Original Article: The Effects of Physical Exercise on the Immune System

Sareh Sangy* | **Faegheh Miryousefiata**

Department of Management, Ilam Branch, Islamic Azad University, Ilam, Iran

Use your device to scan and read the article online

Citation S. Sangy, F. Miryousefiata, **The Effects of Physical Exercise on the Immune System.** *Eurasian J. Sci. Technol.,* **2021**, 1(4), 252-257.

https://doi.org/10.48309/EJST.2021.289261.1040

Article info:
Received: 04 March 2021
Accepted: 15 June 2021
Available Online: 15 June 2021
ID: JSTR-2106-1040
Checked for Plagiarism: Yes
Language Editor:
Dr. Behrouz Jamalvandi
Editor-in-Chef:
Professor Dr. Ali Nokhodchi

Keywords:
Exercise, Leukocyte, Neutrophil, Immune system.

ABSTRACT

Background and Aim: Physical activity and abnormal environments cause changes in the functioning of the immune system. The aim of this study was to compare the effect of exercise in cold, hot and normal temperature conditions on the number of leukocytes and platelets in athletes' blood.
Methods: In this clinical trial study, 10 young male endurance athletes performed the same exercise for one hour with 60% of maximum oxygen consumption in three natural, cold and warm environments. Before, immediately and two hours after exercise, neutrophils, L Monocytes and platelets were counted. Data were analyzed using repeated measures statistical test and Bonferron post hoc test.
Results: The total number of leukocytes increased significantly in all three environments after exercise ($p < 0.0001$), but neutrophils did not increase significantly only in warm environment and lymphocytes did not increase significantly in cold environment ($p < 0.05$). Lymphocytes in cold, normal and warm environment had a significant decrease ($p < 0.05$), but the decrease in leukocytes was not significant except in neutrophils in hot environment ($p < 0.05$).
Conclusion: Exercise excitability in different temperature environments stimulates and accumulates immune cells. However, exercise in warm environments further increases the amount of these cells and also delays the recovery of the immune system to a resting state after exercise.

Introduction

Exercise can lead to changes in the immune system. It has been shown that abnormal environments are an important source of physiological stress that can interfere with the normal functioning of the immune system. Exercise has been shown to have a significant impact on the immune system in both humans and animals in a number of studies. Regular bouts of short-duration (up to 45 minutes) moderate-intensity exercise are thought to be good for host immunological response, especially in older persons and persons with chronic conditions [2]. When physical activity is combined with abnormal environments, it causes two types of physiological stress. These conditions can cause changes in the function and number of immune cells, more than in the case of each alone [3,2].

It is believed that the immune responses during and after athletic activity in various factors such as release of catecholamines, central pituitary-renal activity, or feedback

*Corresponding Author: Sareh Sangy (sareh.sangy@gmail.com)

from other leukocytes. Researchers have shown that inactive warming leads to an increase in the number of neutrophils, monocytes, and lymphocytes. And environmental stress leads to at least one additive effect on immune responses [6]. The human immune system is a well-coordinated network of cells and chemical components that recognize and destroy infections that infiltrate the body, e.g., viruses, bacteria and fungi. Two levels of immune protection, the innate immune system and the acquired (adaptive) immune system must function together to maintain a healthy immune system. There have been numerous hypotheses offered as to why prescribed exercise protects against URTI. According to past studies, a single session of moderate exercise boosts both the innate and acquired immune systems. Millions of immune cells are instantly mobilized after each bout of moderate aerobic activity, and from the mobilized cells initially enter the blood circulation. Many sorts of aerobic activity can provide significant health advantages, e.g., walking, jogging, cycling, swimming, sports play and aerobic dance. According to past studies, 20–40 minutes of moderate-intensity exercise each day is sufficient to give the immune system a boost. To meet your physical activity goals, there are numerous approaches to assess intensity during aerobic exercise [4,5].

Following exercise in hot temperatures, the number of leukocytes present in the blood for a longer period of time remains higher in the center [7,3]. Differences were observed in the activity of the central nervous system in response to the cold. It is more dependent on the exercise itself. An increase in central temperature in response to inflammation is a mechanism that the body uses to destroy and deactivate the invasive microorganisms that can cause active inflammation. Therefore, it can be stimulated [4].

On the other hand, physical activity increases the core body temperature. Also, other forms of psychological distress, and abnormality weakens the immune system, especially in the period of recovery will be effective [9, 8, 4]. If you raise the temperature of the center of activity, the main driver of event Impaired immune system function, so exercise in cold environments can cause fewer changes in immune cells than in other environments [4,8,10]. Few studies have examined the immune responses to exercise in the cold [4, 3]. They may be different, but athletes, climbers, ice skaters, firefighters, and military personnel may be forced to compete in unnatural environments. However, considering that athletes, mountaineers, ice skaters, firefighters and soldiers may be forced to work in unnatural environments, it is also important to stay in the country due to the extreme climatic conditions of the country. Changes in the safety system of sports activities in these areas should be examined. Therefore, the aim of this study was to compare safety responses, during and after sports activities in hot, cold and natural environments [11, 30].

Methods

This clinical trial study was conducted in 2020 after the approval of the Ethics Committee of the University of Tehran. 10 people who had a continuous presence in endurance sports activities for at least 3 years participated in the study. They completed the questionnaire. Personal information, medical and sports records and consent form with full knowledge of how to perform the job voluntarily and with the purpose of being selected in Qom was provided. Admission requirements included absence of any disease, infection and injury in the last month and having a history of at least 3 consecutive years and 8 hours per week of endurance exercise and maximum oxygen consumption exceeding 50 ml per kilogram per minute per minute was recommended. The intensity equations based on the percentage of maximum oxygen consumption, the intensity of the intensity of the pulse, the exchange rate of the polar bearings, the weight of the athletes, and the closure of the hourglass, especially the amount of the minimum pulse were considered [10-12]. In addition, the tests were performed in the moderate season of the year [13]. They have 2 hours rest except water from any food supplement. They did not use energy. The collected data were analyzed using SPSS software. Repeated measures and statistical test and Bonferron follow-up were applied [3].

Results

The mean age of the participants in the study was 2.22 years, the average weight was 67 kg, the average height was176 cm, the body mass index was 3.76 kg, and the average was 1.1 kg / m 2 / m2. 1.6 hours per week of activity and maximum oxygen consumption was 57.2, 3.2 ml / kg.

Based on these results, the total values of leukocytes after exercise in the natural environment, cold and hot, compared with before exercise, respectively are 21.35 and 48.63% ($p < 0.0001$). The number of these cells decreased by 16.8% two hours after activity in the natural environment, decreased by 9.8% in the cold environment and decreased by only 1% in the warm environment. The number of neutrophils after activity in the natural and cold environment increased by 22.9% and 26.4%, respectively, compared with the activity before the activity. Hot environment increased by 37% ($p = 0.018$). The number of lymphocytes after activity in natural and warm environment increased by 42% and 71%, respectively, before activity ($p < 0.0001$), but in cold environment no significant increase was observed ($p = 0.1$). There was a significant decrease of 26% in activity in the natural environment, 19.2% in the warm environment and 36% in the cold environment compared with the activity immediately after the activity ($p < 0.05$). The number of monocytes after physical activity in the natural, cold and hot environment compared with before the activity, respectively, is 91, 48 and 88.5%, respectively. 37% normal, 21% in cold environment, 55% in warm environment ($p < 0.05$). Platelet counts immediately after activity in the natural, cold and hot environment were 27%, 20% and 34% higher than before activation, respectively. 20, 17 and 25% had a significant reduction ($p < 0.0001$).

Discussion

Exercise activity in different temperature environments causes changes in the function of the immune system and the number of leukocytes and platelets [1,2,5]. The results of the present study show that exercise activity in all three environments is associated with an increase in the total number of leukocytes, which is consistent with the results of other studies [3,7,14,15], and is naturally associated with the spread of more leukocytosis [3,7]. The cause of this event seems to be an increase in central temperature, an increase in physical pressure and stress hormones [31].

In addition, Hill et al. (2008) showed an increase in the temperature of the central Pituitary kidney stimulate the pituitary renal function, increased levels of cortisol; however, due to the effect of cortisol on the immune system, increased levels of cortisol cause leukocytosis [16]. It has been shown that the main cause of leukocyte accumulation during exercise is due to increased cardiac output, plasma levels of catecholamines and cortisol. It has been shown that the main cause of leukocyte accumulation during exercise is due to increased cardiac output, plasma catecholamines and plasma cortisol levels [8]. The researchers showed that after exercising in warm conditions, leukocyte counts remained higher than normal temperature for a longer period of time, and that exercise in a warm environment delayed the return of the immune system to its original state [3,7].

This response can be rooted in a lower reduction in centrifugal temperature following exercise in a warm environment [17]. Slight increase in leukocytes before exercise in hot and cold environment compared with natural environment is likely to cause muscle tremors and release of stress hormones in the environment and environment. A very small reduction in the number of leukocytes in the warm environment has also been observed in previous studies. The slightest decrease in cells during the rest period in a warm environment compared with the cold and natural environment is likely to be due to a lower decrease in body temperature during the rest period in a warm environment [4,17]. In the present study, it was observed that an increase in the number of neutrophils that produce sports activity in cold and natural environments, which is consistent with the results of other studies [18]. Catecholamines and cortisol, which are targeted receptors in

neutrophils, have been shown to increase neutrophil counts; recall from bone marrow and increase neutrophil activity [19].

However, it has been reported that the increase in primary neutrophils is rooted in the release of catecholamines and the secondary increase in root activity in plasma cortisol results in the recall of neutrophils from the bone marrow. There is a period of rest after exercise [20]. However, an increase in neutrophil counts after exercise rest which also occurs without cortisol has been reported to be [20]. Another result of the present study was a significant increase in lymphocyte counts after exercise in warm and natural environments and in cold environments there was no significant increase. Brian et. al. (2003) showed that after one hour of activity at 8 and 38 degrees Celsius, the increase in lymphocyte count was significant in warm environment but not significant increase in cold environment [29]. This factor seems to be rooted in changes in body temperature during exercise in different environments. Also, in the present study, the number of monocytes after exercise in all three environments increased significantly and a significant increase in these cells was observed in warm and natural environments compared to cold environments. It has been shown that the number of lymphocytes increases immediately after exercise and during the recovery period, exercise increases the amount of exercise before exercise or even less than the baseline levels, and susceptibility to viral infections [22,21]. Also, it has been reported that if the recovery period is more than one hour, lymphocytic values can fall below baseline [23]. In the study by Jonathan et al (2008), the levels of monocytes and lymphocytes increased after exercise in both environments and more increase was observed in warm environments than in cold environments [17].

In the present study, the number of platelets increased significantly after activity in all three environments and decreased significantly during the rest period. Platelets may not change after moderate-to-moderate exercise, but increase after prolonged or prolonged physical activity. Platelets increase after exercise [24] except for glucocorticoids; doping products have relatively minor impacts on the immune system, while erythropoietin can have significant side effects in rare situations. Glutamine and vitamin C could theoretically protect the immune system from the detrimental consequences of hard exercise, but further research is needed to prove and explain these benefits. Exercise appears to improve immune function, which may help guard against upper respiratory tract infections. Both the humoral and cellular immune systems are affected by exercise. Except for glucocorticoids, doping products have relatively minor impacts on the immune system, while erythropoietin can have significant side effects in rare situations [23, 24].

Conclusion

In conclusion, the results of the present study showed that exercise in all three environments, natural, cold and hot, is associated with stimulation of the immune system, accumulation and increase in the number of immune cells. However, exercising in a warm environment may increase body temperature and release stress-stimulating hormones, further altering immune system components and further enhancing immune cells. In addition, resting in a warm environment prevents leukocyte levels from returning to baseline levels (before exercise) and resting in a cold environment due to a decrease in lymphocyte counts to less than baseline levels, according to the window-opening theory. Therefore, rest in the natural environment can be better than the other two environments. Exercise reduces the trend of osteoporosis, especially in women, (beneficial fat HDL), controlling blood lipid disorders and helping to increase serum levels, reducing the complications of obesity and its treatment, controlling diabetes and reducing the incidence of type 2 diabetes, prevention from atherosclerosis of coronary arteries (hardening of the arteries, (reduction of complications of joint diseases and osteoarthritis (arthritis), reduction of pregnancy complications with stress, strengthening of the immune system, weakness, strengthening of the body,

strengthening the body, strengthening the body, strengthening the body and anxiety, strengthening and creating a sense of freshness, prevention and treatment of addiction.

ORCID

Sareh Sangy
https://orcid.org/0000-0003-0366-741X

References

[1] B.K. Pedersen, L. Hoffman-Goetz, *Physical. Rev.*, **2000**, *80*, 1055-1081. [crossref], [Google Scholar], [Publisher]
[2] D.C. Niman, B.K. Pedersen, *Sport Med.*, **1999**, 27, 73-80. [crossref], [Google Scholar], [Publisher]
[3] J.B. Mitchell, J.P. Dugas, B.K. McFarlin, M.J. Nelson, *Med. Sci. Sports Exerc.*, **2002**, *34*, 1941–1950. [crossref], [Google Scholar], [Publisher]
[4] A. Bozorgian, S. Zarinabadi, A. Samimi, *Journal of Chemical Reviews*, **2020**, *2*, 122-129. [crossref], [Google Scholar], [Publisher]
[5] R.J. Shephard, P.N. Shek, *Crit. Reviews Immunol.*, **1999**, *19*, 285–302. [crossref], [Google Scholar], [Publisher]
[6] R.J. Shephard, *Can. J. Physiol. Pharmacol.*, **1998**, *76*, 539–546. [crossref], [Google Scholar], [Publisher]
[7] A.M. Niess, E. Fehrenbach, R. Lehmann, L. Opavsky, M. Jesse, H. Northoff, H.H. Dickhuth, *Eur. J. Appl. Physiol.*, **2003**, *89*, 344–351. [crossref], [Google Scholar], [Publisher]
[8] I.K. Brenner, J.W. Castellani, C. Gabaree, A.J. Young, J. Zamecnik, R.J. Shephard, P.N. Shek, *J. Appl. Physiol.*, **1999**, *87*, 699–710. [crossref], [Google Scholar], [Publisher]
[9] J.A. Woods, J.M. Davis, J.A. Smith, D.C. Niman, *Med. Sci. Sports Exerc.*, **1999**, *31*, 57–66. [crossref], [Google Scholar], [Publisher]
[10] E.F. Coyle, *Int. J. Sports Med.*, **1998**, *19*, 121–124. [crossref], [Google Scholar], [Publisher]
[11] K.H. Cooper, *Jama,* **1968**, *203*, 201-204. [crossref], [Google Scholar], [Publisher]
[12] N. Kayedi, A. Samimi, M. Asgari Bajgirani, A. Bozorgian, *South African Journal of Chemical Engineering*, **2021**, *35*, 153-158. [crossref], [Google Scholar], [Publisher]
[13] M.C. Ludmila, V.D. Bhargav, B.S. Petra, K. Lesley, S. Logan, *Open Access Journal of Sports Medicine*, **2011**, *2*, 7–11. [crossref], [Google Scholar], [Publisher]
[14] R.L. Starkie, M. Hargreaves, J. Rolland, M.A. Febbraio, *Brain, behavior, and immunity,* **2005**, *19*, 404–412. [crossref], [Google Scholar], [Publisher]
[15] J. Romeo, D. Jiménez-Pavón, M. Cervantes-Borunda, J. Wärnberg, S. Gómez-Martínez, M.J. Castillo, A. Marcos, *J. Physiol. Biochem.*, **2008**, *64*, 197-204 [crossref], [Google Scholar], [Publisher]
[16] E.E. Hill, E. Zack, C. Battaglini, M. Viru, A. Viru, A.C. Hackney, Exercise and circulating cortisol levels: the intensity threshold effect. *J. Endocrinol. Inv.*, **2008**, *31*, 587–591. [crossref], [Google Scholar], [Publisher]
[17] P. Jonathan, J. Jeremiah, C. Peiffer, R. Abbiss, N. Kazunori, O. Mitsuharu, P.B. Laursen, K. Suzuki, *Eur. J. Appl. Physiol.*, **2008**, *102*, 391-401. [crossref], [Google Scholar], [Publisher]
[18] N.P. Walsh, M. Whitham, *Sports Med.*, **2006**, *36*, 941-976. [crossref], [Google Scholar], [Publisher]
[19] K. Suzuki, M. Totsuka, S. Nakaji, M. Yamada, S. Kudoh, Q. Liu, K. Sugawara, K. Yamaya, K. Sato, *J. Appl. Physiol.*, **1999**, *87*, 1360-1367. [crossref], [Google Scholar], [Publisher]
[20] J.B. Mitchell, P.J. Dugas, B.K. Mcfarlin, M.J. Nelson, *Med. Sci. Sports Exerc.*, **2002**, *34*, 1941–1950. [crossref], [Google Scholar], [Publisher]
[21] Y. Tanimura, K. Shimizu, K. Tanabe, T. Otsuki, R. Yamauchi, Y. Matsubara, M. Iemitsu, S. Maeda, R. Ajisaka, *Med. Sci. Sports Exerc.*, **2008**, *40*, 1455-1462. [crossref], [Google Scholar], [Publisher]
[22] J.S. Wang, C.T. Lin, *Eur. J. Appl. Physiol.*, **2010**, *108*, 371-382 [crossref], [Google Scholar], [Publisher]
[23] A.C. Levada-Pires, M.F. Cury-Boaventura, R. Gorjão, S.M. Hirabara, E.F. Puggina, C.M. Peres, R.H. Lambertucci, R. Curi, T.C. Pithon-Curi, *Med. Sci. Sports Exerc.*, **2008**, *40*, 1447-

1454. **[crossref], [Google Scholar], [Publisher]**

[24] M. Gimenez, T. Mohan-Kumar, J.C. Humbert, N. De Talance, J. Buisine, *European Journal of Applied Physiology and Occupational Physiology*, **1986**, *55*, 465-470. **[crossref], [Google Scholar], [Publisher]**

[25] F.E. Sadr, Z. Abadi, N.E. Sadr, M.M. Fard, *Annals of the Romanian Society for Cell Biology*, **2021**, *25*, 6839-6852. **[crossref], [Google Scholar], [Publisher]**

[26] K. Ghajarzadeh, M.M. Fard, H. Alizadeh Otaghvar, S.H.R. Faiz, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M.M. Fard, M.R. Alebouyeh, *Annals of the Romanian Society for Cell Biology*, **2021** *25*, 2449–2456. **[crossref], [Google Scholar], [Publisher]**

[27] K. Ghajarzadeh, M.M. Fard, H. Alizadeh Otaghvar, S.H.R. Faiz, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M.M. Fard, M.R. Alebouyeh, *Annals of the Romanian Society for Cell Biology*, **2021**, *25*, 2457–2465. **[crossref], [Google Scholar], [Publisher]**

[28] K. Ghajarzadeh, M.M. Fard, M.R. Alebouyeh, H. Alizadeh Otaghvar, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M.M. Fard, S.H.R. Faiz, *Annals of the Romanian Society for Cell Biology*, **2021**, *25*, 2466-2484. **[crossref], [Google Scholar], [Publisher]**

[29] A. Susanabadi, S. Etemadi, M.S. Sadri, B. Mahmoodiyeh, H. Taleby, M.M. Fard, *Annals of the Romanian Society for Cell Biology*, **2021**, *25*, 2875–2887. **[crossref], [Google Scholar], [Publisher]**

[30] F. Miryousefiata, S Sangy, *Journal of Medicinal and Chemical Sciences,* **2021**, *4*, 60-74. **[crossref], [Google Scholar], [Publisher]**

[31] S. Sangy, F. Miryousefiata, A. Bahaoddini, H. Dimiati, *Budapest International Research in Exact Sciences (BirEx) Journal*, **2020,** *2(4)*, 458-466. **[crossref], [Google Scholar], [Publisher]**

Copyright © 2021 by SPC (Sami Publishing Company) + is an open access article distributed under the Creative Commons Attribution License(CC BY) license (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.