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ORIGINAL RESEARCH

Haematological responses of HIV-seropositive patients to aerobic and resistance exercise training programs

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Abstract. This study investigated the alterations of haematologic parameters of HIV-positive patients due to a 10-week aerobic and resistance exercise training. The study examined the influence of aerobic and resistance exercises on White Blood Cells (WBC), Red Blood Cells (RBC), Haematocrit (HCT), and Platelets (PLT). The pretest-posttest control-group experimental design was employed in this study. Eighty-eight HIV-seropositive patients in the first two stages of HIV and attending the outpatient clinic at the University of Benin Teaching Hospital participated in the study. Randomization was done into control (30) and two experimental groups, aerobic exercise (28) and resistance exercise (30). The experimental groups exercised for 45 minutes, thrice a week for 10 weeks and the non-experimental group received usual anti-retroviral drugs and counseling. The initial intensity of the exercise was 60% HRmax and 1-RM and progression was by 10% every 3 weeks. Haematologic parameters were recorded initially and on termination of 10 weeks for all three groups. Frequency, mean, standard deviation, and analysis of co-variates (ANCOVA) were used for data analysis. The Bonferroni pairwise comparison was used as a Post-hoc test to identify the source of differences. The outcome of this research showed that exercise resulted in significant alterations in haematologic parameters of WBC, RBC, HCT, and PLT. Recommendations were made based on the outcome of this research that health personnel should prescribe exercise for HIV-infected persons due to the enhancement of haematologic parameters which in turn improves health.

Keywords. Exercise, haematological, human immunodeficiency virus.

Introduction

Human Immunodeficiency Virus (HIV) is a retrovirus that targets cells of the immune system resulting in destruction or functional impairment and overall progressive degradation of the immune system known as "immune deficiency". There has been an enormous reduction in the mortality rate of HIV-infected persons with the discovery and use of Highly Active Anti-Retroviral Therapy (HAART) leading to an improvement in their life expectancy thus making the infection a chronic one. Long-term HIV infection generally presents with muscle atrophy, paresis, lethargy, impaired functional work capacity, despondency, and decreased quality of life, culminating in infirmity and mortality (Bopp et al., 2003).

The effects of HIV infection are also present in the haematological system of the human body. HIV infects haematopoietic precursor cells and sets up dormant cellular storage, disorganizes the bone marrow microenvironment, and also brings about immune disruption (Vishnu & Aboulafia, 2015). Thus, hematological anomalies are frequent problems associated with HIV infection which increases with the

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progression of the disease. Different types of hematological abnormalities occur in individuals on treatment with antiretroviral medications and those who are not. These abnormalities could be due to the effects of the virus causing ineffectual hematopoiesis, nutritional inadequacies, or adverse outcomes of the medications (Akinbami et al., 2010). These haematological abnormalities could manifest as a reduction in red blood cells (anemia), white blood cells (leucopenia), platelets (thrombocytopenia), and even blood clots (thrombosis). The extent of suppression of immunity and extensive reduction in the blood composition is implicated in the possibility of HIV patients' development of severe HIV-related disease (Mohamad et al., 2015). In order to combat these complications of HIV/AIDS and side-effect of HAART, the most common practice is to prescribe medications that add to the pill burden of the patients and oftentimes result in polypharmacy. Based on this, the use of exercise as a non-pharmacological therapy has become vital in sustaining the physiological and fitness status of individuals with HIV/AIDS without the adverse reactions associated with pharmacological treatment.

Exercise has been reported in several studies as a means of preventing chronic ailments and also helps in improving the standard of living of persons with long-term diseases such as diabetes mellitus, chronic obstructive airway diseases, cancers, and depression (Adodo & Omoifo, 2011; American College of Sports Medicine [ACSM], 2010). Its benefits in the prevention of non-communicable diseases have also been well documented globally (Adodo & Omoifo, 2011; Sheikoleslami Ghanbarian, & Azizi, 2018; Saqib et al., 2020). These exercises have the capacity to mitigate a range of adverse outcomes related to HIV infection and the cardiometabolic and morphological distortions that may be associated with HAART.

The respiratory, cardiovascular, and neuromuscular systems undergo many physiological and biochemical changes as consequences of both aerobic and anaerobic exercises which places a great demand on these systems (O'Brien et al., 2016). The effectiveness of the heart in pumping and transporting oxygenated blood to the muscle tissues increases in response to exercise and thus, blood volume is increased with the formation of new capillaries to deliver more blood to the trained muscles. This in turn improves dilatation of existing capillaries, increases haematological profile, blood serology, and improves the efficiency of blood distribution. Aerobic exercise programs like cycling, walking and jogging have been identified as ways to decrease blood sugar levels, total cholesterol, triglycerides, and low-density lipoprotein (LDL) cholesterol while elevating high-density lipoprotein (HDL) cholesterol (Igarashi et al., 2019; Elsayyad et al., 2020).

Therefore, exercise is commonly recommended by physical therapists as a major approach used by individuals infected with HIV (Crystal et al., 2000; Dudgeon et al., 2004). Individual reactions to exercise are particularly contingent upon the exact type of training carried out. There is no unanimity in consideration of the mode, frequency, and intensity of exercises that are more essential in HIV-seropositive patients, thereby making it tougher to make a choice on the utmost training for this group of patients (Gomes-Neto et al., 2013). An improved comprehension of the efficacy and safety of exercise training will enhance effective practice and suitable exercise prescription for People Living with HIV/AIDS (PLWHA) by health care practitioners. Consequently, this study was carried out to examine the changes in haematological parameters of HIV-seropositive patients following exercise training.

Methods

The pretest-posttest experimental and control group design was adopted for this study. The population of this study included five hundred and twenty (520) registered HIV-seropositive patients in the first two stages of HIV who were attending the outpatient clinic between May and July 2019 at the Consultant Out-Patient Department (COPD) of the University of Benin Teaching Hospital (UBTH), Benin-City, Nigeria. The study protocol was approved by the Ethics and Research Committee of UBTH (ADM/E 22/A/VOL.VII/14714) and it was carried out in accordance with the Code of Ethics of the World Medical Association also known as a declaration of Helsinki. The sample size for the study was 106 participants who were selected based on a purposive sampling technique using inclusion and exclusion criteria, followed by simple random sampling. Thereafter, the participants were randomly assigned to any of the three groups namely: control group (CG), aerobic exercise group (AEG), and resistance exercise group (REG). However, eighty-eight HIV-seropositive patients concluded the study. Randomization was done into control (n=30) and two experimental groups,

aerobic exercise (n=28) and resistance exercise (n=30).

Prior to the commencement of the 10-week exercise training, haematological parameters of WBC, RBC, HCT, and PLT were measured. Medical laboratory scientists collected 5ml blood samples from the participants with tripotassiumethylene diamine tetraacetic acid (K3EDTA) bottles for analysis of the full blood count of the participants in the three groups using standard venipuncture procedure. The FBC parameters were derived based on the Beckman Coulter method of counting and sizing combined with an automatic diluting and mixing device as well as a single beam photometer. This generated results for WBC, RBC, HCT, and PLT. These were performed at baseline and completion of the study by the same medical laboratory scientist in order to minimize error and ensure reliability.

ACSM (2009) exercise training protocol for the immune-compromised population was adapted as the intervention exercise protocol for the AEG and REG participants. Prior to the commencement of the exercise training protocol, the maximum weight each participant could lift through the range of motion (1 repetition maximum) was determined and recorded. The participants in the aerobic and resistance exercise groups took part in 10 weeks of exercise training programs at a frequency of 3 times per week (Monday, Wednesday, and Friday). Each session was for a maximum of 40 minutes, 10 minutes warm-up, 20 minutes cycling on the bicycle ergometer at 60% HRR or 20 minutes of resistance exercise with dumbbells and ankle weights at 60% one-repetition maximum (60% 1RM) and 10 minutes cool down. Each resistance exercise involved a dosage of 3 sets of 10 repetitions with 30 seconds of rest between each set. A total of 8 muscle groups were targeted (Biceps, triceps, deltoid, shoulder abductors, quadriceps, hamstrings, hip abductors) the in upper and lower extremities. The session ended 10-minute recovery and relaxation phase and stretches. There was a progression of exercise intensity done every three weeks. The CG participants were encouraged to take their daily anti-retroviral medications (HAART) and other prescribed medications while maintaining their normal daily routine activities and abstain from any exercise program for the duration of the 10-week study. They were monitored weekly via phone calls and text messages to maintain their interest programme. At the end of the 10 weeks, all participants were post-tested.

Descriptive statistics of percentages of mean and standard deviation were used to present the demographic data and clinical characteristics of the participants while inferential statistics of Analysis of Covariance (ANCOVA) were used to determine the differential efficacy of the two independent variables on the dependent variables. This statistical measure helped to determine the significant mean differences observed in the post-treatment data between the groups (control, aerobic exercise, and resistance exercise groups) while controlling the influence of the pre-treatment data. Where there was a significant difference, Bonferroni Post-hoc analysis was used for pairwise comparison thus identifying the sources of the differences. Statistical significance was set at a p-value of <0.05. All analysis was done using the Statistical Package for Social Sciences (SPSS version 22.0).

Results

Table 1 presents the socio-demographic and clinical characteristics of the participants. 59.1% were female while 40.9% were male. Most of them were married (56.8%) with secondary level of education (46.6%). Most of the participants were engaged in business as an occupation. A majority had been diagnosed with HIV for over 10 years (50%) and they have been on HAART (72.7%).

Table 2 shows that there was a statistically significant alteration in the white blood cell count of the HIV-seropositive patients in the control, aerobic, and exercise groups following 10 weeks of exercise training ($F=6.029$; $p=0.004$). Due to this significant difference, the null hypothesis 1 stated above is hereby rejected. Post-hoc analysis using Bonferroni pairwise comparison was carried out to detect where the significant difference lies precisely as shown in Table 3. The comparison between groups showed that there was a significant alteration of the WBC count of the resistance exercise group compared with the aerobic exercise and control groups with mean differences of 1.057 and 1.221 respectively.

ANCOVA presented in Table 4 shows that the RBC count of the HIV-seropositive patients in the control, aerobic, and exercise groups following 10 weeks of exercise training differed significantly ($F=26.229$; $p=0.000$). Due to this significant difference, null hypothesis 2 is hereby rejected. The post-doc comparison as presented in Table 5 showed that the RBC of the participants in the aerobic exercise and

resistance exercise groups also improved significantly more than those in the control group with a mean difference of 0.784 and 0.398 respectively.

Table 1
Socio-demographic and Clinical Characteristics of HIV- Seropositive Patients.

Variables	%
Gender	
Male	40.9
Female	59.1
Age(years)	
Mean±SD	44.10±8.668
Marital Status	
Single	19.3
Married	56.8
Widowed	20.5
Divorced/separated	3.4
Educational Level	
None	5.7
Primary	20.5
Secondary	46.6
Tertiary	27.3
Occupation	
Civil servant	13.6
Business	68.2
Artisan	5.7
Unemployed	12.5
Duration of Diagnosis (years)	
< 1	5.7
1 – 3	11.4
4 – 6	10.2
7 – 9	22.7
>10	50.0
Duration of HAART intake (months)	
1-5	8
6-10	1.1
11-15	15.9
16-20	2.3
> 20	72.7

Table 6 shows that there was a statistically significant alteration in the mean HCT level of the HIV-seropositive patients in the control, aerobic, and exercise groups following 10 weeks of exercise training (F=6.537; *p*=0.002). Therefore, null hypothesis 3 is hereby rejected. Pairwise comparison was carried out as shown in Table 7 that the haematocrit of the participants in the two exercise groups improved significantly compared with the participants in the control group with a mean difference of 1.572 and 1.515 respectively.

ANCOVA presented in Table 8 shows that there was a statistically significant alteration in the mean platelet count of the HIV-seropositive patients in the control, aerobic, and exercise groups following 10 weeks of exercise training (F=3.449; *p*=0.036). Therefore, the null hypothesis 4 stated above is hereby rejected. The post-doc analysis in Table 9 shows that there was a significant improvement in the platelet count of the participants in the aerobic exercise group following 10 weeks of exercise training compared to the resistance exercise group with a mean difference of 27.944 but the mean differences between aerobic and resistance group as well as that of resistance and control groups were not significant statistically.

Discussion

The result of this study showed that 10 weeks of aerobic and resistance training had a significant positive impact on the WBC, RBC, haematocrit, and platelets of HIV seropositive patients in the exercise groups compared with those in the control group who did not engage in exercise training throughout the 10 weeks. Specifically, there was a significant increase in the WBC, RBC, haematocrit, and platelet counts of the participants in both the aerobic exercise group and resistance exercise group in comparison with those in the control group. This alludes to the fact that moderate-intensity exercise training might be of importance in the immune response to HIV infection since CD4 cells; the main targets of the retrovirus are class of WBC.

Haematological abnormalities have been documented as strong independent predictors of morbidity and mortality in HIV-infected individuals (Anastos et al., 2004). Also, haematological complications such as mild-to-severe anemia are associated with HIV disease progression and subsequently reduced survival (Obirikorang & Yeboah, 2009). Anemia was the most common haematological derangement found among Rwandan women infected with HIV (Munyazesa, 2012). The risk of anemia increases as the HIV infection advances and it is known to occur with increasing frequency in the early stages of the infection (Taye, 2016). Exercise has been shown to increase hemoglobin, platelets and haematocrit numbers in young and individuals and these haematological changes suggest that exercise possibly has physiologic impact by mobilizing stem cells thereby enhancing mechanisms that promote tissue repair (Wardyn et al., 2008).

Table 2
Analysis of covariance of white blood cell count of HIV-seropositive patients.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	ηp2
Corrected Model	48.925[a]	3	16.308	7.814	.000*	.218
Intercept	298.672	1	298.672	143.108	.000*	.630
Pre WBC	23.124	1	23.124	11.080	.001*	.117
Group	25.165	2	12.582	6.029	.004*	.126
Error	175.311	84	2.087			
Total	2356.368	88				
Corrected Total	224.236	87				

** p < .05*

Table 3
Bonferroni pairwise comparison for white blood cell count of HIV-seropositive patients.

					95% Confidence Interval for Difference	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Aerobic	Resistance	-1.057*	.382	.021	-1.991	-.123
	Control	.164	.380	1.000	-.764	1.091
Resistance	Aerobic	1.057*	.382	.021	.123	1.991
	Control	1.221*	.380	.006	.291	2.150
Control	Aerobic	-.164	.380	1.000	-1.091	.764
	Resistance	-1.221*	.380	.006	-2.150	-.291

** p < .05*

Table 4
Analysis of covariance of red blood cell counts of HIV-seropositive patients.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	ηp2
Corrected Model	20.566[a]	3	6.855	38.984	.000*	.582
Intercept	5.621	1	5.621	31.966	.000*	.276
Pre_RBC	10.756	1	10.756	61.169	.000*	.421
Group	9.225	2	4.612	26.229	.000*	.384
Error	14.771	84	.176			
Total	1597.416	88				
Corrected Total	35.337	87				

*a. R Squared = .582 (Adjusted R Squared = .567); * p < .05*

Table 5
Bonferroni pairwise comparison for red blood cell count of HIV-seropositive patients.

					95% Confidence Interval for Difference	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Aerobic	Resistance	.386*	.110	.002	.117	.656
	Control	.784*	.108	.000	.520	1.049
Resistance	Aerobic	-.386*	.110	.002	-.656	-.117
	Control	.398*	.110	.002	.129	.667
Control	Aerobic	-.784*	.108	.000	-1.049	-.520
	Resistance	-.398*	.110	.002	-.667	-.129

** p < .05*

Table 6
Analysis of covariance of haematocrit of HIV-seropositive patients.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	ηp2
Corrected Model	344.737[a]	3	114.912	31.934	.000*	.533
Intercept	204.774	1	204.774	56.907	.000*	.404
Pre Haematocrit	298.363	1	298.363	82.915	.000*	.497
Group	47.043	2	23.521	6.537	.002*	.135
Error	302.266	84	3.598			
Total	129871.240	88				
Corrected Total	647.003	87				

*a. R Squared = .533 (Adjusted R Squared = .516); * p < .05*

Table 7
Bonferroni pairwise comparison for haematocrit count of HIV-seropositive patients.

					95% Confidence Interval for Difference	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Aerobic	Resistance	.057	.509	1.000	-1.187	1.300
	Control	1.572*	.495	.006	.362	2.782
Resistance	Aerobic	-.057	.509	1.000	-1.300	1.187
	Control	1.515*	.499	.010	.295	2.735
Control	Aerobic	-1.572*	.495	.006	-2.782	-.362
	Resistance	-1.515*	.499	.010	-2.735	-.295

** p < .05*

Table 8
Analysis of covariance of platelets of HIV-seropositive patients.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	ηp2
Corrected Model	514060.719[a]	3	171353.573	107.036	.000*	.793
Intercept	6627.791	1	6627.791	4.140	.045*	.047
Pre Platelet	462403.467	1	462403.467	288.840	.000*	.775
Group	11042.694	2	5521.347	3.449	.036*	.076
Error	134475.645	84	1600.901			
Total	4874362.000	88				
Corrected Total	648536.364	87				

*a. R Squared = .793 (Adjusted R Squared = .785); * p < .05*

Table 9
Bonferroni pairwise comparison for platelets of HIV-seropositive patients.

					95% Confidence Interval for Difference[b]	
+(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
Aerobic	Resistance	27.944*	10.652	.031	1.923	53.964
	Control	12.762	10.481	.680	-12.843	38.366
Resistance	Aerobic	-27.944*	10.652	.031	-53.964	-1.923
	Control	-15.182	10.514	.457	-40.866	10.502
Control	Aerobic	-12.762	10.481	.680	-38.366	12.843
	Resistance	15.182	10.514	.457	-10.502	40.866

** p < .05*

The findings of this study agree with those of Taye (2016) in Ethiopia who examined the effect of floor aerobic exercise on adult male and female HIV-positive individuals which resulted in a significant increase in WBC, RBC, HCT and PLT. Szygula (1990) also agrees that there was a significant improvement in erythrocytes as a result of engagement in regular physical activities. Agbonlahor & Kubeyinje (2020) found that 6 weeks of aerobic and resistance exercise training significantly improved white blood cells, red blood cells, and haematocrit in female HIV-positive patients. Ezema et al. (2014) also found that 8 weeks of aerobic exercise on cardiovascular and immunologic parameters of PLWHA resulted in a statistically significant increase in CD4 cells, a component of the WBC. Similarly, Maduagwu et al. (2015) found that there was a significant improvement in CD4 cell count after 12 weeks of moderate intensity aerobic (treadmill) exercise.

The enhancement of haematological parameters especially the white blood cells as shown in this study plays a vital role in the ability of the body to mount up a defense against the invading retrovirus. The proliferation of erythrocytes also assists in tissue repair, the oxygen-carrying capacity of the blood, and thus, reducing fatigue and improving the physical performance of the participants. Furthermore, thrombocytopenia has been shown to be one of the haematological complications of HIV infections. Therefore, the improvement in the platelet counts seen in this study buttresses the important role exercise plays in haematopoiesis and this could help in reducing the morbidity and mortality rates among PLWHA as uncontrolled bleeding is minimized.

Based on the findings that emanated from this study, it was therefore concluded that the haematological parameters of WBC, RBC, haematocrit, and platelets were significantly improved in adult HIV-seropositive patients following 10 weeks of aerobic and resistance exercise training.

Authors' Contribution

Study Design: OSK, SO, SMA; Data Collection: OSK, SO, SMA; Statistical Analysis: OSK, SO; Manuscript Preparation: OSK, SO, SMA; Funds Collection: OSK, SO, SMA.

Ethical approval

The study was approved by the Ethics and Research Committee of UBTH (ADM/E 22/A/VOL.VII/14714) and it was carried out in accordance with the Code of Ethics of the World Medical Association also known as a declaration of Helsinki.

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Conflict of Interest

The authors hereby declare that there was no conflict of interest in conducting this research.

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