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Research Article

Haematological and CD4 Parameters of Young Sportspersons (Pre- and Post-Exercise) in Ambrose Alli University (AAU), Ekpoma, Nigeria

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Abstract

Regular physical activity can affect the haematological parameters on an individual. This study was aimed at assessing the haematological and CD4 parameters of young sportspersons (pre-and post-exercise) in Ambrose Alli University, Ekpoma, Nigeria. A total of fifty healthy sportspersons between 16-28 years of age and of both sexes were recruited for this study. The haematological parameters were analyzed using the Sysmex KX-21N haematology autoanalyzer while the CD4 counts were determined by flow cytometry using Partec cyflow counter. The results obtained showed that the mean values of HGB and HCT of post-exercise subjects were significantly reduced ($P<0.05$) in relation to pre-exercise subjects. Whereas there was statistically a significant increase ($P<0.05$) in the PLT of post-exercise subjects compared to pre-exercise subjects. On the other hand, there was no significant difference ($P>0.05$) in the mean values of the WBC, MCV, MCH, MCHC, RBC, NEUT, LYM, MXD RDW-CV, PDW, MPV and CD4 parameters of both subjects. According to sex, only the results of the HGB, HCT, PLT and RDW-CV of the male subjects revealed a statistically significant difference ($P<0.05$) compared to their female counterparts. Age and types of sport did not affect the haematological and CD4 parameters of the subjects studied. In conclusion, it has been revealed that it was only the results of HGB, HCT, PLT and RDW-CV of post exercise subject that were significantly affected in relation to pre-exercise subjects in the study area.

Keywords: Pre-exercise, Post exercise, Haematological parameters, CD4 Count, Ekpoma

Introduction

Sport is a physical activity carried out at any intensity for recreation, competition, or fitness [1]. Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure [1]. In 1995, the US National Institute of Health (NIH) Concensus inserted "health benefits" into the definition of physical activity [2]. In 2018, the World Health Organization's (WHO) Global Strategy on Physical Activity deployed a slight variation of Caspersen's definition. Instead of activity resulting in energy expenditure, the WHO referred to bodily movement that requires energy expenditure [3]. The term exercise has been used interchangeably with "physical activity" [4] and in fact have several common elements.

Haematological parameters are those parameters that are related to the blood and blood forming organs [5]. Haematological components which consist of red blood cells, white blood cells, platelet and certain ratios of these values are valuable is monitoring the health status of an individual [6]. Red blood cells (erythrocytes) serve as a carrier of oxygen. It is this haemoglobin that reacts with oxygen carried in the blood to form oxyhaemoglobin during respiration. Packed cell volume, haemoglobin and mean corpuscular haemoglobin are major indices for evaluating circulating erythrocytes and are significant in the diagnosis of anaemia and serve as useful indices of the bone marrow capacity to produce red blood cells [7]. Blood platelets are implicated in blood clotting [8]. The major functions of the white blood cells and its differentials are to fight infections, defend the body by phagocytosis against invasion by foreign organisms and to produce or at least transport and distribute antibodies in immune response [9]. On the other hand, CD4 (Cluster of Differentiation 4) is a glycoprotein found on the surface of immune cells such as T helper cells, monocytes, macrophages, and dendritic cells. CD4+ T helper lymphocytes play a central role in the regulation of immune response [10]. They have the capacity to help B cells for generating antibodies to recruit and activate macrophages, to recruit neutrophils, eosinophils, and basophils to sites of infection and inflammation [11].

Regular physical activity can affect the haematological parameters. Thus, the haematological parameters can change, depending on the type, intensity, and duration of the sport [12]. Furthermore, the haematological profile values can change during and after vigorous sport, which can vary according to gender, age, environment, or nutrition [13]. Some researchers have found that haematological parameters increase after regular sports [14,15]. Whereas some researchers have indicated that there is no change [16]. Therefore, because of these conflicting reports, this present study was aimed at assessing the haematological and CD4 parameters of young sportspersons (pre-and post-exercise) in Ambrose Alli University, Ekpoma, Nigeria.

Materials and Methods

Study Area

This study was carried out in Ekpoma. Ekpoma is the capital of Esan West Local Government Area in Edo State which falls within the rain forest/savannah transitional zone of Southwestern Nigeria. The area lies between latitudes 6°43[1] and 6°45[1] North of the Equator and longitudes 6°5[1] and 6°8[1] East of the Greenwich Meridian. Ekpoma has a land area of 923 square kilometers with a population of 170,123 people as at the 2006 census [17]. The town has on official post office, and it is home of Ambrose Alli University.

Study Population

A total of fifty (50) young healthy sportpersons between 16 to 28 years of age and of both sexes were recruited for this study.

Ethical Approval

Ethical approval was obtained from the Health Research Ethics Committee (NHREC Registration Number: NHREC 12/06/2013) of Ambrose Alli University, Ekpoma. Informed consent was sought from each participant before sample collection.

Inclusion Criteria

Apparently healthy and fit male and female students of Ambrose Alli University who engaged in active sports such as football, table tennis, jogging and gymnastics at the university sports complex that gave their consent were included in this study.

Exclusion Criteria

Sportsmen and sports women who reported sick, stressed and those who did not give their consent among others were excluded from this study.

Sample Collection

About 4ml of blood was collected from each subject via venepuncture before the commencement of exercise (pre-exercise) and dispensed in Ethylene Diamine Tetra Acetic Acid (E.D.T.A) bottle and mixed immediately by reverse uniform inversion. Another round of 4ml of blood sample was collected into E.D.T.A bottle also from each subject after one hour of physical exercise (post-exercise). All the field samples were placed in cold transport boxes with a temperature range of 2°C 8°C before they were transported to the laboratory for analysis. All samples were collected between 9.00am-12.00 noon each day. Samples were analysed with minimal delay and not longer than 6 hours.

Sample Analyses

Haematology Assay using Sysmex KX-21N autoanalyzer: The haematology parameters were analyzed using Sysmex KX-21N Haematology autoanalyzer (Sysmex Corporation, Kobe, Japan). The Sysmex KX-21N is an automatic, 19-parameters, 3-part differential blood cell counter. The procedure was carried out according to the manufacturer's instructions. The principle of this method is based on then DC (Direct Current) Detection method.

CD4 Count: CD4 cells counts were determined by flow cytometry using Partec cyflow counter (Partec GmbH, 2006) adapted to single platform technology. Forward and side scatter signals were measured using a linear scale. To ensure the optical alignment of the equipment and fluorescence compensation settings, count check bead green was run every day and the count was compared with the manufacturer's range.

Statistical Analysis

The results obtained were presented as mean±standard deviation. Statistical analysis was carried out using Student's t-test and one way analysis of variance (ANOVA). P<0.05 was considered significant.

Results

The results of the socio-demographic characteristics of the subjects studied are presented in Table 1. Distribution according to sex revealed that more male subjects (52%) were recruited for the study compared to female subjects (42%). In terms of age, subjects belonging to the age bracket of 20-23 were the most predominant (42%), followed by 16-19 years (30%) and the least being those in the age range of 24-28 years (28%). The subjects were drawn from different faculties which included Basic Medical Sciences (30%), Education (20%), Physical Sciences (20%), Management Sciences (12%) and Social Sciences (18%). The levels of study revealed that the 100, 200, 300, 400 and 500 students constituted the frequencies of 24%, 16%, 16%, 24% and 20% respectively. Most of the study subjects were Christians (88%) while the Muslims accounted for 12%. Based on the types of sports, Football constituted almost half (42%) of the study subjects, followed by Gymnastics (22%) while Table Tennis and Jogging recorded 18% each. In terms of social habits, 24% of the subjected consumed alcohol while 6% took medications and 4% smoked cigarette. None of the subjects took adrenaline injection and hard drugs. Table 2 reveals the haematological and CD4 parameters (pre- and post-exercise) of the study subjects. The HGB and HCT results of post-exercise subjects were statistically significantly reduced (P<0.05) in comparison to pre-exercise subjects. Whereas there was a statistically significant increase in the PLT of post-exercise subjects in relation to pre-exercise subjects. On the other hand, there was no significant difference (P>0.05) in the mean values of the WBC, MCV, MCH, MCHC, RBC, NEUT, LYM, MXD, RDW-CV, PDW, MPV P-LCR and CD4 of both pre- and post-exercise subjects in the study area.

Table 1: Socio-demographic characteristics of the subjects studied.

Variables	Number observed n = 50	Frequency (%)
Sex		
Male	26	52
Female	24	48
Age		
16-19 years	15	30
20-23 years	21	42
24-28 years	14	28
Faculty of Study		
Basic Medical Sciences	15	30
Education	10	20
Natural/Physical Sciences	10	20
Management Sciences	6	12
Social Sciences	9	18
Level of Study		
100	12	24
200	8	16
300	8	16
400	12	24
500	10	20
Religion		
Christians	44	88
Muslims	6	12
Others	Nil	-
Types of Sports		
Football	21	42
Gymnastics	11	22
Table tennis	9	18
Jogging	9	18
Social habits		
Takeadrenaline injection	0	0
Smoke	4	4
Takealcohol	12	24
Take harddrugs	0	0
Taking medication	6	6

Table 2: Haematological and CD4 parameters of the subjects studied (pre- and post-exercise).

Parameters	Pre-exercise Mean±SD n=50	Post-exercise Mean±SD n=50	t-value	p-value
WBC (x10³/µl)	4.84±1.35	5.11±1.38	0.685	0.69
RBC (x10³/µl)	4.92±0.60	4.89±0.70	0.021	0.127
HGB (g/dl)	13.18±1.57	12.88±1.51	4.311	0.001*
HCT (%)	38.54±4.44	37.40±4.70	4.856	0.001*
MCV (fl)	77.60±4.58	77.95±5.85	0.67	0.378
MCH (pg)	30.61±19.12	26.66±2.50	0.589	0.475
MCHC (g/dl)	34.10±1.19	34.12±1.15	0.104	0.681
PLT (x10³/µl)	210.10±66.69	230.74±59.67	5.611	0.001*
LYM (%)	47.80±9.89	50.18±10.26	0.3	0.304
MXD (%)	10.95±3.29	10.58±5.31	0.174	0.316
NEUT (%)	40.14±15.79	39.53±10.89	0.098	0.174
LYM (x10³/µl)	2.36±0.64	2.45±0.59	0.13	0.159
MXD (x10³/µl)	0.55±0.19	0.55±0.44	0.786	0.488
NEUT (x10³/µl)	2.16±0.83	2.15±0.94	0.365	0.201
RDW-SD (fl)	39.64±2.90	40.03±2.59	0.214	0.244
RDW-CV (%)	13.46±1.14	13.53±0.96	0.404	0.199
PDW (fl)	13.20±2.82	13.11±1.76	0.211	0.651
MPV (fl)	10.46±1.02	10.42±0.78	0.975	0.754
P-LCR (%)	27.90±7.49	34.28±10.32	0.689	0.362
CD4	965.78±312.06	910.54±281.74	1.611	0.316

The haematological and CD4 parameters of sportspersons (pre- and post-exercise) with respect to sex is shown in Table 3. The results of the HGB, HCT, PLT and RDW-CV of the male subjects revealed a statistically significant difference (P<0.05) compared to female subjects. In contrast, there was no significant difference (P>0.05) in the mean values of the WBC, MCV, MCH, MCHC, RBC, NEUT, LYM, MXD, PLT, RDW-SD, PDW, MPV, P-LCR and CD4 results of the male subjects in relation to female subjects. Table 4 shows the haematological and CD4 parameters of the subjects studied according to age. There was not statistically significant (P>0.05) difference in the haematological and CD4 parameters of the subjects studied across the different age groups. Table 5 depicts the haematological and CD4 parameters of the subjects based on types of sports. The results of the statistical analysis showed there was no significant difference (P>0.05) in the haematological and CD4 parameters of the subjects with respect to the type of sports they engaged in.

Table 3: Haematological and CD4 parameters of the subjects studied with respect to sex.

Parameters	Male Mean±SD n=26	Female Mean±SD n=24	t-value	p-value
WBC (x10³/µl)	5.07±1.23	5.26±1.56	0.405	0.69
RBC (x10³/µl)	4.99±0.75	4.65±0.57	0.588	0.127
HGB (g/dl)	13.36±1.67	12.19±1.06	4.512	0.020*
HCT (%)	38.17±5.17	34.98±5.11	3.58	0.012*
MCV (fl)	78.82±6.03	77.50±5.39	0.788	0.439
MCH (Pg)	26.94±2.30	26.48±2.59	0.648	0.523
MCHC (g/dl)	34.09±1.06	34.09±1.21	0.012	0.99
PLT (x10³/µl)	218.65±49.53	243.22±50.54	4.244	0.002*

LYM (%)	58.24±9.11	46.84±9.29	0.214	0.238
MXD (%)	11.80±6.58	9.67±3.85	0.293	0.209
NEUT (%)	30.53±11.27	42.93±9.74	0.55	0.136
LYM (x10³/µl)	2.60±0.67	2.33±0.50	0.521	0.142
MXD (x10³/µl)	0.62±0.60	0.50±0.26	0.854	0.402
NEUT (x10³/µl)	1.95±0.64	2.37±1.18	0.682	0.107
RDW-SD (fl)	39.59±2.68	40.67±2.38	0.37	0.184
RDW-CV (%)	13.12±0.85	13.84±0.86	5.001	0.007*
PDW (fl)	13.47±1.86	12.79±1.76	0.367	0.186
MPV (fl)	10.57±0.62	10.27±0.94	0.247	0.226
P-LCR (%)	42.32±26.62	27.29±6.96	0.423	0.273
CD4	889.95±310.50	1000.61±313.32	2.113	0.405

Note*: KEYS: SD: Standard Deviation; WBC: White Blood Cells; RBC: Red Blood Cells; MCV: Mean Cell Volume; MCHC: Mean Cell Haemoglobin Concentration; PLT: Platelet count; P-LCR: Platelet Large Cell Ratio; HGB: Haemoglobin; HCT: Haematocrit; MCH: Mean Cell Haemoglobin; RDW: Red Cell Distribution Width; MPV: Mean Platelet Volume; PDW: Platelet Distribution Width; NEUT: Neutrophils; LYM: Lymphocytes; fl: Femtolitre; Pg: Picogram; %: Percentage; µl: Microlitre; RDW-CV: Red cell Distribution Width-Coefficient of Variation; RDW-SD: Red cell Distribution Width-Standard Deviation.

Table 4: Haematological and CD4 parameters of the subjects based on age.

Parameters	16-19 years Mean±SD n=15	20-23 years Mean±SD n=21	24-28 years Mean±SD n=14	F-value	p-value
WBC (x10³/µl)	5.00±1.80[a]	5.19±1.43[b]	5.12±1.80[c]	0.547	0.641
RBC (x10³/µl)	4.51±1.11[a]	4.66±0.95[b]	4.21±1.12[c]	0.448	0.632
HGB (g/dl)	12.82±2.64[a]	12.69±2.42[b]	12.61±2.74[c]	0.841	0.156
HCT (%)	37.44±8.47[a]	38.12±8.40[b]	37.81±8.48[c]	0.605	0.389
MCV (fl)	86.93±16.00[a]	84.80±12.06[b]	85.74±15.12[c]	0.655	0.475
MCH (Pg)	33.45±2.76[a]	30.94±13.02[b]	33.55±2.70[c]	0.705	0.395
MCHC (g/dl)	33.94±2.76[a]	33.70±2.14[b]	33.77±2.66[c]	0.612	0.409
PLT (x10³/µl)	195.56±52.04[a]	200.36±70.99[b]	196.60±52.31[c]	0.444	0.514
LYM (%)	64.98±2.67[a]	63.66±0.72[b]	60.77±1.64[c]	0.51	0.367
MXD (%)	5.51±0.18[a]	6.63±0.31[b]	8.44±0.18[c]	0.367	0.259
NEUT (%)	30.17±14.38[a]	29.86±16.13[b]	31.10±17.10[c]	0.394	0.269
LYM (x10³/µl)	2.34±0.12[a]	2.85±0.30[b]	3.01±0.66[c]	0.645	0.421
MXD (x10³/µl)	1.90±0.98[a]	1.85±0.33[b]	1.12±1.60[c]	0.7	0.167
NEUT (x10³/µl)	5.06±1.67[a]	30.85±18.30[b]	1.89±1.53[c]	0.514	0.48
RDW-SD (fl)	40.57±2.68[a]	40.59±2.03[b]	41.93±2.14[c]	0.744	0.389
RDW-CV (%)	12.59±0.66[a]	13.15±0.80[b]	14.67±0.94[c]	0.811	0.6
PDW (fl)	13.29±2.18[a]	13.51±1.93[b]	13.71±2.03[c]	0.608	0.404
MPV (fl)	11.61±1.33[a]	11.41±1.31[b]	11.45±1.80[c]	0.581	0.378
P-LCR (%)	35.73±8.17[a]	34.62±7.75[b]	34.88±8.06[c]	0.475	0.296
CD4	1063.87±439.55[a]	904.05±277.08[b]	1026.67±163.32[c]	1.062	0.358

Note*: Values in a row with the same superscript are significantly different at p<0.05

KEYS: SD: Standard Deviation; WBC: White Blood Cells; RBC: Red Blood Cells; MCV: Mean Cell Volume; MCHC: Mean Cell Haemoglobin Concentration; PLT: Platelet count; P-LCR: Platelet Large Cell Ratio; HGB: Haemoglobin; HCT: Haematocrit; MCH: Mean Cell Haemoglobin; RDW: Red cells Distribution Width; MPV: Mean platelet volume; PDW: Platelet distribution width; NEUT: Neutrophils; LYM: Lymphocyte; fl: Femtolitre; Pg: Picogram; %: Percentage; µl: Microlitre; RDW-CV: Red cell Distribution Width-Coefficient of Variation; RDW-SD: Red cell Distribution Width-Standard Deviation.

Table 5: Haematological and CD4 parameters of subjects based on the types of sports.

Parameter	Football Mean±SD n=21	Gymnastics Mean±SD n=11	Jogging Mean±SD n=09	Table tennis Mean±SD n=09	F- value	p- value
WBC ($x10^3$/µl)	5.03±1.80[a]	5.07±1.23[b]	5.10±1.80[c]	5.12±1.43[d]	0.577	0.641
RBC ($x10^3$/µl)	4.51±1.15[a]	4.58±0.70[b]	4.30±1.12[c]	4.61±0.95[d]	0.364	0.632
HGB (g/dl)	13.20±2.60[a]	13.16±1.67[b]	13.06±2.74[c]	12.65±2.42[d]	0.741	0.156
HCT (%)	37.44±8.47[a]	38.21±5.17[b]	37.88±8.48[c]	38.30±8.25[d]	0.688	0.389
MCV (fl)	85.39±6.00[a]	80.82±6.30[b]	84.74±5.75[c]	85.80±8.60[d]	0.736	0.475
MCH (Pg)	33.45±2.76[a]	30.11±2.30[b]	31.34±2.70[c]	30.94±13.02[d]	0.601	0.395
MCHC (g/dl)	34.94±2.76[a]	33.09±2.60[b]	33.70±2.66[c]	33.67±2.15[d]	0.577	0.409
PLT ($x10^3$/µl)	200.56±52.04[a]	201.65±49.53[b]	196.60±52.31[c]	204.36±60.99[d]	0.814	0.514
LYM (%)	59.98±2.67[a]	58.24±9.11[b]	60.44±1.64[c]	37.66±0.72[d]	0.914	0.367
MXD (%)	9.51±0.18[a]	8.80±6.58[b]	7.44±0.18[c]	6.63±0.31[d]	0.678	0.259
NEUT (%)	31.17±14.38[a]	32.53±11.27[b]	32.10±17.10[c]	36.86±16.13[d]	0.641	0.269
LYM ($x10^3$/µl)	2.34±0.12[a]	2.60±0.67[b]	3.01±0.66[c]	2.85±0.30[d]	0.852	0.421
MXD ($x10^3$/µl)	1.90±0.98[a]	1.62±0.60[b]	1.12±1.60[c]	1.85±0.33[d]	0.466	0.167
NEUT ($x10^3$/µl)	2.06±1.67[a]	1.95±0.64[b]	1.89±1.53[c]	2.85±18.30[d]	0.601	0.48
RDW-SD (fl)	40.57±2.68[a]	39.59±2.68[b]	41.93±2.14[c]	40.59±2.03[d]	0.541	0.389
RDW-CV (%)	12.59±0.66[a]	13.12±0.85[b]	13.67±0.94[c]	13.55±0.80[d]	0.864	0.6
PDW (fl)	13.32±2.18[a]	13.28±1.86[b]	13.31±2.03[c]	13.40±1.93[d]	0.598	0.404
MPV (fl)	11.49±1.33[a]	10.51±0.62[b]	11.50±1.80[c]	11.23±1.31[d]	0.62	0.378
P-LCR (%)	34.73±8.17[a]	33.32±26.62[b]	34.88±8.06[c]	33.62±7.75[d]	0.398	0.296
CD4	875.78±300.06[a]	911.45±291.74[b]	890.78±278.21[c]	885.56±280.41d	1.211	0.214

Note*: Values in a row with the same superscript are significantly different at $p<0.05$

KEYS: SD: Standard Deviation; WBC: White Blood Cells; RBC: Red Blood Cells; MCV: Mean Cell Volume; MCHC: Mean Cell Haemoglobin Concentration; PLT: Platelet count; P-LCR: Platelet Large Cell Ratio; HGB: Haemoglobin; HCT: Haematocrit; MCH: Mean Cell Haemoglobin; RDW: Red cells Distribution Width; MPV: Mean Platelet Volume; PDW: Platelet Distribution Width; NEUT: Neutrophils; LYM: Lymphocytes; fl: Femtolitre; Pg: Picogram; %: Percentage; µl: Microlitre; RDW-CV: Red cell Distribution Width-Coefficient of Variation; RDW-SD: Red cell Distribution Width-Standard Deviation.

Discussion

In the present study, the results of the mean values of the White Blood Cells Total Count (WBC), Red Blood Cells Count (RBC), Mean Cell Volume (MCV), Mean Cell Haemoglobin (MCH), Mean Cell Haemoglobin Concentration (MCHC), Lymphocytes Count (LYM), Middle Cells Count (MXD), Neutrophils Count (NEUT), Red Cells Distribution Width-Standard Deviation (RDW-SD), Red Cells Distribution Width-Coefficient Of Variation (RDW-CV), Platelet Distribution Width (PDW), Mean Platelet Volume (MPV) and platelet- large cell ratio (P-LCR) of pre-exercise and post-exercise subjects were statistically insignificant (P>0.05) in the study area. Whereas the results of the Haemoglobin Estimation (HGB) and Haematocrit (HCT) of post-exercise subjects were significantly decreased (P<0.05) compared to pre-exercise subjects. Our finding is line with the earlier reports of Schumacher, et al. [18] who found reduced HGB, HCT and RBC levels in END (Endurance) compared with POW (strength) and MIX (mixed-trained) categories of distinctive sporting. In another study, Ceylan, et al. [19] observed significant differences in the pre- and post-intervention scores for red blood cells and haematocrit in the step dance group after an exercise session of 3 times a week for 3 months. Ceylan, et al. [19] further observed that when they compared the levels of significantly decreasing haemoglobin (HGB), they found that the aerobic dance group was better than the step dance group. Elsewhere, Cicek [20] established that after the exercise program, some meaningful decreases were observed in the values of RBC, HGB, HCT and MCV of the strength exercise group compared to aerobic exercise. Londeann [21] reasoned that the decrease in HGB and HCT levels may have occurred in athletes that intensely exercise, a condition called “athlete’s anaemia”. Furthermore, Schumacher, et al. [18] attributed this to exercise-induced plasma volume expansion, and only to a less degree and in selected athlete populations, to haemolysis and suggested that the “traumatic” movement of running might trigger the destruction of red blood cells. However, other authors have reported a non-significant difference in the mean values of HGB and HCT. For example, after studying the RBC levels of 9 sedentary and 9 athletes before and after a two-week exercise program, Umit, et al. [22] did not find any significant change in the RBC values. In addition, Mashiko, et al. (2004) indicated that a 20-day exercise program did not significantly change the HCT values of the 25 athlete subjects they studied. Similarly, Pouramir, et al. [23] after studying the blood samples of 35 male gymnasts before and after a 10-week exercise program did not find a significant change in erythrocyte levels. Furthermore, also after evaluating the blood samples of 14 male and 23 female athletes, who were doing regular exercise for a period of 12 weeks, Yeh, et al. [24] did not find any significant change in RBC levels of their subjects. In a similar fashion, Ibis, et al. [25] also noticed no significant differences in the haematological values of the aerobic exercise subjects they studied. In like manner, Cengiz and Cinar [12] found that though there were positive changes in the haematological values of sedentary females after 8 weeks of core exercise program, these changes were not significant for HGB and HCT. The reason for this lack of significant change can be related to the intensity of the exercise embarked on by the subjects studied [12]. In contrast, Bezci and Kaya [12] reported that the haematological parameters of elite women Taekwondoers before and after training were significantly increased in HGB, HCT and RBC. Sazvar, et al. [26] also found that during an 8-aerobic morning exercise, the number of red blood cells, haemoglobin levels and haematocrit percentage increased in the subjects they studied. Similarly, Ceylan, et al. [19] also reported that the HCT level increased significantly more in the step dance group in comparison to aerobic dance group. Having conducted an 8-week long aerobic exercise program among adults (aged 18-29, normal diet and diet with supplements), Gallagher, et al. [27] found a significant increase in the levels of HGB of both groups.

Noushad, et al. [28] also established that immediately after the termination of the 30 minutes of jogging on treadmill exercise, the haemoglobin, haematocrit and erythrocyte levels of their subjects increased significantly when compared with pre-exercise values. According to Wardyn, et al. [29], exercise has been shown to increase haemoglobin and haematocrit numbers in young individuals and these haematological changes suggest that exercise possibly has physiologic impact by mobilizing stem cells thereby enhancing mechanisms that promote tissue repair. In this study, the PLT of post-exercise subjects was significantly increased ($P<0.05$) compared to pre-exercise subjects. Our result is supported by the findings of Bezci and Kaya [12] who observed a significant increase in the platelet count of sportswomen before and after training. Similarly, our observation conforms with the earlier findings of Ceylan, et al. [19] who reported that step dance caused more increment than aerobic dance in terms of platelet (PLT) level. As prior mentioned, exercise has been shown to increase haemoglobin, platelets and haematocrit numbers in young individuals and these haematological changes suggest that exercise possibly has physiologic impact by mobilizing stem cells thereby enhancing mechanisms that promote tissue repair [29]. In contrast, Sazvar, et al. [27] had found that during an 8-week aerobic morning exercise, the number of platelets decreased significantly. The effect of exercise on CD4 count is still under debate [30]. The findings of the present study demonstrated a decrease in the CD4 count of post-exercise subjects, but this decrease was not statistically significant ($P>0.05$) compared to the pre-exercise group of the sportspersons studied. This is in concordance with the observations by O’Brien, et al. [31] who found no significant association in the subjects they studied. Similarly, in a meta-analysis that included most of the trials, Jones, et al. [32] reported no significant difference in change of CD4 for patients in the exercise intervention group compared with the non-exercising control group. In contrast, Yar’Zever, et al. [33] reported a significant improvement in CD4 cell counts of the experimental group they studied compared to the control group. Also, Poton, et al. [34] using a recent meta-analysis examined the effects of resistance training in HIV-infected individuals and reported a potential moderate effect of such intervention on CD4 count. Based on subgroup analysis, *Silva, et al*. [35] reported that only aerobic exercise proved to have a significant effect on CD4. They also observed that when exercise intensities were stratified, only intense training proved to have a significant effect on CD4. According to Pedersen and Pedersen [36] and Pedersen and Nieman [37], the increased lymphocyte concentration may be due to the recruitment of all lymphocyte subpopulations to the blood. Thus, the CD4 T cells, CD8 T cells, CD19 B cells, CD16 natural killer (NK) cells, and CD56 NK cells increase in number during intense exercise lasting at least one hour.

With respect to sex, the mean values of WBC, RBC, MCV, MCH, MCHC, LYM, MXD, NEUT, RDW-SD, PDW, and MPV were statistically insignificant ($P>0.05$) in both sexes. Whereas the mean values of HGB, HCT and RDW-CV of the male subjects were statistically increased ($P<0.05$) compared to female subjects. Our findings are in accord with the recent reports of Pradas, et al. [38] who found that after stimulated padel competition, significant gender differences were recorded in haematological responses involving HGB, HCT and RBC with men obtaining higher values ($P<0.05$) than women. Similarly, other authors have reported these differences. For example, in another study, Prada’s, et al. [39] had earlier reported significant gender difference with respect to HCT, HGB and RBC in professional padel players. The same differences have also been observed in swimmers [40] and in other sports [41-43]. Some authors have cited hormonal differences and differences in muscle mass and physical condition between genders to be responsible for this [41,43,44]. In contrast, the mean values of PLT were statistically significantly increased (P<0.05) in the female subjects compared to male subjects. Our finding is like the observations of Bezci and Kaya [12] who found a significantly increased (P<0.01) PLT count in sports women before and after training. Stevens and Alexander [45] reported that there may be a sex difference; thus, in women the platelet count has been reported to about 20% higher than in men.

Also, with respect to sex, the female subjects had a higher but not significant (P>0.05) CD4 count in comparison to their male counterparts. Our finding is in consonance with the earlier reports of Oladepo, et al. [46] and Miri-Dashe, et al. [47] who in their separate studies reported that female subjects recorded higher CD4 counts than male subjects. Somewhere else, other authors such as Tugume, et al. [48], Prins, et al. [49] and Njoku, et al. [50] have also reported similar findings. According to Prins, et al. [49], a sex hormone effect is one of the possible explanations for the reported difference in CD4 counts between genders.In terms of age, there was no statistically significant difference (P>0.05) in the haematological and CD4 parameters of the sportpersons studied in the study area. In terms of the haematolgical parameters of the sports- persons, our result is supported by Helman and Rubenstein [51] and Kelly and Munan [52] who have reported that the Haemoglobin content (HGB) and Red-Cell Count (RBC) normally rise gradually to almost adult levels by the time of puberty; thereafter the levels in women tend to be significantly lower than those of men. Alan and Alexander [53] and Cruickshank [54] have also reported that sex differences are insignificant in the total leucocyte count until after the age of fifty when the count becomes less in women than in women. In terms of platelets, Lewis [55] reported that within the wide normal range, there were no obvious age differences. With respect to CD4 count and age, our result is tandem with observations of Adoga, et al. [56] who reported the CD4 count did not correlate directly with age. This also agrees with the earlier studies in China and India that found no significant association between CD4 values and age [57-59]. Yan, et al. [60] also observed that there were no significant changes in the percentage of CD4+ cells according to age. In contrast, Ray, et al. [61] observed that changes in age influenced the subset values marginally in both sexes and stated that with advancement of age, the CD4 mean counts decreased consistently in males while an increase was seen in females with advancing age. Our finding was contradicted by Tomschi, et al. [62] who observed that when they separated the subjects they studied by age, the RBC deformability increased with age in male but not in female athletes. They also observed that MCV and HCT increased with increasing age.

The results of this study also showed that there was no significant difference (P>0.05) in the haematological and CD4 parameters of the subjects studied in relation to the type of sports they engaged in. Nevertheless, our findings were dissimilar to the earlier reports of Schumacher, et al. [22] who used three distinctive sporting categories of endurance strength and mixed-training exercises to observe reduction in the HGB, HCT and RBC levels in subjects in the endurance category compared with strength and mixed-training exercises. Similarly, Ceylan, et al. [19] have reported that the HGB was significantly decreased in aerobic dance group compared with the step dance group and they reasoned that this reduction may be associated with malnutrition rather than exercise. Furthermore, Cicek [20] observed a meaningful decrease in the values of RBC, HGB, HCT and MCV of the strength exercise group compared to aerobic exercise. In addition, Silva, et al. [35] noted that when exercise intensities were stratified, only intense training proved to have a significant effect on CD4 count. The different study groups recruited by these authors could be a possible explanation for the statistically significant results observed by them. The reason for the non-significant results we found in our study is not clear, but this may be attributed to the nature of subjects we recruited. For instance, while we recruited subjects involved mostly in aerobic exercises, other authors recruited subjects that were involved in different kinds of training exercises. In conclusion, there was a significant difference (P<0.05) in the mean values of HGB, HCT and PLT of post-exercise subjects compared to pre-exercise subjects. Furthermore, with respect to sex, the HGB and HCT of the female subjects were significantly reduced compared to male subjects. On the other hand, the PLT and RDW-CV of the female subjects were significantly increased compared to their male counterparts. Age and categories of sport did not affect the haematological and CD4 parameters of the subjects studied.

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