

Immune System and Sport – A Changing Relationship

Immunsystem und Sport – Eine wechselhafte Beziehung

From the classical point of view, sports or physical activity has a changing influence on the immune system, which led to the definition of the J-form relationship between physical activity/sports and immune system. In this theory, moderate physical activity leads to strengthening of the immune system and high-level physical activity weakens the immune system with increasing load, at least as an acute reaction.

An immune system activated by acute or chronic inflammation leads on the one hand usually to a reduction of physical/athletic performance capacity. This can be explained, at least in part, that both the immune system and sport involve high metabolic and hormonal stress for the organism, which can result in reciprocal potentiation. This simple mechanistic consideration has adapted over the past 25 years.

There are especially two aspects which led to this adaptation. On the one hand, the basically expanded knowledge of the role of the immune system not only as an “organ” for the defense function of the body, but also in the control of physiological and pathophysiological processes, which is connected to de- and regeneration of the body. On the other hand, the knowledge that physical activity or sport modulates/regulates the immune system not only in the short- but also middle- and long-term and the skeletal muscles plays a central role as the largest “organ” of the body. This has resulted in a more complex picture of the changing relationship between the immune system and sports, which is to be discussed in this Special Issue.

A current overview of the role of physical activity/sports for the immune function is in the focus and will be supplemented by specific considerations of the importance of physical activity/sports in the modulation of neuroinflammatory processes, which play an essential role in neurodegenerative diseases and on the influence of the immune system in muscle regeneration, as well as the influence of the immune system in joint disease and the use of inflammatory markers in the assessment of joint load and status. In considering the changing relationship between the immune system and sports, the aspect cannot be ignored of the activated immune system in inflammations and its relevance for athletic activity, as well as the related consequences for the management of athletes.

The close relationship between the immune system and sports is clear in the important influence sport has on the immune system. Sport results not only in a redistribution of leukocytes in the body, which may be of essential importance for the function of the immune system (1), as recently demonstrated for example in an animal model based on redistribution in the tumor of tumor-cell-repelling NK cells by means of regular training (4), but the function of immune cells is also altered, as studies on the activation of NK cells by sports have shown (5).

This is, however, only a small extract of what sports effects in the immune system. These effects of sports are mediated by the autonomic nervous system, the hormone system and most of all by cytokines released from muscles. Sports also leads to regulation of the T-lymphocytes which regulate the immune system and it can be demonstrated that the so-called suppressive Treg-lymphocytes increase in the blood of elite athletes depending on the maximal oxygen uptake capacity, shifting the immunological equilibrium in the direction of an anti-inflammatory state (7) Sports generally leads to a shift in the release of pro-inflammatory to anti-inflammatory cytokines, which is important for nearly all organ systems and tissues in the body. Moreover, sport has a positive influence in inhibiting the aging of the immune system, which is referred to as immune senescence.

It is becoming increasingly clear that the immune system plays a key role in tissue regeneration, as can be demonstrated for example in muscle regeneration. Especially after structural injuries to the musculature, muscle regeneration is regulated by the immune system. The healing process requires a coordinated cellular process which must be initiated and controlled. In this, the immune system takes on a central role, starting with the release of pro-inflammatory factors and immigration of inflammatory cells, tissue regeneration is regulated by the local inflammatory cells. These alter their function from a pro-inflammatory to a regulatory function, which has thus far been best described for macrophages. Interventions in this process, for example by anti-inflammatory medications, can thus lead to impairment of the course of healing. The regulatory role of the immune system cited for skeletal muscles is likely not limited to muscles alone but can be ascribed for other tissues and organs (2). This leads then to the question of how alterations in the immune system, >



Prof. Dr. Wilhelm Bloch

2. Chairman of the Verein zur Förderung der Sportmedizin e. V.



Article incorporates the Creative Commons Attribution – Non Commercial License. <https://creativecommons.org/licenses/by-nc-sa/4.0/>



QR-Code scannen und Artikel online lesen.

CORRESPONDING ADDRESS:

Univ.-Prof. Dr. Wilhelm Bloch
Stellv. Vorsitzender Verein zur Förderung der Sportmedizin e.V.
Abteilung Molekulare und zelluläre Sportmedizin
Deutsche Sporthochschule Köln
Am Sportpark Müngersdorf 6, 50933 Köln
✉ : w.bloch@dshs-koeln.de

for example by age, nutrition and especially sports, influence tissue regeneration. Do highly-trained elite athletes present altered tissue regeneration due to a shifted immunological equilibrium?

The immune system, however, is not only involved in tissue regeneration, but also has an essential influence on the maintenance of function and structure of tissues and organs in dependence on immunological equilibrium, since a chronic pro-inflammatory state of the immune system leads to tissue and organ damage and, among other things, cardiovascular and metabolic diseases as well as neurodegenerative diseases. Using neurodegenerative diseases as an example, it becomes clear how sports activity can work to offset neurodegeneration in part via the immune system. In the brain, too, sports activity also alters the availability of pro-inflammatory factors and the localization and activation of immune cells so that neuroinflammation is suppressed as the driver of neurodegeneration. This can be shown on the example of sports in patients with multiple sclerosis (9).

Chronic and acute inflammations damage not only the vessels, heart, skeletal muscles and brain, but connective and supporting tissues are subject to pro-inflammatory influences, as clearly seen in osteoarthritis. The degeneration of joint components, especially cartilage, is closely connected to pro-inflammatory processes in the joint. The influence of sports on osteoarthritis has been shown, even though the underlying mechanisms are far from being explained. It can be assumed, however, that the local pro-inflammatory situation plays an essential role. It is no surprise that inflammation factors are used as markers for the influence of sports on multimorbid osteoarthritis (7).

These effects of sports on the immune system and the burden on the immune system which arise especially at high training loads must, however, also be viewed in connection with infectious diseases, since the effect of sports may have a negative effect, at least temporarily, on the defense function of the immune system. This makes appropriate load management necessary in athletes, taking into consideration additional pro-inflammatory stimuli and the occurrence of vulnerable phases for infection. For this reason, information on the practical avoidance of bacterial and viral infections is given in this special edition (3).

Why sports has so great an influence on the immune system is most clear when it is remembered that practically every sport activity results in dependence on volume and intensity in stimulation of the immune system and the immune system is trained as well. It will be important in the future to further understand the effect of sports on the immune system and generate from the knowledge gained practical and clinical recommendations for sports to strengthen the immune system. ■

References

- (1) **ALACK K*, PILAT C*, KRÜGER K.** Current knowledge and new challenges in exercise immunology. *Dtsch Z Sportmed.* 2019; 70: 250-260. doi:10.5960/dzsm.2019.391
- (2) **GEHLERT S, JACKO D.** Gehlert S, Jacko D. The role of the immune system in response to muscle damage. *Dtsch Z Sportmed.* 2019; 70: 242-249. doi:10.5960/dzsm.2019.390
- (3) **PALMOWSKI J*, BOSSLAU TK*, RYL L, KRÜGER K, REICHEL T.** Managing immune health in sports – a practical guide for athletes and coaches. *Dtsch Z Sportmed.* 2019; 70: 219-226. doi:10.5960/dzsm.2019.389
- (4) **PEDERSEN L, IDORN M, OLOFSSON GH, LAUNENBORG B, NOOKAEW I, HANSEN RH, JOHANNESSEN HH, BECKER JC, PEDERSEN KS, DETHLEFSEN C, NIELSEN J, GEHL J, PEDERSEN BK, THOR STRATEN P, HOJMAN P.** Voluntary Running Suppresses Tumor Growth through Epinephrine- and IL-6-Dependent NK Cell Mobilization and Redistribution. *Cell Metab.* 2016; 23: 554-562. doi:10.1016/j.cmet.2016.01.011
- (5) **SCHENK A, KOLIAMITRA C, BAUER CJ, SCHIER R, SCHWEIGER MR, BLOCH W, ZIMMER P.** Impact of Acute Aerobic Exercise on Genome-Wide DNA-Methylation in Natural Killer Cells-A Pilot Study. *Genes (Basel).* 2019;10: 380. doi:10.3390/genes10050380
- (6) **WEINHOLD M, SHIMABUKURO-VORNHAGEN A, FRANKE A, THEURICH S, WAHL P, HALLEK M, SCHMIDT A, SCHINKÖTHE T, MESTER J, VON BERGWELT-BAILDON M, BLOCH W.** Physical exercise modulates the homeostasis of human regulatory T cells. *J Allergy Clin Immunol.* 2016; 137: 1607-1610.e8. doi:10.1016/j.jaci.2015.10.035
- (7) **WIDMANN M, KRAUSS I, JANSSEN P, NIESS AM, MUNZ B.** Biomarkers to monitor efficacy of exercise programs in multimorbid osteoarthritis patients: is inflammation the clue? *Dtsch Z Sportmed.* 2019; 70: 235-241. doi:10.5960/dzsm.2019.388
- (8) **ZIMMER P, BANSI J, RADEMACHER A, SCHLAGHECK ML, WALZIK D, PROSCHINGER S, BLOCH W, JOISTEN N.** Exercise-neuro-immunology – from bench to bedside. *Dtsch Z Sportmed.* 2019; 70: 227-234. doi:10.5960/dzsm.2019.392