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Posted Date: 3 September 2024

doi: 10.20944/preprints202409.0152.v1

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 doi:10.20944/preprints202409.0152.v1

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Results of Testing of Athletes in Martial Arts Using the Star Excursion Balance Test (SEBT) Method (on the Example of Women's Boxing, Kyokushinkai Karate, Fencing and WKF Karate)

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Abstract: The purpose of the study is to investigate SEBT indicators in female representatives of various types of single combats, and to identify differences between them. The research was conducted at the Lviv State University of Physical Culture named after Ivan Bobersky, Ukraine in November-December 2023. Female university students aged 18-22 participated in the study: 10 representatives from Kyokushinkai karate, 6 from boxing, 8 from fencing (epee), 7 from WKF karate. Research methods: analysis of literary sources and materials from the Internet; anthropometry; SEBT; methods of mathematical statistics. The hypothesis of this work is confirmed by the results of the conducted research, which indicates that engaging in a certain type of combat sports has its specific imprint (profile) on the SEBT indicators. The results of the correlations of SEBT indicators in boxing and fencing representatives indirectly indicate the asymmetric impact of these single combats on the arms and legs of a person body. The SEBT results of Kyokushinkai karate representatives indicate the symmetry and uniform development of left and right parts of the body. The indicators of the WKF karate representatives occupy an intermediate place in this comparison: the peculiarities of their SEBT indicators show that along with symmetrical manifestations, asymmetric ones are also observed.

Keywords: star excursion balance test; correlation; boxing; Kyokushinkai; karate; fencing

1. Introduction

The Star Excursion Balance Test (SEBT) method, which is aimed at studying the dynamic balance of a person, is widely used in scientific research in many countries around the world. The SEBT method has been used for more than two decades, mainly in research that has a medical and rehabilitation direction. According to a number of scientists [12,15,17,20], this method is considered sufficiently reliable.

A recent study conducted by scientists from China [25] demonstrated the validity of the SEBT method as a tool for assessing the dynamic balance of the upper limb girdle, their neuromuscular control, and proprioceptive properties. Scientists consider this test to be reliable and reproducible for assessing dynamic balance. Along with the classic version of the Star Excursion Balance Test (SEBT), there is a simplified, so-called modified Y-test. There are attempts to compare the results obtained with the classic SEBT and the modified version of the test—mSEBT [2].

In their study, Japanese scientists [6] determined the relationship between distance measurements in the SEBT test and posture and leg muscle strength in 9 studied students. Scientists

 doi:10.20944/preprints202409.0152.v1

simultaneously measured the strength of flexion and extension of the lower limbs in the hip and knee joints using an isokinetic platform. As a result of testing, the associated factors differed for dominant and non-dominant legs.

A number of scientific works [1,8] are devoted to the study of injuries of the lower extremities of people of different ages using the SEBT method. These works are mainly aimed at the study of chronic instability of the ankle joint. Thus, scientists from the USA [4] set the goal in their study to determine whether the kinematics of the lower limbs in 20 people with ankle instability (CAI) differ during anteromedial, medial, and posteromedial reach during the Star Excursion Balance Test, in comparison with 20 healthy individuals. As a result, the researchers did not find any differences when performing exercises to reach the maximum distance in any direction while maintaining balance. Other scientists [1], in their study, along with the measurement of the Star Excursion Balance Test, simultaneously determined the electromyographic activity of the thigh and trunk muscles. Surface electromyography data were collected from 22 healthy adults. The researchers concluded that trunk and thigh muscle activation was directionally dependent during SEBT. According to the authors, this information can be used during the rehabilitation of the thigh and trunk muscles.

Scientists have also conducted a series of studies on injuries of the lower limbs and asymmetry in representatives of game sports—basketball, handball, and football [7,19,21,23,24]. So, for example, Philp F., Telford C., Reid D. & Mccluskey M. in their work [19] investigated the relationship between the age of young female soccer players and the symmetry index of the limbs and the standards of the modified mSEBT. Scientists [3] also studied the relationships between functional movement screen (FMS), star excursion balance test (SEBT), agility T test, and vertical jump test scores and sports injury risk in 32 junior athletes (11 volleyball, 12 basketball, and 9 handball players). According to their study, junior athletes with a high risk of sports injury did not exhibit differences in terms of FMS, SEBT, and physical fitness test scores.

French researchers [5] applied the modified Y-Star Excursion Balance Test. They believe that the Modified Star Excursion Balance Test (mSEBT) is effective in identifying handball players at risk of injury. However, according to the researchers, a single pre-season mSEBT cannot accurately predict when an injury will occur. The aim of their work was to investigate whether repeated measurement of mSEBT over the course of a season would help to accurately identify the injury risk period for each player. Studying 11 female handball players for 25 weeks, scientists found that a week before the injury, the composite result decreased during repeated mSEBT measurements. A difference of 4 centimeters on the anterior-posterior axis of the test is not a significant indicator of the risk of injury.

The postural and neuromuscular performances in healthy pre-pubertal males taekwondo practitioners (n=12) in comparison with control children (n=17) were examined [11]. The performances of the taekwondo practitioners were better than those of the non-taekwondo active for the SEBT. To the authors' thoughts, taekwondo practice would stimulate sensory input and motor output of the postural system that would enhance its efficiency. In addition, the dynamic nature of taekwondo would develop the muscle power of the lower limbs. According to the authors, in the sample of healthy pre-pubertal males, taekwondo appears to improve postural and neuromuscular functions, but further research is required.

A group of other scientists [9] studied bilateral asymmetries in lower limb strength and dynamic balance in child athletes: 28 fencers (19 boys and 9 girls) and 28 taekwondo athletes (19 boys and 9 girls) were examined for one-leg jump and SEBT performance. This study suggest that child athletes in both laterally dominant and non-laterally dominant sports showed inter-limb asymmetry of leg power and dynamic balance. According to these scientists sex should be an important consideration when evaluating bilateral difference of leg power and dynamic balance for child athletes.

In another study, the same authors [10] investigated performance of single-leg jumps, Star Excursion Balance Test (SEBT), and muscle (hamstring and gastrocnemius) flexibility were measured for 13 elite male child Taekwondo athletes at both the rested and fatigued states to examine the inter-limb asymmetry. As a result of the work, the scientists concluded that fatigue significantly impacts inter-limb asymmetry in jump performances and dynamic balance for child athletes, while the variation of inter-limb asymmetry post fatigue may be different across tests. For the purpose of injury

 doi:10.20944/preprints202409.0152.v1

prevention, practitioners should consider assessing the inter-limb asymmetry for children at both the rested and fatigued state and be mindful of the fatigue response of each leg in functional tests.

The aim of Margnes E. & Paillard T. research [16] was to study the mechanisms of imbalance and the mechanisms of postural regulation in judoka in order to deduce some considerations for teaching. The role of the grip (kumi-kata) is fundamental for the judoka because it provides soma esthetic information about his own movements and positions as well as those of his opponent, it also enables controlling, attacking and defending forces to be applied against the opponent as well as control of the judoka's own balance. Researchers did not use the SEBT technique here.

A group of other researchers [22] studied the peculiarities of anthropometric indicators in elite representatives of various martial arts—kickboxing, karate and taekwondo. The design of a research presupposed the definition of 22 anthropometrical indicators. The performed analysis of elite athletes bodybuilding of combat sports has confirmed the existence of the features caused by specifics of combat sports. Indexes of a ratio of segments of extremities reflect features of the technique of a single combat. It also has to be estimated as a positive factor of the prediction. It is confirmed that there is the competency of application of the special indexes which are especially illustrating ratios of segments of extremities in the monitoring of a functional condition of athletes.

To summarize all of the above, we can state that in the world scientific literature there is not enough researches by the SEBT method in martial arts. As can be seen above, SEBT indicators of the lower extremities were studied in combat sports, and were carried out mainly with the participation of children and adolescents to a limited extent, when studying asymmetry or the risk of injury. In our opinion, this SEBT technique can be used not only for medical and rehabilitation purposes, but also for sports and pedagogical purposes.

We previously conducted a study using this method in athletes from Yoshinkan aikido, boxing, and Kyokushinkai karate [14]. The results of this work revealed certain differences in SEBT indicators among the representatives of the above-mentioned sports. The use of the SEBT technique in that study allowed us to compare: indicators in eight positions between the left and right sides of the athletes' bodies separately in each type of combat sport; indicators in eight positions between the left and right sides of the body of athletes of various types of combat sports.

In another study of ours by using the SEBT technique [13], it was established that the indicators may be related to the level of qualification of the athletes: the amplitude of the SEBT indicators was greater in highly qualified male Kyokushinkai karate competitors than in less qualified Kyokushinkai karate fighters.

It is also worth emphasizing that there are far fewer women in martial arts than men [18]. Therefore, such studies are even more valuable, enriching the knowledge about women who are engaged in martial arts at the highest sports level. These studies are few.

The hypothesis of this work is based on the assumption that long-term practice of a certain type of martial arts leaves its specific imprint on the Star Excursion Balance Test indicators of athletes. The necessity and importance of this research is that the study of SEBT indicators in representatives of various martial arts will allow in the future to determine the shortcomings of the influence of a certain type of single combat on the motor balance of athletes with further its pedagogical correction by using sets of exercises.

The **purpose** of this study was to investigate SEBT indicators in qualified female athletes with many years of experience in various types of martial arts and to identify differences between them.

2. Materials and Methods

The research was conducted at the Lviv State University of Physical Culture named after Ivan Bobersky, Ukraine, at the Department of "Fencing, Boxing and National Combat Sports" in the period of November-December 2023.

Female university students aged 18-22 who are qualified athletes in various types of combat sports (with 10 years of sports experience in average) took part in the study: 10 representatives from Kyokushinkai karate, 6 representatives from boxing, 7 from WKF karate, 8 representatives from fencing (epee). Among them are champions and prize-winners of national and international

 doi:10.20944/preprints202409.0152.v1

competitions, including European Championships and Cups, in the specified types of combat sports. All the athletes studied were formed into separate groups based on the type of martial arts they engage in, and not by belonging to a specific coach or a training pattern. This applies to every female athlete from every single combat sport presented in the study. All athletes participating in the experiment are members of the university's elite martial arts teams. At the time of the examinations, all the athletes under study were healthy, not injured, and not under the negative influence of menstruation. Informed consent was obtained from all subjects involved in the study. All women gave voluntary written consent to the study.

It should be noted that studies with the Star Excursion Balance Test were performed by both right-handed and left-handed athletes, but in this study, for the sake of the purity of the experiment, the results of right-handed athletes were only displayed. We reasonably assumed that left-handed athletes (lefties) differ in terms of Star Excursion Balance Test scores from right-handed athletes.

A number of research methods were used in the work:

- analysis of literary sources and materials from the Internet according to the research topic;
- anthropometry;
- Star Excursion Balance Test (SEBT);
- methods of mathematical statistics.

The analysis of literary sources and materials from the Internet on the topic of the study was used as a traditional method of summarizing information.

Measurement of anthropometric indicators—height, body weight, length of arms and legs—was carried out using generally accepted standard devices and methods, and always preceded the procedure of measuring the Star Excursion Balance Test (SEBT). Leg and arm lengths in the tables below are designated as "Leg L" and "Arm L" respectively, body weight as "Body W".

Measurement of the Star Excursion Balance Test (SEBT) was carried out thanks to the manufacture of a special canvas, similar to the products of the company Movement Assessment Technologies Pty Ltd. (www.mataassessment.com, www.mataassessment.com/megamat), and made it possible to obtain the indicators of the arms and legs of female athletes in eight positions (Figures 1 and 2).

 doi:10.20944/preprints202409.0152.v1

Figure 1. Star Excursion Balance Test (SEBT) measurements (legs).

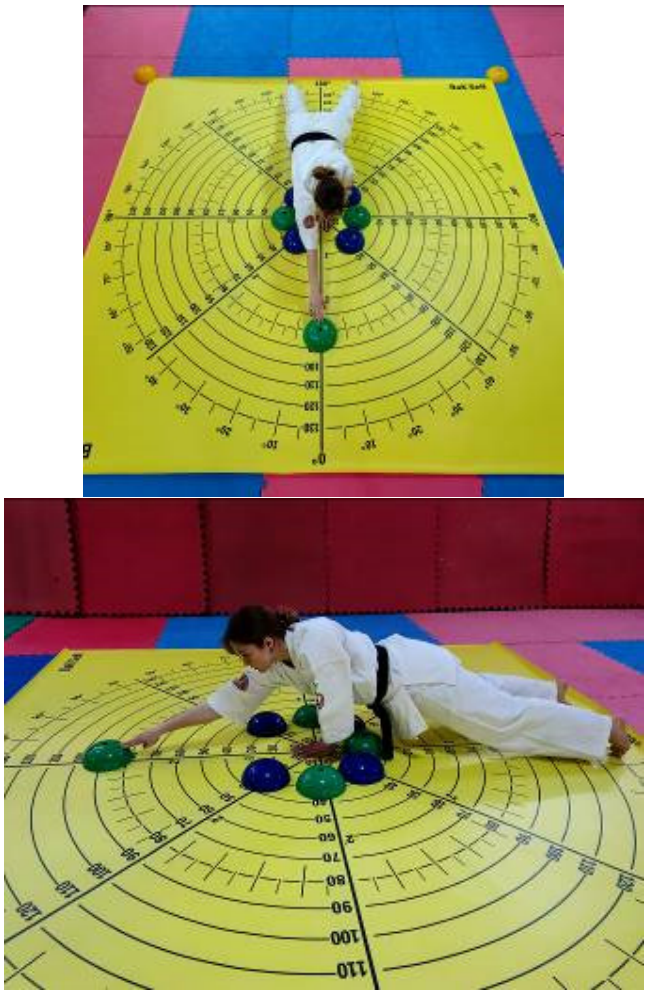

Figure 2. Star Excursion Balance Test (SEBT) measurements (arms).

Each of the eight positions the Star Excursion Balance Test (SEBT) has generally accepted international names for the designation of directions (here and in the tables below): 1—anterior, 2—

 doi:10.20944/preprints202409.0152.v1

anterolateral, 3—lateral, 4—posterolateral, 5—posterior, 6—posteromedial, 7—medial, 8—anteromedial.

SEBT testing took place in compliance with the following requirements:

• the subject female should be dressed in light clothes and barefoot. After that, she stands in the center of the canvas and waits for further instructions;

• using the right leg to reach the maximum point in the given direction, and the left leg for balance as a reference, the subject female should go through the circuit clockwise (8 directions);

• while balancing on the right leg as a support, the subject female should perform the same scheme (8 directions) in a counter-clockwise direction;

• the subject female should be instructed to reach the target with one foot as far as possible and lightly touch the line before returning to the original vertical position, with arms behind the back;

• the test administrator marks the place where the subject female touched the line with the big toe. The results are recorded in the protocol with an accuracy of 0,5 cm; to fix the indicators in our experiment, we used chip cones that were moved by the limbs in different directions.

• testing for each limb (leg or arm) is repeated three times for all directions according to the following scheme: left leg—right leg—left arm—right arm;

• after the subject female has made 3 successful passes with each leg (or arm) in all directions, she is allowed to leave the test area.

The results of all three attempts for each limb (two arms, and two legs) were recorded in the protocol. Subsequently, before entering the data into the computer database, the arithmetic mean value was calculated from the above three attempts for each of the eight positions of the Star Excursion Balance Test.

For statistical processing of the obtained data, the standard computer package of the Statistica 7 program was used in the study. The arithmetic mean value of the indicators (Mean), standard deviation of the arithmetic mean (Std. Dev.), and correlation analysis of indicators using the Pearson method were calculated. The use of the Mann-Whitney U-test statistical method was carried out to compare the SEBT indicators of female athletes of different types of combat sports and was carried out under the requirements for statistical data analysis since the SEBT indicators obtained in small groups were compared.

3. Results

The obtained indicators of the Star Excursion Balance Test and anthropometric data of female athletes for each of the types of combat sports are presented sequentially in tables 1, 2, 3, 4, 5, and 6 with their pairwise comparison using the Mann-Whitney U-test method. It should be noted that a pairwise comparison of athletes data of all types of martial arts involved in the study was conducted to identify differences between them. Therefore, it is natural that the same data for each martial art is repeated several times in different tables.

As it can be seen from Table 1, female representatives of Kyokushinkai karate reliably prevail over representatives of boxing in positions 1-6 of the SEBT of the left leg. For the most part, the average group SEBT indicators of Kyokushinkai karate women are better than those of female boxers. The slight advantage of female boxers in terms of leg length, height, and body weight does not give them an advantage in terms of SEBT. Right-handed female boxers use a left-sided stance with the supporting right leg in fights and training, and this can to some extent explain their low SEBT values of the left leg—female boxers have poor dynamic balance on it. On the other hand, the advantage of Kyokushinkai karate women on all SEBT indicators may indicate their better amplitude indicators than those of boxing women. The above facts indicate clear differences in the systems of sports training of Kyokushinkai karate and boxing female athletes.

 doi:10.20944/preprints202409.0152.v1

Table 1. Comparison of SEBT indicators and anthropometry in female representatives of boxing and Kyokushinkai karate.

Indicator		Boxing (n=6)		Kyokushinkai karate (n=10)		Mann-Whitney U-test		
		Mean	Std.Dev.	Mean	Std.Dev.	U	Z	p-level
SEBT of left leg, cm	1	66,10	10,218	**76,23**	5,034	11,5	**-2,006**	**0,0447**
	2	66,40	8,454	**76,89**	5,298	8,0	**-2,386**	**0,0170**
	3	62,71	8,569	**73,30**	6,561	10,0	**-2,169**	**0,0300**
	4	66,88	10,974	**79,60**	7,524	9,5	**-2,223**	**0,0261**
	5	67,53	12,560	**79,88**	7,164	11,0	**-2,060**	**0,0393**
	6	64,63	11,828	**75,20**	5,353	9,0	**-2,277**	**0,0227**
	7	62,26	11,250	**69,90**	6,810	17,0	-1,410	0,1585
	8	66,88	7,997	**71,66**	4,149	21,0	-0,976	0,3289
SEBT of right leg, cm	1	66,61	10,160	**74,25**	6,836	15,5	-1,572	0,1157
	2	69,58	9,476	**75,97**	7,912	19,5	-1,138	0,2547
	3	67,28	10,864	**73,24**	9,434	20,0	-1,084	0,2780
	4	69,21	11,954	**80,43**	11,828	13,5	-1,789	0,0735
	5	69,73	15,472	**79,92**	10,998	19,0	-1,193	0,2328
	6	69,33	16,054	**76,00**	10,508	23,0	-0,759	0,4477
	7	62,50	10,239	**71,36**	7,479	15,5	-1,572	0,1157
	8	66,66	9,133	**74,47**	5,981	17,0	-1,410	0,1585
SEBT of left arm, cm	1	63,66	10,444	**64,76**	9,706	27,5	-0,271	0,7862
	2	70,40	8,323	70,43	10,134	29,0	-0,108	0,9136
	3	77,05	9,04715	**78,33**	10,262	28,0	-0,216	0,8282
	4	83,05	14,099	**93,67**	15,174	16,0	-1,518	0,1288
	5	76,45	16,623	**95,04**	20,367	15,0	-1,626	0,1037
	6	62,83	12,327	**74,54**	10,663	13,5	-1,789	0,0735
	7	52,40	9,556	**54,26**	4,805	24,0	-0,650	0,5151
	8	56,10	11,084	56,06	8,947	29,0	-0,108	0,9136
SEBT of right arm, cm	1	60,83	16,436	**63,85**	9,909	26,5	-0,379	0,7042
	2	69,11	11,685	69,75	7,499	28,0	-0,216	0,8282
	3	76,38	6,704	**79,51**	9,815	25,0	-0,542	0,5875
	4	81,95	10,216	**91,92**	14,293	19,0	-1,193	0,2328
	5	76,41	15,143	**92,21**	20,714	18,0	-1,301	0,1930
	6	65,06	11,880	**74,90**	16,950	20,0	-1,084	0,2780
	7	50,26	9,559	**53,03**	8,864	26,5	-0,379	0,7042
	8	55,93	15,177	**56,73**	11,871	29,5	-0,054	0,9567
Height, cm		**166,1**	4,792	163,1	5,279	20,0	1,084	0,2780
Body W, kg		**61,38**	8,234	58,15	6,009	22,0	0,867	0,3855
Arm L, cm		68,50	7,035	**70,70**	3,529	26,0	-0,433	0,6643
Leg L, cm		**90,16**	4,020	87,40	4,788	22,0	0,867	0,3855

In Table 2 is shown the indicators of SEBT and anthropometry of female representatives of WKF karate and fencing (epee). With a slight advantage in leg length and height, female fencers have a slight advantage in 3, 4, 5, and 6 “back” SEBT positions of the left and right legs. On the other hand, female karatekas slightly prevail in the “front” positions 1, 2, 7, and 8 of both legs The above facts reflect the differences in the systems of long-term sports training between female WKF karate and fencing athletes. Also, there is a clear trend in the superiority of WKF female karatekas over fencers in SEBT indicators of the upper limbs.

 doi:10.20944/preprints202409.0152.v1

Table 2. Comparison of SEBT indicators and anthropometry in female representatives of WKF karate and fencing (epee).

Indicator		Karate WKF (n=7)		Fencing (n=8)		Mann-Whitney U-test		
		Mean	Std.Dev.	Mean	Std.Dev.	U	Z	p-level
SEBT of left leg, cm	1	**83,34**	9,637	75,67	6,958	16,0	1,388	0,1649
	2	**82,08**	8,055	78,28	7,184	21,0	0,810	0,4178
	3	81,94	9,684	**82,72**	8,646	26,5	-0,173	0,8621
	4	86,27	12,538	**90,08**	14,687	21,5	-0,752	0,4519
	5	85,51	10,930	**93,71**	16,536	17,0	-1,273	0,2030
	6	82,38	11,404	**86,02**	17,173	27,0	-0,115	0,9078
	7	75,52	11,549	75,21	8,408	26,0	0,231	0,8169
	8	**74,34**	7,191	72,05	2,817	24,0	0,462	0,6434
SEBT of right leg, cm	1	**81,08**	10,356	78,41	5,965	26,5	-0,173	0,8621
	2	80,75	10,954	80,00	6,299	26,0	-0,231	0,8169
	3	82,20	9,164	**88,25**	8,625	17,0	-1,273	0,2030
	4	83,32	8,956	**96,21**	18,285	12,5	-1,793	0,0728
	5	85,74	10,563	**96,91**	18,902	17,0	-1,273	0,2030
	6	81,41	9,779	**91,60**	17,288	19,5	-0,983	0,3252
	7	**78,10**	12,853	76,20	8,854	26,0	0,231	0,8169
	8	**77,61**	8,875	73,08	5,342	20,5	0,867	0,3854
SEBT of left arm, cm	1	**73,90**	13,783	64,70	9,023	16,0	1,388	0,1649
	2	**78,51**	11,239	72,53	4,163	18,0	1,1575	0,2471
	3	**87,02**	8,125	80,81	8,998	18,0	1,157	0,2471
	4	**96,80**	13,374	91,78	10,116	21,5	0,7529	0,4519
	5	**87,75**	12,542	86,16	17,001	23,0	0,578	0,5628
	6	**74,37**	12,154	69,78	14,821	20,0	0,925	0,3545
	7	**61,95**	10,977	53,20	5,715	16,0	1,388	0,1649
	8	**66,45**	14,301	56,67	9,817	17,0	1,273	0,2030
SEBT of right arm, cm	1	**73,28**	14,377	61,06	6,845	13,0	1,735	0,0825
	2	**77,75**	12,816	70,52	4,868	19,0	1,041	0,2976
	3	**87,57**	11,895	81,87	7,095	20,0	0,925	0,3545
	4	**93,85**	19,034	91,20	11,303	26,0	-0,231	0,8169
	5	**90,95**	17,050	89,96	16,901	27,5	-0,057	0,9538
	6	**75,71**	15,721	69,31	15,878	15,0	1,504	0,1324
	7	**58,71**	15,701	51,25	7,197	22,0	0,6945	0,4874
	8	**63,44**	15,734	57,50	11,896	20,5	0,8679	0,3854
Height, cm		165,1	6,067	**169,0**	4,375	14,0	-1,620	0,1051
Body W, kg		57,00	9,018	57,25	5,849	23,0	-0,578	0,5628
Arm L, cm		**71,42**	5,191	69,87	1,356	21,0	0,810	0,4178
Leg L, cm		92,85	3,625	**95,75**	3,011	14,5	-1,562	0,1182

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In Table 3 is shown a comparison of SEBT indicators of boxing and WKF karate female representatives. As can be seen from the obtained data, representatives of WKF karate prevail in all indicators of SEBT, having a slight advantage in the length of limbs. As compared to representatives of Kyokushinkai karate, female boxers are just as reliably behind WKF female karatekas in SEBT positions of the left leg. The left leg of right-handed boxers performs a stopping function, which is reflected in low SEBT scores. In addition, representatives of WKF karate prevail over female boxers in SEBT positions 1, 5, and 7 of the right leg. Also, with the general tendency of the WKF karateka to prevail over female boxers in the SEBT indicators of the upper limb girdle, a reliable advantage was recorded in position 3 of the SEBT of the right arm. That is, the training system for this group in women's boxing, judging by comparison with the two types of karate, is not aimed at developing the amplitude characteristics of the athletes' movements, which negatively affects their dynamic balance.

Table 3. Comparison of SEBT indicators and anthropometry in female representatives of boxing and WKF karate.

Indicator		Boxing (n=6)		Karate WKF (n=7)		Mann-Whitney U-test		
		Mean	Std.Dev.	Mean	Std.Dev.	U	Z	p-level
SEBT of left leg, cm	1	66,10	10,218	**83,34**	9,637	4,5	**-2,357**	**0,0184**
	2	66,40	8,454	**82,08**	8,055	3,0	**-2,571**	**0,0101**
	3	62,71	8,569	**81,94**	9,684	3,0	**-2,571**	**0,0101**
	4	66,88	10,974	**86,27**	12,538	3,0	**-2,571**	**0,0101**
	5	67,53	12,560	**85,51**	10,930	4,0	**-2,428**	**0,0151**
	6	64,63	11,828	**82,38**	11,404	5,0	**-2,285**	**0,0222**
	7	62,26	11,250	**75,52**	11,549	10,0	-1,571	0,1160
	8	66,88	7,997	**74,34**	7,191	12,0	-1,285	0,1985
SEBT of right leg, cm	1	66,61	10,160	**81,08**	10,356	7,0	**-2,000**	**0,0455**
	2	69,58	9,476	**80,75**	10,954	9,0	-1,714	0,0864
	3	67,28	10,864	**82,20**	9,164	8,0	-1,857	0,0632
	4	69,21	11,954	**83,32**	8,956	8,0	-1,857	0,0632
	5	69,73	15,472	**85,74**	10,563	7,0	**-2,000**	**0,0455**
	6	69,33	16,054	**81,41**	9,779	14,0	-1,000	0,3173
	7	62,50	10,239	**78,10**	12,853	6,5	**-2,071**	**0,0383**
	8	66,66	9,133	**77,61**	8,875	8,0	-1,857	0,0632
SEBT of left arm, cm	1	63,66	10,444	**73,90**	13,783	12,0	-1,285	0,1985
	2	70,40	8,323	**78,51**	11,239	12,0	-1,285	0,1985
	3	77,05	9,04715	**87,02**	8,125	8,0	-1,857	0,0632
	4	83,05	14,099	**96,80**	13,374	10,5	-1,500	0,1336
	5	76,45	16,623	**87,75**	12,542	12,0	-1,285	0,1985
	6	62,83	12,327	**74,37**	12,154	9,0	-1,714	0,0864
	7	52,40	9,556	**61,95**	10,977	9,0	-1,714	0,0864
	8	56,10	11,084	**66,45**	14,301	10,0	-1,571	0,1160
SEBT of right	1	60,83	16,436	**73,28**	14,377	10,0	-1,571	0,1160
	2	69,11	11,685	**77,75**	12,816	13,0	-1,142	0,2530
	3	76,38	6,704	**87,57**	11,895	7,0	**-2,000**	**0,0455**

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	4	81,95	10,216	**93,85**	19,034	13,0	-1,142	0,2530
	5	76,41	15,143	**90,95**	17,050	12,0	-1,285	0,1985
	6	65,06	11,880	**75,71**	15,721	14,0	-1,000	0,3173
	7	50,26	9,559	**58,71**	15,701	17,0	-0,571	0,5677
	8	55,93	15,177	**63,44**	15,734	17,0	-0,571	0,5677
Height, cm		**166,1**	4,792	165,1	6,067	16,5	0,642	0,5203
Body W, kg		**61,38**	8,234	57,00	9,018	18,0	0,428	0,6682
Arm L, cm		68,50	7,035	**71,42**	5,191	16,0	-0,714	0,4750
Leg L, cm		90,16	4,020	**92,85**	3,625	12,5	-1,214	0,2246

In Table 4 is shown a comparison of SEBT indicators of WKF karate and Kyokushinkai karate female representatives. With some predominance in terms of limb length and height, WKF karate women have a slight advantage in all lower limb SEBT positions over Kyokushinkai karate women, as well as in most upper limb SEBT positions, except for the positions 5 and 6. That is, the indicated positions 5 and 6 distinguish the two types of karate from each other—the slightly longer arms of the representatives of WKF karate do not give them an advantage in this over the representatives of Kyokushinkai karate. This fact unequivocally proves the difference in the specifics of training in the two types of karate.

Table 4. Comparison of SEBT indicators and anthropometry in female representatives of WKF karate and Kyokushinkai karate.

Indicator		Karate WKF (n=7)		Kyokushinkai karate (n=10)		Mann-Whitney U-test		
		Mean	Std.Dev.	Mean	Std.Dev.	U	Z	p-level
SEBT of left leg, cm	1	**83,34**	9,637	76,23	5,034	20,5	1,415	0,1570
	2	**82,08**	8,055	76,89	5,298	22,0	1,268	0,2045
	3	**81,94**	9,684	73,30	6,561	17,5	1,707	0,0876
	4	**86,27**	12,538	79,60	7,524	23,0	1,171	0,2415
	5	**85,51**	10,930	79,88	7,164	20,0	1,463	0,1432
	6	**82,38**	11,404	75,20	5,353	19,0	1,561	0,1184
	7	**75,52**	11,549	69,90	6,810	22,0	1,268	0,2045
	8	**74,34**	7,191	71,66	4,149	29,0	0,585	0,5581
SEBT of right leg, cm	1	**81,08**	10,356	74,25	6,836	25,5	0,927	0,3538
	2	**80,75**	10,954	75,97	7,912	30,5	0,439	0,6605
	3	**82,20**	9,164	73,24	9,434	18,0	1,659	0,0971
	4	**83,32**	8,956	80,43	11,828	31,0	0,390	0,6962
	5	**85,74**	10,563	79,92	10,998	23,0	1,171	0,2415
	6	**81,41**	9,779	76,00	10,508	22,0	1,268	0,2045
	7	**78,10**	12,853	71,36	7,479	25,0	0,975	0,3291
	8	**77,61**	8,875	74,47	5,981	28,0	0,683	0,4945
SEBT of left arm,	1	**73,90**	13,783	64,76	9,706	20,0	1,463	0,1432
	2	**78,51**	11,239	70,43	10,134	21,5	1,317	0,1876
	3	**87,02**	8,125	78,33	10,262	17,0	1,756	0,0789

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	4	**96,80**	13,374	93,67	15,174	27,0	0,780	0,4349
	5	87,75	12,542	**95,04**	20,367	27,0	-0,780	0,4349
	6	74,37	12,154	74,54	10,663	34,5	-0,048	0,9610
	7	**61,95**	10,977	54,26	4,805	22,5	1,219	0,2225
	8	**66,45**	14,301	56,06	8,947	18,0	1,659	0,0971
SEBT of right arm, cm	1	**73,28**	14,377	63,85	9,909	27,0	0,780	0,4349
	2	**77,75**	12,816	69,75	7,499	23,5	1,122	0,2617
	3	**87,57**	11,895	79,51	9,815	19,0	1,561	0,1184
	4	**93,85**	19,034	91,92	14,293	33,0	-0,195	0,8452
	5	90,95	17,050	**92,21**	20,714	33,5	-0,146	0,8836
	6	**75,71**	15,721	74,90	16,950	33,0	0,195	0,8452
	7	**58,71**	15,701	53,03	8,864	28,5	0,634	0,5258
	8	**63,44**	15,734	56,73	11,871	28,0	0,683	0,4945
Height, cm		**165,1**	6,067	163,1	5,279	31,0	0,390	0,6962
Body W, kg		57,00	9,018	**58,15**	6,009	32,0	-0,292	0,7696
Arm L, cm		**71,42**	5,191	70,70	3,529	33,5	0,146	0,8836
Leg L, cm		**92,85**	3,625	87,40	4,788	15,5	1,903	0,0570

In Table 5 is shown the indicators of SEBT and anthropometry of female representatives of boxing and fencing (epee). Female fencers, having a reliable advantage in the length of the legs, quite logically have a reliable advantage in the SEBT indicators of the lower limbs. Having a slight advantage in arm's length and height indicators, female fencers slightly outperform female boxers in SEBT indicators of the upper limb girdle. Boxing representatives also have low dynamic balance indicators of the upper limbs, which can be explained by the difference in many years of training in comparison with fencers: this is the result of the lack of special stretching movements in preparation.

Table 5. Comparison of SEBT indicators and anthropometry in female representatives of boxing and fencing.

Indicator		Boxing (n=6)		Fencing (n=8)		Mann-Whitney U-test		
		Mean	Std.Dev.	Mean	Std.Dev.	U	Z	p-level
SEBT of left leg, cm	1	66,10	10,218	**75,67**	6,958	10,0	-1,807	0,0707
	2	66,40	8,454	**78,28**	7,184	4,0	**-2,581**	**0,0098**
	3	62,71	8,569	**82,72**	8,646	3,0	**-2,711**	**0,0067**
	4	66,88	10,974	**90,08**	14,687	3,0	**-2,711**	**0,0067**
	5	67,53	12,560	**93,71**	16,536	3,0	**-2,711**	**0,0067**
	6	64,63	11,828	**86,02**	17,173	7,0	**-2,194**	**0,0281**
	7	62,26	11,250	**75,21**	8,408	7,0	**-2,194**	**0,0281**
	8	66,88	7,997	**72,05**	2,817	17,0	-0,903	0,3661
SEBT of right leg, cm	1	66,61	10,160	**78,41**	5,965	8,0	**-2,065**	**0,0388**
	2	69,58	9,476	**80,00**	6,299	8,5	**-2,001**	**0,0453**
	3	67,28	10,864	**88,25**	8,625	3,0	**-2,711**	**0,0067**
	4	69,21	11,954	**96,21**	18,285	3,0	**-2,711**	**0,0067**
	5	69,73	15,472	**96,91**	18,902	5,0	**-2,452**	**0,0141**

 doi:10.20944/preprints202409.0152.v1

	6	69,33	16,054	**91,60**	17,288	9,0	-1,936	0,0528
	7	62,50	10,239	**76,20**	8,854	7,0	**-2,194**	**0,0281**
	8	66,66	9,133	**73,08**	5,342	13,0	-1,420	0,1555
SEBT of left arm, cm	1	63,66	10,444	**64,70**	9,023	23,5	-0,064	0,9485
	2	70,40	8,323	**72,53**	4,163	19,5	-0,580	0,5612
	3	77,05	9,04715	**80,81**	8,998	16,5	-0,968	0,3329
	4	83,05	14,099	**91,78**	10,116	18,5	-0,710	0,4776
	5	76,45	16,623	**86,16**	17,001	19,0	-0,645	0,5186
	6	62,83	12,327	**69,78**	14,821	18,0	-0,774	0,4385
	7	52,40	9,556	**53,20**	5,715	22,0	-0,258	0,7962
	8	56,10	11,084	56,67	9,817	23,5	-0,064	0,9485
SEBT of right arm, cm	1	60,83	16,436	**61,06**	6,845	21,5	0,322	0,7468
	2	69,11	11,685	**70,52**	4,868	24,0	0,000	1,0000
	3	76,38	6,704	**81,87**	7,095	15,0	-1,161	0,2452
	4	81,95	10,216	**91,20**	11,303	14,0	-1,290	0,1967
	5	76,41	15,143	**89,96**	16,901	14,0	-1,290	0,1967
	6	65,06	11,880	**69,31**	15,878	23,0	0,129	0,8972
	7	50,26	9,559	**51,25**	7,197	20,0	0,516	0,6055
	8	55,93	15,177	**57,50**	11,896	22,0	0,258	0,7962
Height, cm		166,1	4,792	**169,0**	4,375	15,0	-1,161	0,2452
Body W, kg		**61,38**	8,234	57,25	5,849	16,0	1,032	0,3017
Arm L, cm		68,50	7,035	**69,87**	1,356	21,0	-0,387	0,6985
Leg L, cm		90,16	4,020	**95,75**	3,011	7,0	**-2,194**	**0,0281**

In Table 6 is shown a comparison of SEBT indicators and anthropometry of fencing and Kyokushinkai karate female representatives. Female fencers are significantly superior to representatives of Kyokushinkai karate in terms of height and leg length. Therefore, it is quite natural that they have significantly better SEBT indicators of the lower limbs in positions 3, 4, 5, and 6. At the same time, in some SEBT positions of the lower limbs female fencers have either a slight advantage or are even slightly inferior to representatives of Kyokushinkai karate (Table 6). If to compare the SEBT positions of the upper limbs, then it can be seen the trends of the influence of the sport on them: female fencers have slightly better indicators of "front" positions 2 and 3, but representatives of Kyokushinkai karate have slightly better indicators of "back" positions 5, 6, 7.

Table 6. Comparison of SEBT indicators and anthropometry in female representatives of fencing and Kyokushinkai karate.

Indicator		Fencing (n=8)		Kyokushinkai karate (n=10)		Mann-Whitney U-test		
		Mean	Std.Dev.	Mean	Std.Dev.	U	Z	p-level
SEBT of left leg, cm	1	75,67	6,958	**76,23**	5,034	36,0	0,355	0,7222
	2	**78,28**	7,184	76,89	5,298	32,5	0,666	0,5051
	3	**82,72**	8,646	73,30	6,561	12,5	**2,443**	**0,0145**
	4	**90,08**	14,687	79,60	7,524	19,0	1,865	0,0620
	5	**93,71**	16,536	79,88	7,164	16,0	**2,132**	**0,0329**

 doi:10.20944/preprints202409.0152.v1

	6	**86,02**	17,173	75,20	5,353	19,0	1,865	0,0620
	7	**75,21**	8,408	69,90	6,810	25,5	1,288	0,1976
	8	**72,05**	2,817	71,66	4,149	39,5	0,044	0,9645
SEBT of right leg, cm	1	**78,41**	5,965	74,25	6,836	25,5	1,288	0,1976
	2	**80,00**	6,299	75,97	7,912	26,5	1,199	0,2303
	3	**88,25**	8,625	73,24	9,434	9,0	**2,754**	**0,0058**
	4	**96,21**	18,285	80,43	11,828	17,0	**2,043**	**0,0409**
	5	**96,91**	18,902	79,92	10,998	15,5	**2,176**	**0,0294**
	6	**91,60**	17,288	76,00	10,508	16,5	**2,088**	**0,0367**
	7	**76,20**	8,854	71,36	7,479	30,0	0,888	0,3742
	8	73,08	5,342	**74,47**	5,981	35,5	-0,399	0,6892
SEBT of left arm, cm	1	64,70	9,023	64,76	9,706	39,0	-0,088	0,9291
	2	**72,53**	4,163	70,43	10,134	35,5	0,399	0,6892
	3	**80,81**	8,998	78,33	10,262	34,0	0,533	0,5935
	4	91,78	10,116	**93,67**	15,174	36,0	0,355	0,7222
	5	86,16	17,001	**95,04**	20,367	29,5	-0,932	0,3508
	6	69,78	14,821	**74,54**	10,663	28,0	-1,066	0,2863
	7	53,20	5,715	**54,26**	4,805	34,0	-0,533	0,5939
	8	56,67	9,817	56,06	8,947	37,5	0,222	0,8242
SEBT of right arm, cm	1	61,06	6,845	**63,85**	9,909	30,0	-0,888	0,3742
	2	**70,52**	4,868	69,75	7,499	39,5	0,044	0,9645
	3	**81,87**	7,095	79,51	9,815	34,0	0,533	0,5939
	4	91,20	11,303	91,92	14,293	39,0	-0,0888	0,9291
	5	89,96	16,901	**92,21**	20,714	38,0	0,177	0,8589
	6	69,31	15,878	**74,90**	16,950	31,5	-0,755	0,4501
	7	51,25	7,197	**53,03**	8,864	32,0	-0,710	0,4771
	8	**57,50**	11,896	56,73	11,871	39,0	-0,088	0,9291
Height, cm		**169,0**	4,375	163,1	5,279	13,5	**2,354**	**0,0185**
Body W, kg		57,25	5,849	**58,15**	6,009	39,0	-0,088	0,9291
Arm L, cm		69,87	1,356	**70,70**	3,529	36,0	-0,355	0,7222
Leg L, cm		**95,75**	3,011	87,40	4,788	3,5	**3,243**	**0,0011**

Therefore, the results of a pairwise comparison of the arithmetic mean values of athletes` SEBT indicators between different types of combat sports (Kyokushinkai karate, boxing, fencing, WKF karate) presented in Tables 1–6 make it possible to track their differences in terms of amplitude characteristics. It is possible to notice the differences between the mentioned types of combat sports according to individual SEBT positions of the athletes. As it can be seen from the tables, groups of positions can be divided into “front” 1, 2, 7, 8, and “back” 3, 4, 5, and 6 in various combinations.

The above mentioned comparisons of average values by SEBT positions can be supplemented with data in the form of correlation matrices of different positions within each group of athletes separately. We propose to consider the correlation matrix of SEBT indicators separately for each type of martial arts. Each such matrix displays all intragroup coordination relationships that exist between SEBT positions of all four limbs—two legs and two arms of each athlete in the group. Such

 doi:10.20944/preprints202409.0152.v1

coordination connections of SEBT indicators reflect the specific imprint of the training period on athletes in a certain type of martial arts and demonstrate qualitative changes in such indicators.

Below, in Tables 7–10, the correlations of SEBT indicators of the examined boxing female representatives is presented sequentially. Significant correlations at P<0,05 are highlighted in bold (here and in the all tables below).

Table 7. Correlations of SEBT indicators of the left leg with SEBT indicators and anthropometry in female boxers (n=6).

Indicator		Left leg SEBT positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	1,00	**0,89**	**0,87**	**0,90**	**0,91**	**0,85**	0,36	0,63
	2	**0,89**	1,00	**0,98**	0,76	**0,81**	0,70	0,14	0,55
	3	**0,87**	**0,98**	1,00	**0,84**	**0,88**	0,78	0,23	0,66
	4	**0,90**	0,76	**0,84**	1,00	**0,98**	**0,94**	0,49	0,78
	5	**0,91**	**0,81**	**0,88**	**0,98**	1,00	**0,98**	0,57	0,77
	6	**0,85**	0,70	0,78	**0,94**	**0,98**	1,00	0,68	0,71
	7	0,36	0,14	0,23	0,49	0,57	0,68	1,00	0,64
	8	0,63	0,55	0,66	0,78	0,77	0,71	0,64	1,00
SEBT of right leg	**1**	**0,98**	**0,85**	**0,82**	**0,86**	**0,85**	0,76	0,30	0,67
	2	**0,92**	**0,92**	**0,87**	0,74	0,75	0,62	0,15	0,62
	3	**0,93**	**0,97**	**0,96**	**0,83**	**0,85**	0,73	0,18	0,67
	4	**0,86**	**0,95**	**0,98**	**0,84**	**0,86**	0,73	0,23	0,76
	5	**0,83**	**0,91**	**0,98**	**0,89**	**0,91**	**0,81**	0,28	0,74
	6	**0,91**	**0,93**	**0,97**	**0,91**	**0,91**	0,80	0,22	0,72
	7	**0,95**	**0,93**	**0,96**	**0,93**	**0,96**	**0,91**	0,40	0,67
	8	**0,85**	**0,85**	**0,86**	0,80	0,75	0,60	-0,03	0,62
SEBT of left arm	**1**	0,67	0,59	0,49	0,43	0,52	0,56	0,20	-0,07
	2	0,53	0,48	0,34	0,23	0,32	0,36	0,02	-0,26
	3	0,49	0,36	0,24	0,24	0,26	0,30	-0,14	-0,35
	4	0,59	0,51	0,52	0,57	0,62	0,69	0,20	-0,01
	5	0,75	0,72	0,70	0,68	0,70	0,70	0,05	0,10
	6	0,70	0,75	0,64	0,43	0,54	0,53	0,12	0,02
	7	0,72	0,73	0,62	0,43	0,56	0,55	0,31	0,16
	8	0,45	0,37	0,23	0,14	0,27	0,34	0,33	-0,11
SEBT of right arm	**1**	0,65	0,71	0,60	0,39	0,51	0,52	0,12	-0,03
	2	0,70	0,74	0,63	0,43	0,53	0,52	0,08	-0,01
	3	0,70	0,43	0,36	0,52	0,54	0,60	0,26	0,03
	4	0,79	0,57	0,66	**0,92**	**0,88**	**0,91**	0,43	0,52
	5	0,80	0,65	0,72	**0,90**	**0,87**	**0,88**	0,32	0,45
	6	**0,82**	**0,89**	**0,90**	0,79	**0,83**	0,78	0,12	0,37
	7	0,53	0,69	0,54	0,18	0,32	0,27	0,01	-0,04

 doi:10.20944/preprints202409.0152.v1

	8	0,45	0,54	0,39	0,10	0,25	0,25	0,09	-0,16
Height		0,71	0,43	0,33	0,51	0,43	0,39	0,02	0,20
Body W		-0,24	-0,39	-0,29	0,03	-0,10	-0,03	-0,24	-0,28
Arm L		0,70	0,48	0,61	**0,89**	**0,88**	**0,89**	0,77	0,91
Leg L		**0,92**	**0,81**	**0,85**	**0,96**	**0,91**	**0,85**	0,24	0,64

Table 8. Correlations of SEBT indicators of the right leg with SEBT indicators and anthropometry in female boxers (n=6).

Indicator		Right leg SEBT positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	**0,98**	**0,92**	**0,93**	**0,86**	**0,83**	**0,91**	**0,95**	**0,85**
	2	**0,85**	**0,92**	**0,97**	**0,95**	**0,91**	**0,93**	**0,93**	**0,85**
	3	**0,82**	**0,87**	**0,96**	**0,98**	**0,98**	**0,97**	**0,96**	**0,86**
	4	**0,86**	0,74	**0,83**	**0,84**	**0,89**	**0,91**	**0,93**	0,80
	5	**0,85**	0,75	**0,85**	**0,86**	**0,91**	**0,91**	**0,96**	0,75
	6	0,76	0,62	0,73	0,73	**0,81**	0,80	**0,91**	0,60
	7	0,30	0,15	0,18	0,23	0,28	0,22	0,40	-0,03
	8	0,67	0,62	0,67	0,76	0,74	0,72	0,67	0,62
SEBT of right leg	**1**	1,00	**0,95**	**0,93**	**0,86**	0,78	**0,89**	**0,88**	**0,89**
	2	**0,95**	1,00	**0,97**	**0,91**	0,79	**0,89**	**0,85**	**0,90**
	3	**0,93**	**0,97**	1,00	**0,98**	**0,92**	**0,97**	**0,93**	**0,93**
	4	**0,86**	**0,91**	**0,98**	1,00	**0,97**	**0,98**	**0,92**	**0,91**
	5	0,78	0,79	**0,92**	**0,97**	1,00	**0,98**	**0,94**	**0,86**
	6	**0,89**	**0,89**	**0,97**	**0,98**	**0,98**	1,00	**0,95**	**0,94**
	7	**0,88**	**0,85**	**0,93**	**0,92**	**0,94**	**0,95**	1,00	**0,81**
	8	**0,89**	**0,90**	**0,93**	**0,91**	**0,86**	**0,94**	**0,81**	1,00
SEBT of left arm	**1**	0,55	0,50	0,49	0,35	0,35	0,42	0,62	0,30
	2	0,44	0,42	0,37	0,21	0,18	0,27	0,46	0,20
	3	0,40	0,33	0,29	0,11	0,11	0,23	0,38	0,23
	4	0,42	0,30	0,42	0,35	0,48	0,49	0,66	0,32
	5	0,62	0,55	0,65	0,57	0,65	0,69	0,79	0,59
	6	0,59	0,63	0,63	0,52	0,48	0,54	0,70	0,41
	7	0,64	0,68	0,64	0,53	0,45	0,51	0,69	0,37
	8	0,38	0,37	0,28	0,14	0,06	0,13	0,37	0,00
SEBT of right arm	**1**	0,53	0,57	0,58	0,46	0,45	0,49	0,66	0,35
	2	0,60	0,62	0,63	0,50	0,47	0,53	0,69	0,43
	3	0,63	0,48	0,43	0,27	0,26	0,39	0,56	0,35
	4	0,69	0,50	0,62	0,60	0,71	0,74	**0,81**	0,63
	5	0,70	0,54	0,67	0,65	0,76	0,79	**0,84**	0,67
	6	0,70	0,69	**0,83**	0,80	**0,87**	**0,87**	**0,92**	0,74

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	7	0,47	0,61	0,56	0,45	0,35	0,40	0,52	0,30
	8	0,37	0,47	0,40	0,28	0,19	0,24	0,42	0,13
Height		0,78	0,66	0,54	0,37	0,26	0,46	0,46	0,61
Body W		-0,30	-0,48	-0,36	-0,34	-0,16	-0,16	-0,21	-0,11
Arm L		0,68	0,52	0,60	0,65	0,71	0,69	0,73	0,55
Leg L		**0,90**	0,80	**0,88**	**0,85**	**0,88**	**0,94**	**0,91**	**0,91**

Table 9. Correlations of SEBT indicators of the left arm with SEBT indicators and anthropometry in female boxers (n=6).

Indicator		Left arm SEBT Positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	0,67	0,53	0,49	0,59	0,75	0,70	0,72	0,45
	2	0,59	0,48	0,36	0,51	0,72	0,75	0,73	0,37
	3	0,49	0,34	0,24	0,52	0,70	0,64	0,62	0,23
	4	0,43	0,23	0,24	0,57	0,68	0,43	0,43	0,14
	5	0,52	0,32	0,26	0,62	0,70	0,54	0,56	0,27
	6	0,56	0,36	0,30	0,69	0,70	0,53	0,55	0,34
	7	0,20	0,02	-0,14	0,20	0,05	0,12	0,31	0,33
	8	-0,07	-0,26	-0,35	-0,01	0,10	0,02	0,16	-0,11
SEBT of right leg	**1**	0,55	0,44	0,40	0,42	0,62	0,59	0,64	0,38
	2	0,50	0,42	0,33	0,30	0,55	0,63	0,68	0,37
	3	0,49	0,37	0,29	0,42	0,65	0,63	0,64	0,28
	4	0,35	0,21	0,11	0,35	0,57	0,52	0,53	0,14
	5	0,35	0,18	0,11	0,48	0,65	0,48	0,45	0,06
	6	0,42	0,27	0,23	0,49	0,69	0,54	0,51	0,13
	7	0,62	0,46	0,38	0,66	0,79	0,70	0,69	0,37
	8	0,30	0,20	0,23	0,32	0,59	0,41	0,37	0,00
SEBT of left arm	**1**	1,00	**0,97**	**0,90**	**0,84**	**0,84**	**0,95**	**0,90**	**0,87**
	2	**0,97**	1,00	**0,94**	0,74	0,75	**0,92**	**0,86**	**0,88**
	3	**0,90**	**0,94**	1,00	0,78	0,79	0,79	0,67	0,71
	4	**0,84**	0,74	0,78	1,00	**0,94**	0,74	0,60	0,50
	5	**0,84**	0,75	0,79	**0,94**	1,00	**0,81**	0,66	0,46
	6	**0,95**	**0,92**	0,79	0,74	**0,81**	1,00	**0,96**	**0,83**
	7	**0,90**	**0,86**	0,67	0,60	0,66	**0,96**	1,00	**0,91**
	8	**0,87**	**0,88**	0,71	0,50	0,46	**0,83**	**0,91**	1,00
SEBT of right arm	**1**	**0,96**	**0,93**	0,80	0,77	**0,81**	1,00	**0,94**	**0,84**
	2	**0,96**	**0,94**	**0,83**	0,77	**0,84**	1,00	**0,94**	**0,82**
	3	**0,90**	**0,86**	**0,89**	0,77	0,76	0,74	0,72	0,74
	4	0,53	0,35	0,44	0,78	0,79	0,42	0,36	0,16
	5	0,59	0,42	0,50	**0,84**	**0,87**	0,51	0,41	0,18

 doi:10.20944/preprints202409.0152.v1

	6	0,69	0,57	0,54	**0,81**	**0,93**	0,76	0,64	0,33
	7	0,78	**0,81**	0,60	0,44	0,54	**0,92**	**0,93**	**0,82**
	8	**0,85**	**0,88**	0,68	0,49	0,52	**0,92**	**0,94**	**0,93**
Height		0,54	0,54	0,64	0,33	0,49	0,45	0,47	0,43
Body W		-0,17	-0,19	0,11	0,29	0,18	-0,38	-0,57	-0,51
Arm L		0,16	-0,06	-0,09	0,31	0,33	0,12	0,23	0,03
Leg L		0,48	0,33	0,38	0,61	0,77	0,49	0,44	0,13

Table 10. Correlations of SEBT indicators of the right arm with SEBT indicators and anthropometry in female boxers (n=6).

Indicator		Right arm SEBT Positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	0,65	0,70	0,70	0,79	0,80	**0,82**	0,53	0,45
	2	0,71	0,74	0,43	0,57	0,65	**0,89**	0,69	0,54
	3	0,60	0,63	0,36	0,66	0,72	**0,90**	0,54	0,39
	4	0,39	0,43	0,52	**0,92**	**0,90**	0,79	0,18	0,10
	5	0,51	0,53	0,54	**0,88**	**0,87**	**0,83**	0,32	0,25
	6	0,52	0,52	0,60	**0,91**	**0,88**	0,78	0,27	0,25
	7	0,12	0,08	0,26	0,43	0,32	0,12	0,01	0,09
	8	-0,03	-0,01	0,03	0,52	0,45	0,37	-0,04	-0,16
SEBT of right leg	**1**	0,53	0,60	0,63	0,69	0,70	0,70	0,47	0,37
	2	0,57	0,62	0,48	0,50	0,54	0,69	0,61	0,47
	3	0,58	0,63	0,43	0,62	0,67	**0,83**	0,56	0,40
	4	0,46	0,50	0,27	0,60	0,65	0,80	0,45	0,28
	5	0,45	0,47	0,26	0,71	0,76	**0,87**	0,35	0,19
	6	0,49	0,53	0,39	0,74	0,79	**0,87**	0,40	0,24
	7	0,66	0,69	0,56	**0,81**	**0,84**	**0,92**	0,52	0,42
	8	0,35	0,43	0,35	0,63	0,67	0,74	0,30	0,13
SEBT of left arm	**1**	**0,96**	**0,96**	**0,90**	0,53	0,59	0,69	0,78	**0,85**
	2	**0,93**	**0,94**	**0,86**	0,35	0,42	0,57	**0,81**	**0,88**
	3	**0,80**	**0,83**	**0,89**	0,44	0,50	0,54	0,60	0,68
	4	0,77	0,77	0,77	0,78	**0,84**	**0,81**	0,44	0,49
	5	**0,81**	**0,84**	0,76	0,79	**0,87**	**0,93**	0,54	0,52
	6	**1,00**	**1,00**	0,74	0,42	0,51	0,76	**0,92**	**0,92**
	7	**0,94**	**0,94**	0,72	0,36	0,41	0,64	**0,93**	**0,94**
	8	**0,84**	**0,82**	0,74	0,16	0,18	0,33	**0,82**	**0,93**
SEBT of right arm	**1**	1,00	**0,99**	0,74	0,41	0,51	0,75	**0,91**	**0,92**
	2	**0,99**	1,00	0,78	0,45	0,55	0,77	**0,90**	**0,90**
	3	0,74	0,78	1,00	0,66	0,66	0,55	0,50	0,60
	4	0,41	0,45	0,66	1,00	**0,98**	0,78	0,08	0,07

 doi:10.20944/preprints202409.0152.v1

	5	0,51	0,55	0,66	**0,98**	1,00	**0,86**	0,18	0,15
	6	0,75	0,77	0,55	0,78	**0,86**	1,00	0,56	0,46
	7	**0,91**	**0,90**	0,50	0,08	0,18	0,56	1,00	**0,97**
	8	**0,92**	**0,90**	0,60	0,07	0,15	0,46	**0,97**	1,00
Height		0,40	0,49	0,79	0,50	0,48	0,35	0,30	0,31
Body W		-0,34	-0,31	0,04	0,35	0,33	0,00	-0,66	-0,60
Arm L		0,10	0,11	0,32	0,78	0,69	0,47	-0,08	-0,12
Leg L		0,45	0,51	0,58	**0,90**	**0,91**	**0,84**	0,24	0,14

The analysis of the SEBT correlations of female boxers presented in Tables 7–10 allows us to formulate the following propositions:

• SEBT indicators in female boxers do not have reliable connections with anthropometric indicators of body weight and height;

• female boxers have multiple highly reliable correlations between the SEBT indicators of the right and left legs in most positions (except for positions 7 and 8 of the left leg);

• there are multiple highly reliable correlations between the SEBT indicators of the right and left arms in all positions;

• the SEBT positions of each of the limbs separately (left leg, right leg, left arm, right arm) have direct high correlations among themselves, which indicates the amplitude proportionality in the indicators of the SEBT positions of each of the group members;

• the indicators of many SEBT positions of the left and right legs of female boxers have direct reliable relationships with the "back" 4, 5, 6 SEBT positions of the right arm, which is located in the combat stance behind and participates in accentuated blows. These relationships probably reflect neuromuscular proprioception and coordination in boxing;

• indicators of SEBT of the left and right legs of female boxers are closely related to indicators of leg length in a directly proportional relationship;

• the SEBT indicators of the left arm (located in front of the female boxers in the combat stance) do not have reliable connections with the indicators of the left and right legs. The left arm during a bout performs both a defensive and striking function, unlike the right arm, so range of its movements is very wide. Therefore, the indicators of its SEBT positions do not have the same proportionality as the indicators of the right arm. In fact, by this way, we can note its certain autonomous activity.

The above-mentioned patterns of ratios of SEBT indicators in female boxers generally reflect the dynamic, neuromuscular, and coordination features of this type of combat sport, and indirectly indicate its asymmetric impact on the human body.

In Tables 11–14 is shown the SEBT correlation matrix of the examined female representatives of Kyokushinkai karate.

Table 11. Correlations of SEBT indicators of the left leg with SEBT indicators and anthropometry in female representatives of Kyokushinkai karate (n=10).

Indicator		Left leg SEBT positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	1,00	**0,74**	0,49	0,30	0,41	0,18	0,48	0,32
	2	**0,74**	1,00	**0,69**	0,51	0,60	0,38	0,08	0,23
	3	0,49	**0,69**	1,00	**0,76**	**0,86**	**0,78**	0,23	0,44
	4	0,30	0,51	**0,76**	1,00	**0,89**	**0,73**	0,16	-0,00
	5	0,41	0,60	**0,86**	**0,89**	1,00	**0,87**	0,27	0,24

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	6	0,18	0,38	**0,78**	**0,73**	**0,87**	1,00	0,25	0,14
	7	0,48	0,08	0,23	0,16	0,27	0,25	1,00	-0,02
	8	0,32	0,23	0,44	-0,00	0,24	0,14	-0,02	1,00
SEBT of right leg	**1**	**0,85**	**0,91**	0,57	0,41	0,42	0,10	0,11	0,33
	2	**0,88**	**0,83**	**0,69**	0,61	0,60	0,32	0,33	0,27
	3	0,53	**0,68**	**0,86**	**0,91**	**0,91**	**0,78**	0,38	0,06
	4	**0,63**	**0,71**	**0,78**	**0,87**	**0,87**	**0,70**	0,40	0,04
	5	0,53	**0,72**	**0,67**	**0,84**	**0,82**	0,56	0,36	-0,02
	6	0,39	0,57	**0,63**	**0,86**	**0,66**	0,51	0,31	-0,27
	7	0,53	0,57	0,53	**0,67**	0,50	0,29	0,52	-0,22
	8	0,60	**0,80**	**0,90**	**0,76**	**0,87**	0,62	0,13	0,54
SEBT of left arm	**1**	0,42	0,32	**0,63**	0,41	**0,73**	**0,78**	**0,65**	0,36
	2	0,34	0,30	**0,75**	0,47	**0,74**	**0,82**	0,48	0,48
	3	0,32	0,35	**0,82**	**0,75**	**0,88**	**0,85**	0,32	0,44
	4	0,11	0,05	0,61	**0,79**	**0,66**	0,60	0,32	0,18
	5	0,14	0,01	0,47	**0,74**	**0,67**	0,53	0,50	0,08
	6	-0,03	-0,15	0,42	0,62	0,44	0,45	0,42	-0,01
	7	0,01	-0,35	-0,04	-0,01	0,18	0,44	0,48	-0,14
	8	0,25	0,02	0,13	-0,15	0,25	0,24	0,33	**0,65**
SEBT of right arm	**1**	0,25	0,14	0,56	0,28	0,56	**0,64**	**0,73**	0,40
	2	0,46	0,13	0,55	0,41	0,59	**0,63**	**0,77**	0,35
	3	0,35	0,22	**0,70**	**0,66**	**0,79**	**0,81**	0,48	0,43
	4	0,07	0,04	**0,65**	**0,74**	**0,72**	**0,71**	0,51	0,14
	5	0,07	-0,05	0,49	**0,73**	**0,70**	**0,65**	0,51	0,06
	6	-0,14	-0,24	0,39	0,61	0,54	0,53	0,45	0,04
	7	-0,06	-0,28	0,09	-0,19	0,10	0,43	0,46	0,18
	8	0,27	-0,21	0,07	-0,28	-0,00	0,08	0,55	**0,63**
Height		**0,68**	0,59	0,61	**0,74**	**0,72**	0,45	0,29	0,35
Body W		0,35	0,39	0,41	0,56	**0,63**	0,30	0,41	0,27
Arm L		0,34	0,29	-0,04	0,18	-0,04	-0,23	-0,30	0,11
Leg L		0,47	0,47	**0,64**	**0,73**	0,59	0,53	0,17	0,13

Table 12. Correlations of SEBT indicators of the right leg with SEBT indicators and anthropometry in female representatives of Kyokushinkai karate (n=10).

Indicator		Right leg SEBT positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	**0,85**	**0,88**	0,53	0,63	0,53	0,39	0,53	0,60
	2	**0,91**	**0,83**	**0,68**	**0,71**	**0,72**	0,57	0,57	**0,80**
	3	0,57	**0,69**	**0,86**	**0,78**	**0,67**	0,63	0,53	**0,90**
	4	0,41	0,61	**0,91**	**0,87**	**0,84**	**0,86**	**0,67**	**0,76**

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	5	0,42	0,60	**0,91**	**0,87**	**0,82**	**0,66**	0,50	**0,87**
	6	0,10	0,32	**0,78**	**0,70**	0,56	0,51	0,29	0,63
	7	0,11	0,33	0,38	0,40	0,36	0,31	0,52	0,13
	8	0,33	0,27	0,06	0,04	-0,02	-0,27	-0,22	0,54
SEBT of right leg	**1**	1,00	**0,92**	0,55	0,62	0,61	0,51	0,60	**0,73**
	2	**0,92**	1,00	**0,77**	**0,83**	**0,76**	**0,69**	**0,75**	**0,78**
	3	0,55	**0,77**	1,00	**0,98**	**0,91**	**0,87**	**0,77**	**0,81**
	4	0,62	**0,83**	**0,98**	1,00	**0,93**	**0,86**	**0,78**	**0,79**
	5	0,61	**0,76**	**0,91**	**0,93**	1,00	**0,86**	**0,81**	**0,77**
	6	0,51	**0,69**	**0,87**	**0,86**	**0,86**	1,00	**0,93**	0,57
	7	0,60	**0,75**	**0,77**	**0,78**	**0,81**	**0,93**	1,00	0,49
	8	**0,73**	**0,78**	**0,81**	**0,79**	**0,77**	0,57	0,49	1,00
SEBT of left arm	**1**	0,14	0,33	0,60	0,57	0,48	0,23	0,21	0,56
	2	0,13	0,30	0,57	0,48	0,35	0,21	0,14	0,61
	3	0,23	0,42	**0,72**	**0,64**	0,53	0,44	0,29	**0,76**
	4	0,08	0,36	**0,66**	0,58	0,49	0,61	0,49	0,50
	5	0,03	0,36	**0,67**	**0,65**	**0,64**	0,60	0,54	0,46
	6	-0,09	0,24	0,55	0,48	0,39	0,60	0,54	0,24
	7	-0,47	-0,22	0,07	0,08	-0,12	-0,17	-0,23	-0,19
	8	-0,03	0,01	-0,00	0,03	0,02	-0,42	-0,35	0,27
SEBT of right arm	**1**	0,00	0,20	0,47	0,40	0,37	0,18	0,24	0,43
	2	0,11	0,36	0,53	0,49	0,34	0,27	0,31	0,43
	3	0,14	0,39	**0,67**	0,62	0,49	0,39	0,28	0,63
	4	-0,02	0,28	**0,68**	0,58	0,52	0,57	0,48	0,49
	5	-0,09	0,24	**0,64**	0,59	0,54	0,53	0,43	0,42
	6	-0,26	0,06	0,48	0,40	0,37	0,43	0,35	0,27
	7	-0,45	-0,34	-0,07	-0,14	-0,28	-0,33	-0,33	-0,13
	8	-0,10	-0,02	-0,13	-0,14	-0,24	-0,42	-0,25	0,04
Height		**0,66**	**0,76**	**0,70**	**0,75**	**0,72**	0,59	0,55	**0,78**
Body W		0,37	0,42	0,51	0,53	**0,73**	0,43	0,47	0,63
Arm L		0,48	0,42	0,08	0,19	0,19	0,24	0,21	0,18
Leg L		0,49	0,60	**0,65**	0,62	0,49	**0,67**	0,56	0,58

Table 13. Correlations of SEBT indicators of the left arm with SEBT indicators and anthropometry in female representatives of Kyokushinkai karate (n=10).

Indicator		Left arm SEBT Positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	0,42	0,34	0,32	0,11	0,14	-0,03	0,01	0,25
	2	0,32	0,30	0,35	0,05	0,01	-0,15	-0,35	0,02
	3	0,63	**0,75**	**0,82**	0,61	0,47	0,42	-0,04	0,13

 doi:10.20944/preprints202409.0152.v1

	4	0,41	0,47	**0,75**	**0,79**	**0,74**	0,62	-0,01	-0,15
	5	**0,73**	**0,74**	**0,88**	**0,66**	**0,67**	0,44	0,18	0,25
	6	**0,78**	**0,82**	**0,85**	0,60	0,53	0,45	0,44	0,24
	7	**0,65**	0,48	0,32	0,32	0,50	0,42	0,48	0,33
	8	0,36	0,48	0,44	0,18	0,08	-0,01	-0,14	**0,65**
SEBT of right leg	**1**	0,14	0,13	0,23	0,08	0,03	-0,09	-0,47	-0,03
	2	0,33	0,30	0,42	0,36	0,36	0,24	-0,22	0,01
	3	0,60	0,57	**0,72**	**0,66**	**0,67**	0,55	0,07	-0,00
	4	0,57	0,48	**0,64**	0,58	**0,65**	0,48	0,08	0,03
	5	0,48	0,35	0,53	0,49	**0,64**	0,39	-0,12	0,02
	6	0,23	0,21	0,44	0,61	0,60	0,60	-0,17	-0,42
	7	0,21	0,14	0,29	0,49	0,54	0,54	-0,23	-0,35
	8	0,56	0,61	**0,76**	0,50	0,46	0,24	-0,19	0,27
SEBT of left arm	**1**	1,00	**0,91**	**0,77**	0,40	0,51	0,28	0,59	**0,69**
	2	**0,91**	1,00	**0,90**	0,54	0,45	0,34	0,50	0,54
	3	**0,77**	**0,90**	1,00	**0,78**	**0,66**	0,53	0,33	0,35
	4	0,40	0,54	**0,78**	1,00	**0,88**	**0,91**	0,17	-0,04
	5	0,51	0,45	**0,66**	**0,88**	1,00	**0,86**	0,26	0,16
	6	0,28	0,34	0,53	**0,91**	**0,86**	1,00	0,18	-0,15
	7	0,59	0,50	0,33	0,17	0,26	0,18	1,00	0,43
	8	**0,69**	0,54	0,35	-0,04	0,16	-0,15	0,43	1,00
SEBT of right arm	**1**	**0,91**	**0,85**	**0,68**	0,45	0,54	0,43	0,46	0,63
	2	**0,86**	**0,87**	**0,79**	0,63	0,62	0,53	0,61	0,50
	3	**0,82**	**0,87**	**0,94**	**0,79**	**0,73**	0,61	0,48	0,46
	4	0,62	**0,70**	**0,83**	**0,93**	**0,89**	**0,87**	0,32	0,11
	5	0,60	0,60	**0,77**	**0,90**	**0,96**	**0,85**	0,43	0,19
	6	0,47	0,51	**0,67**	**0,89**	**0,91**	**0,90**	0,35	0,09
	7	**0,65**	**0,68**	0,40	0,09	0,04	0,07	**0,78**	0,54
	8	0,56	0,55	0,33	0,15	0,16	0,11	0,47	**0,77**
Height		0,45	0,45	**0,70**	0,63	0,60	0,38	-0,04	0,18
Body W		0,50	0,38	0,54	0,45	**0,64**	0,30	-0,11	0,37
Arm L		-0,38	-0,38	-0,08	0,10	0,01	0,02	-0,45	-0,25
Leg L		0,26	0,45	**0,68**	**0,71**	0,43	0,51	-0,02	-0,24

Table 14. Correlations of SEBT indicators of the right arm with SEBT indicators and anthropometry in female representatives of Kyokushinkai karate (n=10).

Indicator		Right arm SEBT Positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of	**1**	0,25	0,46	0,35	0,07	0,07	-0,14	-0,06	0,27
	2	0,14	0,13	0,22	0,04	-0,05	-0,24	-0,28	-0,21

 doi:10.20944/preprints202409.0152.v1

	3	0,56	0,55	**0,70**	**0,65**	0,49	0,39	0,09	0,07
	4	0,28	0,41	**0,66**	**0,74**	**0,73**	0,61	-0,19	-0,28
	5	0,56	0,59	**0,79**	**0,72**	**0,70**	0,54	0,10	-0,00
	6	**0,64**	**0,63**	**0,81**	**0,71**	**0,65**	0,53	0,43	0,08
	7	**0,73**	**0,77**	0,48	0,51	0,51	0,45	0,46	0,55
	8	0,40	0,35	0,43	0,14	0,06	0,04	0,18	**0,63**
SEBT of right leg	**1**	0,00	0,11	0,14	-0,02	-0,09	-0,26	-0,45	-0,10
	2	0,20	0,36	0,39	0,28	0,24	0,06	-0,34	-0,02
	3	0,47	0,53	**0,67**	**0,68**	**0,64**	0,48	-0,07	-0,13
	4	0,40	0,49	0,62	0,58	0,59	0,40	-0,14	-0,14
	5	0,37	0,34	0,49	0,52	0,54	0,37	-0,28	-0,24
	6	0,18	0,27	0,39	0,57	0,53	0,43	-0,33	-0,42
	7	0,24	0,31	0,28	0,48	0,43	0,35	-0,33	-0,25
	8	0,43	0,43	**0,63**	0,49	0,42	0,27	-0,13	0,04
SEBT of left arm	**1**	**0,91**	**0,86**	**0,82**	0,62	0,60	0,47	**0,65**	0,56
	2	**0,85**	**0,87**	**0,87**	**0,70**	0,60	0,51	**0,68**	0,55
	3	**0,68**	**0,79**	**0,94**	**0,83**	**0,77**	**0,67**	0,40	0,33
	4	0,45	**0,63**	**0,79**	**0,93**	**0,90**	**0,89**	0,09	0,15
	5	0,54	0,62	**0,73**	**0,89**	**0,96**	**0,91**	0,04	0,16
	6	0,43	0,53	0,61	**0,87**	**0,85**	**0,90**	0,07	0,11
	7	0,46	0,61	0,48	0,32	0,43	0,35	**0,78**	0,47
	8	**0,63**	0,50	0,46	0,11	0,19	0,09	0,54	**0,77**
SEBT of right arm	**1**	1,00	**0,85**	**0,76**	**0,69**	0,61	0,57	**0,69**	**0,66**
	2	**0,85**	1,00	**0,89**	**0,75**	**0,72**	**0,63**	**0,67**	**0,70**
	3	**0,76**	**0,89**	1,00	**0,82**	**0,82**	**0,71**	0,50	0,50
	4	**0,69**	**0,75**	**0,82**	1,00	**0,95**	**0,95**	0,31	0,24
	5	0,61	**0,72**	**0,82**	**0,95**	1,00	**0,96**	0,26	0,23
	6	0,57	**0,63**	**0,71**	**0,95**	**0,96**	1,00	0,26	0,22
	7	**0,69**	**0,67**	0,50	0,31	0,26	0,26	1,00	**0,70**
	8	**0,66**	**0,70**	0,50	0,24	0,23	0,22	**0,70**	1,00
Height		0,30	0,55	**0,70**	0,50	0,54	0,36	-0,12	0,15
Body W		0,50	0,43	0,53	0,52	0,57	0,47	-0,07	0,17
Arm L		-0,47	-0,21	-0,02	-0,24	-0,15	-0,24	-0,56	-0,20
Leg L		0,18	0,51	**0,64**	0,55	0,47	0,37	0,00	-0,01

The analysis of the SEBT correlations of female representatives from Kyokushinkai karate, presented in Tables 11–14, allows us to formulate the following provisions:

• indicators of some SEBT positions in Kyokushinkai karate representatives have reliable connections with anthropometric indicators of body weight, height, and leg length. No such relationships of SEBT positions have been established with arm length;

• representatives of Kyokushinkai karate have multiple highly reliable correlations between the SEBT indicators of the right and left legs in most positions (except for positions 7 and 8 of the left leg);

 doi:10.20944/preprints202409.0152.v1

• there are multiple highly reliable correlations between the SEBT indicators of the right and left arms in most positions;

• most of the SEBT positions of each of the limbs separately (left leg, right leg, left arm, right arm) have direct reliable relationships among themselves, which indicates the amplitude proportionality in the indicators of the SEBT positions of each of the participants of the Kyokushinkai karate group;

• SEBT positions 1, 2, 3, 4, and 5 of the right and left arms of Kyokushinkai karate representatives have multiple cross-direct connections with positions 3, 4, 5, 6, 7, 8 of the right and left legs. Positions 1 and 2 of both legs and positions 6 and 7 of both arms do not enter the cross ligaments;

• most SEBT positions of the right (1, 2, 3, 4, 5, 6, 8) and left (1, 3, 4, 5) legs, as well as position 3 of the right and 3, 4 of the left arm, are almost symmetrically related with indicators of height and leg length.

So, the above-mentioned regularities of the ratio of SEBT indicators in Kyokushinkai karate female representatives generally reflect the dynamic, neuromuscular, and coordination features of this type of combat sports, and indicate the symmetry of biolinks (arms and legs) and the uniform development of the human body as a result of sports training.

In Tables 15–18, the SEBT correlation matrix of the examined female representatives of fencing (epee) is presented sequentially.

Table 15. Correlations of SEBT indicators of the left leg with SEBT indicators and anthropometry in female fencers (n=8).

Indicator		Left leg SEBT positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	1,00	**0,93**	**0,87**	**0,78**	**0,81**	**0,81**	**0,74**	**0,79**
	2	**0,93**	1,00	**0,97**	**0,88**	**0,85**	**0,81**	**0,84**	**0,77**
	3	**0,87**	**0,97**	1,00	**0,90**	**0,84**	**0,77**	**0,82**	0,67
	4	**0,78**	**0,88**	**0,90**	1,00	**0,98**	**0,94**	**0,97**	**0,80**
	5	**0,81**	**0,85**	**0,84**	**0,98**	1,00	**0,98**	**0,98**	**0,85**
	6	**0,81**	**0,81**	**0,77**	**0,94**	**0,98**	1,00	**0,95**	**0,87**
	7	**0,74**	**0,84**	**0,82**	**0,97**	**0,98**	**0,95**	1,00	**0,88**
	8	**0,79**	**0,77**	0,67	**0,80**	**0,85**	**0,87**	**0,88**	1,00
SEBT of right leg	**1**	0,64	**0,82**	**0,86**	**0,90**	**0,87**	**0,81**	**0,88**	0,62
	2	0,60	**0,81**	**0,85**	**0,83**	**0,77**	0,70	**0,79**	0,47
	3	**0,76**	**0,89**	**0,89**	**0,83**	**0,82**	**0,77**	**0,80**	0,60
	4	**0,83**	**0,82**	**0,77**	**0,88**	**0,94**	**0,96**	**0,90**	**0,80**
	5	**0,80**	**0,78**	**0,75**	**0,87**	**0,94**	**0,96**	**0,86**	**0,76**
	6	0,70	0,68	0,61	**0,77**	**0,87**	**0,91**	**0,82**	**0,75**
	7	0,57	0,64	0,60	0,71	**0,77**	**0,78**	**0,75**	0,55
	8	0,11	0,29	0,27	0,30	0,32	0,34	0,38	0,12
SEBT of left arm	**1**	0,32	0,48	0,40	0,43	0,47	0,45	0,55	0,60
	2	0,35	0,48	0,45	0,60	0,66	0,61	0,68	0,67
	3	-0,14	-0,14	-0,17	0,03	0,13	0,11	0,11	0,19
	4	0,06	0,12	0,00	0,04	0,14	0,14	0,17	0,24
	5	0,29	0,32	0,19	0,18	0,29	0,30	0,29	0,37

 doi:10.20944/preprints202409.0152.v1

	6	0,33	0,40	0,31	0,26	0,34	0,32	0,34	0,37
	7	0,50	0,50	0,46	0,41	0,50	0,46	0,40	0,37
	8	0,47	0,55	0,50	0,61	0,66	0,63	0,67	**0,74**
SEBT of right arm	**1**	0,33	0,30	0,14	0,31	0,43	0,47	0,48	**0,72**
	2	0,16	0,17	0,07	0,26	0,40	0,42	0,39	0,45
	3	-0,37	-0,34	-0,32	-0,12	-0,04	-0,06	-0,06	-0,17
	4	-0,22	-0,19	-0,27	-0,22	-0,12	-0,11	-0,11	-0,09
	5	0,09	0,11	0,00	-0,02	0,08	0,08	0,08	0,17
	6	0,06	0,10	-0,03	-0,01	0,11	0,13	0,14	0,26
	7	0,49	0,39	0,21	0,21	0,34	0,40	0,34	0,63
	8	0,24	0,22	0,05	0,11	0,25	0,31	0,27	0,45
Height		-0,26	-0,29	-0,24	0,12	0,22	0,27	0,16	0,03
Body W		-0,44	-0,37	-0,28	-0,17	-0,23	-0,20	-0,18	-0,49
Arm L		-0,24	-0,27	-0,31	-0,03	0,04	0,09	0,09	0,30
Leg L		0,12	-0,08	-0,05	0,14	0,24	0,33	0,08	0,04

Table 16. Correlations of SEBT indicators of the right leg with SEBT indicators and anthropometry in female fencers (n=8).

Indicator		Right leg SEBT positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	0,64	0,60	**0,76**	**0,83**	**0,80**	0,70	0,57	0,11
	2	**0,82**	**0,81**	**0,89**	**0,82**	**0,78**	0,68	0,64	0,29
	3	**0,86**	**0,85**	**0,89**	**0,77**	**0,75**	0,61	0,60	0,27
	4	**0,90**	**0,83**	**0,83**	**0,88**	**0,87**	**0,77**	**0,71**	0,30
	5	**0,87**	**0,77**	**0,82**	**0,94**	**0,94**	**0,87**	**0,77**	0,32
	6	**0,81**	0,70	**0,77**	**0,96**	**0,96**	**0,91**	**0,78**	0,34
	7	**0,88**	**0,79**	**0,80**	**0,90**	**0,86**	**0,82**	**0,75**	0,38
	8	0,62	0,47	0,60	**0,80**	**0,76**	**0,75**	0,55	0,12
SEBT of right leg	**1**	1,00	**0,95**	**0,95**	**0,84**	**0,83**	**0,78**	**0,84**	0,61
	2	**0,95**	1,00	**0,94**	**0,77**	**0,71**	0,66	**0,82**	0,67
	3	**0,95**	**0,94**	1,00	**0,86**	**0,83**	**0,79**	**0,85**	0,63
	4	**0,84**	**0,77**	**0,86**	1,00	**0,97**	**0,96**	**0,90**	0,48
	5	**0,83**	**0,71**	**0,83**	**0,97**	1,00	**0,96**	**0,85**	0,41
	6	**0,78**	0,66	**0,79**	**0,96**	**0,96**	1,00	**0,92**	0,52
	7	**0,84**	**0,82**	**0,85**	**0,90**	**0,85**	**0,92**	1,00	**0,74**
	8	0,61	0,67	0,63	0,48	0,41	0,52	**0,74**	1,00
SEBT of left arm	**1**	0,58	0,41	0,55	0,43	0,44	0,51	0,43	0,48
	2	0,69	0,46	0,57	0,56	0,62	0,66	0,55	0,32
	3	0,13	-0,09	0,02	0,11	0,19	0,32	0,23	-0,02
	4	0,32	0,22	0,37	0,30	0,26	0,48	0,53	0,53

 doi:10.20944/preprints202409.0152.v1

	5	0,43	0,33	0,53	0,47	0,44	0,61	0,63	0,55
	6	0,54	0,44	0,62	0,47	0,46	0,60	0,62	0,56
	7	0,60	0,49	0,68	0,60	0,65	0,70	0,67	0,33
	8	0,62	0,38	0,54	0,54	0,62	0,61	0,41	0,19
SEBT of right arm	**1**	0,31	0,10	0,29	0,47	0,44	0,59	0,42	0,18
	2	0,42	0,22	0,38	0,50	0,52	0,70	0,62	0,43
	3	0,09	0,00	-0,01	0,05	0,07	0,24	0,35	0,23
	4	0,09	0,02	0,13	0,07	0,06	0,28	0,38	0,44
	5	0,27	0,17	0,35	0,26	0,24	0,44	0,47	0,45
	6	0,26	0,13	0,32	0,26	0,25	0,45	0,44	0,49
	7	0,25	0,08	0,37	0,45	0,46	0,57	0,37	0,21
	8	0,29	0,14	0,37	0,41	0,40	0,59	0,49	0,49
Height		0,13	-0,05	-0,08	0,19	0,32	0,36	0,26	0,16
Body W		-0,12	0,07	-0,20	-0,16	-0,24	-0,22	0,04	0,34
Arm L		-0,19	-0,43	-0,38	-0,14	-0,05	-0,02	-0,28	-0,27
Leg L		-0,02	-0,10	-0,06	0,26	0,40	0,32	0,14	-0,09

Table 17. Correlations of SEBT indicators of the left arm with SEBT indicators and anthropometry in female fencers (n=8).

Indicator		Left arm SEBT Positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	0,32	0,35	-0,14	0,06	0,29	0,33	0,50	0,47
	2	0,48	0,48	-0,14	0,12	0,32	0,40	0,50	0,55
	3	0,40	0,45	-0,17	0,00	0,19	0,31	0,46	0,50
	4	0,43	0,60	0,03	0,04	0,18	0,26	0,41	0,61
	5	0,47	0,66	0,13	0,14	0,29	0,34	0,50	0,66
	6	0,45	0,61	0,11	0,14	0,30	0,32	0,46	0,63
	7	0,55	0,68	0,11	0,17	0,29	0,34	0,40	0,67
	8	0,60	0,67	0,19	0,24	0,37	0,37	0,37	**0,74**
SEBT of right leg	**1**	0,58	0,69	0,13	0,32	0,43	0,54	0,60	0,62
	2	0,41	0,46	-0,09	0,22	0,33	0,44	0,49	0,38
	3	0,55	0,57	0,02	0,37	0,53	0,62	0,68	0,54
	4	0,43	0,56	0,11	0,30	0,47	0,47	0,60	0,54
	5	0,44	0,62	0,19	0,26	0,44	0,46	0,65	0,62
	6	0,51	0,66	0,32	0,48	0,61	0,60	0,70	0,61
	7	0,43	0,55	0,23	0,53	0,63	0,62	0,67	0,41
	8	0,48	0,32	-0,02	0,53	0,55	0,56	0,33	0,19
SEBT of left arm	**1**	1,00	**0,86**	0,41	0,65	0,69	**0,76**	0,48	**0,88**
	2	**0,86**	1,00	0,70	0,62	0,64	**0,71**	0,65	**0,94**
	3	0,41	0,70	1,00	0,69	0,59	0,58	0,60	0,54

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	4	0,65	0,62	0,69	1,00	**0,97**	**0,93**	**0,71**	0,45
	5	0,69	0,64	0,59	**0,97**	1,00	**0,97**	**0,81**	0,53
	6	**0,76**	**0,71**	0,58	**0,93**	**0,97**	1,00	**0,86**	0,61
	7	0,48	0,65	0,60	**0,71**	**0,81**	**0,86**	1,00	0,56
	8	**0,88**	**0,94**	0,54	0,45	0,53	0,61	0,56	1,00
SEBT of right arm	**1**	**0,74**	**0,77**	0,67	**0,74**	**0,75**	0,68	0,50	**0,73**
	2	0,66	**0,80**	**0,83**	**0,88**	**0,87**	**0,83**	**0,74**	0,65
	3	0,06	0,37	**0,81**	0,63	0,49	0,44	0,49	0,08
	4	0,37	0,41	**0,72**	**0,93**	**0,84**	**0,78**	0,63	0,20
	5	0,60	0,57	0,68	**0,98**	**0,97**	**0,94**	**0,78**	0,43
	6	**0,74**	0,64	0,66	**0,97**	**0,95**	**0,92**	0,67	0,54
	7	**0,74**	0,61	0,44	0,70	**0,80**	**0,76**	0,59	0,69
	8	**0,76**	0,63	0,54	**0,88**	**0,92**	**0,87**	0,62	0,60
Height		0,04	0,34	0,50	0,08	0,01	-0,01	0,11	0,25
Body W		-0,54	-0,56	-0,49	-0,38	-0,47	-0,52	-0,55	-0,69
Arm L		0,37	0,41	0,40	-0,01	-0,09	-0,11	-0,27	0,50
Leg L		-0,31	-0,11	-0,04	-0,37	-0,28	-0,32	-0,01	-0,02

Table 18. Correlations of SEBT indicators of the right arm with SEBT indicators and anthropometry in female fencers (n=8).

Indicator		Right arm SEBT Positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	0,33	0,16	-0,37	-0,22	0,09	0,06	0,49	0,24
	2	0,30	0,17	-0,34	-0,19	0,11	0,10	0,39	0,22
	3	0,14	0,07	-0,32	-0,27	0,00	-0,03	0,21	0,05
	4	0,31	0,26	-0,12	-0,22	-0,02	-0,01	0,21	0,11
	5	0,43	0,40	-0,04	-0,12	0,08	0,11	0,34	0,25
	6	0,47	0,42	-0,06	-0,11	0,08	0,13	0,40	0,31
	7	0,48	0,39	-0,06	-0,11	0,08	0,14	0,34	0,27
	8	**0,72**	0,45	-0,17	-0,09	0,17	0,26	0,63	0,45
SEBT of right leg	**1**	0,31	0,42	0,09	0,09	0,27	0,26	0,25	0,29
	2	0,10	0,22	0,00	0,02	0,17	0,13	0,08	0,14
	3	0,29	0,38	-0,01	0,13	0,35	0,32	0,37	0,37
	4	0,47	0,50	0,05	0,07	0,26	0,26	0,45	0,41
	5	0,44	0,52	0,07	0,06	0,24	0,25	0,46	0,40
	6	0,59	0,70	0,24	0,28	0,44	0,45	0,57	0,59
	7	0,42	0,62	0,35	0,38	0,47	0,44	0,37	0,49
	8	0,18	0,43	0,23	0,44	0,45	0,49	0,21	0,49
SEB T of	**1**	**0,74**	0,66	0,06	0,37	0,60	**0,74**	**0,74**	**0,76**
	2	**0,77**	**0,80**	0,37	0,41	0,57	0,64	0,61	0,63

 doi:10.20944/preprints202409.0152.v1

	3	0,67	**0,83**	**0,81**	**0,72**	0,68	0,66	0,44	0,54
	4	**0,74**	**0,88**	0,63	**0,93**	**0,98**	**0,97**	0,70	**0,88**
	5	**0,75**	**0,87**	0,49	**0,84**	**0,97**	**0,95**	**0,80**	**0,92**
	6	0,68	**0,83**	0,44	**0,78**	**0,94**	**0,92**	**0,76**	**0,87**
	7	0,50	**0,74**	0,49	0,63	**0,78**	0,67	0,59	0,62
	8	**0,73**	0,65	0,08	0,20	0,43	0,54	0,69	0,60
SEBT of right arm	**1**	1,00	**0,84**	0,33	0,53	0,68	**0,77**	**0,86**	**0,83**
	2	**0,84**	1,00	0,69	**0,80**	**0,85**	**0,87**	**0,72**	**0,86**
	3	0,33	0,69	1,00	**0,81**	0,61	0,51	0,06	0,33
	4	0,53	**0,80**	**0,81**	1,00	**0,93**	**0,87**	0,47	**0,72**
	5	0,68	**0,85**	0,61	**0,93**	1,00	**0,96**	**0,72**	**0,87**
	6	**0,77**	**0,87**	0,51	**0,87**	**0,96**	1,00	**0,80**	**0,95**
	7	**0,86**	**0,72**	0,06	0,47	**0,72**	**0,80**	1,00	**0,92**
	8	**0,83**	**0,86**	0,33	**0,72**	**0,87**	**0,95**	**0,92**	1,00
Height		0,16	0,45	0,55	0,21	0,03	0,10	-0,06	0,13
Body W		-0,61	-0,41	0,04	-0,20	-0,47	-0,48	**-0,73**	-0,49
Arm L		0,47	0,27	0,03	-0,07	-0,08	0,13	0,26	0,22
Leg L		-0,19	0,00	0,00	-0,26	-0,34	-0,31	-0,11	-0,13

The analysis of the SEBT correlations of fencing female representatives presented in Tables 15–18 allows us to formulate the following propositions:

• there are no correlations between the longitudinal indicators of the body (height, length of arms and legs) and the indicators of SEBT of epee female fencers;

• indicators of almost all SEBT positions of the left and right legs are tightly connected with each other by a strong direct connection (except for position 8 of the right leg—located in front in the combat stance), which indicates amplitude proportionality in the indicators of the SEBT positions of each member of the fencing group;

• indicators of most SEBT positions of the left and right legs are closely interconnected by strong direct connections, which indicates the amplitude proportionality of the indicators as well;

• there are high statistical interrelationships of indicators of many SEBT positions of the left and right arms, both among themselves and for each arm separately;

• "Front" positions 1, 2, 7, 8 of the SEBT of the left arm (located behind in the combat stance) of female fencers are connected by reliable high cross correlations with the indicators of the SEBT of the right leg (located in front of the combat stance). On the other hand, there are no cross correlations in the left-pushing leg, and the right arm is located in front in a combat stance. The right arm of female fencers is similar to the left arm of female boxers in its function.

The above-mentioned patterns of ratios of SEBT indicators in female fencers reflect the peculiarities of this type of single combat and indicate a disproportionately high development of legs in relation to the level of development of arms in female fencers. There is reason to say that the determining factor for fencers is physical training and development of the lower limbs, but not the presence of anthropometric advantages. The obtained SEBT results of female fencers indirectly indicate the presence of an asymmetric effect of fencing on the biolinks of the human body.

Tables 19–22 show the SEBT correlation matrix of the examined female WKF karate representatives.

 doi:10.20944/preprints202409.0152.v1

Table 19. Correlations of SEBT indicators of the left leg with SEBT indicators and anthropometry in female representatives of WKF karate (n=7).

Indicator		Left leg SEBT positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	1,00	**0,95**	**0,76**	0,72	0,72	**0,87**	**0,91**	**0,84**
	2	**0,95**	1,00	**0,89**	**0,84**	**0,86**	**0,87**	**0,92**	**0,80**
	3	**0,76**	**0,89**	1,00	**0,92**	**0,93**	**0,79**	**0,78**	0,54
	4	0,72	**0,84**	**0,92**	1,00	**0,97**	**0,81**	**0,83**	0,62
	5	0,72	**0,86**	**0,93**	**0,97**	1,00	**0,84**	**0,87**	0,68
	6	**0,87**	**0,87**	**0,79**	**0,81**	**0,84**	1,00	**0,93**	**0,84**
	7	**0,91**	**0,92**	**0,78**	**0,83**	**0,87**	**0,93**	1,00	**0,93**
	8	**0,84**	**0,80**	0,54	0,62	0,68	**0,84**	**0,93**	1,00
SEBT of right leg	**1**	**0,82**	**0,84**	0,63	0,47	0,52	0,53	0,68	0,67
	2	**0,90**	**0,88**	0,65	0,53	0,52	0,60	0,69	0,65
	3	0,74	**0,83**	0,75	0,53	0,60	0,54	0,61	0,54
	4	0,59	0,71	0,70	0,42	0,51	0,41	0,45	0,36
	5	0,64	**0,80**	**0,78**	0,57	0,67	0,51	0,60	0,51
	6	0,71	**0,79**	0,68	0,47	0,52	0,60	0,54	0,52
	7	0,65	**0,79**	0,69	0,54	0,61	0,49	0,56	0,55
	8	**0,81**	**0,84**	0,59	0,52	0,56	0,55	0,71	0,75
SEBT of left arm	**1**	0,68	**0,77**	0,75	0,73	0,67	0,42	0,60	0,41
	2	0,64	**0,76**	**0,80**	0,74	0,70	0,41	0,57	0,35
	3	**0,91**	**0,97**	**0,85**	**0,75**	**0,78**	**0,83**	**0,84**	**0,78**
	4	0,56	0,58	0,46	0,27	0,30	0,53	0,36	0,40
	5	0,19	0,28	0,24	0,04	0,12	0,26	0,07	0,17
	6	0,52	0,62	0,54	0,32	0,35	0,35	0,31	0,32
	7	**0,84**	**0,88**	0,75	0,68	0,67	0,55	0,73	0,62
	8	0,68	0,72	0,67	0,66	0,58	0,38	0,57	0,38
SEBT of right arm	**1**	**0,83**	**0,90**	**0,80**	**0,80**	0,75	0,62	**0,76**	0,63
	2	**0,85**	**0,89**	**0,78**	**0,79**	0,73	0,63	**0,76**	0,63
	3	**0,87**	**0,90**	**0,78**	0,73	0,68	0,72	0,71	0,62
	4	0,49	0,49	0,44	0,27	0,22	0,43	0,22	0,18
	5	0,34	0,39	0,36	0,16	0,17	0,35	0,13	0,14
	6	**0,76**	0,75	0,57	0,40	0,36	0,52	0,48	0,46
	7	**0,94**	**0,96**	**0,77**	**0,77**	**0,77**	**0,76**	**0,90**	**0,84**
	8	**0,88**	**0,87**	0,69	0,70	0,65	0,61	**0,78**	0,68
Height		0,62	0,57	0,28	0,06	0,09	0,24	0,33	0,41
Body W		0,49	0,39	0,10	0,10	0,10	0,49	0,35	0,55
Arm L		0,63	0,71	0,62	0,53	0,68	0,59	0,75	0,73

 doi:10.20944/preprints202409.0152.v1

Leg L	0,38	0,48	0,45	0,17	0,21	0,03	0,16	0,09

Table 20. Correlations of SEBT indicators of the right leg with SEBT indicators and anthropometry in female representatives of WKF karate (n=7).

Indicator		Right leg SEBT positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	**0,82**	**0,90**	0,74	0,59	0,64	0,71	0,65	**0,81**
	2	**0,84**	**0,88**	**0,83**	0,71	**0,80**	**0,79**	**0,79**	**0,84**
	3	0,63	0,65	0,75	0,70	**0,78**	0,68	0,69	0,59
	4	0,47	0,53	0,53	0,42	0,57	0,47	0,54	0,52
	5	0,52	0,52	0,60	0,51	0,67	0,52	0,61	0,56
	6	0,53	0,60	0,54	0,41	0,51	0,60	0,49	0,55
	7	0,68	0,69	0,61	0,45	0,60	0,54	0,56	0,71
	8	0,67	0,65	0,54	0,36	0,51	0,52	0,55	0,75
SEBT of right leg	**1**	1,00	**0,94**	**0,94**	**0,86**	**0,87**	**0,82**	**0,87**	**0,96**
	2	**0,94**	1,00	**0,86**	0,75	0,75	**0,82**	**0,80**	**0,92**
	3	**0,94**	**0,86**	1,00	**0,98**	**0,97**	**0,90**	**0,94**	**0,87**
	4	**0,86**	0,75	**0,98**	1,00	**0,96**	**0,89**	**0,92**	**0,76**
	5	**0,87**	0,75	**0,97**	**0,96**	1,00	**0,85**	**0,95**	**0,82**
	6	**0,82**	**0,82**	**0,90**	**0,89**	**0,85**	1,00	**0,92**	**0,79**
	7	**0,87**	**0,80**	**0,94**	**0,92**	**0,95**	**0,92**	1,00	**0,89**
	8	**0,96**	**0,92**	**0,87**	**0,76**	**0,82**	**0,79**	**0,89**	1,00
SEBT of left arm	**1**	0,71	**0,77**	0,67	0,58	0,65	0,48	0,63	0,72
	2	0,71	0,72	0,72	0,66	0,72	0,50	0,65	0,67
	3	**0,87**	**0,88**	**0,89**	**0,80**	**0,86**	**0,91**	**0,88**	**0,87**
	4	0,57	0,63	0,65	0,66	0,57	**0,91**	0,71	0,55
	5	0,35	0,31	0,50	0,58	0,49	**0,77**	0,63	0,34
	6	0,75	0,74	**0,83**	**0,86**	**0,80**	**0,95**	**0,91**	0,74
	7	**0,90**	**0,92**	**0,83**	0,72	**0,78**	0,65	**0,76**	**0,89**
	8	0,69	**0,77**	0,62	0,51	0,57	0,41	0,54	0,69
SEBT of right arm	**1**	**0,81**	**0,88**	**0,76**	0,64	0,72	0,66	**0,76**	**0,86**
	2	**0,79**	**0,88**	0,71	0,58	0,66	0,60	0,68	**0,82**
	3	**0,77**	**0,90**	0,75	0,66	0,68	**0,84**	**0,77**	**0,80**
	4	0,42	0,59	0,50	0,52	0,39	**0,79**	0,54	0,39
	5	0,39	0,46	0,52	0,58	0,46	**0,82**	0,60	0,36
	6	**0,80**	**0,91**	**0,78**	0,74	0,66	**0,91**	**0,77**	**0,77**
	7	**0,88**	**0,91**	**0,79**	0,64	0,74	0,68	0,75	**0,91**
	8	**0,83**	**0,91**	0,70	0,55	0,63	0,57	0,65	**0,86**
Height		**0,88**	**0,87**	**0,78**	0,74	0,65	**0,77**	0,72	**0,81**
Body W		0,36	0,47	0,27	0,20	0,18	0,61	0,40	0,46

 doi:10.20944/preprints202409.0152.v1

Arm L	0,74	0,54	0,75	0,67	**0,80**	0,51	0,67	0,71
Leg L	**0,79**	0,69	**0,85**	**0,89**	**0,82**	0,70	**0,79**	0,69

Table 21. Correlations of SEBT indicators of the left arm with SEBT indicators and anthropometry in female representatives of WKF karate (n=7).

Indicator		Left arm SEBT Positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	0,68	0,64	**0,91**	0,56	0,19	0,52	**0,84**	0,68
	2	**0,77**	**0,76**	**0,97**	0,58	0,28	0,62	**0,88**	0,72
	3	0,75	**0,80**	**0,85**	0,46	0,24	0,54	0,75	0,67
	4	0,73	0,74	0,75	0,27	0,04	0,32	0,68	0,66
	5	0,67	0,70	**0,78**	0,30	0,12	0,35	0,67	0,58
	6	0,42	0,41	**0,83**	0,53	0,26	0,35	0,55	0,38
	7	0,60	0,57	**0,84**	0,36	0,07	0,31	0,73	0,57
	8	0,41	0,35	**0,78**	0,40	0,17	0,32	0,62	0,38
SEBT of right leg	**1**	0,71	0,71	**0,87**	0,57	0,35	0,75	**0,90**	0,69
	2	**0,77**	0,72	**0,88**	0,63	0,31	0,74	**0,92**	**0,77**
	3	0,67	0,72	**0,89**	0,65	0,50	**0,83**	**0,83**	0,62
	4	0,58	0,66	**0,80**	0,66	0,58	**0,86**	0,72	0,51
	5	0,65	0,72	**0,86**	0,57	0,49	**0,80**	**0,78**	0,57
	6	0,48	0,50	**0,91**	**0,91**	**0,77**	**0,95**	0,65	0,41
	7	0,63	0,65	**0,88**	0,71	0,63	**0,91**	**0,76**	0,54
	8	0,72	0,67	**0,87**	0,55	0,34	0,74	**0,89**	0,69
SEBT of left arm	**1**	1,00	**0,98**	0,67	0,17	-0,12	0,46	**0,94**	**0,99**
	2	**0,98**	1,00	0,66	0,16	-0,09	0,47	**0,91**	**0,95**
	3	0,67	0,66	1,00	0,74	0,50	**0,77**	**0,82**	0,60
	4	0,17	0,16	0,74	1,00	**0,89**	**0,87**	0,34	0,10
	5	-0,12	-0,09	0,50	**0,89**	1,00	**0,80**	0,04	-0,22
	6	0,46	0,47	**0,77**	**0,87**	**0,80**	1,00	0,58	0,38
	7	**0,94**	**0,91**	**0,82**	0,34	0,04	0,58	1,00	**0,93**
	8	**0,99**	**0,95**	0,60	0,10	-0,22	0,38	**0,93**	1,00
SEBT of right arm	**1**	**0,95**	**0,90**	**0,84**	0,39	0,09	0,60	**0,96**	**0,92**
	2	**0,95**	**0,90**	**0,81**	0,34	0,00	0,53	**0,96**	**0,94**
	3	**0,76**	0,70	**0,91**	0,73	0,41	**0,76**	**0,82**	0,71
	4	0,24	0,22	0,61	**0,92**	0,74	**0,79**	0,31	0,20
	5	0,07	0,07	0,57	**0,96**	**0,93**	**0,85**	0,17	-0,01
	6	0,57	0,53	**0,83**	**0,86**	0,59	**0,88**	0,71	0,56
	7	**0,83**	**0,78**	**0,90**	0,43	0,12	0,54	**0,94**	**0,81**
	8	**0,92**	**0,85**	**0,79**	0,31	-0,05	0,48	**0,97**	**0,92**
Height		0,47	0,43	0,66	0,65	0,46	**0,77**	0,68	0,49

 doi:10.20944/preprints202409.0152.v1

Body W	-0,07	-0,17	0,52	**0,80**	0,68	0,55	0,14	-0,09
Arm L	0,45	0,52	0,69	0,22	0,15	0,35	0,65	0,40
Leg L	0,62	0,67	0,56	0,45	0,39	**0,79**	0,69	0,59

Table 22. Correlations of SEBT indicators of the right arm with SEBT indicators and anthropometry in female representatives of WKF karate (n=7).

Indicator		Right arm SEBT Positions (Marked correlations are significant at P < 0,05)							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEBT of left leg	**1**	**0,83**	**0,85**	**0,87**	0,49	0,34	**0,76**	**0,94**	**0,88**
	2	**0,90**	**0,89**	**0,90**	0,49	0,39	0,75	**0,96**	**0,87**
	3	**0,80**	**0,78**	**0,78**	0,44	0,36	0,57	**0,77**	0,69
	4	**0,80**	**0,79**	0,73	0,27	0,16	0,40	**0,77**	0,70
	5	0,75	0,73	0,68	0,22	0,17	0,36	**0,77**	0,65
	6	0,62	0,63	0,72	0,43	0,35	0,52	**0,76**	0,61
	7	**0,76**	**0,76**	0,71	0,22	0,13	0,48	**0,90**	**0,78**
	8	0,63	0,63	0,62	0,18	0,14	0,46	**0,84**	0,68
SEBT of right leg	**1**	**0,81**	**0,79**	**0,77**	0,42	0,39	**0,80**	**0,88**	**0,83**
	2	**0,88**	**0,88**	**0,90**	0,59	0,46	**0,91**	**0,91**	**0,91**
	3	**0,76**	0,71	0,75	0,50	0,52	**0,78**	**0,79**	0,70
	4	0,64	0,58	0,66	0,52	0,58	0,74	0,64	0,55
	5	0,72	0,66	0,68	0,39	0,46	0,66	0,74	0,63
	6	0,66	0,60	**0,84**	**0,79**	**0,82**	**0,91**	0,68	0,57
	7	**0,76**	0,68	**0,77**	0,54	0,60	**0,77**	0,75	0,65
	8	**0,86**	**0,82**	**0,80**	0,39	0,36	**0,77**	**0,91**	**0,86**
SEBT of left arm	**1**	**0,95**	**0,95**	**0,76**	0,24	0,07	0,57	**0,83**	**0,92**
	2	**0,90**	**0,90**	0,70	0,22	0,07	0,53	**0,78**	**0,85**
	3	**0,84**	**0,81**	**0,91**	0,61	0,57	0,83	**0,90**	**0,79**
	4	0,39	0,34	0,73	**0,92**	**0,96**	**0,86**	0,43	0,31
	5	0,09	0,00	0,41	0,74	**0,93**	0,59	0,12	-0,05
	6	0,60	0,53	**0,76**	**0,79**	**0,85**	**0,88**	0,54	0,48
	7	**0,96**	**0,96**	**0,82**	0,31	0,17	0,71	**0,94**	**0,97**
	8	**0,92**	**0,94**	0,71	0,20	-0,01	0,56	**0,81**	**0,92**
SEBT of right arm	**1**	1,00	**0,99**	**0,89**	0,40	0,25	0,72	**0,94**	**0,96**
	2	**0,99**	1,00	**0,88**	0,38	0,19	0,70	**0,94**	**0,98**
	3	**0,89**	**0,88**	1,00	0,75	0,61	**0,91**	**0,85**	**0,84**
	4	0,40	0,38	0,75	1,00	**0,94**	**0,86**	0,34	0,32
	5	0,25	0,19	0,61	**0,94**	1,00	**0,77**	0,22	0,12
	6	0,72	0,70	**0,91**	**0,86**	**0,77**	1,00	0,70	0,69
	7	**0,94**	**0,94**	**0,85**	0,34	0,22	0,70	1,00	**0,95**
	8	**0,96**	**0,98**	**0,84**	0,32	0,12	0,69	**0,95**	1,00
Height		0,57	0,55	0,64	0,56	0,52	**0,86**	0,62	0,62
Body W		0,23	0,20	0,55	0,70	0,71	0,65	0,35	0,24
Arm L		0,54	0,51	0,38	-0,08	0,01	0,28	0,72	0,54
Leg L		0,58	0,53	0,52	0,40	0,42	0,67	0,50	0,52

The analysis of the SEBT correlations of female WKF karate representatives presented in Tables 19–22 allows us to formulate the following propositions:

 doi:10.20944/preprints202409.0152.v1

• indicators of almost all SEBT positions separately for the left leg and separately for the right leg are closely related to each other, which indicates the amplitude proportionality in the indicators of the SEBT positions of each of the participants of the WKF karate group;

• "front" positions 1, 2, and 3 SEBT of the left leg have multiple connections with most positions of the SEBT of the right leg. At the same time, positions 4, 5, 6, 7, 8 of the left leg are not related to the SEBT positions of the right leg;

• SEBT positions of the right leg are related to anthropometric indicators—height and leg length. This fact is not observed with SEBT indicators of the left leg;

• SEBT indicators of the right and left arm have multiple correlations;

• all four limbs (two arms and two legs) have cross-multiple correlations of SEBT indicators.

The above-mentioned features of SEBT in WKF karate female representatives indicate that, along with symmetrical manifestations (multiple cruciate ligaments of all limbs), asymmetric manifestations are observed under the influence of the left-sided combat stance: according to SEBT indicators, the right leg is more developed than the left leg (located in front of combat stance).

4. Discussion

In the ***Introduction*** of this article, we substantiated the relevance of using the Star Excursion Balance Test technique in martial arts. Many studies have been previously conducted in sports using this technique for medical and rehabilitation purposes, as well as in the study of asymmetry. These studies were carried out mainly with representatives of sports games (such as basketball, football, volleyball, etc). There have been very few studies using the SEBT technique in martial arts. Our work is unique with using the SEBT methodology for sports and pedagogical purposes. In order to achieve such goals, it is necessary to thoroughly study the specifics of the influence of each type of combat sport on the dynamic balance of the upper and lower limbs of the athletes, and their neuromuscular and proprioceptive properties.

Each type of martial arts has its own training system, which has certain requirements for the manifestation of motor (physical) qualities of athletes in accordance with the competition rules of this type of martial arts. Using the SEBT methodology exactly as presented in this study allows us to monitor athletes` dynamic balance and identify advantages and disadvantages in their training system.

As can be seen from Tables 1–6 in the ***Results***, the pairwise comparison of the average group indicators of SEBT and anthropometry in representatives of different combat sports using the Mann-Whitney U-test method made it possible to reveal amplitude differences between them that reflect dynamic balance, as well as some features of the application of the Star Excursion Balance Test itself in this aspect:

• Tables 1–6 showed the differences between the women's types of Kyokushinkai karate, fencing, and WKF karate according to arithmetic mean indicators due to the separation of their SEBT positions into different groups (as described in the ***Results***); female boxers had the lowest amplitude indicators of SEBT, and therefore their features were not clearly manifested;

• differences in SEBT positions of athletes between combat sports are traced by highlighting dominant mean values when comparing them pairwise.

The presented correlation matrices (Tables 7–22) quite logically and clearly prove the differences in each group of martial arts athletes, described in detail in the ***Results*** section. During the study, it was possible to trace the differences in SEBT indicators in women who have been professionally involved for many years in the types of martial arts presented in the article: the correlation matrices of SEBT indicators qualitatively reflect the intragroup coordination connections of the upper and lower extremities that participate in duels.

The results of this study of SEBT indicators in representatives of boxing and fencing indirectly indicate the asymmetrical impact of these martial arts on the arms and legs of the human body. SEBT indicators and their correlations prove the long-term asymmetrical influence of the fighting stance on the body of each athlete in these martial arts.

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Thus, female boxers are characterized by low SEBT scores, which can be explained by the insufficient use of balancing and stretching exercises in their training. Competition in modern boxing involves speed-power combat at a high tempo, where during the fight it is necessary to maintain a stable vertical position of the body while fast movements and especially when striking. Actually, this leads to a limitation of the dynamic balance of the upper and especially lower extremities—the movements of the torso when performing strikes are rotational in nature around a vertical axis. In this case, the left leg in front in a fighting stance (for right-handed boxers) performs a stopping function—so that the athlete does not fall forward when performing strikes. The left hand of right-handed boxers is multifunctional (defense, feint, strike). The right hand is used to deliver an accented blow. The right leg performs the main function of maintaining dynamic balance and getting closer to the opponent—it is more developed.

Among representatives of fencing, the specificity of training is completely different—it is not rotational, but translational movements of the torso and legs that predominate. The requirement for the athlete is to give the thrust as quickly and accurately as possible. To do this, he (she) uses jumping movements with legs and maximum bends of torso forward with arm outstretched with an epee. Exercises to develop leg strength and flexibility are widely used in the training of fencers, which is confirmed by the SEBT results in our study. The right hand (for right-handed fencers) is always in front in a fighting stance—it has many functions (defense, feint, thrust). The left hand is always behind, performing a balancing function. The fencer's left leg performs the main function of maintaining dynamic balance and getting closer to the opponent, while the right leg performs the stopping function.

The SEBT results of Kyokushinkai karate representatives indicate the symmetry and uniform development of the left and right parts of their body. Kyokushinkai karate is a full-contact striking martial art that uses a wide range of actions with all four limbs, and has good centuries-old traditions in training athletes: symmetrical development of all limbs is mandatory. The philosophy of this type of martial arts is based on the harmonious development of the fighter. Thus, in the training of fighters, amplitude stretching exercises, as well as dynamic balance, is widely used. The results of SEBT correlations among female Kyokushinkai karate representatives in our study confirm this.

The indicators of WKF karate representatives occupy an intermediate place in this comparison: the features of their SEBT indicators show that along with symmetrical manifestations, asymmetrical ones are also observed. WKF Karate, unlike Kyokushinkai karate, is not a full contact striking sport. In terms of its requirements for training athletes, it is closer to fencing. Athletes in this type of martial arts do not strike, but only touch the opponent during the fight. That is, they do not need to use all their force in the forward movement—they need to return back very quickly after touching. During the training of WKF karate athletes, stretching and balance exercises are widely used for all four body limbs—arms and legs. Attention is paid to improving leg movements, the same way as in fencing. Thus, the results of SEBT of WKF karate athletes, presented in the ***Results*** section, confirm the above-described features of this type of martial arts.

The method we propose for apply SEBT can be used both to compare different groups of athletes of the same type of martial arts, as well as to compare different types of martial arts with each other. The application of the SEBT technique can be suitable to support the introduction of certain sets of exercises from other combat sports to develop (or improve) the necessary qualities in one's combat sport.

In addition, a comparison of the anthropometric data of athletes with their SEBT indicators (Tables 1–6) quite reasonably allows us to formulate a new hypothesis for subsequent research: long-term training in a certain type of martial arts influences the formation of the physique of athletes. The absence of correlations between anthropometric indicators and SEBT indicators in fencers (Tables 15–18), and vice versa, the presence of such correlations in representatives of boxing (Tables 7–10), two types of karate (Tables 11–14 and 19–22) involved in the study, require scientific explanation.

The results of this study will be used for sports and pedagogical purposes in the following directions:

 doi:10.20944/preprints202409.0152.v1

1. The use of the SEBT technique with further analysis of its indicators in athletes of a certain type of combat sport will allow to identify shortcomings and advantages in the balance of their upper and lower limbs in each of the eight positions of the test. The next step will be the selection of a set of exercises (more likely from related types of martial arts), the effectiveness of which will be confirmed by positive changes in indicators of previously lagging positions of SEBT. This approach will improve the athlete's balance in lagging directions of his (or her) movements, and therefore will significantly increase his (or her) motor base.

2. The use of correlation analysis of SEBT indicators in a group of athletes of the same type of martial arts allows us to identify intra-group coordination connections between all limbs—arms and legs (in other words, to identify a specific imprint of the preparation period). Correlation reflects the trends of this group as a whole, and therefore of each of its individual members in particular. Each such SEBT coordination imprint will demonstrate both the advantages and shortcomings of the influence of athletes` training in a certain type of combat sport, which will allow pedagogical corrections to be made in the training process.

5. The Limitation of the Research

Conclusions from our studies are limited by the caveat that these were studies with relatively small samples.

6. Conclusions

The hypothesis of this work is confirmed by the results of the conducted research, which indicates that engaging in a certain type of combat sports has its own specific imprint on the indicators of Star Excursion Balance Test. The obtained data of SEBT indicators in female representatives of boxing, Kyokushinkai karate, fencing, and karate WKF are different and reflect in general the dynamic, neuromuscular, and coordination features of each athletes` group of the studied combat sports. The results of the correlations of SEBT indicators of boxing and fencing representatives indirectly indicate the asymmetric impact of these combat sports on the links of the body (arms and legs) of a person. The SEBT results of the Kyokushinkai karate female representatives testify, on the contrary, to the symmetry and uniform development of both parts of the body—left and right. WKF karate female representatives occupy an intermediate place in this: the peculiarities of their SEBT indicators show that along with symmetrical manifestations, asymmetric ones are also observed under the influence of competitive activity in the left-sided combat stance.

Author Contributions: Conceptualization, B.K. and S.N.; methodology, B.K. and S.N; validation, B.K., S.N. and W.J.C; investigation, B.K., S.N., S.W., V.B., and W.J.C; resources, B.K., S.N., S.W., V.B., Z.S., I.K., I.B., I.I., and W.J.C; software, S.N., B.K., and W.J.C.; formal analysis, S.N., B.K., S.W., V.B., I.K., and W.J.C.; writing—original draft preparation B.K., S.N. and W.J.C.; writing—review and editing, B.K., S.N. and W.J.C.; data curation, B.K., S.N., and W.J.C.;visualization, B.K., S.N.; supervision, B.K., S.N.; project administration, B.K., S.N., and W.J.C.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was approved by the Ethics Committee of the Idokan Poland Association, Committee of Scientific Research, in accordance with the Declaration of Helsinki (Opinion No. A2/2023).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The authors confirm that the data supporting the findings of this study are available within the article.

Conflicts of Interest: The authors declare no conflicts of interest.

 doi:10.20944/preprints202409.0152.v1

References

1. Bhanot, K., Kaur, N., Brody, L.T., Bridges, J., Berry, D.C., & Ode, J.J. (2019). Hip and Trunk Muscle Activity During the Star Excursion Balance Test in Healthy Adults. Journal of Sport Rehabilitation, 28(7), 682-691. doi: 10.1123/jsr.2017-0145.
2. Bulow, A., Anderson, J.E., Leiter, J.R., MacDonald, P.B., & Peeler J. (2019). The modified star excursion balance and y-balance test results differ when assessing physically active healthy adolescent females. International Journal of Sports Physical Therapy, 14(2), 192-203.
3. Chang, Wen-Dien & Chou, Li-Wei & Chang, Nai-Jen & Chen, Shuya (2020). Comparison of Functional Movement Screen, Star Excursion Balance Test, and Physical Fitness in Junior Athletes with Different Sports Injury Risk. BioMed Research International, 2020, 1-8, DOI: 10.1155/2020/8690540.
4. de la Motte, S., Arnold, B.L., & Ross, S.E. (2015). Trunk-Rotation Differences at Maximal Reach of the Star Excursion Balance Test in Participants With Chronic Ankle Instability. Journal of Athletic Training, 50(4), 358–365. doi: 10.4085/1062-6050-49.3.74
5. Drouet, N., Bassement, J., & Barbier, F. (2022). The modified star excursion balance test for the detection of the risk of injury in elite handball female players. Journal of sports medicine and therapy, 7: 019-027. DOI: 10.29328/journal.jsmt.1001059
6. Endo, Y., & Miura, M. (2021). Effects of posture and lower limb muscle strength on the results of the Star Excursion Balance Test. The Journal of Physical Therapy Science, Vol. 33, No. 9, 641-645.
7. Gonell, A.C., Romero, J.A., & Soler L.M. (2015). Relationship between the y-balance test scores and soft tissue injury incidence in a soccer team. International Journal of Sports Physical Therapy, 10(7), 955-966.
8. Gribble, P.A., Hertel, J., & Denegar, C.R. (2007). Chronic ankle instability and fatigue create proximal joint alterations during performance of the Star Excursion Balance Test. International Journal of Sports Medicine, 28(3), 236–242.
9. Guan, Yanfei & Bredin, Shannon & Taunton, Jack & Jiang, Qinxian & Wu, Lina & Kaufman, Kai & Wu, Nana & Warburton, Darren (2020). Bilateral difference between lower limbs in children practicing laterally dominant vs. non-laterally dominant sports. European Journal of Sport Science, 21, 1-23, DOI: 10.1080/17461391.2020.1814425.
10. Guan, Yanfei & Bredin, Shannon & Jiang, Qinxian & Taunton, Jack & Li, Yongfeng & Wu, Nana & Wu, Lina & Warburton, Darren (2021). The effect of fatigue on asymmetry between lower limbs in functional performances in elite child taekwondo athletes. Journal of Orthopaedic Surgery and Research, 16, DOI: 10.1186/s13018-020-02175-7.
11. Jlid, M. & Maffulli, Nicola & Souissi, Nizar & Chelly, Mohamed Souhaiel & Paillard, Thierry (2016). Pre-pubertal males practising Taekwondo exhibit favourable postural and neuromuscular performance. BMC Sports Science, Medicine and Rehabilitation, 8, DOI: 10.1186/s13102-016-0040-2.
12. Karagiannakis, D.N., Iatridou, K.I., & Mandalidis, D.G. (2020). Ankle muscles activation and postural stability with Star Excursion Balance Test in healthy individuals. Human Movement Science, 69, 102563.
13. Kindzer B.M., Nikitenko S.A., Vyshnevetskyi S.M. (2024). Pokaznyky dynamichnoi rivnovahy za metodykoiu Star Excursion Balance Test u sportsmeniv riznoi kvalifikatsii z Kiokushyn karate [Indicators of dynamic balance by the method of star excursion balance test in athletes of different qualifications in Kyokushinkai karate]. Yedynoborstva [Martial arts]. Kharkiv, № 1 (31). S. 49-57. ISSN (Ukrainian ed. Online) 2523-4196 . DOI:10.15391/ed.2024-1.05
14. Kindzer B. M., Nikitenko S. A. (2023). Vymiriuvannia dynamichnoi rivnovahy u sportsmeniv z Kiokushyn karate, boksu ta aikido za metodykoiu Star Excursion Balance Test (SEBT) [Measurement of dynamic balance in Kyokushin karate, boxing and aikido athletes using the Star Excursion Balance Test (SEBT) method]. Suchasni tendenci*i*′ ta perspektyvy rozvytku fizychnoi′ pidgotovky ta sportu Zbrojnyh Syl Ukra*i*′ny, pravoohoronnyh organiv, rjatuva*l*′nyh ta inshyh specia*l*′nyh sluzhb na shljahu jevroatlantychno*i*′ integraci*i*′ Ukra*i*′ny [Current trends and prospects for the development of physical training and sports of the Armed Forces of Ukraine, law enforcement agencies, rescue and other special services on the path of Euro-Atlantic integration of Ukraine], 415-418 [in Ukrainian].ISBN 978-617-7187-92-8
15. Kinzey, S.J., & Armstrong C.W. (1998). The reliability of the Star-Excursion Test in assessing dynamic balance. Journal of Orthopaedic and Sports Physical Therapy, 27(5), 356–360.
16. Margnes E., Paillard T. (2011). Teaching balance for judo practitioners. Ido Movement for Culture. Journal of Martial Arts Anthropology, 11 (1), 42-46.
17. Munro, A.G., & Herrington, L.C. (2010). Between-session reliability of the star excursion balance test. Physical Therapy in Sport, 11, 128–132.
18. Pawelec P., Swider P., Yu J.H. (2022). Topics concerning women practicing fighting systems in the discourse of selected scientific journals—A short bibliometric analysis, Ido Movement for Culture. Journal of Martial Arts Anthropology, 22(1), 58-67; DOI: 10.14589/ido.22.1.8

19. Philp, F., Telford, C., Reid, D., & Mccluskey, M. (2019). Establishing normative performance values of modified Star Excursion Balance Test (mSEBT) and Limb 4 Symmetry Index (LSI) scores and their relationship to age in female adolescent footballers. http://dx.doi.org/10.31236/osf.io/k2e5t
20. Picot, B., Terrier, R., Forestier, N., Fourchet, F., & McKeon, P.O. (2021). The Star Excursion Balance Test: An Update Review and Practical Guidelines. International Journal of Athletic Therapy and Training, 26(6), 285–293.
21. Plisky, P.J., Rauh, M.J., Kaminski, T.W., & Underwood, F.B. (2006). Star Excursion Balance Test as a predictor of lower extremity injury in high school basketball players. Journal of Orthopaedic and Sports Physical Therapy, 36(12), 911-919. doi: 10.2519/jospt.2006.2244.
22. Podrigalo L., Cynarski W.J., Rovnaya O., Volodchenko O., Halashko O., Volodchenko J. (2019). Studying of physical development features of elite athletes of combat sports by means of special indexes. Ido Movement for Culture. Journal of Martial Arts Anthropology, vol. 19, no. 1, pp. 75–81; DOI: 10.14589/ido.19.1.5.
23. Smith, C.A., Chimera, N.J., & Warren M. (2015). Association of y-balance test reach asymmetry and injury in division I athletes. Medicine & Science in Sports & Exercise, 47(1), 136-141. doi: 10.1249/MSS.0000000000000380.
24. Stiffler, M.R., Bell, D.R., Sanfilippo, J.L., Hetzel, S.J., Pickett, K.A., & Heiderscheit, B.C. (2017). Star Excursion Balance Test Anterior Asymmetry is Associated with Injury Status in Division I Collegiate Athletes. Journal of Orthopaedic and Sports Physical Therapy, 47(5), 339–345.
25. Yang Q-H, Zhang Y-H, Du S-H, et al. (2024). Reliability and Validity of the Star Excursion Balance Test for Evaluating Dynamic Balance of Upper Extremities. Sports Health. doi:10.1177/19417381231221716