Immune Resistance in Athletes Depends on Aerobic or Anaerobic Mode of Training

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Aerobic (skiing) and anaerobic (wrestling) physical exercises exert opposite effects on the functional state of phagocytes, antibody production, and susceptibility to infectious diseases.

Key Words: *physical exercises; immunity; morbidity*

Many researchers believe that regular physical exercises increase functional capacity of the oxygen transport systems and resistance to hypoxia, which, in turn, improve the resistance to various stress factors due to a cross-resistance phenomenon. However, the activities generally referred to as physical activity, physical training, sport, *etc.*, in reality are presented by distinct kinds of training. From the physiological point of view, it is most important to divide physical exercises into aerobic (cyclic exercises) and anaerobic (speed-power and complex coordination exercises). In training the athletes of different specializations, either anaerobic (wrestling), or aerobic (skiing) exercises are predominant [8]. It seems important to compare positive and negative effects of aerobic and anaerobic exercises on the immunobiological surveillance system in athletes and their susceptibility to infectious diseases.

MATERIALS AND METHODS

The study was carried out on healthy male volunteers, qualified professional skiers (201 men) and wrestlers (unarmed self-defense and judo, 128 men). The athletes were examined in autumn-winter (from November to February) during 2-3-day rest from training and competitions.

Maximum oxygen consumption (MOC) was measured on a Spirolit-2 gas analyzer [5] during graded bicycle exercises adjusted individually depending on the age and body weight. MOC was referred to the body weight (kg) and surface area (m^2). Peripheral blood monocytes and neutrophils were isolated as described elsewhere [9]. Spontaneous and induced chemiluminescence (sChL and iChL, respectively) of neutrophil granulocytes was measured as described previously [1]. Phagocytosis was assayed by uptake of latex particles [4]. The concentration of plasma immunoglobulins was assessed by radial immunodiffusion in agar [7] with modifications [3].

RESULTS

Compared to wrestlers, skiers had significantly higher MOC/kg (65.3±0.52 *vs.* 57.2±0.78 ml/min/kg in wrestlers) and MOC/m^2 (2.46±0.02 *vs.* 2.19±0.03 liter/min/m^2 in wrestlers). These data are in line with the generally accepted idea that cyclic exercises increase the capacity of the oxygen transport system [8].

When analyzing the effect of aerobic or anaerobic exercise on phagocyte activity, we found that wrestlers had better parameters of neutrophil and monocyte phagocytic reactions (Table 1).

The most informative indices of neutrophil killing activity were sChL and the iChL/sChL ratio. The intensity of sChL in the skiers 3-fold exceeded that in wrestlers (Table 1), while the iChL/sChL ratio was significantly higher in wrestlers. The differences in sChL and the iChL/sChL ratio between the groups of athletes correspond to the concept of the so-called discrete conditioning of phagocytes [2]. Relative activation of neutrophilic phagocytosis in wrestlers was accompanied by reduced spontaneous production of free ra-

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TABLE 1. Phagocytic Activity of Neutrophils and Monocytes in Skiers and Wrestlers *(M±m)*

Group	Phagocytic activity, %		Intensity, number of particles		sChL, $\times 10^3$ cpm	iChL/sChl, rel. units
	monocytes	neutrophils	monocytes	neutrophils		
Skiers (*n*=201)	45.65±1.48	54.03±1.77	153.30±8.06	233.79±11.96	579.65±76.42	44.18±5.97
Wrestlers (*n*=128)	54.88±2.21*	61.95±2.11*	210.65±12.35**	318.16±16.96**	154.39±36.37**	79.59±11.86*

Note. Here and in Table 2: *$p<0.01$, **$p<0.001$ in comparison with skiers.

TABLE 2. Plasma Content of Ig (ME/liter) in Athletes *(M±m)*

Group	IgG	IgM	IgA
Skiers (*n*=201)	95.91±1.98	130.14±3.01	126.21±2.55
Wrestlers (*n*=128)	163.67±5.44**	153.33±3.36**	139.43±3.11*

dicals and increased production of active oxygen forms in response to additional stimulation *in vitro*, which attest to enhanced uptake of heterologous materials by phagocytes and increased neutrophil reactivity.

These findings indicate mobilization effector cell pool of nonspecific immune resistance with simultaneous realization of their biocide potential in skiers, while in wrestlers functional phagocyte pool is preserved and their reactivity to additional *in vitro* stimulation increased.

A significant intergroup difference was revealed when comparing plasma immunoglobulin concentrations (Ig). Plasma content of all Ig was significantly higher in wrestlers (Table 2). The most pronounced difference was observed for IgG: its content in wrestlers surpassed that in skiers by 71%. These data suggest that humoral immune response is more strained in wrestlers.

This strain probably results from relatively low killing activity of phagocytes in this group of athletes. If this suggestion is true, the intensified phagocyte reaction of neutrophils and monocytes in wrestlers is directed to antigen "representation" to lymphocytes rather than to the cleaning of the internal medium.

The most important task of immunological investigations is to compare laboratory indices with the frequency of immunodeficiency manifestations. Sometimes, pronounced differences revealed by laboratory investigations have no prognostic value with respect to infectious diseases [6]. Therefore, we compared the incidence of respiratory infections in these groups of athletes.

The incidence of respiratory diseases in skiers, whose oxygen transport system was adapted to long-term aerobic exercise and low temperatures, was less than half (14.4%) of that in wrestlers (33.7%).

Thus, regular aerobic or anaerobic training exerts a pronounced immunomodulatory effect. Under conditions of the South Urals, training with cyclic (aerobic) exercises had a more beneficial effect on the immune system and resistance to respiratory infections.

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