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Original Article

Body posture biogeometric profile parameter variations of arm wrestlers owing to post-isometric relaxation

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Abstract.
The modern training system for elite arm wrestlers exists due to heavy exercise load, which sometimes can approach the physiological capabilities in terms of both amount and intensity. The fact remains that the lack of recommended practice for individual-specific training of arm wrestlers and further posture correction requires a more detailed study of the biogeometric profile of the musculoskeletal system of this category of athletes. Study objective: analysis of body posture biogeometric profile of arm wrestlers, taking into account the introduction of corrective exercises into the work-out sessions. Material & methods: the study included 2 groups of arm wrestlers aged 24 to 32 years. The Group 1 (n=16), the Group 2 (n=14), sports qualification – master of sport. The subjects were identical in terms of morphofunctional parameters. Postural examination was performed in frontal and sagittal planes using the Reedco's posture score. Shoulder index was calculated as the ratio between shoulder width and shoulder arch. Athletes of the Group 1 did additional post-isometric relaxation sessions with a physical therapist. Arm wrestlers of the Group 2 did Pilates exercises after working out. According to the Reedco's posture score, the Group 1 arm wrestlers had about 72.06±1.39 points, and the Group 2 subjects had about 69.15±1.42 points out of 100 points with respect to the norm, that is shoulder roundness was detected. According to statistically average data, shoulder index of arm wrestlers of the Group 1 corresponded to 76-84%, and for arm wrestlers of the Group 2 ranged from 70 to 80%. One month after the introduction of additional corrective exercises into the work-out sessions, a positive response was noticed. That is because in the Group 1 there was an increase in the Reedco's scale by 10.04 % ($p>0.05$), and an increase in shoulder index by 5.81% ($p<0.05$). In the Group 2 there was an increase in the Reedco's scale by 4.77% ($p>0.05$), and an increase in shoulder index by 2.81% ($p>0.05$). It means that after sessions with a physical therapist body posture biogeometric profile parameters acquired a higher value. Conclusions. The study allowed to make adjustments to the work-out sessions of arm wrestlers. Due to the use of post-isometric relaxation under the supervision of a physical therapist, the body posture biogeometric profile parameters of the arm wrestlers were significantly improved. Unassisted doing Pilates exercises suggests reasonability of performing these exercises after working out.
Keywords: arm wrestling, body posture, biogeometric profile, post-isometric relaxation.

Introduction.

The popularity of such a sport as arm wrestling is growing all around the world. It has been known that the basis of the work-out sessions in arm wrestling is associated with the development of muscle strength and improving speed-power qualities. However, physical strength has particular nature, so arm wrestlers use almost all strength training techniques during their work-out sessions. It is considered that resistance exercises are the most effective means to develop strength, that is why arm wrestlers pay the most attention to them. The modern literature provides a sufficient description of the both directions wrestling technique which is subject to harmony and symmetry in the development of physical qualities (Dzhym et al., 2017; Khudik et al., 2018; Mazurenko 2019; Ruban et al., 2021). On the other hand, elite sports are a predisposing factor not only for traumatizing athletes but also for the development of musculoskeletal diseases. Occurrence of pathological changes in the spine, changes in the biogeometric profile prevent the improvement of physical qualities of arm athletes. Irrational approach to workout sessions without regard to current changes in biogeometric profile leads to deviation from raining cycle, reduction of sports performance and results (Farahbakhsh et al. 2018).

Posture disorders in athletes is one of the most pressing challenge of modern sport. Due to the prevalence of this problem, a sufficient amount of medical-biological and sports-pedagogical studies has been carried out in recent years (Bugayeva et al., 2015; Chikurov et al., 2016; Burdukiewicz et al., 2018; Kamayev et al., 2020). However, the problem of lack of information on the influence of certain sports, in particular arm wrestling, on the biogeometric profile of the musculoskeletal system still remains. The modern training system for elite arm wrestlers exists due to heavy exercise load, which sometimes can approach the physiological capabilities in

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terms of both amount and intensity (Lazarieva et al., 2014; Litvinenko et al., 2015; Moskvin et al., 2015). The desired level of complexity of arm wrestlers' competitive activity has greater need for functional state of the spine. Insufficient mobility in the joints can limit the demonstration of power, responsiveness and speed of movements, endurance, increasing energy demands and reducing performance effectiveness, and often leads to severe muscle and ligament injuries (Ruban et al., 2021). The fact remains that the lack of recommended practice for individual-specific training of arm wrestlers and further posture correction requires a more detailed study of the biogeometric profile of the musculoskeletal system of this category of athletes. To perform motions with maximum amplitude in arm wrestling requires a lot of attention to exercises aimed at development of flexibility. Flexibility of athletes depends on many factors. First of all, it is a functional state of the spine and musculoskeletal system. All of the above roused to the choice of research direction and allowed to form the study objective: analysis of body posture biogeometric profile of arm wrestlers, taking into account the introduction of corrective exercises into the work-out sessions (Harcarik 2013; Sak et al., 2015; Ruban et al., 2017; Jagiełło et al., 2018).

Material & methods.

It was a prospective study conducted in the scientific and fundamental research laboratory of Kharkiv State Academy of Physical Culture (KhSAPhC). The study involved 30 athletes aged 24 to 32 years, sports qualification – master of sport. The study was conducted in accordance with international standards of bioethics and recommendations of the Bioethics Committee of the Ministry of Health of Ukraine. The tested arm wrestlers were randomly divided into two groups: the Group 1 – 16 athletes, the Group 2 – 14 athletes. The subjects were identical in terms of morphofunctional parameters ($p>0.05$) (table 1).

Table 1

Morphofunctional parameters of the arm wrestlers

Parameters	Group 1 (n=16)	Group 2 (n=14)	p
	X±m	X±m	
Height, cm	173.7±1.75	172.4±1.62	>0.05
Weight, kg	76.8±2.01	78.4±2.34	>0.05
Body mass index, kg/cm^2	25.45±0.44	26.37±0.63	>0.05
Chest excursion, cm	5.02±0.12	5.37±0.26	>0.05
Lung capacity, ml	3,850±0.85	3,980±0.64	>0.05

The musculoskeletal system condition was evaluated by assessing body posture and shoulder index. Body posture examination was done in frontal and sagittal planes according to the Reedco's posture score (Honcharov et al., 2020). Overall assessment according to the Reedco's posture score rated from 0 to 100 points. The higher the number of points, the better the body posture. Shoulder index (SI) is calculated as a percentage of the shoulder width to the shoulder arch. If the SI value is ≥ 85% – it is normal range, 81–85 % – is tendency to shoulder roundness, < 80 % – shoulder roundness (Honcharov et al., 2019; Ruban et al., 2021).

Statistical processing was done using STATISTICA 13.0 (StatSoft) statistics package. Arithmetical mean – X; error of arithmetical mean– ±m, were calculated. Student's t-test (t) was used to determine significant difference, $p<0.05$ was considered statistically significant difference.

Work-out sessions of the athletes included technical and tactical training as well as body conditioning (BC) in the ration of 35% to 65% of exercises. BC included 50% of free-weight exercises (dumbbells. barbell), and 15% of simulator exercises. Work-out was conducted three times a week.

To work on correcting their body posture biogeometric profile, the athletes of the Group 1 were asked to do additional post-isometric relaxation sessions with a physical therapist (Ruban et al., 2017; 2021). The purpose of post-isometric relaxation of muscles (PIR) is to relax tight muscles, which is achieved by a combination of short-term (5 to 10 s) muscle contraction with their further slow passive stretching (5 to 10 s).

PIR of cervical rotator muscles. Starting position – sitting on a chair. The right hand of a physical therapist wraps around the athlete's head. The thumb of the left hand rests on the spinous process of the lower vertebra of the immobilized segment, and the palm fixes the base of the neck. The physical therapist turns the athlete's head towards the direction of the limited movement until the feeling of the slight resistance, while asking to press lightly on the hand in the opposite direction. Then the athlete relaxes and exhales slowly. After that, the physical therapist turns the patient's head up to low resistance, slightly increasing the range of motion. PIR shall be repeated up to 5–7 times.

PIR of scalene and sternocleidomastoid muscles. Starting position – sitting on a chair. The physical therapist stands behind the athlete supporting him with his body. The right hand wraps around the head from the side, turning and extending it without any resistance to the opposite side at an angle of 45°, the left hand pulls clavicles and upper ribs down. The athlete is asked to lightly press forward and medially on the physical therapist's right hand alongside with turning his gaze and exhaling slowly. The physical therapist maintains

equivalent resistance to the motion slightly increasing the pressure in two directions up to 7–10 s. Then the athlete relaxes (while exhaling) and the physical therapist passively stretches the muscle extending the head. PIR shall be repeated up to 5–7 times.

PIR of trapezius muscle (horizontal portion) Starting position – sitting on a chair. The physical therapist stays behind the patient supporting him with his body. One hand wraps around the half of the head (without pressing on the ear), the other hand fixes the patient's shoulder girdle. The patient simultaneously slops down the shoulder and tilts his head towards it (while inhaling), herewith the physical therapist maintains resistance during 7 to 10 s. Then the patient relaxes (while exhaling) and the physical therapist passively stretches the muscle pressing on the patient's head. PIR shall be repeated up to 3–5 times.

PIR of subscapular muscle. Starting position – supine position on the couch. The hand is abducted in a supine position, with elbow flexion at a right angle. The physical therapist puts one hand on the patient's wrist, and with the other hand fixes the elbow joint from below. The patient tries (while inhaling) to elevate the forearm and rotates the hand around the shoulder axis. The physical therapist maintains light resistance during 7 to 10 s. After the patient relaxes (while exhaling), the physical therapist presses down on the wrist stretching the muscle. PIR shall be repeated up to 5–10 times.

PIR of latissimus dorsi and teres major muscle. Starting position – supine position on the couch. The hand is abducted in a supine position, with elbow flexion at a right angle. One hand of the physical therapist is on the athlete's chest (near the shoulder joint), the other hand of the physical therapist fixes the athlete's wrist from below. The patient tries to simultaneously lower and adduct the hand (while exhaling). The physical therapist maintains slight resistance during 7 to 10 s. During the relaxation period (while exhaling) the hand should raise above the head level. PIR shall be repeated up to 5–10 times.

PIR of lumbar muscles. Starting position – side lying with the knee in a flexion position. Resistance is provided with the physical therapist's knee, who presses towards the knee of the athlete's leg in the position of hip flexion. The physical therapist's hands press on the patient's shoulder which is in upper position. PIR shall be repeated up to 5–7 times.

Arm wrestlers of the Group 2 were offered to do Pilates exercises after working out (Lin et al., 2016):

Exercise 1 – shoulder and back muscles. Stand straight, legs shoulder-width apart, arms bending in shoulder height. Raise elbows to shoulder height. Take a deep breath and exhale with the hands to the sides. Go back to starting position while exhaling, 10 to 12 repetitions.

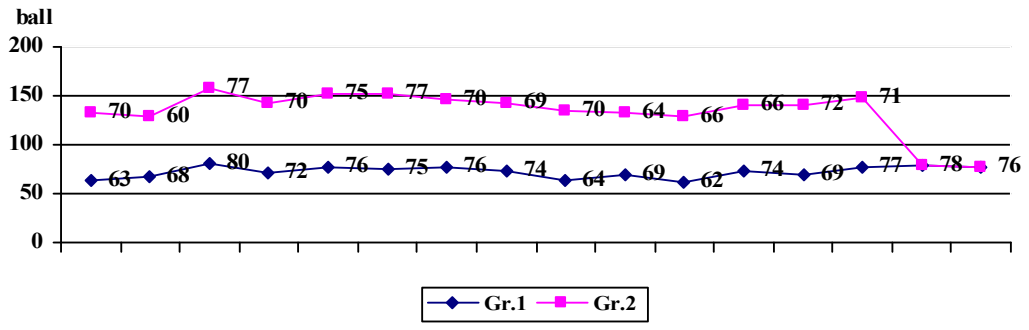
Exercise 2 – upper back muscles. Straight, wide straddle stand. Abs are squeezed, shoulders are relaxed. Keep your hands just above the head with wrists shoulder-width apart. Take a deep breath and exhale with the hands to the sides. Lower your arms in front of your chest to shoulder height. Go back to starting position, 10 to 12 repetitions.

Exercise 3 – equilibrium exercise. Straight, wide straddle stand. Lunge at the right leg, step on the resistance band end, rest your right hand on the knee. Do pull ups with the left hand. The left hand should be extended horizontally, 10 to 12 repetitions for each hand.

Results. At the first stage of the research, we studied the biogeometric profile parameters of the arm wrestlers, specifically body posture examination in the frontal and sagittal planes according to the Reedco's posture score and shoulder index (SI) calculation. According to the Reedco's posture score, the arm wrestlers of the both groups showed deviations, that is shoulder roundness. According to posture score, the points of the arm wrestlers of the both groups ranged within 72.06±1.39 out of 100 points as a norm, the subjects of the Group 2 had it within 69.15±1.42 points which is significantly lowered compared to normal value ($p<0.05$). According to the findings, in our opinion these changes arise out of large amount and high intensity training load when ignoring the current changes in athletes' biogeometric profile (fig. 1).

Fig. 1.

Body posture assessment of the arm wrestlers in both groups according to the Reedco's posture score



One of the tasks of the study was to calculate the shoulder index. According to average data, the shoulder index of the arm wrestlers in the Group 1 was equal to 76-84%, and in arm wrestlers of the Group 2 ranged within 70-80% (table. 2).

Table 2

Assessment of arm wrestlers' shoulder index in both groups

Shoulder index	Group 1 (n=16)	Group 2 (n=14)
	Persons/%	Persons/%
70-75%	-	6 / 42.86
76-80%	5 / 31.25	8 / 57.14
81-85%	11 / 68.75	-

In 1 month after introduction into the work-out sessions of the additional PIR sessions for the arm wrestlers of the Group 1 and Pilates exercises for the Group 2, positive response was observed. Conspicuous is the fact that biogeometric profile parameters of the athletes in the Group 1 acquired higher value than those of the athletes in the Group 2. Thus, table 3 shows the changes according to the Reedco's posture score and SI parameters of the subjects in both groups.

Table 3

Dynamics of postural parameters according to the Reedco's posture score and shoulder index in the arm wrestlers of both groups

Tests/period	Reedco's posture score		Shoulder Index	
	Group 1 (n=16) X±m	Group 2 (n=14) X±m	Group 1 (n=16) X±m	Group 2 (n=14) X±m
Before experiment	69.43±1.36	69.75±1.25	78.51± 1.40	77.92±0.92
After experiment	77.18±1.11	73.25±1.75	83.36±1.32	80.17±0.86
Gain (%)	10.04%	4.77%	5.81%	2.81%
Statistical significance (t, p)	t=4.41; p<0.05	t=1.63; p>0.05	t=2.52; p<0.05	t=1.79; p>0.05

Table 3 shows that additional post-isometric relaxation sessions with the physical therapist provide significant increase in parameters characterizing body posture biogeometric profile of arm wrestlers. The fact remains that the parameter according to Reedco's posture score increased by 10.04% ($p<0.05$), shoulder index parameter increased by 5.81% ($p<0.05$). Positive changes were also noticed in the group of arm wrestlers who did unassisted Pilates exercises, but they were not significant. Thus, the parameter according to Reedco's posture score increased by 4.77% ($p>0,05$), shoulder index parameter increased by 2.81% ($p>0.05$).

The results of the study conform that the introduction of PIR and Pilates exercises into the work-out sessions has rationale, first of all from the theoretical position and practical evidence and can be recommended for the practice of coaches to correct body posture profile of arm wrestlers.

Discussion.

Arm wrestling is a kind of sport where it is important to succeed in the development level of arm strength. Many scientists (Dzhym et al., 2017; Kamayev et al., 2020; Makarova et al., 2020; Podrihalo et al., 2020) have emphasized that the main success predictors in strength sport, particularly in arm wrestling, are muscular development, strong physique and strength value of the conditional moment of the extremities of the segment.

Kashuba V.O. et al. (2019) state that postural disorder is one of the key problems of the society. One of the factors negatively affecting functional capabilities is the imbalance of the musculoskeletal system, which can manifest as impaired body posture biogeometric profile (Kashuba et al., 2016; 2018; 2019; 2020a; 2020b). However, there are almost no studies on body posture biogeometric profile of arm wrestlers in the scientific literature.

Khudik S., Chikurov A., Petrova M. & Burmistrov A. (2018) insist that along with stabilization of the musculoskeletal asymmetry in athletes, motion pattern becomes stable leading to sporting performance failure. In the kinds of sport where the asymmetry is the limiting factor, it is necessary to use training techniques aimed at asymmetry alignment (Khudik et al., 2018). Our findings confirm the opinion of the authors.

Podrigalo L.V. et al. (2017) developed a scheme predicting the athletes' success using morphological and functional characteristics. The developed predicting scheme includes characteristics representing the functional state of the athletes. The most of the used parameters are goniometric and represent the range of motion of the shoulder joints. Some criteria show relative strength of forearm and finger muscles (Podrihalo et al., 2017; Volodchenko et al. 2017). Our findings support the fact that in order to predict success it is necessary to study body posture biogeometric profile of arm wrestlers.

Volkova O.A. and Smirnov G.I. (2019) after studying, came to the conclusion that the majority of people involved in athletic gymnastics have shoulder roundness. To prevent these impairments and to recover muscle tone after working-out, it is a must to do relaxation and stretching exercises for tight muscles (Volkova et

al. 2018). The use of post-isometric relaxation and Pilates exercises in our practice proved the opinion of many authors on body posture correction.

Conclusions.

The results of the study confirmed the occurrence of changes in body posture biogeometric profile of the athletes in both groups. According to REEDCO scale, arm athletes in both groups showed significant decrease in the shoulder index compared to the standard value ($p<0,05$). The study allowed to make adjustments to the work-out sessions of arm wrestlers. Thus, the athletes of the Group 1 additionally did PIR supervised by the physical therapist. The athletes of the Group 2 did unassisted Pilates exercises. After 1 month, it was noticed that the body posture biogeometric parameters of the athletes of the Group 1 acquired a higher value, an increase in the REEDCO scale by 10.04% ($p <0.05$), an increase in the shoulder index by 5.81% ($p <0.05$). The athletes of the Group 2 had an increase in the REEDCO scale by 4.77% ($p> 0.05$), increase in the shoulder index by 2.81% ($p> 0.05$). The study allowed to make adjustments in the work-out sessions of the arm wrestlers. Body posture biogeometric profile parameters of the arm wrestlers improved significantly due to the use of post-isometric relaxation assisted by the physical therapist. Unassisted doing Pilates exercises suggests reasonability of performing these exercises after working out.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest. Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed Consent Informed consent was obtained from all individual participants included in the study. All subjects of the institutional survey gave consent for anonymized data to be used for publication purposes.

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