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DEVELOPMENT OF COORDINATION ABILITIES IN FEMALE ATHLETES PLAYING TECHNICAL AND ARTISTIC SPORTS

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Abstract: The article presents the results of a survey of 97 highly qualified female athletes involved in various technical and artistic sports and training the development of coordination abilities. The specifics of the development in the central and sensory parts of the postural system have been established, depending on the direction of physical activity. The highest vertical stability among female athletes, according to the results of the "Target" stabilometric test, was found in the artistic gymnastics group, the weakest vertical stability was noted in the aerial strength athletics group. Differences in the density and rigidity of intrasystem relationships revealed when analyzing correlations between the indicators of stabilometric tests and the sensory link according to psychophysiological reactions to biologically significant stimuli. The identified physiological characteristics reflect the specificity of the development of coordination abilities in athletes involved in various technical and artistic sports, which will allow us to pay attention to the weak links in their preparation.

Keywords: air power athletics, rhythmic gymnastics, artistic gymnastics, sports acrobatics, sports aerobics

Introduction

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In sports physiology, one of the main questions to study is the research question of effects of long-term adaptation in the athletes' body to physical activity during sports. Technical and artistic sports rightfully occupy a leading place among the many sports that train coordination abilities. Therefore, it is advisable to study the advantages and disadvantages of developing coordination abilities in certain types of technical and artistic sports. Technical and artistic sports includes: various types of gymnastics, rhythmic gymnastics, aesthetic gymnastics, sports acrobatics, figure skating, sports ballroom dancing, aerial strength athletics and circus aerial gymnastics, and acrobatics, synchronized swimming, various types of freestyle, snowboard. The main emphasis influencing the formation of fitness is the development of coordination abilities, which has characteristic features in certain selected sports. As is known, with the systematic and long-term implementation of various gymnastic, dance, acrobatic, and other movements, athletes are distinguished by different coordination capabilities, both quantitatively and qualitatively (Lyakh V.I., 2006).

It is extremely important to study the functioning of various parts of the postural system, which reflects the coordination abilities of athletes, namely: orientation in space, maintaining balance, speed of response to various stimuli, differentiating the accuracy of motor reactions, prompt restructuring of motor actions, etc. As we known, the main support the links in the functioning of the postural system are : the study of the characteristics of the functioning of the central nervous system and sensory systems (Zakharyeva N.N., 2023). Postural control is not a simple mechanical skill, it set of static reflexes, it is a complex dynamic complex of sensorimotor mechanisms that must be studied when practicing various sports that train the development of coordination abilities. Posture control is a motor skill based on dynamic sensorimotor processes. This article provides a comparative analysis of the functioning of the central and sensory parts of the postural system in highly qualified female athletes involved in 7 different technical and artistic sports. The data obtained can form the basis for determining directions for improving coordination among highly qualified female athletes at the stage of sports excellence and correcting their motor programs.

Purpose of the study: to determine the characteristics the development of coordination abilities and the functional state of highly qualified female athletes involved in various technical and artistic sports.

Research objectives:

1. To conduct a comparative analysis at the differences in the functional state and coordination abilities in highly qualified female athletes involved in various technical and artistic sports.

2. To conduct an intersystem correlation analysis of the relationships between the indicators of stabilographic and psychophysiological testing among highly qualified female athletes involved in various technical and artistic sports.

Methods

Female athletes - 97 highly qualified female athletes (HQA)), involved in various technical and artistic sports, completed clinical and physiological testing. Average age in female athletes was: 18.95 ± 0.94 years; the average length of experience in sport: 12 ± 18 years; the average volume of training load (hours per week): 11.7 ± 19 hours. All female athletes competed at various levels (from interregional to World Championships) and regularly took high prizes. All subjects showed a high level of skill in the relevant sports. The studies were carried out during the special preparatory stage in the preparatory period of the training cycle (table 1).

Table 1. Subject population

Group number	Group composition	Number of people
Gr1- women	Russian national team in air and strength athletics (AirSatl)	6
Gr2 - women	Sports ballroom dancing (SBD)	17
Gr3- women	Rhythmic gymnastics (RG)	30
Gr4- women	Sports and fitness aerobics (CiFAer)	17
Gr5- women	Artistic gymnastics (ArtG)	10
Gr6 - women	Sports acrobatics (SAcr)	7
Gr7- women	Aesthetic gymnastics (AesG)	10
Total subjects:		97

Physiological testing was carried out from September 2022 to June 2024 on the basis of the laboratory of "Medical and biological support of sports teams" of the Research Institute of Sports and Sports Medicine in the The Russian University of Sport «GTSOLIFK» during the hours of physiological sympathicotonia: from 9.00 to 12.10. in the conditions of a functional diagnostics room at a room temperature of 21 ± 1 °C and air humidity of 57%, in compliance with the ethical biomedical standards set out in the Declaration of Helsinki and the Directives of the European Community.

Physiological testing included stabilography - (stabilometry), - registration of the projection of the general center of gravity (GCT) on the support - is a modern and informative method for assessing a number of indicators of the state of the human body, both in normal and pathological conditions. The study used a stabilizer analyzer with bio-feedback "Stabilan 01-2" (manufactured by ZAO RITM, Taganrog). All female athletes performed the "Target" test. The athletes stood on the platform in a European stance: the feet were positioned symmetrically relative to the center line of the platform, heels together, toes spread to the sides by approximately 30°, arms along the body. The test

was carried out in one stage with visual feedback. After preliminary calibration, recording lasted 20 seconds. The female athlete, standing on the platform, had to deflect her body to keep the marker in the center of the target. The StabMed 2 program automatically analyzed the stabilogram and displayed linear and vector indicators with the eyes open. The analysis of the stabilographic signal was carried out by software using methods: statistical, spectral, visual analysis of statokinesiograms.

Psychophysiological testing was carried out on a personal computer or laptop using the IVPS 2.1 program. ("Researcher of temporal and spatial properties of a person version 2.1.") (Koryagina Yu.V., 2004). Psychophysiological testing included the study of a simple reflex reaction to biologically significant stimuli: visual and sound reactions, reactions to a moving object, choice reactions, test "Individual minute" and tapping test. Psychophysiological studies were carried out by the subjects binocularly, with the dominant hand, after appropriate instructions. Psychomotor performance determined using a computerized method by V.V. Sonkin, V.V. Zaitseva, V.D., Sonkin, which allows one to track the dynamics of changes in performance during work, as well as adjust the complexity of tasks at a threshold level. The test was carried out in 3 stages. The individual threshold for mental performance was considered to be 5 errors. More than 5 errors indicated that the subject did not cope well with testing (Sonkin V.V., 2009). The normality of data distribution was determined using the Kolmogorov-Smirnov test, and frequency distribution histograms were also visually assessed and analyzed. Data presented as arithmetic mean $\pm$ standard deviation. Differences between the two groups assessed using Student's t test. Differences were considered statistically significant at $p < 0.05$. Statistical data processing was carried out using Microsoft Excel 2010 and Statistica 10.0 (StatSoft, Inc., USA).

Results and discussion

We examined 97 highly qualified female athletes (HQA), involved in various technical and artistic sports, divided into 7 comparison groups according to sports specializations. The athletes performed the "Target" stabilometric test on a domestic stabiloanalyzer with biofeedback "Stabilan 01-2". The results of the study are present in Table 2.

As can be seen from Table 2, the best results of the "Target" test were noted in **Gr5** (ArtG), where the indicator "Ellipse Area" has the lowest values in the comparison groups: $47,7 \pm 27,3 \text{ mm}^2$, and the weakest results of the test noted by athletes from group **Gr1** (AirSatl). Significant differences in the performance of the "Target" test task revealed in **Gr1** (AirSatl) with athletes from most comparison groups, namely: artistic gymnastics, rhythmic gymnastics, sports acrobatics, sports and fitness aerobics, sports ballroom dancing, aesthetic gymnastics, almost according to the main test indicators. The maximum intergroup differences **Gr1** (AirSatl) established with the main indi-

cators of the statokinesiogram “Ellipse area” and “Length of the trajectory of the CP along the front”, (in mm). As is known, the indicator “Ellipse area” (area of the confidence ellipse) is an important indicator that characterizes the main area of the subject’s working support. It shows the overall stability of a person, and reflects 90-95% of the total area of oscillation in the frontal and sagittal directions. As we known, the smaller the area of the ellipse, the better the postural stability (Skvortsov D.V., 2010).

Athletes from the **Gr1** group (AirSATl) note the highest values of the “Ellipse Area” indicator (mm²) in the comparison groups and, therefore, the worst vertical stability. The indicator “Ellipse area” in **Gr1** (AirSATl) indicates significant differences with **Gr3** (RG): g1-g3 ($p=0.035$); with **Gr4** (SandFAer): g1-g4 ($p=0.05$) and, of course, with group **Gr5** (ArtG): g1-g5 ($p=0.05$).

Indicator “CP trajectory length” (L) frontal (X) or sagittal (Y) (mm) – the trajectory length reflects the displacement along the sagittal and frontal based on the total distance traveled. It considered one of the reliable indicators of the development of vertical stability. Pose stability is higher if the trajectory length is shorter. According to the established data, the minimum values of the indicator “Length of the CP path along the front” (in mm) were established in groups **Gr5** (ArtG) and **Gr4** (S and FAer), in comparison with the values of indicators of other groups. However, significant differences in this indicator were again revealed when comparing the values of athletes from **Gr1** (AirSATl) with the values of athletes from the groups: **Gr5** (ArtG), **Gr4** (SiFAer) and **Gr6** (SAcr): g1-g4 ($p = 0.05$); g1-g5 ($p=0.037$); g1-g6 ($p=0.031$). The priority of the development of coordination abilities in gymnasts involved in artistic gymnastics is also emphasized by the single significance of the differences revealed when comparing the values of the indicator “Length of the trajectory of the CP along the sagittal” (in mm) between the comparison groups **Gr1** (AirSATl) and **Gr5** (ArtG): g1-g5 ($p=0.021$).

The “Speed Index” indicator also has minimal values in comparison groups in **Gr5** (ArtG), emphasizing its priority for the development of coordination abilities in comparison groups. However, significant differences were revealed, as before, when comparing the indicators of athletes from **Gr1** (AirSATl) and athletes from groups **Gr5** (ArtG), **Gr4** (SandFAer): g1-g5 ($p=0.027$) and in groups g1-g4 ($p=0.021$) in favor of the development of coordination abilities in gymnasts involved in artistic gymnastics and sports and fitness aerobics.

The indicators of “Average linear speed” and V_{av} (mm/s) - “Average speed of movement of the CP” during the examination indicate the only significant differences in **Gr1** (AirSATl) with the group **Gr5** (ArtG): g1-g5 ($p = 0.029$) in favor low speed in female athletes involved in artistic gymnastics, which determines a high degree of involvement of all postural control systems and indicates their normal operation.

Table 2. The results of the “Target” test for female athletes, practicing technical and artistic sports

Physiological test data	Gr 1 (AirSatI) M±St.dev.	Gr 2 (SBD) M±St.dev.	Gr 3 (RG) M±St.dev.	Gr 4 (CfAer) M±St.dev.	Gr 5 (AG) M±St.dev.	Gr 6 (Sacr) M±St.dev.	Gr 7 (AesG) M±St.dev.	p-level
Frontal displacement, mm	-0.12±0.44	-0.01±0.86	-0.11±0.79	-0.11±0.79	0.24±0.79	-0.75±0.81	-	g1-g6 (p=0.027)
Sagittal displacement, mm	-0.1±1	0±0.8	0.1±1.1	0.1±1.1	0±1.2	-0.1±1.1	-	-
Number of points scored	93.2±3.9	93.6±4.7	93.3±3.5	94.1±1.8	95.6±2.1	94.6±3.4	94.5±2.1	-
Frontal spread, mm	2.3±0.7	2.2±0.9	2.2±0.6	1.9±0.5	-0.75±0.81	1.8±0.6	-	-
Average spread, mm	3±0.8	2.9±0.9	2.9±0.6	2.7±0.4	2.2±0.5	2.4±0.6	-	-
Ellipse area, mm2	87.1±49	84.7±54.8	78.8±35.4	66.5±19.7	47.7±27.3	58.8±31.8	82.1±39.3	g1-g3 (p=0.035) g1-g4 (p=0.05) g1-g5 (p=0.05) g1-g6 (p=0.032)
Speed index	6.7±2.3	6.5±2.2	6.6±1.7	5.7±1.3	5.5±1.4	6±1.3	-	g1-g4 (p=0.021) g1-g5 (p=0.027)
Quality of the equilibrium function (in %)	76.5±14.1	77.2±11.7	77.1±9.1	82.1±7.8	83.8±7.4	81±6.8	78.4±11	g1-g2 (p=0.021) g1-g3 (p=0.05)
Average linear speed, (mm/sec)	10.6±3.7	10.4±3.4	10.5±2.6	9.1±2.2	8.7±2.3	9.5±2.1	-	g1-g5 (p=0.029)
Average speed of movement of the CD, (mm/sec)	10.6±3.7	10.4±3.4	10.5±2.6	9.1±2.2	8.7±2.3	9.5±2.1	24.9±33.5	g1-g5 (p=0.023)
Average angular velocity, (degrees/sec)	22.5±4.8	21.8±4	20.3±6.2	21.9±6.2	24.5±2.3	23.8±4.7	-	-
Angular velocity asymmetry coefficient, (%)	-0.1±5.9	2.5±11.5	-1±8.4	3.8±6.3	-3.8±9.9	-2±6.7	-	g1-g6 (p=0.041)
Curvature coefficient, (rad/mm)	0±0.6	0±0.8	0.2±0.8	-0.2±1	0±0.5	0.5±1.2	-	g1-g4 (p=0.024)
Speed change statokinesigram area, (mm2/sec)	11.1±6.1	10.1±6.5	10±4.6	8±2.6	6.3±3.8	7.6±3	25.6±33.6	-
Sharp change factor eg movement, (%)	12.9±4.7	12.7±3.7	11±5.8	12.6±6.2	15.2±2	14.5±4.7	-	-
Asymmetry coefficient of relative frontal displacement, (%)	1.2±4.8	-2.8±10.6	3±9.2	-3.4±6.2	-0.4±9.8	-0.4±9.3	-	-
The length of the trajectory of the center of pressure along the front, (mm)	129.3±52.4	125.5±60	125.7±39.6	103.5±21.6	103.3±14.9	116.4±24	120.1±34.5	g1-g4 (p=0.05) g1-g5 (p=0.037) g1-g6 (p=0.031) g2-g5 (p=0.05)
Length of the trajectory of the center of pressure along the sagittal, (mm)	138.3±43.8	136±37.8	139.5±37.8	125.2±42.3	116.2±35.1	123.4±33.9	148.2±46.4	g1-g5 (p=0.021)
Length depending on area, l/mm	2.6±0.6	3±1.1	3±1.2	2.7±0.9	4.1±1.4	3.7±1.5	-	-
Asymmetry coefficient relative to mode (front)	6.7±17.6	32.6±33.2	16.4±30.2	55.6±20.7	31.8±31.3	29.6±38.5	-	g1-g4 (p=0.037) g2-g4 (p=0.024)

The indicator "Quality of the equilibrium function" (in %) is calculated based on the data of the indicator "Area of the ellipse". Significant differences in the indicator "Quality of the balance function" (in%) were established in favor of the priority of the development of coordination abilities among dancers involved in physical exercise and gymnasts involved in rhythmic gymnastics in comparison with athletes involved in airlifting: g1-g2 ($p = 0.021$) and g1-g3 ($p=0.05$).

When comparing the data of the "Target" test of gymnasts engaged in various types of gymnastics, (SBD) dancers and acrobats, much fewer significant differences revealed, than when comparing the test indicators of athletes from groups **Gr2-7** with the aerial and power athletics group.

It was established reliability of the differences in the comparison groups in athletes **Gr2** (SBD) and **Gr5** (ArtG). It is noteworthy, emphasizing the priority of the development of coordination skills in gymnasts involved in artistic gymnastics in comparison with dancers involved in SBD: the indicator "Length of the trajectory of the center of pressure along the front" has significantly higher values in group **Gr2** (SBD): g2-g5 ($p=0.05$).

In groups **Gr4** (S and FAer) and **Gr6** (SAcr), single significance differences were established when comparing the indicator "Frontal displacement" (in mm) in favor of female athletes involved in sports and fitness aerobics over sports acrobats.

The indicator "Coefficient of asymmetry of angular velocity" (in %) indicates a smaller number of tremor-like oscillations when maintaining a pose and greater vertical stability in gymnasts involved in rhythmic gymnastics, in comparison with sports acrobats: g3-g6 ($p = 0.041$).

It has been established that the weakest vertical stability, based on the results of the stabilometric test "Target", development of coordination abilities in comparison groups of highly qualified athletes involved in various technical and artistic sports, involved in various technical and artistic sports, is noted by athletes involved in aerial and power athletics. The highest development of coordination abilities noted in the artistic gymnastics group, which is also inferior in the development of coordination abilities to female dancers. It is important to note that among highly qualified athletes involved in complex coordination sports among comparison groups of various types of gymnastics, artistic, aesthetic sports acrobatics, sports ballroom dancing, the reliability of the differences is minimal and more often does not concern the main indicators of the stabilometric test "Target".

The level of development of the sensory component of the postural system characterizes the performance of psychophysiological tests by athletes, which determine the

difference in the ability of athletes to respond to biologically significant stimuli and psychomotor performance.

Among 10 psychophysiological tests, differences were established in the speed of reflex reactions to biologically significant stimuli in the tests: "Reaction time to light and sound" (in ms), "Reaction to a moving object" (RMO) (ms) and "Individual minute" (ms) and the results of tapping test attempts, where significant differences were noted in most comparison groups.

The greatest number of differences noted in the test "Reaction time to sound" (in ms). The most accurate and fastest are the athletes from group Gr4 (Sports and Fitness Aerobics) g4-g5 ($p=0.01$). A fairly fast reaction in the "Reaction time to sound" test (in ms) among masters of sports, rhythmic gymnastics and ballroom dancing in comparison with athletes from Gr5 (ArtG): g3-g5 ($p=0.01$); g3-g5 ($p=0.05$); g2-g5 ($p=0.01$). The weakest results of the reaction to the sound stimulus were noted in group Gr1 (AirSatl).

The results of the test "Reaction time to light" (ms) revealed the fastest reaction among dancers in Gr 2 (SBD). There was a high level of significant differences in g2-g3 ($p=0.01$) (Table 3). Among the comparison groups in the test "Reaction time to light" (ms), there were quite fast reactions in Gr 2 (SBD) < Gr 4 (Sports and Fitness Aerobics) < Gr 3 (RG). Group Gr 7 (AesG) showed the fastest reaction to a moving object among the comparison groups (Table 3). In the comparison groups Gr5 (AG), Gr6 (SAcr) and Gr7 (AesG), the time of the reflex reaction to light (ms) is significantly shorter in comparison with the athletes of the groups: Gr2 (SBD); Gr4 (Sports and Fitness Aerobics) and Gr3 (RG).

Table 3. Results of identifying significant differences in the psychophysiological characteristics of groups of female athletes involved in sports ballroom dancing (SBD) and rhythmic gymnastics (RG).

Physiological test data	SBD (n = 17)		RG (n = 30)		p-level
	M	St. dev.	M	St. dev.	
Light reaction time test (ms)	271.96	30.39	312.92	56.52	0.01
Reaction to a moving object test (ms)	225.29	23.51	94.41	26.64	0.05
Tapping test, 10 sec (2)	64.71	5.83	60.00	6.25	0.01
URA, test stage 2 attempt 2 (number of errors)	0.00	0.00	0.67	0.14	0.05

Assessing the results of psychophysiological tests, the weakest results of psychomotor performance and reactions to biologically significant stimuli were noted in group Gr1 (VSAtl), which significantly distinguishes it from all other comparison groups in the tests "Reaction time to light and sound", "Reaction to moving object" and "Selection reaction": g2-g1: ($p=0.01$); g3-g1: ($p=0.01$); g5-g1: ($p=0.01$); g4-g1: ($p=0.05$); g6-g1: ($p=0.05$); g7-g1 ($p=0.01$).

The results of the Individual Minute (IM) test revealed the lowest result in group Gr4 (Sports and Fitness Aerobics), which reflects pronounced neuroticism and may be associated with high physical and cognitive load when combining training and studying at a sports university: g4-g3 ($p=0.01$) and g4-g5 ($p=0.05$) and g4-g6 ($p=0.01$) (Table 4).

Table 4. Results of identifying significant differences in the psychophysiological characteristics of groups of female athletes involved in rhythmic gymnastics (RG) and artistic gymnastics (ArtG).

Physiological test data	RG (n = 30)		ArtG (n = 10)		p-level
	M	St. dev.	M	St. dev.	
Sound reaction time test (ms)	352.31	100.13	435.76	63.05	0.01
Reaction to a moving object test (ms)	94.41	20.64	113.40	22.69	0.01
Tapping test, interval 1 (number of presses)	71.27	10.54	66.70	4.11	0.05
Tapping test, interval 3 (number of presses)	58.40	5.69	61.90	4.65	0.05
Tapping test, interval 5 (number of clicks)	55.10	6.47	59.80	7.54	0.05
Tapping test, interval 6 (number of clicks)	55.67	5.42	60.40	8.62	0.05
URA, stage 1 attempt 4 (number of errors)	0.53	0.13	3.50	0.74	0.05
URA, stage 1 attempt 8 (number of errors)	6.53	2.09	3.40	0.81	0.01
URA, stage 1 attempt 9 (number of errors)	8.30	2.15	5.80	1.42	0.05

The results of the tapping test from 6 attempts indicate the highest frequency of wrist movements during practice at the initial stages of the test in the rhythmic gymnastics group, however, on the 3rd attempt, the master of sports in artistic gymnastics most actively maintained the pace. High reliability of the differences was revealed when comparing the results of the initial test attempts in groups g3-g2 ($p=0.01$) and g3-g4 ($p=0.01$). A lower level of significant differences at the initial and final stages of the test was noted in groups g3-g5 ($p=0.05$) and g3-g6 ($p=0.05$).

The performance of the “Mental Performance” test, abbreviated as “URA” (V.V. Sonkin (2009)), was noted to have the highest results of psychomotor performance among athletes from the Gr5 (AG) and Gr2 (SBD) groups. Moreover, at the 2nd and 3rd stages of the test, the most difficult stages of the test, athletes from Gr5 (SG) note the highest speed and accuracy of completing test tasks among comparison groups, while significant differences were noted in groups g5-g2 ($p = 0.05$); g2-g3 ($p=0.05$); g2-g7 ($p=0.05$). It should be noted that the high speed of completing tasks of the “URA” test was also noted among masters of sports in the sports acrobatics group, where athletes dominate when performing the 3rd most difficult stage of the test, at a constant speed, over dancers: g6-g2 ($p = 0.05$). The significance of the differences was established in the groups: g5-g7 ($p=0.01$), where the speed of completing tasks of the “URA” test by masters of sports in artistic gymnastics in comparison with masters of sports in aesthetic gymnastics exceeds 3.39 times ($p=0.01$) (Table 5).

Table 5. Results of identifying significant differences in the psychophysiological characteristics of groups of female athletes involved in artistic gymnastics (ArtG) and Aesthetic gymnastics (AesG).

Показатели	AG (n = 10)		Aesthetic G (n = 10)		p-level
	M	St. dev.	M	St. dev.	
Reaction to a moving object (ms)	113.40	22.69	17.80	3.04	0.01
URA, stage 1 attempt 8 (number of errors)	3.40	2.81	5.67	1.79	0.05
URA, stage 1 attempt 9 (number of errors)	5.80	1.42	8.33	2.58	0.05
URA, stage 2 attempt 6 (number of errors)	2.70	0.90	0.67	0.21	0.01
URA, stage 2 attempt 8 (number of errors)	2.30	0.70	4.33	1.15	0.05
URA, speed at stage 3 (ms)	263.00	51.16	866.67	115.47	0.01

Discusion

This study presents a comparative analysis of the features of the functioning of the postural system in female athletes involved in technical and artistic sports and having a high level of training in them. A comparative analysis of the functioning of the central and sensory parts of the postural system in female athletes involved in technical and artistic sports was carried out on the basis of objective data from stabilometric and psychophysiological testing. The highest level of functioning of the central link of the postural system and psychomotor performance in the “URA” test was revealed in the group of female athletes engaged in artistic gymnastics Gr5 (ArtG). A high level of spatio-temporal characteristics, accuracy and speed of reactions to biologically significant stimuli was noted in the groups: sports ballroom dancing, sports and fitness aerobics, and rhythmic gymnastics (Gr3, Gr2, Gr4), but the athletes of these comparison groups noted a weaker development of the vertical stability when performing tasks of the stabilometric test “Target” in comparison with Gr5 (ArtG). Since coordination abilities cannot stand apart from the development of physical qualities such as: flexibility, speed, endurance and strength, then, indirectly, we can conclude that there is some priority for the development of these physical qualities when practicing artistic gymnastics, where there is a need to perform a large number of difficult tasks technical physical exercises. Highly qualified athletes involved in sports ballroom dancing, sports acrobatics and aesthetic gymnastics should use in their training programs physical exercises to develop coordination, performed by artistic gymnasts without apparatus on the floor. The weakest results of the “Target” stabilometric test, psychomotor performance, accuracy of assessment of spatio-temporal parameters and speed of reactions to biologically significant stimuli were noted in the air-strength athletics group, which dictates the need to improve the training process of Gr1 (VSAtl) female

athletes with possible inclusion in the training process female athletes doing physical exercise, developing coordination abilities from artistic gymnastics, sports ballroom dancing and rhythmic gymnastics.

Conclusions

1. We revealed significant differences in vertical stability among highly qualified female athletes involved in various technical and artistic sports and with a high level of training, which reflects different degrees of tension in the physiological mechanisms of adaptation to specific physical loads and differences in the responses of the effectors of muscle activity depending on the specifics of the selected activities kind of sport.
2. Female athletes involved in artistic gymnastics have clear advantages in maintaining vertical stability when performing the "Target" stabilometric test, which is confirmed by the largest values of the KFR indicator (%), the smallest values of the indicator "Ellipse area ELL sq. mm" and the lowest values of the indicator "Average linear speed" mm/sec, noted in the comparison groups.
3. Female athletes involved in aerial strength athletics note the worst results in performing the stabilometric test "Target", psychomotor performance and orientation in space and time among the comparison groups, which is confirmed by significantly low values of the indicator "Quality of balance function", maximum values of the area of the confidence ellipse, average spread frontal, speed index and linear speed index and the worst results of psychophysiological tests in comparison groups.

Practical recommendations

1. For female athletes involved in air and strength athletics and ballroom dancers; for gymnasts involved in rhythmic and aesthetic gymnastics, sports and fitness aerobics and acrobatics at the stage of sports perfection, we recommend physical exercises to improve coordination abilities from the artistic gymnastics training program, which can be divided into 4 groups:

- **group 1** – "Turns" – this is the rotational movement of the athlete's body around its vertical axis. Dancers are recommended to perform complicated variations: on half toes on one leg, with the working leg fixed on the knee (sur le cou-de-pied or passé), turns should be performed at 180°, 360°, 540°, 720°, arms should be used during these movements bend your elbows and press them to your chest

- **group 2** – "Jumping" is a way to overcome space by quickly moving the body after pushing off from some support point. This motor action consists of the following

phases: push-off, flight and landing. Jumps are at one time divided into simple and jumps with turns. Athletes involved in dance sports recommended to perform jumps without turns, legs together, legs apart, bending the legs forward, bending the legs back. Also, for rotational training, it is recommended to perform jumps with a rotation of 180°, 360°, 540°, 720°.

- **group 3** – “Balancing”. We recommended to perform the exercises on the floor: holding the body in a half-squat for 30 seconds, arms forward, arms up, arms to the sides. Standing on half toes with straight legs, legs together, holding the body for 30 seconds, arms forward, arms up, arms to the sides. Standing on half toes on straight legs, legs apart, holding the body for 30 seconds, arms forward, arms up, arms to the sides. All of the above exercises can be performed on a rubber hemisphere.

- **group 4** – “Balance” – this is maintaining the stability of the posture in static body positions. Balance on the right, left leg forward, to the side and back, the same exercise on the other leg. When performing exercises, you can hold your hands up, forward, to the side or on your waist. For variety and to develop vestibular stability, you can perform exercises of groups 3 and 4 with your eyes closed.

2. To develop vertical stability for highly qualified athletes involved in airlifting and dancers; gymnasts engaged in rhythmic and aesthetic gymnastics, sports and fitness aerobics and acrobatics at the stage of sports perfection are recommended to conduct strength training with physical exercises to strengthen the deep muscles of the spine with.

References

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