

## Effects of short moderate exercise on hematological parameters and stem cells in healthy humans

Sochoń K.<sup>1</sup>, Sienkiewicz D.<sup>1</sup>, Okurowska-Zawada B.<sup>1</sup>, Paszko-Patej G.<sup>1</sup>, Wojtkowski J.<sup>1</sup>, Dmitruk E.<sup>1</sup>, Żak J.<sup>2</sup>, Kułak W.<sup>1\*</sup>

1. Department of Pediatric Rehabilitation, Medical University of Białystok, Poland

2. Department of Pediatric Laboratory Diagnostics, Medical University of Białystok, Poland

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**A**- Conception and study design ; **B** - Collection of data; **C** - Data analysis; **D** - Writing the paper; **E**- Review article; **F** - Approval of the final version of the article; **G** - Other

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### ABSTRACT

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**Introduction:** Exercise at various durations and intensities impact on blood and stem cells. This pilot study examined the effects of 30 minutes of treadmill walking on hematological indices and progenitor stem cells CD34+ in healthy subjects.

**Materials and methods:** A total of 17 non-smoking, healthy students, aged 20 to 22 years participated. Hemoglobin, hematocrit, white blood cells, platelets, and stem cell CD34+ numbers were assessed before and after moderate exercise. Statistical analyses examined the relationships between CD34+ cells versus hematological indices, age, and body mass index.

**Results:** Following exercise, significant increases were observed in leukocytes, neutrophils, eosinophils, and CD34+ cells numbers. For CD34+ cells, a fourfold increase was seen. Significant correlations between CD34+ cells, white blood cells, and neutrophils were found.

**Conclusion:** Our results suggest that moderate exercise has a physiological impact on hematologic parameters and stem cells CD34+ in healthy subjects. Furthermore, our findings suggest that brief treadmill exercise may enhance tissue repair mechanisms so important in physiotherapy.

**Key words:** Exercise, healthy subjects, stem cells

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#### \*Corresponding author:

Wojciech Kułak  
17 Waszyngtona street, 15-274 Białystok  
Department of Pediatric Rehabilitation  
Medical University of Białystok, Poland  
e-mail: kneur2@wp.pl

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## INTRODUCTION

Cumulative evidence indicates that human-induced pluripotent stem cells introduce a new perspective to studying the biology of different diseases [1]. Stem cells have been used in the treatment of many diseases, including neurodegenerative diseases, cardiovascular diseases, and diabetes [2]. Stem cells are found in the bone marrow, umbilical cord blood, and, in small numbers, in peripheral blood.

In order to harvest stem cells from the circulating peripheral, blood donors are injected with a cytokine, such as granulocyte-colony stimulating factor, which induces cells to leave the bone marrow and circulate in the blood vessels [3]. Although not as well-known, that physical activity may also induce the mobilization of stem cells from bone marrow into the blood [4]. Furthermore, the role of stem cells in the cardio protection and brain plasticity offered by exercise has been discussed [5].

The physiological impact of exercise at various durations and intensities, including measurements of hemoglobin levels and platelet and leukocyte counts, has previously been investigated. Hemoglobin has been shown to increase after exercise [6]. Leukocyte numbers have been found to increase in circulation immediately following exercise [7].

The CD34+ antigen is a family of differentially glycosylated type I transmembrane single-chain glycoproteins that is expressed on virtually all hematopoietic precursor cells. Cells expressing CD34 (CD34+ cell) are normally found in the umbilical cord and bone marrow as hematopoietic cells [8].

This study was designed to investigate the effects of moderate exercise on the circulating CD34+ cell numbers and hematologic indices in healthy subjects.

## MATERIALS AND METHODS

### *Participants*

A total of 17 non-smoking, healthy volunteers (14 female and 3 male), who were students of physiotherapy at the Medical University of Białystok, were recruited. All subjects were screened for cardiovascular abnormalities as well as pulmonary and metabolic disorders. Prior to the study, all of the volunteers received physical examinations. Arterial blood pressure was measured with a sphygmomanometer at rest and three minutes post-exercise. Their heart rates were also recorded five minutes before exercising and three minutes after exercising. All participants refrained from heavy physical exercise during the 48 hours before sampling for hematological indices and CD34+

cells. Written informed consent was obtained from each patient under the supervision of the ethics committee of the Medical University of Białystok, Poland.

### *Procedures*

Blood samples were collected from participants 30 minutes prior to the treadmill-walking test and within 120 minutes after the testing finished. Blood was collected after two hours because mobilization of circulating progenitor cells during exercise is time-dependent. Ten milliliters of blood was collected during each blood draw. A complete blood count was performed. Remaining blood cells were processed and analyzed using a flow cytometry to determine CD34+ cells. The volunteers underwent a modified Bruce treadmill exercise protocol [9].

Aerobic exercise consisted of 30 minutes of treadmill walking. Thus, brisk walking at 5 km/h for half an hour (a moderate intensity activity of 3.3 MET) accounts for about 100 MET-min and is, in this aspect, equivalent to running at 10 km/h for 10 minutes (a vigorous intensity activity of 10 MET).

### *Statistical analysis*

Significance of difference in CD34+ cells was assessed by Wilcoxon rank sum test because data were not normally distributed. Correlations were sought using Spearman correlation analyses. Changes in hematological variables were tested for statistical significance with paired *t*-tests. Statistical significance was assumed at  $p < 0.05$ .

## RESULTS

The main characteristics, anthropometric and performance data are shown in Table 1.

All the participants were able to complete 30 minutes of treadmill exercise. Thirty minutes treadmill walking resulted in a significant increase in leukocytes versus baseline and neutrophils as well as eosinophils (Table 2). No change in hematocrit was found. No change was observed in the hemoglobin concentration, in erythrocyte content, and in number of thrombocytes. Similarly, number of lymphocytes, monocytes, and basophils did not significantly increase. After finishing the treadmill exercise a significant rise in cell number of CD34+ compared to baseline was observed (Table 2).

No significant correlations between the number of CD34+ cells and age, height, BMI, heart rate, lymphocytes, monocytes, eosinophils, basophils, erythrocytes, hemoglobin and thrombocytes after the treadmill exercise were found. Significant correlations between the number of CD34+ cells and leukocytes ( $R=0.584$ ;  $p=0.014$ ), and neutrophils ( $R=0.588$ ;  $p=0.012$ ) were noted.

**Table 1.** Characteristics of healthy volunteers

Characteristics	
Age, year	20.8 ± 0.8
Body mass index, kg/m <sup>2</sup>	21.4 ± 2.9
Height, cm	1.71 ± 0.1
Systolic blood pressure at rest, mmHg	114.7 ± 13.1
Diastolic blood pressure at rest, mmHg	75.3 ± 8.9
Systolic blood pressure post-exercise, mmHg	119.53 ± 10.9
Diastolic blood pressure post-exercise, mmHg	77.88 ± 7.6
Resting heart rate, beat/min	75.7 ± 14.7
After exercise heart rate, beat/min	97.4 ± 15.26

Values are mens ± SD

**Table 2.** Changes in blood constituents and CD34+ cells at baseline and 120 minutes post-exercise

Variables	Baseline	At 120 min	P- value
<b>CD34+</b>	197.32 ± 83.80	780.58 ± 433.69	<0.001
<b>Hematocrit</b>	38.72 ± 2.85	38.21 ± 3.08	0.688
<b>Hemoglobin (g/dl)</b>	13.32 ± 1.17	13.13 ± 1.15	0.160
<b>Erythrocytes (10<sup>6</sup>/μl)</b>	4.51 ± 0.40	4.46 ± 0.44	0.074
<b>Thrombocytes (10<sup>3</sup>/μl)</b>	244.47 ± 50.17	250.29 ± 50.21	0.087
<b>Leukocytes (10<sup>3</sup>/μl)</b>	5.89 ± 1.85	6.78 ± 1.95	0.002
<b>Neutrophils (10<sup>3</sup>/μl)</b>	2.85 ± 1.65	3.78 ± 3.17	0.001
<b>Lymphocytes (10<sup>3</sup>/μl)</b>	2.02 ± 0.43	1.91 ± 0.48	0.268
<b>Monocytes (10<sup>3</sup>/μl)</b>	0.54 ± 0.16	0.55 ± 0.16	0.742
<b>Eosinophils (10<sup>3</sup>/μl)</b>	0.09 ± 0.06	0.06 ± 0.03	0.001
<b>Basophils (10<sup>3</sup>/μl)</b>	0.05 ± 0.03	0.07 ± 0.03	0.147

## DISCUSSION

This study was designed to investigate brief moderate treadmill exercise impacted CD34+ cells and hematologic indices in healthy students. Exercise was associated with changes in hematological parameters (leukocytes, neutrophils, eosinophils) and increases in the number of circulating stem cell numbers.

Furthermore, for CD34+ cells, a fourfold increase was seen. These changes occurred in healthy individuals suggesting this exercise has a direct effect on hematopoietic indices and circulating CD34+ cell numbers. The hematologic data were consistent with previous studies [6,7]. Treadmill exercise significantly changed the level of circulating CD34 + cells in the majority of subjects. The present study demonstrates evidence that CD 34+ cells, circulate in the bloodstream in healthy subjects.

Nowadays, sedentary lifestyle is popular among children and adolescents in Europe. The WHO developed the “Global Recommendations on Physical Activity for Health,” with the overall aim of providing national and regional level policy makers with guidance on the dose-response relationship between the frequency, duration, intensity, type, and total amount of physical activity needed for

preventing noncommunicable diseases (autoimmune diseases, heart disease, stroke, cancers, asthma, diabetes, osteoporosis, and cataracts) [10].

Children and youth aged 5–17 should accumulate at least 60 minutes of moderate-to vigorous-intensity physical activity daily. Adults aged 18–64 should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate and vigorous-intensity activity.

## CONCLUSION

In summary, this study found that moderate exercise significantly affected on the circulating CD34+ cell numbers and hematologic indices in healthy subjects. Presence of stem cells in the circulation can be increased by a simple and brief exercise (treadmill walking) suggests a physiological mechanism by which exercise might contribute to tissue repair. It might be possible to enhance repair mechanisms and promote rehabilitation through exercise by mobilization of stem cells to different tissues.

### **Conflicts of interest**

The authors have no conflicts of interest to disclose.

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