The relationship between exercise and the immune system

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Abstract. Many studies have proved that exercise can improve the human immune system, so that people can better resist diseases, and people who exercise for a long time do have a great advantage in disease resistance and recovery than ordinary people. But how this happens, middle school biology teaches students how the immune system works, how it helps us to destroy our enemies. This is inseparable from the cells in the human body and the substances secreted by the cells. The improvement of the human immune system from exercise certainly does not happen in a vacuum. The human body undergoes great changes during exercise, and these changes must also have an impact on the human immune system. What changes occur in the human body during exercise? Does improving your immune system after exercise work the same way you build muscle and strength after exercise? In order to understand how exercise improves the immune system, the changes of cells and substances closely related to the immune system in the human body after exercise were searched and collected. These cells or substances are important components of the immune system and play a decisive role in a person’s immune system, and their changes often directly reflect the strength of the human immune system.

Keywords: exercise, immune cell, material in human body.

1. Introduction

Nowadays, more and more people decide to take regular physical exercise because they believe that the exercise not only can help them become more robust but also can make their body healthier and even help them resist disease. In addition, many scientists have proved that people who usually exercise have stronger resistance to certain kinds of diseases. Why can the exercise improve our immune system? As early as 1902, scientists have found that leukocytes counts rise by looking at how people respond to marathons [1]. What else happens to our bodies during exercise?

2. Cytokines

A cytokine is a soluble factor that is produced by one type of cell and can act on another cell to change the function of the target cell. Cytokines can be thought of as hormones in immune and inflammatory responses [2].

Based on their roles, cytokines are divided into pro- and anti-inflammatory groups. Exercise and other factors such as oxidative stress or hormones might affect the production of cytokines. Muscle contraction causes a rise in the release of pro- and anti-inflammatory cytokines, the amount of which is dependent on the exercise’s length, intensity, and contraction mass volume [3].

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Cytokines can act like hormones in the body, and their release can increase after exercise, its increase may make the immune system more sensitive and ultimately improve the body's immune capacity.

3. Neutrophils

One of the body's primary cellular mediators of the elimination of pathogens, the neutrophil invariably causes damage to the host's cells and tissues. Most of the time, neutrophil-mediated tissue destruction is a life-saving mechanism, and one of the primary information sources that initiates inflammation and immunity in the host is tissue damage. The recruitment, activation, and programming of macrophages and dendritic cells are all facilitated by neutrophils. The sterilization of microorganisms, the production of signals that impede the growth of additional neutrophils, and the activation of a macrophage-based program that transforms damaged epithelium from pro-inflammatory and nonreplicative to anti-inflammatory and replicative are all crucial functions of neutrophils in the healing of wounds [4].

Both the damaged and control limbs experience a biphasic rise in oxidant generation following an acute muscular stretch injury and the necessary operations to cause the injury, which may indicate a systemic immune response. An increase in active neutrophils could be the reason for the 4 h increase in oxidant production. When engaging in physical activity, the activation of muscle fibers increases the release of calcium (Ca2 +), which in turn stimulates the production of pro-inflammatory cytokines such as TNF-α and IL-1 β. These cytokines function to regulate selections, which ultimately draw neutrophils to the area. There is a notable decrease in neutrophil chemotaxis following aerobic exercise (around 24 hours), but bactericidal action is unaffected. Within 48 hours following physical exercise, the decrease in neutrophil chemotaxis is restored, allowing infectious bacteria to potentially multiply [4].

Because of the activation of muscle fibers, which causes neutrophils to be attracted, exercise means that a large number of muscle fibers are activated, which leads to the production and aggregation of neutrophils, but these decrease after 24 hours. Neutrophils, in turn, affect the body's ability to kill microorganisms, heal wounds, and initiate inflammation. Since neutrophils can increase during and 24 hours after exercise, this explains why people who exercise are better able to fight off disease because their bodies always have cells on standby. People who exercise for a long time have stronger immunity because the neutrophils drop 24 hours after exercise.

4. Leukocytes

Leukocytes are essential for wound healing, tumor surveillance, innate and adaptive immunology, and tissue remodeling. In addition to actively phagocytosing and eliminating infections, neutrophils and macrophages play a crucial role in controlling the inflammatory response because of their potent ability to start and maintain the numerous inflammatory mediator cascades mentioned previously. Despite the fact that billions of dollars have been invested in the still-failed hunt for immunomodulatory drugs that might successfully suppress this response, it is now evident that a healthy and vigorous inflammatory response is in fact essential for survival [5].

Another factor contributing to the rise in circulating leukocyte concentration is physical activity. Numerous immune response alterations are brought about by physical activity, and different types of exercise—both intense and prolonged—can raise white blood cell counts. The quality and quantity of white blood cells are physiologically altered by intense exercise, which impacts the body's capacity to combat common infections. After extended activity, cytokines are produced, and circulating white blood cells may generate IL-8, IL-10, and IL-1ra, which are associated with exercise-induced leucocytosis. The observed leucocytosis is consistent with prior findings, namely an increase in total white blood cells and lymphocytes during aerobic exercise, even if cytokines were not assessed. White blood cell and lymphocyte counts rose with exercise, but not monocyte counts. This suggests that intense activity soon following exercise induced notable short-term immune system disruptions. White blood cell counts revert to resting levels 24 hours following exercise, indicating that the leucocytosis response brought on by exercise is transient [6].

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Like neutrophils, white blood cells increase after exercise and will decrease after 24 hours. white blood cells are the main force of phagocytic pathogens, but also the leading cause of inflammation; its increase will undoubtedly enhance the human ability to kill pathogens and improve the immune system.

5. Antigen-presenting cells (APCs)

Aerobic exercise inhibits the helper T 1 (Th1) inflammatory response by lowering the expression of toll-like receptors (TLRs) in macrophages and dramatically reducing the antigen presented to T cells. Therefore, the absence of inflammatory activity eliminates the possibility of tissue damage brought on by inflammatory mediators, which lowers the likelihood of long-term inflammatory processes. On the other hand, vulnerability to microbial infections within cells rises [7].

6. Natural killer cells (NKs)

NK cells are a type of lymphoid population that lacks clonally dispersed antigen-specific receptors, unlike T or B lymphocytes. NK cells are mostly found in the spleen, bone marrow, and peripheral circulation under normal circumstances, but they can also migrate to inflammatory tissues in response to various chemoattractants. They seem to be involved in slowing the growth of tumors in vivo and halting the spread of metastatic cancers quickly. Furthermore, NK cells play a critical role in the body's defense against some cytopathic viruses, most notably herpes viruses. When activated, natural killer (NK) cells release cytokines and chemokines that affect the course of subsequent adaptive responses, regulate haematopoiesis, regulate the growth and function of monocyte and granulocyte cells, and cause inflammatory reactions [8].

The enhanced capacity of every NK cell to eliminate its target cell causes an increase in NK cell activity during a period of moderate exercise. These are only temporary variations; in one to three hours, readings often recover to levels similar to those before the exercise. Though the question of whether regular exercise training results in long-term increases in NK cell activity has not been sufficiently studied, detailed long-term endurance exercise, such as marathon running, has been linked to 6-hour and 21-hour recoveries of declines in NK cell activity and numbers [9].

NK cells play a significant role in killing viruses and fighting cancer, and aerobic exercise can enhance its ability to make it more active so that it can destroy viruses more efficiently. The enhanced ability of NK cells naturally also enhances the immune system, which means that people can better resist diseases caused by viruses and better cope with cancer cells. And the increase in NK cells, which returned to pre-exercise levels shortly after exercise, corresponds to the fact that people who exercised for a long time had a more muscular immune system than those who exercised occasionally.

7. Lymphocytes

Exercise increases the synthesis of several hormones, including catecholamines, cortisol, and opioid neuropeptides like beta-endorphins. Exercise for 35 minutes raised plasma cortisol and caused granulocytosis, but it had no effect on lymphocyte function. Following physical activity, there was also a notable rise in the number of lymphocytes in circulation. Furthermore, it was shown that following exercise, there was a notable rise in the quantity of natural killer cells as well as inhibitory or cytotoxic T cells. The concentration of lymphocytes in the vascular bed rises with moderate physical exercise and falls to pre-exercise levels during vigorous exercise [10].

Lymphocytes play a key role in the specific immunity of the human body, and the emergence of more lymphocytes is undoubtedly a good thing for the immune ability of the human body, but vigorous exercise will make the decline of lymphocytes also reflects the objective fact that vigorous exercise has a negative impact on the human body.

8. Myokine

Myokine is a substance that muscles can make, and it can change with exercise. In addition to playing a crucial part in boosting cytotoxicity and immune cell penetration into the tumor, myokines may directly suppress cancer. Research that uses post-exercise blood serum directly on different kinds of

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cancer cell lines shed light on how exercise affects the soluble and cell-free blood contents, which in turn inhibits the growth of cancer. Myokines are cytokines that are secreted into the bloodstream by muscle. They have the potential to improve cellular metabolism in a number of ways, including decreased insulin resistance, enhanced glucose absorption, and decreased adiposity. Exercise can also change the amounts of myokines in the blood. The growth of cancer may be directly inhibited by changes in the levels of myokines such as IL-6, IL-15, IL-10, irisin, secreted protein acidic risk in cysteine (SPARC), myostatin, oncostatin M, and decorin. These changes may do this by promoting apoptosis, apoptosis inhibition, cell-cycle arrest, and inhibition of the epithermal transition to mesenchymal cells. Exercise-induced myokines can control this environment by controlling adipocytes and adipose tissue. Insulin resistance, hyperinsulinemia, and hyperlipidemia are associated with obesity and can generate an environment that is favorable for tumor growth. Myokines produced by exercise are also essential for boosting cytotoxicity and immune cell penetration into the tumor [11].

9. IL- 6

The first myokine to be described that was produced solely TNF-independently and exponentially in response to post-exercise muscle contraction was IL-6. Exercise duration and intensity, together with the mass of the muscles involved in the mechanical stress, are all related to the release of IL-6 from muscles. Muscular IL-6 increases insulin sensitivity through participating in AMPK-mediated fat oxidation, skeletal muscle lipolysis, and insulin-stimulated glucose uptake. Regular exercise has anti-inflammatory and immunoregulatory effects that are partially mediated by IL-6. This is because IL-6 promotes the secretion of classic anti-inflammatory cytokines like IL-10 and IL-1ra and controls TNF-α levels. Unlike the advantageous effects of muscle IL-6, in vivo IR, Mets, obesity, and physical inactivity are strongly correlated with persistently high blood IL-6 levels, which are produced by adipocytes and immune cells in the visceral adipose tissue. Interestingly, a pleiotropic myokine secreted by contracting myotubes is oncostatin M (OSM), a member of the IL-6 superfamily. OSM has been demonstrated to significantly reduce tumor cell lines' growth in a range of tissues, including lung, ovarian, melanoma, and mammary epithelial cells [11].

10. IL- 15

A myokine that suppresses adiposity, IL-15 is a 15 kDa protein that is abundantly expressed in skeletal muscle, particularly after resistance and aerobic exercise. As an actual myokine, IL-15 has hypertrophic and anabolic effects on muscle tissue. In addition, as part of the muscle-adipose cross-talk, IL-15 also has numerous metabolic effects by promoting glucose uptake and fat oxidation in muscle tissue, promoting lipolysis, and inhibiting preadipocyte differentiation and lipogenesis. Plasma IL-15 levels are low in obese people. It's interesting to note that in male mice, IL-15 decreases the number of white adipocytes and serum leptin levels while increasing the synthesis of the anti-inflammatory and anti-neoplastic hormone adiponectin, downregulating visceral adiposity [11].

Myokine has a direct relationship with muscles, which are absolutely inseparable from exercise. It can be said that myokine has a direct relationship with exercise, and exercise increases the secretion of myokine. Some kinds of myokine have been proven to help the human body produce an immune response. Exercise boosts the immune system.

11. Conclusion

We found that physical exercise has an effect on the number of immune cells in the body, and the muscles exercised during exercise also produce more mokyine, which is good for the body and the immune system. These changes in numbers may be why physical exercise helps people better protect against infectious diseases and cancer. However, I believe that this evidence is not convincing enough. It is because most of the changes caused by exercise will recover in a short period of time. Thus, I think we need to spend more figuring out the principles.

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