



# The Biomechanics of the Overhead Volleyball Serve

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## Introduction and Review of Literature

The volleyball serve is an extremely critical movement to the sport. According to Mackenzie et al, 2012, the primary goal of the movement is to make the served ball as difficult as possible for the opposing team to pass (Mackenzie et al, 2012). Proper execution of this movement requires powerful flexion and extension of the upper limb, rotational motion in the transverse plane, and movement of the entire athlete in the sagittal plane to generate sufficient force. Additionally, movement in the frontal plane should be limited to ensure the movement is executed efficiently, through successful conversions of power. There is significant research which explains that maximum angular velocity in various overhead movements is produced in a specific proximal to distal sequencing of involved muscles (Escamilla & Andrews, 2009). According to Wagner et al., 2014, different phases of the volleyball serve overhead movement require recruitment of specific muscles of the body to perform appropriately. There are significant differences in the upper body muscles recruited throughout the various phases of this movement, all of which are crucial to ensuring proper execution of this skill.

## Wind-Up Phase

**Primary Plane of Movement:** Sagittal

**Primary Muscle Contributors:** Infraspinatus, teres minor, rotator cup muscles

**Critical Skill Sequencing Components:** According to Escamilla & Andrews, the wind up phase begins with the shoulder abducted and extended, and ends with the initiation of shoulder external rotation. This phase is commonly referred to as the “tossing” phase in the performance environment. Specific muscles are recruited to rapidly elevate the arm overhead. It is important the arm exhibits complete elbow extension during this phase. This ensures the athlete will eventually contact the ball at an appropriate height.

**Video Clip Analysis:** The athlete displays almost complete extension at the elbow of the hitting arm. Also, the core appears to be engaged which is also important to the success of this movement.

**Training Exercise Suggestion:** It is important to implement drills which require complete elbow extension while the arm is overhead. For example, coaches could have athletes attempt to reach a certain marker on a wall or other flat surface, while maintaining elbow extension.

## Cocking Phase

**Primary Plane of Movement:** Sagittal, Transverse

**Primary Muscle Contributors:** Infraspinatus and supraspinatus

**Critical Skill Sequencing Components:** According to Escamilla & Andrews, the cocking phase involves the initiation of shoulder external rotation to maximal shoulder external rotation. The rotator cuff muscles are heavily recruited during this phase to generate glenohumeral compression and resist distraction. It is during this phase when rotational motion should begin to be observed, as this is when the initiation of power generation occurs.

**Video Clip Analysis:** The athlete exhibits slight rotation of the trunk when compared to the perpendicular trunk displayed within the wind-up phase. This marks the beginning of trunk rotation to generate force during this movement sequence. The initiation of shoulder external rotation can also be observed in this phase.

**Training Exercise Suggestion:** The athlete should focus on drills which activate trunk rotation to ensure force generation can occur during this phase.



Wind-up Phase



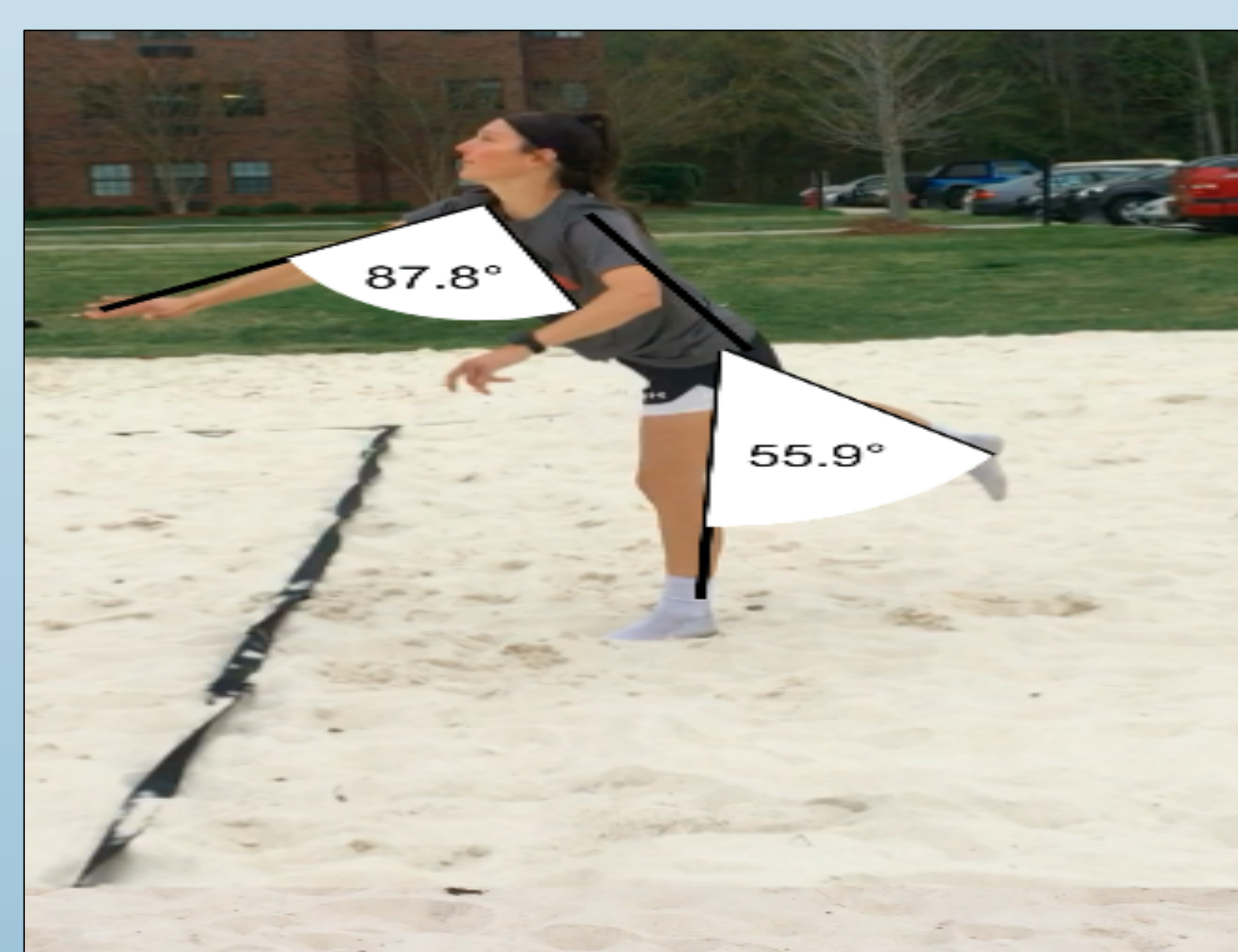
Cocking Phase



Acceleration Phase



Deceleration Phase



Follow Through Phase

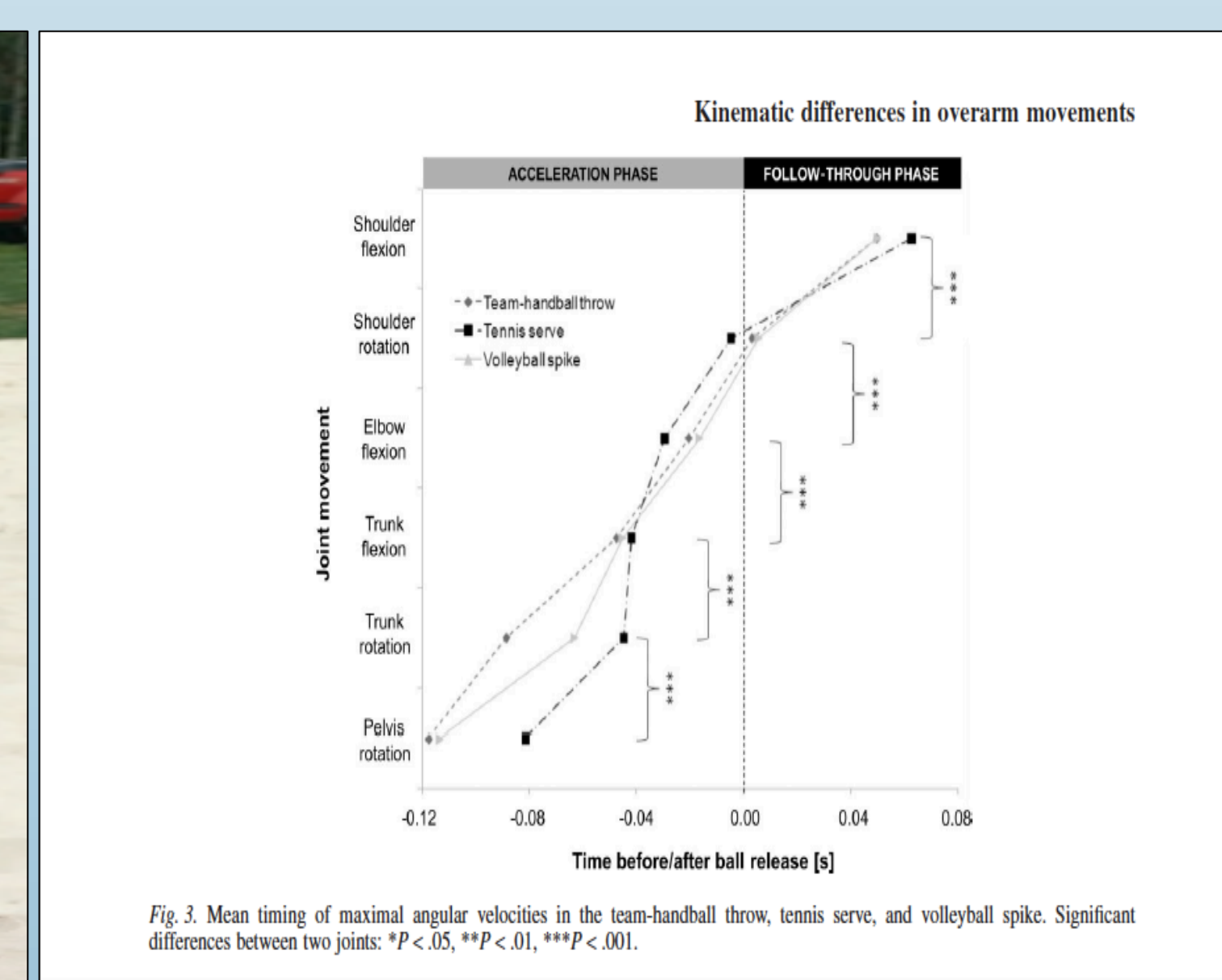


Fig. 3. Mean timing of maximal angular velocities in the team-handball throw, tennis serve, and volleyball spike. Significant differences between two joints: \* $P < .05$ , \*\* $P < .01$ , \*\*\* $P < .001$ .

Escamilla & Andrews, 2009

## Acceleration Phase

**Primary Plane of Movement:** Sagittal, Transverse

**Primary Muscle Contributors:** Teres major, subscapularis, pectoralis major and latissimus dorsi

**Critical Skill Sequencing Components:** According to Hadzik et al. 2014, it is maximum external rotation of the shoulder which activates stored energy by twisting the torso. This is what allows the generation of sufficient force necessary to execute the serve. According to Escamilla & Andrews, the acceleration phase is distinguished by the transition from maximum shoulder external rotation to ball contact, classified by internal shoulder rotation and maintenance of elbow extension (Escamilla & Andrews, 2009).

**Video Clip Analysis:** The shoulder begins to display significant external rotation, and the elbow displays sufficient flexion. The opposing arm maintains extension at the elbow to track the tossed ball, which promotes good contact.

**Training Exercise Suggestion:** Banded shoulder external rotation exercises would aid in allowing this critical movement to be proficient during this phase.

## Deceleration Phase

**Primary Plane of Movement:** Sagittal

**Primary Muscle Contributors:** Internal rotators of the shoulder

**Critical Skill Sequencing Components:** According to Escamilla & Andrews, the deceleration phase is characterized by impact with ball to when upper arm becomes perpendicular to trunk. This phase involves high activity of infra and supraspinatus to the control the arm as it begins to complete its movement. (Escamilla & Andrews, 2009). The shoulder should be quickly internally rotated forward to complete the movement and continue the conversion of energy which was activated by the maximal external rotation.

**Video Clip Analysis:** It is clear the athlete has internally rotated the shoulder, as the entire upper limb is now in a forward position due to flexion at the shoulder. The arm maintained extension at the elbow throughout the deceleration which is important to ensure proper contact and maintenance of power.

**Training Exercise Suggestion:** The focus for this phase is ensuring the arm begins to decelerate movement, and the muscles of the shoulder remain strong enough to support the rapid movement of the upper limb. Training and strengthening the shoulder muscles to support the arm with various shoulder exercises would be a good training regiment for this phase..

## Follow Through Phase

**Primary Plane of Movement:** Sagittal

**Primary Muscle Contributors:** Anterior Deltoid, Infraspinatus,

**Critical Skill Sequencing Components:** The follow through phase is crucial in ensuring successful conversion of power and force, as well as accuracy in where the ball travels. The body must act in a way to successfully transfer energy throughout the kinetic chain, to ensure that sufficient force is produced. Additionally, smaller flexion and extension movements at the wrist are important to producing the desired type of serve, and aiming the ball where you want it to go.

**Video Clip Analysis:** It is extremely obvious there is significant losses in the conversion of power very early in the kinetic chain. This is evident as the foot is abducted and there is significant lateral flexion at the hip.

**Training Exercise Suggestion:** Drills should focus on athletes following through to a target and ensuring the end positioning of their arm allows for the ball to travel where they want the ball to end up.

## Conclusion

In conclusion, the analyzed photos display a relatively successful completion of this overhead movement. This movement pattern aligned with existing research concerning various overhead movements in regard to its sequencing and skill components. It is clear that specific muscles are recruited for the various different phases of this overhead movement. Additionally, maximum external rotation of the shoulder, rotational motion of the trunk and successful energy transfer up the kinetic chain are all crucial in successfully completing this skill. The athlete proficiently externally rotated the shoulder and rotated at the trunk to produce force, but did not successfully transfer this produced force throughout the entire movement.

## References

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