Short report

Exercise induced mobilisation of the marginated granulocyte pool in the investigation of ethnic neutropenia

Doraline Phillips, Katy Rezvani, Barbara J Bain

Abstract
This study was designed to determine whether ethnic neutropenia is caused by an increased proportion of neutrophils being present in the marginated granulocyte pool. Thirty two healthy volunteers, half of whom were African or Afro-Caribbean and half of whom were white, exercised vigorously for 10 minutes on a step machine to mobilise granulocytes from the marginated granulocyte pool into the circulating granulocyte pool. The amount of work performed and the pulse rate response of the two ethnic groups were compared to determine whether the exercise carried out was comparable. A full blood count and an automated differential count were performed before and after the exercise. The haemoglobin concentration, platelet count, and absolute counts of total leucocytes and leucocyte subsets before and after exercise were compared in each individual and the values in the two ethnic groups both before and after exercise were compared. The absolute increase in neutrophils in the two ethnic groups was compared. The African/Afro-Caribbean group was found to have a reduced rather than enhanced ability to mobilise neutrophils from the marginated granulocyte pool. Therefore, increased margination of neutrophils is unlikely to be the cause of ethnic neutropenia.

(J Clin Pathol 2000;53:481–483)

Keywords: ethnic neutropenia; circulating and marginated granulocyte pool; exercise

Several studies from the 1940s onwards have shown that healthy subjects of African ancestry have lower white blood cell counts (WBCs) and neutrophil counts than do white individuals. This has been demonstrated for Afro-Americans, Afro-Caribbeans, East Africans, Central Africans, and West Africans. In healthy white subjects, the neutrophils in the peripheral blood are distributed, more or less equally, between the circulating and the marginated granulocyte pools, the latter pool comprising cells adherent to the endothelium in postcapillary venules. Only the circulating granulocyte pool is sampled when a venous blood specimen is obtained. It has been suggested that ethnic neutropenia is consequent on those of African ancestry having a larger proportion of their neutrophils in the marginated granulocyte pool, but there is no published evidence to confirm or refute this hypothesis.

The marginated granulocyte pool can be mobilised by vigorous exercise of by administration of epinephrine, neither of which affects the total blood granulocyte pool, the disappearance time of neutrophils from the blood, or the granulocyte turnover rate. The effects of exercise and epinephrine are very similar and it is likely that exercise mediates its effect by the release of endogenous epinephrine. The action of epinephrine appears to be mediated by increased synthesis of cAMP in vascular endothelial cells, with subsequent release of cAMP into the bloodstream, in turn leading to reduced neutrophil adhesiveness.

We have studied the effect of exercise on the total white blood cell count and the absolute count of neutrophils and other leucocytes in healthy subjects of African or non-African ethnic origin to investigate whether the explanation of ethnic neutropenia is that those of African ancestry have a higher proportion of neutrophils in the marginated granulocyte pool.

Methods
After ethical committee approval, healthy volunteers, mainly medical students and hospital and medical school staff, were recruited to our study. Volunteers were required to be in good health and between the ages of 18 and 46 years. Equal numbers of men and women and equal numbers of Africans/Afro-Caribbeans and white subjects were recruited. The pulse rate was recorded and a venous blood sample was taken immediately before exercise. The volunteer then exercised vigorously for 10 minutes on a step machine in a gymnasium. The amount of exercise was standardised for body weight, but subjects who found the exercise too taxing were permitted to reduce the work load to a level that they found...
comfortable. The pulse rate was recorded immediately after finishing the exercise and a further venous blood sample was taken shortly afterwards. A full blood count and differential count were performed on all blood samples, using a Bayer-Technicon H2 automated full blood counter.

The age, sex, and prevalence of cigarette smoking were compared for the two ethnic groups to confirm that the groups were of similar composition. The amount of work done and the postexercise pulse rates were also compared to ascertain whether the exercise performed and the physiological response to it were comparable in the two groups. The total leucocyte counts and absolute counts of different cell types after exercise were compared with pre-exercise values, and values before and after exercise were compared between the two ethnic groups.

When data had a Gaussian distribution and similar variance, comparison was by means of an unpaired student’s t test. When data were non-Gaussian or had dissimilar variance, comparison was by means of a Mann-Whitney U test. Paired data were compared by either a paired t test or a Wilcoxon matched pairs test.

Results
We studied 32 subjects, 16 whites and 16 Africans/Afro-Caribbeans. Twelve subjects were men and 20 were women. Comparison of the two ethnic groups showed no significant difference in biological variables (table 1). Comparison of pulse rate before and after exercise and of work performed showed that the amount of exercise and the physiological response to it were similar in the two ethnic groups (table 1).

Table 1 Comparison of biological variables, work performed, and pulse rate before and after exercise in white and Africans/Afro-Caribbean subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Caucasians mean (SD or median range)</th>
<th>Africans/Afro-Caribbeans mean (SD or median range)</th>
<th>Difference in mean or median (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of men</td>
<td>6</td>
<td>6</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Number of smokers</td>
<td>1</td>
<td>2</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>23.5 (22 to 46)</td>
<td>31.5 (22 to 43)</td>
<td>−4 (−9 to 2)</td>
<td>0.18</td>
</tr>
<tr>
<td>Power (Watts)</td>
<td>125.31 (25.61)</td>
<td>119.19 (23.89)</td>
<td>6.13 (−11.75 to 24)</td>
<td>0.24</td>
</tr>
<tr>
<td>Pre-exercise pulse rate (beats/min)</td>
<td>72 (60 to 88)</td>
<td>76 (68 to 84)</td>
<td>−3.5 (−6 to 4)</td>
<td>0.37</td>
</tr>
<tr>
<td>Postexercise pulse rate (beats/min)</td>
<td>106 (92 to 140)</td>
<td>106 (96 to 160)</td>
<td>0 (−12 to 8)</td>
<td>0.73</td>
</tr>
<tr>
<td>Increase in pulse rate (%)</td>
<td>42.7 (22.7 to 100)</td>
<td>45.9 (14.3 to 122)</td>
<td>−1.8 (−16.2 to 17.0)</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Data are the mean or median and the 95% range (SD), except for the significance of the difference where the 95% confidence interval (CI) is given.

The expected ethnic differences were seen in the pre-exercise total WBC and neutrophil count (table 2). The haemoglobin concentration and the lymphocyte, monocyte, and eosinophil counts did not differ significantly and the difference in the platelet count (lower in Africans/Afro-Caribbeans) was of only marginal significance.

In both ethnic groups, exercise led to a significant increase in the total WBC and the neutrophil, eosinophil, and monocyte counts (table 2). After exercise, the ethnic differences in the WBC and neutrophil counts were greater than they had been before exercise (table 2).

The percentage rise tended to be less rather than greater in the African/Afro-Caribbean group, although this was of only marginal significance (p = 0.27 for the WBC and p = 0.17 for the neutrophil count). The absolute increase in neutrophils was significantly less in the African/Afro-Caribbean group (0.49 × 10^7/litre; p = 0.036).

In neither ethnic group was the response of the neutrophil count to exercise greater in those with the lowest counts before exercise. For both groups, the correlation between the exercise induced increment and the pre-exercise count tended to be positive rather than negative (r = 0.14 for white subjects; r = 0.34 for Africans/Afro-Caribbeans), although this was not significant. After exercise, a significant ethnic difference was present in the monocyte count (mean, 0.5 × 10^7/litre for white subjects; 0.4 × 10^7/litre for Africans/Afro-Caribbeans).

Table 2 Haematological variables before and after exercise in healthy white and African/Afro-Caribbean subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Caucasians mean (SD or median range)</th>
<th>Africans/Afro-Caribbeans mean (SD or median range)</th>
<th>Differences in mean or median (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-exercise WBC</td>
<td>5.73 (1.44)</td>
<td>4.82 (0.26)</td>
<td>0.91 (0–1.81)</td>
<td>0.049</td>
</tr>
<tr>
<td>Postexercise WBC</td>
<td>8.11 (2.14)***</td>
<td>6.51 (1.80)***</td>
<td>1.61 (0.18–3.03)</td>
<td>0.028</td>
</tr>
<tr>
<td>% Increase in WBC</td>
<td>40.1 (12.7–93.1)***</td>
<td>25.95 (7.7–126.1)***</td>
<td>10.5 (−6.4 to 25)</td>
<td>0.27</td>
</tr>
<tr>
<td>Pre-exercise neutrophil count</td>
<td>3.34 (1.02)</td>
<td>2.36 (0.21)</td>
<td>0.98 (0.03–1.65)</td>
<td>0.006</td>
</tr>
<tr>
<td>Postexercise neutrophil count</td>
<td>4.18 (1.22)***</td>
<td>2.86 (1.01)***</td>
<td>1.33 (0.52–2.13)</td>
<td>0.002</td>
</tr>
<tr>
<td>% Increase in neutrophil count</td>
<td>26.4 (−2.4 to 57.1)</td>
<td>13.96 (5.9 to 88.9)</td>
<td>6.8 (−5.5 to 19.0)</td>
<td>0.169</td>
</tr>
<tr>
<td>Absolute increase in neutrophil count</td>
<td>0.84 (0.53)</td>
<td>0.49 (0.48)</td>
<td>0.35 (0.02 to 0.68)</td>
<td>0.036</td>
</tr>
<tr>
<td>Pre-exercise monocyte count</td>
<td>0.36 (0.10)</td>
<td>0.34 (0.08)</td>
<td>0.02 (−0.04 to 0.09)</td>
<td>0.449</td>
</tr>
<tr>
<td>Postexercise monocyte count</td>
<td>0.50 (0.30 to 1.00)***</td>
<td>0.40 (0.30 to 0.60)***</td>
<td>0.10 (0 to 0.20)</td>
<td>0.026</td>
</tr>
<tr>
<td>% Increase in monocyte count</td>
<td>49.4 (36.0)</td>
<td>23.75 (24.5)</td>
<td>25.6 (3.4 to 47.9)</td>
<td>0.025</td>
</tr>
<tr>
<td>Absolute increase in monocyte count</td>
<td>0.1 (0 to 0.4)</td>
<td>0.1 (−0.1 to 0.2)</td>
<td>0.1 (0.05 to 0.15)</td>
<td>0.144</td>
</tr>
<tr>
<td>Pre-exercise eosinophil count</td>
<td>0.11 (0.07 to 0.31)***</td>
<td>0.11 (0.04 to 0.74)*</td>
<td>0.01 (−0.05 to 0.05)</td>
<td>0.63</td>
</tr>
<tr>
<td>Postexercise eosinophil count</td>
<td>0.15 (0.08 to 0.42)</td>
<td>0.13 (0.02 to 0.75)</td>
<td>0.03 (−0.02 to 0.07)</td>
<td>0.29</td>
</tr>
<tr>
<td>% Increase in eosinophil count</td>
<td>36.0 (30.65)</td>
<td>14.7 (30.1)</td>
<td>21.3 (−0.65 to 43.2)</td>
<td>0.057</td>
</tr>
</tbody>
</table>

Cell counts are given as ×10^9 cells/litre.

p Values of < 0.05 are shown in bold type.

*p < 0.05 for the difference from the pre-exercise value; **p < 0.01 for the difference from the pre-exercise value; ***p < 0.001 for the difference from the pre-exercise value.
short report

483

findings in healthy volunteers di
with the lowest counts before exercise. These
phi count to exercise was no greater in those
cise. Furthermore, the response of the neutro-
cantly fewer neutrophils in response to exer-
cide subjects, mobilised signifi-
were significantly lower than those of a group
hit of healthy Africans and Afro-
gate the cause of ethnic neutropenia. We found
volunteers of di
We studied mobilisation of neutrophils from

Discussion
We studied mobilisation of neutrophils from
the marginal granulocyte pool in healthy
towners of different ethnic origins to investi-
gate the cause of ethnic neutropenia. We found
that a group of healthy Africans and Afro-
beans, whose mean neutrophil counts
were significantly lower than those of a group
of healthy white subjects, mobilised signifi-
cantly fewer neutrophils in response to exer-
cise. Furthermore, the response of the neutro-
olph count to exercise was no greater in those
with the lowest counts before exercise. These
findings in healthy volunteers differ from those
in patients, of unstated ethnic origin, who were
investigated for idiopathic or disease related
neutropenia.9 These patients were heterogeneous
in their responses but many of them,
particular those with the lowest counts, had a
pronounced increase in neutrophil count after
exercise, indicating that their neutropenia was
at least in part caused by increased margina-

The African/Afro-Caribbean group also mo-
bilised fewer monocytes in response to exer-
cise, suggesting that the total circulating
monocyte pool might also show an ethnic
difference.

Our results suggest that ethnic neutropenia
is unlikely to be caused by increased neutrophil
margination. The absolute number of neu-
trophils mobilisable from the marginated
granulocyte pool is less than in white subjects
and, because the neutrophil count in the
resting state is also lower, it appears likely that
the total blood granulocyte pool is lower than
in whites. We cannot totally exclude the possi-
bility that those of African ancestry have both
increased margination and impaired ability to
mobilise neutrophils, but this appears unlikely.
Because our data do not support increased
neutrophil margination as the cause of ethnic
neutropenia, we suggest an alternative
hypothesis—that there is an ethnic difference
in bone marrow neutrophil production or
release.

We thank those who volunteered for this study and also St
Mary’s Hospital Medical School Gym Club and Mr Rupert
Mortll for permission to use the gymnasium. We are also grate-
ful to Mrs Donna Hammell for statistical advice and Dr John
Lucift for his help and advice.

1 Forbes WH, Johnson RE, Consolazio F. Leucopenia in
2 Bain BJ. Ethnic and sex differences in the total and differenti-
al white cell count and the platelet count. J Clin Pathol
3 Shaper AG, Kyohe J, Stansfield D. Haematological observa-
tions on an East African student population. East Afr Med
4 Ezeilo GC. Neutropenia in Africans. Trop Geogr Med 1971;
5 Howells DP. Neutropenia in people of African origin. Lancet
III. The distribution of granulocytes in the blood of normal
7 Hoffbrand AV, Pemitt JE. Essential haematology, 3rd ed.
IV. The total blood, circulating and marginated granulo-
cyte pools and granulocyte turnover rate in normal
9 Boxer LA, Allen JM, Babher RL. Diminished polymorpho-
10 Joyce RA, Boggs DR, Hasiba U, et al. Marginal neutrophil
pool size in normal subjects and neutropenic patients as
measured by epinephrine infusion. J Lab Clin Med

WHAT’S YOUR VIEW?

Pathology Interactive: useful or useless?

To make Pathology Interactive more useful tool to help you in your CPD

. . . we need your views

Please take time to complete a self completion questionnaire and fax it back to us

Questionnaire available for printing out on:

Pathology Interactive CD Vol 1 issue3 (Dec 1999)
Pathology Interactive CD Vol 2 2000
Journal of Clinical Pathology website - www.jclinpath.com

Fax completed forms to Natalie Davies, Editorial Assistant, Journal of Clinical
Pathology (+44 (0)20 7383 6668).

Your time and help are appreciated. We especially thank all those ACP members who
returned questionnaires circulated in the September 1999 journal issue for their valuable
feedback.

Pathology Interactive 2000 offers up to three CPD credits per article; later issues
feature case study and picture quiz formats
Exercise induced mobilisation of the
marginated granulocyte pool in the
investigation of ethnic neutropenia
Doraline Phillips, Katy Rezvani and Barbara J Bain

J Clin Pathol 2000 53: 481-483
doi: 10.1136/jcp.53.6.481

Updated information and services can be found at:
http://jcp.bmj.com/content/53/6/481

These include:

References
This article cites 6 articles, 1 of which you can access for free at:
http://jcp.bmj.com/content/53/6/481#BIBL

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections
Articles on similar topics can be found in the following collections
Immunology (including allergy) (1664)

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/