An integrated approach in the assessment of professional athletes’ functional status

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Summary
The article analyses functional status of highly skilled five-a-side football (futsal) players that allows individualizing preparation process and also provides an integrated approach to the solution of players’ sportswear optimization problem.

Variation of volume and intensity of training load is caused by reserve opportunities of respiratory system of athlete’s organism. Indicators of external breath function that provide highly skilled athletes with correct selection of training loads in sports during preparatory as well as competitive periods of year training cycle are generalized in the article.

Genetic diagnostics is the advanced method of athlete’s opportunities assessment. The analysis of genetic markers has allowed objectively to define predisposition of the athlete to particular kind of activity (specialization) that has created favourable conditions for effective formation of team’s line-up in such sport as five-a-side football (futsal).

Methodical recommendations, presented in the publication, allow experts approaching the selection of athletes while taking into account their genetic markers and functionality that are considered as informative characteristics; and, as considered, it influences training and competitive process that provides achievements of high sports results in the chosen sport.

Keywords: sport, functional diagnostics, hereditary predisposition, spirography, heart rate variability.

Introduction
Recently, the term of complex diagnostics of athletes’ readiness that forms a base for the development of rational and effective principles and methods of athletes’ training for the achievement of high sport results in the competitions has become actively used in elite sport.

As a result of complex diagnostics, three status types of athletes (Chmura, 2001; Jaskolska, 2008; Dehesselles, 2011; Aliyev et al., 2012; Guba, 2012a, b) are selected:

1. The first type of status – the long, the landmark, remaining for several weeks or months such as „sportswear“ or status of fatigue, etc. To change them, quite long periods are necessary. These statuses shall match on time at certain stages of preparation.

For the assessment of athlete’s readiness status at the end of each stage, the control, expressed in landmark comprehensive examination, shall be exercised.

2. The second type of status – leaking, which changes under the influence of one or several training sessions, depends on the level of competitive loading, and is subject to the influence of climatic and social factors. Accounting of the current status of athlete forms a basis for planning of the next training sessions that is especially important at the stage of pre-competitive preparation for the principal competitions, at the stage of mid-mountain preparation, at the stage of shock training, at the stage of enhancement of technical skills, etc., i.e., in the case of trainings with large total amount, high intensity or mental strength of loading. For the assessment of daily oscillations, current monitoring, expressing in the present surveys, serves for the status of athlete.

3. The third type of status – operational status that changes under the influence of any exercise or a series of exercises, combinations, a double-side game, etc. These statuses are easily transferred during one training occupation and are also connected to the change of working capacity. The operational status shall be considered when planning the intervals of the rest of the game in the course of competitions.

The greatest informativity in the modern professional sport about a status of readiness of an athlete represents innovative instrumental techniques that are widely used in pedagogics, medicine, biology, and psychology. The change
of athlete’s organism under the influence of permanently progressing physical activity leads to a status of exhaustion that does not allow effectively to perform competitive work (Januway, Travers, Walport, Capra, 1999; Sallers, Davies, 2012; Guba, 2012). Effective management of training process of highly qualified athletes, in many aspects, is caused by rational program of complex diagnostics of athletes’ readiness, which undertakes the use of pedagogical, medico-biological and psychological techniques that allow quickly obtaining necessary information on athletes’ status of fitness (MacKay, 1993; Rogozkin et al., 2005; Solodkov, Sologub, 2005; Kulinenkov, 2007; Ahmetov, 2009; Aliyev et al., 2012; Guba, 2012).

The obtained data serve as a model for methodological basis formation in case of results and features interpretation of athlete’s response to training and competitive loads.

In athletes of high qualification, different adaptive mechanisms that allow increasing special and general endurance are created, but, at the same time, functions of some systems, in particular, function of external respiration can be broken; in turn, that results in lowering of sport results (Trainerstab der TSG 1899 Hoffenheim, 2009).

External respiration can quite limit the endurance, in contrary to a judgment that the general endurance is in direct dependence on oxygen transporting ability of blood, cardio respiratory productivity, power of systems of tissue respiration, a level of a vascularization of muscles as well as perfection of the regulatory mechanisms, providing their adequate blood supply during an operating time.

**Research objective** was to study functional status of highly skilled players in five-a-side football (futsal) for the subsequent individualization of preparation process.

**Material and methods**

The research was conducted during 2016–2018 at the basis of professional mini-football club “Norilsk Nickel”, which is the participant of the Russian Football Championship; among teams, there are Superleagues. 24 highly skilled athletes (MS and MSMK) of age from 20 to 36 have participated in this research. The assessment of functional status of professional five-a-side football (futsal) athletes was carried out by the means of NS-Spiro that allowed determining parameters of players’ function changes of external respiration; genetic markers of athletes were studied as well.

On spirogram of the highly qualified football players, the following indices were evaluated: the respiration frequency (RF), the respiratory volume (RV), the minute volume of respiration (MVR), the vital capacity of lungs (VCL), the maximum cooling of lungs (MCL), the reserve volume of respiration (RVR), the expiratory reserve volume (ERV), the respiration reserve (RR), the index of motion speed of air (IMSA), the forced vital capacity of lungs (FVCL), the volume of forced exhalation in 1 second (OFV1), the relation of volume of the forced exhalation in 1 second to the forced vital capacity (OFV1/FZhEL), the average volume rate of air in the middle of the forced exhalation between 25 and 75% of FZhEL (SOSSh 25–75), the peak volume speed (PVS), the instantaneous volume speed at the time of an exhalation of 25% of FZhEL (MOS25), the instantaneous volume speed at the time of an exhalation of 50% of FZhEL (MOS50), and the instantaneous volume speed at the time of an exhalation of 75% of FZhEL (MOS75).

Fitness level assessment with the use of the method of heart rate variability registration has been carried out during the analysis of 26 qualified mini-football players of age 20–30. The 1st group included 14 athletes of the main structure, the 2nd group was formed from 12 people of youth structure.

Shapiro-Ulna’s criterion was applied to check normality of distribution. As distribution of the majority of VRS indicators differed from normal, since processing of results was carried out by nonparametric methods. Quantitative parameters are presented in the form of median and by 10–90 percentiles.

The molecular and genetic analysis of polymorphism of DNA estimates the options of genes, causing individual differences in development and manifestation of phnotypical signs. Polymorphism of genes of ACE, ACTN3, AMPD1, BDKRB2, HIF1A, MYF6, NFATC4, PPARA, PPARG, PPARD, PPARGC1A, PPARGC1B, PPP3R1, TFAM, UCP2, UCP3, VEGFA, and VEGFR2 are the most significant to markers.

**Results and discussion**

The specific statuses that are extremely seldom, endured by the person, who is not training high-speed
and force qualities or endurance, are characteristic to athlete’s organism. The achievement of a certain level of sport readiness, transferring of sharp and chronic exhaustion, and overtraining, caused by excess physical activities, is characteristic as well.

### Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial indicators, % due</th>
<th>After physical activity (training, game), % due</th>
<th>Conclusion</th>
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<td>FZHEL, л</td>
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<td>The gain of key indicators when performing physical activity; sufficient reserve opportunities of respiratory system.</td>
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<td>MOC25, l/s</td>
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<td>MOC50, l/s</td>
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<td>MOC75, l/s</td>
<td>103</td>
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Extreme exercise stresses limit physical activity due to the development of bronchial obstruction, the cellular infiltration of bronchi mucosa, and the remodelling of respiratory tract. The augmentation of capacity of vascular capillary bed, rising of viscosity of blood become perceptible and the time of mucociliary clearance is extended; at the same time, the augmentation of blood filling of lungs under the maximum loads in qualified athletes leads to the distress syndrome, the compression of vessels of a small circle of circulation – to the development of acute respiration. It forms the basis for remodelling of respiratory tract: there is a hypertrophy of a respiratory maculation as well as the development of sub-endothelial fibrosis, depression of bronchus wall elastics, ruptures of alveoli, occlusion of pulmonary capillaries under the conditions of mechanical and oxidative stress, and rising of tonus of VNS sympathetic department, which becomes perceptible and leading to vasoconstriction and a reduction of vascular bed.

Prophylaxis of these states is a necessary part of operating control in elite sport as confirmed by conducted researches. The crucial role in planning training process and its individualization as well as in the definition of an optimum load is played by the analysis and assessment of a functional condition of cardiovascular system of an athlete.

In a number of the researches, executed in various contingents of athletes, it was revealed that signs of depolarization disturbance as one of the implications of an acute or chronic overstrain of cardiovascular system had been taped in 15% of athletes.

As conducted researches have revealed, practically all analysed athletes had irregular heart rate. The dispersion of RR intervals in athletes of the main and youth compositions could be carried to a physiological norm. Values of the dispersion of RR intervals less than 155 could be considered as a low-variable rate.

High frequency of offset episodes of the driver of a rate in younger football players attracts attention. In 12 athletes (43.9%) of the 1st and 2nd groups, where the sudden lengthening of intervals of RR, which was not connected to the act of respiration, single supraventricular extra-systole has been revealed. Besides, in the 2nd group, offset episodes of the rate driver as a multifocal rate were registered. Such supraventricular violations of a rate as atrioventricular dissociation, sinoatrial blockade, and supraventricular extra-systole have not been registered.

As showed in the conducted researches, all components of spectral power in highly-trained athletes were authentically above; at the same time, proportional increase in the indices, characterizing both sympathoadrenal activity and parasympathetic department of VNS, was observed. Specified balance of independent regulation system was the result of the active orthostatic test. It indicates high values of reactivity of parasympathetic department of VNS as well as significant increase in the indices, characterizing sympathoadrenal activity (LF/HF and spectral power of a LF component).

Thus, in qualified athletes, it is possible to refer the following features of variability of heart rate: higher activity of both parasympathetic and sympathetic department of VNS, total power of range (TR) – more than 2500 ms2/Hz, balance of departments of BHC (LF/HF) – ranging from 0.5 to 1.5. These three indices of spectral power (TP, LF/HF VLF, %) are the most informative in case of the assessment and interpretation of VRS indices. Considering the value of TR reflecting variability of a warm rate, it is possible to judge the current...
functional status of an organism. The relation of LF/HF allows to describe the balance of departments of VNS, VLF, % in young people, where it reflects a cerebral contribution to the ergotropy of structures in modulation of a warm rate.

Both insufficient and excessive physical activity exerts the negative impact on organism and can be the cause of different pathological changes that are especially significant in growing organism of a young athlete. Under timely and adequate assessment of a status of athlete’s cardiovascular system, the level of its functional reserve will allow correctly correlating possibilities of children's organism to develop in the mode of effective training and competitive process and will be able to execute health saving function.

Presently, in the conditions of an intensification of technologies of sport, the problem of early orientation and selection of athletes draws attention of sport scientists, who set specific objectives of the relevant forecast of high achievements. Intensive sport activities, inappropriate to genetic predisposition of the person, can cause irreparable harm to health. Creating a choice of sport specialization, taking into account genetic predisposition of the person, not only to execution of different loads but also as a possibility of organism to support homeostasis, to avoid maladaptation and development of pathological statuses, are considered as expedient. The concept of selection shall provide the use of health saving technologies in sport activities, considering early determination of genetic polymorphisms of predisposition to high physical activity in sport, taking into account type of power supply of physical activity as well as timely prediction of developing risk of pathological violations of organism hindering execution of intensive physical activities.

In this regard, the development of adequate choice, for example, loads on the basis of genetic predisposition to different activities in early stage of sports career, and also correction of training process in later stages, taking into account specific features of an organism, are one of the most important problems of the modern science.

Four general groups of genes, according to importance degree for the development of chronic pathology, are of fered for studying:

• Genes, which products define degree of detoxication of xenobiotics, antioxidant protection, and cellular protection against the influence of adverse factors of the environment;
• Genes, which products are significant for haemoid dynamics of the bodies and systems, defining a vascular tone, a condition of function endothelia, and the systems of fibrillation;
• Genes, which products are significant to the system of immune protection;
• Genes, which products are significant to power supply during physical activity, metabolism of the main nutrients in organism.

The genetic predisposition to high-speed strength sports is favourable for five-a-side football (futsal). Genotypes combination of predisposition to a training of endurance is also a positive factor in the achievement of high sports result.

In the analysis of DNA polymorphisms of the qualified athletes of master and youth teams structure, individual genotypes, having options (alleles) of genes, promoting realization of the athlete in this sport specialization along with the alleles, creating risk of manifestation of pathological conditions of cardiovascular system, have been established.

The majority of surveyed athletes have sufficient predisposition to indicators of speed/force and endurance in their sport specialization.

DNA polymorphisms, creating risk for the development of multifactorial pathology, are limiting success and duration of preservation of high training and game rates. The existence of such polymorphism does not demand application of any measures, limiting sports career: in a complex genotype of the person, there are sequences of DNA compensating “negative” genes. However, extreme and inadequate physical activities as well as overtraining can promote higher risks of cardiovascular system pathology (including a syndrome of sudden death). In this regard, the existence of polymorphisms, adverse for sports, demands more attentive and frequent medical examination, operating control of the state of health, and reserve opportunities of cardiovascular system.

On this basis, molecular and genetic diagnostics in sport has to be applied with the use of maximum number of markers, additionally to already existing phonotypical tests, used within physical education.

The results, received during the researches, demonstrate sufficient involvement of polymorphic genes, where each makes only a small contribution to the general development of physical qualities of the person.
An important point of raising a selection for the efficiency of different types of sport in children conditions the analysis of genetic markers of the most trained physical qualities: general endurance and dexterity.

In the course of long-term training, indicators of rate are enlarged by 1.5–2 times, quality of force – by 1.5–4 times, and quality of endurance – by 10 times at the expense of a wide range of adapted mechanisms.

Since the majority of sports selection of athletes is made by trainers on the basis of physical training at the time of selection, the investigation of particular potential opportunities of high sport results achievement in the future becomes very difficult. In such situation, trainers can be assisted by clarification of genetic predisposition of an athlete to performance of various exercise stresses. The use of methods, taking into account genetic predisposition on certain genetic markers, opens real opportunities for differentiated approach to the organization and carrying out athletes’ training process.

On this basis, molecular and genetic diagnostics in sport has to be applied with the use of maximum number of markers in addition to already existing phytotypical tests, used within biomedical support of physical education.

As preventive action an intensifying aluminous and vitamin mineral component is desirable: the use of antihypoxant (succinct acid, Q10 coenzyme, cytochrome C) during the period of special preparation as well as during competitive period; regulators of lipid exchange – during the preparatory period (a L-carnation, Acetum lipoicum), antioxidants – during the competitive period (vitamins A, C, E, B5, B-Carotene). Profound landmark medical control is recommended (1 time in 3 months).

The conducted researches allow noting that indicators of function of external respiration and cardiovascular system in highly skilled professionals of five-a-side football (futsal) are in many aspects caused by the training load, applied in the course of year-round training process. These data are confirmed by results of leading experts in the field of sports physiology and medicine (Solodkov, Sologub, 2005; Akhmetov, 2009); thus, it confirms the need of planning training loads, taking into account the indicators of function of external respiration and activity of cardiovascular system, providing increase in fitness of players in various stages of a year training cycle.

Results of researches confirm earlier made conclusions by experts (Dehesselles, 2011; Aliyev, Andreev, Guba, 2012) that demonstrate the efficiency of planning and management of training process, caused by complex control of the functional status of professional athletes, creating favourable conditions for further sport skills increase and achievement of high sports results in competitive activity.

Conclusion
Carried-out monitoring of indicators of external respiration function reveals slight heart rate variability as well as the divergence of reactions of respiratory tract, the autonomic nervous system, and local cellular and humeral factors.

The orientation of processes on adaptation and rising oxygen of transport function in the conditions of sub-maximal load undergoes involution in 15% of examined athletes that can lead to realization of the limiting influence of bronchospasm, edema, and hypersecretion of slime on entering of oxygen in alveoli and, in the turn, on mediating depression of physical work capacity.

The genetic analysis of polymorphisms of highly skilled athletes in five-a-side football (futsal) demonstrates that high-class players have high-speed and power abilities, and also, on the high level, there are indicators of the development of coordination abilities, providing effective participation in game activity.

Dynamic monitoring of training process, in the assessment of complex of indicators, allows perceiving and correcting the factors, limiting sports working capacity at an early stage as well as carrying out an early diagnostic and pharmacological intervention.

REFERENCES

DIDELIO MEISTRIŠKUMO SPORTININKŲ FUNKCINĖS BŪKLĖS KOMPLEKSINIS ĮVERTINIMAS

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SANTRAUKA
Darbo tikslas – išanalizuoti didelio meistriškumo salės futbolininkų funkcinę būklę, kuri leidžia individualizuoti jų rengimo procesą bei kompleksiškai spręsti žaidėjų sportinės formos optimizavimo problemas.
Fizinio krūvio apimties ir intensyvumo variacijų galimybes lemia sportinininkų organizmo kvėpavimo sistemos rezervinės galimybės. Darbe apibendrinti išorinio kvėpavimo funkcijų rodikliai, nuo kurių priklauso žaidėjų fizinio krūvio korektiškas pasirinkimas metinio treniruočių ciklo parengiamuoju ir varžybų laikotarpiais.
Genetinė diagnostika yra patikimas, šiuolaikinis sportininko galimybių įvertinimo metodas. Genetinių markeių analizė leidžia objektyviai nustatyti sportininko tinkamumą kuriai nors veiklos rūšiai, o tai sudaro palankias sąlygas tinkamai formuoti komandos sudėtį salės futbolo sporto šakoje. Straipsnyje pateiktos metodinės rekomendacijos leidžia specialistams geriau atlikti jaunųjų žaidėjų atranką, atsižvelgiant į jų genetinius markerių ir funkcines galimybes, kuriuos yra pakankamai informatyvios. Žais visiakūniškai varžybose ir treniruočių procese galima pasiekti didesnių sporto rezultatų pasirinktoje sporto šakoje.

Raktažodžiai: sportas, funkcinė diagnostika, paveldimumas, spirografija, širdies ritmo variabilumas

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