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Hematological Indices in Elite Wrestlers

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Abstract

Background: Because of varying reports, there is still need to investigate the impact of wrestling on hematological indices.
Objectives: We investigated differences in the basic hematological indices in wrestlers compared to sedentary controls.
Patients and Methods: The blood samples containing anticoagulant were collected from 12 male elite wrestlers (age = 24 ± 1.2 years, weight = 76 ± 5 Kg) with a history of more than 9.5 years of experience and from 13 apparently healthy male silent controls (age = 24 ± 0.8 years, weight = 85 ± 4 Kg). All the participants were at rest for 24 hours during the blood collection. Red blood cell (RBC) count, hemoglobin (Hb) concentration, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular Hb concentration (MCHC), total and differential white blood cell (WBC) counts, and platelet count were analyzed using an automated hematology analyzer.
Results: Concentration of Hb (154 ± 2 g/L), PCV (45.3 ± 0.6%), and lymphocyte percent (22.6 ± 3%) were lower in wrestlers than in the controls (Hb: 165 ± 3 g/L, PCV: 48.6 ± 0.8%, and lymphocyte: 33.2 ± 2%). However, higher neutrophil count (68.7 ± 3%) was seen in the athletes than in the controls (60.6 ± 2%). The other indices showed no differences between the two groups.
Conclusions: A low level of Hb concentration and PCV was detected in the blood of wrestlers. In addition, lymphocyte/neutrophil ratio was lower in the wrestlers, which may be a reason for wrestlers' susceptibility to viral infections.

Keywords: Hematologic Tests, Leukocyte Count, Erythrocyte Count, Platelet Count, Hemoglobinometry, Hematocrit, Wrestling

1. Background

It is well documented in the literature that physical exercise affects hematological status and the immune system. In line with these findings, in athletes involved in intensive physical activity, suboptimal hematologic parameters have been recorded; some have termed this "sport anemia" (1-3). Some research has also shown that total hemoglobin (Hb) and red blood cell (RBC) mass can be increased due to exercise training, which enhances oxygen carrying capacity. It is supposed that exercise training can stimulate erythropoiesis via hyperplasia of hematopoietic bone marrow, enhance hormone and cytokine release, and improve the hematopoietic microenvironment (4, 5).

On the other hand, there are also reports of an association between different types of exercise and different effects on the hematological indices (1, 6, 7). For example, a study by Spodaryk et al. showed that mean Hb concentration, packed cell volume (PCV), and RBC count in endurance trained athletes were significantly lower than in controls. However, there were no differences between the strength trained athletes and the controls (3). Therefore, most of the research has focused on the effects of specific disciplines or special training characteristics, such like strength or endurance training, on hematological parameters.

2. Objectives

Because currently available studies have provided inconsistent results about the effects of wrestling on hematological variables (1, 3) and due to the lack of studies about how strength-trained athletes such as wrestlers compare with endurance sports athletes (2, 3, 5, 8), we investigated basic hematological indices in the wrestlers and sedentary controls.

3. Patients and Methods

3.1. Study Subjects

This study was a part of a larger study to explore the effects of wrestling on the hematological and immune systems (9). This cross sectional study was conducted at the

Research Center for Molecular Medicine affiliated with the Hamadan University of Medical Sciences in Iran. All the participants gave their informed written consent to participate in the study, which was approved by the Ethics Committee of the Hamadan University of Medical Sciences. All the participants were male students in the Azad University of Hamadan and completed a questionnaire assessing their physical activities, past medical histories, and demographic characteristics and verifying that they had not recently have any high altitude exposure or taken iron supplements or other medications. Due to their monthly blood loss through menstruation, female athletes were not considered in the present study (7, 10).

Fifteen trained free-style wrestlers with a history of training three times per week for more than 9.5 years were chosen. In addition, 13 age and sex-matched, apparently healthy, and unrelated control subjects who had been sedentary for more than six months were recruited. To avoid the acute hemodiluting effects of exercise, the wrestlers were asked to stop physical training and competition for 24 hours prior to the blood collection. Of the enrolled wrestlers, 12 subjects completed all measurements.

3.2. Blood Collection

Fasting venous sterile blood samples were taken from the cubital vein with the participant at rest in the morning between 9 am and 11 am. The blood samples were collected in bottles containing ethylenediamine tetraacetic acid (EDTA) as an anticoagulant. All of the blood samples were analyzed within two hours (11, 12).

3.3. Hematological Parameters

RBC count, Hb concentration, PCV, mean corpuscular volume (MCV), mean corpuscular Hb (MCH), mean corpuscular Hb concentration (MCHC), total and differential circulating white blood cell (WBC) count, and platelet count of the samples were determined by using standard laboratory procedures and an MS9 cell counter analyzer (Melet Schloesing MS9; Cergy Pontoise, France (11, 12)) available

3.3.1. Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS for Windows, Version 16). Results were expressed as mean ± standard error. An unpaired Student's t-test was used to compare the means of the examined groups. All comparisons were two-sided; P values are noted for each group to indicate statistical significance. The statistical significance threshold was $P < 0.05$.

4. Results

Twelve professional wrestlers and thirteen silent controls were enrolled in this study; the data in Table 1 show the main demographic characteristics of the study populations. There were no differences between the ages and weights of the two groups.

Table 1. Main Demographic Characteristics of the Study Populations[a]

Group	No.	Gender	Age, y	Weight, Kg
Wrestlers	12	Male	24 ± 1.2	76 ± 5
Controls	13	Male	24 ± 0.8	85 ± 4
P Value [b]	NA	NA	0.864	0.154

Abbreviation:Na, not available.
[a]Data are presented as mean ± SD.
[b]An unpaired student's t-test was used to compare the means of the examined groups. All comparisons were two-sided; P values are noted for each group to indicate statistical significance.

Table 2 shows the results for RBC count, Hb concentration, PCV, MCV, MCH, and MCHC of the samples. There were significant differences between Hb concentration and PCV in the two study groups. Hb concentration (154 ± 2 g/L) and PCV (45.3 ± 0.6%) were lower in wrestlers than in controls (Hb: 165 ± 3 g/L, P = 0.011 and PCV: 48.6 ± 0.8%, P = 0.003) (Table 2).

Table 2. Comparison of the RBC Variables in the Wrestlers and Controls[a]

Parameter	Wrestlers	Controls	P Value [b]
RBC count ($\times 10^{12}$/L)	5.27 ± 0.1	5.66 ± 0.2	.053
Hb concentration, g/L	154 ± 2	165 ± 3	.011 [c]
PCV, %	45.3 ± 0.6	48.6 ± 0.8	.003 [c]
MCV, fl	86.2 ± 1	86.4 ± 2	.908
MCH, pg/cell	29.4 ± 0.3	29.3 ± 0.8	.934
MCHC, g/L	342 ± 3	339 ± 4	.497

Abbreviations: Hb, hemoglobin; MCHC, mean corpuscular Hb concentration; MCH, mean corpuscular Hb; MCV, mean corpuscular volume; PCV, packed cell volume; RBC, Red blood cell.
[a]Data are presented as mean ± SEM.
[b]An unpaired Student's t-test was used to compare the means of the examined groups. All comparisons were two-sided; P values are noted for each group to indicate statistical significance. Test values are expressed using the International System of Units (13).
[c]Significant.

Table 3 shows the results of the total and differential WBC counts and platelet counts of the samples. The mean value of neutrophil concentrations (68.7 ± 3%) was significantly (P = 0.036) higher in the wrestlers than in the silent controls (60.6 ± 2%). On the other hand, the lymphocyte concentrations in the wrestlers (22.6 ± 3%) were significantly (P = 0.008) lower than in the controls (33.2 ± 2%).

Table 3. Comparison of WBC Differential Counts in the Wrestlers and Controls[a]

Parameter	Wrestlers	Controls	P Value [b]
Neutrophils, %	68.7 ± 3	60.6 ± 2	.036 [c]
Lymphocytes, %	22.6 ± 3	33.2 ± 2	.008 [c]
Monocytes, %	4.4 ± 0.6	4.8 ± 0.6	.635
Eosinophils, %	3.4 ± 2	2 ± 0.3	.481
Basophils, %	1 ± 0.3	1.3 ± 0.3	.685
Platelets ($\times 10^9$/L)	271 ± 17	244 ± 14	.240
Total WBC count ($\times 10^9$/L)	8.43 ± 0.8	7.22 ± 0.4	.177

[a] Data are presented as mean ± SEM.
[b] An unpaired Student's t-test was used to compare the means of the examined groups. All comparisons were two-sided; P values are noted for each group to indicate statistical significance. Test values are expressed using the International System of Units (13).
[c] Significant.

5. Discussion

Hematological evaluation showed that Hb and PCV were significantly lower in wrestlers than in healthy sedentary controls. These results are comparable to the results of a study by Boyadjiev et al. (1), which assessed the basic RBC variables in highly trained pubescent athletes (mean duration of training 3.52 ± 0.07 years), including 220 young male wrestlers, and compared the results with those of an untrained control group. The pubescent wrestlers and other athletes had lower RBC counts, PCV, and Hb concentrations than the controls. As in our study, Boyadjiev et al. found no difference in MCV between the groups.

In contrast, a study by Spodaryk, which investigated the effects of long-lasting endurance and strength training on several hematological parameters in male athletes from a Polish team, the mean Hb concentration, PVC, and RBC measured in the endurance athletes were significantly lower than in the control group. However, there were no differences between the strength-trained subjects, which included nine male wrestlers, and the controls. Meanwhile, as in our study, there were no significant differences in MCV, MCH, or MCHC between the groups of athletes and the control group (3).

Furthermore, a study by Schumacher et al. investigated the characteristics of the RBC system in athletes of different sporting disciplines (endurance and strength, including wrestlers) at different levels of performance (internationally, nationally, locally competitive, and leisurely). Their results showed that, compared with sedentary subjects, athletes had higher RBC with no significant difference in Hb or PCV. Within the athlete population, higher readings for RBC, Hb, and PCV were found in strength-trained athletes. In addition, physical activity of increasing duration and workload (amateurs compared with competitive athletes) leads to lower PCV in internationally power-trained athletes than in local competitors (7). Other studies have also reported a decline in Hb concentration and PCV during more intensive periods of training (6). Although the results are controversial and debatable, Hb and PCV are important factors in exercise performance and can determine the oxygen-carrying capacity during physical activity. According to our data, wrestling can decrease Hb concentration and PCV (14).

Although lower Hb and PCV have been reported due to exercise induced hemolysis and iron deficiency in athletes, these mechanisms are proposed to have only a minor role in the reduction of Hb and PCV. Meanwhile, it has been demonstrated that lower Hb and PCV may be attributed to exercise induced hemodilution and expansion in the volume of plasma in athletes (8, 10). Plasma volume increase in athletes is thought to be primarily caused by a higher renal sodium reabsorption rate due to aldosterone (15), higher plasma protein production (16), and a plasma protein shift into the intravascular space (17). The sum of erythrocyte volume and plasma volume make up the total blood volume. Erythrocyte volume and plasma volume can be changed separately due to exercise adaptation and subsequently alter the blood volume. Furthermore, there are some reports that exercise induces the release of hormones and cytokines that stimulate erythropoiesis, resulting in higher PCV. However, it seems that PCV increase due to exercise is outpaced by a far greater increase in plasma volume, resulting in lower PCV (4, 10, 18).

There were no significant differences in MCV, MCH, and MCHC between elite wrestlers and controls in this study. This means that there were no significant differences in the turnover of RBC between the two study groups.

Total and differential WBC count results in wrestlers showed significantly higher neutrophil percentages and significantly lower lymphocyte percentages than in controls. Therefore, it seems that strength training activities such as wrestling may increase the concentration of neutrophils and decrease the concentration of lymphocytes in the blood. There are some reasons that sports activities could cause corticosteroid induced-release of neutrophils from the bone marrow (19). As a consequence, elite athletes may be more susceptible to viral infections (20, 21)). There were no differences in the other leukocyte indices between the two study groups. These data are consistent with a study by Kilic et al., in which erythrocyte, leukocyte, and thrombocyte concentrations were assessed in 20 male university student wrestlers who were engaged in wrestling for more than six years (13).

In conclusion, Hb concentration and PCV are lower in wrestlers, but these differences seem to result from plasma

volume increase, and they do not appear to lead to functional defects in blood or to anemia. In addition, a decrease in the ratio of lymphocytes to neutrophils in wrestlers may cause higher susceptibility to some viral diseases.

Footnotes

Authors' Contribution: Mostafa Omidi took part in the design and performance of the study. Mohammad Abbasi assisted with writing and clinical consulting. Mohammad Mahdi Eftekharian and Behrooz Shishean contributed to the project design. Alireza Zamani was involved in all parts of the study and in writing the manuscript.

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References

1. Boyadjiev N, Taralov Z. Red blood cell variables in highly trained pubescent athletes: a comparative analysis. *Br J Sports Med.* 2000;**34**(3):200–4. [PubMed: 10854020].
2. Broadbent S. Seasonal changes in haematology, lymphocyte transferrin receptors and intracellular iron in Ironman triathletes and untrained men. *Eur J Appl Physiol.* 2011;**111**(1):93–100. doi: 10.1007/s00421-010-1635-z. [PubMed: 20821024].
3. Spodaryk K. Haematological and iron-related parameters of male endurance and strength trained athletes. *Eur J Appl Physiol Occup Physiol.* 1993;**67**(1):66–70. [PubMed: 8375368].
4. Hu M, Lin W. Effects of exercise training on red blood cell production: implications for anemia. *Acta Haematol.* 2012;**127**(3):156–64. doi: 10.1159/000335620. [PubMed: 22301865].
5. Hu M, Finni T, Xu L, Zou L, Cheng S. Effects of resistance training on biomarkers of bone formation and association with red blood cell variables. *J Physiol Biochem.* 2011;**67**(3):351–8. doi: 10.1007/s13105-011-0082-6. [PubMed: 21394549].
6. Banfi G, Lundby C, Robach P, Lippi G. Seasonal variations of haematological parameters in athletes. *Eur J Appl Physiol.* 2011;**111**(1):9–16. doi: 10.1007/s00421-010-1641-1. [PubMed: 20842374].
7. Schumacher YO, Schmid A, Grathwohl D, Bultermann D, Berg A. Hematological indices and iron status in athletes of various sports and performances. *Med Sci Sports Exerc.* 2002;**34**(5):869–75. [PubMed: 11984308].
8. Videman T, Lereim I, Hemmingsson P, Turner MS, Rousseau-Bianchi MP, Jenoure P, et al. Changes in hemoglobin values in elite cross-country skiers from 1987-1999. *Scand J Med Sci Sports.* 2000;**10**(2):98–102. [PubMed: 10755280].
9. Zamani A, Omidi M, Hemmatfar A, Salehi I, Bazmamoun H. Wrestlers' immune cells produce higher interleukin-6 and lower interleukin-12 and interleukin-13 in response to in vitro mitogen activation. *Iran J Basic Med Sci.* 2014;**17**(11):917–2. [PubMed: 25691935].
10. Schumacher YO, Jankovits R, Bultermann D, Schmid A, Berg A. Hematological indices in elite cyclists. *Scand J Med Sci Sports.* 2002;**12**(5):301–8. [PubMed: 12383076].
11. Zamani A, Ghiasvand T, Hadei J, Babaahmadi-Rezaei H, Pishdadian A. Effect of garlic consumption on total antioxidant status and some biochemical and haematological parameters in blood of rats. *J Sci Food Agr.* 2009;**89**(8):1434–7. doi: 10.1002/jsfa.3617.
12. Reinke S, Taylor WR, Duda GN, von Haehling S, Reinke P, Volk HD, et al. Absolute and functional iron deficiency in professional athletes during training and recovery. *Int J Cardiol.* 2012;**156**(2):186–91. doi: 10.1016/j.ijcard.2010.10.139. [PubMed: 21145121].
13. Kilic M, Baltaci AK, Gunay M. Effect of zinc supplementation on hematological parameters in athletes. *Biol Trace Elem Res.* 2004;**100**(1):31–8. doi: 10.1385/BTER:100:1:031. [PubMed: 15258317].
14. Smith JA. Exercise, training and red blood cell turnover. *Sports Med.* 1995;**19**(1):9–31. [PubMed: 7740249].
15. Milledge JS, Bryson EI, Catley DM, Hesp R, Luff N, Minty BD, et al. Sodium balance, fluid homeostasis and the renin-aldosterone system during the prolonged exercise of hill walking. *Clin Sci (Lond).* 1982;**62**(6):595–604. [PubMed: 7083752].
16. Nagashima K, Cline GW, Mack GW, Shulman GI, Nadel ER. Intense exercise stimulates albumin synthesis in the upright posture. *J Appl Physiol (1985).* 2000;**88**(1):41–6. [PubMed: 10642360].
17. Haskell A, Nadel ER, Stachenfeld NS, Nagashima K, Mack GW. Transcapillary escape rate of albumin in humans during exercise-induced hypervolemia. *J Appl Physiol (1985).* 1997;**83**(2):407–13. [PubMed: 9262434].
18. Green HJ, Sutton JR, Coates G, Ali M, Jones S. Response of red cell and plasma volume to prolonged training in humans. *J Appl Physiol (1985).* 1991;**70**(4):1810–5. [PubMed: 2055858].
19. Bain BJ, Phillips D, Thomson K, Richardson D, Gabriel I. Investigation of the effect of marathon running on leucocyte counts of subjects of different ethnic origins: relevance to the aetiology of ethnic neutropenia. *Br J Haematol.* 2000;**108**(3):483–7. [PubMed: 10759703].
20. Gannon GA, Rhind SG, Suzui M, Shek PN, Shephard RJ. Circulating levels of peripheral blood leucocytes and cytokines following competitive cycling. *Can J Appl Physiol.* 1997;**22**(2):133–47. [PubMed: 9140667].
21. Imai T, Seki S, Dobashi H, Ohkawa T, Habu Y, Hiraide H. Effect of weight loss on T-cell receptor-mediated T-cell function in elite athletes. *Med Sci Sports Exerc.* 2002;**34**(2):245–50. [PubMed: 11828233].