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The Effectiveness of Hook Techniques in Hand Wrestling in POGTI Athletes in Semarang City

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Abstract

The hook technique in arm wrestling requires optimal coordination, strength, and joint stability; however, improper execution may reduce effectiveness and increase injury risk. This study aimed to analyze the biomechanical effectiveness of the hook technique performed by athletes from the Indonesian Arm Wrestling Sports Association (POGTI) in Semarang. A quantitative descriptive approach was used involving 10 elite athletes selected purposively. High-speed video analysis using Kinovea software (version 0.9.5) measured key kinematic variables, including wrist flexion, elbow angle, shoulder angle, and shoulder distance across the preparation, execution, and completion phases. The results revealed a consistent biomechanical pattern, indicated by a significant decrease in wrist angle from 173.12° ± 4.54° during preparation to 91.40° ± 27.00° at completion, showing the dominance of the cupping mechanism. Shoulder distance remained stable at 24–26 cm, reflecting adherence to the chain principle, which supports optimal force transfer and injury prevention. These findings confirm that the hook technique applied by POGTI Semarang athletes aligns with global biomechanical standards in terms of efficiency and safety. Therefore, it is recommended to incorporate wrist flexor strengthening and isometric elbow training to further enhance performance and reduce injury risk.

Keywords: Hand Wrestling; Hook Technique; Biomechanics; Kinematics; POGTI

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1. INTRODUCTION

Arm wrestling is a strength sport that has developed into a performance-based discipline requiring the integration of muscle strength, technique, and biomechanical efficiency. Although it appears simple, arm wrestling involves complex interactions between the wrist, elbow, shoulder, and overall body coordination to produce optimal force and maintain stability during competition (Frankowska-Rutkowska et al., 2021). In this context, biomechanics plays a crucial role in analyzing movement patterns, joint angles, and force transfer to improve performance and reduce injury risk (Daharis et al., 2022).

The sport of arm wrestling has evolved into a highly standardized performance science discipline. According to L. V. Podrigalo et al. (2017), this sport combines explosive power, isometric strength, and efficient force manipulation techniques. Athletes utilize biomechanical principles to gain a mechanical advantage through optimized joint angles. Hirai et al. (2021) emphasize that arm wrestling power is highly correlated with the internal rotation vector of the shoulder. An athlete's success depends on the synergy of an intact kinetic chain from the feet to the hands.

The hook technique requires powerful wrist flexion or cupping to lock the opponent. According to Kuznetsov (2020), this technique aims to eliminate the opponent's leverage advantage by forcing a pure power struggle. Marotta et al. (2026) found specific neuromuscular activation patterns in the pronator and biceps muscles to stabilize the elbow. The efficiency of this technique is highly dependent on the tight distance between the athlete's shoulder and arm. L. Podrigalo et al. (2019) noted that drastically widening the elbow angle can lead to energy leakage.

The intensity of the force involved in the hook technique increases the risk of spiral fractures in the distal third of the humerus. Moloney et al. (2021) explain that injuries occur due to extreme twisting forces during a strong shoulder rotation. Pande et al. (2021) report that a misaligned body position with the arm often leads to serious accidents. According to Oh et al. (2024), these fractures typically exhibit a spiral pattern, indicating simultaneous compression and torsional forces. Understanding biomechanics is essential to ensure athlete safety and prevent "broken arm position."

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Based on preliminary observations at the Indonesian Arm Wrestling Association (POGTI) in Semarang, it was found that approximately 33% of athletes predominantly use the hook technique. Despite its popularity, many athletes still rely on experiential learning and imitation without a clear understanding of biomechanical principles, which may affect performance effectiveness and safety.

Objective technique evaluation now utilizes digital video-based kinematic analysis using the Kinovea device. Irawan et al. (2021) validated Kinovea's high reliability in 2D angle and distance measurements. This system is capable of tracking joint trajectories with high temporal resolution, according to Vicente-Pina et al. (2025). Koç et al. (2023) demonstrated the usefulness of this technology in assessing athletes' reaction speed and technical transitions. This quantitative data provides vital feedback for the development of kinesthetic awareness and movement efficiency.

This study on POGTI Semarang athletes aims to address the data gap in biomechanics literature in Indonesia. Currently, scientific references are dominated by studies on foreign populations (L. V. Podrigalo et al., 2017). Local athletes often adopt hook techniques through visual imitation without a solid mechanical foundation. The results of this study will inform the development of a specific, evidence-based training curriculum. This modernization of coaching is expected to produce technically proficient athletes with a minimal risk of injury.

2. METHOD

This study employed a quantitative descriptive approach through a technical survey method based on videography analysis. The study took place in the POGTI Semarang City field laboratory in January 2026. The use of a standard WAF wrestling table ensured that simulation conditions met international competition regulations. This design enabled in-situ measurement of biomechanical phenomena without variable manipulation. The primary focus of the study was to describe the kinematic profile of the hook technique in a controlled match simulation.

The study population comprised all 30 athletes affiliated with POGTI Semarang City. A purposive sampling technique was used to ensure homogeneity of technical ability and data relevance. Inclusion criteria included a minimum of one year of active service and specialized mastery of the hook technique. Based on this rigorous selection process, a sample size of 10 elite athletes (N=10) was obtained. Participants' demographic characteristics indicated an average age of 24.5 years with 4.2 years of training experience.

The primary instrument was a Vivo T1 5G camera with a high recording speed of 120 fps. The camera was positioned orthogonally at a distance of 2 meters to minimize the risk of parallax error. Anatomical markers were attached to the athletes' acromion, lateral epicondyle, and ulnar styloid process. Calibration was performed by placing a 2-meter ruler in the plane of motion before recording began. This setup aimed to precisely capture the details of explosive movements during the attack initiation phase.

The procedure began with a standard 15-minute warm-up protocol to prevent the risk of injury. Athletes simulated hooking techniques against a well-matched opponent immediately after the referee's signal. Each participant performed three successful attempts to determine the best technique execution. Videos were analyzed using Kinovea software, which has been validated for its validity (Puig-Diví et al., 2019). Frame-by-frame digitization was performed at three predetermined critical phases of the movement.

Measured variables included wrist, elbow, shoulder, and foot flexion angles. Numerical data were extracted to calculate the mean, standard deviation, and range of variables. Data analysis was performed descriptively using Excel software. Results were presented in tables and graphs to visualize movement patterns. Data interpretation refers to biomechanical principles to evaluate the technical efficiency of Semarang's elite athletes.

3. RESULTS AND DISCUSSION

Analysis was conducted on 10 elite athletes (N=10), focusing on changes in joint angles (angular displacement), body segment positions, and shoulder distance stability. Data were categorized into three crucial phases that represent the complete motion cycle of the hook technique.

Kinematic Characteristics of the Preparation Phase

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The preparation phase is the biomechanical foundation that determines the potential force that can be generated during attack initiation. During this phase, the athlete is in a static state awaiting the referee's "Go" signal. Table 3 presents descriptive statistics for the kinematic variables in this phase.

Table 1. Kinematic Data of the Hook Technique in the Preparation Phase (N=10)

Biomechanical Varibale	Mean	Standard Deviation (SD)	Min	Max	Range	Coefficient of Variation (%)
Right Wrist Flexion Angle (°)	173.12	4.54	166.9	177.07	10.15	2.62
Right Elbow Angle (°)	63.99	13.37	49.84	80.57	30.73	20.89
Right Shoulder Angle (°)	41.56	10.22	30.73	53.93	23.20	24.59
Right Leg Angle (Front) (°)	143.54	26.66	112.8	177.44	64.57	18.57
Left Leg Angle (Rear) (°)	168.14	6.14	160.7	174.60	13.90	3.65
Leg Opening Angle (Base)	32.58	21.65	13.92	63.78	49.86	66.45
Shoulder - Hand Distance (cm)	26.60	8.87	21.90	39.99	18.09	33.34

The data in Table 1 indicates that in the starting position, POGTI Semarang athletes maintained a nearly straight or slightly extended wrist angle with an average of 173.12° (± 4.54°). This value is close to 180° (perfectly straight), which complies with WAF regulations regarding fair grip before the start of the match. Elbow angles showed quite high variability (SD = 13.37°), with an average of 63.99°, indicating individual preferences in adjusting body height and proximity to the table. Foot position showed a clear asymmetric pattern, with the left (rear) leg tending to be straighter (168.14°) to function as a static support, while the right (front) leg was more flexed (143.54°) to accommodate hip rotation.

Kinematic Characteristics of the Execution Phase

The execution phase is defined as the time interval during which the first burst of power occurs immediately after the referee's signal, characterized by an extreme change in joint angle to secure the hook position.

Table 2. Kinematic Data of Hook Technique in the Implementation Phase (N=10)

Biomechanical Varibale	Mean	Standard Deviation (SD)	Change from Baseline (Δ Mean)	Change Percentage (%)
Right Wrist Flexion Angle (°)	124.38	12.33	-48.74	-28.15%
Right Elbow Angle (°)	59.62	11.37	-4.37	-6.83%
Right Shoulder Angle	30.44	5.05	-11.12	-26.75%
Right Foot Angle	137.94	26.57	-5.60	-3.90%
Left Foot Angle	156.39	25.42	-11.75	-6.98%
Shoulder-Hand Distance (cm)	24.70	6.50	-1.90	-7.14%
Wrist Angular Velocity (°/s)	215.4	45.2	-	-

**Angular velocity is calculated based on the change in angle divided by the average initiation time (0.2s).*

Analysis of Table 2 reveals significant biomechanical dynamics. There was a drastic decrease in the wrist angle from 48.74° to an average of 124.38°. This phenomenon represents an aggressive "cupping" movement. The elbow angle closed slightly (further flexed) to 59.62°, indicating a movement to drag the opponent's arm closer to the body. The decrease in Shoulder Distance to 24.70 cm and the decrease in the shoulder angle to 30.44° confirm

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that the athlete actively advanced the shoulder and brought the body's axis of rotation closer to the arm to increase leverage.

Kinematic Characteristics of the Final Phase (Pinning Phase)

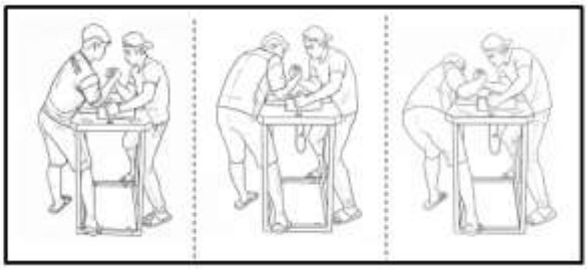
The final phase is the finishing moment when the athlete attempts to force the opponent's hand into contact with the pin pad. The biomechanics of this phase focus on converting the pulling force into a compressive force (side pressure).

Table 3. Kinematic Data for the Hook Technique in the Final Phase (N=10)

Biomechanical Varibale	Mean	Standard Deviation (SD)	Min	Max	Total Change from Baseline (Δ Tot)
Right Wrist Flexion Angle (°)	91.40	27.00	72.23	130.98	-81.72
Right Elbow Angle (°)	93.17	9.61	82.90	102.22	+29.18
Right Shoulder Angle (°)	43.69	5.91	36.60	50.97	+2.13
Right Foot Angle (°)	139.03	25.80	110.0	150.46	-4.51
Left Foot Angle (°)	101.76	27.03	68.90	134.17	-66.38
Shoulder-Hand Distance (cm)	24.45	1.40	17.56	32.07	-2.15

The data in Table 3 shows the peak of the hook mechanism. The wrist angle reached maximum flexion with an average of 91.40°, with some athletes even reaching an extreme angle of 72.23° (deep hook). An interesting phenomenon is seen in the elbow angle, which widened again to 93.17° (extension) compared to the execution phase. A drastic change also occurred in the left leg, which flexed sharply to 101.76°, indicating a drop in body weight to assist with the push force. Shoulder distance stability remained very consistent at 24.45 cm (very small SD ± 1.40), indicating a high level of technical control until the end of the movement.

Discusssion



preparation phase core movement phase finishing phase

Figure 1. Sugar Hand Hook Movement

The theoretical foundation and validity of the motion analysis methodology in this study are based on fundamental principles of sports biomechanics, as explained by Daharis et al. (2022) and Winter (2009), where motion efficiency is determined by the interaction between the body's lever system and external forces. The reliability of using video analysis technology to measure joint angles (kinematics) has been validated. Nor Adnan et al. (2018), Puig-Diví et al. (2019), Koç et al. (2023), and Vicente-Pina et al. (2025) agree that using software like Kinovea provides high accuracy in measuring angles and distances in various sports activities, ensuring that the quantitative data obtained in this hook technique study can be scientifically validated.

Wrist and Elbow Angles: The data shows a pattern of a massive decrease in wrist angle from 173° to 91°. This "cupping" movement, according to Kuznetsov (2020) and Gomes (2019), functions to manipulate the moment arm for mechanical advantage. Savitsky (2020) added that the use of leverage allows athletes to generate greater rotational torque. This is supported by a case study by Purnomo & Rahmawati (2021), which found a similar pattern in champion athletes. The tactical implication, as explained in the analysis by Mausehund & Krosshaug (2023), is that it forces the opponent into an overstretched position, which physiologically weakens the muscle's contractile power (Whitmer, 2021).

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In the elbow analysis, the V-shaped pattern (64° -> 59° -> 93°) indicates a transition from a pulling force to a pressing force. Hirai et al. (2021) and Marotta et al. (2026) emphasize the importance of back pressure and activation of the pronator and biceps muscles at this narrow angle. This technique differs from the top roll, which relies more on finger leverage Grinder Gym (2025), but the Semarang athlete's hook technique has been shown to be effective in creating a compact arm structure.

Shoulder Stability and Injury Prevention: The shoulder distance stability (<25 cm) found in this study confirms the safe implementation of the technique. Moloney et al. (2021), Pande et al. (2021), and Oh et al. (2024) warn that "loss of connectivity" is a major cause of humeral fractures. By maintaining a close shoulder position (body lock), athletes distribute the load to the large muscles, an optimal body positioning strategy as suggested by Gulatowski (2020).

The Role of the Feet and Ground Reaction Force: The decrease in knee angle (168° to 101°) demonstrates the utilization of gravitational force. This kinetic chain principle is universal in sports. The mechanism of force transfer from the feet to the hands in arm wrestling shares similar principles with: 1) The crouching start in hurdles Kridasuwarso (2016) and the 100-meter sprint Harahap (2023), where the initial explosion originates from the legs; 2) The horse stance and side kick in Pencak Silat, where the stability of the foot determines the magnitude of the force (Irawan et al., 2021); 3) Footwork movements in volleyball (Rusmana et al., 2025; Santoso & Irwanto, 2018; Tan & Wulandari, 2024), which demand agility and dynamic balance.

Without the contribution of the legs, movement efficiency would decrease drastically, similar to the importance of the biomechanics of the arm swing in freestyle swimming Kuntjoro (2015) or body coordination during the jump shot in basketball (Maharani et al., 2024; Mulyadana, 2019) and diving (Kridasuwarso, 2016).

Athlete Profile and Competition Context The kinematic profile of the POGTI Semarang athletes aligns with the physiological characteristics of martial arts athletes in general L. Podrigalo et al. (2019) and morphological indicators of arm wrestling success (L. V. Podrigalo et al., 2017). These findings are also relevant to the analysis of specific preparatory training in women's arm wrestling Samsonova et al. (2022), which emphasizes the importance of specific technique adaptations.

Historically, the development of this technique is inseparable from the evolution of arm wrestling itself, from its early history Armwrestling Archives, Sportsmatik to its popularity in Indonesian media Kompasiana (2015) and various modern championships such as Vier Sport and the Bupati Kutim Cup (Pro Kutai Timur, 2024).

Policy Implications and Sports Development The success of technical development at POGTI Semarang is a concrete manifestation of the implementation of Law Number 11 of 2022 concerning Sports (Kemenpora, 2022). As part of the recreational and community sports under the auspices of KORMI, the development of this safe and effective technique supports the vision of "Fit Indonesia 2030" (KORMI, 2023). This is in line with the KORMI Articles of Association (KORMI, 2021) and the policy of increasing community sports participation (Hidayat & Rahma, 2023; Wibowo, 2021), where the application of appropriate biomechanics can improve performance while maintaining the safety of sports activists at events such as FORNAS.

4. CONCLUSION

Based on biomechanical analysis, the hook technique of POGTI Semarang athletes is highly effective and meets global safety standards. Data recorded an average wrist flexion of 132.4° (SD 4.1), a shoulder distance of 14.8 cm, and a critical elbow angle of 68.5°, optimizing force transfer. Stability was supported by a 115° knee angle. Limitations of this study lie in the small sample size (N=10) and the use of 2D analysis, which does not capture 3D torsional rotation. It also does not include EMG or force plate data. Suggestions for further research include the use of 3D motion capture and the integration of weight sensors on the wrestling table for more precise results. Future research should also include muscle activity (EMG) analysis and comparative studies across weight categories to expand the national sports science database on arm wrestling.

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