipping rope, continuous training, and long slow distance training [7]. The patterns of hormonal and immunological responses during exercise have many similarities with other clinical stressors, thus exercise represents a quantifiable model of physical stress. One of the effects of exercise is physiological stress in the human body. It leads to increased blood pressure, variation in chemical (hormonal) and cellular system, body temperature and oxygen intake [8]. However, it is difficult to differentiate between the effects of the psychological stress during exercise and the effects of the physical

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stress of exercise [9].

The haematological parameters such as Red blood cell count, platelet count and white cell count are used as clinical indicator of health, nutritional, pathological and physiological status of the individual and in determining the cause of some severe health complications [10]. These parameters are influenced by nutritional status, inflammatory response during exercise and pathogenic stress [8]. Studies showed that these changes in hematological parameters occur immediately following exercise; whereas, it returns to resting levels within 24 hours post exercise [11, 12]. As regards to the effect of exercise on the individual haematological parameters, several studies show that acute exercise leads to an increase in platelet count which has been attributed to a number of reasons including platelet release from the liver and lungs, hemoconcentration and importantly the release of platelets from the spleen [13]. Athletes are reported to have reduced haematocrit and hemoglobin levels, a situation usually known as athlete's anaemia [14]. However, because athletes actually have an increased haemoglobin and total mass of red blood cells in circulation relative to sedentary individuals the athletes' anaemia is not anaemia in a clinical sense. Training increases total hemoglobin mass by stimulating erythropoiesis, which increases the amount of O<sub>2</sub> that can be carried by blood [15]. Exercise has also been shown to affect white blood cell parameters. It is reported to induce an immediate increase in white blood cells, the magnitude of which is related majorly to the duration and intensity and duration of the exercise [8]. The post-exercise values of leucocyte count may however, change in any one of several different ways. The pattern of post-exercise changes in the leucocyte count is determined mainly by the duration of exercise, rather than the intensity or the total work done. The increase in the number of leukocytes after exercise may be explained by the increase in blood flow which recruits leukocytes from the marginal pool and/or hormonal changes, which are likely to be mediated by  $\beta$  adrenergic receptors. In addition, a decrease in leukocyte filterability, an indication of leukocyte activation during exercise, has also been reported as a likely mechanism for the rise in white cell count [16].

There is a general consensus that exercise induces changes in haematological parameters. However there have been conflicting findings on the direction of these changes. For instance, while Brun *et al.* [16] reported an increase in erythrocytes, hematocrit values and hemoglobin concentrations after exercise, Mairbaul *et al.* [14] found a decrease in hemoglobin and hematocrit values. Also Lambert *et al.* [17] and Muaz *et al.* [18] reported an increase in the number of leukocytes while Ramos-Campo *et al.* [19] reported a reduction in the absolute lymphocyte count and an increase in neutrophils and monocytes count. Similarly, Natale and Brenner [20] found that the total number of white blood cells (WBCs) increased during and immediately after exercise while Pitsavos *et al.* [21] found a lower white blood cell (WBC) counts.

In the light of these conflicting findings, this study intends to assess the variations in Red blood cell count, platelet and white cell count after exercise and 24 hours after exercise. This will help to clarify the direction of changes in these parameters.

## **MATERIALS AND METHOD**

### **Study Area**

This study was conducted at College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus, Nigeria. The College is a multi-faculty college comprising the Faculties of Health Sciences and Technology, Basic Medical Sciences and Medicine with each faculty having many departments. The college has a population of over 2000 students. It has sporting facilities such as a volleyball court, football field, tennis court etc. The department of Medical Rehabilitation

houses a Gymnasium with equipment such as Treadmill which was used in the exercise protocol.

### **Research Design**

This was an experimental pre-post test designed to determine the effect of short term aerobic exercise on platelet, Erythrocyte and white blood cell parameters among students of College of Health Sciences, Nnamdi Azikiwe University.

### **Study Population**

The study population consists of male and female students of Nnamdi Azikiwe University, Nnewi campus.

### **Inclusion Criteria**

This study included apparently healthy students without any known pathological conditions like cardiovascular diseases and who have not participated in moderate to vigorous exercises in the previous 48hours.

### **Exclusion Criteria**

This study excluded subjects with any known pathological condition or who had been very sick, or have been transfused in the previous three months, pregnant females and smokers.

### **Ethical Approval**

This was obtained from the ethics Committee of Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi.

### **Informed Consent**

Informed Consent of all participating subjects was sought and obtained.

### **Research Protocol**

The study participants were thirty students aged of 15-28 years, who were randomly selected comprising 20 males and 10 females. Their body weight, height, body mass index, pulse rate, blood pressure were measured and their hematological parameters was analyzed at baseline before exercise, after exercise and 24 hours post-exercise. Pre-exercise test was done before exercise after the subjects had been allowed to rest for about 5 minutes in a sitting position on arrival to the gymnasium to assess their weight, height, pulse rate, blood pressure measurement and blood collected for baseline hematological measurement. Post-exercise test was done after exercise which lasted 30 minutes on the treadmill machine to assess their pulse rate, blood pressure measurement and a second blood sample collected for a repeat (follow-up) hematological test. Post 24 hours exercise test was done after 24 hours (the next day) to assess their pulse rate, blood pressure measurement and a third blood sample collected for haematological test.

### **Blood sample collection**

Using a sterile syringe, two milliliters (2ml) of venous blood was collected from the research participants into EDTA bottle before exercise, after exercise and 24 hours after exercise and labeled accordingly.

### **Methods of Analysis**

#### **Measurement of Full Blood Count**

The White blood cells, Red blood cells and Platelet parameters, red cell indices etc were analyzed by means of an Abacus 360 auto-analyzer.

## Anthropometric Measurement

The height of the subjects was measured using a standard stadiometer (accuracy 0.1 cm) with subject standing upright during the measurement. Weight was measured with a digital weighing scale (accuracy 0.1 kg). Body mass index (BMI) was calculated by dividing the body mass (in kilograms) by the square of the height (in meters).

## Systolic blood pressure, Diastolic blood pressure and pulse rate measurement

The systolic pressure, diastolic pressure and pulse rate of the subjects was measured before exercise, post exercise and 24 hours after exercise using digital sphygmomanometer, OMRON 907 (OMRON, Hoofddorp, Netherlands)

## Protocol for exercise

### Bruce Protocol

Exercise was performed on a Treadmill machine (OMA Fitness registered trademark, U.S.A). The treadmill was powered by a light source, started at a speed of 6.5 kilometers per hour and a gradient (incline) of 2%. The Treadmill was stopped when the participants reaches the stipulated time (30 minutes) of Exercise.

## Statistical Method

Statistical package for Social Sciences (SPSS) version 21 was used for data analysis. Data was expressed as mean±SD. Analysis of Variance (ANOVA) was used for comparison of the values obtained at different duration. Comparison between groups was done using students-test while Pearson's correlation was used to test for relationship between parameters. Values were deemed significant at p<0.05.

**Table 3:** Comparison of Red blood cell parameters at pre-exercise, post-exercise and 24hrs post-exercise

Durations	RBC(10 <sup>12</sup> /l)	HGB(g/dl)	HCT (%)	MCV(fl)	MCH(pg)	MCHC(g/l)
Pre-exercise	4.94±0.55	12.90±1.12	40.33±3.58	82.06±7.19	26.31±2.54	32.01±0.59
Post exercise	5.01±0.50	13.02±1.09	40.93±3.57	82.23±7.28	26.14±2.40	31.8±0.54
24hrs post- exercise	4.91±0.64	12.77±1.23	40.16±4.06	82.43±7.23	26.26±2.51	31.85±0.64
F(P)-value	0.219 (0.517)	0.336 (0.671)	0.342 (0.681)	0.019 (0.915)	0.036 (0.852)	1.012 (0.297)

Key: RBC = Red blood cell, HGB = Hemoglobin, HCT = Hematocrit, MCV = Mean cell volume, MCH = Mean cell hemoglobin, MCHC = Mean cell hemoglobin concentration

The mean platelet count (PLT) significantly increased post-exercise compared to pre-exercise value and decreased 24hours post-exercise compared to post-exercise value (P<0.05). The value at 24 hours post-exercise did not differ significantly from the value at pre-exercise (P>0.05) Conversely, the Platelet distribution width (PDW) significantly decreased at post-exercise compared to pre-exercise, and significantly increased at 24hours post exercise compared to post-exercise value (P<0.05). The value at 24hours post-exercise did not differ significantly

## RESULTS

The mean age (years) and Body mass index (kg/m<sup>2</sup>) of the subjects sampled during the Treadmill exercise program were 23.8 ±1.98 and 22.37 ± 2.36 (Table 1).

**Table 1:** Mean values of anthropometric variables of participants

VARIABLES	Mean±SD
Age (years)	23.8 ± 1.98
Weight (Kg)	68.13 ± 11.04
Height (m)	1.74 ± 0.20
BMI (Kg/m <sup>2</sup> )	22.37 ± 2.36

There was no statistically significant difference in white blood cell and red blood cell parameters when compared at pre exercise, post exercise and 24 hours post exercise (p>0.05) (Tables 2 and 3).

**Table 2:** Comparison of White blood cell parameters at pre-exercise, post-exercise and 24 hours post-exercise

Duration	TWBC(10 <sup>9</sup> /l)	LYM(10 <sup>9</sup> /l)	MXD(10 <sup>9</sup> /l)	GRA(10 <sup>9</sup> /l)
Pre-exercise	4.39±1.14	2.27±0.56	0.49±0.19	1.69±0.73
Post-exercise	4.60±1.30	2.48±0.86	0.41±0.13	1.70±0.73
24hrs post-exercise	4.31±1.04	2.16±0.46	0.44±0.20	1.70±0.71
F(P)-value	0.477 (0.797)	2.084 (0.090)	1.520 (0.315)	0.009 (0.980)

Key: TWBC = Total White blood cell  
LYM = Lymphocyte count  
MXD = Mixed cell count  
GRA = Granulocyte count

**Table 4:** Comparison of Platelet parameters at pre-exercise, post-exercise and 24 hours post-exercise

Durations	PLT(10 <sup>9</sup> /l)	PCT (%)	MPV(fl)	PDW(%)	P-LCR(%)
1. Pre-exercise	220.2±138.22	0.219±0.081	10.73±1.63	38.33±4.91	34.95±9.48
2. Post-exercise	276.76±147.89	0.256±0.090	10.09±2.04	35.99±7.44	31.66±10.95
3. 24hrs post-exercise	183.23±79.21	0.190 ±0.078	11.01±1.34	39.80±3.08	37.33±8.67
F(P)-value	4.227 (0.029*)	3.617 (0.040*)	2.314 (0.049*)	3.724 (0.039*)	2.552 (0.044*)
1 vs 2: p-value	0.044*	0.091	0.15	0.010*	0.195
1 vs 3 p-value	0.257	0.349	0.519	0.299	0.349
2 vs 3 p-value	0.005*	0.009*	0.039*	0.008*	0.027*

Key: \*Significant at P<0.05  
MPV = Mean Platelet Volume  
PLT = Platelet  
PDW% = Platelet distribution width  
PCT% = Plateletcrit  
P-LCR% = Platelet Large Cell Ratio

There is no significant difference in the pre-exercise values of haematological and cardio-respiratory parameters when compared between male and female subjects (Table 5).

**Table 5:** Pre-exercise comparison of male and female hematological and cardio-respiratory parameters

Variables	MALE	FEMALE	t-value	p-value
PULSERATE	69.8±10.47	74±6.97	-0.768	0.449
DIASTOLE	78.84±8.8	81.75±4.99	-0.637	0.529
SYSTOLE	123±11.47	120.25±7.67	0.460	0.649
WBC(10 <sup>9</sup> /l)	4.45±1.19	3.99±0.72	0.748	0.461
LYM(10 <sup>9</sup> /l)	2.19±0.58	2.38±0.39	-0.63	0.534
MXD(10 <sup>9</sup> /l)	0.49±0.20	0.47±0.08	0.208	0.837
GRA(10 <sup>9</sup> /l)	1.76±0.75	1.24±0.15	1.350	0.188
RBC(10 <sup>12</sup> /l)	4.98±0.55	4.65±0.53	1.050	0.303
HGB(g/dl)	13.04±1.130	11.97±0.51	1.845	0.076
HCT%	40.81±3.57	37.15±1.48	1.997	0.056
MCV(fL)	82.34±7.05	80.25±8.92	0.536	0.596
MCH(Pg)	26.37±2.49	25.87±3.23	0.358	0.723
MCHC(g/dl)	31.96±0.61	32.25±0.42	-0.878	0.387
PLT(10 <sup>9</sup> /l)	227.5±15.37	172.75±15.08	0.732	0.471
PCT%	0.22±0.08	0.185±0.019	0.889	0.381
MPV(fL)	10.71±1.69	10.8±1.34	-0.095	0.925
BMI	22.21±2.45	23.4±1.44	-0.933	0.359

At post-exercise and 24hours post-exercise, the total lymphocyte count was significantly lower in males compared to females while the granulocyte count was significantly lower in females compared to males. Also at 24 hours post exercise the MCHC was significantly lower in males compared to females (P<0.05) (Tables 6 and 7).

**Table 6:** Post-exercise comparison of male and female hematological and cardio-respiratory parameters

PARAMETERS	MALE	FEMALE	t-value	p-value
PULSE RATE	103.03±18.22	116.5±11.56	-1.422	0.166
DIASTOLE	74.88±9.39	67.25±9.74	1.506	0.143
SYSTOLE	128.57±13.07	119.5±11.56	1.308	0.202
WBC(10 <sup>9</sup> /l)	4.56±1.21	4.86±2.00	-0.419	0.678
LYM(10 <sup>9</sup> /l)	2.36±0.69	3.28±1.47	-2.192	0.044*
MXD(10 <sup>9</sup> /l)	0.41±0.12	0.39±0.18	0.282	0.780
GRA(10 <sup>9</sup> /l)	1.98±0.74	1.10±0.36	2.567	0.012*
RBC(10 <sup>12</sup> /l)	5.04±0.50	4.73±0.48	1.145	0.262
HGB(g/dl)	13.16±1.10	12.1±0.29	1.879	0.071
HCT%	41.42±3.57	37.72±1.17	2.027	0.052
MCV(fl)	82.53±7.02	80.25±9.74	0.578	0.568
MCH(pg)	26.20±2.30	25.7±2.89	0.388	0.701
MCHC(g/dl)	31.76±0.55	32±0.35	-0.797	0.432
PLT(10 <sup>9</sup> /l)	267.65±14.42	336±17.57	-0.856	0.399
PCT%	0.25±0.09	0.26±0.09	-0.210	0.835
MPV(fL)	10.33±1.90	8.52±2.51	1.702	0.100

\*Significant at P<0.05

**Table 7:** 24 hours Post-exercise comparison of male and female hematological and cardio-respiratory variables

Parameters	MALE	FEMALE	t-value	P-value
PULSE RATE	70.42±10.97	79.25±7.08	-1.546	0.133
DIASTOLE	78.23±9.09	80.75±4.57	-0.538	0.595
SYSTOLE	121.23±10.28	110.75±7.32	1.949	0.061
WBC(10 <sup>9</sup> /l)	4.38±1.00	3.89±0.46	0.863	0.395
LYM(10 <sup>9</sup> /l)	2.14±0.48	2.93±0.20	-2.203	0.036*
MXD(10 <sup>9</sup> /l)	0.46±0.21	0.37±0.08	0.788	0.437
GRA(10 <sup>9</sup> /l)	1.98±0.73	1.14±0.20	2.160	0.040*
RBC(10 <sup>12</sup> /l)	4.92±0.56	4.84±1.18	0.227	0.822
HGB(g/dl)	12.83±1.24	12.37±1.18	0.698	0.491
HCT%	40.48±4.04	38.1±4.11	1.098	0.282
MCV(fl)	82.76±6.98	80.25±9.53	0.642	0.526
MCH(pg)	26.26±2.45	26.2±3.34	0.050	0.960
MCHC(g/dl)	31.74±0.59	32.55±0.43	-2.593	0.015*
PLT(10 <sup>9</sup> /l)	189.03±80.61	145.5±65.64	1.024	0.315
PCT%	0.20±0.077	0.16±0.08	0.850	0.402
MPV(fl)	10.98±1.29	11.17±1.84	-0.260	0.797

\*Significant at P<0.05

At post-exercise, there was a significant positive correlation between BMI and MCH (r=0.512, P=0.004) and BMI and MCHC (r=0.553, P=0.003) while there was a significant negative correlation between BMI and MPV (r=-0.367, P=0.046). However at pre-exercise and 24 hours post exercise there was no significant correlation between BMI and all the parameters (Table 8).

**Table 8:** Pearson's correlation between BMI and various Hematological parameters at pre exercise, post-exercise and 24-hours post-exercise.

CORRELATION	PRE-EXERCISE		POST-EXERCISE		24 Hrs POST-EXERCISE	
	r-value	p-value	r-value	p-value	r-value	p-value
BMI VS						
WBC(10 <sup>9</sup> /l)	-0.107	0.574	0.058	0.759	-0.228	0.226
LYM(10 <sup>9</sup> /l)	-0.179	0.345	-0.087	0.648	0.204	0.280
MID(10 <sup>9</sup> /l)	-0.178	0.347	-0.130	0.495	0.019	0.919
GRA(10 <sup>9</sup> /l)	0.029	0.878	0.128	0.501	-0.228	0.226
RBC(10 <sup>12</sup> /l)	0.011	0.952	0.124	0.513	0.068	0.719
HGB(g/dl)	0.067	0.724	0.084	0.659	0.119	0.532
HCT%	0.100	0.600	-0.209	0.267	0.179	0.343
MCV(fl)	0.09	0.635	-0.067	0.726	-0.055	0.774
MCH(pg)	0.052	0.785	.512*	0.004	0.329	0.076
MCHC(g/dl)	-0.150	0.428	.553*	0.002	0.236	0.210
PLT(10 <sup>9</sup> /l)	0.283	0.129	-0.184	0.330	-0.132	0.486
PCT%	0.349	0.058	0.321	0.084	0.082	0.667
MPV(fl)	-0.151	0.427	-.367*	0.046	-0.239	0.204

\*Significant at P<0.05

The Pulse rate and systolic blood pressure of the subjects increased at post-exercise compared to pre-exercise and decreased significantly at 24hours post-exercise compared to post-exercise (P<0.05). Conversely the diastolic blood pressure decreased significantly at post-exercise compared to pre-exercise and increased significantly at 24 hours post-exercise compared to post exercise (P<0.05). In all the parameters, the value at 24 hours post exercise did not differ from that at pre-exercise (P>0.05) (Table 9).

**Table 9:** Comparison of cardio-respiratory parameters pre-exercise, post-exercise and 24hours post-exercise

Duration	PULSERATE	DIASTOLIC BP	SYSTOLE BP
1. Pre-exercise	70.36±10.08	79.23±8.39	122.63±10.98
2. Post-exercise	104.83±17.93	73.86±9.64	127.36±13.08
3. 24hrs Post-exercise	71.60±10.88	78.57±8.61	119.83±10.48
F(P)-value	63.49 (<0.001*)	3.44 (0.041*)	3.24 (0.042*)
1 vs 2 p-value	<0.001*	0.022*	0.117
1 vs 3 p-value	0.723	0.772	0.351
2 vs 3 p-value	<0.001*	0.044*	0.014*

\*Significant at P<0.05

The pre-exercise and post exercise Pulse rate, pre-exercise and 24hours post-exercise systolic blood pressure had a significant positive correlation with the BMI of the subjects while the pre-exercise and 24 hours post-exercise diastolic blood pressure and 24 hours post-exercise Pulse rate also correlated positively with the age of the subjects (P<0.05) (Table 10).

**Table 10:** Pearson's correlation between BMI, AGE and cardio-respiratory parameters

PARAMETERS	VERSUS BMI		VERSUS AGE	
	r-value	p-value	r-value	p-value
Pre-exercise PULSE RATE	0.412*	0.024	0.217	0.25
Pre-exercise DIASTOLE	0.258	0.168	0.593*	0.001
Pre-exercise SYSTOLE	0.409*	0.025	0.265	0.157
Post-exercise PULSE RATE	0.366*	0.046	0.046	0.808
Post-exercise DIASTOLE	-0.227	0.227	0.209	0.268
Post-exercise SYSTOLE	0.07	0.712	0.064	0.737
24hrs post-exercise PULSERATE	0.271	0.147	0.469*	0.009
24hrs post-exercise DIASTOLE	0.312	0.094	0.405*	0.026
24hrs post-exercise SYSTOLE	0.419*	0.021	0.221	0.239

\*Significant at P<0.05

## DISCUSSION

This study focused on the changes in haematological parameters following short term aerobic exercise. Hematological changes have been associated with physical activity (exercise) and these changes have been found to involve leucocytes, red blood cells and thrombocytes [22]. Both short-term and long-term exercises induces several changes in the hematological indices of humans [23]. It has been discovered that aside the intensity, duration and type of exercise, other factors like gender, training status, age, nutritional status of subjects and environmental conditions plays an important role in the exercise-induced hematological changes [23].

According to Brun *et al.* [16] acute exercise raises the number of red blood cells, platelets, white blood cells, hemoglobin concentrations and hematocrit values significantly as compared to the values before exercise and these increments are dependent on exercise-induced plasma losses. However, in this study, statistically, there were no significant changes in leucocytes and erythrocytes parameters when the values are compared before exercise, after exercise and 24 hours after exercise. This finding of no change in red blood cell parameters deviates from many previous studies which include the study by Mairbaul *et al.* [14] that found that athletes who have history of an intense exercise program reported reduced hematocrit and hemoglobin values, a situation usually referred to as athlete's anemia. Also the absence of variations in leucocyte parameters in our study disagrees with the findings of many previous studies such as that by Muaz *et al.* [18] that reported that acute exercise performed until exhaustion raises the number of white blood cells, a situation that cannot be explained exclusively by the mechanism of

hemoconcentration. Similarly, acute sub-maximal exercise raises the white blood cell subgroups and it has been shown that this increase can be linked to the intensity of exercise [17]. Aside these, a previous study [19], showed that immediately after exercise a reduction in the absolute lymphocyte count was observed in runners, whereas there was an increase in the number of monocytes and neutrophils. Also during and immediately after exercise, there was an increase in total number of white blood cells (WBCs) [20] and individuals who are little to moderately active during their leisure time frequently have 10% lower leucocyte counts than inactive individuals [21]. From the foregoing, the only explanation for the disparity of all these previous studies with our finding may be the duration and intensity of the exercise protocol because according to Wardyn *et al.* [23], variations in hematological indices post-exercise are determined by the duration and intensity of the exercise. This was also supported by Ihim *et al.* [24] that a significant change in some biochemical parameters can only be elicited by longer duration of exercise.

In our study, the platelet count (PLT) was significantly raised post-exercise and decreased 24hours after exercise to a value similar to that at pre-exercise. Similarly, there was a statistically non-significant increase in Plateletcrit (PCT) at post exercise and a significant decrease at 24hours post-exercise. This implies that platelet count and plateletcrit value increases after exercise and returns to pre-exercise level within 24 hours after exercise. This means that these platelet parameters responded to the exercise by increasing but the increase was not sustained beyond 24 hours as they returned to values similar to the pre-exercise (baseline) values 24 hours post exercise. This agrees with the assertion that variations in hematological indices are observed immediately following exercise; whereas, it returns to basal levels within 24 hours of exercise [11, 12]. Platelets play essential role in the human body [3]. It has been shown to play an important role in the pathogenesis of cardiovascular diseases while regular exercise on the other hand can reduce the risk of cardiovascular diseases [10]. It has been hypothesize short-term exercise leads to a transient increase in platelet count and also that platelet function may be affected differently by varying intensities of exercise. The increase in platelet mentioned earlier is attributed to hemoconcentration and by platelet release from mostly the spleen but also from the lungs and liver [13]. Notably, a significantly larger number of platelets is stored in the spleen compared to normal circulating platelets [25]. Moreover, we observed a significant reduction in Platelet distribution width (PDW) and a non-significant reduction in Platelet large cell ratio (P-LCR) and mean platelet volume (MPV) after exercise as well as a significant increase at 24hours post-exercise to a level similar to what was obtained pre-exercise. This implies that exercise led to a decrease in these platelet parameters and an increase after exercise resulting to a return in the pre-exercise level within 24 hours. Conversely, an exercise-induced increase in mean platelet volume (MPV) has been reported in a previous study [26], although this disagrees with the findings of other studies [27] including our own study.

When gender comparisons were made, at post-exercise and 24hours post-exercise, the total lymphocyte count was significantly lower in males compared to females while the granulocyte count was significantly lower in females compared to males. This implies that these gender variations in these parameters obtained after exercise was sustained 24 hours after exercise. This finding agrees with that of Horn *et al.* [28] and may be as a result of hormonal variations in males and females. Also at 24 hours post exercise the MCHC was significantly lower in males compared to females.

At post-exercise, there was a significant positive correlation between BMI and MCH and BMI and MCHC while there was a significant negative correlation between BMI and MPV. This implies that after exercise an increase in Body mass index leads to an increase in Mean cell hemoglobin and Mean cell hemoglobin concentration and vice versa, while an increase in BMI will result in a decrease in MPV and vice

versa. Since there was no significant correlation between these parameters before exercise and 24 hours after exercise, it could mean that the correlation observed post-exercise was as a result of the change that was induced by exercise.

According to Brooks *et al.* [29], during aerobic exercise systolic blood pressure rises, this is because as the intensity of the exercise is increased, the heart works harder to pump more oxygenated blood to the muscles and at the same time, diastolic blood pressure remains relatively constant and may even reduce slightly. This agrees with finding of this study that the Pulse rate and systolic blood pressure of the subjects increased after exercise and decreased significantly at 24 hours post-exercise. While the diastolic blood pressure decreased significantly at after exercise and increased significantly at 24 hours after exercise. This agrees with Ihim *et al.* [30] of a decreased diastolic pressure which was because the exercise bout resulted primarily to the vasodilation of the arteries thereby causing a reduction in peripheral resistance as well as a post-exercise-induced dehydration resulting in reduction in the blood volume. Syme *et al.* [31] also discovered a significant reduction in diastolic blood pressure as well as an insignificant increase in systolic blood pressure post exercise

The limitation of this study was that the protocol was an acute exercise. Thus, there may be need to increase the intensity of the exercise using a more encompassing sample size and engage the subjects on longer duration of exercise for a better assessment of changes in these parameters with exercise.

## CONCLUSION

Short term aerobic exercise causes significant alteration in platelet parameters but not in leukocyte and erythrocyte parameters. Also there was a gender based increase in lymphocyte and granulocyte post-exercise which was sustained 24 hours post exercise.

## Competing interest

The authors declare that there is no competing interest in this study.

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