

Functional state of team sports athletes in the annual training cycle

Estado funcional de los atletas de deportes de equipo en el ciclo anual de entrenamiento

*Dmitrii Babaskin, **Farhod Masharipov, ***Olga Savinkova, ****Natalia Shustikova, *****Nina Volkova

*Sechenov First Moscow State Medical University (Russia), **Urgench State University (Uzbekistan), ***Voronezh State Academy of Sports (Russia), ****Moscow University for Industry and Finance "Synergy" (Russia), ***** Moscow Aviation Institute (Russia)

Abstract. Determination of the dynamics of the functional state of the musculoskeletal system of team sports athletes in the annual training cycle. The achievement of this goal will allow for providing scientifically-based management of training and competitive processes in the annual training cycle and contribute to the normalization of the functional state of the athlete's musculoskeletal system. The authors assessed the functional state of the musculoskeletal system of athletes involved in football, handball, and field hockey, using goniometry, and stabilometry, as well as testing physical abilities, associated with the flexibility of the joints (forward bend from a standing position (on the bench), bridge, transverse and longitudinal (best of 2 possible), splits). Testing was conducted during the annual training cycle, after the competitive period, and at the beginning and at the end of the preparatory period. Assessment of the functional state of the musculoskeletal system of athletes at the end of the competition period showed the low and below average flexibility levels. Static support ability (stabilometry) and joint mobility (goniometry) were below average and average levels. Decrease in static support ability testified to violations of the vestibular apparatus and proprioceptive sensitivity, which have a significant impact on balance. The low results of joint flexibility and mobility indicated the lack of elasticity of the musculoskeletal apparatus, which indicated the presence of overstrain. Diagnosed positive changes in the state of the musculoskeletal system of athletes at the beginning and at the end of the preparatory period, regardless of the team sport, indicated a partial restoration of the functional state of the musculoskeletal system during the transition period. According to the results of the study, recommendations were given for including in the training process, along with prestretching, corrective and preventive exercises based on the use of the myofascial relaxation technique, which contribute to the restoration of the functional state of the musculoskeletal system of team sports athletes.

Keywords: football players, handball players, hockey players, functional state, musculoskeletal system, flexibility, stabilometry, goniometry.

Resumen. Este estudio se enfoca en determinar la dinámica del estado funcional del sistema musculoesquelético de los atletas de deportes de equipo durante el ciclo anual de entrenamiento. Lograr este objetivo permitirá proporcionar una gestión científicamente basada del entrenamiento y los procesos competitivos en el ciclo anual de entrenamiento, contribuyendo a la normalización del estado funcional del sistema musculoesquelético del atleta. Los autores evaluaron el estado funcional del sistema musculoesquelético de atletas que practican fútbol, balonmano y hockey sobre césped, utilizando goniometría y estabilometría, así como pruebas de habilidades físicas asociadas con la flexibilidad de las articulaciones (inclinación hacia adelante desde una posición de pie (en el banco), puente, splits transversales y longitudinales (el mejor de 2 posibles)). Las pruebas se realizaron durante el ciclo anual de entrenamiento, después del período competitivo, y al inicio y al final del período preparatorio. La evaluación del estado funcional del sistema musculoesquelético de los atletas al final del período competitivo mostró niveles de flexibilidad bajos y por debajo del promedio. La capacidad de soporte estático (estabilometría) y la movilidad articular (goniometría) fueron por debajo del promedio y niveles promedio. La disminución en la capacidad de soporte estático testificó violaciones del aparato vestibular y la sensibilidad propioceptiva, que tienen un impacto significativo en el equilibrio. Los bajos resultados de flexibilidad y movilidad articular indicaron la falta de elasticidad del aparato musculoesquelético, lo que señaló la presencia de sobreesfuerzo. Los cambios positivos diagnosticados en el estado del sistema musculoesquelético de los atletas al inicio y al final del período preparatorio, independientemente del deporte de equipo, indicaron una restauración parcial del estado funcional del sistema musculoesquelético durante el período de transición. Según los resultados del estudio, se dieron recomendaciones para incluir en el proceso de entrenamiento, junto con el preestiramiento, ejercicios correctivos y preventivos basados en el uso de la técnica de relajación miofascial, que contribuyen a la restauración del estado funcional del sistema musculoesquelético de los atletas de deportes de equipo.

Palabras clave: futbolistas, jugadores de balonmano, jugadores de hockey, estado funcional, sistema musculoesquelético, flexibilidad, estabilometría, goniometría.

Fecha recepción: 26-04-23. Fecha de aceptación: 06-02-24

Dmitrii Babaskin
babaskind@yandex.ru

Introduction

Team sports games in the system of Olympic and professional sports are particularly popular. The analysis of high-level competitions indicates that team sports games are turning into a powerful industry that gathers tens of thousands of fans at stadiums and multi-million viewers (Shakirov and Zhuiko 2021), which, in turn, significantly increases competition in sports and the entertainment quality of competitions (Glebova and Desboard, 2020; Gostian Ropotin et al. 2022). In recent years, there has been a tendency to increase the popularity of sports games and, to a

greater extent, team game sports (Fomicheva et al., 2021; Rao et al., 2023). Such popularity of team sports games requires updating knowledge in the theory and methodology of training athletes and doing modern research, considering the trends inherent in sports of the 21st century and sports games in particular (Banciu, Popirlan, & Cosma, 2021; Saenz Lopez et al. 2023).

The reflection of modern trends in the system of athletes' training in team sports games has been the object of research of the last decade, where the researchers scientifically substantiated the solution to such problems as the management of athletes' training (Fedotova 2007;

Shamardin 2006; Tyulenkov 2007); evaluation, modeling, and forecasting of team results (Golubev, Shchedrina 2020; Ballesteros, Peñas 2010); sports selection and orientation (Popovich et al. 2020; Jordanskaya 2008); structure and content of the training process at various stages of long-term training (Fedotova 2001; Aleshin, Rybakov 2007; Ignatieva et al. 2005); management of technical and tactical activities (Zheleznyak et al. 2004; Fedotova 2004); the use of information technologies in the preparation of athletes playing game sports (Tryapichnikov 2020; Rusmanto et al. 2023), etc.

Scientific research and competitive practice show that the greatest success is achieved by teams that, firstly, have a modern material and technical base and financial support, secondly, which include high-class athletes, and thirdly, carry out their activities based on scientifically sound management of training and competitive processes (Vovk 2007).

The main tendency of modern sports is to increase the intensity of training and competitive activity of athletes (Popovich et al. 2016; Vila Suarez et al. 2023). Therefore, against the background of an increase in the volume of training work, an operational assessment of the functional state of the main physiological systems supporting the body's performance (musculoskeletal (Shahzad, Zulfiqar, & Ali, 2022; Guillen Pereira et al. 2023), cardio-respiratory (Pla Pla et al. 2022), etc.), becomes important (Morozova, 2014). Accordingly, research aimed at finding and developing new highly informative methods for assessing the functional state of athletes and introducing team sports into practice is of particular importance (Vilar et al. 2013).

Human health presupposes a sufficiently high level of physical fitness, physical development, and working capacity (Colangelo et al., 2023), which causes the problem of finding physical activities adequate to the physical condition of the individual (Navarro & Safar, 2020). This problem, first of all, is faced by coaches, whose goal, on the one hand, is to contribute to the achievement of high athletic results for their students, and on the other hand, to preserve and improve the functional state of the athletes' body without mobilizing their reserve capabilities (Witvrouw et al. 2003).

From many studies that relate to the modern problems of functional training of athletes, it is known that elite sport is characterized by a sharp increase in the volume and intensity of training loads, the high psycho-emotional intensity of training, and competitive processes (Stukova et al., 2023; Schumann, Wojciechowski and Bunn, 2023). These circumstances lead to increased demands on the functional state of athletes, a potential decrease in functional abilities, performance, an increase in fatigue, and sometimes to maladaptation and overwork (Sassi and Tibaudi, 2007).

The creation of effective means and methods for restoring the health of athletes after loads in the training and competitive periods, often reaching a critical value, is a significant task for modern sports training (Chan et al., 2012).

In this connection, the development of an optimal

system for restoring the entire body of an athlete in a complex, aimed at increasing the level of its functional state, helps to maintain working capacity at a high level and prevents the negative consequences of overwork and overstrain (Komarov et al. 2013).

At the same time, studies have noted an increase in micro-traumatism in team sports due to chronic overwork and overstrain of the musculoskeletal system (hereinafter called MSS) (Jerez Mayorga & Villaquiran Hurtado, 2023), especially in game sports (Stojanovic and Ostojic, 2011).

Constant physical overload and the associated overstrain of the MSS lead to an increase in the likelihood of injury to the athlete and subsequent diseases of the MSS, which own a significant proportion of the pathological conditions of athletes, which makes it impossible for them to complete training and participate in competitions for a long period (Jordanskaya and Yuditseva, 2006).

Thus, directly dependent on the functional state of the MSS, the flexibility of athletes with overstrain tends to significantly decrease, which leads to the development under conditions of overstrain can significantly decrease, which is why this phenomenon leads to the development of muscle imbalance (Korzun, 2012).

Henceforth, the development of efficient means and methodologies aimed at restoring athletes' health during both training and competitive periods, along with the optimal restoration system of the entire body, constitute pressing tasks in contemporary sports training.

Regarding team sports, regular monitoring of the musculoskeletal functional state, coupled with timely overstrain prevention, presents an opportunity to adjust the training process of individual athletes and the team as a whole. Consequently, it may aid in averting injuries to athletes while promoting individual and team success.

Against this backdrop, this study aims to determine the dynamics of the musculoskeletal functional state of athletes partaking in team sports within the annual training cycle.

Methods

Study design

The study was conducted among athletes playing football, handball, and field hockey in integrated sports schools in the Moscow region, Russia.

During the annual training cycle, three tests were supposed to be conducted: after the competition period (September 2021) and at the beginning and end of the preparatory period (February and May 2022, respectively).

Study sample

The study involved 122 athletes aged 16-17 years, of which: the first group (46 people) were male teenagers who had been playing football for a long time; the second group (39 people) were male teenagers who had been playing handball for a long time and the third group (37 people) were male teenagers who had been playing field hockey for a long time.

Materials and methods

We used the following methods: the study and analysis of scientific and methodological literature, pedagogical observations, assessment of the functional state, and statistical processing of study results. We studied (with subsequent analysis) scientific and methodological literature on changes in the functional state of athletes at various stages of the annual training cycle.

The evaluation of the musculoskeletal system's functional state was conducted using goniometry, stabilometry, and physical ability tests, which included assessments of joint flexibility.

In the current study, motor tests (Jordanskaya, Yudinseva 2006; Korzun 2012) were used to assess the mobility of the joints of the lower extremities and spine. Several simple tests were selected, such as leaning forward from a standing position (on a bench), gymnastic bridge, cross split, and forward/backward splits (the best of 2 possible).

Stabilometric indicators, such as the total length of the stabilometry path (L, mm) and the area of the statokinesiogram (S, mm²) with eyes open, were evaluated. The development level of these parameters was determined based on the arithmetic mean value of the group. For each of the considered parameters, the level of its development was determined according to the average group value with the determination of the arithmetic mean and deviation from the arithmetic mean ($M \pm \sigma$).

Table 1.

Indicators of flexibility and stabilometry tests performed on athletes at the end of the competition period of the annual macrocycle ($M \pm \sigma$)

Indicators under study	Football players		Handball players		Hockey players	
Forward tilt from a standing position, cm	5.92±2.05	a	5.76±1.88	a	5.22±2.13	a
Gymnastic bridge from the initial position lying on the ground, cm	69.34±3.41	b/a	67.53±4.07	b/a	71.32±3.12	b/a
Cross split, cm	59.41±1.13	b/a	61.36±1.25	b/a	57.74±0.98	b/a
Backward/forward split on the left (right) leg, cm	45.52±1.53	b/a	44.69±1.26	b/a	46.32±1.65	b/a
Statokinesiogram length (L), mm	531.32±12.81	b/a	523.34±13.41	b/a	526.72±11.889	b/a
Statokinesiogram area (S), mm ²	206.27±42.82	b/a	209.32±41.75	b/a	205.24±44.51	b/a

Notes: a: average; b/a: below average; a/a: above average

Stabilometric measurements conducted at the end of the competitive period revealed that nearly half of the athletes diagnosed with team sports had a static support ability below the average level. Additionally, approximately 60% of the athletes demonstrated insufficient vertical posture stability, indicating a decline in balance ability. Furthermore, a significant number of subjects demonstrated low displacement of the common center of mass's rear projection in the frontal (22%) and sagittal (46%) planes. Notably, 64% of the subjects exhibited statokinesiogram areas corresponding to average and below-average levels, with less than 36% having lengths corresponding to average levels. Analysis of the goniometry data of the joints of the lower extremities of the subjects revealed that the indicators of joint mobility in athletes were also within the average and below average levels (Table 2). The planned measurement of the functional state of the MSS carried out at the beginning of the preparatory period (February 2022), allowed us to establish the presence of positive changes in the examined athletes, regardless of their

During the measurement, the ST-150 stabilometric platform with a laptop was used. The platform itself is directly connected to the USB port of the computer, from which it is also powered.

Goniometry was used to measure the mobility (flexion, extension, abduction) of the hip, knee, and ankle joints in angular values (degrees).

An iGaging electronic goniometer was used for the measurement. Three measurements of the same movement were carried out, and the maximum indicators were recorded.

Processing of results

Mathematical processing of the results of the study was carried out using the SPSS Statistics software, and it allowed us to determine the arithmetic mean values of independent distributions (M) and the standard deviation from the arithmetic mean of the attribute (σ).

Results and Discussion

The initial assessment of the musculoskeletal system's functional state was conducted as scheduled at the conclusion of the competitive period (September 2021). The findings revealed that most of the flexibility indicators were below the average level, with only the "Forward bend from a standing position" test yielding an average performance level (Table 1).

engagement in a certain type of sport (see Table 3

Table 2.

Results of goniometry in athletes at the end of the competition period of the annual macrocycle, ($M \pm \sigma$, degrees)

	Joint	Flexion	Extension	Abduction				
Football players	Hip	R	116.05±2.44	a	-	-	43.43±1.16	a
		L	115.65±2.11	a	-	-	42.66±0.82	b/a
	Knee	R	125.77±1.88	a	-	-	-	-
		L	126.94±1.31	a	-	-	-	-
	Ankle	R	33.48±1.82	b/a	7.15±0.83	a	-	-
		L	34.76±1.60	b/a	8.25±0.86	a	-	-
Handball players	Hip	R	112.15±2.35	a	-	-	44.55±1.19	a
		L	115.23±2.21	a	-	-	43.34±0.72	b/a
	Knee	R	126.75±1.87	a	-	-	-	-
		L	127.80±1.27	a	-	-	-	-
	Ankle	R	33.53±1.73	b/a	7.14±0.74	a	-	-
		L	34.66±1.72	b/a	8.29±0.94	a	-	-
Hockey players	Hip	R	109.35±1.98	a	-	-	44.43±1.17	a
		L	108.53±1.87	a	-	-	43.68±0.92	b/a
	Knee	R	120.53±1.66	a	-	-	-	-
		L	122.67±1.37	a	-	-	-	-
	Ankle	R	32.43±1.63	b/a	7.02±0.74	a	-	-
		L	33.86±1.69	b/a	8.18±0.82	a	-	-

Notes: r: right joint; l: left joint; a: average; b/a: below average; a/a: above average; the lack of data on several indicators is explained by the impossibility of obtaining them from the initial position when measuring due to the physiological features of the structure of the joints of the lower extremities of the human body

Table 3.

Indicators of flexibility and stabilometry tests performed on athletes at the beginning of the preparatory period of the annual macrocycle ($M \pm \sigma$)

Indicators under study	Football players		Handball players		Hockey players	
Forward tilt from a standing position, cm	8.31±1.88*	a/a	8.76±1.69*	a/a	9.22±2.04*	a/a
Gymnastic bridge from the initial position lying on the ground, cm	55.35±3.21*	a	57.43±3.87*	a	59.22±3.06*	a
Cross split, cm	38.22±1.09*	a/a	33.54±1.15*	a/a	41.24±0.97*	a
Backward/forward split on the left (right) leg, cm	35.32±1.23*	a	36.45±1.46*	a	35.35±1.72*	a
Statokinesiogram length (L), mm	435.45±10.21*	a	426.56±12.32*	a	413.57±10.77*	a
Statokinesiogram area (S), mm ²	136.44±1.76*	a	129.23±40.55*	a	135.42±41.16*	a

Notes: a: average; b/a: below average; a/a: above average; *: the probability of statistical differences with the previous stage, $p < 0.05$

According to the results of stabilometry conducted at the beginning of the preparatory period of the annual macrocycle, more than 85% of the studied football players, handball players, and hockey players had an above-average level in terms of static supportability.

Besides, for indicators of stability of the vertical posture, more than 75% had an above-average level, which indicates an improvement in the balance function.

Displacement of the common center of mass's rear projection in the frontal and sagittal planes was higher than the typical indicators for the average level in over 70% of the examined athletes. Furthermore, the area of the statokinesiogram corresponded to average and above-average levels in over 90% of the subjects, with the average length of the statokinesiogram noted to be above average in more than 66% of the players. A comparative analysis of flexibility and stabilometry test results at the end of the competition period and the beginning of the preparatory period indicated significant differences in all indicators (Table 3). The analysis of goniometry results revealed that the indices of lower extremity joint mobility in athletes were also within average and above-average levels (Table 4). Athletes at the end of the competition and the beginning of the preparatory period of the annual macrocycle showed significant differences in all indicators (Table 4). The last (third) routine testing in the annual training cycle of team sports

athletes was conducted at the end of the preparatory period (May 2022) and allowed to establish the presence of both positive and negative minor changes in the examined athletes (Table 5)

Table 4.

Indicators of goniometry in athletes at the beginning of the preparatory period of the annual macrocycle ($M \pm \sigma$, deg.)

	Joint	Flexion	Extension	Abduction				
Football players	Hip	R	125.23±2.33*	a/a	-	-	51.22±1.09*	a/a
		L	123.88±1.97*	a/a	-	-	52.46±0.75*	a/a
	Knee	R	141.66±1.57*	a/a	-	-	-	-
		L	139.48±1.24*	a/a	-	-	-	-
	Ankle	R	41.55±1.62*	a	10.15±0.83*	a	-	-
		L	39.87±1.49*	a	11.25±0.86*	a	-	-
Handball players	Hip	R	127.84±1.86*	a/a	-	-	52.31±1.19*	a/a
		L	125.52±1.81*	a/a	-	-	51.34±0.62*	a/a
	Knee	R	140.57±1.48*	a/a	-	-	-	-
		L	138.95±1.14*	a/a	-	-	-	-
	Ankle	R	40.26±1.75*	a	11.51±0.73*	a	-	-
		L	40.33±1.69*	a	12.43±0.82*	a	-	-
Hockey players	Hip	R	122.54±1.76*	a/a	-	-	50.88±0.79*	a/a
		L	123.72±1.41*	a/a	-	-	51.13±0.68*	a/a
	Knee	R	141.21±1.19*	a/a	-	-	-	-
		L	139.46±1.62*	a/a	-	-	-	-
	Ankle	R	42.11±2.03*	a	10.39±0.59*	a	-	-
		L	39.67±1.95*	a	10.64±0.67*	a	-	-

Notes: r: right joint; l: left joint; a: average; b/a: below average; a/a: above average; *: the probability of statistical differences with the previous stage, $p < 0.05$; the lack of data on several indicators is explained by the impossibility of obtaining them from the initial position when measured due to the physiological features of the structure of the joints of the lower extremities of the human body

Table 5.

Indicators of flexibility and stabilometry tests of athletes at the end of the preparatory period of the annual macrocycle ($M \pm \sigma$)

Indicators under study	Football players		Handball players		Hockey players	
Forward tilt from a standing position, cm	8.72±1.92	a/a	8.88±1.46	a/a	9.87±2.14	a/a
Gymnastic bridge from the initial position lying on the ground, cm	54.35±3.45	a	58.77±3.21	a	61.56±3.13	a
Cross split, cm	39.25±1.19	a/a	33.54±1.15	a/a	41.24±0.97	a
Backward/forward split on the left (right) leg, cm	34.22±1.13	a	35.48±1.56	a	34.53±1.27	a
Statokinesiogram length (L), mm	440.76±9.12	a	436.56±11.38	a	415.34±9.87	a
Statokinesiogram area (S), mm ²	139.51±39.67	a	126.44±41.77	a	136.53±40.72	a

Notes: Notes: a: average; b/a: below average; a/a: above average

Statistical analysis did not show significant differences in the performance of flexibility tests and stabilometry of athletes at the beginning and the end of the preparatory period of the annual macrocycle. Analysis of the goniometry data of the joints of the lower extremities of the subjects demonstrated that the indicators of joint mobility in athletes were still within the average and above average levels (Table 6). Statistical analysis showed no significant differences in the goniometry of athletes at the beginning and the end of the preparatory period of the annual macrocycle.

The low scores in stabilometry, goniometry, and flexibility tests of team sports athletes at the end of the competitive period may be attributed to natural fatigue and associated reductions in both physical and functional readiness. Our opinion is supported by findings from previous studies

on the subject (Sassi et al., 2013). The improvement of the test results for the indicators of joint flexibility, stabilometry, and goniometry at the beginning and the end of the preparatory period of the annual macrocycle is because the functional state of the MSS was restored during the transition period of the annual macrocycle. However, some researchers believe that to restore joint flexibility indicators, it is mandatory to use specially developed recovery techniques (Maestroni et al., 2020).

The generalization of the obtained results and their comparison with the data of previous studies necessitated the search for a solution to the problem of the development of joint flexibility for athletes engaged in team sports and the restoration of the state of their MSS. Thus, according to some researchers, this can be facilitated by the use of

innovative techniques of myofascial relaxation (Witvrouw et al., 2003), firstly, as a means of muscle stretching and secondly, for recovery after high physical exertion to prevent injuries of the MSS, due to insufficient elasticity of the myofascial structures of the athletes' body.

It is worth noting that an appropriate selection of sports rehabilitation methods following significant physical exertion may elevate the musculoskeletal system's functional state indicators to higher levels and maintain them for prolonged durations during the subsequent competitive period (Vilar et al., 2013), and thus to contribute to a high final result of the athletes' work at competitions. Some researchers suggest that the use of yoga exercises in the educational and training process of athletes playing game sports also has a positive effect on the functional state of the MSS and thereby contributes to the correction and prevention of chronic overstrain and injuries (Abaïdia and Dupont, 2018; Schumann, Wojciechowski and Bunn, 2023). With a decrease in the range of motion in individual joints in the pelvis and lower extremities in athletes playing game sports, researchers suggest the use of both static and dynamic stretching, the use of which showed a significant increase in hip flexion indicators (Mahrová et al., 2014). The program with static stretching alone showed a significant improvement in ankle flexion indicators (Thompson and Rogerson, 2020). Thus, a stretching program can lead to an increase in the range of motion in some joints after a special program.

Table 6.
Results of goniometry tests in athletes at the end of the preparatory period of the annual macrocycle ($M \pm \sigma$, degrees)

	Joint		Flexion	Extension	Abduction		
Football players	Hip	R	126.23±2.33	a/a	-	62.22±1.09	a/a
		L	124.99±1.94	a/a	-	61.46±0.46	a/a
	Knee	R	142.66±1.64	a/a	-	-	-
		L	140.49±1.24	a/a	-	-	-
Ankle	R	42.66±1.62	a	11.16±0.93	a	-	-
	L	40.94±1.49	a	10.26±0.96	a	-	-
Handball players	Hip	R	125.94±1.96	a/a	-	62.31±1.19	a/a
		L	126.62±1.91	a/a	-	61.34±0.62	a/a
	Knee	R	141.64±1.49	a/a	-	-	-
		L	141.96±1.14	a/a	-	-	-
Ankle	R	41.26±1.46	a	10.61±0.43	a	-	-
	L	42.33±1.69	a	11.43±0.92	a	-	-
Hockey players	Hip	R	121.64±1.46	a/a	-	61.99±0.49	a/a
		L	123.42±1.41	a/a	-	60.13±0.69	a/a
	Knee	R	142.21±1.19	a/a	-	-	-
		L	140.46±1.62	a/a	-	-	-
Ankle	R	41.11±2.03	a	11.39±0.69	a	-	-
	L	40.64±1.96	a	11.64±0.64	a	-	-

Notes: r: right joint; l: left joint; a: average; b/a: below average; a/a: above average; the lack of data on several indicators is explained by the impossibility of obtaining them from the initial position when measuring due to the physiological features of the structure of the joints of the lower extremities of the human body

Conclusion

The low level of the musculoskeletal system's functional state of athletes at the end of the competitive period, as indicated by the results of stabilometry, goniometry, and joint flexibility tests, implies poor ligamentous apparatus elasticity. This is one of the signs of chronic musculoskeletal system overstrain, which could lead to decreased work capacity. Insufficient recovery and increased physical and mental overload may increase the likelihood of injuries and

subsequent illnesses.

After the competition period, there was a decrease in the stabilometric indicators in general and, in particular, the values of indicators characterizing the stability of the vertical posture. This fact may indicate individual disorders of the MSS, instability of the joints of the lower extremities, or the presence of vestibular and proprioceptive disorders.

The measurement of the functional state of the MSS carried out at the beginning and at the end of the preparatory period made it possible to establish the presence of positive changes in the examined athletes, regardless of their doing a certain type of sport. This fact may indicate a partial restoration of the functional state of the MSS during the transition period of the annual macrocycle.

In addition to the usual preliminary stretching (pre-stretching), the athletes were recommended to include corrective and preventive exercises using the technique of myofascial relaxation (MFR) in the training process, which will contribute to the normalization of the functional state of the MSS and reduce the risk of injury.

The limitations of the study include the lack of variability of the studied sample of athletes by age and the lack of consideration of age-related features of the dynamics of the functional state of the MSS of athletes playing team sports in the annual training cycle.

The prospect of further studies may be the search for a solution to the problem of the development of joint flexibility of athletes in team sports and the restoration of their MSS through the development of individual components of personal programs and a group (team) model of rehabilitation measures.

References

- Abaïdia A.-E., Dupont G. (2018). Recovery strategies for football players. *Swiss Sports & Exercise Medicine*, 66(4), 28–36.
- Aleshin, I. N., & Rybakov, V. V. (2007). Modelirovanie godichnoi podgotovki v komandnykh igrovyykh vidakh sporta [Modeling of one-year training in team game sports]. *Teoriya i praktika fiz. kultury*, 10, 43–45.
- Ballesteros, J., & Peñas, C. (2010). Performance in Team Sports: Identifying the Keys to Success in Soccer. *Journal of Human Kinetics*, 25, 85-91.
- Banciu, A., Popirlan, C., & Cosma, G. (2021). Managing ITF Juniors Tennis Tournaments in the Context of Tourism. *Journal Of Environmental Management And Tourism*, 12(6), 1687-1693. doi:10.14505//jemt.v12.6(54).24
- Bonkalo, T.I., Shmeleva, S.V., Kovalchuk, D.F., Aralova, E.V., Romanova, A.V., & Tsygankova, M.N. (2023). Semantic Regulation of mental states of the individuals during the SARS-COV-2 Pandemic. *Research Journal of Pharmacy and Technology*, 16(1), 55-61. doi: 10.52711/0974-360X.2023.00010.
- Bustos-Viviescas, B. J., Acevedo-Mindiola, A. A., & García Yerena, C. E. (2022). Reflexión crítica sobre los

- términos “aeróbico y anaeróbico” utilizados en fisiología del ejercicio. *Gaceta Médica De Caracas*, 130(1), 182–188.
- Chan, K., Mahomoodally, F. M., & Veeren, R. (2012). Open Stretching in the prevention of hamstring strains: Attitudes, beliefs, and current practices among football coaches in Mauritius. *Open Journal of Preventive Medicine*, 2(2), 141-148.
- Colangelo J, Smith A, Buadze A, Keay N, Liebreuz M. (2023). Mental Health Disorders in Ultra Endurance Athletes per ICD-11 Classifications: A Review of an Overlooked Community in Sports Psychiatry. *Sports*, 11(3):52. <https://doi.org/10.3390/sports11030052>
- Fedotova, E. V. (2001). Osnovy upravleniya mnogoletnei podgotovkoi yunykh sportsmenov v komandnykh igrovnykh vidakh sporta [Fundamentals of management of long-term training of young athletes in team sports]. Moscow: Kompaniya Sputnik.
- Fedotova, E. V. (2004). Osnovy taktiki igry i takticheskoi podgotovki v khokkee na trave [Fundamentals of game tactics and tactical training in field hockey]. Moscow: Sportivnaya kniga.
- Fedotova, E. V. (2007). Sorevnovatel'naya deyatelnost i podgotovka sportsmenov vysokoi kvalifikatsii v khokkee na trave [Competitive activity and training of highly qualified athletes in field hockey]. Kazan: Logos Tsentr.
- Fomicheva, T. V., Dolgorukova, I. V., Sulyagina, J. O., Kryukova, E. M., Filimonova, N. N., & Zhukova, V. I. (2021). Changing national health values of Russian youth aged 13-17: Motivation for engagement in physical culture and sports in regions. *International Journal of Health Sciences*, 5(3), 542–549. <https://doi.org/10.53730/ijhs.v5n3.2322>
- Glebova, E., & Desbord, M. (2020). Tekhnologicheskie transformatsii potrebitelskogo opyta zritelei sportivnykh meropriyatiy [Technological transformations of consumer experience in spectators of sports events]. In E. A. Timme & S. G. Rudnev (Eds.), *Materialy IV Vserossiiskoi nauchno-prakticheskoi konferentsii "Den sportivnoi informatiki" 4-5 dekabrya 2020 goda* [Materials of the 4th All-Russian research and practice conference "Sports informatics day". December 4-5, 2020] (pp. 20-27). Moscow.
- Golubev, D. V., & Shchedrina, Yu. A. (2020). Integralnyi monitoring rezultatov sorevnovatel'noi deyatelnosti futbolistov [Integral monitoring of the results of competitive activity in football players]. In E. A. Timme & S. G. Rudnev (Eds.), *Materialy IV Vserossiiskoi nauchno-prakticheskoi konferentsii "Den sportivnoi informatiki" 4-5 dekabrya 2020 goda* [Materials of the 4th All-Russian research and practice conference "Sports informatics day". December 4-5, 2020] (pp. 48-56). Moscow.
- Gostian Ropotin, L. A., Ruano Arriagada, K., & Asensio Castañeda, E. (2022). Taller de role-playing para la Generación Z: un camino hacia la simulación creativa en Expresión Corporal (Role-playing workshop for Generation Z: a pathway through the creative simulation in Body Expression). *Retos*, 45, 1144–1153. <https://doi.org/10.47197/retos.v45i0.91469>
- Guillen Pereira, L., Managón Pesantez, R. M., Rendón Morales, P. A., & Beltrán Vásquez, M. A. (2023). Ejercicios pliométricos para desarrollar la potencia muscular de los miembros inferiores del nadador en la técnica de salida (Plyometric exercises to develop the muscular power of the swimmer's lower limbs in the start technique). *Retos*, 50, 57–69. <https://doi.org/10.47197/retos.v50.99258>
- Ignateva, V. Ya., Tkhorov, V. M., & Petracheva, I. V. (2005). Podgotovka gandbolistov na etape vysshego sportivnogo masterstva [Training of handball players at the stage of advanced sportsmanship]. Moscow: Fizicheskaya kultura.
- Iordanskaya, F. A. (2008). Monitoring funktsionalnoi podgotovlennosti vysokokvalifitsirovannykh sportsmenov pri podgotovke k Olimpiiskim igram sovremennosti [Monitoring of the functional readiness of highly qualified athletes in preparation for the modern Olympic Games]. *Vestnik sportivnoi nauki*, 4, 70–79.
- Iordanskaya, F. A., & Yudinseva, M. S. (2006). Monitoring zdorovya i funktsionalnaya podgotovlennost vysokokvalifitsirovannykh sportsmenov v protsesse uchebno-trenirovochnoi raboty i sorevnovatel'noi deyatelnosti: Monografiya [Health monitoring and functional readiness of highly qualified athletes in the process of educational and training work and competitive activity: A monograph]. Moscow: Sovetskii sport.
- Jerez Mayorga, D. A., & Villaquiran Hurtado, A. F. (2023). Efectos del entrenamiento de fuerza en lesiones de tobillo en futbolistas: una revisión sistemática (Effects of strength training on ankle injuries in soccer players: a systematic review). *Retos*, 49, 657–665. <https://doi.org/10.47197/retos.v49.95794>
- Komarov, A. P., Shamardin, A. A., & Seredintseva, N. V. (2013). Optimizatsiya vosstanovleniya posle fizicheskikh nagruzok u futbolistov [Optimization of recovery after physical activity in football players]. *Fundamentalnye issledovaniya*, 11(2), 320-324.
- Korzun, D. L. (2012). Metody kontrolya funktsionalnoi podgotovlennosti futbolistov [Methods for controlling the functional readiness of football players]. Minsk: BGU.
- Maestroni L., Read P., Bishop C., et al. (2020). Strength and power training in rehabilitation: underpinning principles and practical strategies to return athletes to high performance. *Sports Medicine*, 50(2): 239–252.
- Mahrová, A., Hráský, P., Zahálka, F., & Požárek, P. (2014). The effect of two types of stretching on flexibility in selected joints in youth soccer players. *Acta Gymnica*, 44(1), 23–32. <https://doi.org/10.5507/ag.2014.003>
- Morozova, E. V. (2014). Otsenka funktsionalnogo sostoyaniya oporno-dvigatel'nogo apparata futbolistov 16-17 let [Assessment of the functional state of the

- musculoskeletal system of football players aged 16-17]. *Pedagogiko-psikhologicheskie i mediko-biologicheskie problemy fizicheskoi kultury i sporta. Rossiiskii elektronnyi nauchnyi zhurnal*, 2(31), 121-127.
- Navarro, D. P., & Safar, M. L. (2020). Felix Pifano: la historia viviente de medicina tropical. *Gaceta Médica De Caracas*, 111(2), 171-172.
- Pla Pla, P., Ballesté Escorihuela, M., & Solé Llussà, A. (2022). ¿Cómo influyen las horas de actividad física semanal en la capacidad cardiorrespiratoria?: una indagación científica guiada a través del vídeo en educación primaria (How do the hours of weekly physical activity influence on cardiorespiratory fitness?: a: El vídeo como soporte del proceso de indagación en las aulas de educación física. *Retos*, 45, 113-123. <https://doi.org/10.47197/retos.v45i0.90667>
- Popovich, A. P., Kolomiichuk, T. A., & Gordievskaya, V. I. (2020). Gandbol: unikalnye metodiki garmonichnogo vospitaniya molodezhi [Handball: unique methods of harmonious education of youth]. Ekaterinburg: Izdatelstvo Uralskogo universiteta.
- Popovich, A. P., Mekhovich, G. I., Kolomiichuk, T. A., Kunysheva, S. D., & Goncharova, E. A. (2016). Metodika podgotovki gandbolistov na osnove ikh anatomo-fiziologicheskikh i individualnykh osobennostei [Methodology for the preparation of handball players based on their anatomical, physiological and individual characteristics]. Ekaterinburg: Izdatelstvo Uralskogo universiteta.
- Rao, U. S. M., Zin, T., Suganya, M., Pandian, S., Sangara, S. N. S., Mogan, S. M., Rajah, S. S., & Khan, M. B. M. A. (2023). Effects of Physical Activity on Body Mass Index among Medical Students from East Coast Peninsular Malaysian Public University. *Research Journal of Pharmacy and Technology*, 16(1), 200-204. <https://doi.org/10.52711/0974-360X.2023.00037>
- Rusmanto, R., Tomoliyus, T., Sulastion, A. ., Gazali, N. ., Abdullah, K. H. ., Gil-Espinosa, F. J. ., & Setiawan, E. . (2023). Realidad virtual para promover el compromiso deportivo y las habilidades técnicas en atletas de fútbol: un ensayo controlado aleatorio de 12 semanas (Virtual Reality to Promoting Sports Engagement and Some Technical skills in Junior Football Athletes: A 12-Week Randomized Controlled Trial). *Retos*, 50, 1129-1133. <https://doi.org/10.47197/retos.v50.100319>
- Saenz Lopez, P., Moncada, J., & Cordero, R. (2023). Relación de la intensidad en los entrenamientos con el rendimiento deportivo, la condición física y variables emocionales (Relationship of intensity in sport training with sports performance, physical fitness and emotional variables). *Retos*, 47, 156-163. <https://doi.org/10.47197/retos.v47.94259>
- Sassi, R., & Tibaudi, A. (2007). Modulirovanie nagruzki pri podgotovke futbolistov: teoriya, praktika, polevye ispytaniya [Load modulation in the preparation of football players: theory, practice, field trials]. Moscow: Olimpiya; Chelovek.
- Schumann, C., Wojciechowski, M., Bunn, J.A. (2023). Comparing Two Methods of Acute: Chronic Workload Calculations in Girls' Youth Volleyball. *Sports*, 11(3):51. <https://doi.org/10.3390/sports11030051>
- Shahzad, M., Zulfiqar, T., & Ali, A. (2022). Radiographic evaluation of knee joint in patients with knee pain and its correlation with osteoarthritis and gender. *Adv. life sci.*, 9(3), 309-312.
- Shakirov, A. R., & Zhuiko, D. A. (2021). Razvitie komandnykh vidov sporta v Rossii [The development of team sports in Russia]. In Materialy XI Mezhdunarodnoi nauchno-prakticheskoi konferentsii (1 iyunya 2021 g., Krasnoyarsk) [Materials of the 11th international research and practice conference (June 1, 2021, Krasnoyarsk)] (pp. 323-325).
- Shamardin, A. I. (2006). Funktsionalnaya podgotovka futbolistov razlichnoi igrovoi spetsializatsii v raznye periody trenirovochnogo tsikla [Functional training of football players of various game specialization in different periods of the training cycle]. Saratov.
- Stojanovic, M. D., & Ostojic, S. M. (2011). Stretching and Injury Prevention in Football. *Current Perspectives, Research in Sports Medicine*, 19(2), 73-91.
- Stukova, E. A., Byankina, L.V., Manikovskaya, M.A., Galitsyn, S.V., & Byankin, V.V. (2023). Implementation of the principle of consciousness and activity in the process of training young sambo wrestlers as the embodiment of harmony between body and spirit. *Retos*, 47, 887-892. <https://doi.org/10.47197/retos.v47.93487>
- Thompson, S. W., & Rogerson, D. (2020). The effectiveness of two methods of prescribing load on maximal strength development: a systematic review. *Sports Medicine*, 50(5), 919-938.
- Tryapichnikov, E. V. (2020). Primenenie sovremennykh tsifrovyykh tekhnologii v obrazovatelnom i trenirovochnom protsessakh v uchilishchakh olimpiiskogo rezerva: zadachi, problemy i perspektivy [The use of modern digital technologies in the educational and training processes in the schools of the Olympic reserve: tasks, problems, and prospects]. In E. A. Timme & S. G. Rudnev (Eds.), Materialy IV Vserossiiskoi nauchno-prakticheskoi konferentsii "Den sportivnoi informatiki" 4-5 dekabrya 2020 goda [Materials of the 4th All-Russian research and practice conference "Sports informatics day". December 4-5, 2020] (pp. 153-155).
- Tyulenkov, S. Y. (2007). Teoretiko-metodicheskie podkhody k sisteme upravleniya podgotovkoi futbolistov vysokoi kvalifikatsii [Theoretical and methodological approaches to the management system for the training of highly qualified football players]. Moscow: Fizicheskaya kultura.
- Vila Suarez, H., Khortabi, A. ., Rezavandzayeric, F. ., & Cancela Carral, J. M. . (2023). Los efectos de un programa de entrenamiento de resistencia de alta intensidad y fuerza excéntrica en el rendimiento de jugadores de

balonmano (The effects of a high intensity resistance and eccentric strength training program on the performance of handball players). *Retos*, 50, 1333–13339. <https://doi.org/10.47197/retos.v50.98948>Vilar, L., et al. (2013). Science of winning soccer: Emergent pattern-forming dynamics in association football. *Journal of Systems Science and Complexity*, 26(1), 73–84.Vovk, S. I. (2007). *Dialektika sportivnoi trenirovki* [Dialectics of sports training]. Moscow: Fizicheskaya kultura.

Witvrouw, E., Danneels, L., Asselman, P., D'Have, T., & Cambier, D. (2003). Muscle flexibility as a risk factor for developing muscle injuries in male professional soccer players: a prospective study. *The American Journal of Sports Medicine*, 31, 41-46.

Zheleznyak, Yu. D., Portnov, Yu. M., Savin, V. P., & Leksakov, A. V. (2004). *Sportivnye igry: Tekhnika, taktika, metodika obucheniya* [Sports games: Technique, tactics, teaching methods] (2nd ed.). Moscow: Izdatelskii tsentr Akademiya.

Datos de los autores:

Dmitrii Babaskin	babaskind@yandex.ru	Autor/a
Farhod Masharipov	prof2597@gmail.com	Autor/a
Olga Savinkova	sfmsmu@mail.ru	Autor/a
Natalia Shustikova	nathalie.shustikova@gmail.com	Autor/a
Nina Volkova	petrovnvolkova@mail.ru	Autor/a
Anna Chakalova	l320@aspirans.info	Traductor/a