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# Immunogenetic Bases of Athletes' Adaptation and Prospects for Their Use in Sports Selection

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**Abstract:**

Associations with the HLA phenotype, dynamics of T-lymphocytes and B-lymphocytes, antigen-binding lymphocytes (ASL) specifically sensitized to the vaccine antigen, as well as titer increases of specific antibodies were studied in 110 athletes of the Uzbek population with antigenic exposure to typhoid vaccine. It was found that a high level of immune reactivity and antibody production was observed with the HLA-B15 phenotype; a low level of immune response and AT titer was detected with the HLA-B5 and HLA-B35 phenotypes. The immune response to typhoid vaccination with high antibody titer production is associated with an increase in the number of T-lymphocytes and T-helper subpopulation in the blood, the content of ASL and a decrease in B-lymphocytes. High immune reactivity in the HLA-B15 phenotype indicates broad adaptive capabilities, and a low immune response in the HLA-B5 and HLA-B35 phenotypes indicates limited adaptive capabilities of the body, in particular to increased physical exertion.
**Keywords:** Genotype, athlete's phenotype, immune response, HLA antigen complex, determination, antibody titer, T and B lymphocytes, vaccination.

## Introduction

Modern sports involve loads on the verge of physical and psychological capabilities of a person. Under these conditions, a scientifically based approach to the organization of the training process with insufficient individualization, the combination of intensive training with other activities provokes the manifestation of hidden defects in health, prevents the achievement of high athletic results and leads to loss of fitness at the time of intensive training and responsible competitions. An additional factor provoking athletes' breakdowns at the time of responsible competitions is the depletion of their functional reserves – the "overtraining syndrome". It often occurs due to insufficient objectivity of indicators of the state of the athletes' body.

The most labile structures, which are very sensitive to the effects of exogenous and endogenous factors, and in particular to physical exertion, include the immune system.

Early studies indicate the stimulating effect of moderate physical exertion on the immune system and immunological reactivity. The analysis of the research results at subsequent stages allowed us

to state that intense loads typical for modern sports, reaching a stressful level, negatively affect the immune system and cause violations of immune homeostasis. This is expressed by changes in the quantitative characteristics of the T and B immune systems, indicators of natural resistance, and the severity of autoimmune processes. The phenomenon of the complete disappearance of certain classes of immunoglobulins and antibodies from the blood and biological fluids of athletes at the time of responsible competitions has also been established, indicating a breakdown in the processes of immunological adaptation and depletion of immune reserves. The state of the immune system, which develops when adaptation processes are disrupted, can be characterized as a very pronounced secondary immunodeficiency (6).

In order to timely identify the discrepancy between the loads presented to the capabilities of the immune system, as well as to predict the body's tolerance to heavy physical exertion, an individual approach is necessary, taking into account the genetic determinacy of the immune response (1).

However, to date, the assessment of the immune status of athletes using genetic markers has not been widely used. It is considered established that among the absolute genetic markers, the antigens of the HLA complex dominate in the determination of immune processes, since they include genes that determine specific cellular immune responses [2,4].

Taking into account the association of HLA complex genes with the development of a number of immunopathological conditions, we conducted studies to study the dependence of the dynamics of the immune system of athletes with the HLA phenotype on antigenic exposure. Routine vaccination with typhoid vaccine was used as an antigenic effect.

**Research materials and methods.** During routine vaccination with sorbed typhoid vaccine, 110 athletes aged 17 to 21 years were examined at the Uzbek State University of Physical Culture and Sports. At the time of vaccination, 10-12 and 28-30 days after vaccination, the quantitative content of populations of T-lymphocytes and B-lymphocytes, subpopulations of T-lymphocytes, as well as antigen-binding lymphocytes (ASL) specifically sensitized to the vaccine antigen was studied. At the time of vaccination and on day 28-30, the titer of specific antibodies was studied. In all studies, blood was taken from the ulnar vein.

The NDA phenotype was determined in a standard lymphocytotoxic test using a panel of antisera obtained from the Center for Immunological Tissue Typing at the St. Petersburg Research Institute of Blood Transfusion. Peripheral blood lymphocytes were isolated in a density gradient of ficoll-verografin.

ASL was determined using the Gurari N.I. method. The titer of specific antibodies was determined in the reaction of passive hemagglutination (RPGA) with erythrocyte salmonellosis O-diagnosticum on the principle of paired sera. The reaction was performed on normal rabbit serum with appropriate control in isotonic solution. The effectiveness of vaccination was assessed by the degree of increase in antibody titer.

The digital data was subjected to statistical processing. The average values, the reliability of their differences and mutual correlations were calculated. Differences satisfying $p < 0.05$ were considered reliable.

**The results and their discussion.** The dynamics of antibody formation in athletes with different NDA phenotypes varied widely. Both the increase and decrease in antibody titer in the majority of the subjects had values relatively close to the average group-wide indicators. However, with the phenotypes HLA-B5, HLA-B15 and HLA-B35, the differences in antibody titer are significant: if the phenotypes HLA-B5 and, especially, B-35 were associated with a low content of antibody titer up to a decrease, then the phenotype HLA-B15 was associated with a marked increase in the titer of specific antibodies (Table 1).

The dynamics of ASL in the examined contingent of athletes on 10-12 days after vaccination is characterized by an increase in the average group indicators. However, the most pronounced differences in the dynamics of USL were also noted in individuals with phenotypes NA-B5, AH-B 35 and NA-B 15. The dynamics of ASL in individuals with the NDA-B5 and NDA-B35 phenotypes is characterized by an insignificant increase or decrease in the number of ASL, both relative to the initial and relative to the average group indicator. At the same time, a marked increase in ASL, both relative to the initial and relative to the average group index, was noted in carriers of the NDA-B15 phenotype, in whom the most significant increase in the antibody titer multiplicity was revealed.

| The HLA phenotype | Dynamics of antibody formation | | Dynamics of ASL |
|---|---|---|---|
| | Normal rabbit serum | Isotonic solution | |
| HLA-A9 | -2,7 | -2,2 | 8,25 |
| HLA-A10 | +1,5 | +2,0 | +9,36 |
| HLA-B5 | -4,0 | -1,5 | -0,5 |
| HLA-B13 | -1,7 | -2,2 | +7,0 |
| HLA-B15 | +0,5 | +4,0 | +20,0 |
| HLA-B16 | -1,4 | -1,7 | +3,24 |
| HLA-B35 | -1,5 | -3,0 | +2,0 |

The analysis of the T- and B-cell link indicators showed that in the dynamics of post-vaccination immunity, there is an increase in the pool of T lymphocytes, which is associated with the predominance of the T-helper subpopulation over the T-suppressor. The dynamics of B lymphocytes is characterized by a steady decrease in their content as the intensity of antibody formation increases. Fluctuations in T- and B-lymphocyte indices after vaccination were least pronounced in individuals with the HLA-B5 and HLA-B35 phenotypes, while the highest degree of fluctuations in indicators was noted in the HLA-B15 phenotype. This suggests that immunogenesis with the formation of a high antibody titer is accompanied by a high degree of fluctuations in the dynamics of cellular immunity, whereas at a low level of antibody genesis, the degree of severity of fluctuations in T- and B-links of immunity is insignificant.

The obtained research results indicate the existence of HLA-associated genetic control of cellular and humoral immunity, and the strength of the immune response and the nature of the immune response to typhoid antigenic effects depend directly on the HLA phenotype. There is similar data in the literature on the existence of a dependence of the manifestation of functional specificity and activity of the immune system on immunogenetic features (7). It has been established that the action of the HLA-B35 associated gene manifests itself through a multidirectional level of two different subpopulations of immune component cells: increased activity of natural killers (EC) and decreased mitogenic response of T lymphocytes. The athletes of the Uzbek population examined by us with certain HLA-B15 showed a marked increase in antibody titer, a significant increase in the number of ASL in the blood, pronounced fluctuations in the indicators of the total pool of T and B lymphocytes, which indicates an adequate immune response in response to antigenic effects and characterizes a high level of immune reactivity with intensive production of specific antibodies. This allows us to make a prediction that athletes of the Uzbek population – carriers of

the HLA-B15 antigen in the phenotype also have the ability to adapt to a high degree to physical exertion of various volume and power.

The opposite nature of the immune response was revealed for athletes with HLA-B5 and HLA-B35 phenotypes: an inadequately low level of immune response allows us to judge the limitations of their adaptive capabilities of the immune system, one of the main systems for controlling and maintaining homeostasis. Individuals with this type of immune response are often predisposed to prolongation and chronization of a number of infectious diseases (4,7). Therefore, carrier athletes in the HLA-B5 and HLA-B35 phenotypes can be classified as a risk group capable of disruptions during responsible competitions. The results obtained indicate the possibility of predicting the adaptive abilities of the athletes' body to increased functional loads based on signs of immune status and taking into account the characteristics of their HLA-B5 and HLA phenotype.

**Conclusions.**

1. In athletes of the Uzbek population, the nature of the immune response in response to vaccination with typhoid vaccine depends on the characteristics of the HLA phenotype: a high level of immunoreactivity and production of specific antibodies was observed in carriers of the HLA-B15 antigen in the phenotype; a low level of immune response and titer of specific antibodies was detected in the presence of HLA-B5 antigens in the phenotype and HLA-B35.
2. The immune response to typhoid vaccination with the production of a high titer of specific antibodies is associated with an increase in the number of T-lymphocytes and T-helper subpopulation in the blood, the content of antigen-binding lymphocytes specifically sensitized to the vaccine antigen, as well as a decrease in the level of B-lymphocytes.
3. High immune reactivity in athletes of the Uzbek population with the HLA-B15 phenotype indicates broad adaptive capabilities, and a low immune response with the HLA-B5 and HLA-B35 phenotypes indicates limited adaptive capabilities of the body, in particular to increased physical exertion.

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