INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 09 Issue 01 January 2026

DOI: 10.47191/ijmra/v9-i1-39, Impact Factor: 8.266

Page No. 283-287

Literature Review: Kinematic Analysis of the Drawing and Release Phases in Archery Using TIASPORTS

Yudik Prasetyo[1], Rina Yuniana[2], Wahyu Aji Nugroho[3]

[1,2,3]Faculty of Sports Science, Yogyakarta State University, Indonesia

ABSTRACT*:* Success in archery is largely determined by biomechanical consistency during the draw and release phases. This article aims to analyze the kinematic characteristics of these two critical phases through a literature review focused on the use of TIARA-ASSEGAF Sport Software (TIASPORTS). The method used is a systematic literature review of experimental and descriptive research results utilizing digital video analysis. The results of the study indicate that the stability of the elbow angle (draw arm) and minimization of finger oscillation during release are the main determinants of accuracy. The use of TIASPORTS has proven effective in providing quantitative data in the form of angles, speeds, and trajectories in real time, which allows coaches to make data-driven technique corrections. The conclusion of this study confirms that the integration of digital motion analysis technology is essential to achieve movement efficiency and score consistency in archery athletes.

KEYWORDS: Biomechanics, Archery, Kinematics, TIASPORTS, Drawing, Release

I. INTRODUCTION

Archery is a discipline that demands extreme levels of precision and repetition of movements, the success of a shot depends heavily on the dynamic stability of the body (Y. Prasetyo et al., 2018). In archery mechanics, the draw and release phases are identified as the two most crucial phases that determine the flight characteristics of the arrow (Lease et al., 2024). Empirically, research shows that the consistency of body position during the full draw phase has a linear correlation with the final score (Lease et al., 2024). Data from biomechanical studies show that a 1° to 2° variation in shoulder angle during holding can result in a shift in the arrow's impact point of up to 15–20 cm on a 70-meter target (Santos et al., 2025a). This confirms that microscopic deviations at the joint level will be significantly amplified as the target distance increases.

The drawing phase involves complex coordination between the rhomboid, trapezius, and deltoid muscles to achieve even load distribution on the skeletal structure (Vendrame et al., 2022). Empirical facts in kinematics research reveal that elite athletes are able to maintain draw arm stability with angular fluctuations of less than 0.5° during the holding phase, while novice athletes show variations of up to 3.5° (Z. Ahmad et al., 2014). In addition, inconsistency in the anchor point is a major cause of poor vertical grouping of arrows. Literature studies have noted that a vertical shift of just 5 mm in the draw arm is enough to alter the launch angle of the arrow, mechanically disrupting the planned parabolic trajectory (Lease et al., 2024).

The transition from the holding phase to the release phase is a critical moment, lasting only 20 to 40 milliseconds. During this phase, even the slightest disturbance to the string will trigger an uncontrolled Archer's paradox (H. Prasetyo et al., 2022). Research data using high-speed cameras shows that plucking, which is the movement of the finger away from the face during release, can increase the amplitude of the lateral oscillation of the arrow by up to 15% (Fahrizqi et al., 2021). This results in a loss of kinetic energy and decreased aerodynamic stability. High-performance athletes consistently demonstrate a dead release or linear follow-through technique, in which the pulling hand moves straight back parallel to the line of force, minimizing torsional disturbances on the string (Hardi et al., 2020). Although this aspect of kinematics is vital, conventional visual observation often fails to detect sub-millisecond technical errors or very small angular changes (Abdillah et al., 2023; Bsa et al., 2019; Putranto et al., 2018; Yachsie, 2019).

Therefore, the integration of sports science technology through motion analysis software is an urgent need. TIARA-ASSEGAF Sport Software (TIASPORTS) is presented as an image processing-based evaluation instrument capable of providing objective quantitative data on joint coordinates and movement speed. By utilizing TIASPORTS, the process of identifying technical anomalies in the draw and release phases is no longer based on coach intuition, but on accurate empirical data, thus enabling more scientific and measurable training interventions for archers.

METHOD

This research design adopted a Systematic Literature Review approach with a descriptive meta-analysis framework to synthesize biomechanical findings in archery. The research protocol began with the identification of literature through reputable bibliographic databases such as ScienceDirect, Google Scholar, and PubMed using a combination of specific keywords: "Archery Biomechanics," "Kinematic Analysis," "Drawing-Release Phase," and "Sport Analysis Software." Strictly defined inclusion criteria included original journal articles presenting empirical data on kinematic variables—such as joint articulation angles, angular velocity, and coordinate stability—as well as studies integrating the use of digital video analysis instruments, particularly those with similar operational parameters to TIARA-ASSEGAF Sport Software (TIASPORTS).

Table 1. Source database

No	Database	Total
TIARA-ASSEGAF Sport Software (TIASPORTS) evaluation instruments image processing based	Google Scholar	7
	Copernicus	8
	Scopus	8
	Unpublished research	2
Amount		25

The data analysis process was carried out using structured content analysis techniques, where raw data from various case studies were classified into kinematic taxonomies relevant to the drawing and release phases (Graha et al., 2024; Salafi et al., 2023). The next methodological stage involved cross-validation of the experimental results to evaluate the consistency of the findings regarding the relationship between motion precision and score accuracy (Vendrame et al., 2022). This approach allows researchers to deconstruct complex biomechanical mechanisms into measurable parameters (Li et al., 2025). The use of TIASPORTS software in the context of this literature is analyzed based on its effectiveness in processing digital images into quantitative data through anatomical landmark tracking algorithms, which are then synthesized to formulate technical performance standards for archery athletes based on scientific evidence (evidence-based practice).

RESULTS

Analysis of various literature shows a stark difference in kinematic parameters between elite (expert) and beginner archers. Data extracted through motion analysis software such as TIASPORTS provides an objective picture of angular and stability variables during critical phases. Based on a synthesis of data from several archery biomechanics studies, the following is a comparison of the average kinematic parameters during the full draw and release phases:

Table 2. Comparison of Kinematic Variables of Elite vs. Novice Athletes

Kinematic Variables	Elite Athlete (Expert)	Novice Athlete	Impact on Performance
Draw Arm	165° - 175°	145°- 160°	The elite angle is more linear, maximizing the transfer of energy to the back muscles.
Holding Stability (Deviation)	< 0.5°	2.0° - 4.5°	Low deviation in elite athletes maintains consistency of aiming.
Release Duration (ms)	20° - 30°	45°- 70°	Quick release minimizes finger friction on the strings.
Lateral Follow-through Deviation	< 1.0o	3.0°- 5.5°	The straight backward movement maintains the horizontal stability of the arrow.

The data in Table 1 shows that elite athletes have a pulling elbow angle that is closer to a straight line (180°) (Hakim & Adi, 2025a). Empirically, this position allows the draw weight of the bow to be supported by the bone structure and middle trapezius muscle, not by the biceps muscle (Santos et al., 2025b; Vendrame et al., 2022). TIASPORTS analysis results often show that novice athletes who have an elbow angle of less than 160° experience a 40% increase in tremors (vibrations) when holding for more than 3 seconds (Santos et al., 2025b). This is directly proportional to the decrease in accuracy due to faster arm muscle fatigue using the frame-by-frame feature on TIASPORTS, it was found that elite athletes perform a passive (reflex) release, while beginners tend to make an active "release" movement that increases the duration of contact between the finger and the string (up to 70 ms). The data shows that every 10 ms increase in string contact duration can shift the impact of the arrow by 5-8 cm from the center of the target at a distance of 50 meters. In addition, the follow-through variable is an indicator of release success.

DISCUSSION

In biomechanical analysis, the drawing phase is not simply the act of pulling the bowstring, but rather the process of achieving the most stable mechanical structure of the body. Based on data review, it was found that power efficiency is highly dependent on the formation of a linear angle of the draw arm relative to the target line.(N. Ahmad et al., 2024; Daharis et al., 2022). Academically, this position is referred to as achieving optimal line of force, where the load of the bow is transferred from the small muscles of the arm to the large muscles in the back/scapula area (Nasrulloh et al., 2018). Failure to achieve this linear angle often results in excessive stress on the shoulder joint, which has been empirically shown to contribute to decreased shooting consistency and increased risk of long-term injury. Using TIASPORTS offers a solution in the form of Real-time Angular Feedback. Unlike conventional methods, this software allows coaches to set a "virtual reference line" on the screen as the athlete performs the pull (Sukenda & Iskandar, 2026). If an athlete's elbow angle deviates from the ideal parameters (e.g., less than 165°), the system can provide an instant visual warning. This innovation allows athletes to make self-corrections based on precise coordinate data, thus maturing muscle memory much more quickly and accurately than subjective verbal instructions (Vanderheiden, 2026).

The holding phase is a critical period in which the athlete must maintain complete composure before the release. Kinematically, this phase is often disturbed by micro-tremors or subtle vibrations that are not visible to the naked eye but have a significant impact on the stability of the aiming point (Bratt, 2026; Subramaniam et al., 2026). Data shows that increasing the holding duration beyond 4 seconds without proper biomechanical structure will increase the vibration amplitude by 30%. This phenomenon is academically explained as a failure of neuromuscular control due to isometric muscle fatigue, which directly impairs the consistency of arrow grouping on the target (Hakim & Adi, 2025b; Ogasawara et al., 2021; Saing et al., 2022a; Сьен et al., 2020). TIASPORTS integrates a Motion Tracking Analysis feature that can map the vibration trajectories of the fingertips and elbows in detail. The innovative solution offered is the development of a "Personal Stability Profile." By analyzing oscillation data over time, this software can determine the window of opportunity, or the most stable holding duration, for each athlete before vibrations increase drastically. This way, athletes can be trained to release the arrow precisely at the peak of their highest stability, based on the algorithm calculating each individual's kinematic data (de Azevedo et al., 2025; Fan et al., 2025a).

The release phase is the point at which all of the bow's potential energy is converted into the arrow's kinetic energy. The main problem that often arises is lateral interference with the bowstring due to unclean finger movements (plucking) (Sukenda & Iskandar, 2026; Yachsie et al., 2024). Biomechanically, the ideal release should occur passively and result in a straight backward follow-through movement (Ogasawara et al., 2021; Saing et al., 2022a). Empirical data confirms that a deviation of the drawing hand by 1 cm from the linear path can cause significant deflection of the arrow, which in the academic world is known as the disturbance of the archer's paradox phenomenon (Ivanov, 2025; Ji et al., 2025). The innovation presented through TIASPORTS is the Multi-Axis Trajectory Mapping feature. This software is capable of analyzing the hand movement during release into the X and Y axes simultaneously. The clever solution is the use of Ghost Overlay, where a recording of the athlete's best release technique is overlaid with the movement just performed (Basri et al., 2025; Fan et al., 2025b; Zaffar et al., 2025). By comparing these two trajectories digitally, athletes can visually see where the movement deviations are (Saing et al., 2022b; Santos et al., 2025c). This science-based approach ensures that each training session has an objective improvement target, transforming subjective evaluation into evidence-based evaluation (Jacquot et al., 2025).

CONCLUSIONS

Based on the results of a literature review and in-depth analysis of kinematics, it can be concluded that the draw and release phases are the main determinants of an archer's accuracy and consistency. The integration of TIARA-ASSEGAF Sport Software (TIASPORTS) technology has proven that the subjective approach of conventional coaches can be replaced with precise quantitative data. Optimal elbow angle parameters (between 165° and 175°) and minimizing oscillation at the time of release are the biomechanical keys to achieving movement efficiency. These findings confirm that the use of video analysis software is no longer just an additional tool, but an essential instrument for dissecting movement anomalies that are not captured by human vision. Furthermore, this study concludes that innovative solutions such as Real-time Angular Feedback and Trajectory Mapping in TIASPORTS have a significant impact on the speed of athletes' motor adaptation. With objective data visualization, athletes are able to build stronger neuromuscular connections, so that muscle memory formation occurs more systematically and measurably.

Academically, the use of this technology has changed the training paradigm from trial-and-error methods to evidence-based training methods, which empirically increase the competitiveness of athletes at higher levels of achievement.

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