THE EFFECT OF EXERCISE AND TRAINING STATUS ON LEUCOCYTES COUNT

1.*Musa, I., 2Mabrouk, M.A. and 3Tanko, Y.

1Department of Human Physiology, Kogi State University, Anyigba
2Department of Human Physiology, Bayero University, Kano
3Department of Human Physiology, Ahmadu Bello University, Zaria

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 leucocyte 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 leucocyte count increased significantly (P<0.05) after exercise in all subjects. Baseline leucocyte number in the trained were lower (P<0.05) than in untrained immediately after the match (149.95±3.89 X 50mm$^3$ vs. 140.10±1.65 X 50mm$^3$, P=0.009), whereas leucocyte 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 leucocytes count of the subjects who are physically active and those who are sedentary respond differently to same exercise protocol. The lower leucocyte 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 leucocyte 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 (Sisovic 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).

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 leucocytes 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$_{2}$max of 58.39±0.3mL/kg per min). Twenty untrained subjects with lower VO$_{2}$max 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 before coming for the tests. All subjects were assessed for VO\textsubscript{2max} as described by Jackson \textit{et al.} (1990). The estimation of VO\textsubscript{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\textsubscript{2max} was then computed using the formula:

\[
\text{VO}_{2\text{max}} = 56.363 + (1.921 \times \text{PA-R}) - (0.381 \times \text{AGE}) - (0.754 \times \text{BMI}) + (10.987 \times \text{Gender})
\]

Where: Male = 1, Female = 0  
BMI = Weight in kg / Height\textsuperscript{2} in meters  
PA-R = Score on the physical activity questionnaire

Experimental trial

On the morning of an experiment subjects reported to the field between 09:00 and 11:00 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\textsuperscript{3} and 15.34% at 142.05 X 50mm\textsuperscript{3} for the trained and untrained post-acute exercise blood leucocyte count, respectively. The %CV for this assay was 8.19% at 134.50 X 50mm\textsuperscript{3} and 5.27% at 140.10 X 50mm\textsuperscript{3} for the trained and untrained pre-acute exercise blood leucocyte count, respectively.

Acute Exercise Study

The study involved a 90 minute football match as described by Rahnama \textit{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 results pre and post exercise in trained and untrained healthy adult male.

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

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>Pre Exercise</th>
<th>Sedentary</th>
<th>Trained</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Vs Pre</td>
<td>Post Vs Post</td>
<td></td>
</tr>
<tr>
<td>Leucocyte Count</td>
<td>140.10±1.65</td>
<td>134.50±2.46</td>
<td>149.95±3.89\textsuperscript{a}</td>
</tr>
<tr>
<td>(X 50mm\textsuperscript{3})</td>
<td>140.10±1.65</td>
<td>134.50±2.46</td>
<td>149.95±3.89\textsuperscript{a}</td>
</tr>
</tbody>
</table>

\* 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.

Figure 2. Leucocyte Count test results pre-exercise between 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\textsuperscript{3} vs. 140.10±1.65 X 50mm\textsuperscript{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\textsuperscript{3} vs. 142.05±4.87X 50mm\textsuperscript{3}, P =0.031).
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 50/mm³ vs. 134.50 x 50/mm³), (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 50/mm³ vs. 142.05 x 50/mm³ 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, acute exercise has been shown to affect 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 immediately after 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


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