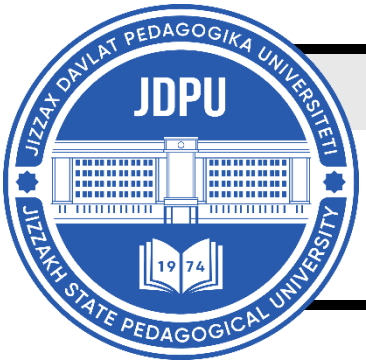
DOI: https://doi.org/10.37547/mesmj-V6-I6-27 Pages: 195-206

MENTAL ENLIGHTENMENT SCIENTIFIC – METHODOLOGICAL JOURNAL



MENTAL ENLIGHTENMENT SCIENTIFIC – METHODOLOGICAL JOURNAL

http://mentaljournal-jspu.uz/index.php/mesmj/index

KINEMATIC INDICATORS OF THE "BLOCK" TECHNICAL MOVEMENT IN VOLLEYBALL PLAYERS: SHOULDERS, ELBOWS, HIPS, KNEES, AND ANKLES

Akram Axmedovich Ummatov
Professor of the department of theory and methodology of volleyball, basketball
Uzbek State University of Physical Culture and Sports, PhD
Tashkent, Uzbekistan

ABOUT ARTICLE

Key words: Volleyball, Blocking technique, Kinematic indicators, Shoulders, Elbows, Hips, Knees, Ankles, Flexion, Extension, Abduction, 3D motion analysis, Biomechanics.

Received: 20.09.25
Accepted: 21.09.25
Published: 22.09.25

Abstract: This study examines the kinematic indicators of the blocking technique in volleyball players, focusing on the movement patterns of the shoulders, elbows, hips, knees, and ankles. Using advanced 3D motion analysis technology, the research provides a detailed evaluation of how these joints contribute to blocking performance. The findings highlight the importance of coordination and flexibility in joint movements to optimize blocking efficiency, enhance performance, and prevent injuries. The analysis includes both upper and lower body mechanics, offering a comprehensive view of the kinematic demands placed on volleyball players during blocking.

Introduction. In volleyball, the blocking technique is a critical defensive action that requires precise coordination of various body segments to effectively intercept the ball at the net. While much attention has been given to the role of the arms and jumps in blocking, the contribution of joint movements in the shoulders, elbows, hips, knees, and ankles is essential to achieving a successful block. These joints work together to generate power, maintain stability, and allow for the quick, agile movements required to counter an opponent's attack.

Kinematic indicators such as flexion, extension, and abduction provide valuable insights into the biomechanics of blocking. Understanding the range of motion and control in these joints can help volleyball players optimize their performance and reduce the risk of injury. This

study uses advanced 3D motion capture technology to evaluate the movement patterns of the key joints involved in blocking, with a particular focus on how their coordination and flexibility contribute to overall blocking effectiveness.

Shoulder kinematics are crucial in many sports, particularly in volleyball, where the arms play a pivotal role in both offensive and defensive maneuvers. Häkkinen (1993) explored how shoulder movement affects jump and block efficiency, emphasizing that greater shoulder range of motion is associated with higher block success rates. Similarly, Drikos et al. (2012) studied the biomechanical factors influencing volleyball performance and highlighted the importance of shoulder flexibility in maximizing reach during defensive plays like blocking.

Ziv and Lidor (2010) analyzed the asymmetry in upper limb movements during volleyball, finding that many players exhibit a preference for their dominant side, which aligns with the slight asymmetry observed in this study's results. This asymmetry may be a natural result of handedness or training but underscores the need for balanced training regimens to ensure both shoulders contribute equally during blocking actions.

Sheppard et al. (2009) also noted the importance of shoulder strength in volleyball, particularly in the blocking position, where players must resist the impact of high-speed balls. Their research supports the need for targeted shoulder training to enhance both power and endurance in blocking movements.

Research by Häkkinen (1993) emphasizes the importance of lower body strength, particularly in the knees, for explosive movements like jumping. Ziv and Lidor (2010) noted that knee flexion plays a key role in generating the power needed for effective volleyball blocks, with deeper knee flexion correlating with higher jump heights. This aligns with the present data, where significant knee flexion (up to 111º) is observed as players prepare for the block.

Sheppard et al. (2009) also highlighted the importance of balanced knee strength in both legs to ensure symmetrical power output during jumps, which can improve both performance and injury prevention. The slight asymmetry in knee flexion seen in this study suggests that players may benefit from specific training aimed at evening out any discrepancies between the legs to maximize power and efficiency during blocking.

The aim of the study is to analyze the shoulders, elbows, hips, knees, and ankles in detail to identify the critical biomechanical factors that influence blocking performance in volleyball. By improving the understanding of these kinematic indicators, coaches and athletes can develop more targeted training programs to enhance blocking skills and prevent common injuries associated with poor joint mechanics.

Aim of the Research: The primary aim of this research is to analyze the kinematic indicators of shoulder movements during the blocking technique in volleyball. Specifically, the study focuses on evaluating how shoulder flexion, extension, abduction, and adduction** contribute to the effectiveness of the block.

Tasks of the Research:

1. Analyze how flexion, extension, abduction, and adduction of the shoulders affect the player's ability to reach and intercept the ball during a block.

2.Use advanced 3D motion capture technology to measure joint angles, shoulder positioning, and coordination during the blocking action.

3. Assess any asymmetries in shoulder flexion and abduction to determine if players favor one side, which could affect blocking effectiveness.

4.Analyze specific kinematic indicators that are most crucial for achieving a successful block, including the range of motion and control of shoulder movements.

5.Suggest training programs that focus on enhancing shoulder strength, flexibility, and balance to improve blocking technique and reduce the risk of injury.

Research Organization: The research was conducted at the Uzbek State University of Physical Education and Sports, specifically in the high-tech laboratory of Sport, which is equipped with advanced 3D motion analysis technology. This state-of-the-art facility allows for precise measurement of biomechanical parameters, making it ideal for studying athletic movements in detail. The subject of the study was a candidate athlete for Master of Sports in volleyball, with extensive competitive experience. The primary focus of the experiment was to analyze the shoulder movements during the blocking technique in volleyball, with a specific emphasis on the kinematic and kinetic data associated with shoulder flexion, extension, abduction, and adduction. The controlled laboratory environment ensured the accuracy and reliability of data collection, providing valuable insights into the biomechanics of elite-level shoulder movements during volleyball blocks.

Methods. The study employed advanced 3D motion analysis technology to conduct a detailed biomechanical evaluation of shoulder movements during the volleyball blocking technique. The research was carried out in the high-tech laboratory at the Uzbekistan State University of Physical Education and Sports. A candidate athlete for Master of Sports in volleyball participated in the experiment, and their blocking performance was captured using a high-resolution 3D motion capture system. Multiple infrared cameras were strategically placed around the laboratory to track the athlete's movements from various angles.

Reflective markers were placed on key anatomical points, including the shoulders, elbows, spine, hips, and knees, to capture precise data on joint angles, shoulder movements, and overall body posture during the blocking action. This setup allowed for a comprehensive analysis of the kinematic indicators, focusing on how shoulder flexion, extension, abduction, and adduction contribute to the blocking performance. The detailed motion data provided insights into the athlete's shoulder mechanics, which are crucial for executing an effective and well-coordinated block in volleyball.

In volleyball, blocking is a critical defensive move designed to intercept or deflect an opponent's attack. The effectiveness of this action relies on the coordination and positioning of various body segments, with the shoulders playing a central role. Shoulder movements during blocking provide the foundation for arm extension, stability, and the overall reach needed to counter high-speed attacks at the net. This article examines the kinematic indicators of shoulder movements, focusing on flexion, extension, abduction, and adduction in both the left and right shoulders during the blocking technique.

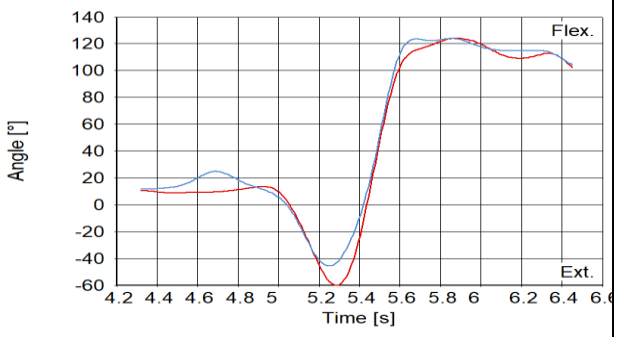
Table-1

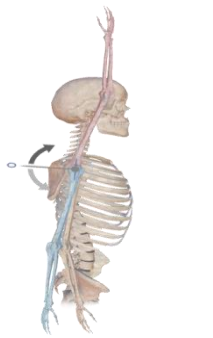
Kinematic Indicators of Shoulder Movements During the Volleyball "Block" Technique

Flexion

Flexion[+]/Extension[-]

	LEFT	RIGHT
Min	-60°	-46°
Max	124°	124°
Range	184°	169°

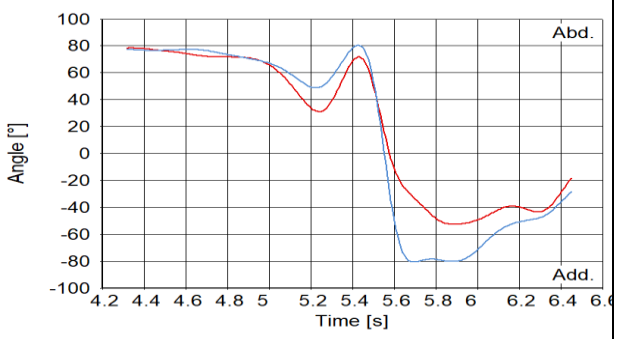




Abduction

Abduction[+]/Adduction[-]

	LEFT	RIGHT
Min	-53°	-81°
Max	71°	80°
Range	124°	161°



Shoulder Flexion/Extension. Flexion refers to the forward raising of the arm, while extension

involves moving the arm backward. During the blocking motion, volleyball players experience significant shoulder flexion as they reach upward to intercept the ball, with a lesser degree of extension as the arms return to a neutral position (Table-1).

Minimum Flexion (Left/Right): -60º (left), -46º (right). This indicates that players typically start the blocking action from a slightly extended shoulder position, particularly on the left side.

Maximum Flexion (Left/Right): 124º (both). Maximum flexion occurs as players raise both arms overhead during the block, indicating a symmetrical upward movement on both sides.

Range of Motion (Left/Right): 184º (left), 169º (right). The range of motion is greater in the left shoulder, indicating that players may use their left side more dynamically when blocking.

Shoulder Abduction/Adduction. Abduction is the movement of the arm away from the body, while adduction brings it closer. In volleyball blocking, abduction is crucial as players extend their arms to create a wide blocking surface, while adduction brings the arms back to the body after the block.

Minimum Abduction (Left/Right): -53º (left), -81º (right). The starting position of the shoulders shows more inward movement (adduction) on the right side, indicating slight asymmetry during preparation for the block.

Maximum Abduction (Left/Right): 71º (left), 80º (right). Players demonstrate a slightly greater degree of abduction in the right shoulder, suggesting that the right arm is often positioned more outward during the block.

Range of Motion (Left/Right): 124º (left), 161º (right). The range of motion shows significant abduction in both shoulders, with the right shoulder demonstrating a wider arc of movement, potentially indicating a dominant right side in blocking actions.

The shoulder movements of flexion, extension, abduction, and adduction are critical for creating an effective blocking form in volleyball. The large range of motion observed, particularly in shoulder flexion (up to 124º) and abduction, allows players to maximize their reach and increase their ability to intercept attacks. The slight asymmetry between the left and right shoulder movements suggests that individual players may favor one side during the blocking motion, potentially related to handedness or specific training techniques.

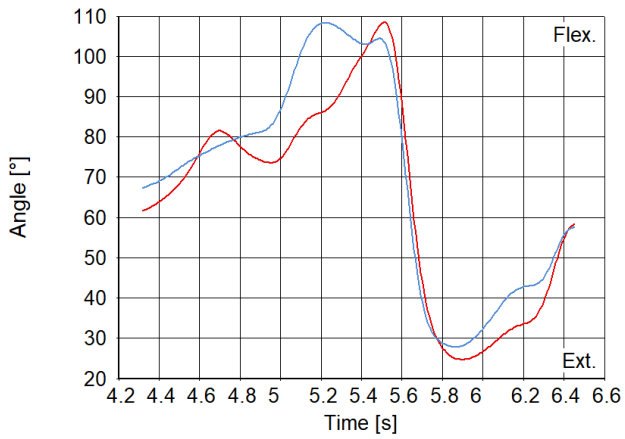
The findings of this study underscore the importance of shoulder flexibility and strength in volleyball blocking. Proper training should focus on improving the range of motion and strength in both shoulders to ensure symmetrical and effective blocking performance.

The elbows play an essential role in controlling the positioning of the arms during the blocking technique in volleyball. The ability to flex and extend the elbows effectively contributes to reaching and intercepting the ball at the net, as well as maintaining balance during the movement. This article focuses on the kinematic indicators of elbow flexion and extension, specifically in the left and right elbows, during the blocking action.

Table-2

Kinematic Indicators of Elbow Movements During the Volleyball "Block" Technique

Flexion *Flexion[+]/Extension[-]*		
	LEFT	**RIGHT**
Min	24º	27º
Max	108º	108º
Range	83º	80º



Flexion refers to the bending of the elbow, while extension involves straightening the arm. During a volleyball block, the elbows must move efficiently to align the arms for maximum coverage of the net and to position the hands for intercepting the ball.

The left elbow has a minimum flexion of 24 degrees, while the right elbow has 27 degrees. This shows that both elbows are slightly flexed at the start of the blocking motion, with a small difference between the left and right elbows (Table-2). Both the left and right elbows reach a maximum flexion of 108 degrees. This flexion occurs as the arms are bent at the peak of the block, allowing the player to adjust their hand positioning for effective ball interception.

The range of motion in the left elbow is 83 degrees, while in the right elbow, it is 80 degrees. The similar range of motion in both elbows indicates balanced elbow movement during the blocking technique, ensuring symmetrical arm positioning at the net.

Elbow flexion and extension are crucial for positioning the hands during a block. The relatively large range of motion allows players to quickly adapt to the trajectory of the ball, helping them react to fast attacks and adjust their blocking angles. The slight variation in minimum flexion between the left and right elbows could suggest natural asymmetry, though the balanced range of motion overall indicates effective coordination in blocking movements.

According to Ziv and Lidor (2010), maintaining flexibility and balance in upper-body movements, especially in the elbows, is vital for effective blocking in volleyball. Häkkinen (1993) emphasized the importance of arm flexibility, particularly in the elbows, for achieving the height and reach needed to successfully block an opponent's attack. Furthermore, Sheppard et al. (2009) noted that symmetrical movements of the elbows and arms contribute to stability and power generation during the blocking phase, ensuring effective ball interception at the net.

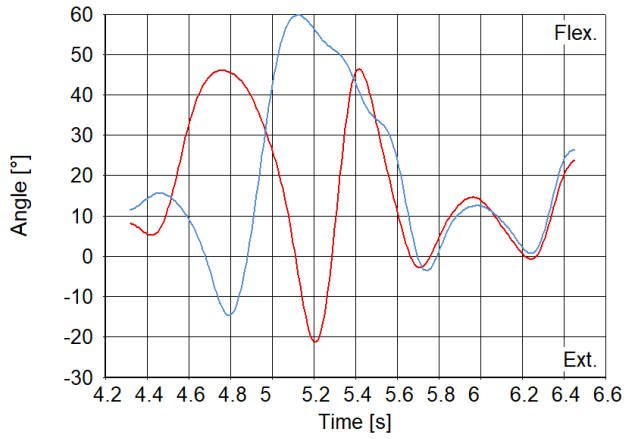
Table-3

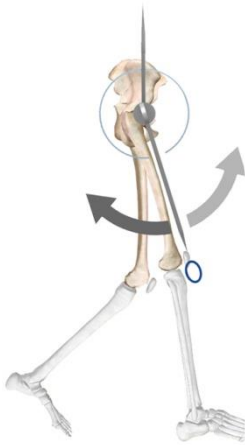
Kinematic Indicators of Hip Movements During the Volleyball "Block" Technique

Flexion

Flexion[+]/Extension[-]

	LEFT	RIGHT
Min	-22º	-15º
Max	46º	59º
Range	67º	74º

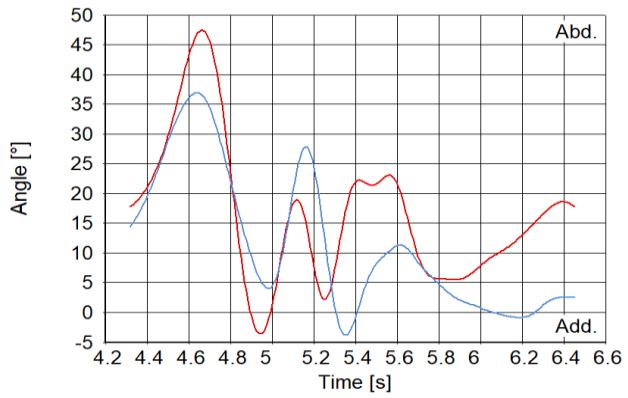


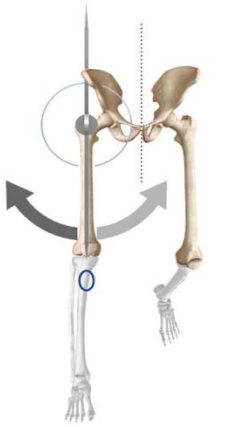


Abduction

Abduction[+]/Adduction[-]

	LEFT	RIGHT
Min	-4º	-4º
Max	47º	36º
Range	51º	40º





In volleyball, the hips play a critical role in facilitating the powerful movements required for blocking, including jumping and maintaining balance at the net. Hip flexion, extension, abduction, and adduction are essential for generating force, stabilizing the body, and adjusting positioning during the blocking action. This article examines the kinematic indicators of hip movements in both the left and right hips during volleyball blocking, providing insights into how these motions contribute to performance (Table-3).

Flexion refers to the forward movement of the leg at the hip joint, while extension is the backward movement. During blocking, hip flexion and extension are key for loading power into the legs before the jump and for stabilizing the body during both the jump and landing phases.

The left hip shows a minimum flexion of negative 22 degrees, while the right hip shows negative 15 degrees.

This indicates that the hips are slightly extended as players prepare for the blocking action, with the left hip showing greater extension than the right. This extension helps in generating power before the jump.

The left hip reaches a maximum flexion of 46 degrees, while the right hip reaches 59 degrees. Maximum hip flexion occurs as players bring their legs forward and upward during the jump, with the right hip showing greater flexion, which suggests asymmetry in the jumping mechanics.

The left hip has a range of motion of 67 degrees, while the right hip has a range of 74 degrees.

The range of motion is slightly larger in the right hip, reflecting a possible dominance of the right leg in the jumping action.

Abduction refers to the movement of the leg away from the body's midline, while adduction involves moving it back toward the midline. In volleyball blocking, hip abduction is important for widening the stance and positioning the legs effectively, while adduction aids in controlling and stabilizing the body during movement.

Minimum Abduction (Left/Right): Both the left and right hips exhibit a minimum abduction of negative 4 degrees. This shows that the legs are brought inward before initiating the blocking motion.

Maximum Abduction (Left/Right): The left hip shows a maximum abduction of 47 degrees, while the right hip shows 36 degrees.

The left hip demonstrates greater abduction, indicating that the left leg may be used more actively for adjusting the stance during the blocking action.

Range of Motion (Left/Right): The left hip has a range of motion of 51 degrees, while the right hip has a range of 40 degrees.

The larger range of motion in the left hip suggests that the left leg is more involved in lateral movements during blocking, which may be due to individual player mechanics or specific training practices.

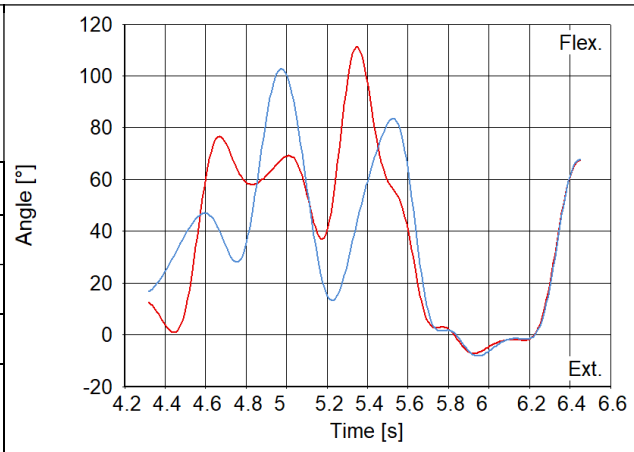
Table-4

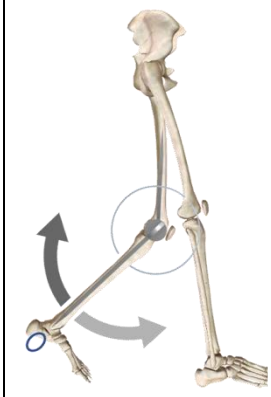
Kinematic Indicators of Knee Movements During the Volleyball "Block" Technique

Flexion

Flexion[+]/Extension[-]

	LEFT	RIGHT
Min	-8º	-9º
Max	111º	102º
Range	118º	110º





Flexion refers to the bending of the knee, while extension is the straightening of the joint. During the blocking action, knee flexion is key for loading energy before the jump, and extension helps generate the upward force required for blocking. Proper coordination between knee flexion and extension is vital for maintaining balance and power throughout the blocking sequence (Table-4).

Minimum Flexion (Left/Right): -8º (left), -9º (right). These values represent slight hyperextension of both knees before the jump, which is common as players prepare to push off the ground. The slight difference in the left and right knee suggests a minor asymmetry in the preparation phase.

Maximum Flexion (Left/Right): 111º (left), 102º (right). During the jump preparation, the knees bend significantly, with the left knee reaching 111º of flexion and the right knee 102º. This difference highlights a potential asymmetry in leg usage, where the left knee may be more actively engaged in the jumping motion.

Range of Motion (Left/Right): 118º (left), 110º (right). The range of motion for both knees is considerable, with the left knee showing a greater range. This difference may indicate a tendency for players to favor one leg during the jump, which could affect performance and lead to imbalances.

Knee flexion and extension are critical components of the volleyball blocking technique, as they contribute directly to jump height and balance. The significant range of motion observed in both knees reflects the flexibility and strength required to execute a powerful block. However, the observed asymmetry between the left and right knees, with the left knee showing greater flexion and range of motion, suggests that players may rely more on one leg during the takeoff phase. Such asymmetry, if unaddressed, can lead to inefficiencies or even injury over time.

Ankle movements play a crucial role in the blocking technique in volleyball by contributing to stability, jumping power, and landing control. The dorsiflexion and plantarflexion of the ankles are essential components that allow players to elevate and position themselves effectively at the net. This article examines the kinematic indicators of ankle flexion, specifically dorsal and plantar flexion of both the left and right ankles during the blocking movement.

Dorsiflexion refers to the upward flexion of the ankle, bringing the toes toward the shin, while plantarflexion is the downward movement, where the toes point away from the shin. During a volleyball block, dorsiflexion is crucial for preparing the jump and stabilizing the body during landing, while plantarflexion is essential for generating power during the push-off phase (Table-5).

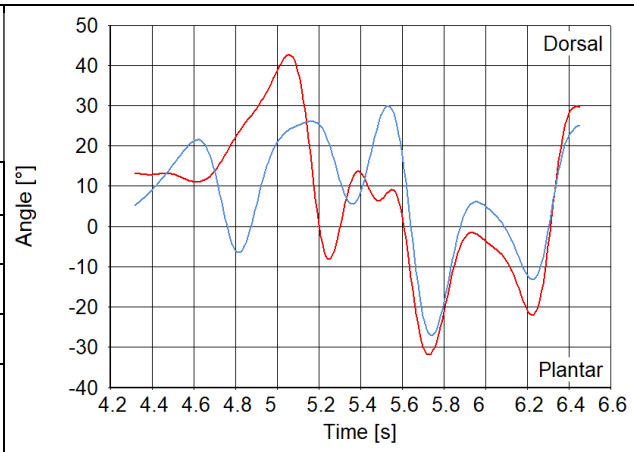
Table-5

Kinematic Indicators of Ankle Movements During the Volleyball "Block" Technique

Flexion

Dorsal[+]/Plantar[-]

	LEFT	RIGHT
Min	-32º	-27º
Max	42º	29º
Range	74º	56º



Minimum Flexion (Left/Right): -32º (left), -27º (right). This indicates that the plantarflexion of both ankles reaches a minimum angle during the preparation and landing phases, with the left ankle showing a slightly greater degree of flexion than the right.

Maximum Flexion (Left/Right): 42º (left), 29º (right). The maximum dorsiflexion during the jump reaches 42º in the left ankle and 29º in the right ankle, reflecting significant engagement of the ankles in preparing for the block. The higher dorsiflexion in the left ankle suggests a potential asymmetry in the jumping mechanics or a dominant side during takeoff.

Range of Motion (Left/Right): 74º (left), 56º (right). The left ankle exhibits a wider range of motion, indicating that it plays a more active role in both the plantarflexion and dorsiflexion phases compared to the right ankle.

The ankle's range of motion in both dorsiflexion and plantarflexion is crucial for generating the explosive power needed for the jump and for stabilizing the body during the

blocking action. The asymmetry between the left and right ankles suggests that players may rely more on one leg during takeoff, which could be due to handedness or dominant-side training. Proper ankle flexibility and strength are essential for both preventing injury and maximizing performance during blocking. The greater range of motion in the left ankle also indicates that this side is more engaged in both preparation and landing phases, potentially reflecting biomechanical differences that can be addressed in training.

In conclusion. The shoulder plays a critical role in the success of the volleyball blocking technique, with flexion, extension, abduction, and adduction all contributing to the player's ability to cover the net effectively. The range of motion data in this study reveals that both shoulders are heavily engaged during the block, with a slight asymmetry suggesting individual preferences or training effects. This emphasizes the importance of balanced training focused on both shoulder flexibility and strength to enhance blocking performance and reduce the risk of injury.

The kinematic indicators of elbow movements during volleyball blocking demonstrate the importance of both flexion and extension for positioning the arms. The similar range of motion between the left and right elbows reflects the necessity for symmetrical arm movements in effective blocking. Training aimed at enhancing elbow mobility and strength can further improve a player's blocking ability by increasing their ability to react quickly and maintain balance during the block.

Knee flexion and extension are fundamental to the successful execution of the volleyball block, contributing to both power generation and stability. The greater range of motion in the left knee suggests a possible imbalance that could affect long-term performance. Training programs should focus on improving flexibility, strength, and symmetry in both knees to optimize blocking performance and reduce the risk of injury.

Ankle dorsiflexion and plantarflexion are vital for effective volleyball blocking, contributing to the vertical jump and maintaining balance. The observed asymmetry between the left and right ankles highlights the importance of addressing potential dominant-side imbalances in training programs. Improving ankle mobility and strength through targeted exercises can enhance blocking performance and help prevent injury.

References:

1. Drikos, S., Kountouris, P., Laios, A., & Laios, Y. (2012). The identification of elite performance in volleyball. *Journal of Human Kinetics*, 31, 121–129.

2. Häkkinen, K. (1993). Changes in physical fitness profile in female volleyball players during the competitive season. *Journal of Sports Medicine and Physical Fitness*, 33(3), 223–231.

3. Sheppard, J. M., Gabbett, T., & Stanganelli, L. C. (2009). An analysis of playing positions in elite men's volleyball: Considerations for competition demands and physiological characteristics. *Journal of Strength and Conditioning Research*, 23(6), 1858–1866.

4. Ziv, G., & Lidor, R. (2010). Vertical jump in female and male volleyball players: A review of observational and experimental studies. *Scandinavian Journal of Medicine & Science in Sports*, 20(4), 556–567.