

MENTAL ENLIGHTENMENT SCIENTIFIC –
METHODOLOGICAL JOURNALMENTAL ENLIGHTENMENT SCIENTIFIC –
METHODOLOGICAL JOURNAL<http://mentaljournal-jspu.uz/index.php/mesmj/index>KARATE PLAYERS OF DIFFERENT CATEGORIES «MAVASHE-
GERI» SHOT INDIVIDUAL INDICATORS OF KINEMATICS**S. Tajibayev***Uzbekistan state university of physical education and sport,
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ABOUT ARTICLE

Key words: Knimatics, 3D Ma analysis,
sagittal axis, range, angle**Received:** 08.10.24**Accepted:** 10.10.24**Published:** 12.10.24**Abstract:** This article provides a comprehensive kinematic analysis of the "Mawashi-Geri" technique among karate students. Utilizing motion capture technology, the study recorded and analyzed the movements involved in executing the roundhouse kick. The methodology focused on capturing angular velocities, trajectories, and force generation of the participants' limbs during the technique. Results indicated significant variations in kinematic patterns between novice and experienced practitioners, with experienced individuals demonstrating more efficient energy transfer and higher impact velocities. The discussion underscores

the importance of proper alignment and timing in maximizing the effectiveness of the "Mawashi-Geri," as well as the potential for injury if executed incorrectly. The conclusion emphasizes the value of kinematic analysis in comprehending martial arts techniques and improving training routines. The study's findings provide valuable insights that can assist coaches and athletes in refining their skills and achieving optimal performance in karate.

Relevance

In our country, consistent measures are being implemented to popularize physical education and sports, create necessary conditions and infrastructure for promoting a healthy lifestyle among the population, especially the youth, and ensure our nation's worthy participation in international sports arenas. As a result of the opportunities being created today, our athletes are participating commendably in international competitions. In the development of all sports, including Karate, it is of utmost importance to review and update the curricula and programs for Karate in sports-education institutions based on advanced international experience. This includes developing curricula and agendas that meet international standards, creating specialized education programs, and enhancing and scientifically-methodologically supporting the developed programs and plans to further advance the sport.

Karate is a martial art that is well-known for its striking techniques. Its biomechanics and kinematics have been thoroughly studied to determine what makes it a competitive sport as well as an effective self-defense method. The roundhouse kick, also known as the "Mawashi-Geri," is one of the more intricate and potent techniques. In order to shed light on the mechanics of the move and its implications for training and performance, this article will analyze the kinematic features of the "Mawashi-Geri" as performed by karate students. A crucial karate move that calls for exact timing, balance, and coordination is the "Mawashi-Geri." We can learn more about the elements that lead to this technique's efficacy by dissecting how karate students move when executing it. Examining the kick's angular velocity, trajectory, and force production as well as the function of the torso and supporting leg in carrying out the movement are all included in this.

Our goal with this kinematic analysis is to provide coaches and practitioners with insightful feedback by emphasizing the essential elements that can improve the way the "Mawashi-Geri" is performed. In addition, this research fosters a more empirical approach to

training and technique improvement by acting as a link between traditional martial arts practice and contemporary scientific inquiry.

M. Alijonov (2023) discussed enhancing young karate practitioners' techniques and tactics using innovative methods. N. Masatoshi (2023) provided detailed descriptions of the correct movements involved in specific blocks, strikes, or punches that a karate practitioner intends to perform, as well as instructions on combining defensive techniques with decisive counterattacks.

In the training process, it is necessary to improve the technique of the "Mawashi-geri" kick and understand the basic principles of the biomechanics of attack techniques. As a result, having information about the biomechanical indicators of the attack movement helps the coach correctly select the means and methods to improve the technique of the "Mawashi-geri" kick.

Karate practitioners acknowledge the significance of performing kinematic analysis on the "Mawashi-geri" kick technique, as these analyses can offer vital insights into the efficacy of attack techniques. Consequently, the exploration of the kinematic characteristics of the "Mawashi-geri" kick technique is regarded as one of the prominent subjects among contemporary research topics.

The aim of the study is to determine the kinematic characteristics of the "Mawashe-geri" kicking technique among first-grade karate practitioners and candidates for sports mastery.

The purpose of the study:

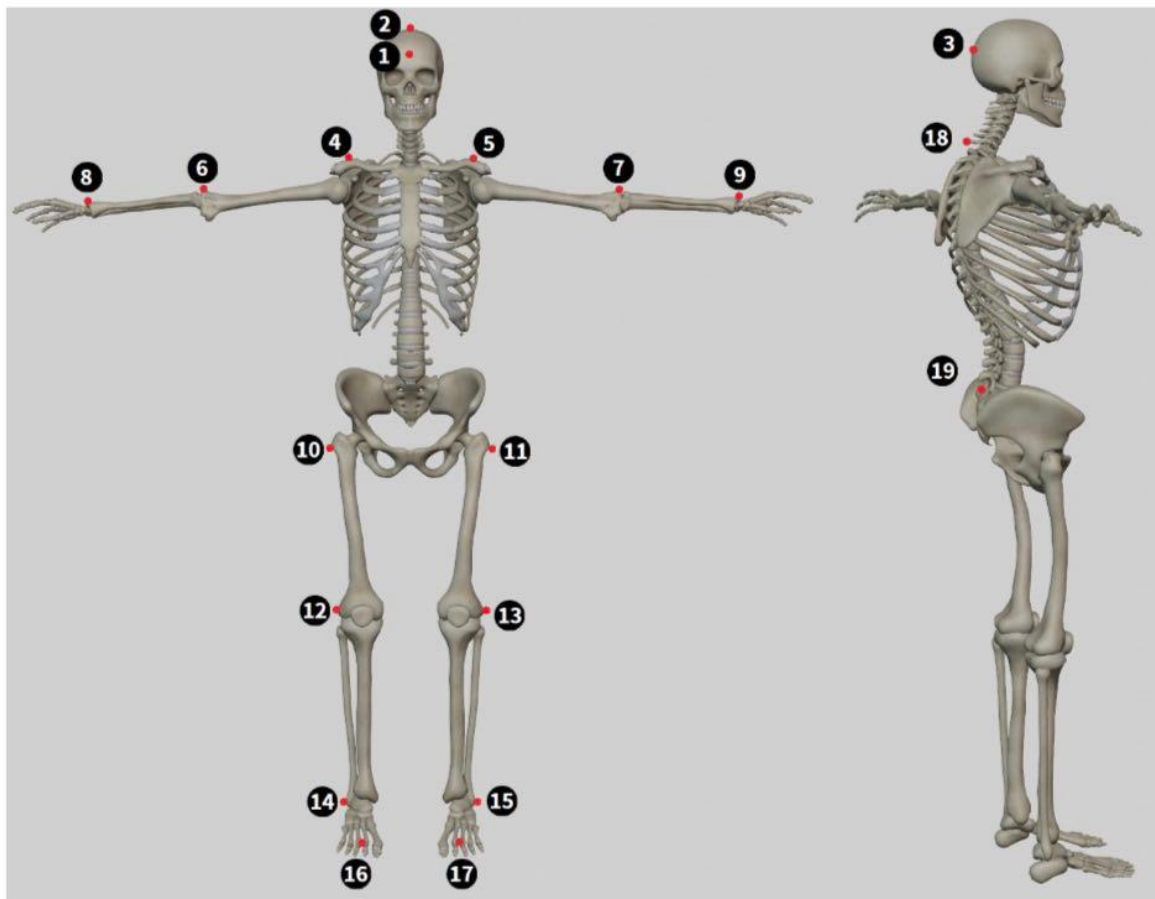
- To determine the kinematic indicators of the movements of the "Mawashe-geri" kicking technique of karatekas of the first-grade and candidates for master of sports.

- To compare the kinematic characteristics of the movements of the "Mawashe-geri" kick technique of karatekas of the 1st grade and candidates for master of sports.

The research methods and its organization.

The research was conducted at the "SPORT 360° 3D MA Biomechanics Laboratory" located at the Uzbekistan State University of Physical Education and Sports.

Highly skilled karate practitioners, first-degree karatekas and candidates for sports mastery, participated in the research. During the research, karate practitioners were engaged in 15-minute exercises, followed by explanations on the technique and 3D analysis features of the "Mawashi-geri" kick. Participants were provided with guidance on the accuracy and proper execution of the "Mawashi-geri" kick technique to the best of their ability.

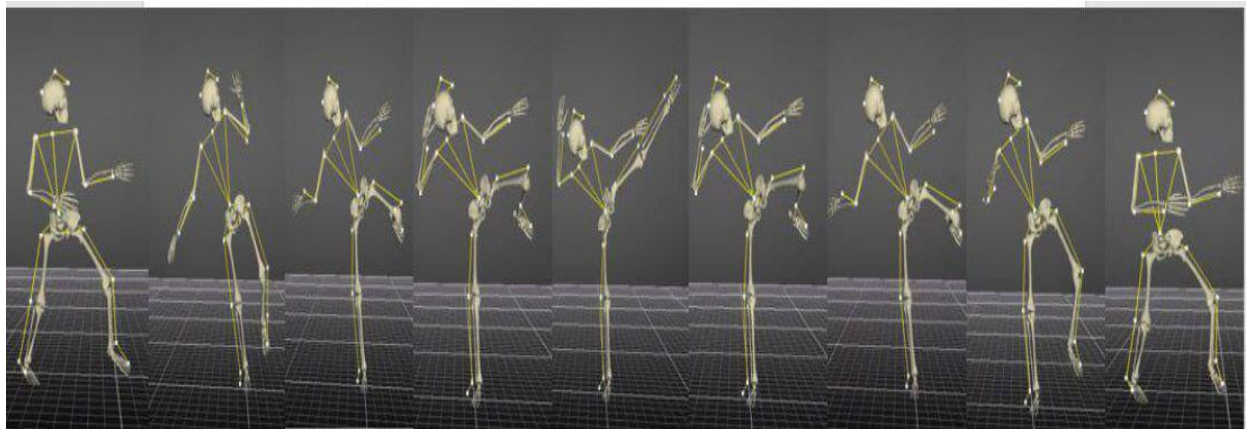


1st figure. Locations of sensor markers installed along the entire body.

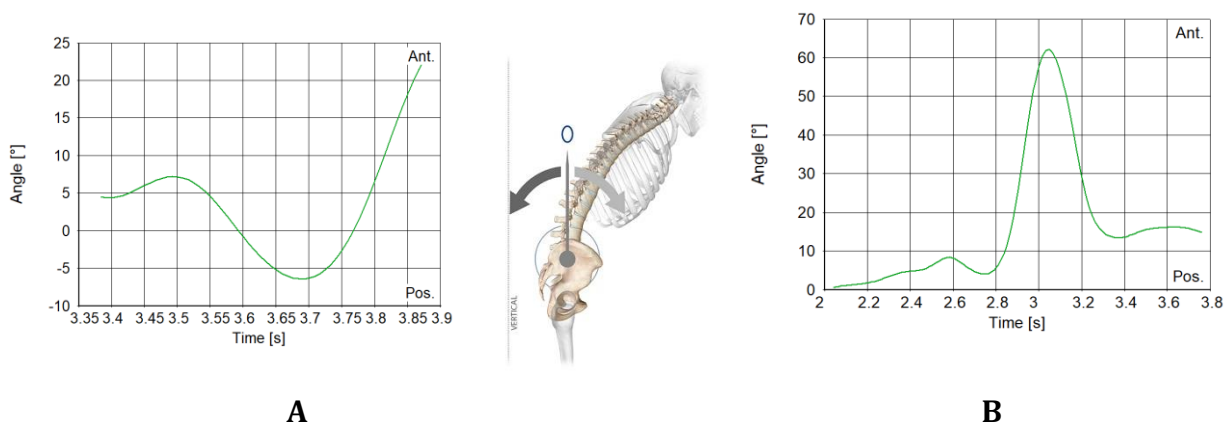
Note: Detailed marker placement description. 1. Head (front) Centered on the forehead (front of the cap, helmet or head band). 2. Head (top) Centered on top of the head (top of the cap, helmet or head band). 3. Head (back) Centered on the back of the head (back of the cap, helmet or head band). 4. Right shoulder Acromion of the right scapula. 5. Left shoulder Acromion of the left scapula. 6. Right elbow Lateral epicondyle of the right humerus. 7. Left elbow Lateral epicondyle of the left humerus. 8. Right wrist on the right ulnar styloid process. 9. Left wrist on the left ulnar styloid process. 10. Right hip Greater trochanter of the right femur. 11. Left hip Greater trochanter of the left femur. 12. Right knee Lateral epicondyle of the right femur. 13. Left knee Lateral epicondyle of the left femur. 14. Right ankle Lateral malleolus of the right fibula. 15. Left ankle Lateral malleolus of the left fibula. 16. Right toes on the distal end of 2nd-3rd metatarsal bone of right foot. 17. Left toes on the distal end of 2nd-3rd metatarsal bone of left foot. 18. C7 C7 vertebra (most prominent protrusion when bending down the head). 19. S2 S2 vertebra (between left and right PSIS).

Analysis of the research results. In our research, the 3D biomechanical analysis results related to the sagittal plane flexion and extension of the trunk during the execution of the "Mawashi-geri" kick the first-degree and candidates for sports mastery in karate were depicted

(2nd image). A - Kinematics of movements of the first-degree karate practitioner. B - Kinematics of movements of the karate practitioner candidate for sports mastery.



1st image. 3D kinematic analysis of the "Mawashi-geri" kick technique.



2nd figure. Kinematics of forward and backward flexion of the trunk during the execution of the "Mawashi-geri" kick technique.

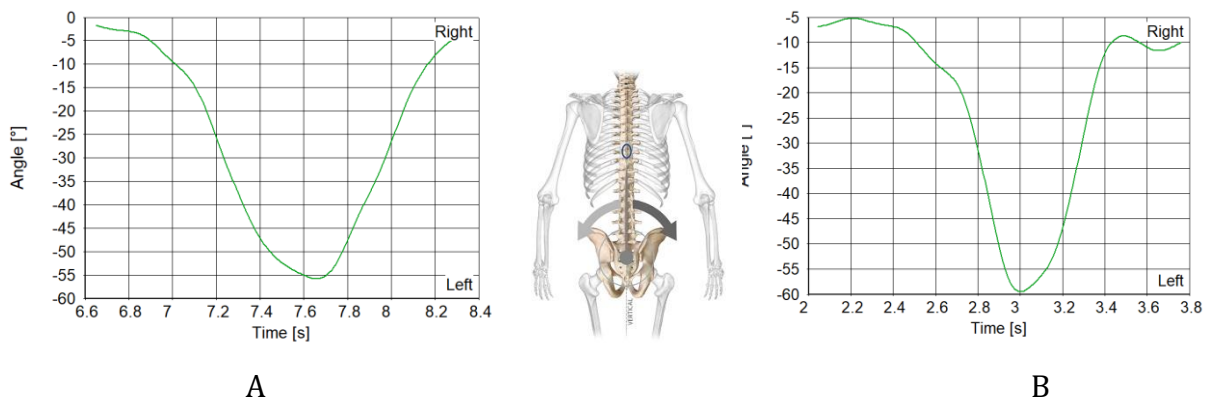
At the initial point of execution of the "Mawashi-geri" kick technique by the first-degree karate practitioner, the trunk flexion is positioned at a sagittal plane angle of -45° , and throughout the movement, this indicator progresses along the sagittal plane, ranging from 4° to 48° (refer to Table 1). Karate practitioners initially continue the movement with forward and backward flexion during the execution of the "Mawashi-geri" kick.

Table 1
Kinematics of forward-backward and lateral flexion of the trunk

	A			B		
	Min	Max	Range	Min	Max	Range
Flexion	-45	4°	48°	0°	62°	62°
Forward-backward flexion	-56	0°	55°	-60°	0°	59°

From the kinematic analysis of the above movements, we can see that during the execution of the "Mawashi-geri" kick, the first-degree karate practitioner exhibits trunk

movements with a minimal angle of 0.45° and a maximal angle of 58° , exceeding the range of motion of the sports mastery candidate by 14° .

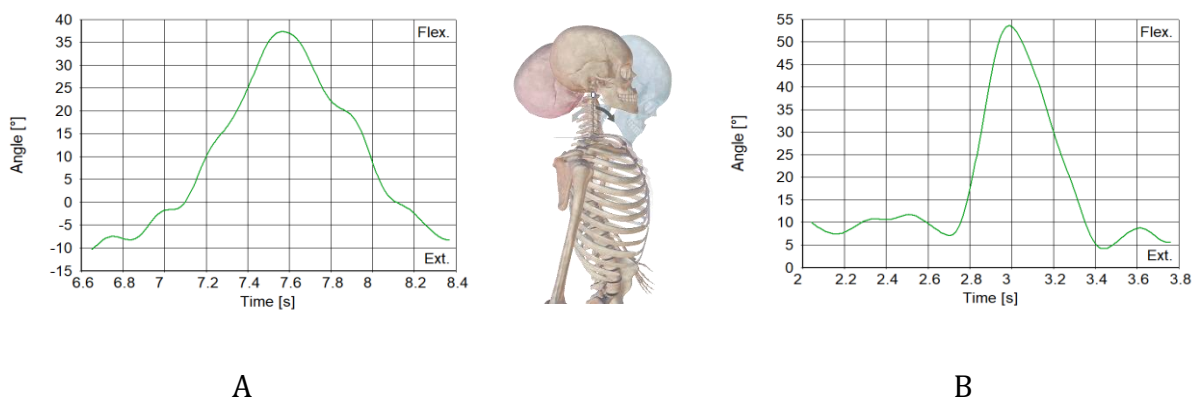


3rd figure. Kinematics of right and left lateral flexion of the trunk during the execution of the "Mawashi-geri" kick.

The forward and backward flexion of the trunk along the transverse axis during the execution of the "Mawashi-geri" kick by first-degree and sports mastery candidate karate practitioners is depicted.

The results show that during the movement of the first-degree karate practitioners, the trunk flexed forward and backward along the transverse axis at an angle ranging from a minimum of -56° to 0° , and then returned at an angle of 55° (refer to Figure 3).

Initially, during the execution of the "Mawashi-geri" kick, the athlete continues the movement with forward and backward flexion of the trunk. It can be observed that first-degree karate practitioners exhibit a greater range of flexion compared to sports mastery candidates, with a minimal angle of -4° , a maximal angle of 0° , and an increased range of 4° (refer to Table 1).



4th figure. Kinematics of neck muscle flexion and extension during the execution of the "Mawashi-geri" kick.

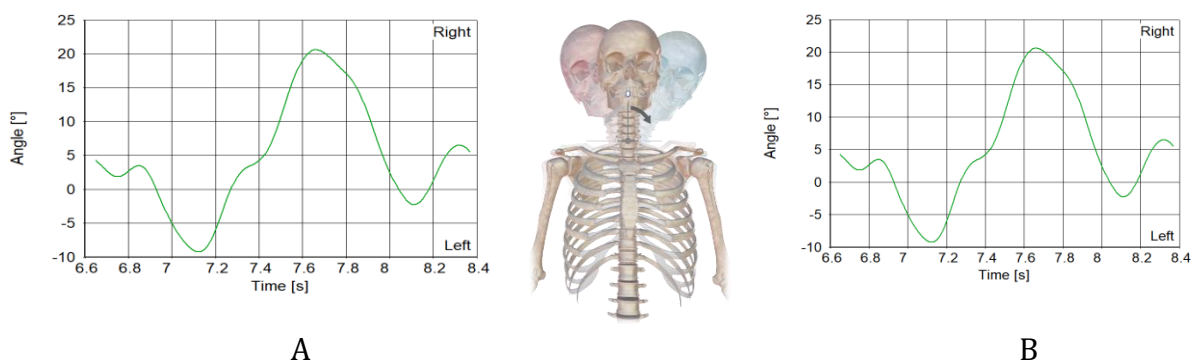
The 3D biomechanical analysis results of neck flexion and extension along the sagittal axis during the execution of the "Mawashi-geri" kick by the sports mastery candidate are presented (refer to Figure 4).

Table 2

Kinematic indicators of neck flexion, lateral flexion, and rotation

	A			B		
	Min.	Max.	Range	Min.	Max	Range
Flexion	-0°	37°	37°	0°	53°	53°
Lateral flexion	-10°	20°	29°	26°	60°	33°
Rotation	38°	0°	-39°	68°	85°	16°

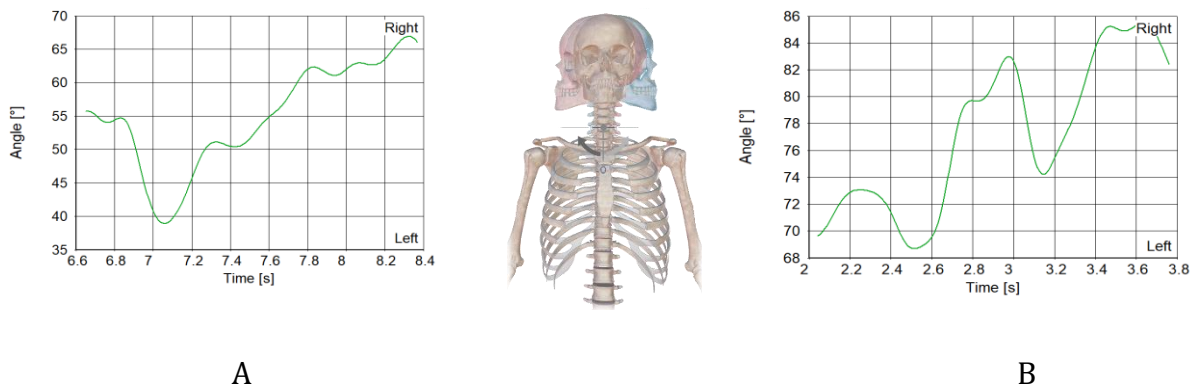
At the initial point of movement, the neck is positioned at 0° flexion relative to the sagittal axis, and during the movement, this indicator reaches a maximum of 53°, with a range of motion between 0° and 53° (refer to Table 2). The karate practitioner initially faces the opponent before executing the "Mawashi-geri" kick. From the above movements, it can be deduced that sports mastery candidates exhibit greater neck flexion compared to first-degree karate practitioners, with a forward inclination of 0°, a maximum of 16°, and a range of motion of up to 16°.



5th figure. Kinematics of neck muscle flexion during the execution of the "Mawashi-geri" kick.

In the 3D biomechanical analysis results concerning trunk flexion along the transverse axis during the execution of the "Mawashi-geri" kick technique by first-degree karate practitioners, it is indicated that the initial point of the movement is at a leftward inclination of -10° relative to the transverse axis, and during the movement, this indicator reaches 20° before finally positioning at a rightward inclination of 29° (refer to Figure 5).

During the execution of the "Mawashi-geri" kick, the karate practitioner initially directs their gaze towards the opponent, then shifts their focus towards the direction of the kick. The above indicators suggest that first-degree karate practitioners exhibit a leftward inclination of -16° at the starting point of the movement, a maximum of 40° during the movement, and an overall range of motion exceeding that of sports mastery candidates by 4° (refer to Table 2).



6th figure. Kinematics of neck muscle rotation during the execution of the "Mawashi-geri" kick.

The result of the 3D biomechanical analysis of lateral rotation of the neck on the horizontal plane during the technical movement of performing the "Mawashi-geri" kick by a first-degree karate practitioner (see Figure 6).

**Table 3
Kinematic indicator of shoulder rotation and lateral displacement**

		A			B		
		Min	Max	Range	Min	Max	Range
Rotation	Left	-34°	77°	111°	-26°	104°	129°
	Right	-23°	35°	57°	-458°	48°	92°
Lateral displacement	Left	15°	0°	16°	22°	88°	109°
	Right	6°	0°	-7°	23°	70°	46°

At the starting point of the movement, the neck is rotated at an angle of -62° to the left along the horizontal axis, and during the movement, this indicator increases to a maximum of 44° angle, with the total range reaching 106° (Table 3). Based on the above indicators, it can be observed that first-degree karate practitioners demonstrate angles that are -5° lower than those of experienced athletes at the starting point of the movement along the horizontal axis, reaching a maximum angle of 27° during the movement, and rotating towards the left by less than -5° along the horizontal axis.

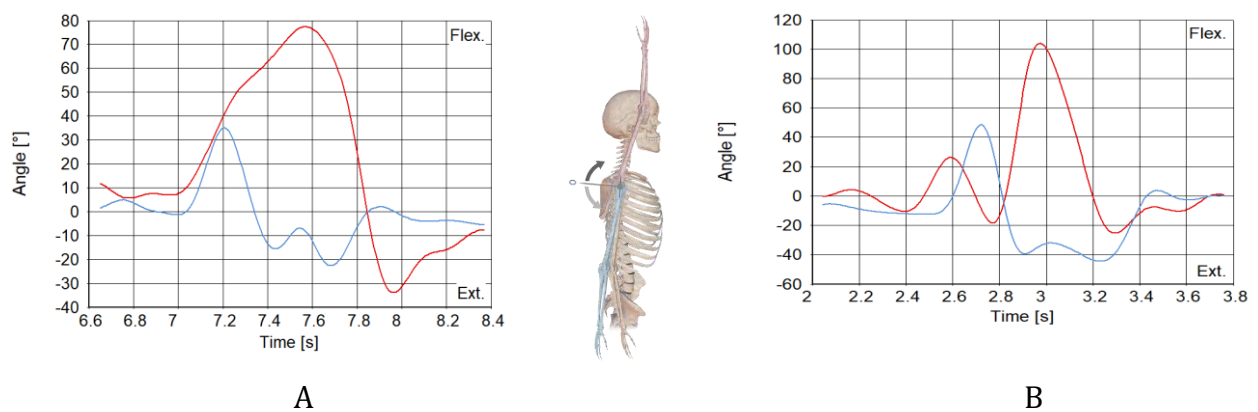


Figure 7. Rotational kinematics of shoulder muscles during the execution of the "Mawashi-geri" kick.

The analysis of the "Mawashi-geri" kick through 3D biomechanics for karate athletes striving for the master of sports title revealed the forward and backward rotation of the shoulder bones in both arms along the sagittal axis during the technical execution. At the onset, the right arm's shoulder bones were positioned at -458° relative to the sagittal axis, while during the movement, this ranged between 48° and 92° . Similarly, for the left arm, the shoulder bones were initially at -26° along the sagittal axis, with this ranging from 104° to 109° during the movement (refer to Table 3).

Based on the kinematic indices provided, it's evident that at the beginning of the movement, the shoulder bones of the right arm for karate candidates aiming for the master of sports title are positioned 134° lower in the front, while those of the left arm are at an 8° higher point. During the movement, the maximum movement for the right arm's shoulder bones is 13° within a range of 35° , whereas for the left arm, it's -8° at the maximum point of movement, within a range of 18° (refer to Figure 7).

It's observed that karate fighters with greater experience execute the "Mawashi-geri" kick at a slower pace, completing it in less time. This implies that first-rank karatekas take more time to perform the "Mawashi-geri" kick compared to those of higher ranks.

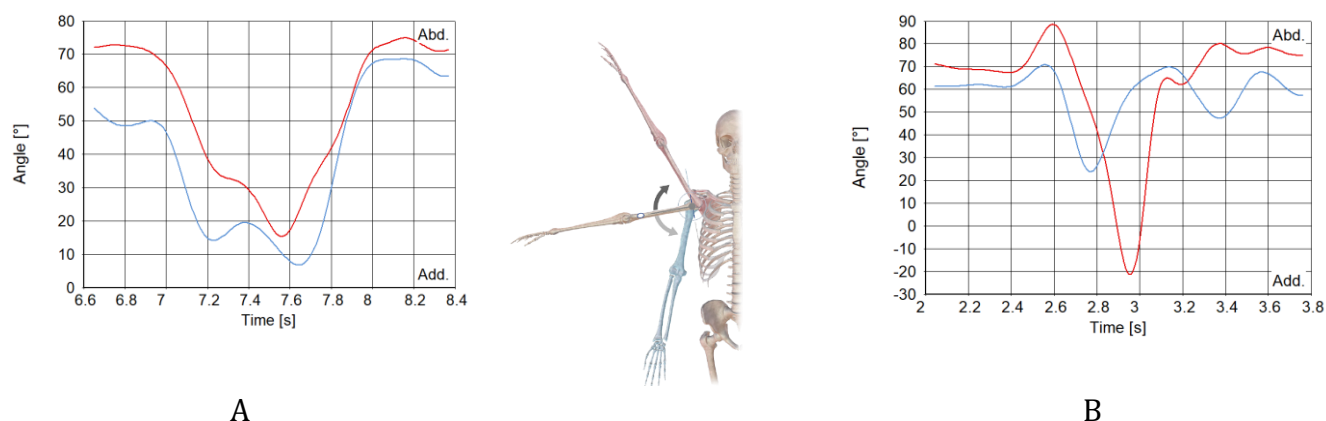


Figure 8. Kinematics of lateral movement of the right and left bones during the "Mawashi-geri" kick.

The results of the 3D biomechanical analysis indicate that during the technical execution of the "Mawashi-geri" kick by first-level karateka, there is displacement of the shoulder bones of the right and left arms to the sides along the transverse axis. Initially, at the inner point of the movement, the shoulder bones of the right arm are shifted outward at an angle of 6° along the transverse axis.

During the movement, the indicator moved outward within the range of 0° to -7° , while the left shoulder bones, initially positioned at a 15° angle to the transverse axis, shifted within a sub-range (see Figure 8).

During the execution of the "Mawashi-geri" kick, at the initial point of the movement, the shoulder bones of the right arm of first-degree karate athletes, relative to the master of sports candidates, were positioned at a downward angle of 17° along the sagittal axis, and during the movement, they deviated outward in a range from a maximum of 70° to 39° . On the other hand, the shoulder bones of the left arm initially deviated outward at a lesser angle of 7° along the sagittal axis, and during the movement, they showed less deviation within a range from a maximum of 88° to 93° (refer to Table 3).

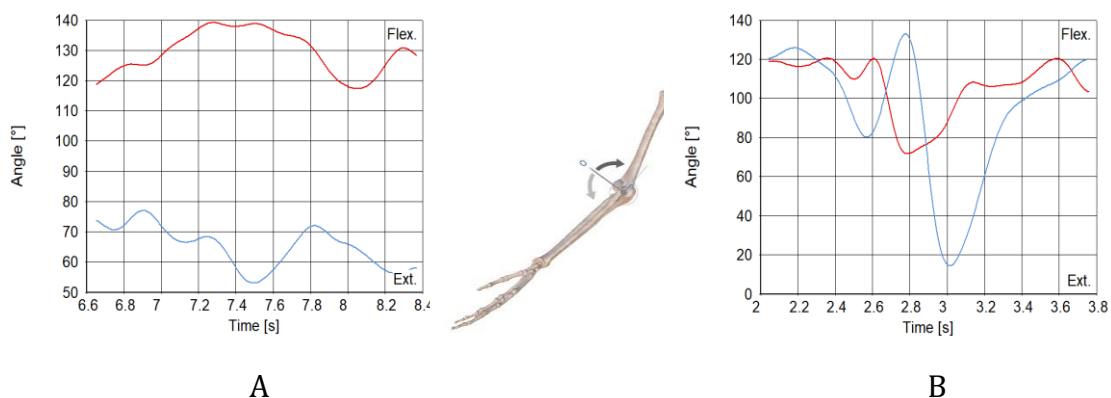


Figure 9. Bending kinematics of the right and left elbows during the "Mawashi-geri" kick.

The 3D biomechanical results pertaining to the bending of the right and left elbow joints forward and backward along the sagittal and transverse axes during the technical execution of the "Mawashi-geri" kick by first-class karateka which can be observed in Figure 9.

**Table 4
Kinematic Indicators of Elbow Flexion**

		A			B		
		Min	Max	Range	Min	Max	Range
Flexion	Left	15°	0°	-16°	117°	139°	21°
	Right	6°	0°	-7°	53°	77°	24°

At the beginning of the movement, the elbow joint of the right hand did not move along the transverse axis, maintaining a constant angle of 15° throughout the movement. In contrast, we observed that the shoulder of the left hand flexed at a 15° angle forward along the sagittal axis, fluctuating within the range of 0° to -16° during the movement (Table 4).

At the initial point of the movement, according to the index, the right arm ulnar angle for karate athletes nominated for the title of Master of Sports was 53° along the transverse axis, while the left arm ulnar angle was 102° . During the movement, the right arm ulnar angle reached a maximum of 77° , and the left arm ulnar angle reached a maximum of 139° . It was

determined that the right arm ulnar angle moved by an excess of 17° within the range, and the left arm ulnar angle moved by -5° during the movement.

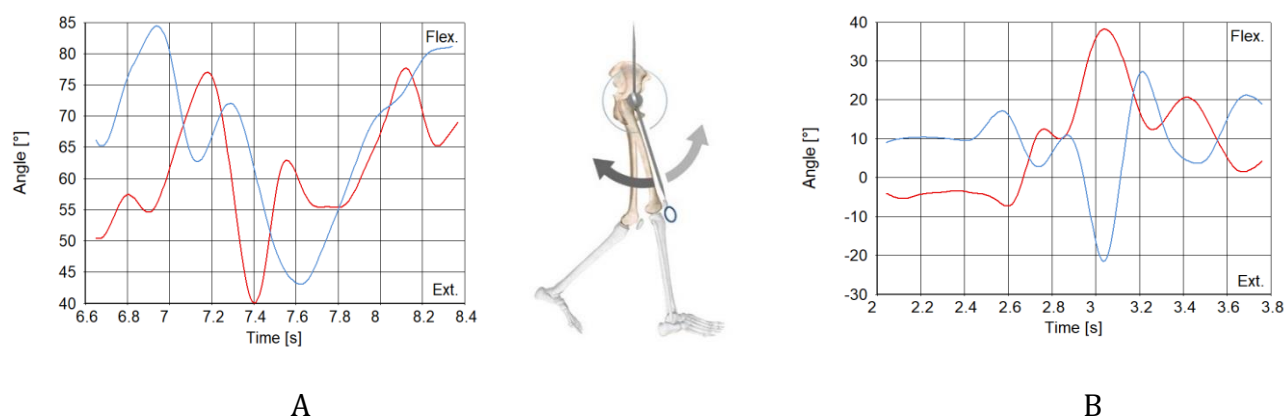


Figure 10. Kinematics of flexion of the right and left femurs during the "Mavashe-geri" kick.

The 3D biomechanical analysis results are related to the forward and backward tilting of the right and left femur angles along the sagittal axis during the technical movements of executing the "Mavashe-geri" strike by 1st-degree karate athletes. (Figure 10.)

Table 5

Kinematic indicator of hip flexion and lateral displacement

		A			B		
		Min	Max	Range	Min	Max	Range
Flexion	Left	40°	77°	37°	12°	38°	25°
	Right	43°	84°	41°	-22°	27°	48°
Lateral displacement	Left	48°	75°	27°	26°	59°	33°
	Right	45°	82°	36°	8°	58°	50°

During the movement, it was observed that the femurs of the right leg were bent at an angle of 43° along the sagittal axis. This angle varied from 84° to 41° throughout the movement. Similarly, the femurs of the left leg were bent at an angle of 40° along the sagittal axis, and during the movement, this angle changed from 77° to 37° (Table 5).

From the kinematic index of the described actions, it can be inferred that in the "Mavashe-geri" position, the femur of the right leg moves forward and bends more than the left leg. Additionally, the left foot serves as the foundation for maintaining balance during the execution of the "Mavashe-geri" kick.

At the beginning of the technical movement of the "Mavashe-geri" strike, it was observed that the right femurs of the first-grade karateka moved -21° less along the sagittal axis compared to the candidate karatekas, while the femurs of the left leg moved 28° more. During the movement, it was noted that the right femur had a maximum range of 57° and a minimum range of 7° , while the left femur had a maximum range of -39° and a minimum range of 12° .

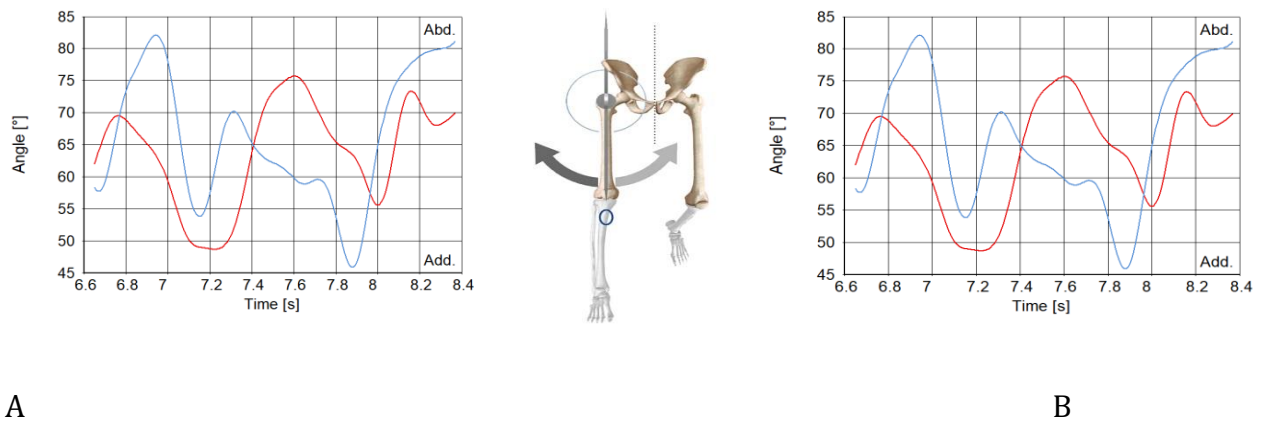


Figure 11. Kinematics of lateral movement of the right and left bones during the "Mavashe-geri" kick.

The results of the 3D biomechanical analysis on the displacement of the femurs of the right and left legs sideways along the transverse axis during the execution of the technical movements of the "Mavashe-geri" kick by 1st-grade karate athletes reveal that initially, the femurs of the right leg are not turned in relation to the transverse axis. However, during the movement, this indicator shifts outward and inward at an angle of 37° relative to the axis. Similarly, it was observed that the femurs of the left leg move outward along the transverse axis, forming an angle of 27° outward and inward during the movement (Fig. 11).

At the beginning of the technical movement of the "Mavashe-geri" kick, it was observed that the right femurs of first-level karatekas were 37° less than those of candidate karatekas relative to the transverse axis. During the movement, it was found that the femurs had a maximum of 24° deviation, with an excess movement range of 14° (Table 5).

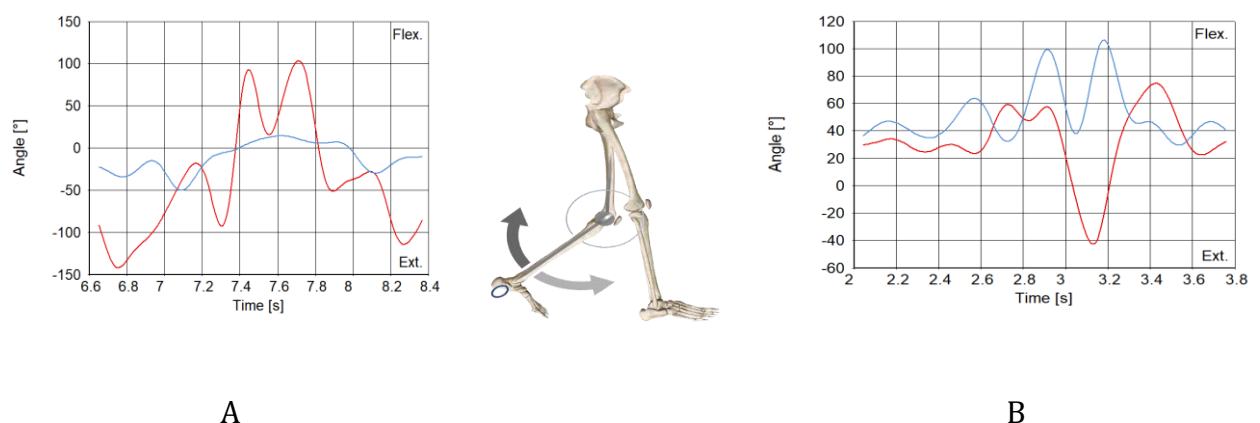


Figure 12. Kinematics of bending the knees of the right and left legs during the "Mavashe-geri" kick.

The results of the 3D biomechanical analysis depicted the forward and backward rotation of the knee joints of the right and left legs along the sagittal axis during the technical movement of the karateka executing the "Mavashe-geri" kick (Fig. 12).

Table 6

Kinematic index of knee flexion

Knees	A				B		
		Min.	Max	Range	Min	Max	Range
	Bending	Left	-142°	103°	245°	-43°	74°
	Right	-50°	14°	64°	29°	106°	76°

At the beginning of the movement, the knee joint of the right leg for 1st-grade karate fighters is not bent in relation to the sagittal axis. However, during the movement, this indicator varies within the angle range from -50° to 14°. Additionally, it was observed that this indicator operated within the angle range from -142° to 103°. After the execution of the "Mavashe-geri" kick, the knee joint of the left leg is bent.

As evident from the above results, at the beginning of the movement, first-grade karateka demonstrated a result on the right leg, i.e., 21°, compared to the candidates for the title of Master of Sports. During the subsequent movement, the maximum and the range of movements exceeded by 92° increased. At the starting point of the movement of the left leg, the knee joint performed 99° less, with a maximum of 29°, and a range of excess movement of 128° (Table 6).

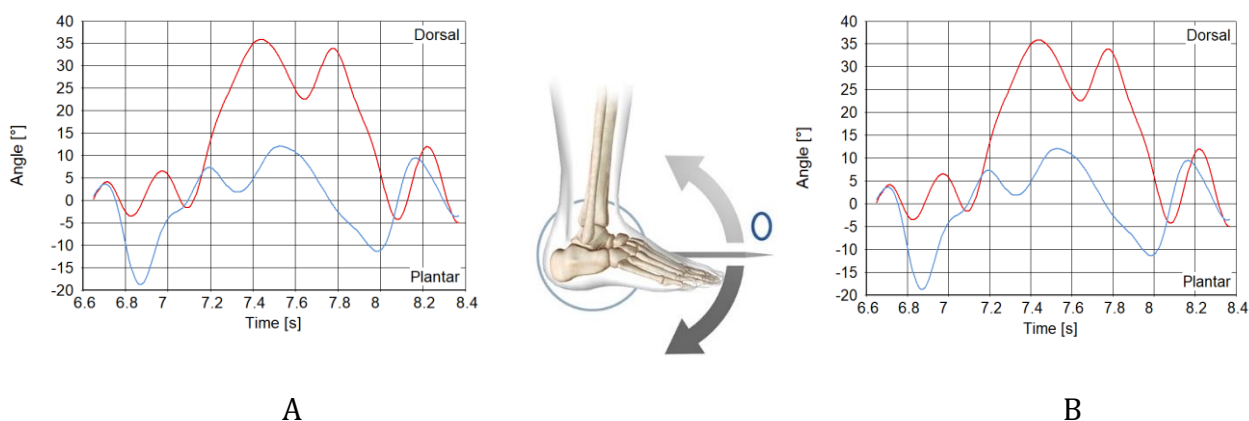


Figure 13. Kinematics of flexion of the right and left ankles during the execution of the "Mavashe-geri" kick.

The results of the 3D biomechanical analysis (Fig. 13) of the forward and backward bending of the ankle joint of the right and left legs along the sagittal axis during the technical movements of the kick 'Mavashe-geri' by karateka are presented.

Table 7

Kinematic indicators of heel flexion

	A			B		
	Min	Max	Range	Min	Max	Range
Left	-5°	35°	40°	-20°	24°	43°
Right	-19°	12°	30°	-38°	24°	62°

It was observed that the heel joint of the right leg did not move in relation to the sagittal axis at the point of movement of the 1st grade karate athlete, and the movement was 15° without changing this indicator. Moreover, the left ankle joint is at an angle of 0° along the sagittal axis. For movement 5, it is initially directed downwards from 35° to 40° , and then an angle of -4° is expected upwards. (Table 7).

From the above movements, the following can be determined: at the starting point of the technical movement of the 'Mavashe-geri' kick, the right legs of the 1st-grade karate athletes, compared to sports mastery-nominated karate athletes, are positioned at -24° along the sagittal axis of the heel joint, while the left legs are positioned at -5° . During the movements, the right legs reach a maximum heel joint of 8° , less than 32° in range. It was found that the left legs exceeded the maximum range by 6° , reaching 4° during the movement.

Summary: The 3D biomechanical analysis conducted in our research on karate attack techniques allows us to draw the following conclusions:

1. Reviewing research conducted by both domestic and international scientists on the topic highlights the importance of kinematic analysis of technical movements performed by karate practitioners across various sports categories.

2. For first-grade karate practitioners, the forward and backward bending of the spine joint during the execution of the kick "Mavashe-geri" compared to sports mastery-nominated karate candidates ranged from a minimum of 0.45° to a maximum of 58° , with a range expanded by 14° . Analyzing the rotation to the right and left, it was determined that the tilting movement during the execution of the kick "Mavashe-geri" ranged from a minimum of -4° to a maximum of 0° , with a range expanded by 4° .

3. From the results of the analysis of the forward and backward bending, as well as the outward and inward movement of the shoulder bones of first-level karateka during the execution of the "Mawashi-geri" kick, it can be determined that at the starting point of the movement, the shoulder bones of the right hand are in the sagittal plane, compared to karate candidates for master of sports, forward by 134° at the lower point. The left arm shoulder bones are 8° higher at the point, with the right shoulder bones showing a minimum range of movement of 13° within 5° during the motion. The shoulder bones of the left hand performed 8° less movement in a range of 35° at the maximum point of movement. Based on the results of this analysis, it can be concluded that during the technical movements of performing the "Mawashi-geri" kick, karate fighters with the first rank had insufficient rotation of the shoulder bones, leading to a significant decrease in the effectiveness of the kick.

Considering the aforementioned findings, it can be stated that kinematic analysis of karate players across various sports categories is instrumental in enhancing attack techniques, leading to the development of an optimal model for technical actions. These results can also be beneficial for handball specialists, providing them with valuable insights for improving their techniques.

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