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Full Length Research Article

THE EFFECT OF EXERCISE AND TRAINING STATUS ON LEUCOCYTES COUNT

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ABSTRACT

Untrained and trained men respond differently to the same intensity of exercise, this is probably related to their physical activity levels. The aim of this study was to investigate the effect of an acute bout of exercise on leukocyte count in trained and untrained subjects and to observe if they respond differently to the same intensity of exercise.The practical significance of this study was that many sedentary people engage in occasional strenuous exercise that may predispose them to risk of heart disease(decrease immunity) and habitual, sustained exercise has been postulated to reduce the incidence of decrease immunity and ischemic heart disease. Fasting blood samples were collected from 40 male subjects, pre and post 90 minute football matches.Baseline leukocyte count increased significantly ($P<0.05$) after exercise in all subjects. Baseline leukocyte numbers in the trained were lower ($P<0.05$) than in the untrained ((134.50±2.46 X 50mm^3 vs. 140.10±1.65 X 50mm^3, P =0.009)), whereas leukocyte count in trained was higher ($P<0.05$) than in untrained immediately after the match (149.95±3.89 X 50mm^3 vs. 142.05±4.87 X 50mm^3, P =0.031).We conclude that leukocytes count of the subjects who are physically active and those who are sedentary respond differently to same exercise protocol.The lower leukocyte counts in athletes at rest might probably represent an adaptive response, not underlying pathology. This observation has implications for sports physicians or others involved in haematological assessment of healthy athletes in regular training, diagnostic and screening settings. Prospective longitudinal studies are needed to assess the gender responses to leukocyte count and exercise training.

Key words: Serum Leukocyte, Physical Activity Level, Trained, Untrained, Ischemic Heart Disease.

INTRODUCTION

Epidemiological studies have described a complex relation between exercise and cardiovascular disease (Powell *et al*., 1987). Habitual, sustained exercise has been postulated to reduce the incidence of ischemic heart disease (Morris *et al*., 1953; Morris *et al*., 1980; Paffenbarger *et al*., 1984; Kannel *et al*., 1986; Paffenbarger *et al*., 1986; Fletcher *et al*., 1992).However, acute exertion has also been reported to be a cardiovascular stressor particularly in men who are sedentary (Siscovic *et al*., 1984; Weaver *et al*., 1982). It has been shown that sustained exercise leads to an abrupt (first 10–20 minutes) increase in leucocytes in adults (Gabriel and Kinderman, 2001). This initial increase in the number of circulating leucocytes is believed to result from recruitment of cells from the marginal pool (Foster *et al*., 1986). The pulmonary and splanchnic vasculature are considered to be important reservoirs of this marginated pool (Nielsen *et al*., 1997; Hogg, 1987). In addition, leucocytes counts have recently been shown to be a predictor of cardiovascular events (Horne *et al*., 2005).

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Although several studies have reported that lower physical activity levels are associated with higher levels of inflammatory markers such as high-sensitivity CRP (hs-CRP) and leucocytes counts (Aronson *et al*., 2004; Mora *et al*., 2006; Ichihara *et al*., 2002). We hypothesize that leukocytes of the subjects who are physically active and those who are sedentary may respond differently to same exercise protocol.

MATERIALS AND METHODS

Forty healthy, age (18-25 years), weight (60.25±1.3 kg) and height (1.76±0.0m) matched; male volunteers were recruited for this present study, which was approved by the Ahmadu Bello University Teaching Hospital Human Research Ethics Committee. Twenty subjects were well trained, as defined by a history of regular (more than 4–5 h/week) participation in aerobic exercise (endurance trained foot ballers), higher maximum oxygen uptake (VO_2max of 58.39±0.3mL/kg per min). Twenty untrained subjects with lower VO_2max of 50.26±0.3mL/kg per min. participated in less than 2 h/week of any kind of activity. All subjects were non-smokers with no history of bleeding disorders, diseases of the circulatory system or family history of coronary heart disease, thrombosis or 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 hours 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_2max as described by Jackson *et al.*(1990).The estimation of VO_2max 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_2max was then computed using the formula:

VO_2max (ml.kg-1.min-1) = 56.363 + (1.921 × PA-R) - (0.381 × AGE) - (0.754 × BMI) + (10.987 × Gender)

Where: Male = 1, Female = 0
BMI = Weight in kg / Height^2 in meters
PA-R = Score on the physical activity questionnaire
Results obtained were rated using a standard VO_2max table.

Experimental trial

On the morning of an experiment subjects reported to the field between 09:00 and 011:00 h after a 12–14-h overnight fast. After a rest period of 10 min, a venous blood sample (3 mL) was collected. The subjects then commenced 90 minute football match. A further blood sample (3 mL) was taken immediately upon completion of the match, and analyzed for leucocyte count, by flow cytometry. The %CV for this assay was 11.60% at 149.95 X 50mm^3 and 15.34% at 142.05 X 50mm3 for the trained and untrained post-acute exercise blood leukocyte count, respectively. The %CV for this assay was 8.19% at 134.50 X 50mm^3 and 5.27% at 140.10 X 50mm^3 for the trained and untrained pre-acute exercise blood leukocyte count, respectively.

Acute Exercise Study

The study involved a 90 minute football match as described by Rahnama *et al.* (2009).The match consists of 45 minute each after which there was sides change between the playing teams. It was organized for the athletic and the non-athletic group on separate days. The athletic group played as two separate teams on day one, while the non-athletic group played as two separate teams on day two of the test. This test was done on a standard football field measuring 100 by 70 meters.

Statistical analysis

The data generated were expressed as mean ± standard error of mean (X±SEM). For statistical analysis, SPSS software (version 20.0) was used; the independent samples-t -test was used to compare values between the two groups. A comparison was considered statistically significant if the P value was < 0.05.

RESULTS

Table 1 show the subject Leukocyte Count Test resultspre and post exercise in trained and untrained healthy adult male.

Trained subjects showed significantly lower (P<0.05) Leukocyte Counts compared with untrained at rest (134.50±2.46 X 50mm^3 vs. 140.10±1.65 X 50mm^3, P =0.009). Leukocyte Counts increased in all subjects after exercise (Table 1). However, the increase was only significant(P<0.05) in the trained and not in the untrained subjects.Trained subjects had significantly (P<0.05) higher leukocyte counts compared with the sedentary subjects after the exercise (149.95±3.89X 50mm^3 vs. 142.05±4.87X 50mm^3, P =0.031).

Table 1. Leucocyte Count Test results pre and post exercise in trained and untrained healthy adult male

VARIALE	Exercise	Sedentary	Trained
Leucocyte Count (X 50mm^3)	Pre Exercise	140.10±1.65	134.50±2.46
	Post Exercise	142.05±4.87^{Ns}	149.95±3.89*
	Pre Vs Pre	140.10±1.65	134.50±2.46*
	Post Vs Post	142.05±4.87	149.95±3.89*

* Significant at P<0.05
Ns non significant (p>0.05)

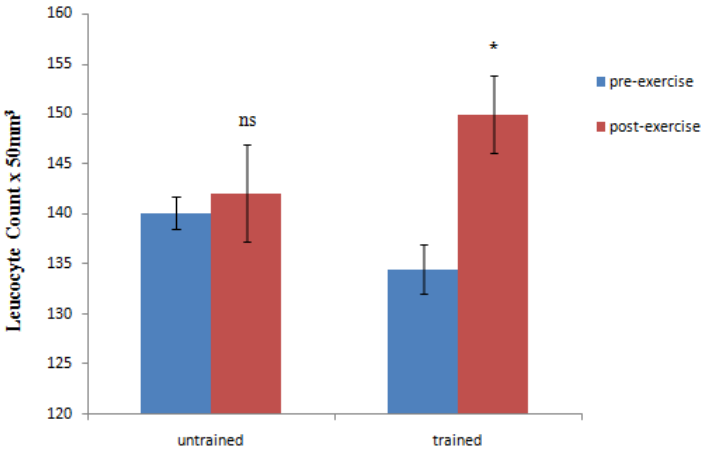

Figure 1. Leucocyte Count test results pre and post exercise in trained and untrained healthy adult male.

*** significant post exercise vs pre exercise**
ns non significant post exercise vs pre exercise

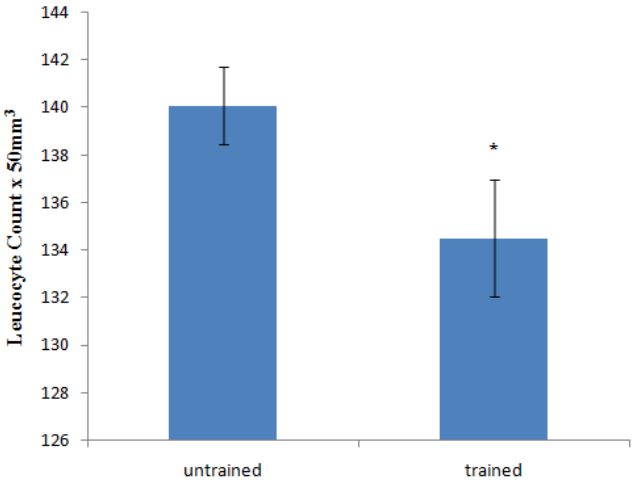

Figure 2. Leucocyte Count test results pre-exercise between trained and untrained healthy adult male.

*** significant (p<0.05) trained vs untrained**
ns non significant (p>0.05) trained vs untrained

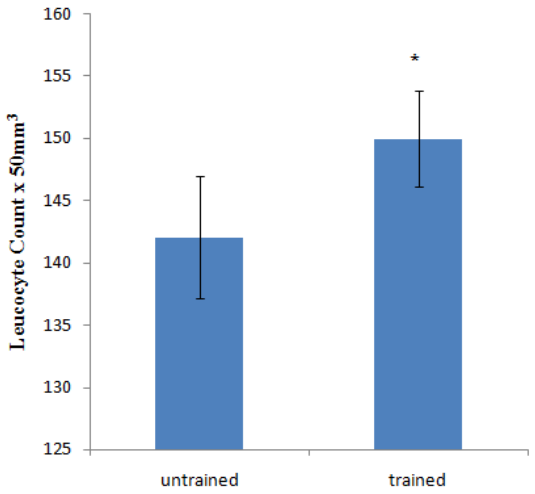

Figure 3. Leucocyte Count test results post-exercise between trained and untrained healthy adult male.

*** significant (p<0.05) trained vs untrained**
ns non significant (p>0.05) post exercise vs pre exercise

DISCUSSION

The present study was designed to observe the effect of exercise and training status on leukocytes count in trained and untrained apparently healthy adult males. The results of the present study demonstrated that: (1) Leukocyte Counts was higher in untrained compared with trained subjects at rest (140.10 x 50mm^{3}vs. 134.50 x 50mm^3), (2)Leukocyte Counts increased in all subjects after exercise. However, the increase was only significant (P<0.05) in the trained and not in the untrained subjects. (3)Trained subjects had a higher number of Leukocyte count compared with untrained subjects post exercise.(149.95 x 50mm^3 vs. 142.05 x 50mm^3, P = 0.031).The lower resting Leukocyte counts observed among the trained subjects may represent an anti-inflammatory adaptation induced by regular exercise training rather than pathological response (Horn *et al.,* 2010). Also the trained subject had high immune response than the untrained. This result is similar to the finding reported in elite endurance athletes in Horn *et al.* (2010) studies. In a contrary, volley ball players and long-distance runners in Saygin *et al.*(2006) study and orienteers in Risøy *et al.*(2003) study had higher neutrophil values at rest than sedentary controls.

The observed low leukocyte count is of clinical interest because, in general, these individuals have increased susceptibility to bacterial infections. Given the presence of multidrug-resistant bacteria in the community (including the sporting community), athletes must be vigilant with personal hygiene and pay attention to even seemingly trivial skin wounds (Buss *et al*., 2009; Redziniak *et al*., 2009; Saunders, 2009). As the low total leukocyte counts reported in our studies are from active healthy athlete at rest, we consider these findings most likely to reflect a training induced adaptive anti-inflammatory response operating within broader homeostatic limits. The reasons for the exercise-induced low leukocyte counts are unclear, but could include decreased cell production by bone marrow stem-cell precursors, increased cell destruction, increased transit rate into tissues, increased endothelial adhesion, or a mix of these mechanisms (Barreda *et al*., 2004). In addition, it is believed that leukocyte often increase during exercise in response to tissue damage, which may occur during vigorous exercise.

But as the cells move from the blood to the injured tissue, the leukocyte count usually decreases. This observation has implications for sports physicians or others involved in haematological assessment of healthy athletes in regular training.In addition, acuteexercisehas been shown to affects the number and the function of circulating cells of both innate adaptive immune systems (Walsh *et al*., 2011b). In 1932, Edwards and Wood described leukocytosis, an increase in total white blood cell count, in response to hard muscular work and increase seemed to be proportional to intensity and duration of the exercise. They described 200-300% leukocytosis in American football players immediately after the match. Authors also reviewed the results of the other researchers, who detected leukocytosis in athletes after marathon run and shorter distance runs (Edwards, 1932).

The data concerning the effects of the mode, duration and intensity of the exercise on leukocytosis is controversial. Gimenez *et al.* (1986) reported that endurance exercise induced leukocytosis was more related to the intensity than duration; in contrast Natale *et al.* 2003. found that prolonged exercise caused greater leukocytosis than high intensity short exercise and resistance exercise bout. In the present study, both protocols lasted about 90 minutes and thus seems that mode of the exercise (90 minute football match) affected the leukocytosis.Consistent with this, we found Physical fitness of the trained subjects to significantly increase the number of circulating leukocytes,immediatelyafter the 90 minutes football match compare with the untrained.

Conclusion

The present study show that leukocytes of the subjects who are physically active and those who are sedentary respond differently to same exercise protocol. This observation has implications for sports physicians or others involved in haematological assessment of healthy athletes in regular training, diagnostic and screening settings. Prospective longitudinal studies are needed to assess the gender responses to leukocyte count and exercise training.

REFERENCES

Aronson, D., Sheikh-Ahmad, M., Avizohar, O., Kerner, A., Sella, R., Bartha, P., Markiewicz, W., Levy ,Y., Brook, G.J. 2004. C Reactive protein is inversely related to physical fitness in middle-aged subjects. *Atherosclerosis,* 176:173-9.

Barreda, D.R., Hanington, P.C. and Belosevic, M. 2004. Regulation of myeloid development and function by colony stimulating factors. *Dev Comp Immunol.,* 28:509–554

Buss, B., Mueller, S., Theis, M., Keyser, A. and Safranek, T.J. 2009. Populationbased estimates of methicillin-resistant Staphylococcus areus (MRSA) infections among high school athletes. *J SchNurs.,* 25:282–291

Edwards, H. T. and W.,W.B. 1932. A study of leukocytosis in exercise.Arbeitsphysiologie; 6 (1-2), 73-83.

Fletcher, G.F., Blair, S.N., Blumenthal, J., Casperson, C., Chaitman, B., Falls, H., Froelicher, E.S., Froelicher, V.F. and Pina, I.P. 1992. Statement on exercise: Benefits and recommendations for physical activity programs for all Americans. Circulation86:340–344.

Foster, N.K., Martyn, J.B., Rangno, R.E., Hogg, J.C. and Pardy, R.L. 1986. Leukocytosis of exercise: role ofcardiac output and catecholamines. *J ApplPhysiol*61:2218–23.

Gabriel, H.H.W. and Kinderman, W. 2001. Adhesion molecules during immune responseto exercise. *Can J PhysiolPharmacol,* 76:512–23.

Gimenez, M., Mohan-Kumar, T., Humbert, J. C., De Talance, N. and Buisine, J. 1986. Leukocyte, lymphocyte and platelet response to dynamic exercise. Duration or intensity effect? European *journal of applied physiology and occupational physiology*, 55 (5), 465-470.

Hogg, J.C. 1987. Neutrophil kinetics and lung injury. *Physiol Rev.,* 67:1249–5.

Horn, P. L., Pyne, D. B., Hopkins, W. G. and Barnes, C. J. 2010. Lower white blood cell counts in elite athletes training for highly aerobic sports. *European journal of applied physiology,* 110 (5), 925-932.

Horne, B.D., Anderson, J.L., John, J.M., Weaver, A., Bair, T.L., Jensen, K.R., Renlund, D.G. and Muhlestein, J.B. 2005. Which white blood cell subtypes predict increased cardiovascular risk? *J.Am. CollCardiol,* 45:1638-43.

Ichihara, Y., Ohno, J., Suzuki, M., Anno, T., Sugino, M. and Nagata, K. 2002. Higher C-reactive protein concentration and white bloodcell count in subjects with more coronary risk factorsand/or lower physical fitness among apparently healthyJapanese. *Circ J.,* 66:677 -84.

Jackson, R. B., Manwaring, J.H. and Caldwell, M.M. 1990. Prediction of functional aerobic capacity without exercise testing.Medicine and Science in Sports and Exercise. 22:863-870.

Kannel, W.B., Belanger, A., D'Agostino, R., Israel, I. 1986. Physical activity and physical; demand on the job and the risk of cardiovascular disease and death. *Am Heart J.,* 112:820–825.

Mora, S., Lee, I.M., Buring, J.E. and Ridker, P.M. 2006. Association of physicalactivity and body mass index with novel and traditionalcardiovascular biomarkers. JAMA 295:1412-9.

Morris, J.N., Everitt, M.G., Pollard, R., Chave, S.P.W. and Semmence, A.M. 1980. Vigorous exercise in leisure-time: Protection against coronary heart disease. Lancet;ii:1207–1210, Bibliographic links.

Morris, J.N., Heady, J.A., Raffle, P.A.B. and Inco, A. 1953. A. Coronary heart disease and physical activity of work. Lancet; ii:1053–1057, Context links.

Nielsen, H.B., Secher, N.H., Kristensen, J.H., Christensen, N.J., Espersen, K. and Pedersen, B.K. 1997. Splenectomy impairslymphocytosis during maximal exercise. *Am. J. Physiol,* 272(6 Pt2):R1847–52.

Natale V.M., Brenner I.K., Moldoveanu A.I., Vasiliou P., Shek P. and Shepard R.J. 2003. Effect of three different types of exercise on blood leukocytes count during and following exercise. *Sao Paulo Medical Journal*, 121 (1): 9-14.

Paffenbarger, R.S., Hyde, R.T., Wing, A.L. and Hsieh, C.C. Physical activity, all-cause mortality, and the longevity of college alumni. *New Engl. J. Med*., 1986;314:605–613.

Paffenbarger, R.S., Hyde, R.T., Wing, A.L. and Steinmetz, C.H. 1984. A natural history of athleticism and cardiovascular health. *J Am Med Assoc,* 252:491–495.

Powell, K.E., Thompson, P.D., Caperson, C.J. and Kendrick, J.S. 1987. Physical activity and the incidence of coronary heart disease. *Annu Rev Public Health,* 8:253–287, Bibliographic links.

Rahnama, N., Younesian, A., Mohammadion, M. and Bambaeichi, E. 2009. A 90 minute soccer match decreases triglyceride and low density lipoprotein but not high-density lipoprotein and cholesterol levels. *Journal of Research in Medical Sciences,* Nov-Dec; 14(6): 335–341.

Redziniak, D., Diduch, D., Turman, K., Hart, J., Grindsta, V.T., Macknight, J. and Mistry, D. 2009. Methicillin-resistant Staphylococcus aureus(MRSA) in the athlete. *Int. J. Sports Med.,* 30:557–562

Risoy, B. A., Raastad, T., Hallen, J., Lappegard, K. T., Baeverfjord, K., Kravdal, A., Siebke, E. M. and Benestad, H. B. 2003. Delayed leukocytosis after hard strength and endurance exercise: aspects of regulatory mechanisms. BMC *physiology,* 3, 14.

Saunders, J. 2009. Reducing MRSA infections in college student athletes. *J Community Health Nurs.,* 26:161–172

Saygin, O., Karacabey, K., Ozmerdivenli, R., Zorba, E., Ilhan, F. and Bulut, V. 2006. Effect of chronic exercise on immunoglobin, complement and leukocyte types in volleyball players and athletes. *Neuro endocrinology letters,* 27 (1-2), 271-276.

Siscovic, D.S., Weiss, N.S., Fletcher, R.H. and Lasky, T. 1984. The incidence of primary cardiac arrest during vigorous exercise. *New Engl J Med.,*311:874–877.

Walsh, N. P., Gleeson, M., Shephard, R. J., Gleeson, M., Woods, J. A., Bishop, N. C., Fleshner, M., Green, C., Pedersen, B. K., Hoffman-Goetz, L., Rogers, C. J., Northoff, H., Abbasi, A. and Simon, P. 2011b . Position statement. Part one: Immune function and exercise. Exercise immunology review,; 17, 6-63.

Weaver, W.D., Cobb, L.A. and Halstrom, A.P. 1982. Characteristics of survivors of exertion and non exertion related cardiac arrest: Value of subsequent exercise testing. *Am J Cardiol.*, 50:671–676.

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