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Indicator of Symmetry of Functional  
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## The Equilibrium Function as an Indicator of Symmetry of Functional Status of Arm Wrestlers

### Abstract

The article is devoted to the study of asymmetry in physical development of arm wrestling athletes at the stage of sports perfection. It presents the results of a pedagogical experiment with the use of static motor-cognitive tests and stabilometry in the detection of asymmetry and proves the effectiveness of the developed system of physical training, based on the achieved improvements of the indicators of equilibrium function of arm wrestlers compared to the standard training system.

**Keywords:** arm wrestling, arm wrestling athletes, asymmetry of physical development, statokinetic stability, equilibrium, diagnostic of asymmetries using stabilometry.

The article substantiates the use of static motor-cognitive tests and stabilometry in the study of equilibrium function and in the assessment of symmetry of physical development of arm wrestlers at the stage of sports perfection.

The increasing popularity of arm wrestling in our country and around the world and the fact that this sport is not only a spectacular competitive discipline, but also a unique tool for the development of younger generation in the system of mass physical culture, dictates the necessity to find the ways to improve theoretical and practical training of athletes and coaches. In this regard, it is very im-

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portant to study the types of equilibrium, biomechanical parameters and indicators of its stability and vestibular, visual, and proprioceptive effects on the equilibrium related to arm wrestling.

A well-known opinion that motor skills and physical qualities in arm wrestling as in any other sport are manifested and developed in the process of motor activity became a *physiological basis* of biomedical research in the equilibrium function in arm wrestling athletes. This requires certain conditions and the use of appropriate physical exercises [1], [2]. According to a number of authors (M.P. Shestakov, 2007; O.V. Kubriak, S.S. Grokhovsky, 2012; V.S. Beliaev, 2015), it is important to consider the indicators of equilibrium function in the organization of training as the maintaining of equilibrium during the execution of movements is an active process and the degree of equilibrium may vary from stable to unstable. The physiological interpretation of instability is the fact that a relatively small supporting area of standing position and a high centre of gravity easily put athlete's body into a state of "unstable equilibrium". The slightest movement or change of body position in which the projection of the centre of gravity falls outside the supporting area leads to a loss of equilibrium. Accordingly, the preservation of this function requires continuous regulation and therefore training. So, in order to achieve highest results in arm wrestling an athlete should develop the ability to maintain his equilibrium. However, training plans often neglect the importance of this function. The study of several specific indicators of equilibrium function, such as the dynamics of height of general centre of mass (GCM); the distance from GCM projection to the edge of the support; the migration of general centre of pressure (GCP); the motor-cognitive test with biological feedback "Romberg test with European feet position" with the use of stabilometer ST-150, which allows to identify the level of statokinetic stability; an impact of visual/proprioceptive and vestibular analyzers and the indicators of frontal and sagittal asymmetries [3], [7] before and after training mesocycle can sufficiently characterize the degree of "unstable equilibrium" and hence the degree of asymmetry in arm wrestling athletes that will surely have certain practical importance.

It is known that the right arm, the right leg and the right side of the body are developed better in most people [5], [6], [10]. This difference could be minimal or very significant and it also affects the equilibrium function of arm wrestlers.

People with symmetrically developed muscles, i.e. those whose right arm has the same strength as the left one and whose right leg has the same strength as the left one, are extremely rare in arm wrestling. According to leading experts in the field most of the athletes in arm wrestling are right handed and unilateral training is an additional factor contributing to a pronounced asymmetry with disturbed equilibrium function and thus disharmony in the development of physical qualities. Tactical and technical preparedness of such athletes is often worse than that of their rivals. Therefore, it is very important for an arm wrestler to not only have equally strong arms, but also to be able to maintain equilibrium [13].

**Relevance of the study.** These disadvantages in technical preparedness in some cases are compensated with natural characteristics and abilities. However, if an athlete does not train his both arms at an early stage of his sports career, it can adversely affect his results in the future and it will be very difficult, and sometimes impossible, to catch up at a later age.

According to the experts (A.N. Lenz; 1964, N.N. Sorokin; 1960) the inability to carry out technical actions with both arms does not allow an athlete to carry out a duel with an opponent more rationally and achieve good results. These authors point to the need for teaching technical actions for both arms from an early age [7], [9].

The fact that the harmony and symmetry in the development of physical qualities, including equilibrium function, affect the ability to wrestle with both arms is well known and described in the literature on the subject [2], [7]. Based on the foregoing, we have set a goal – to determine the state of equilibrium function and assess the degree of asymmetry in athletes engaged in arm wrestling.

**Object of the study:** the process of formation of symmetry of the equilibrium function in surveyed athletes.

**Subject of the study:** the methods of correction of asymmetry using the developed integrated training system in arm wrestling.

**Hypothesis of the study:** we assume that our system of physical training will help arm wrestlers to correct the existing asymmetry of the equilibrium function and ultimately improve their results.

In order to achieve this goal we set the following tasks:

1. Performing an experimental study of the level of statokinetic stability and equilibrium function of the surveyed arm wrestlers using a static motor-cognitive test with biological feedback on support reaction according to the method of stabilometry, immediately prior to the scheduled training mesocycle.
2. Taking into account the obtained data, developing a system of physical training aimed at the formation of symmetry of equilibrium functional state and its further improvement.
3. Applying that system in the course of planned training mesocycle, studying the influence of the system on the indicators of symmetry in the assessment of equilibrium functional state and substantiating recommendations for its use in the specified sport.

## **Methods and organization of the study**

The research was conducted at the Department of Theory and Methodology of Applied Sports of the Pedagogical Institute of Physical Culture and Sports with the use of common pedagogical methods: analysis of scientific literature, pedagogical observation, pedagogical testing with the study of equilibrium func-

tion, pedagogical experiment, and mathematical and statistical processing of the obtained results according to the Student t-test.

The pedagogical experiment was conducted in “Yuzhnoe Butovo” culture and leisure centre in Moscow and involved 10 athletes aged 18 to 22 years. Classes were held 3 times a week (Monday, Wednesday and Friday).

It should be noted that arm wrestlers who took part in the experiment had been training throughout their sports careers according to the standard program, which included training of technical and tactical actions and general physical preparation. 62% of the exercises in the block of general physical preparation of that programme were supposed to be done alternately with right and left arms using free weights (kettlebells and dumbbells); 24% of the exercises – on simulators and the rest of them (no more than 14%) – with the barbell.

In further studies, the technical and tactical training of athletes remained the same, however we decided to change the physical training. The reason was that the barbell provides equal distribution of weight on both sides and in this way it contributes to the harmonization, i.e. the uniform development of physical qualities of athletes [3], [7]. This concept formed the basis for the development of an integrated system with the inclusion of a new technique of physical training of arm wrestlers, according to which it is physiologically advisable to give priority to barbell exercises and those simulators which allow to work with both arms simultaneously. For this purpose, we chose 76%–80% specially selected exercises which involve simultaneous work of the muscles of right and left arms, torso and entire the shoulder girdle.

The remaining 24% of the exercises within our system were focused on alternating work of arms using kettlebells and dumbbells. Such a significant increase of barbell exercises (80%) in the structure of training should, in our opinion, eliminate the existing asymmetry of the equilibrium function in arm wrestlers.

In order to confirm the specified theory we organized and conducted further pedagogical research. The experiment lasted for 2 months.

The efficiency of our integrated system during the experiment was assessed via *motor-cognitive test* with biological feedback “Romberg test with European feet position” with the use of the ST-150 stabilometer, which allowed to identify the level of equilibrium, the impact of visual/proprioceptive and vestibular analyzers on equilibrium function and the indicators of frontal and sagittal asymmetries.

## Results and discussion

Before the experiment, the equilibrium function (EF) of athletes, who trained according to the standard program, according to the Romberg test before and after the training, did not exceed the “satisfactory” mark. This re-

sult indicated a fairly pronounced asymmetry in the state of equilibrium function. After the experiment (and after the application of the newly developed training system for 2 months), as seen from the Table 1, according to general correlation of the investigated parameters, EF before the training increased by 63.8%, EF after the training – by 71.6%.

Another indicator – “an impact of visual analyzer on the equilibrium function” – obtained in the course of that test also showed positive dynamics. Before the experiment, the influence of visual analyzer, before and after the training, was reduced by 18.5% (negative growth that was considered by the developers as “high anomaly” of that indicator) [4], [11], after the experiment, this influence amounted to only 8.6%.

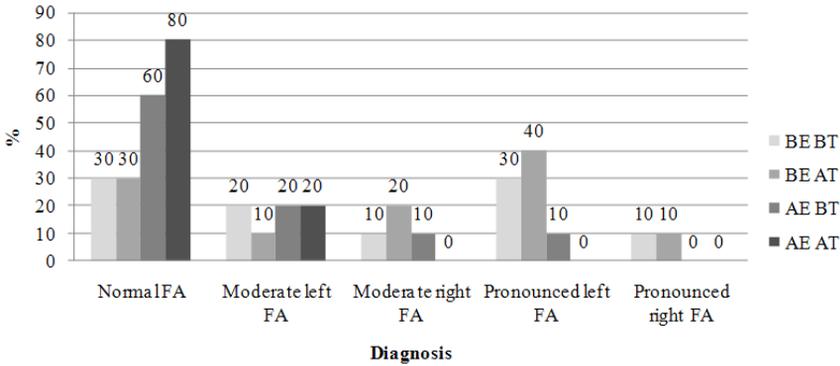
**Table 1.** Dynamics of indicators of the static motor-cognitive test “Romberg test with European feet position” of arm wrestlers in the process of the pedagogical experiment.

Indicators Measurements	The assessment of the equilibrium function			The assessment of the impact of visual analyzer on the equilibrium function		
	Before the training, (n-10)	After the training, (n-10)	Growth, %	Before the training, (n-10)	After the training, (n-10)	Growth, %
Before the experiment, $\bar{X} \pm \delta$	44,5±32,6	49,7±38,1	11,68	217,3±91,8	176,8±105,2	-18,5
After the experiment, $\bar{X} \pm \delta$	72,9±34,1	85,3±24,6	17,0	232,7±62,6	212,7±53,8	-8,6
Correlation, %	<b>63,8</b>	<b>71,6</b>		<b>7,0</b>	<b>20,3</b>	

Such an unprecedented improvement of equilibrium function according to static motor-cognitive test “Romberg test with European feet position” demonstrates the advantage of the new integrated system of physical training and is a direct confirmation that the selection of means and the calculation of training loads have sufficient impact on the normalization of the equilibrium function.

Similar improvement was recorded in the indicators of equilibrium function in the frontal and sagittal planes. As shown in Figure 2, before the experiment, the indicator “Normal frontal asymmetry” of 30% of the subjects did not change after the training. The remaining 70% of the subjects were distributed between the “Moderate left frontal asymmetry”, “Moderate right frontal asymmetry”, “Pronounced left frontal asymmetry” and “Pronounced right frontal asymmetry”. Thus, the program used before the experiment did not contribute to normalization of the existing frontal asymmetry.

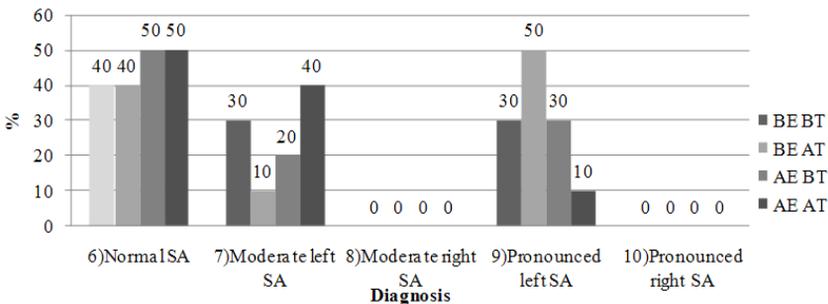
After the experiment, under the influence of our integrated system the indicator “Normal frontal asymmetry” did not change after the training in 80% of the subjects and none of the subjects was diagnosed with “Pronounced frontal asymmetry” (0%).



Note: FA – frontal asymmetry; BE BT – before experiment, before training; BE AT – before experiment, after training; AE BT – after experiment, before training; AE AT – after experiment, after training.

**Fig. 2.** Percentage of the “frontal asymmetry” in arm wrestlers in the process of the pedagogical experiment

In relation to the equilibrium function in the sagittal plane we revealed that the most significant dynamics of post-training indicators after the experiment (Figure 3) was recorded for the diagnosis “Pronounced left sagittal asymmetry”. As indicated by Figure 3, this parameter decreased by 40% (from 50% to 10%). Further analysis of the data concerning the dynamics of deviations in the parameter “Pronounced left sagittal asymmetry” showed that before the experiment this parameter increased after the training from 30% to 50%, reflecting the inadequacy of exercises used in the standard program. However, after the experiment, there was a decrease in that deviation from 30% to 10%. Thus, there is a reason to believe that the recorded positive trend for the parameter “Pronounced left sagittal asymmetry” reflected the fact that the introduction of the new integrated system into the process of training certainly contributed to the normalization of the existing sagittal asymmetry and that explained the increase in the number of subjects diagnosed with “Normal sagittal asymmetry” up to 50%.

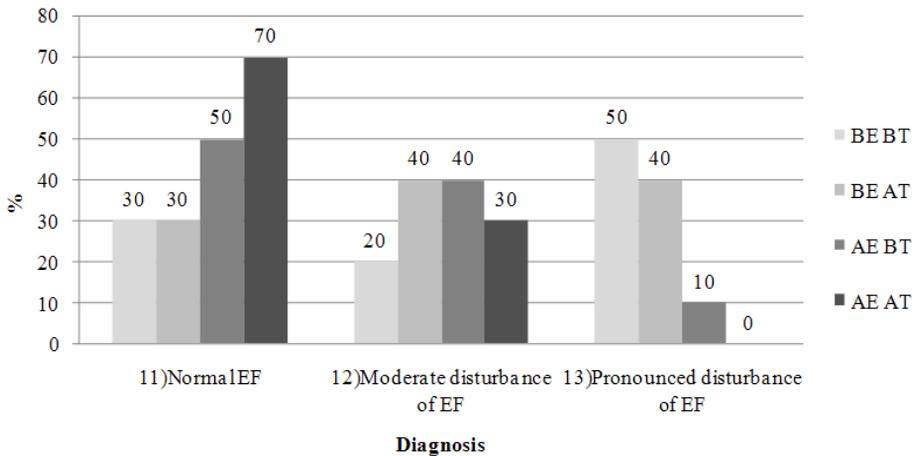


Note: SA – sagittal asymmetry; BE BT – before experiment, before training; BE AT – before experiment, after training; AE BT – after experiment, before training; AE AT – after experiment, after training.

**Fig. 3.** Percentage of the “sagittal asymmetry” in arm wrestlers in the process of the pedagogical experiment

Positive changes in the frontal and sagittal planes were reflected in the overall equilibrium function (EF). As shown in Figure 4, there were no dynamics of the index of “Normal EF” before (30%) and after the training (30%) before the experiment. The percentage of diagnoses “Moderate disturbance of the equilibrium function” before the experiment and after the training (BE, AT) doubled (from 20% to 40%), confirming the irrational selection of means in the standard program. The use of the new system, just the opposite, reduced the percentage of athletes with this diagnosis to 30%.

And if before the experiment there were 40% of diagnoses “Pronounced disturbance of the equilibrium function”, after the experiment (AE, AT) there were none. It is quite natural that against the background of such positive dynamics, the percentage of subjects with “Normal EF” increased from 30% to 70%.



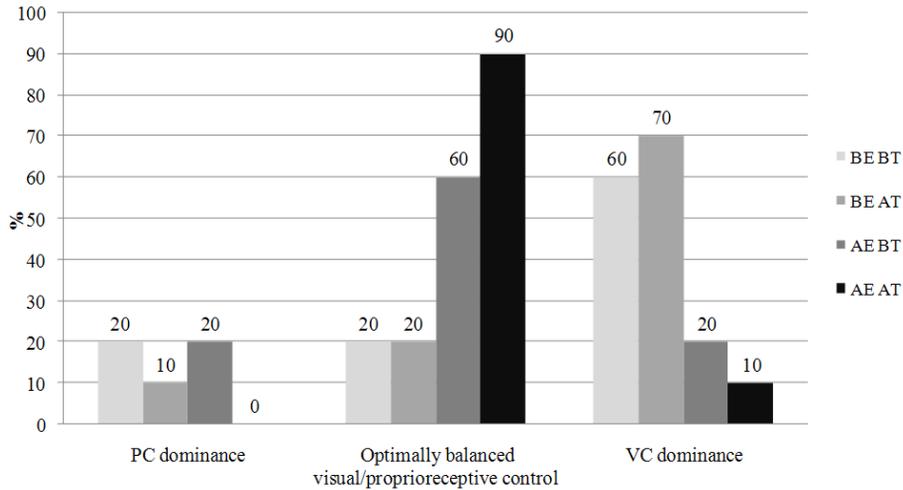
Note: EF – equilibrium function; BE BT – before experiment, before training; BE AT – before experiment, after training; AE BT – after experiment, before training; AE AT – after experiment, after training.

**Fig. 4.** Percentage of the “Moderate disturbance of the equilibrium function” and “Pronounced disturbance of the equilibrium function” in arm wrestlers in the process of the pedagogical experiment

In addition to the effect of visual analyzer on the equilibrium function in the mentioned static motor-cognitive test “Romberg test with European feet position” (Table 1), here are the results of the study of the influence of proprioceptive, visual/proprioceptive and visual control on that function.

As shown in Figure 5, before the experiment visual control dominated in the regulation of the equilibrium function (60% to 70% after the training) while the optimally balanced visual/proprioceptive control was only in 20% of the subjects before and after the training. After the experiment, the indicator of optimally balanced visual/proprioceptive control reached 90% (the dominance of proprioceptive control did not manifest at all, 0%), suggesting that our system

of physical training had a positive effect on the formation of stable equilibrium function and contributed to the correction of its asymmetry in athletes arm wrestlers.



Note: PC – proprioceptive control; VPC – visual/proprioceptive control; VC – visual control; BE BT – before experiment, before training; BE AT – before experiment, after training; AE BT – after experiment, before training; AE AT – after experiment, after training.

**Fig. 5.** Percentage of the effect of proprioceptive, visual and visual/proprioceptive control on the equilibrium function in arm wrestlers in the process of the pedagogical experiment

The results show that the proposed integrated system corresponds to the nature of the qualities an arm wrestler should possess. Previously used standard training program, as shown by the parameters recorded before the experiment, was characterized by the unilateral and asymmetrical condition of the equilibrium function in athletes. The use of the developed system with integrated support in the process of the pedagogical experiment led to a significant improvement of the same parameters, namely: the data of the static motor-cognitive test “Romberg test with European feet position”, the indicators of the frontal and sagittal asymmetry, and the normalization of the balance of visual/proprioceptive control considering the preexisting asymmetry.

The results of the pedagogical experiment allow to believe that the developed integrated system of means is justified primarily in terms of theoretical positions and the applied aspects of the theory are confirmed by the practical results of the experiment. Accordingly, the specified integrated system can be recommended to coaches for the correction of asymmetry of the equilibrium function in athletes arm wrestlers.

## **Practical recommendations**

It is advisable for arm wrestling coaches to monitor athletes' symmetry of the equilibrium function, primarily because in this sport, such proportionality improves the tactical and technical abilities of the athletes and thus positively influences the results of competitive activity.

According to the developed integrated system, within general physical preparation of athletes the priority should be given to specially selected exercises with a barbell (from 76% to 82%) which should become the main apparatus, and to those simulators which allow simultaneous actions for both right and left arms. This way the muscles of both arms, torso and all shoulder girdle should work simultaneously and that is the key to asymmetry correction.

We recommend to allocate no more than 24% of exercises to the alternating execution of actions with dumbbells and kettlebells. Such a significant increase in the structure of training loads of specially selected exercises with a barbell and on special simulators, as shown in the experiment, should eliminate the existing asymmetry in the condition of equilibrium function, that is a prerequisite for further improvement of tactical and technical preparedness and, consequently, sports results.

## **Conclusions**

1. Those arm wrestlers who trained before the experiment on the standard program showed the following of asymmetry: an insignificant increase (only 11,68%) of the indicator of equilibrium function in the static motor/cognitive test after the training; the prevalence of the pronounced frontal (up to 40%) and sagittal (up to 50%) asymmetries; minor dynamics (10%) in the parameter "Pronounced disturbance of the equilibrium function" after the training; the significant dominance (70%) of the visual control in the assessment of the equilibrium function with no improvements.
2. Previously accepted program of general physical training is regarded as unilateral, meaning that it does not provide a symmetry of the equilibrium function according to the specified indicators.
3. The application of our theoretically substantiated integrated system of physical training for athletes arm wrestlers, which gives priority to specially chosen exercises with a barbell and special simulators which provide simultaneous work of the muscles of both arms, torso and all shoulder girdle, contributed to:
  - a significant growth (by 71.6%) of the indicator of equilibrium function on support reactions in the static motor/cognitive test with biological feedback ("Romberg test with European feet position");

- the normalization of the frontal equilibrium in 80% of the subjects, who were diagnosed earlier with “Pronounced frontal asymmetry”;
- a decrease by 40% of diagnoses “Pronounced left sagittal asymmetry” and a 50% increase in the amount of subjects with the normal value of this parameter;
- an increase from 30% to 70% of diagnoses “Normal equilibrium function”;
- an increase of optimally balanced visual/proprioceptive control in the regulation of the equilibrium function after the experiment in 90% of the subjects.

On the basis of the obtained results we have developed an integrated system of means, which can be recommended to coaches for the correction of asymmetry of the equilibrium function in arm wrestling athletes.

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## **Funkcja równowagi jako wskaźnik symetrii stanu czynnościowego zawodników siłujących się na rękę**

### **Streszczenie**

Artykuł poświęcony jest badaniu asymetrii w rozwoju fizycznym zawodników siłujących się na rękę. Przedstawiono w nim wyniki eksperymentu pedagogicznego, w którym użyto testów statycznego rozpoznania ruchowego oraz stabilometrii w diagnozowaniu asymetrii i udowodniono efektywność opracowanego układu ćwiczeń fizycznych, opartego na progresie wskaźników funkcji równowagi zawodników siłujących się na rękę, w porównaniu do wyników osiągniętych przy pomocy standardowego systemu treningowego.

**Słowa kluczowe:** siłowanie się na rękę, zawodnicy siłujący się na rękę, asymetria rozwoju fizycznego, stabilność statyczno-kinetyczna, równowaga, diagnostyka symetrii przy użyciu stabilometrii.