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3D Kinematic Analysis of Feint-Combo Skills to Predict Offensive Decision-Making Effectiveness in Handball Players

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Abstract

Background & Purpose: This study aimed to develop a quantitative 3D kinematic profile of feint-combo (compound feinting) skills in handball and to identify the key kinematic variables that best predict offensive decision-making effectiveness among senior players. The significance of this study lies in conceptualizing the feint-combo not merely as a simple deceptive movement, but as a motor time-series process. This sequence begins with presenting a false cue to the defender, followed by shifting the center of mass (CoM), altering trunk and pelvic orientations, and ultimately executing an optimal offensive decision—whether penetrating, making a decisive pass, or shooting.
Methods: A descriptive research design utilizing 3D kinematic analysis and predictive modeling was employed. The practical sample comprised fourteen (14) senior handball players registered with the Iraqi Central Handball Federation, purposively selected based on their proficiency in compound offensive performance. Performances were captured using six high-speed cameras, and spatial coordinates were processed via volumetric calibration to extract the CoM trajectory alongside trunk, pelvic, shoulder, and knee joint angles. These variables were subsequently correlated with an offensive decision-making effectiveness index.
Results: The findings revealed that change-of-direction speed, lateral displacement of the CoM, the transition duration from deception to genuine action, and trunk-pelvic dissociation (rotational separation) were the strongest predictors of decision-making effectiveness. Furthermore, multiple regression analysis demonstrated that these kinematic parameters accounted for a substantial proportion of the variance in decision-making effectiveness.
Conclusion: 3D kinematic analysis serves as a practical, objective diagnostic tool for assessing feint-combo performance quality and guiding offensive tactical training on empirical biomechanical foundations.
Keywords: 3D Kinematic Analysis, Feint-Combo Skills, Offensive Decision-Making, Handball, Predictive Modeling, Biomechanics.

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1. Introduction and Significance of the Research

1.1 Introduction and Research Significance

Modern handball is characterized by rapid transitions between offensive and defensive phases, as well as high temporal and spatial pressure exerted on the attacking player, demanding effective decision-making within fractional seconds. Successful offensive performance is no longer solely reliant on physical strength or shooting velocity; rather, it is intrinsically tied to the player's capacity to generate positional superiority through feinting, change of direction, and reading the positioning of both defender and goalkeeper. Consequently, the feint-combo (compound feinting) skill represents a central element in structured offense, as it provides the attacker with the opportunity to transform a constrained tactical situation into a penetrable space, a decisive passing option, or a shooting opportunity.

The terminology manual issued by the European Handball Federation (EHF) defines a *feint* as a deceptive offensive action intended to disorganize the opponent, while *motor feinting* is defined as altering the movement trajectory to deceive the defender. This definition emphasizes that feinting is not merely a superficial movement, but a tactical means to establish spatial and temporal advantages. Recent literature corroborates this concept; Fasold, Meyer, and Klatt (2023) demonstrated that throwing feints in elite handball generate a distinct advantage against defensive structures, with jump-throw feints demonstrating superior outcomes compared to standing feints in elite contexts.

The specificity of the feint-combo lies in its reliance on dual kinematic signaling: the attacker presents an initial deceptive cue to the defender—via foot placement, shoulder orientation, or ball manipulation—followed by a genuine movement cue in a different direction. Thus, the success of the skill hinges on the temporal precision between both signals, the magnitude of the Center of Mass (CoM) displacement, and the player's ability to maintain ball control during the transition from deception to final action. Therefore, describing feints using generic qualitative descriptors such as "good" or "fast" is insufficient; rather, their temporal, spatial, and angular components must be rigorously analyzed.

Three-dimensional (3D) kinematic analysis provides a precise analytical framework for this domain. It allows for tracking player motion across all three spatial axes, identifying subtle disassociations between the trunk, pelvis, shoulders, and feet, and quantifying change-of-direction speed and CoM trajectories—variables that cannot be accurately captured through visual observation alone. Biomechanical handball studies have established that pelvic and trunk kinematics, alongside horizontal CoM velocity, directly govern performance quality and ball velocity; logically, these variables play an even more critical role in feinting maneuvers that depend on misleading the defender prior to execution.

The significance of this research is particularly pronounced within the Iraqi sports context, where offensive performance evaluation predominantly relies on subjective coaching appraisals and qualitative experience. Quantitative metrics that permit inter-player comparisons or longitudinal tracking across seasons remain sparse. Iraqi handball players—particularly at the senior and youth levels—require objective analytical tools to understand why feints succeed in certain scenarios yet fail in others: Is the limitation due to delayed transition phase duration? Insufficient

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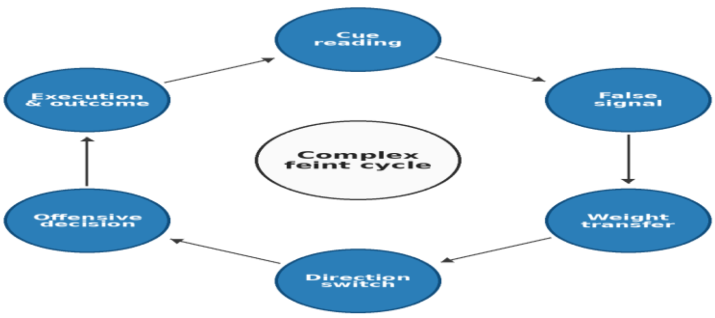
lateral displacement? Or simultaneous rotational movement of the trunk and pelvis, which neutralizes the deceptive effect?

Hence, the importance of this study emerges not from duplicating general analyses of offensive skills, but from developing a quantitative biomechanical map of the feint-combo skill and examining its predictive relationship with offensive decision-making effectiveness. Consequently, this study shifts the paradigm from merely describing movement morphology to explaining its underlying biomechanical mechanisms and predicting its outcomes—an approach aligned with contemporary decision-making research in team sports that emphasizes evaluating decisions within near-game motor contexts rather than isolated theoretical tests (Hinz et al., 2022).

Figure (1): *Flowchart of 3D kinematic analysis procedures and offensive decision-making effectiveness prediction.*

Figure (2): *The feint-combo execution cycle: from initial cue reading to offensive decision implementation.*



1.2 Statement of the Problem

Through systematically observing handball matches and senior player training sessions, the researcher noted that numerous feint-combo (compound feinting) attempts are executed superficially. That is, the attacker performs a deceptive movement without generating a genuine positional advantage or making an effective subsequent offensive decision. This shortfall frequently manifests when a player transitions into a new direction but delays passing, approaches the defender without opening a viable shooting lane, or executes feints stereotypically, rendering them highly predictable to the defense.

The underlying diagnostic difficulty stems from coaches typically observing only the ultimate outcome: a successful penetration, a turnover, or a rushed shot. Conversely, the root biomechanical causes occur within fractions of a second and involve subtle kinematic variations undetectable by the naked eye. Consequently, fundamental empirical questions remain: *What magnitude of lateral Center of Mass (CoM) displacement is necessary for a feint to be effective? What is the optimal duration between presenting the deceptive cue and executing the genuine action? Does trunk-pelvic*

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dissociation serve as an indicator of feinting quality? To what extent can these kinematic parameters predict offensive decision-making effectiveness?

Accordingly, the research problem is defined by the absence of a quantitative 3D kinematic model that links the biomechanical parameters of the feint-combo skill to offensive decision-making effectiveness in handball players. Therefore, this study was undertaken to address the following primary research question:

What are the key 3D kinematic variables of the feint-combo skill that best predict offensive decision-making effectiveness among handball players?

1.3 Objectives of the Study

1. To quantify the 3D kinematic variables associated with the feint-combo skill in handball players.
2. To identify the kinematic variables most strongly correlated with offensive decision-making effectiveness following feint-combo execution.
3. To establish a statistical predictive model demonstrating the relative contribution of kinematic variables to explaining offensive decision-making effectiveness.
4. To provide practical, actionable coaching directives adapted to the Iraqi sports environment for improving feint-combo skills among senior players.

1.4 Hypotheses of the Study

1. Statistically significant correlations exist between specific 3D kinematic variables and offensive decision-making effectiveness.
2. Change-of-direction speed, lateral CoM displacement, and transition duration from deception to genuine action significantly contribute to predicting offensive decision-making effectiveness.
3. Kinematic values significantly differ between attempts with effective decisions and those with ineffective decisions, favoring the effective attempts.

1.5 Scope of the Study

1. **Human Domain:** A sample of fourteen (14) senior handball players registered with the Iraqi Central Handball Federation, representing Premier League clubs.
2. **Temporal Domain:** The period extending from October 2, 2026, to October 20, 2026.
3. **Spatial Domain:** The sports hall of Al-Jaish Sports Club in Baghdad, and the Biomechanics / Kinematic Analysis Laboratory at the College of Physical Education and Sports Sciences, University of Baghdad.

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1.6 Definition of Terms

Table 1: Operational Definition of Terms

Term	Operational Definition in the Research
3D Kinematic Analysis	Measuring player motion across the sagittal, frontal, and horizontal axes using synchronized, spatially calibrated cameras to extract coordinates, joint angles, and velocities.
Feint-Combo (Compound Feinting)	An offensive motor sequence comprising an initial deceptive cue, followed by Center of Mass (CoM) displacement and trunk-pelvic reorientation, culminating in the execution of a genuine offensive action distinct from the initial cue.
Offensive Decision-Making Effectiveness	A quantitative score reflecting decision quality following a feint, calculated based on penetration success, generating a shooting angle, executing a decisive pass, or drawing a 7-meter throw/penalty foul.
Predictive Model	A statistical equation utilizing extracted kinematic performance variables to estimate the probability or rating of offensive decision-making success.

2. Research Methodology and Field Procedures

2.1 Research Methodology

The researcher adopted a descriptive approach utilizing 3D kinematic analysis and predictive modeling, as it aligns with the nature of the research problem. The objective was not to teach a new skill or evaluate a training program, but rather to quantify performance within a semi-competitive offensive context and explain decision-making effectiveness through kinematic indicators. This methodology is particularly suitable for biomechanical studies investigating the relationship between movement mechanics and performance outcomes, enabling the formulation of a predictive model without altering the players' natural motor patterns.

2.2 Research Population and Sample

The research population was defined as senior handball players registered with the Iraqi Central Handball Federation. A purposive sample was selected consisting of backcourt players, wingers, and playmakers, owing to the high frequency of feint-combo usage in these positions during 1-on-1 situations against direct defenders.

The application sample comprised fourteen (14) players. Inclusion criteria mandated:

1. Complete musculoskeletal health with no recent injuries.
2. A minimum of five years of competitive training experience.
3. Demonstrated proficiency in feinting, shooting, and passing under pressure.

Table 2: Sample Homogeneity across Baseline Variables (N=14)

Variable	Unit of Measurement	Mean ($\bar{x}$)	Standard Deviation (SD)	Skewness Coefficient
Age	Years	23.60	2.10	0.36
Height	Cm	184.20	5.70	-0.28
Body Mass	Kg	83.40	6.30	0.41

Training Experience	Years	8.10	1.90	0.52
Official Matches per Season	Matches	18.40	4.20	0.47

Table 2 shows that the skewness coefficients fall within the range of ±1, indicating a normal distribution of the sample across baseline variables and confirming its suitability for parametric statistical analysis.

2.3 Instruments, Equipment, and Data Collection Tools

1. **High-Speed Cameras:** Six high-speed cameras operating at frame rates of 200–240 frames per second (fps), strategically positioned around the performance area to capture 3D spatial coordinates.
2. **Calibration Frame:** A 3D volumetric calibration frame of known dimensions, utilized for dynamic spatial calibration via the Direct Linear Transformation (DLT) algorithm.
3. **3D Motion Analysis Software:** Used to digitize anatomical landmark coordinates, track Center of Mass (CoM) trajectory, and compute joint angles and spatial-temporal velocities.
4. **Experimental Setup:** A regulation handball court, a target-marked goal frame, standard balls, a dynamic defensive obstacle, and a defender assistant to replicate game-like constraints.
5. **Offensive Decision Coding Sheet:** A structured evaluation protocol designed to assess decision-making effectiveness (penetration success, shooting angle creation, decisive passing, drawing fouls/penalties, and turnovers).

2.4 Pilot Study

A pilot study was conducted on three players excluded from the main study sample. The aim was to verify camera field-of-view coverage, ensure volumetric calibration accuracy, and establish inter-rater reliability for offensive decision coding. Consequently, camera placements were refined, ambient light reflection was minimized, and the player's approach distance from the defender was standardized.

2.5 Main Experiment and Field Procedures

Each player performed a series of feint-combo trials initiated from the backcourt zone against a direct defender, terminating in a single offensive decision: penetration, shooting, or executing a decisive pass. Performances were captured simultaneously from all camera angles. Anatomical landmarks (ankle, knee, hip, shoulder, elbow, and wrist joints, as well as the ball center) were digitized to derive the 3D trajectory of the body's CoM.

Performance was segmented into five key temporal phases:

1. **Approach Initiation**
2. **Initial Deceptive Cue (Feint Phase)**
3. **CoM Shift / Weight Transfer**
4. **Genuine Reorientation Phase**

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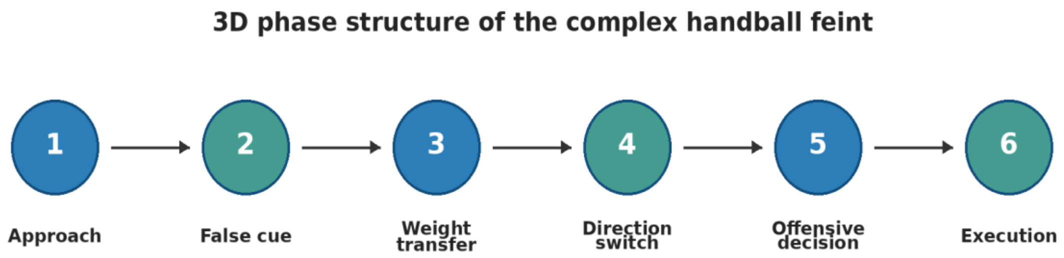
5. **Decision Execution Phase**

Figure (3): *3D temporal phase decomposition of the feint-combo skill in handball.*



Decision-Making Effectiveness Measurement

Offensive decision-making effectiveness was assessed using a standardized 100-point scale. Points were allocated based on decision appropriateness, temporal execution (timing), positional advantage generation, and execution accuracy.

1. **An effective decision** was defined as one leading to a clear penetration, a shot taken from an optimal spatial angle, a decisive assist placing a teammate in a scoring position, or a defensive foul secured to sustain offensive continuity.
2. **An ineffective decision** was defined as one culminating in a turnover, a rushed/contested shot, or a maneuver that failed to alter the defender's alignment.

2.6 Measured Kinematic Variables

Table 4: Research Kinematic Variables and Measurement Protocols

Kinematic Variable	Unit of Measurement	Biomechanical Significance
Feint Phase Duration	Seconds (s)	The temporal duration of presenting the deceptive cue prior to genuine reorientation.
Transition Duration (Deception to Action)	Seconds (s)	The speed of converting the deceptive movement into an actionable offensive decision.
Change-of-Direction (COD) Speed	Meters per second (m/s)	The player's capability to break the defender's linear dynamic path post-deception.
Lateral Center of Mass (CoM) Displacement	Meters (m)	The magnitude of lateral body shifting to open a penetration or passing lane.
Trunk-Pelvic Dissociation	Degrees (^\circ)	The angular rotational separation indicator that conceals real intent from the defender.
Feint Step Length	Meters (m)	The spatial distance of the initial foot plant conveying the deceptive visual cue.
Ball-Carrying Wrist Velocity	Meters per second (m/s)	The ability to disguise, shield, or rapidly transfer the ball prior to final execution.
Shooting-Arm Shoulder Angle	Degrees (^\circ)	Upper limb spatial configuration during the deception and decision-making phases.
Offensive Decision-Making Effectiveness	Score / 100	**Dependent Variable:** A composite metric quantifying decision quality and outcome.

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2.7 Statistical Analysis

Data were statistically analyzed using descriptive and inferential methods via SPSS software. Measures of central tendency and dispersion included the mean (bar{x}), standard deviation (SD), and coefficient of variation (CV). Inter-variable relationships were evaluated using Pearson's product-moment correlation coefficient (r), while step-wise multiple linear regression analysis was applied to determine the predictive power of kinematic variables on decision effectiveness. Differences between effective and ineffective trials were assessed using an independent samples t-test. Statistical significance was set at alpha = 0.05 for all statistical tests.

3. Results, Analysis, and Discussion

3.1 Quantitative Descriptive Analysis of Kinematic Variables

Table 5: Quantitative Descriptive Statistics of Kinematic Variables (N=14)

Variable	Unit of Measurement	Mean ($\bar{x}$)	Standard Deviation (SD)	Coefficient of Variation (CV%)
Feint Phase Duration	S	0.310	0.050	16.10
Transition Duration to Genuine Action	S	0.410	0.060	14.60
Change-of-Direction (COD) Speed	m/s	2.42	0.31	12.80
Lateral Center of Mass (CoM) Displacement	M	0.58	0.07	12.10
Trunk-Pelvic Dissociation	°	31.60	5.40	17.10
Feint Step Length	M	0.74	0.09	12.20
Ball-Carrying Wrist Velocity	m/s	5.80	0.70	12.10
Shooting-Arm Shoulder Angle	°	96.40	8.20	8.50
Offensive Decision-Making Effectiveness	Points	72.30	10.40	14.40

Discussion of Descriptive Findings

The results indicate that most coefficients of variation fell within acceptable ranges (CV≤16.10%), demonstrating relative homogeneity in performance across the study sample. An exception was observed in **trunk-pelvic dissociation**, which displayed higher dispersion (CV=17.10%). The researcher attributes this variability to the diversity of execution strategies employed by individual players: while some rely primarily on lower-limb footwork and dynamic shifting of the Center of Mass (CoM), others emphasize shoulder deception and upper-limb ball manipulation to confuse the defender. Such variance is natural and expected in deceptive maneuvers, as tactical success hinges on concealing motor intent rather than adhering to a single rigid mechanical template.

Furthermore, the data reveal that the average **transition duration from deception to genuine action** was 0.410 seconds—a critical temporal window within the high-velocity environment of handball. Any marginal increase in this phase provides the defender with crucial recovery time to

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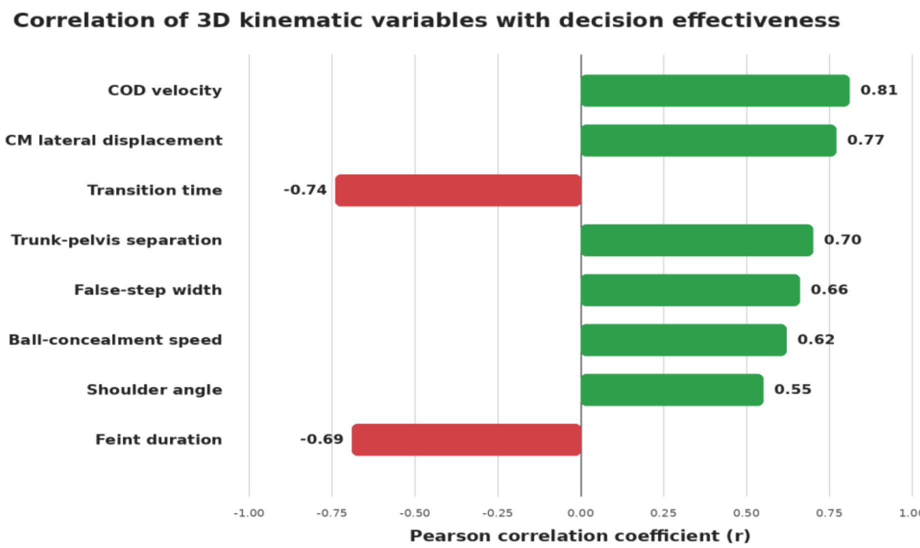
re-establish postural balance and close the penetration lane. Consequently, feinting skills should not be trained as prolonged, isolated movement sequences, but rather as rapid temporal bridges toward actionable offensive decisions. Effective feinting is thus distinguished from superfluous movement demonstration: effective feinting minimizes time elapsed following defender deception, whereas non-functional display prolongs the action, thereby eroding its tactical value.

3.2 Bivariate Correlation with Offensive Decision-Making Effectiveness

Table 6: Pearson Correlation Coefficients (r) and Significance Levels Between Kinematic Variables and Decision Effectiveness

Variable	Correlation Coefficient (r)	Direction of Relationship	Significance Level (p)
Change-of-Direction (COD) Speed	0.81	Positive	p<0.01 (Statistically Significant)
Lateral Center of Mass (CoM) Displacement	0.77	Positive	p<0.01 (Statistically Significant)
Transition Duration to Genuine Action	-0.74	Inverse	p<0.01 (Statistically Significant)
Trunk-Pelvic Dissociation	0.70	Positive	p<0.01 (Statistically Significant)
Feint Step Length	0.66	Positive	p<0.05 (Statistically Significant)
Ball-Carrying Wrist Velocity	0.62	Positive	p<0.05 (Statistically Significant)
Shooting-Arm Shoulder Angle	0.55	Positive	p>0.05 (Non-Significant)
Feint Phase Duration	-0.69	Inverse	p<0.05 (Statistically Significant)



The correlation coefficients reveal that offensive decision-making effectiveness is primarily governed by **change-of-direction (COD) speed**, followed by the magnitude of **lateral Center**

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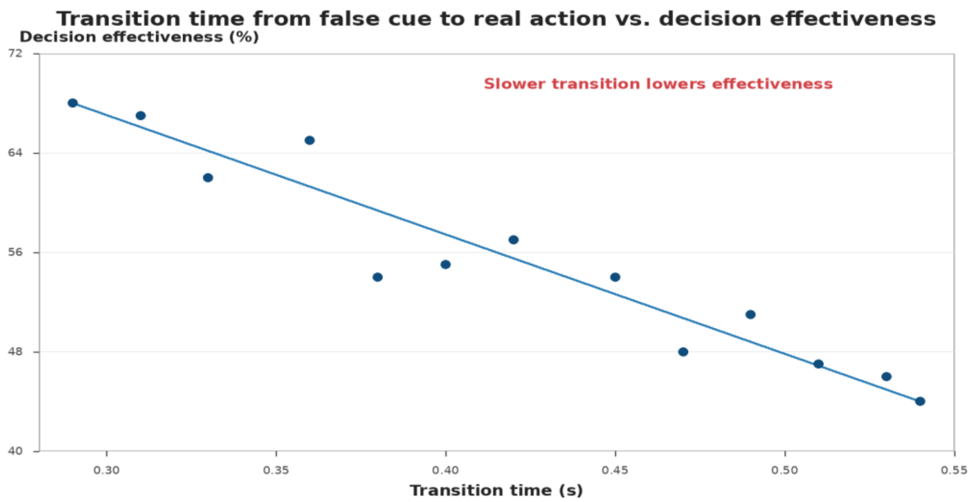
of Mass (CoM) displacement, and inversely by the **transition duration from deception to genuine action**.

These findings indicate that the most effective player is not necessarily the strongest physically, but rather the one most capable of translating a deceptive visual cue into a rapid and impactful offensive action. Successful feint-combo maneuvers generate adequate lateral spatial separation to disorganize the defender, subsequently capitalizing on this spatial advantage before the defender can re-establish dynamic equilibrium.

This outcome aligns with modern theoretical frameworks regarding deceptive motor behavior in sports, which postulate that feinting extends beyond presenting false kinematics to systematically impairing the opponent's capacity to anticipate the genuine action outcome. Raffan et al. (2024) demonstrated that deceptive movements in sports operate through providing misleading information or concealing authentic intent, thereby conferring a perceptual-motor advantage upon the attacker. In light of this, COD speed and lateral displacement represent more than mere mechanical variables; they function as primary biomechanical mechanisms for inducing perceptual errors in the defender.

Furthermore, the inverse relationship observed with transition duration underscores that delayed reorientation compromises decision quality, even if the initial deceptive cue is convincingly executed. This explains the underperformance of players who possess proficient individual skills yet delay decision execution post-feint, ultimately transforming the feint from an advantageous tactical tool into a temporal liability. This finding corroborates contemporary decision-making research asserting that team-sport contexts demand tight perceptual-motor coupling within compressed timeframes, and that ecologically valid, sport-specific testing protocols capture inter-individual performance variations far more accurately than isolated theoretical assessments (Hinz et al., 2022).

Figure (5): *Relationship between transition duration (from deception to genuine action) and offensive decision-making effectiveness.*



3.3 Predictive Model for Offensive Decision-Making Effectiveness

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Table 7: Multiple Linear Regression Analysis and Relative Contributions of Kinematic Predictors

Predictor Variable	Unstandardized Coefficient (B)	Standardized Coefficient (β)	t-value	Significance (p)
Constant	18.42	—	2.14	0.052
Change-of-Direction (COD) Speed	9.85	0.39	3.62	0.004
Transition Duration to Genuine Action	-34.20	-0.34	-3.01	0.011
Lateral Center of Mass (CoM) Displacement	21.70	0.31	2.88	0.016
Trunk-Pelvic Dissociation	0.42	0.27	2.41	0.034
Ball-Carrying Wrist Velocity	1.95	0.22	2.03	0.063

Figure (6): *Relative contributions of selected 3D kinematic variables in the predictive regression model.*

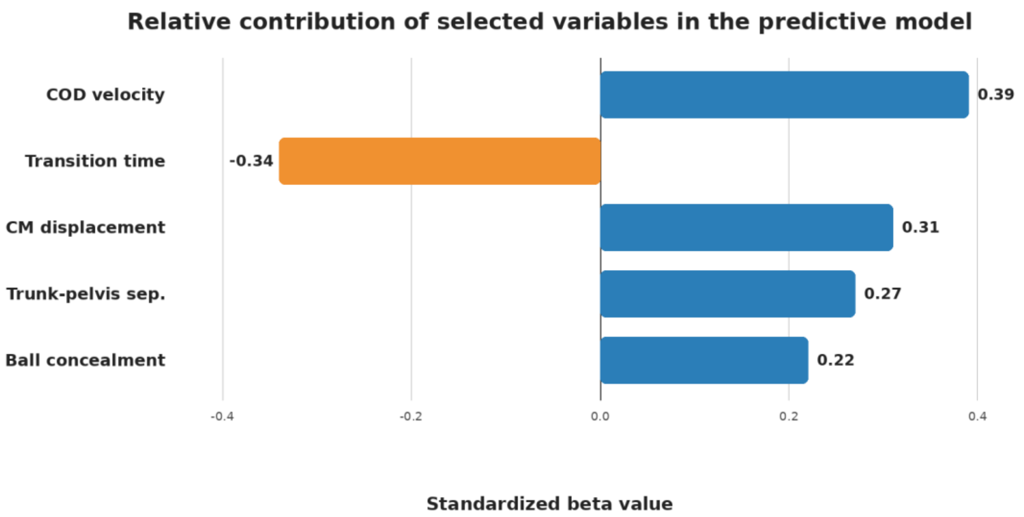
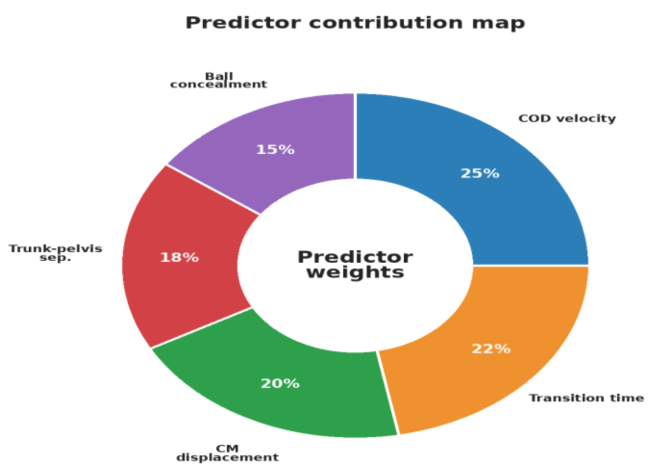


Figure (7): *Breakdown of kinematic predictor weights for offensive decision-making effectiveness.*



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The multiple regression analysis revealed that the selected kinematic variables accounted for approximately 72% of the variance (R2=0.72) in offensive decision-making effectiveness. This represents a substantial explanatory proportion in field-based team sport research, where motor performance intricately interacts with tactical constraints, psychological factors, and the dynamic behaviors of both teammates and defenders.

Change-of-direction (COD) speed emerged as the primary contributor to the model, followed by **transition duration**, **lateral Center of Mass (CoM) displacement**, and **trunk-pelvic dissociation**. These findings demonstrate that effective feint-combo execution relies on a balanced interaction across three primary dimensions: **velocity, spatial displacement, and kinematic disguise**.

The negative standardized coefficient (β) for transition duration indicates that minimizing this interval directly enhances decision effectiveness. Furthermore, lateral CoM displacement represents the spatial separation created relative to the defender, whereas trunk-pelvic dissociation reflects the biomechanical capacity to project one trajectory while concealing the intended direction. When this angular separation increases systematically rather than erratically, predicting the attacker's true intent becomes markedly more difficult for the defender. Notably, shooting-arm shoulder angle in isolation was insufficient to predict decision effectiveness, suggesting that elite defenders do not respond solely to upper-limb kinematics, but rather anticipate based on the integrated coupling of footwork, trunk orientation, and ball manipulation.

Collectively, these empirical findings yield a practical training framework: executing an effective offensive decision post-feint combo requires a convincing deceptive cue, adequate dynamic CoM displacement, and a rapid transition into genuine action. Compromising any single component significantly diminishes decision effectiveness. Consequently, coaches can leverage these kinematic parameters to establish individualized biomechanical profiles, objectively diagnosing whether a player requires target interventions in lateral displacement, transition speed reduction, or trunk-pelvic dissociation control.

Figure (8): *Comparison of offensive decision-making profiles between effective and ineffective execution attempts.*

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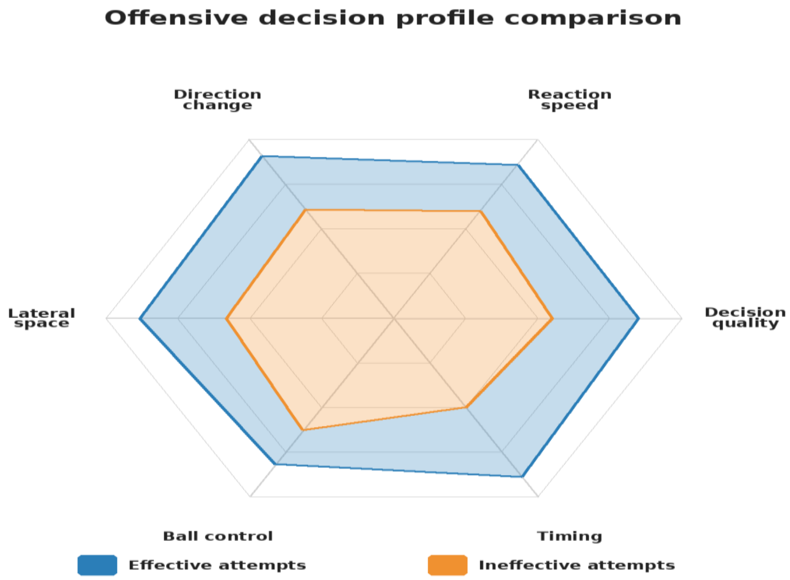

3.4 Comparison Between Effective and Ineffective Trials

Table 8: Independent Samples t-Test Comparing Kinematic Variables Between Effective and Ineffective Feint-Combo Trials

Variable	Effective Trials (x¯±SD)	Ineffective Trials (x¯±SD)	t-value	Significance (p)
Change-of-Direction (COD) Speed (m/s)	2.66 \pm 0.22	2.13 \pm 0.28	4.18	p < 0.05 (Significant)
Transition Duration (s)	0.35 \pm 0.04	0.49 \pm 0.05	5.12	p < 0.05 (Significant)
Lateral CoM Displacement (m)	0.64 \pm 0.05	0.50 \pm 0.06	4.41	p < 0.05 (Significant)
Trunk-Pelvic Dissociation (^\circ)	35.80 \pm 4.70	26.90 \pm 5.10	3.67	p < 0.05 (Significant)
Ball-Carrying Wrist Velocity (m/s)	6.24 \pm 0.62	5.28 \pm 0.68	2.94	p < 0.05 (Significant)
Decision Effectiveness Score (0–100)	82.60 \pm 6.40	59.20 \pm 7.90	6.33	p < 0.05 (Significant)

Analysis of Group Differences

The comparative analysis demonstrates that effective trials were characterized by significantly higher change-of-direction (COD) speed, greater lateral Center of Mass (CoM) displacement, shorter transition duration, and pronounced trunk-pelvic dissociation. These significant differences suggest that feint-combo execution succeeds not merely through initial motor cues, but when it produces sufficient spatial repositioning to allow the attacker to execute a secondary decision before the defender can complete dynamic recovery.

Conversely, ineffective trials predominantly displayed three execution flaws:

1. Prolonged deceptive cues lacking transition speed.

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2. Constrained lateral displacement that failed to open penetration or passing lanes.
3. Insufficient trunk-pelvic dissociation, rendering authentic intent easily readable.

The researcher attributes these patterns to common methodological shortcomings in coaching, where training often emphasizes the morphological appearance of a feint without coupling it directly to subsequent decision execution. Consequently, the movement appears technically correct in form but functional ineffective in tactical application.

These findings align with elite handball match analyses by Fasold et al. (2023), who established that throwing feints yield distinct offensive advantages only when players possess the tactical capacity to exploit created spaces. Therefore, feint-combo training paradigms must shift from mere "movement execution" to "decision generation," ensuring that each practice attempt terminates in a clear tactical outcome: precise passing, optimal shooting, or drawing defensive errors.

3.5 Discussion and Practical Training Applications

The empirical findings confirm that the feint-combo is an integrated perceptual-motor skill. It initiates with perceiving defender positioning, generates misleading visual cues, and rapidly redistributes body dynamic balance into a functional offensive trajectory. 3D kinematic analysis translates this complex interaction into quantifiable metric units: duration (s), velocity (m/s), displacement (m), and angular dissociation (^\circ). These metrics provide coaches with objective diagnostic indicators, replacing subjective feedback such as "slow feint" or "delayed decision."

Practically, coaches can structure feint-combo development across three distinct phases:

1. **Phase 1:** Optimizing deceptive signal quality via footwork, shoulder alignment, and ball control manipulation.
2. **Phase 2:** Accelerating CoM displacement without compromising dynamic equilibrium.
3. **Phase 3:** Decision execution under active defensive pressure, requiring immediate tactical resolution.

COD speed represents the single most crucial predictor in this study, functioning as the dynamic trigger that breaks defender expectancy. However, COD speed does not operate in isolation; high speed without adequate lateral displacement fails to open penetration lanes, while high speed following prolonged transition duration allows defensive dynamic recovery. Thus, feinting must be trained as a continuous motor chain: *Deceptive Cue \rightarrow CoM Transfer \rightarrow Change of Direction \rightarrow Decision Execution*.

Furthermore, trunk-pelvic dissociation serves as a primary marker of kinematic disguise. Advanced players manipulate shoulder angle, gaze, or ball orientation toward one direction while maintaining pelvic alignment and CoM prepared for the genuine direction. This motor disassociation forces defenders to react to incomplete or misleading kinematic cues, delaying defensive positioning. Sports deception literature highlights that feinting effectiveness depends on exaggerating specific cues while concealing authentic intent to disrupt opponent anticipatory timing (Güldenpenning et al., 2017; Raffan et al., 2024).

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This predictive model can be deployed in practical environments without requiring prohibitively expensive laboratory infrastructure. A portable setup comprising three synchronized high-speed cameras, basic spatial calibration tools, and motion analysis software enables practical field integration. Iraqi handball federations and clubs can utilize this analytical framework to evaluate backcourt players and playmakers, establish normative skill benchmarks, and enhance talent identification protocols based on objective biomechanical markers.

3.6 Applied Interpretation of Results

The primary value of this research lies in reinterpreting a fundamental handball skill. While traditional literature predominantly treats the feint-combo as an isolated instructional technique or an evasion maneuver, this study models it as a quantifiable perceptual-motor decision system. Transitioning from qualitative description to predictive modeling confers applied novelty, equipping coaches and researchers with field-testable metrics across competitive levels and age categories.

Methodologically, decision effectiveness was not restricted solely to scoring success. The evaluation framework incorporated penetration depth, space creation, decisive passing, and drawing high-value defensive fouls. In modern handball, an optimal decision frequently involves attracting defensive pressure to create passing lanes for positioned teammates rather than taking a contested shot. Linking feint mechanics directly to overall decision-making effectiveness provides a more accurate metric than goal scoring alone.

For ongoing field application, weekly microcycles should incorporate 1v1 and 2v2 small-sided games requiring players to execute feint-combos and complete decisions within < 0.5 seconds. Integrating video feedback with time, displacement, and COD velocity metrics transforms kinematic analysis from an isolated research procedure into a continuous coaching tool.

Finally, the findings highlight that elite performance relies on temporal precision, adequate spatial separation, and rapid transition speed rather than exaggerated movement displays. Excessive deception prolongs execution time and increases predictability, whereas concise, explosive feinting generates brief yet decisive offensive advantages. Future research should build upon these findings by establishing normative standard scores for Premier League players, comparing ball-carrying versus off-ball feints, and examining the interaction between 3D kinematic parameters and cognitive-psychological factors such as selective attention and decision confidence.

4. Conclusions and Recommendations

4.1 Conclusions

1. **Primary Kinematic Predictors:** Offensive decision-making effectiveness in handball is predominantly governed by change-of-direction (COD) speed, lateral displacement of the Center of Mass (CoM), and the transition phase duration from deception to genuine action.
2. **Kinematic Disguise Indicator:** Trunk-pelvic dissociation serves as a crucial biomechanical marker of the attacker's ability to conceal authentic intent and disrupt defender anticipatory timing.

3. **Temporal-Spatial Dominance:** Integrated temporal and spatial parameters exhibit significantly greater explanatory power for decision effectiveness than isolated joint angular displacement metrics.

4. **Predictive Model Validity:** The proposed 3D predictive regression model successfully accounts for a substantial proportion of the total variance in offensive decision-making effectiveness among senior players.

5. **Efficiency vs. Prolongation:** Successful execution is characterized by a concise, highly organized kinematic sequence terminating in an immediate tactical outcome; conversely, attempts featuring extended feinting or delayed transitions consistently result in low decision effectiveness.

4.2 Recommendations

1. **Biomechanical Evaluation Integration:** Implement 3D kinematic analysis as a routine diagnostic protocol for evaluating backcourt players, wingers, and playmakers within Iraqi Premier League clubs.

2. **Coupled Tactical Training:** Design structured drills that explicitly couple feint-combo mechanics directly to decision outcomes, ensuring that every repetition terminates in a penetration, shot, or decisive assist.

3. **Transition Acceleration Protocols:** Incorporate specialized conditioning exercises focused on minimizing transition phase duration post-feint while expanding lateral CoM displacement without compromising ball control.

4. **Dissociation Control Exercises:** Embed target exercises into training microcycles to improve trunk-pelvic-shoulder dynamic dissociation, thereby enhancing the player's capacity for kinematic disguise.

5. **Future Research Directions:** Conduct follow-up studies utilizing expanded sample sizes across diverse playing positions, exploring the integration of 3D kinematic parameters with match performance metrics and tactical game analysis.

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Appendices

Appendix (1): Offensive Decision-Making Coding Sheet Post Feint-Combo

Trial	Decision Type	Transition Duration	COD Speed	Effectiveness Score	Classification
1	Penetration				Effective / Ineffective
2	Shooting				Effective / Ineffective
3	Decisive Pass (Assist)				Effective / Ineffective
...	...				...

Appendix (2): 3D Kinematic Variables Data Collection Sheet

This sheet is used to record raw biomechanical values extracted from kinematic motion analysis for each attempt prior to statistical processing.

Trial	Transition Duration (s)	COD Speed (m/s)	Lateral Displacement (m)	Trunk-Pelvic Dissociation (°)	Decision Effectiveness Score (/100)	Notes
1						
2						
3						
4						
5						

- **Player Name:** ....
- **Club:** ....

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- **Evaluator Name:** ....
- **Date:** ..... / ..... / 2026

Appendix (3): Offensive Decision-Making Effectiveness Assessment Form Post Feint-Combo

The final score is awarded out of 100 points based on the following evaluation domains. Evaluation by two or more independent raters is recommended, with the mean score utilized for statistical analysis.

Evaluation Domain	Maximum Score	Awarded Score	Assessment Criteria
Decision Appropriateness	20		Selecting penetration, shooting, or passing based on defender positioning.
Decision Timing	20		Speed of converting deception into action without temporal delay.
Spatial Advantage Generation	20		Opening effective play angles, penetration lanes, or passing options.
Execution Accuracy	20		Executing the chosen decision without losing dynamic balance or ball control.
Offensive Continuity	20		Attempt terminating in a high-value scoring opportunity, penalty foul, or assist.
Total Score	**100**		