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AN INTEGRAL ESTIMATION OF THE FUNCTIONAL STATUS OF THE EXTERNAL RESPIRATORY SYSTEMS OF QUALIFIED FUTSAL PLAYERS

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Abstract

The purpose of the study was to analyze index changes of the flow-volume curve during training of elite futsal players.

The conducted monitoring of respiration rates shows multidirectional responses of bronchial tubes of the respiratory system, vegetative nervous system, local cell and humoral factors.

The orientation of the processes to adaptation and enhancement of the oxygen transport function at submaximal loads is developed in the opposite direction among 15% of the subjects, which can result in limiting the effect of bronchismus, edema and mucus hypersecretion to the oxygen delivered to the alveolus and ultimately, decrease physical working capacity.

The dynamic monitoring of the training process when estimating the flow-volume curve indices ensures (especially in youth team players) early detection and correction of exercise-induced bronchospasm, specifying its etymology and making an early diagnosis and pharmacological intervention, that makes training and competitive processes more efficient.

Key words: *futsal, functional status, external respiratory system, elite athletes.*

Relevance

Given the modern conditions of intensification of loads in sports activity new scientific criteria should be developed to estimate the functional state of the respiratory system of qualified athletes [2, 4, 5]. An athlete's body influenced by permanent loads is characterized by specific conditions that are extremely rare for an average person. Elite futsal players usually cope well with acute and chronic fatigue, and overtraining due to excessive physical loading [1, 3].

Increased and extreme physical loading in sport limit physical activity due to the development of bronchial obstruction, cellular infiltration of the bronchial mucosa, and remodeling of the respiratory tract. Depending on the loading volume the capacity of the vascular capillary bed increases, along with blood viscosity, extended mucociliary clearance time, while increased pulmonary engorgement at maximum loading in qualified athletes results in compression of the vessels of the pulmonary circuit and development of acute respiratory distress syndrome. It serves as a basis for the respiratory tract remodeling: respiratory muscle hypertrophy occurs, subendothelial fibrosis is developed, the decrease in elasticity of the bronchial wall is marked, along with ruptures of alveoli and pulmonary capillary occlusion under mechanical and oxidative stress, increased tone of the sympathetic ANS, which leads to vasoconstriction and reduction of the vascular bed.

Recently, researchers have been more interested in nitric oxide (II) (NO) as a significant biomarker of immune inflammation. The concentration of nitrogen oxide in the exhaled air

(NOex) increases significantly especially in the case of eosinophilic airway inflammation. However, despite the extensive experience of using this marker, some aspects are still interpreted ambiguously. The relevance of measuring the athletes' NOex level is little studied [6-9].

It is therefore vital to define the clinical relevance of the NOex level in qualified athletes under strenuous loading to estimate the comparability of this marker with bronchospasm manifestations of physical loading, as well as to predict bronchial hyperresponsiveness.

The purpose of the present study was to analyze index changes of the flow-volume curve during training of elite futsal players.

Materials and methods

The study involved 26 members of the Russian national futsal team (youth and first team, 2012) aged 18-29 years. The study was performed 4 times: in the morning on an empty stomach, after a workout (in the aerobic mode), after training (during submaximal anaerobic exercise), in the early recovery period using a portable electrochemical NO-analyzer ("NObreath", Bedfont Scientific Ltd.).

To assess changes in the status of external respiratory function a spirogram was recorded using the spirograph "Spiro Spectrum" by Neurosoft. The spirogram was used to estimate the following indicators: vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV1 / FVC ratio), average air flow rate in the middle of the forced expiration between 25 and 75 % FVC (SOS 25-75), peak flow rate (PFR), instant expiratory flow rate 25 % FVC (MEF25), instant expiratory flow rate 50 % FVC (MEFR50), instant expiratory flow rate 75 % FVC (MEF75).

Results and discussion

Proceeding from the spirographic monitoring of athletes, the majority of those examined in the analysis of the flow-volume curve had an increase of velocity and volume respiratory indices, which can be described as adequate adaptive responses of the respiratory system, particularly lung ventilation, to the training load (Fig. 1).

With the increase in intensity of physical loading during exercise there was a rise in the indicators of respiratory spare abilities (FEV1, FVC, MEF50-75) and of mobilization readiness of the respiratory system to perform additional loading (Fig. 2). These changes were due to involvement of bronchial tubes and bronchioles of the distal respiratory system. The detected capacities indicate the presence of the backup resource of the respiratory system in a group of examined athletes.

High tolerance of endurance exercises in the studied group of athletes, the chance of growth in fitness and sports skills is expected.

However, some athletes (12%) noted the emergence of maladaptive changes with the increase in training loading up to submaximal level.

The findings prove the reduction of the flow-volume curve indices, characterizing speed capabilities of the respiratory system.

According to the analysis of the results, the deterioration in the external respiratory function is mainly caused by bronchial obstruction due to dysregulation of the autonomic tone with the activation of the parasympathetic division of the autonomic nervous system, reflex decrease of bronchial obstruction in response to lower levels of surfactant in the alveoli, which are observed as a consequence of hypoxic activation of lipid peroxidation processes in response to submaximal loading.

Fig. 1. Indices of external respiratory function in qualified futsal players in the dynamics of physical loading.

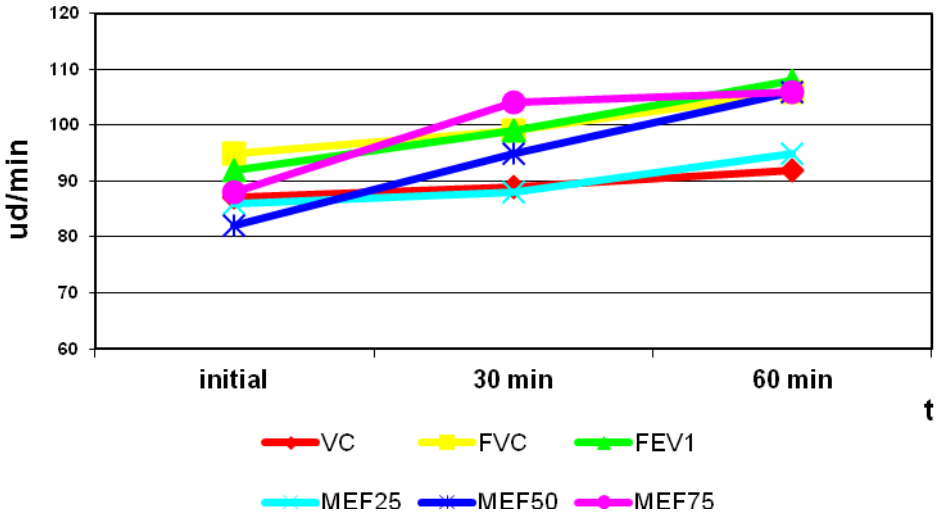
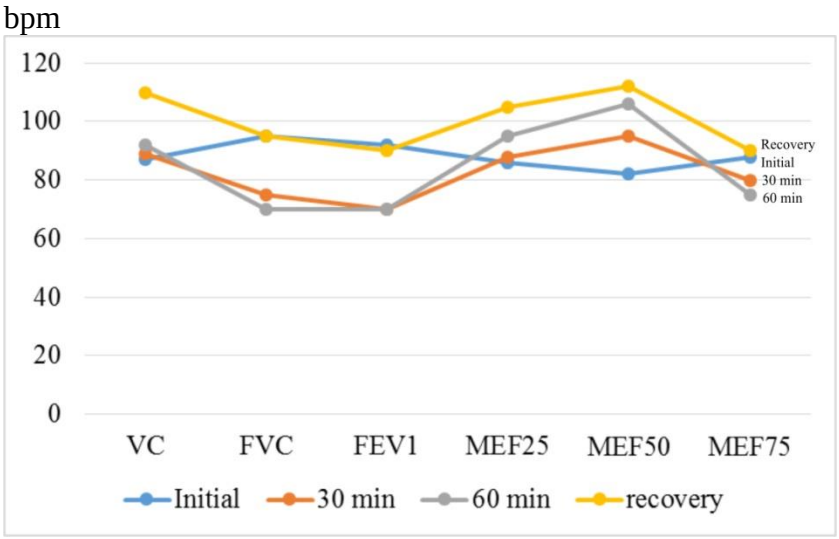


Fig. 2. Indices of external respiratory function in qualified futsal players at the build-up of intensity of physical loading

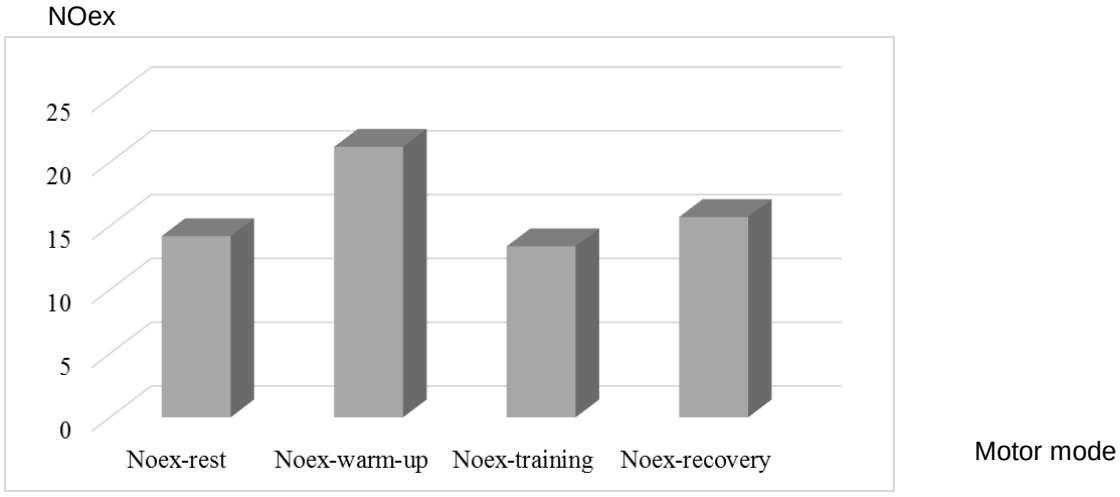


The mean level of NOex was 14,2±0,7 ppb at rest, 21,2±0,4 - after a warm-up, 13,4±0,6 - at build-up of intensity of physical loading, 15,7±0,5 - in the recovery period (Fig. 3).

A significant increase in NO production is marked at the build-up of physical loading and preserved overproduction of nitric oxide with exhaled air – during recovery.

These dynamics show the fluctuation in NOex in the area of pathological values, probably associated with a possible immune inflammation. The estimation of FER in the examined athletes has not revealed a diagnostically significant decrease in FEV1 MEF25 -75 in the dynamics of physical loading.

Fig. 3. Expiratory nitrogen oxide in qualified futsal players in the various modes of physical loading.



Note. Significance of differences at p<0,05

Conclusion

The changes detected in elite futsal players indicate the need to reduce the intensity of cyclic and speed-strength loading of submaximal power during the training process.

The conducted one-time screening of the dynamics of changes in the concentration of nitric oxide in the exhaled air with the increase in the intensity of physical loading in the youth team has detected the undulating dynamics of NO products, significantly associated with the intensity of anaerobic work. The increase of the NO values above 20 ppb for individual athletes indicates a possible risk of overproduction of this biomarker along with the subclinical process of immune inflammation in the respiratory tract. The lack of significant decrease in FEV1 in the examined athletes testifies to sufficient compensatory changes and the high respiratory potential of athletes who train for speed, strength and endurance abilities. Athletes with average and high production of nitric oxide should be regarded as a high risk group for bronchial hyperresponsiveness with constant monitoring not only of the national team, but also at club level.

In terms of preventive measures it is desirable to strengthen protein, vitamin and mineral components in the diet, use antihypoxants (succinic acid, coenzyme Q10, mildronat, cytochrome C) during specialized training and in the competition period, regulators of lipid metabolism in the pre-seaon (L-carnitine, lipoic acid), and antioxidants in the competition period (vitamins A, C, E, B5, B- carotene). In-depth phased medical supervision is recommended (once every 3 months).

The monitoring of the indicators of the external respiratory function has shown mixed reactions of bronchial tubes of the respiratory tract, autonomic nervous system, local cellular and humoral factors.

The orientation of the processes to adaptation and increase of the oxygen transport function at submaximal loading undergoes reverse development in 15 % of patients which can lead to the realization of the limiting effect of bronchospasm, edema and mucus hypersecretion in response to oxygen supply to the alveoli, and, in turn, provoke a decrease inphysical working capacity.

Dynamic monitoring of the training process in the evaluation of the flow-volume curve indices enables (especially in youth team players) to identify at an early phase and correct bronchospasm, caused by physical loading, to clarify its etiology and implement early diagnostic and pharmacological interventions to enhance the effectiveness of the training and competitive processes.

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