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Genetic Markers that Predict the Formation of Certain Body Types and the Development of Motor Qualities

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Purpose of the study-development of criteria and techniques for the prognostic selection of athletes based not only on the signs of the phenotype but also on the indicators of genetic markers that predict the development of certain physical qualities and the formation of certain body types. The assessment of the physical development of athletes was carried out based on anthropometric methods according to the recommendations set forth by E.G. Martirosov, 1982 [1]. The type of constitution was determined by the Heath-Carter method, 1989 with the identification of ecto, endo, and mesomorphic components, calculated using special formulas. The HLA- genetic system was identified by typing in the microcyto-lymphotoxin test according to the method of Yu.M. Zaretskaya, and V.M. Abramov [3]. Athletes-rowers with the highest sports qualifications - masters of sports of international class and masters of sports, represent a fairly homogeneous sample: 75% of athletes have an endo-mesomorphic type, 16.7% have an ecto-endomorphic type, 8.3% have an ecto-mesomorphic type of. For a more reliable clarification of the role of the HLA system genes in the program of individual development, the associations of sub loco A, B, and C of the HLA complex with the somatotype were studied. So, for endo-mesomorphic somatotypes, significant specific associations with antigens HLA-A3, HLA-A9, HLA-A11, sublocus HLA-B35, as well as HLA-?W4 and HLA-?W6 were revealed. Ecto-mesomorphic somatotypes had significant associations with antigens of the sublocus HLA-CW-5, A-10. It has been established that for athletes specializing in speed-strength sports (rowing, boxing), the haplotype HLA-A1 and B-35 are specific at X2-5.76. Intergroup comparison of frequencies of registration of the antigenic composition revealed that the content of HLA-B7 in athletes - power workers (wrestling) are significantly higher and significantly at x = 6.645, that is, HLA-B7 can be considered as a genetic marker of strength qualities. It has been established that for athletes specializing in speed-strength sports (rowing, boxing), the haplotype HLA-A1 and B-35 are specific at X2-5.76. Specific genetic markers associated not only with the formation of certain types of physique but also predicting the spectrum of development of several physical qualities that are of selective importance in the practice of sports have been established.

Keywords: Genetic Markers Homogeneous; Somatotype; Sport.

The problem of selection in professional sports, sports of the highest achievements is complex. Its main aspects are pedagogical, psychological, and biomedical, in particular, genetic ones. In recent years, the achievements of genetics are widely introduced into the practice of sports. Many authors note that the formation of sports talent, sports talent, and endurance is significantly influenced by the genetic predisposition of an athlete. Outstanding sports achievements are

not only the result of hard training but also the extraordinary hereditary data that he possesses.[14; 15; 16; 12]. For predictive selection, it is extremely promising to use genetic markers associated with both the development of motor qualities and the formation of certain somatotypes. Currently, in the practice of sports, issues related to genetic predisposition and the role of heredity in the implementation of processes that ensure optimal physical development of a person, as well as hereditary conditioning of the development of the body's motor qualities, remain poorly studied. According to modern genetic hypotheses, certain genetic loci influence the development of morphological features of an organism[4; 7]. There are suggestions that there are certain genes responsible for the formation of the somatotype, and the influence of the genetic component on the development of sports abilities has been studied[7;8;9;10;11;17]. According to G. Grebe, Gedd, who conducted research on identical and fraternal twins, the degree of inheritance of athletic abilities in monozygotic twins was 70%, and in fraternal twins only 22%. According to P.V. Schwartz,[15] the development of motor skills, and aerobic and anaerobic mechanisms of energy supply of muscle activity are genetically determined and are determined by their genotype. Genetic markers are phenotypic signs of an organism that have a rigid genetic determination and are inherited over generations. Genetic markers are characterized by the following features: they are inherited according to the laws of Mendel, they are stable and stable, do not change in the process of individual development, and are not affected by environmental factors. There are absolute and conditional genetic markers: absolute genetic markers include some signs of dermatoglyphics and odontoglyphics, blood groups, the immunogenetic system HLA, NOS, and some serological indicators. Conditional genetic markers include somatotype, temperament, type of nervous activity, and acetylation phenotype. Therefore, the primary task of selection, orientation, and prediction of sports achievements is the development of criteria and methods of selection "by genotype". According to B.A. Nikityuk,[6] "modern methods of selection by "phenotype" may not reveal hereditarily gifted top-class athletes. Genetic markers can be represented by a polymorphic range of biochemical and immunological features determined by biologically active substances: enzymes, transport proteins, antigens, etc. Currently, more than 120 polymorphic gene loci have been described, some of which are represented in the genome by multiple alleles. Therefore, genetic markers are considered the most accurate and objective criteria for prognostic selection, both in assessing the development of physical qualities and in determining the genetic determinism of the somatotype. The foregoing was the rationale for conducting studies confirming the assumption that absolute genetic markers make it possible to identify their association with individual morphological parameters of the body build of athletes, as well as with such physical qualities as strength, speed, and speed-strength qualities.

The purpose of the study is to develop criteria and techniques for the prognostic selection of athletes according to phenotypic indicators, but also according to genotypic characteristics.

The object of the study was members of the national team of Uzbekistan in kayaking, and members of the national team of R.Uzbekistan in various types of martial arts. Determination of the genetic status of athletes was carried out by identifying the specifics of the genetic status by the method of HLA-typing in the microcytolymphotoxic test[3] in athletes specializing in power sports (117 people, as well as types (rowers, boxers-166 people).

MATERIAL AND METHODS

1. Anthropometric studies were carried out using standard instruments, under the requirements and rules set out in the manual of E.G. Martirosova.
2. Body type was determined according to the modified method of Heath-Carter. Initially, standard anthropometric measurements were carried out according to 7-dimensional characteristics: body length, weight, the diameter of the distal part of the shoulder in tension, shin circumference were determined, and the thickness of skin-fat folds in 4 regions of the body. The somatotype was diagnosed in the quantitative expression of three somatic components: I. F - fat component - endomorphy; II. M - muscle component - mesomorphy; III. The weight-height indicator was determined by the formula LÖ^{3}Đ. The components were calculated according to special formulas, based on which not

only the body mass composition was revealed in the scoring, but also the somatotype was diagnosed according to the somatogram proposed by Heath-Carter.

3. HLA typing was carried out according to the method of Zaretskaya Yu.M., V.Yu. Abramov,[3]. Identification of HLA antigens was carried out in a lymphocytotoxic test with antisera obtained from the Republican Center for Immunological Tissue Typing at the St. Petersburg Research Institute of Hematology and Blood Transfusion. To avoid errors, during typing, each antigen was identified by a "battery" consisting of 2-9 antisera. The principle of the method consists of a two-stage effect on peripheral blood lymphocytes with antisera and complement. Antigens of loci HLA-A, B, C, Cw, and DR were detected. The frequency of HLA antigen loci was calculated using the formula $f = N/n$, where n is the number of individuals with a given antigen, and N is the total sample size. The frequencies of antigens were determined by the formula ð=I-ÖI–A; where p is the allele frequency, and A is the frequency of the corresponding antigen. The x2 value was calculated using the formula $ð^2=(f-f^1)^2: f^1$ where f and - f1 respectively observed and expected frequency of the phenotype. During this section, methodological and advisory assistance was provided by the senior researcher of the NIIEMIZ r. Uzbekistan Ph.D. Shimolin A.P.

RESULTS AND DISCUSSION

To study the influence of purposeful sports activity on the formation of an athlete's morphotype, the morphological section of the research included methods of anthropometry and somatotype according to Heath-Carter 1986. A comparative analysis of the somatotypes of rowers of different levels of sportsmanship made it possible to establish differences in phenotypic indicators of physique, in particular, both in the degree of severity of the component composition of body mass and in the distribution of somatotype categories. Athletes-rowers with the highest sports qualifications - masters of sports of international class and masters of sports, represent a fairly homogeneous sample: 75% of athletes have an endo-mesomorphic type, 16.7% have an ecto-endomorphic type, 8.3% have an ecto-mesomorphic type of. It has been established that for athletes specializing in speed-strength sports (rowing, boxing), the haplotype HLA-A1 and B-35 are specific at X^2-5.76.

In the sample of athletes with sports qualifications of candidates for master of sports, 4 types of somatotype were identified: endo-mesomorphic-30.6%, ectomesomorphic-23%, 31% was endo-ectomorphic type and only 15.4% of athletes have identified the ecto-endomorphic type of constitution. In terms of the severity of the component composition in the compared groups, significant differences were established for the ectomorphic component. So, the average indicator of the somatotype of elite athletes is 3.6: 4.9: 2.5, and for rowers - candidates for the master of sports 3.5: 3.8: 3.00. Quite high values of the endomorphic (fat) component are characteristic of all rowers.

For a more reliable clarification of the role of the HLA system genes in the program of individual development, associations of subloci A, B, and C of the HLA complex with ecto and endomesomorphic somatotypes were studied. So, for endo-mesomorphic somatotypes, significant specific associations with antigens HLA-A3, HLA-A9, HLA-A11, sublocus HLA-B35, as well as HLA-ÑW4 and HLA-ÑW6 were revealed.

Ecto-mesomorphic somatotypes had significant associations with HLA-A10, HLA-CW5, and HLA-B8 sublocus antigens. The obtained facts testify to the connection of HLA antigens with the features of the formation of body types, which confirms the judgment about the significant influence of hereditary factors on the formation of the somatic type in the process of individual development of the organism (Table 1, Table 2).

Among the indicators used by athletes that meet the requirements of the chosen specialization, morphological methods, and some physiological indicators for physical activity are used more often than others[2;20]. However, the question remains open - what genetic indicators are associated with the development of certain physical qualities, in particular, power, speed, and speed-strength qualities. In connection with the above, we used the HLA typing technique, which is a genetic system located on the short arm of chromosome VI in the vicinity of the immune response genes. At present, the biological role of the HLA system remains

largely unclear, in particular, questions about the role of histocompatibility antigens in reproduction are under development, as the relationship of the D and DR loci with the antigenic composition of the A, B, C loci is being clarified. Nevertheless, there is no doubt that this genetic system plays a primary role in maintaining the immunological homeostasis of the organism as a whole since the role of antigens in the development of cellular cooperation during the immune response is already known[18;19].

Intergroup comparison of frequencies of registration of the antigenic composition revealed that the content of HLA-B7 in athletes-power workers is significantly higher and significantly at X^2=6.645, that is, HLA-B7 can be considered as a genetic marker of strength qualities.

The frequency of occurrence of antigens of the system in speed athletes was analyzed.

In the group of athletes specializing in speed-strength sports, the haplotype HLA-A7,

Table 1. Genotypic conditionality of athletes with an ecto-mesomorphic type of constitution

Locus A HLA systems	Colossal	Gene frequency	Antigen frequency	Locus BHLA systems	Colossal	Gene frequency	Antigen frequency
A 1	10	2,201	0,2500	-	-	-	-
A 2	11	0,960	0,275	B 5	6	0,056	0,150
A 3	11	1,373	0,275	B 7 +	6	1,953	0,150
A 9	5	1,453	0,125	B 8 +	6	2,979	0,150
A 10 +	13	3,524	0,325	B 12	4	0,058	0,100
A 11	4	0,397	0,100	B 13	10	0,582	0,250
A 19	5	2,448	0,125	B 14	1	0,107	0,025
A 28	1	0,756	0,025	B 15	4	0,229	0,100
				B 16	2	0,008	0,050
Locus C				B 17	3	0,799	0,075
CW 3	4	1,930	0,100	B 18	2	0,151	0,050
CW 4	4	0,397	0,140	B 21	3	0,001	0,075
CW 5 +	3	7,013	0,075	B 27	1	0,188	0,025
CW 6	4	0,256	0,100	B 35	2	2,679	0,050
				B 40	4	0,453	0,100

Table 2. Genotypic conditionality of athletes with the endo-mesomorphic type of constitution

Locus A HLA systems	Colossal	Gene frequency	Antigen frequency-norm	Antigen frequency	Locus B	Colossal	Gene frequency	Antigen frequency-norm	Antigen frequency
A 1	16	0,866	0,156	0,200	B 5	9	0,302	0,136	0,1125
A 2	21	2,306	0,354	0,2625	B 7	7	0,027	0,082	0,0875
A 3 +	5	7,780	0,195	0,0625	B 8 +	2	2,217	0,070	0,025
A 9 +	5	8,845	0,206	0,0625	B 12	8	0,103	0,113	0,100
A 10	21	1,694	0,195	0,2625	B 13	10	2,220	0,198	0,125
A 11 +	24	11,336	0,136	0,300	B 14	5	1,157	0,035	0,0625
A 19	2	1,418	0,058	0,025	B 15	5	0,209	0,078	0,0625
A 28	4	0,080	0,053	0,050	B 16	2	0,549	0,047	0,025
					B 17	5	0,523	0,043	0,0625
Locus C					B 18	6	0,075	0,066	0,075
CW 2	4	0,369	0,035	0,05	B 21	4	0,549	0,074	0,050
CW 3	1	1,923	0,047	0,0125	B 22	1	0,004	0,012	0,0125
CW 4	4	4,428	0,136	0,05	B 27	1	-	0,039	0,0125
CW 5	-	0,874	0,012	-	B 35 +	3	6,519	0,144	0,0375
CW 6	1	9,035	0,128	0,0125	B 40	3	0,070	0,070	0,0375
					B 41	1	0,019	0,019	0,0125

HLA-B35, with X^2=5.76, turned out to be a specific genetic marker. Thus, specific genetic markers associated not only with the formation of certain body types but also predicting the spectrum of development of some physical qualities that are of selective importance in the practice of sports, have been identified. The foregoing suggests that the morphogenetic approach to the study of the constitution of athletes is an effective and objective tool for sports prediction and selection.

CONCLUSIONS

1. Significant correlations between the HLA-antigenic composition and various categories of somatotypes of athletes were revealed. For athletes specializing in power sports, the dominant type is the endomesomorphic type, which has associative links with HLA-A3, HLA-A11, HLA-B35, HLA-Cw4, and HLA-Cw6. The ecto-mesomorphic type is typical for athletes specializing in high-speed sports and is marked with the HLA-Cw5 and HLA-10 antigens.
2. Athletes specializing in speed-strength sports are distinguished by the greatest variation in constitutional types, which is due not only to the multidirectional of motor activity but also to the strict requirements for their game role. It has been established that for athletes specializing in speed-strength sports (rowing, boxing), the haplotype HLA-A1 and B-35 are specific at X^2-5.76.
3. The most labile and subject to the influence of exogenous factors seems to be a balanced-mesomorphic type of constitution. Under the influence of training modes of different intensity and orientation (wrestling, boxing, rowing), changes occur that affect not only the quantitative indicators of the component composition of body weight but changes in the somatotype category as a whole.
4. The role of hereditary factors in the development and manifestation of physical qualities has been established. The HLA-B7 antigen is a genetic marker that predicts the manifestation of strength qualities. For athletes specializing in speed-strength sports, a specific haplotype HLA-A1 HLA-B35 was identified, which determines the manifestation of the quality of endurance.
5. Based on the morphogenetic criteria we used, it is possible to solve two aspects of sports selection with high reliability: the development of individual recommendations for choosing a sports specialization for each teenager, and on the other hand, a scientifically based selection of talented children for big-time sports.

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Conflict of interest

The authors have declared that no conflict of interest exists.

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