مجلة دامو لعلوم الرياضة
DAMU JOUNRAL OF SPORT SCIENCE (DJSS)
ISSN-L: 3005-8244 ، ISSN-P: 3005-8236
https://www.iasj.net/iasj/journal/460
DAMU JOUNRAL of sport science

The Effect of Biomechanical Characteristics of Compound Offensive Skill Speed on Shooting Accuracy Index for Junior Handball Players

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Research receipt date: May 10, 2025, Research publication date: August 25, 2025

Abstract

Successful handball shooting emerges from the coordinated interaction of approach speed, whole-body momentum transfer, release position, movement time, and target control. Applied video analysis can quantify selected features of this complex offensive sequence.
Purpose: To describe selected biomechanical characteristics of a compound offensive shooting task and examine their reported relationships with compound-skill performance and the shooting-accuracy index in junior handball players.
Methods: A descriptive correlational design was used. The source population comprised 10 players from the Al-Diwaniyah Specialized Handball School in 2025; three players were excluded, leaving seven participants. Two Galaxy S25 Ultra cameras recorded the task at 240 frames/s from lateral and posterior views. Kinovea-2025. was used to obtain launch speed, hip height at ball release, and movement time. The task consisted of ball pickup, chest pass and reception, a feint around a mannequin, shooting, and returning to the start, repeated with six balls. Descriptive statistics and Pearson correlations were reported.
Results: Published means were 13.68 for compound-skill performance, 4.58 m/s for launch speed, 1.39 m for hip height at release, 4.16 s for movement time, and 2.65 points/s for the shooting-accuracy index. The reported correlations of compound-skill performance were r = -0.63 with launch speed, r = -0.75 with hip height, r = -0.82 with movement time, and r = -0.72 with the accuracy index.
Conclusion: The published data indicates substantial inverse associations between compound-skill performance and the selected biomechanical outcomes. Because the sample was small and the source tables contain internal inconsistencies in several units, dispersion values, and p values, the findings should be interpreted as exploratory and should not be treated as causal.

Keywords:
Handball; junior athletes; shooting accuracy; compound offensive skill; sports biomechanics; two-dimensional video analysis

1. Introduction

Handball is an intermittent, high-intensity team sport in which decisive offensive actions combine acceleration, passing, receiving, deception, jumping, and shooting under severe temporal and spatial constraints. The overarm throw is a whole-body action: momentum is generated by the lower limbs and trunk and transferred through a proximal-to-distal sequence toward the throwing arm and ball (Wagner et al., 2011). The quality of this sequence affects release velocity, release position, and the athlete's ability to direct the ball toward a target.

Throwing performance is not determined by ball speed alone. Research comparing age and skill groups shows that skilled and older handball players generally produce greater pelvis, arm, hand, and ball velocities, whereas accuracy differences may be less consistent (Moreno et al., 2023). Experimental work also demonstrates that instructions emphasizing speed or accuracy can modify release velocity and task strategy, supporting a context-dependent speed-accuracy relationship rather than a single universal optimum (García et al., 2013; Van Den Tillaar & Ettema, 2003). Three-dimensional studies further identify meaningful contributions from run-up velocity, pelvis and trunk motion, and technique-specific coordination (Jöris et al., 1985; Serrien et al., 2015; Wagner et al., 2011).

For junior athletes, compound offensive tasks may provide greater ecological relevance than isolated stationary throws because they incorporate approach movement, direction change, ball handling, deception, and shooting. Youth handball performance is also influenced by growth, anthropometry, and upper- and lower-body strength; therefore, regular age-appropriate monitoring is recommended (Fernandez-Fernandez et al., 2022). Biomechanical measurements should be interpreted together with the tactical goal of completing the sequence efficiently and accurately. Evidence from another explosive overhead sport has shown that exercises structured around antagonistic muscle action and joint angles can improve biomechanical characteristics and electromyographic activity during volleyball spiking, illustrating the value of integrating mechanical and neuromuscular assessments in complex sport skills (Abbas, H,A. & Shubbar, 2024).

Two-dimensional high-speed video is a practical option for applied analysis. Kinovea has demonstrated acceptable validity and reliability for angular, distance, and selected jump measurements under controlled conditions (Pueo et al., 2020; Puig-Diví et al., 2019). Nevertheless, the quality of field estimates depends on camera alignment, calibration, event definition, digitization reliability, and out-of-plane motion. These details are especially important in a compound task that includes forward movement, a feint, and a shot.

Recent sport-biomechanics research has also explored predictive modeling. Ibrahim and Shubbar used artificial neural networks to classify biomechanical profiles in a volleyball blocking task (Ibrahim & Shubbar, 2023), illustrating how measured variables may support data-driven performance models. Broader evidence on markerless artificial-intelligence systems, however, indicates that validation remains specific to the task, joint, plane, and outcome (Abbas, H,A. & Shubbar, 2024). Such technologies are promising for future handball research, but they do not remove the need for transparent measurement and validation.

The purpose of the present study was to describe selected biomechanical characteristics of a compound offensive handball task and examine their reported relationships with compound-skill performance and the shooting-accuracy index in junior players. Because the original study was observational, the word effect in the preserved title is interpreted as statistical association rather than causation.

2. Materials and Methods

2.1 Study design and setting

A descriptive correlational design was used. The study was conducted in the indoor sports hall in Al-Diwaniyah Governorate, Iraq, during the period from September 11, 2024, to February 10, 2025. The pilot experiment was conducted on January 11, 2025, and the main experiment on January 13, 2025, at 3:00 p.m.

2.2 Participants

The study population comprised 10 junior players from the Al-Diwaniyah Governorate Specialized Handball School during 2025. Three players were excluded because they did not comply with the testing procedures, leaving a final sample of seven players (70% of the source population). Participants were selected purposively. The source report did not provide sex, playing positions, eligibility criteria, injury status, or individual-level data.

Table 1. Published participant characteristics

Characteristic	Unit	Mean	SD	Reported CV (%)
Biological age	years	15.30	0.403	8.786
Standing height	cm	176.55	12.20	3.577
Body mass	kg	75.66	2.089	9.745

CV, coefficient of variation; SD, standard deviation. Values are reproduced as published. Several reported CV values are not arithmetically consistent with the corresponding means and SDs and could not be verified without raw data.

2.3 Equipment and software

The equipment included two Galaxy S25 Ultra video cameras operating at 240 frames/s, two tripods, a scale reference, a computer, Kinovea version -2025., a metal measuring tape, a height-and-mass measurement device, 10 handballs, a regulation handball court, timing devices, and a wooden mannequin representing a defender.

2.4 Compound offensive-skill test

The player stood 6 m behind the 9-m line with the balls positioned in front. On the start signal, the player picked up a ball, delivered a chest pass to an assistant positioned approximately 6 m away, continued forward, received the return pass near the 9-m line, performed a movement feint around the wooden mannequin, shot at goal, and returned to the starting position. The sequence continued until six balls had been completed.

A direct goal without contact with the goal frame received three points; a goal after contact with the frame received two points; and a miss, an illegal action, or contact with the 6-m line received zero. One point was deducted for an error in ball pickup, pass or reception, or execution of the feint. The maximum score was 18 points. Completion time was recorded to the nearest 0.01 s from the start signal until the sixth ball was completed and the player returned to the starting line. The shooting-accuracy index was calculated as total score divided by completion time.

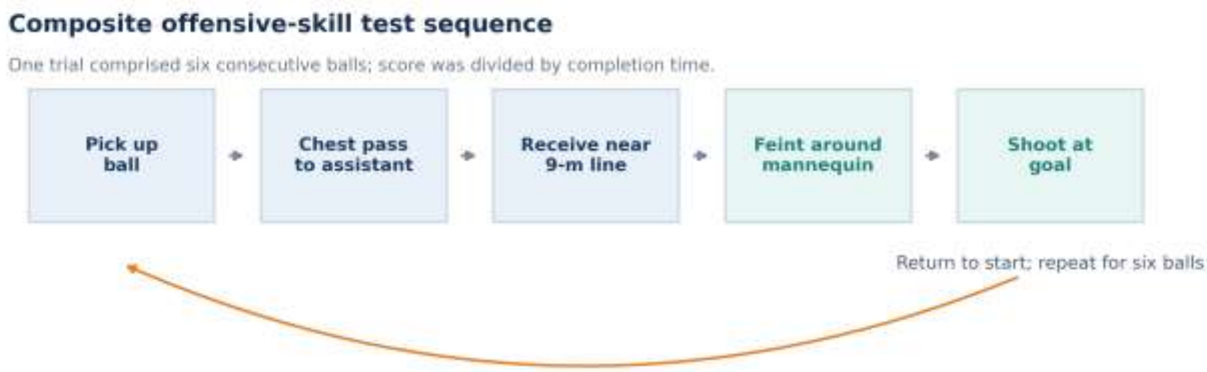

Figure 1. Operational sequence of the compound offensive-skill test.

2.5 Pilot study and video acquisition

The pilot experiment involved two junior players and was used to assess test feasibility, equipment suitability, assistant-team procedures, and potential implementation obstacles. The main experiment used a lateral camera to capture the preparatory, main, and final phases and a posterior camera to observe the performer and ball path. The source report states that the camera positions were fixed and marked before testing but does not provide camera distance, lens height, exposure settings, shutter speed, or synchronization procedures.

2.6 Biomechanical outcome definitions

Launch speed (m/s): The displacement of the body from immediately before leaving the floor to the instant of ball release divided by the corresponding elapsed time, after spatial calibration. This is a mean translational speed across the defined interval rather than instantaneous release velocity.

Hip height at ball release (m): The vertical distance from the hip landmark to the floor at the instant the ball was shot, converted through the stated scale reference.

Movement time (s): The elapsed time from the player's initial movement toward the ball until ball contact and subsequent landing, as described in the source report. This definition differs from the completion time used to calculate the shooting-accuracy index.

Compound-skill performance: The source table reports a numerical performance variable with a mean of 13.68 but labels its unit as degrees. Because the method describes performance through score and time rather than an angular measure, the unit is treated as unclear and is not reclassified without raw data.

Shooting-accuracy index (points/s): The six-ball test score divided by total test completion time.

Variable definitions were clarified using standard biomechanical distinctions among displacement, elapsed time, mean velocity, and instantaneous velocity (Robertson et al., 2014).

2.7 Statistical analysis

The source analysis reported the mean, standard deviation, median, skewness, coefficient of variation, minimum, maximum, and Pearson correlation coefficient. The statistical software and alpha threshold were not identified. Exact raw observations and confidence intervals were unavailable.

The final sample comprised seven athletes. Consequently, the correlations are presented as exploratory effect magnitudes. Small samples produce unstable coefficients, and any repeated observations from the same athlete must be modeled as clustered rather than statistically independent; otherwise, uncertainty can be underestimated (Lazic, 2010).

3. Results

3.1 Descriptive outcomes

The published means were 13.68 for compound-skill performance, 4.58 m/s for launch speed, 1.39 m for hip height at ball release, 4.16 s for movement time, and 2.65 points/s for the shooting-accuracy index (Table 2). Because the variables have different units and scales, Figure 2 presents each outcome in a separate panel.

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Table 2. Published descriptive statistics for the study outcomes

Outcome	Unit	Mean	SD	Median	Skewness	Reported CV	Min-Max
Compound-skill performance	unclear	13.68	0.93	13.00	0.54	16.41	11.00-15.00
Launch speed	m/s	4.58	0.63	4.00	-0.39	2.36	3.00-6.00
Hip height at ball release	m	1.39	0.48	1.36*	-0.78	17.76	1.27-1.48*
Movement time	s	4.16	1.72	4.50	0.97	6.64	3.00-5.00
Shooting-accuracy index	points/s	2.65	0.702	2.60	0.80	4.00	1.70-4.65

*SD, standard deviation. Values are reproduced from the source table. *Hip median, minimum, and maximum were printed as 136, 127, and 148 and have been expressed in meters to match the stated unit. The published SD and CV columns show internal inconsistencies and should be checked against the original dataset before confirmatory use.*

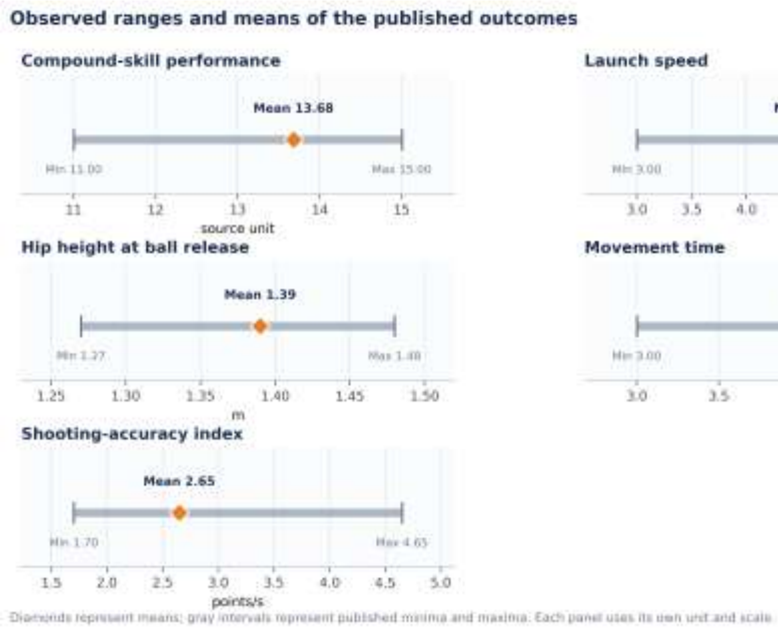

Figure 2. Published means and observed ranges of the biomechanical and performance outcomes.

3.2 Reported associations

Compound-skill performance was reported to correlate negatively with launch speed (r = -0.63), hip height at release (r = -0.75), movement time (r = -0.82), and the shooting-accuracy index (r = -0.72). The source reported p values of 0.02, 0.13, 0.03, and 0.04, respectively (Table 3). The reported p values are reproduced for transparency but are not interpreted as confirmatory because they appear inconsistent with the stated sample size and no analysis-level sample count was provided.

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Table 3. Published correlations with compound-skill performance

Variable	Reported r	Direction	Magnitude	Reported p	Interpretation
Launch speed	-0.63	Negative	Moderate-to-strong	0.02	Exploratory
Hip height at release	-0.75	Negative	Strong	0.13	Exploratory
Movement time	-0.82	Negative	Very strong	0.03	Exploratory
Shooting-accuracy index	-0.72	Negative	Strong	0.04	Exploratory

r, Pearson correlation coefficient. Magnitude descriptors are descriptive only. Inferential verification requires the original observations, a clear analysis-level sample size, and an athlete-level or clustered model if repeated attempts were included.

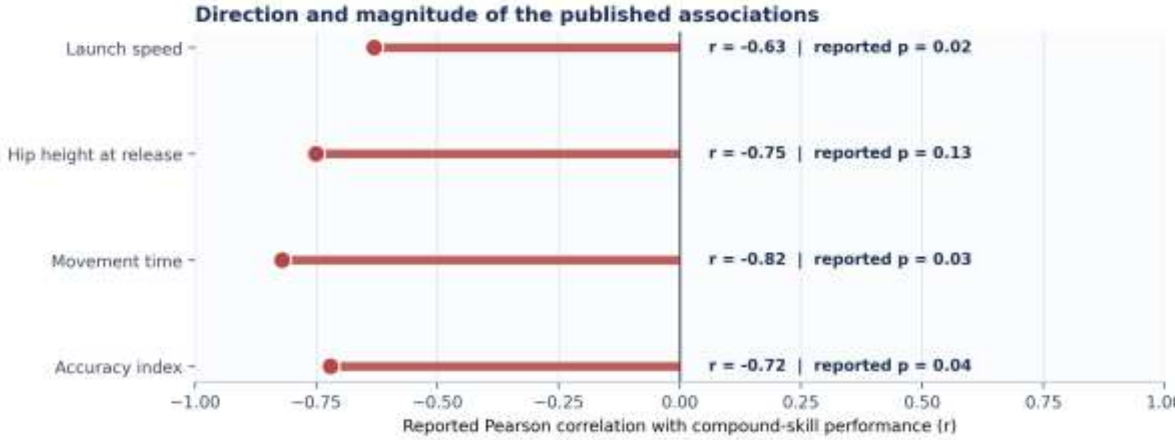

Figure 3. Direction and magnitude of the published correlations with compound-skill performance.

4. Discussion

The study sought to connect the mechanics of a compound offensive sequence with shooting performance in junior handball players. All four published correlations were negative and moderate-to-very-strong in magnitude. The pattern suggests that the compound-performance variable changed systematically with launch speed, release height, movement time, and the accuracy index. However, the direction cannot be interpreted mechanically until the unit and scoring direction of the compound-performance variable are confirmed.

Launch speed and release height are plausible contributors to effective shooting. In handball, run-up and pelvis-trunk motion influence ball velocity, while skilled performers use coordinated segmental actions to transfer momentum (Jöris et al., 1985; Serrien et al., 2015; Wagner et al., 2011). Yet the present launch-speed variable represents body displacement divided by time over a defined interval, not ball release speed. It should therefore not be compared directly with radar-derived ball velocity in previous studies.

The inverse association with movement time may reflect greater task efficiency: players who completed the defined movement phase more quickly may also have achieved better compound-performance values, depending on the direction of the score. At the same time, speed and accuracy may trade off when instructions or task constraints change (García et al., 2013; Van Den Tillaar & Ettema, 2003). A compound test that includes pickup, pass, reception, deception, shooting, and return also blends technical quality with locomotor speed and decision timing. Future studies should report phase-specific times in addition to the total score/time index.

The shooting-accuracy index combines points and completion time, which is practical but difficult to interpret because improvement may arise from a higher score, shorter time, or both. Reporting raw accuracy score, completion time, hit distribution, and the derived index separately would allow coaches and researchers to distinguish technical precision from execution speed. Fatigue and repeated high-intensity activity may also alter shoulder strength or throwing effectiveness, supporting standardized rest intervals and trial order (Andrade et al., 2016).

High-frame-rate video is a strength in field biomechanics, but two-dimensional analysis is sensitive to camera geometry and out-of-plane motion. A feint and handball throw are multiplanar actions. Future protocols should use a calibrated two-dimensional frame in the movement plane, document camera distance and height, synchronize views, define every analysis event by frame, and report intra- and inter-rater reliability. When available, three-dimensional or validated markerless analysis may provide more complete segmental information (Ibrahim & Shubbar, 2023).

4.1 Limitations

The findings are constrained by a final sample of seven athletes from one specialized school. Raw observations, trial counts per athlete, confidence intervals, and a priori power analysis were not available. The participant table contains coefficients of variation that do not match the published means and standard deviations. The outcome table includes unclear units and internally inconsistent dispersion values. The correlation table reports p values that cannot be reconciled confidently with the stated sample size. In addition, the source participant section identifies seven included players, whereas the main-experiment description ambiguously refers to two selected players. These issues cannot be resolved without the original dataset and study records.

Other unreported information includes sex, playing positions, biological-maturation method, injury status, training experience, warm-up, rest intervals, camera geometry, calibration method, filtering, digitization reliability, and ethical approval. Accordingly, the numerical results are retained as a transparent English rendering of the published article rather than presented as independently verified estimates.

4.2 Practical applications

Coaches may use a standardized compound test to observe how junior players integrate approach movement, ball handling, deception, and shooting. For monitoring, the raw accuracy score and total completion time should be stored separately, while launch speed, release height, and phase times should be evaluated with consistent camera placement and event definitions. The present values should not be used as normative targets until the source data are verified and reliability is established.

5. Conclusion

The published study reported substantial negative correlations between compound-skill performance and launch speed, hip height at ball release, movement time, and the shooting-accuracy index in junior handball players. These relationships are potentially useful for hypothesis generation, but their biomechanical meaning depends on confirmation of the performance variable, units, analysis-level sample size, and raw observations. A larger, preregistered study using a standardized protocol, separate speed and accuracy outcomes, reliability testing, and athlete-level or multilevel analysis is required before causal or training recommendations can be made.

Recommendations

1. Retain separate measures of raw shooting score, total completion time, and the derived accuracy index.
2. Define launch, ball-release, landing, and task-completion events operationally at the frame level.
3. Document camera geometry, calibration, synchronization, filtering, and digitization reliability.
4. Analyze repeated trials with athlete-level summaries or a multilevel model rather than treating all trials as independent.
5. Replicate the protocol in larger samples, across playing positions, and with maturation and injury status reported.

6. Validate any neural-network or markerless system specifically for the handball task and outcome before applied use.

English-version statement

This English-language version corresponds to the previously peer-reviewed and published Arabic study and was prepared for the same journal. The title, study population, test description, and published numerical results are retained. The English language, article organization, methodological terminology, literature context, tables, and figures have been revised to improve international readability. No raw data were available for independent recalculation.

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