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Research Article
Association of Leukocyte with Maximal Oxygen Uptake in Trained and Untrained Healthy Adult Males

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Abstract

Background and Objective: Despite the tremendous health benefits exercise training confers on the cardiac functions or coronary heart disease, the precise mechanisms by which exercise training improves heart function and cardiovascular disease are not well investigated. This study was designed to investigate the association between leukocyte count and maximal oxygen uptake in trained and untrained healthy adult males. **Materials and Methods:** Data were collected from 20 trained and 20 untrained adult healthy males of age (18-25 years), weight (60.25±1.3 kg) and height (1.76±0.0 m). The evaluation was completed between November 1, 2013 and January 31, 2014 in the Department of Human Physiology, of Ahmadu Bello University Zaria, Nigeria. The study procedure was approved by the Ahmadu Bello University Teaching Hospital Human Research Ethics Committee. A non-exercise regression equation was performed to determine the estimated maximal oxygen uptake (VO_2 max). Statistical analysis was done by using student's unpaired t-test with the social sciences (SPSS) software (version 20.0 for Windows; SPSS Inc., Chicago, IL) was used. Linear regression analysis was also used for prediction of any association. The level of significance was set at $p<0.05$. **Results:** The univariate regression analysis showed that VO_2 max was correlated with leukocyte counts. VO_2 max was negatively and positively associated with leukocyte counts in the trained ($r = -0.218$, $p<0.05$) and the untrained ($r = 0.030$, $p<0.05$) respectively. **Conclusion:** These results suggested that VO_2 max is a sensitive factor of inflammatory status that confers cardiovascular protective effects in the trained adult males.

Key words: Aerobic capacity, leukocyte count, VO_2 max, inflammation, cardiovascular effects

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Cardiovascular disorders are becoming an emergent public health problem worldwide[1]. The number of incidence has increased from 594 million in 1975-1.13 billion in 2015[2]. There is growing concern that the incidence of cardiovascular disease is increasing in Nigeria and Africa and portends a grave situation in this region of the world where most health resources are channeled into combating infectious diseases and malaria[3]. Though physical activity (PA) appears in general to induced changes in body organ systems[4], Specific training regimens induced specific modifications on the structure and functions of the organ systems[5]. Epidemiological studies have established that an increase in the level of physical activities is associated with improved notable health outcomes[6]. Several mechanisms were proposed including the downregulation of several inflammatory markers[7]. "Recently, the results obtained from the Italian diabetes and exercise study suggested that the anti-inflammatory effect of exercise training was dependent on type, dose and intensity of exercise"[8]. However, more data on inflammatory markers are required to fully elucidate the training induced anti inflammation and how this translates to benefit the cardiopulmonary function and disorders. Unfortunately, none of these studies compared the VO_2 max and inflammatory markers in trained and untrained healthy adult humans so far. VO_2 max is known to reflects the function of the cardiopulmonary system or as a risk factor for atherosclerosis[9]. The objective of this research was to examine the relationship between the VO_2 max and leukocyte counts in trained and untrained healthy adult males. It was hypothesize that increases in VO_2 max in the trained decrease the inflammatory markers. This study was designed to investigate the association of leukocyte count with maximal oxygen uptake in trained and untrained healthy adult males. This study had significantly uncovers mechanism by which exercise training improve cardiovascular function and disease. Thus, a new theory on exercise induced anti-inflammation and cardioprotection may be arrived at.

MATERIALS AND METHODS

The data of this study were collected from the trained and untrained adult healthy males, at the Department of Human Physiology , Ahmadu Bello University Zaria, Nigeria in which the evaluation was completed between November 1, 2013 and January 31, 2014. This study was approved by the Human Research Ethics Committee of the Ahmadu Bello University Teaching Hospital, Zaria, Nigeria. All volunteers gave written, informed consent before the procedures.

About 40 healthy male volunteers with age (18-25 years), weight (60.25±1.3 kg) and height (1.76±0.0 m) matched were recruited for this study. Trained subjects (20) are those that have history of regular (more than 4-5 h/week) participation in aerobic exercise (endurance trained foot ballers) and higher maximum oxygen uptake (VO_2 max) of 58.39±0.3 mL kg^{-1} min^{-1}. About 20 untrained subjects are those that have lower VO_2 max of 50.26±0.3 mL kg^{-1} min^{-1} and participated in less than 2 h/week of any kind of physical activity. The exclusion criteria include smoking, history of bleeding disorders, diseases of the circulatory system, family history of coronary heart disease, thrombosis and diabetes.

Preliminary testing: One week before the study, health screening, anthropometric measurements and maximal oxygen uptake measurements were completed. The subjects were asked to refrain themselves from any form of strenuous physical activity for at least 24 h prior to the tests. The subjects were also instructed not to take tea or coffee or cola nut before coming for the tests. All subjects were assessed for VO_2 max as previously described by Jackson *et al.*[10]. The estimation of VO_2 max with this test requires a score from a simple exercise history questionnaire in addition to age, height, weight and gender. No exercise was performed but a measure of past exercise was determined by the questionnaire. The VO_2 max was then computed using the Eq.[10]:

$$VO_2\ max\ (mL\ kg^{-1}\ min^{-1}) = 56.363+(1.921\times PA\text{-}R)-(0.381\times AGE)-(0.754\times BMI)+(10.987\times Gender)$$

Where:
Male = 1
Female = 0
BMI = Weight in kg/height in m
PA-R = Score on the physical activity questionnaire

Results obtained were rated using a standard VO_2 max table.

The CV (%) for this measurement was 2.84% at 58.40 mL kg^{-1} min^{-1} and 3.00% at 50.30 mL kg^{-1} min^{-1} for the trained and untrained resting VO_2 max, respectively.

Experimental trial: On the morning of an experiment, subjects reported to the laboratory between 09:00 and 11:00 am after they were fasted for 12-14 h overnight. After a rest period of 10 min, a venous blood sample (3 mL) was collected and analyzed for leukocyte count, by flow cytometry[11] (Beckman-Coulter). The CV (%) for this assay was

8.19% at 134.50±50 SEM mm^3 and 5.27% at 140.10±50 mm^3 for the trained and untrained resting blood leukocyte count, respectively. The resting heart rate, systolic blood pressure and diastolic blood pressure were also measured at the same time using an automated blood pressure monitor (Omron) for both subjects. The CV (%) for this measurement was 14.83% at 65.40 beat min^{-1} and 20.30% at 80.40 beat min^{-1}, in the trained and untrained resting heart rate, respectively. The CV (%) for this measurement was 7.34% at 128.05 mmHg and 8.36% at 128.00 mmHg for the trained and untrained resting systolic blood pressure, respectively. The CV (%) for this measurement was 10.84% at 74.15mmHg and 11.35% at 69.05 mmHg for the trained and untrained resting diastolic blood pressure, respectively.

Statistical analysis: The data generated were expressed as mean±standard error of mean. For statistical analysis, social sciences (SPSS) software (version 20.0 for Windows; SPSS Inc., Chicago, IL) was used; statistical significance was assessed by the independent samples t-test to compare values between the 2 groups. Associations among measured parameters were analyzed using Pearson's linear regression (coefficient, r). A comparison was considered statistically significant if $p<0.05$.

RESULTS

Baseline characteristics of the coronary risk factors were compared between the trained and untrained groups. BMI, heart rate, diastolic blood pressure and VO_2 max exhibited significant differences between the untrained and trained groups. Leukocyte counts in the untrained group (140.10±1.65×50 mm^3) was significantly ($p<0.05$) higher compared to the trained group (134.50±2.46×50 mm^3) (Table 1). The association of leukocyte counts with CAD risk factors was determined by univariate regression analysis. Leukocyte counts correlated positively with age, heart rate, systolic blood pressure ($p<0.0001$), VO_2 max ($p<0.05$) and negatively with BMI and diastolic blood pressure ($p<0.0001$), in the untrained group. Similarly, authors found, leukocyte counts correlated positively with age ($p<0.0001$), BMI, systolic blood pressure ($p<0.05$) and negatively with VO_2 max ($p<0.05$), heart rate, diastolic blood pressure ($p<0.0001$), in the trained group (Table 2).

Table 1: Differences in coronary risk factors in th untrained and trained groups

Coronary risk factors	Untrained	Trained
Age (years)	20.00±0.48	20.60±0.54
BMI (kg m^{-2})	20.20±0.31	19.35±0.29*
Heart rate (beat min^{-1})	80.40±3.64	65.40±2.17*
Systolic blood pressure (mmHg)	128.00±2.40	128.05±2.10
Diastolic blood pressure (mmHg)	69.05±1.80	74.15±1.80*
VO_2 max (mL kg^{-1} min^{-1})	50.30±1.50	58.40±1.70*
Leukocyte counts (X 50 mm^3)	140.10±1.65	134.50±2.46*

Data are expressed as mean±SEM. BMI: Body mass index, VO_2 max: Maximum oxygen uptake, *indicate significant difference at $p<0.05$ when compared with untrained group

Table 2: Association between leukocyte and coronary risk factors calculated by simple regression analysis

	Leukocyte counts			
	Untrained		Trained	
Coronary risk factors	Beta	p<0.05	Beta	p<0.05
Age (years)	0.000	0.000	0.166	0.000
BMI (kg m^{-2})	-0.047	0.000	0.162	0.011
Heart rate (beat min^{-1})	0.074	0.000	-0.022	0.000
Systolic blood pressure (mmHg)	0.171	0.000	0.026	0.002
Diastolic blood pressure (mmHg)	-0.023	0.000	-0.156	0.000
VO_2 max (mL kg^{-1} min^{-1})	0.030	0.034	-0.218	0.024

Data are expressed as the coefficient of correlation. BMI: Body mass index, VO_2 max: Maximum oxygen uptake

DISCUSSION

Epidemiological studies have described a complex relation between exercise and cardiovascular disease. The most interesting conclusion of this study is that VO_2 max which is regarded as the best measurement of cardiorespiratory endurance and overall aerobic fitness, correlated negatively with the leukocyte counts in the trained adult males. The trained demonstrated higher VO_2 max with significant decrease in the leukocyte counts as compared with the untrained group. The result from the present study is similar to the findings of the previous authors. Several studies have demonstrated an association between inflammatory markers and the level of physical activity[12-14]. In addition, Mora *et al.*[13] reported that decreased physical activity levels in middle-aged women were associated with increased levels of inflammatory markers.

Similarly, Ichihara *et al.*[14] reported that elevated CRP levels and white blood cell counts were associated with lower VO_2 max levels. Unfortunately, the precise mechanism between the VO_2 max and inflammation has not been clearly elucidated and remain unknown. However, Adamopoulos *et al.*[15] postulated that higher VO_2 max seen from endurance training could be effective enough to inhibit monocyte infiltration into the vascular wall. Therefore, increases in VO_2 max may be a sensitive marker of cardioprotection due to its potential to decrease leukocyte count in trained humans. The significant decreased in the leukocyte count is of clinical interest because, in general, these individuals have increased susceptibility to bacterial infections. However, since the leukocyte counts

reported in these studies were from active healthy trained humans, it is consider these findings most likely to reflect a training induced anti-inflammatory response operating within broader homeostatic limits indicating its cardiovascular protective effects. This study is novel, as to our knowledge, no studies to date have examined this association. This finding has implications for sports physicians, diagnosis or applied exercise physiology and general population. Limitations of the present study include the cross-sectional design, rendering causal inferences not possible. Additionally and although leukocytes are linked with cardiovascular risk, it was not possible to assess other components of leukocytes. Despite these limitations, major strengths of this study include an investigation of this under studied topic, using an objective measure of physical activity and employing a representative sample of trained and untrained adult males. Further studies are needed, with much focuses on the mechanism explaining the association between VO_2 max and leukocytes in the trained adult healthy humans.

CONCLUSION

An inverse relationship between VO_2 max and leukocyte counts was demonstrated in the trained adult healthy males. Therefore, VO_2 max could be a potential factor for cardioprotection.

SIGNIFICANCE STATEMENT

This study verifies the association between leukocyte count and maximal oxygen uptake in healthy adult trained males that can be beneficial for athletics (trained people). This study uncovers mechanism by which exercise improve cardiovascular function and disease. Thus, a new theory on exercise induced anti-inflammation and cardioprotection may be arrived at.

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