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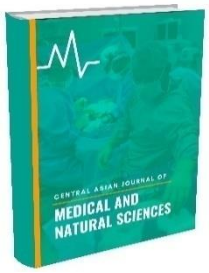

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Interrelation of Allelic-Genotype Variants of Sports Genes with Psychophenotypic and Neuromediator Indicators of Athletes

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Abstract: This scientific paper presents the genetic characteristics of physical performance, allelic-genotypic variants of some sports genes in relation to the parameters of the psychotype, and higher nervous activity, as well as their associations in rowing athletes and their associations in rowing athletes.

Keywords: allele, allele-genotype variant, genotype, gene polymorphism, psychotype, rowing athletes, sports genes .

For the successful phenotypic development of athletes' fitness in terms of increasing the growth of sports performance, it is important to take into account the individual genetic predisposition to a particular physical activity [1,8]. In this aspect, the possibilities of molecular genetics of sports can be used, in particular, the use of genetic markers in combination with phenotypic diagnostics [2]. This contributes not only to the optimization and correction of the training process, but also to the prevention of various diseases associated with the professional activities of athletes [1,3]. At the same time, it is necessary to take into account the total contribution of genotypes and alleles of genes to the determination of hereditary predisposition to motor activity and to the development of professional pathologies in athletes. At the same time, it should be noted that so far the results of genetic testing do not yet allow a clear answer to the fact that an athlete will really achieve high sports results. Since, unexplored gene polymorphisms in a particular individual or significant mutations in his genome can completely reduce the genetic “advantages” that were identified based on the study of a limited range of candidate gene polymorphisms [4,20]. Therefore, it is very important, along with the assessment of certain alleles of genes associated with sports activity and parameters of the phenotypes of athletes. At the same time, the interpretation of the results of genetic analysis should precede phenotypic diagnosis, as well as the collection of complete information about the athlete, up to the family history [8].

In the sport for the highest achievements, a special role is given to the degree of psychological preparedness of an athlete [7,12]. Indeed, the psychological preparation of an athlete for the training process and, especially, for the upcoming competitions is an integral part of the entire preparatory process. Sports success depends not only on the degree of physical fitness, but also on the psychological stability and the state of the athlete's higher nervous activity [15,16]. Therefore, the parameters of the psychological status and higher nervous activity can be one of the indicators of the

athlete's phenotype, and taking this into account is an important task of the preparatory period [10,14]. Taking into account the fact that the prediction of the success and adequacy of an athlete's preparation for specialized physical and mental loads largely depends on genetic characteristics, it becomes obvious that it is necessary to take into account the relationship between the parameters of the athlete's phenotype and the indicators of individual genetic predisposition to a certain physical activity.

In connection with the above, the purpose of this work was to study the features of the relationship between indicators of psychological status and higher nervous activity in rowing athletes with alleles of some genes of predisposition to motor activity.

Materials and research methods

The research was conducted on the basis of a sample of athletes in 2019-2021. The number of athletes was 20 people, aged 18-34 years. When selecting specific individuals, their nationality was not taken into account. The sampling of biological material for DNA extraction was carried out taking into account the established procedure for human rights, which was carried out with the written consent of the subjects [5].

The collection of blood samples from athletes was carried out on the basis of the sports federation of Uzbekistan. Venous blood in the amount of 1.5 ml was collected in 3 ml of EDAA (ethylenediaminetetraacetic acid) solution and stored at -20°C. DNA extraction from whole blood was carried out using a Ribo-prep reagent kit (the kit was manufactured by Interlabservis, Russia). Detection of polymorphism of the studied genes was determined by the Real-Time PCR method (production of the kit - LLC NPF Litekh, Moscow, Russia). For real-time PCR amplification, GeneAmp® PCR was used - ABI 7500 Fast Real-Time PCR with 96-well block.

To determine the type of temperament, the Eysenck personality questionnaire was used. The parameters of the autonomic nervous system were assessed using the questionnaire "Research of autonomic tone" in combination with clinorthostatic tests, where the results were calculated in points, according to the sum, which determined the predominance of the tone of the autonomic nervous system. The strength of the nervous processes of athletes was diagnosed on the hardware-software complex "NS-PsychoTest" using the "Tapping-test" technique. The obtained data were processed by the method of variation statistics.

Results and discussion

Based on the aim of our study, among the examined athletes, the frequency of occurrence of temperament types, parameters of the higher nervous system and the strength of the nervous system were studied. As can be seen from the presented data, among the surveyed athletes, each third had a choleric and phlegmatic temperament, and every fourth had a sanguine temperament. And the traits of a melancholic took place in every tenth rowing athletes surveyed. Consequently, among the surveyed rowers, faces with the features of phlegmatic, choleric and sanguine prevailed.

Analysis of the typology of the higher nervous system in the examined athletes shows that most of them are sympathetic, only a few athletes revealed the predominance of the parasympathetic nervous system. Every fourth examined athlete had a mixed nature of the typology of the nervous system (combination of sympathotonia with vagotonia). Consequently, the sipatotonic type of the higher nervous system prevailed in the examined rowers.

When studying the strength of the nervous system among rowers, there is a predominance of athletes with moderate strength. Every fourth athlete has a strong strength, and only every seventh sportsman has a below average or weakly expressed strength of nervous processes. Consequently, the examined athletes mostly had faces with a moderately pronounced strength of the nervous system.

Thus, obtained results by us during the research of the neuropsychological characteristics of the examined athletes indicate that athletes with relatively high psychological activity and aggressiveness (choleric and sanguine) predominate among them, which is also confirmed by the frequency of occurrence among them of athletes with a predominance of the sympathetic typology of the nervous system with an average her strength. In all likelihood, the revealed picture of the neuropsychological status of the examined athletes to a certain extent corresponds to the specifics of the sport under study.

We also studied in these athletes allelic variants of some genes responsible for physical performance and their association.

In the presented data, 10% of the examined patients had a combination of three alleles of the studied ACE, PPRA and PPRGC1a genes responsible for endurance (Ins/Ins:G/G:G/G, respectively), in ¼ of the athletes a combination of two alleles of the studied genes responsible for endurance (Ins/Ins:G/G; G/G:G/G; Ins/Ins:G/G*, respectively), also in ¼ athletes a combination of two alleles of the studied genes responsible for both endurance and strength and speed (Del /Del: G/G; Del/Del:G/G*, respectively). It should be noted that athletes with only one allele responsible for endurance also occurred in 25% of the examined athletes. Moreover, in 3/5 part it was due to the G/G allele-genotype variant of the PPRA gene, and in 2/5 part it was due to the Ins/Ins allele-genotype variant of the ACE gene. At the same time, only 5% of the examined patients had an A/A allele-genotypic variant of the PPRGC1a gene. The data we obtained on the association of alleles and genotypes of the studied genes made it possible to conditionally divide the examined athletes according to the carriage of these genes into the following categories: athletes with a pronounced quality of endurance, with moderately pronounced endurance, with weakly expressed endurance, with weakly expressed strength and speed qualities, and mixed qualities. Consequently, such a division of athletes according to the predominance of certain sports qualities contributes to the choice of the optimal distance for an athlete, taking into account the individual genetic predisposition to physical activity, as well as the formation of the most adequate training program.

Based on the fact that certain characteristics are inherent in the examined athletes, both in relation to the parameters of neuropsychology and in terms of individual genetic predisposition, it was of particular interest for us to analyze the relationship between these characteristics.

First of all, an analysis was made of the relationship between the alleles and genotypes of the studied genes with indicators of the psychotype and the nervous system.

Among the examined athletes, depending on the genotypes of the ACE gene, there were 1.5 times more choleric people among athletes with a carrier of the heterozygous Ins/Del genotype. At the same time, this type of temperament was not found among athletes with the carriage of the Ins/Ins genotype. An analysis of the frequency of occurrence of another type of temperament - sanguine people, depending on the ACE gene genotypes, shows that among athletes, Ins/Del carriers were 1.5 times less common than among athletes carrying the Del/Del genotype. And among athletes carrying the Ins/Ins genotype, this type of temperament in frequency occupied an intermediate position between the carriers of the Del/Del and Ins/Del genotypes. Melancholic among the examined athletes were found only among carriers of the heterozygous Ins/Del genotype.

At the same time, phlegmatic patients were more than 2 times more common among carriers of the Ins/Ins genotype compared to carriers of the Del/Del genotype. Consequently, the types of temperament are distributed among the examined athletes in a certain dependence on the carriage of the ACE gene genotypes. If we take into account the fact that Del/Del and Ins/Ins genotypes provide different sports qualities, strength and speed, as well as endurance, respectively [4,6,17], then it becomes obvious that carriers have different types of temperament. these genotypes.

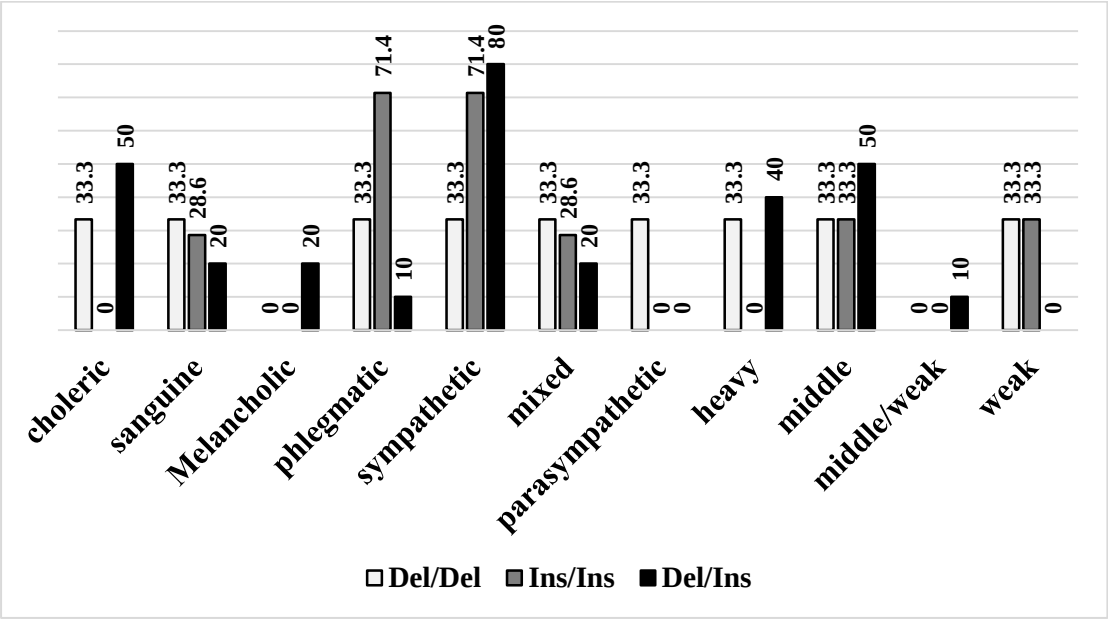

Figure 1. Distribution frequency of temperament types, types and strength of the nervous system in athletes depending on the ACE gene genotypes (in %).

As can be seen, the highest frequency of occurrence of the predominance of the sympathetic nervous system took place among athletes carrying the Ins/Ins and Ins/Del genotypes. At the same time, in terms of frequency, this type of nervous system was more than 2 times less common among athletes carrying the Del/Del genotype. And the frequency of occurrence of the mixed type of the nervous system had the opposite character. Most often, this type of nervous system occurred among carriers of the Del/Del genotype, and the least common among carriers of the Ins/Del genotype. And here, the dependence of the types of the nervous system on the genotypes of the ACE gene is also traced. When analyzing the dependence of the strength of the nervous system on the carriage of the ACE gene genotypes, apparently, no pronounced differences were found.

It should be noted that this gene among the examined athletes was represented by two genotypes. The G/G genotype determines the predisposition to endurance [1,4,9,11] and the heterozygous G/C genotype. And the C/C genotype associated with strength and speed [1,4,18] was not identified among the examined athletes.

Among carriers of the G/G genotype, sanguine and choleric patients are equally common and occurred in almost every third athlete. The proportion of choleric people was slightly less and was found in almost every fourth athlete. And melancholics among the surveyed athletes carrying this genotype were even rarer, almost every seventh athlete. At the same time, among the carriers of the G/C genotype, the proportion of sanguine people was comparable to the carriers of the G/G genotype; there were almost 1.5 times more phlegmatic people, respectively. And melancholics were not found among athletes with this genotype.

In terms of the frequency of occurrence of the predominance of the sympathetic nervous system, both groups of athletes did not differ significantly in terms of the carriage of the genotypes of the studied gene. At the same time, the frequency of occurrence of a mixed variant of the typology of the nervous system was 25.4% higher in the group of athletes carrying the G/C genotype. Therefore, no significant differences in the genotypes of the PPRA gene were found in the typology of the nervous system.

When analyzing the dependence of the strength of the nervous system on the carriage of the genotypes of the PPRA gene, it was revealed that if the carriers of the G/G genotype are characterized by a

relatively frequent occurrence among athletes of the nervous system of medium and below average strength, then the carriers of the G/C genotype are characterized by strong and medium strength, respectively.

An analysis of the frequency of occurrence of the type of temperament - choleric, depending on the genotypes of the PPRGC1a gene shows that among athletes carrying the A / A genotype of the gene under study, their proportion is the highest and occurs in 2/3 of athletes. At the same time, the frequency of occurrence of sanguine people is the highest among athletes with the G/C genotype and occurs in almost every third athlete with this genotype. The frequency of occurrence of phlegmatic people is high among athletes with the G/G genotype (every second athlete with the G/G genotype is phlegmatic). Therefore, if among the carriers of the A/A genotype responsible for speed-strength qualities [9,11,19,22], athletes with the choleric temperament type are most often found, then among the carriers of the G/G genotype responsible for endurance [4,8 ,9,22], most often there are athletes with a phlegmatic temperament type.

The results of the analysis of the frequency distribution of types of the nervous system in the examined athletes, depending on the genotypes of the PPRGC1a gene, show that the majority of the examined athletes, both carriers of the A/A and G/G genotypes, are sympathetic. Vagotonics and the mixed type of the nervous system are much less common. And among athletes, carriers of the A / A genotype practically do not occur. Consequently, athletes carrying the A/A genotype are absolute sympathotonics, and carriers of the G/G genotype are, in most cases, vagotonics.

When analyzing the dependence of the strength of the nervous system on the genotypes of the gene under study, there is a clear trend that among the carriers of the A / A genotype there is a high frequency of occurrence of a strong nervous system, and among the carriers of the G / G genotype - an average strength of the nervous system, respectively.

Thus, the results of the analysis indicate that there is a certain dependence between the types of temperament, nervous system and genotypes of the studied genes in the examined athletes, both in relation to individual genes and in relation to their genotypes. Moreover, if choleric people are most often found among athletes with a carriage of the A/A genotype of the PPRGC1a gene, then sanguine people are among athletes with a carriage of the Del/Del genotype of the ACE gene and the G/G genotype of the PPRA gene.

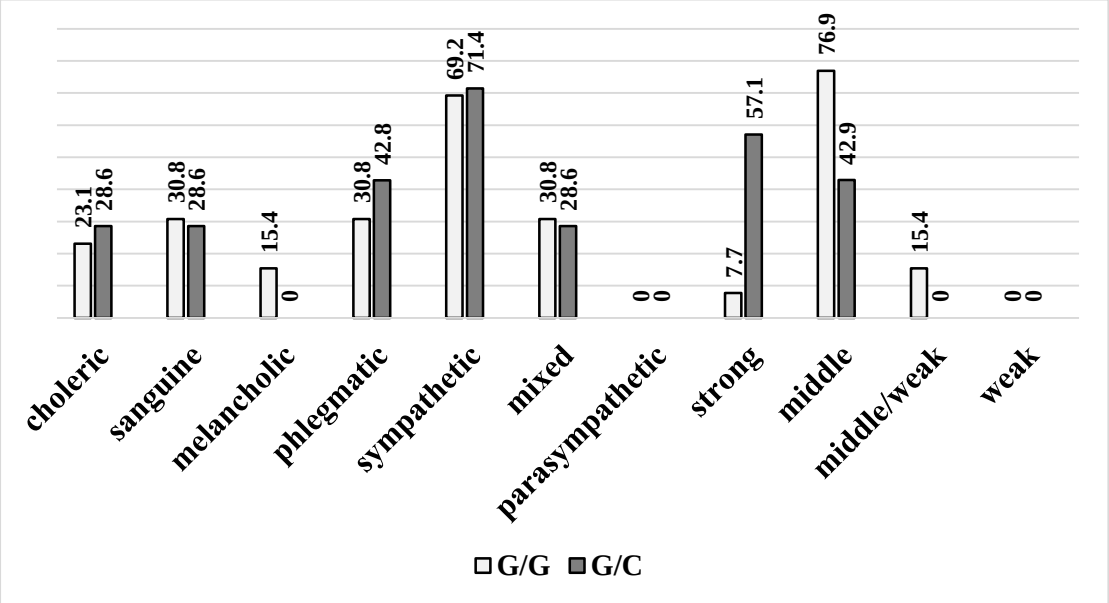

Figure 2. Frequency distribution of temperament types, types and strength of the nervous system in athletes depending on the genotypes of the PPRA gene (%).

Phlegmatic people are most often represented among carriers of the Ins/Ins genotype of the ACE gene, the G/G genotype of the PPRA gene, and the A/A genotype of the PPRGC1a gene. The predominance of the sympathetic nervous system is characteristic of carriers of the Ins/Ins genotype of the ACE gene, the G/G genotype of the PPRA gene, and both A/A and G/G genotypes of the PPRGC1a gene. At the same time, if the strength of the nervous system does not have a special dependence on the genotypes of the ACE gene, then in relation to the PPRA gene, its average strength predominates among carriers of the G/G genotype. And in relation to the PPRGC1a gene, the predominance of a strongly pronounced strength of the nervous system among the carriers of its A / A genotype and the predominance of medium strength - among the carriers of the G / G genotype of the PPRGC1a gene. It is known that the genes we study have genotypes that determine the opposite predisposition to each other [2,4,13]. At the same time, while the genotypes Ins/Ins of the ACE gene, G/G of the PPRA gene, and G/G of the PPRGC1a gene are responsible for endurance, the Del/Del genotypes of the ACE gene and A/A of the PPRGC1a gene are responsible for speed and strength [14, 21, 22]. Based on the above, it becomes obvious that the features of the relationship between the genotypes of the studied genes with the indicators of the neuropsychological status of the examined athletes can serve as a kind of help for their differentiation in relation to individual motor activity in relation to the nature of the neuropsychostatus.

Given that the genetically determined sports qualities that we have identified are presented in varying degrees of severity, it is of particular interest to analyze the relationship between neuropsychostatus indicators, taking into account the severity of these qualities. The results of this analysis are presented in Table 1.

The obtained results show that if choleric among the examined athletes with a pronounced degree of endurance does not occur, then among moderate and weakly expressed endurance it occurs in every fifth athlete. At the same time, among athletes with mixed physical performance (endurance/strength and speed), the proportion increases and reaches up to 40% of the examined. Consequently, as the degree of endurance severity “decreases”, the frequency of occurrence among athletes with a choleric type of temperament. Unlike choleric people, the frequency of occurrence of phlegmatic people, on the contrary, decreases as the degree of endurance decreases. In relation to sanguine and melancholic persons, a clear dependence on the manifestations of physical performance was not revealed.

An analysis of the dependence of the types of the nervous system on the degree of severity of the types of performance shows that, regardless of the severity of physical performance, sympathotonics prevail among athletes compared to vagotonics. However, it should be noted that as the severity of endurance decreases among the examined athletes, there is a slight decrease in the frequency of occurrence of sympathotonics due to the appearance of athletes with vagotonics and a mixed type of nervous system.

When analyzing the dependence of the strength of the nervous system on the degree of endurance, a pattern is traced indicating the predominance of athletes with a strongly pronounced strength of the nervous system among athletes with weak endurance and mixed physical performance compared to athletes with a more pronounced degree of endurance, where athletes with an average strength of the nervous system predominate. . Consequently, there is also a certain relationship between the degree of endurance and the frequency of manifestations of the neuropsychological sphere of athletes, and this can be used in the formation of individual training plans for athletes.

Thus, the results of the conducted studies allow us to conclude that for a more complete assessment of the potential capabilities of athletes, the study and assessment of the frequency response of the occurrence of alleles and genotypes of the set of genes responsible for the performance of athletes is insufficient. At the same time, it is expedient to study and analyze the relationship between indicators and characteristics of the athlete's phenotype with alleles and genotypes of sports genes and the nature of the athlete's motor activity determined by it. Such a solution of the issue contributes to the

definition of the "sports portrait" of an athlete and to develop on this basis biomedical and tactical and technical approaches to the preparation of an athlete at the stages of sports activity.

Conclusions: The surveyed athletes rowers are represented mainly by the genotypes of the ACE, PPRA and PPRGC1a genes responsible for endurance with varying degrees of severity. Among the rowing athletes, the most common are athletes with moderate and weak degrees of endurance and with mixed qualities (endurance/strength and speed). There is a certain relationship between the genotypes of the ACE, PPRA and PPRGC1a genes and the parameters of temperament types, which expresses with the advantage the frequency of occurrence of choleric people among athletes with the A/A PPRGC1a genotype, sanguine people with the Del/Del ACE genotype and G/G PPRA genotype, phlegmatic - among carriers of the Ins/Ins ACE, G/G PPRA genotypes and the A/A PPRGC1a genotype. Also, among the carriers of the Ins/Ins ACE, G/G PPRA and A/A PPRGC1a genotypes, as well as the G/G PPRGC1a genotype, the predominance of the sympathetic nervous system is characteristic. The predominance of the nervous system with moderate strength often occurs among athletes carrying the G/G PPRA and G/G PPRGC1a genotypes, and the predominance of the nervous system with strong pronounced strength among athletes with the A/A PPRGC1a genotype.

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