PSYCHOPHYSIOLOGICAL STRUCTURES OF FOOTBALL PLAYERS' TEMPERAMENT AND THEIR INFLUENCE ON THE EFFICIENCY OF INDIVIDUAL PLAY TAKING INTO ACCOUNT NEUROENDOCRINE AND CARDIOREGULATORY PARAMETERS

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The article presents the results of a comprehensive study of the influence of psychophysiological structures of temperament on morphometric, somatotypical and functional characteristics of young football players. The study included 55 athletes aged 14 to 17 years, whose temperament type, body parameters were determined, and physical fitness and cardiorespiratory regulation were assessed. The greatest functional advantages - high speed-strength endurance, better recovery and pronounced mesomorphy - were observed in football players with a harmonized type of temperament. Disharmonized types demonstrated less physical stability and an increased heart rate at rest and after exercise. The data obtained emphasize the importance of taking into account individual psychophysiological characteristics in the system of sports selection, training planning and distribution of game roles in young athletes.

Introduction. Temperament as a basic psychophysiological characteristic of personality determines the individual style of response to physical and emotional stimuli and largely predetermines behavior in sports activities [1, 2]. In young athletes at the stage of active physical and mental development, the type of temperament can be a critical factor influencing the level of adaptation to training loads, competitive tension, as well as the choice of playing role [3].

Modern research confirms that certain types of temperament (e.g. choleric and sanguine) are more often correlated with higher results in game and speed-strength sports, while phlegmatic and melancholic types often require individual support and a longer period of adaptation [4, 5]. At the same time, the neurophysiological and somatotypic correlates of

these differences in adolescent football remain insufficiently studied, especially in terms of functional endurance, regulation of heart rate and body type [6].

In addition, the specificity of football as a team and high-energy sport requires the athlete to combine resistance to stress, quick switching, motor coordination and the ability to recover, which directly depends on the interaction of nervous, hormonal and autonomic regulation - systems that are partially influenced by temperamental characteristics [7, 8].

The relevance of this study is due to the need for a comprehensive approach to the selection and support of young football players based not only on their physical and technical training, but also on individual psychophysiological characteristics that determine their potential and resistance to overloads [9, 10].

Objective and research . To study the influence of psychophysiological structures of temperament of junior football players on their morphometric, somatotypic and functional indicators.

Materials and methods of the study. The study was conducted in the format of a prospective comparative analysis with elements of a cohort design. The object of the study were young football players aged 14–17 years who underwent an in-depth medical and psychophysiological assessment. All participants were divided into subgroups according to the predominant temperament structures based on the results of psychodiagnostic testing. Further, the differences between the groups in morphometric, somatotypic and functional indicators were studied. The study included 55 young football players representing specialized sports schools and academies of the city of Tashkent. Inclusion in the sample was carried out subject to the following conditions: age from 14 to 17 years, regular training at least three times a week and the absence of acute or chronic diseases at the time of the examination. Athletes who suffered injuries within three months before testing, as well as those who used drugs or supplements that potentially affect neurophysiological indicators were excluded. All participants and their legal representatives provided written informed consent to participate in the study.

To assess the structure of temperament, a modified FCZ-KT questionnaire for adolescents was used, covering 12 scales, including activity, emotional reactivity, endurance, plasticity, impulsivity and sensitivity. Based on the combination of these indicators, three types of temperament were identified: harmonized, characterized by high activity and endurance with low reactivity; disharmonized, with a predominance of high emotional reactivity and reduced endurance; and a mixed type with intermediate characteristics.

Morphometric assessment included measurement of height, body weight, body mass index, and shoulder, chest, and hip measurements. Additionally, the thickness of skin and fat folds was determined at five standard points. The Heath-Carter method was used to assess body type, calculating the somatotype based on endomorphy, mesomorphy, and ectomorphy components.

Functional fitness was assessed using a set of tests. The standing long jump allowed us to determine the explosive power of the lower extremities. Speed qualities were recorded based on the results of a 30-meter sprint using an electronic timer. Maneuverability was assessed during a 4×10-meter shuttle run. Aerobic abilities were determined based on the results of the 12-minute Cooper test. In addition, the Yo -Yo Intermittent Recovery Test Level 1 (IR1) test was used, designed to assess the ability to recover between repeated high-intensity intervals. The result was considered to be the total distance covered before failure.

Cardiorespiratory parameters were measured in parallel. Heart rate was recorded at rest in the morning, immediately after the Cooper and Yo -Yo IR1 tests, and during recovery in the third and fifth minutes. Blood pressure was recorded with an automatic tonometer before and after the load. Some participants also had their heart rate variability (HRV) assessed using specialized applications (Polar Flow, Elite HRV).

The stage of puberty was determined by self-assessment using the visual Tanner scale, which made it possible to take into account biological age in the analysis of the results obtained.

The results were processed using the SPSS version 26 statistical package. The Shapiro–Wilk test was used to check the normality of distribution. The comparison of the parameters between the groups was performed using the t- -test for independent samples with normal data distribution or the Mann–Whitney U-test if it was violated. Correlation analysis was used to identify the relationships between the variables using the Pearson or Spearman correlation coefficient, depending on the nature of the data. The level of statistical significance in all analyses was taken to be $p < 0.05$.

Research results. Based on the collected data, a comprehensive assessment of the psychophysiological, morphometric, somatotypical and functional characteristics of young football players with different temperament structures was conducted. The results are presented in the form of a comparative analysis between three types of temperament - harmonized, disharmonized and mixed. In this case, the main attention was paid to identifying reliable differences in the levels of physical fitness, cardiovascular regulation indicators, aerobic endurance and the ability to recover from exercise. The data obtained made it possible to establish a number of statistically significant relationships between the typological features of temperament and the sports efficiency of players, which is presented in the following tables.

Table 1.

Distribution of participants by temperament types and average age

Temperament type	Number of participants (n)	% of sample	Average age (years)	Tanner phase (cf. ± σ)
Harmonized	22	40.0%	15.6 ± 1.0	3.4 ± 0.6
Disharmonized	18	32.7%	15.2 ± 0.9	3.2 ± 0.7

Mixed	15	27.3%	15.3 ± 1.1	3.3 ± 0.5
Total	**55**	**100%**	**15.4 ± 1.0**	**3.3 ± 0.6**

Table 1 shows the distribution of 55 young football players aged 14–17 years by types of psychophysiological structures of temperament, as well as their average age and phase of puberty according to the Tanner scale. According to the table, the largest proportion of participants (40.0%, n = 22) belong to the harmonized type of temperament. This group is characterized by the most balanced combination of psychophysiological characteristics — high activity and endurance with low emotional reactivity. The average age of players in this group was 15.6 ± 1.0 years, which is slightly higher than in other groups. The phase of puberty according to the Tanner scale was also higher (3.4 ± 0.6), which may indicate a more advanced biological age and, possibly, greater maturity of vegetative and hormonal regulation.

The disharmonized type of temperament is represented by 32.7% of players (n = 18). Participants in this group demonstrated more pronounced emotional reactivity and less resistance to external stimuli. The average age of players in this category was 15.2 ± 0.9 years, and the average Tanner phase was 3.2 ± 0.7. These indicators are close to the overall average value, but when statistically compared with the group of harmonized players, a tendency towards lower biological indicators was noted.

The mixed type of temperament made up the smallest share - 27.3% (n = 15). Participants in this subgroup demonstrated variable combinations of psychophysiological features without a pronounced dominance of harmonious or disharmonious traits. The average age of football players in this group was 15.3 ± 1.1 years, Tanner phase - 3.3 ± 0.5. These indicators were practically no different from the general group values, which confirms the intermediate nature of this subgroup.

Overall, the average age of all participants was 15.4 ± 1.0 years, and the Tanner phase was 3.3 ± 0.6, which corresponds to the stage of active sexual and physiological development of male adolescents. Such a distribution confirms the correctness of the sample formation and allows for comparison between groups with minimal distortion due to biological age.

The most represented type of temperament among football players was harmonized, which may reflect selective selection in sports schools with a preference for stable and balanced athletes in behavior. The groups were comparable by age and phase of sexual development, which excludes the influence of biological maturity as the main factor of differences in the further analysis of functional and morphometric indicators.

The obtained data substantiate the possibility of comparing three psychophysiological subtypes of football players within the same age range, taking into account the stage of puberty.

Table 2.

Morphometric and somatotypic parameters (mean ± standard deviation)

Indicator	Harmonized (n=22)	Disharmonized (n=18)	Mixed (n=15)	*p* - value
Height (cm)	170.4 ± 5.9	168.7 ± 6.3	169.5 ± 5.6	> 0.05
Body weight (kg)	60.2 ± 6.1	58.8 ± 5.5	59.3 ± 5.8	> 0.05
BMI (kg/m²)	20.7 ± 1.4	20.6 ± 1.5	20.7 ± 1.6	> 0.05
Endomorphy	2.3 ± 0.4	2.5 ± 0.5	2.4 ± 0.4	> 0.05
Mesomorphy	4.1 ± 0.6	3.6 ± 0.7	3.9 ± 0.5	**0.043**
Ectomorphy	3.5 ± 0.5	3.9 ± 0.4	3.7 ± 0.5	0.048

Note: Harmonized types were characterized by statistically more pronounced mesomorphy, while disharmonized types were characterized by a tendency toward ectomorphy.

Table 2 shows the average values of morphometric and somatotypical parameters of young football players, grouped by psychophysiological types of temperament: harmonized, disharmonized and mixed. The analysis was conducted to identify possible physiological differences due to individual characteristics of temperament.

The average height of the athletes varied within the range of 168.7–170.4 cm. The highest values were recorded in the group with a harmonized type of temperament (170.4 ± 5.9 cm), which may indicate more favorable morphogenetic and hormonal conditions for development. However, statistically significant differences between the groups were not found ($p > 0.05$), which confirms the relative homogeneity of the sample in terms of height.

Body weight also showed no significant differences between the groups: 60.2 ± 6.1 kg in harmonized, 58.8 ± 5.5 kg in disharmonized, and 59.3 ± 5.8 kg in mixed. Thus, body weight and height do not demonstrate a pronounced dependence on the structure of temperament in adolescence.

BMI was within 20.6–20.7 kg/m² in all groups, which corresponds to the norm for adolescents. The absence of significant differences ($p> 0.05$) indicates that football players of all psychophysiological types have comparable and physiologically harmonious body builds in terms of weight-to-height ratio.

Endomorphy (proportion of body fat) varied from 2.3 to 2.5, with no statistically significant differences between groups ($p>0.05$). This suggests that all participants had moderately low levels of body fat, which is typical for highly active football players.

Mesomorphy (development of muscle and bone mass) was significantly higher in the group with harmonized temperament (4.1 ± 0.6) compared to disharmonized (3.6 ± 0.7) ($p = 0.043$). This may indicate an advantage in physical development in athletes with balanced

nervous and hormonal reactions, which is consistent with their higher endurance and adaptability revealed in other tests.

Ectomorphy (the tendency toward an elongated, thin physique) is not shown in this table, but in the previous analysis (taking into account the early data) there was a tendency for it to increase in the disharmonized group, which may reflect less developed muscle mass and insufficient adaptation to the load.

The harmonized type of temperament is associated with the most pronounced mesomorphic component, which confirms physical maturity and potential effectiveness in team sports.

Despite the absence of differences in height, body weight and BMI, it is the body type (through somatotype components) that allows us to assume differences in the ability to perform physical exercise, fatigue resistance and adaptation propensity. Disharmonized athletes tend to have less developed muscle mass, which may reflect their higher emotional lability and lower resistance to training stress.

Table 3.

Functional and cardiorespiratory parameters in young football players

Indicator	Harmonized	Disharmonized	Mixed	*p* - value
Standing long jump (cm)	210.2 ± 11.4	199.8 ± 10.2	205.1 ± 11.0	**0.032**
Sprint 30m (s)	4.64 ± 0.15	4.77 ± 0.17	4.69 ± 0.16	**0.041**
Shuttle run 4x10 m (s)	10.9 ± 0.5	11.3 ± 0.6	11.1 ± 0.6	> 0.05
Cooper test (m)	2630 ± 140	2485 ± 150	2560 ± 135	**0,019**
Yo -Yo IR1 (m)	1600 ± 180	1320 ± 190	1480 ± 175	**0,011**
Resting heart rate (bpm)	62.3 ± 4.1	66.7 ± 4.5	64.8 ± 4.2	**0.038**
HR after Yo -Yo IR1 (bpm)	176.4 ± 6.2	184.1 ± 5.8	180.2 ± 6.4	**0.026**
Heart rate recovery after 3 min (bpm)	112.8 ± 6.1	122.3 ± 7.2	117.9 ± 6.4	**0,021**
Flexibility (forward bend, cm)	13.4 ± 3.2	11.9 ± 3.6	12.7 ± 3.5	> 0.05

Table 3 presents the average values (mean ± standard deviation) of nine key indicators of physical and cardiorespiratory performance in three groups of football players with

different psychophysiological structures of temperament - harmonized, disharmonized and mixed. The *p values* show the statistical significance of differences between the groups.

Harmonized football players demonstrated the highest result in the standing long jump (210.2 cm), which reliably exceeds the similar indicator of the disharmonized ones (199.8 cm, $p = 0.032$). This test reflects the explosive power of the lower limbs, and the advantage of the harmonized types may be due to better neuromuscular coordination and motivation for maximum effort. Harmonized players again demonstrate a better time (30 m sprint) (4.64 sec), compared to the disharmonized ones (4.77 sec), $p = 0.041$. The speed of reaction and starting speed is directly related to central nervous regulation and motor control, which is probably more effective in athletes with a balanced temperament. The 4×10 m shuttle run test was slightly better for harmonized (10.9 sec) than for disharmonized (11.3 sec), but no statistically significant difference was found ($p > 0.05$). This test requires not only speed but also coordination when changing direction, which may depend on playing skills, not just temperament.

The Cooper test (12-minute run) showed the highest average result in harmonized football players - 2630 m, versus 2485 m in disharmonized ones ($p = 0.019$). This indicates high aerobic endurance in harmonious types, probably associated with more stable vegetative regulation and a lower tendency to premature fatigue.

In the Yo - Yo test , a clear advantage is noted in harmonized players (1600 m) compared to disharmonized (1320 m), $p = 0.011$. This test is particularly sensitive to the athlete's ability to perform high-intensity actions with short recovery periods. Higher efficiency in the harmonized group may indicate an optimal combination of central and peripheral regulation.

At rest, the harmonized subjects had a lower heart rate (62.3 bpm) than the disharmonized subjects (66.7 bpm), $p = 0.038$. This indicates a more economical cardiac activity mode in the former, typical of trained and stress-resistant athletes. After the Yo-Yo test, the harmonized subjects had 176.4 bpm, while the disharmonized subjects had 184.1 bpm ($p = 0.026$). A lower heart rate indicates a more effective adaptation to physical exertion. Recovery after 3 minutes: the harmonized subjects had a heart rate of 112.8 bpm, while the disharmonized subjects had a heart rate of 122.3 bpm ($p = 0.021$). This reflects higher parasympathetic (restorative) reserves and a better ability to regenerate after exercise.

The differences between the groups in flexibility (forward bending) did not reach statistical significance ($p > 0.05$). The mean values were comparable (13.4–11.9 cm), indicating comparable elasticity of the back and leg muscles regardless of the type of temperament.

Thus, harmonized temperament in football players is associated with better physical fitness, including speed, endurance and recovery functions of the cardiovascular system. Disharmonized types show reduced functional stability, higher heart rate and shorter distance in aerobic tests, which may reflect both emotional instability and psychosomatic

fatigue. The data obtained confirm that temperament has a significant effect on a number of key functional parameters, which should be taken into account when individualizing the training process and distributing roles.

Discussion. The aim of this study was to investigate the influence of psychophysiological structures of temperament of young football players on their morphometric, somatotypical and functional indicators. Within the framework of this goal, the following tasks were solved: (1) to carry out a typology of temperament in athletes aged 14–17 years, as well as to determine the features of physique and biological maturity depending on the type of temperament, (3) to evaluate differences in functional fitness, including aerobic abilities, speed-strength qualities and parameters of cardioregulation.

The analysis of the distribution by temperament types (Table 1) showed that the largest proportion were football players with a harmonized psychophysiological structure (40%), characterized by high activity, endurance and low emotional reactivity. The groups differed not only in the structure of temperament, but also in the average Tanner phase, reflecting the degree of sexual and physiological maturation: harmonized athletes had a slightly higher biological age, which potentially affects physical performance and stress resistance. Morphometric and somatotype analysis did not reveal reliable differences in height, body weight and body mass index, indicating the relative physiological homogeneity of the sample. However, the differences became obvious when analyzing the components of physique. Athletes with a harmonized temperament reliably had a predominance of mesomorphy (development of muscle and bone mass), while disharmonized players showed a tendency toward more pronounced ectomorphy associated with a lean body type. These data are consistent with the fact that athletes with a more balanced temperament have an anatomical and physiological base favorable for strength and game loads.

The most pronounced differences between the groups were revealed in the analysis of functional and cardiorespiratory parameters.

Athletes with a harmonized temperament type showed significantly better results in such tests as standing long jump, 30 m sprint, Cooper and Yo-Yo tests, indicating a higher level of explosive power, aerobic endurance and speed qualities. A lower heart rate at rest and after exercise, as well as a faster recovery of heart rate after 3 minutes, indicate a favorable cardioregulatory status in harmonized athletes. This may be due to a high level of adaptive capacity of the autonomic nervous system and an adequate stress response.

Disharmonized athletes showed less pronounced functional characteristics and increased heart rate values both at rest and after exercise, which may indicate lower resistance to physical and emotional stress. This confirms that emotional lability, impulsivity and high anxiety can reduce the effectiveness of the training and competitive process in this category of athletes.

Thus, the obtained results demonstrate that the structure of temperament has a significant impact on sports performance and functional adaptation. Harmonious temperament

contributes to the formation of a mesomorphic physique, better regulation of the cardiovascular system, higher results in aerobic and speed-strength tests. Disharmonious structures of temperament, on the contrary, require a more individualized approach, including the inclusion of psychological support, fatigue prevention and the development of gentle training models.

The identified features should be taken into account when distributing roles, planning the training cycle and developing personalized rehabilitation and recovery programs. In particular, athletes with a harmonious temperament can be recommended roles that require high intensity and responsibility (central midfielder, striker), while disharmonized athletes require psycho-emotional support and long-term adaptation to competitive stress.

Conclusion. The results of the conducted study confirmed that the psychophysiological structures of the temperament of young football players have a significant impact on their morphometric, somatotypical and functional characteristics. The most pronounced differences were found between harmonized and disharmonized types of temperament.

Football players with a harmonized structure demonstrated a predominantly mesomorphic physique, higher aerobic and speed-strength performance, and favorable vegetative regulation of the heart rate. This allows us to consider this type of temperament as a predictor of high individual efficiency in game and competitive conditions. In contrast, disharmonized athletes were characterized by reduced physical endurance, higher heart rate at rest and after exercise, and a less pronounced muscular component of the physique.

The obtained data indicate the need to take into account the typological features of temperament in the selection, functional training, distribution of roles and psychological and pedagogical support of young athletes. Particular attention should be paid to optimizing training loads and the emotional environment for football players with a disharmonized temperament, in order to prevent fatigue, maladaptation and decreased motivation.

Thus, the integration of psychophysiological typology into sports diagnostics allows not only to more accurately predict individual effectiveness, but also to form personalized training models that ensure the harmonious development and professional growth of football players during their active development.

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