# Relationships between drop jump–derived variables and sprint and change-of-direction performance in collegiate football players

## *Relaciones entre variables derivadas del drop jump y el rendimiento en sprint y cambio de dirección en futbolistas universitarios*

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## Abstract

Introduction: Collegiate football performance is characterized by repeated sprinting and frequent changes of direction, imposing high neuromuscular demands related to explosive force production and rapid movement execution.
Objective: The primary objective of this study was to examine the relationships between variables derived from the drop jump test and multidimensional sprint and change-of-direction performance in male collegiate football players.
Methodology: A cross-sectional correlational design was applied with thirty-five male collegiate football players. Participants completed a drop jump assessment, sprint tests over multiple distances, and several standardized change-of-direction tests. Correlation analyses and explanatory regression models were conducted.
Results: Jump height was identified as the primary explanatory indicator of maximal sprint performance over forty meters. In contrast, the reactive strength index consistently explained performance across multiple change-of-direction tasks. No significant relationships were observed with short-distance sprint performance.
Discussion: These findings are consistent with previous research indicating distinct neuromuscular demands for sprinting and directional changes.
Conclusions: The results demonstrated task-specific relationships between drop jump variables and football performance. Jump height was associated with maximal sprint capability, while the reactive strength index was more strongly related to change-of-direction performance. Task-specific interpretation of neuromuscular assessments is essential.

## Keywords

Drop jump; reactive strength index; sprint performance; change-of-direction ability; stretch–shortening cycle.

## Resumen

Introducción: El rendimiento en el fútbol universitario se caracteriza por acciones repetidas de sprint y frecuentes cambios de dirección, lo que impone elevadas demandas neuromusculares relacionadas con la producción de fuerza explosiva y la ejecución rápida del movimiento.
Objetivo: El objetivo principal de este estudio fue examinar las relaciones entre las variables derivadas de la prueba de drop jump y el rendimiento multidimensional en sprint y cambio de dirección en futbolistas universitarios masculinos.
Metodología: Se aplicó un diseño correlacional transversal con treinta y cinco futbolistas universitarios masculinos. Los participantes realizaron una evaluación de drop jump, pruebas de sprint en múltiples distancias y varias pruebas estandarizadas de cambio de dirección. Se llevaron a cabo análisis de correlación y modelos de regresión explicativa.
Resultados: La altura de salto se identificó como el principal indicador explicativo del rendimiento en el sprint máximo de cuarenta metros. En contraste, el índice de fuerza reactiva explicó de forma consistente el rendimiento en múltiples tareas de cambio de dirección. No se observaron relaciones significativas con el rendimiento en sprints de corta distancia.
Discusión: Estos resultados son coherentes con investigaciones previas que indican demandas neuromecánicas diferenciadas para el sprint y el cambio de dirección.
Conclusiones: Los resultados demostraron relaciones específicas según la tarea entre las variables del drop jump y el rendimiento en fútbol. La altura de salto se asoció con la capacidad de sprint máximo, mientras que el índice de fuerza reactiva se relacionó más estrechamente con el rendimiento en cambio de dirección. La interpretación específica de la tarea resulta esencial en la evaluación neuromuscular.

## Palabras clave

Drop jump; Índice de fuerza reactiva; rendimiento en sprint; capacidad de cambio de dirección; ciclo de estiramiento–acortamiento.

## Introduction

Football performance in contemporary collegiate sport is characterized by repeated short-distance sprints, rapid accelerations and decelerations, frequent changes of direction, and physical contacts, requiring high levels of speed, agility, and responsiveness (Popowczak et al., 2021). These intermittent high-intensity actions impose substantial demands on multiple energy systems, necessitating the coordinated contribution of the ATP–PCr, anaerobic glycolytic, and aerobic pathways to support explosive efforts and recovery throughout match play (Potisaen et al., 2025). Football-specific research has identified sprint speed, change-of-direction (COD) ability, agility, and intermittent endurance as key determinants of performance, with training interventions incorporating high-intensity running, directional changes, and eccentric–multidirectional loading demonstrating meaningful improvements in sprint- and COD-related outcomes during the competitive season (Paprancová et al., 2025; González Alcántara et al., 2025). Accordingly, collegiate football players must develop well-rounded sprint, COD, and explosive strength capacities to meet the physical and mechanical demands of modern match play (Ramírez-Campillo et al., 2018).

Football match performance is dominated by high-intensity actions over short distances, typically ranging from 5 to 20 m, combined with rapid movement initiation, braking, and directional changes at angles between 90° and 180° (Bradley et al., 2013; Harper & Kiely, 2018). Importantly, sprint performance in football should not be conceptualized as a single, uniform quality. Rather, it comprises distinct performance components, including reaction speed during movement initiation, acceleration capacity over short distances, and maximal sprint speed achieved over longer distances (Lee et al., 2024; Repullo et al., 2025). Each component reflects different mechanical and neuromuscular demands, highlighting the importance of assessing sprint performance across multiple distances to accurately profile football-specific speed capabilities (Morin et al., 2021; Barrera et al., 2023).

Similarly, COD performance represents a complex and multidimensional physical attribute (Healy et al., 2018; Healy et al., 2019). Different COD tests emphasize distinct mechanical requirements, such as braking efficiency, rapid force reapplication during re-acceleration, trunk and lower-limb control, and coordination across multiple planes of movement (Dos' Santos et al., 2020; Čaušević et al., 2023). Consequently, reliance on a single COD assessment may fail to capture the full scope of an athlete's directional change ability (Kozinc & Šarabon, 2022). The use of multiple COD tests, including the 505 Agility Test, T-Test, Illinois Agility Test, Semo Test, and Arrowhead Agility Test, enables a more comprehensive evaluation of the diverse neuromuscular and biomechanical factors underlying COD performance in football (Apte et al., 2023; Singh et al., 2024).

Both sprint and COD performance are strongly influenced by the biomechanical and neuromuscular mechanisms governing movement execution, particularly the stretch–shortening cycle (SSC). The SSC involves a rapid eccentric muscle action followed immediately by a concentric contraction, facilitating enhanced force production, efficient energy transfer, and rapid movement execution (Ramírez-Campillo et al., 2023; Zheng et al., 2025). Efficient SSC function is critical for explosive actions, rapid braking, and quick re-acceleration, which are fundamental to football performance (Pedley et al., 2022; Moeskops et al., 2022). Among field-based assessments, the drop jump test is widely used as a specific indicator of SSC efficiency, reflecting the neuromuscular system's ability to absorb and reapply force within very short ground contact times.

The drop jump test allows for the assessment of several key SSC-related variables, including jump height, flight time, ground contact (or contraction) time, peak power, and the reactive strength index (RSI) (Pedley et al., 2022; Moeskops et al., 2022; Southey et al., 2024). These variables provide insight into neuromuscular function and have been increasingly applied to evaluate performance potential in sports requiring speed, explosive strength, and rapid directional changes. Previous research has consistently reported negative relationships between drop jump–derived indicators of SSC function (particularly RSI, jump height, and contact time) and sprint or COD outcomes, suggesting that superior SSC function is generally associated with faster sprint times and more efficient directional changes (Douglas et al., 2021; Jarvis et al., 2022).

However, the magnitude and consistency of these relationships vary across sprint distances, COD test designs, and the specific drop jump variables examined. Many previous studies have focused on a limited subset of SSC-related variables or employed restricted sprint and COD assessments, thereby limiting the ability to fully explain the neuromechanical contributions of SSC function to football-specific performance (Healy et al., 2018; Healy et al., 2019). Moreover, much of the existing literature has relied primarily on bivariate correlation analyses, offering limited insight into the explanatory contribution of drop jump variables for sprint and COD performance. Variations in testing protocols, measurement equipment, and heterogeneous participant samples further constrain the generalizability of findings, particularly for clearly defined populations such as collegiate football players (McFarland et al., 2016; Bishop et al., 2019; Falces-Prieto et al., 2022; Čaušević et al., 2023; Gísladóttir et al., 2024).

From a practical perspective, identifying which drop jump variables are most informative for performance assessment and athlete monitoring may enhance the practical value of drop jump testing in collegiate football. Collegiate football players represent a critical developmental stage in which neuromuscular characteristics remain highly adaptable, making this population particularly relevant for understanding the neuromuscular determinants underlying sprint and change-of-direction performance. Despite the increasing use of drop jump assessments, there remains a lack of integrated explanatory analyses examining comprehensive sets of SSC-related variables alongside multidimensional sprint and COD outcomes within this population.

Therefore, the primary objective of this study was to examine the relationships between variables derived from the drop jump test and multidimensional sprint and change-of-direction performance in male collegiate football players. This objective was addressed by evaluating sprint performance across multiple distances to represent distinct speed components, assessing change-of-direction performance using a battery of standardized COD tests with different mechanical demands, and identifying influential drop jump–derived variables associated with sprint and COD outcomes using explanatory regression analyses.

## Method

### *Study Design*

A cross-sectional correlational research design was employed to examine the relationships between drop jump–derived variables and sprint as well as change-of-direction (COD) performance in male collegiate football players. In addition, explanatory regression analyses were conducted to identify influential drop jump–derived variables associated with sprint and COD performance outcomes. All testing procedures were conducted under standardized conditions during the competitive season.

### *Participants*

Thirty-five male collegiate football players (n = 35) voluntarily participated in this study. All participants were actively competing at the university level and engaged in regular football training at the time of data collection. Prior to participation, all players received detailed information regarding the study procedures, potential risks, and benefits, and provided written informed consent. The study protocol was approved by the Human Research Ethics Committee of Nakhon Ratchasima Rajabhat University (Thailand) under project number HE-RDI-NRRU.042/2569 and conducted in accordance with the principles of the Declaration of Helsinki.

### *Procedure*

All testing procedures were conducted in accordance with the study protocol and completed within a single testing session. To minimize fatigue and potential order effects, the test battery was organized from lower to higher metabolic demand, beginning with the drop jump assessment, followed by linear sprint tests, and concluding with change-of-direction (COD) tests. Prior to testing, all participants completed a standardized dynamic warm-up lasting approximately 10 minutes, consisting of light aerobic activity, dynamic stretching, and progressive acceleration drills.

Participants were instructed to refrain from strenuous physical activity for at least 24–48 hours before testing, to maintain their usual hydration and dietary habits, and to wear the same footwear throughout all performance assessments. All tests were performed at the same time of day and under consistent environmental conditions to minimize variability related to circadian rhythm and testing environment.

A familiarization procedure was implemented prior to data collection. Participants received standardized verbal instructions and demonstrations for each test and completed two submaximal practice trials before recorded attempts. This procedure was intended to ensure task understanding, technical consistency, and to minimize potential learning effects during data collection.

For each performance assessment, participants completed two to three maximal trials, as specified for each test, and the best performance was retained for subsequent statistical analyses. Rest intervals of approximately 2 minutes were provided between repeated trials of the same test. To further reduce residual fatigue, additional rest periods of approximately 3 minutes were provided between different test categories, particularly following longer sprint efforts and COD tasks, which impose greater neuromuscular and mechanical demands.

All performance tests were administered and supervised by experienced investigators trained in sport performance assessment. One investigator was responsible for providing standardized instructions and start signals, while additional personnel assisted with equipment setup, timing systems, and monitoring test execution to ensure consistency and participant safety throughout the testing session.

### *Drop Jump Test*

The drop jump test was performed to assess neuromuscular performance related to the stretch–shortening cycle (SSC). Participants stepped off a standardized platform with a height of 40 cm and immediately executed a maximal vertical jump upon ground contact, with explicit instructions to minimize ground contact time while maximizing jump height. The drop jump protocol, including platform height selection and execution instructions, followed established procedures commonly used in neuromuscular performance assessment (Markwick et al., 2015).

Drop jump performance was measured using a force plate system (ForceDecks, VALD Performance, Australia), which enabled the quantification of SSC-related kinetic and temporal variables. The system recorded flight time, ground contact time (contraction time), jump height, peak power, and the reactive strength index (RSI), consistent with biomechanical principles describing force production and energy transfer during SSC actions (Bobbert et al., 1987). Each participant performed two trials with a two-minute rest interval between trials, and the best performance for each variable was retained for subsequent statistical analyses.

### *Sprint Performance Tests*

Sprint performance was assessed across multiple distances to reflect distinct components of football-specific speed. Short-distance acceleration performance was evaluated using sprint split times over 0–5 m and 0–10 m, representing initial acceleration and start performance rather than true reaction time, as timing gates were triggered by movement initiation. Acceleration ability was further assessed over 20 m and 30 m, while maximal sprint speed was evaluated using a 40 m sprint and a flying 20 m sprint.

For the flying 20 m sprint, participants completed a 20-m build-up phase to achieve near-maximal running velocity, followed immediately by a 20-m timed section during which sprint time was recorded. This procedure ensured that the measured sprint time reflected maximal running speed rather than acceleration capacity.

All sprint times were recorded using an electronic dual-beam timing gate system (SmartSpeed, VALD Performance, Australia) with a temporal resolution of 0.01 s. The dual-beam configuration was employed to minimize false triggering caused by arm swing or trunk movement during sprint initiation. Sprint performance outcomes were expressed as time (s), with lower values indicating superior performance.

### *Change-of-Direction Tests*

Change-of-direction (COD) performance was evaluated using a battery of standardized tests, including the 505 Agility Test, Semo Test, T-Test, Illinois Agility Test, and Arrowhead Agility Test.

These tests were selected to capture the multidimensional nature of COD performance in football, emphasizing distinct mechanical demands such as braking efficiency, rapid re-acceleration, trunk control, and multi-planar movement coordination.

The 505 Agility Test was used to assess high-intensity braking and 180° turning ability (Živković et al., 2025). The T-Test evaluated multidirectional COD ability involving forward, lateral, and backward movements (Sassi et al., 2009). The Illinois Agility Test assessed complex agility patterns requiring rapid changes of direction under spatial constraints (Hachana et al., 2013). Multidirectional movement capacity was further assessed using the Semo Test (Tulyakul & Thammathes, 2024). In addition, the Arrowhead Agility Test evaluated angled and diagonal COD performance relevant to football match play (Rago et al., 2020).

All COD tests were conducted according to established protocols. Each test was performed for multiple trials, with a two-minute rest interval between trials, and the best performance (fastest completion time) was retained for subsequent statistical analyses. Performance outcomes were recorded as completion time (s), with lower values indicating superior COD performance.

### *Data analysis*

Descriptive statistics were calculated for all variables and are presented as mean ± standard deviation. Normality of data distribution was assessed using the Shapiro–Wilk test.

Pearson's product–moment correlation coefficients were used to examine relationships between drop jump variables and sprint as well as COD performance measures. To address the explanatory aims of the study, multiple linear regression analyses were conducted to evaluate the relative explanatory contribution of drop jump–derived variables to sprint and COD performance outcomes.

Prior to regression analyses, multicollinearity was examined using variance inflation factor (VIF) values, with VIF < 5 considered acceptable. A stepwise regression method was employed to identify influential predictors. Model fit was evaluated using the coefficient of determination ($R^2$), adjusted $R^2$, and standard error of estimate (SEE). Statistical significance was set at $p < 0.05$. All analyses were performed using SPSS software (version 26.0; IBM Corp., Armonk, NY, USA). Regression analyses were interpreted as explanatory rather than predictive.

## Results

### *Descriptive Statistics and Normality*

The physical characteristics and performance descriptive statistics of the male collegiate football players (n = 35) are presented in Table 1. All variables demonstrated normal distributions according to the Shapiro–Wilk test ($p > 0.05$), supporting the use of parametric statistical analyses.

Table 1. Descriptive statistics of physical characteristics and performance variables in male collegiate football players (n = 35).

| Variable | Mean ± SD | 95% CI [Lower, Upper] | Range (Min–Max) |
|---|---|---|---|
| Physical Characteristics | | | |
| Age (years) | 19.94 ± 0.54 | [19.76, 20.12] | 19 – 21 |
| Body Mass (kg) | 65.06 ± 8.44 | [62.26, 67.85] | 51 – 87 |
| Height (cm) | 174.06 ± 3.76 | [172.81, 175.30] | 168 – 181 |
| Drop Jump Variables | | | |
| Jump Height (cm) | 33.47 ± 7.08 | [31.04, 35.91] | 19.8 – 45.0 |
| Contact Time (ms) | 485.60 ± 103.14 | [450.17, 521.03] | 252 – 646 |
| Reactive Strength Index (RSI) | 0.73 ± 0.26 | [0.65, 0.82] | 0.35 – 1.30 |
| Sprint Performance (s) | | | |
| 5 m Split | 0.99 ± 0.06 | [0.97, 1.01] | 0.90 – 1.15 |
| 10 m Split | 1.76 ± 0.11 | [1.72, 1.80] | 1.53 – 2.00 |
| 40 m Sprint | 5.70 ± 0.36 | [5.58, 5.83] | 5.01 – 6.61 |
| Flying 20 m | 2.46 ± 0.30 | [2.36, 2.57] | 1.88 – 3.34 |
| Change-of-Direction Performance (s) | | | |
| 505 Agility Test | 2.86 ± 0.23 | [2.78, 2.94] | 2.45 – 3.38 |
| T-Test | 11.37 ± 0.70 | [11.13, 11.61] | 9.38 – 12.63 |
| Illinois Agility Test | 17.78 ± 1.20 | [17.39, 18.19] | 16.17 – 21.70 |
| SEMO Test | 12.46 ± 0.97 | [12.13, 12.79] | 10.25 – 14.23 |

| | | | |
|---|---|---|---|
| Arrowhead Agility Test | 9.65 ± 0.67 | [9.42, 9.88] | 8.25 – 11.42 |

Note: SD = standard deviation; CI = confidence interval; RSI = reactive strength index. All sprint and change-of-direction variables are expressed as time-based outcomes (s), where lower values indicate superior performance. For bilateral COD tests (505 and Arrowhead), mean values of left and right directions were used for analysis.

## ***Relationships Between Drop Jump Variables and Performance***

Pearson correlation analysis revealed significant relationships between drop jump–derived variables and both sprint and change-of-direction (COD) performance (Table 2).

Table 2. Pearson's correlation coefficients between drop jump variables and sprint and change-of-direction performance (n = 35)

| Drop Jump Variables | 5 m | 10 m | 40 m | Flying 20 m | 505 | T-Test | Illinois | SEMO | Arrowhead |
|---|---|---|---|---|---|---|---|---|---|
| Jump Height (cm) | 0.07 | −0.03 | −0.42* | −0.21 | −0.37* | −0.28 | −0.31 | −0.15 | −0.38* |
| Contact Time (ms) | 0.06 | 0.08 | 0.17 | −0.01 | 0.02 | 0.40* | 0.35* | 0.21 | 0.20 |
| Reactive Strength Index (RSI) | 0.04 | −0.04 | −0.38* | −0.17 | −0.24 | −0.51* | −0.42* | −0.25 | −0.37* |

Note: Values are Pearson correlation coefficients (r). Statistical significance was set at $p < 0.05$. All sprint and change-of-direction variables are expressed as time-based outcomes (s), where lower values indicate superior performance. For bilateral change-of-direction tests (505 and Arrowhead), mean values of left and right directions were used for analysis.

### *Sprint Performance*

Jump height demonstrated a significant moderate negative correlation with 40 m sprint time ($r = -0.42$, $p < 0.05$). Reactive strength index (RSI) also showed a significant moderate negative association with 40 m sprint time ($r = -0.38$, $p < 0.05$). No significant relationships were observed between drop jump variables and short-distance sprint splits (5 m and 10 m) or flying 20 m sprint performance (all $p > 0.05$).

### *Change-of-Direction Performance*

Jump height exhibited significant moderate negative correlations with the 505 Agility Test (mean of left and right directions; $r = -0.37$, $p < 0.05$) and the Arrowhead Agility Test (mean of left and right directions; $r = -0.38$, $p < 0.05$).

RSI demonstrated the strongest associations with COD performance, showing significant negative correlations with the T-Test ($r = -0.51$, $p < 0.05$), Illinois Agility Test ($r = -0.42$, $p < 0.05$), and Arrowhead Agility Test ($r = -0.37$, $p < 0.05$).

Ground contact time exhibited significant positive correlations with T-Test ($r = 0.40$, $p < 0.05$) and Illinois Agility Test performance ($r = 0.35$, $p < 0.05$).

## ***Explanatory Regression Models of Sprint and Change-of-Direction Performance***

Stepwise multiple regression analyses were performed to examine the explanatory contribution of drop jump–derived variables to sprint and change-of-direction (COD) performance in male collegiate football players. Separate regression models were developed for sprint performance and COD outcomes to ensure clarity of interpretation and alignment with the study objectives. Regression analyses were conducted to identify influential drop jump–derived variables explaining variance in sprint and COD performance rather than to establish explicit predictive equations.

Prior to model estimation, multicollinearity diagnostics confirmed acceptable independence among predictors, with all variance inflation factor (VIF) values well below the recommended threshold (VIF < 5). Assumptions of linearity, normality of residuals, and homoscedasticity were satisfied for all models.

### *Sprint Performance (Explanatory Model)*

For sprint performance, stepwise regression analysis identified jump height as the only significant predictor of 40-m sprint performance (Table 3). The final model accounted for 17.3% of the variance in 40-m sprint time ($R^2 = 0.173$, adjusted $R^2 = 0.148$), and the overall model was statistically significant ($F = 6.92$, $p = 0.013$), with a standard error of the estimate (SEE) of 0.31 s.

Jump height demonstrated a moderate negative standardized association with 40-m sprint time ($\beta = -0.42$), indicating that athletes who achieved greater jump heights during the drop jump tended to exhibit superior maximal sprint performance. Reactive strength index (RSI) and ground contact time were not retained in the final model after accounting for shared variance among predictors, suggesting that jump height represented the most relevant drop jump–derived indicator for maximal sprint performance in the present sample.

### *Change-of-Direction Performance (Explanatory Models)*

Stepwise regression analyses revealed reactive strength index (RSI) as the most consistent predictor of COD performance across all tested tasks (Table 4). For the T-Test, RSI was retained as the sole predictor, explaining 26.0% of the variance in performance ($R^2 = 0.260$, adjusted $R^2 = 0.237$). The model was statistically significant ($F = 11.57$, $p = 0.002$), with an SEE of 0.59 s. The standardized regression coefficient indicated a strong negative association between RSI and T-Test completion time ($\beta = -0.51$).

Similarly, RSI was retained as a significant explanatory variable for Illinois Agility Test performance, accounting for 17.9% of the variance ($R^2 = 0.179$, adjusted $R^2 = 0.154$; $F = 7.18$, $p = 0.011$; SEE = 0.78 s). For the Arrowhead Agility Test, RSI was again retained as a significant predictor, explaining 13.5% of the variance in performance ($R^2 = 0.135$, adjusted $R^2 = 0.109$; $F = 5.15$, $p = 0.030$; SEE = 0.52 s).

Across all COD models, higher RSI values were consistently associated with shorter completion times, indicating superior reactive strength characteristics. Jump height and ground contact time were not retained as independent predictors in the final COD regression models once the contribution of RSI was considered.

### ***Model Diagnostics and Statistical Considerations***

All regression models satisfied key statistical assumptions, and multicollinearity diagnostics indicated robust predictor independence, with VIF values below 2.0 across all analyses. Given the moderate effect sizes observed and the number of predictors retained, the sample size ($n = 35$) was considered sufficient to detect meaningful explanatory associations in the regression analyses.

Table 3. Stepwise regression model predicting sprint performance (n = 35).

| Dependent Variable | Predictor | β | $R^2$ | Adj. $R^2$ | F | p | SEE (s) |
|---|---|---|---|---|---|---|---|
| 40 m Sprint | Jump Height | −0.42 | 0.173 | 0.148 | 6.92 | 0.013 | 0.31 |

Note: Values are presented as standardized regression coefficients (β). The coefficient of determination ($R^2$) reflects the proportion of variance explained by the predictor retained in the explanatory model. SEE represents the standard error of the estimate. The regression models were interpreted as explanatory rather than strictly predictive.

Table 4. Stepwise regression models predicting change-of-direction performance (n = 35).

| Dependent Variable | Predictor | β | $R^2$ | Adj. $R^2$ | F | p | SEE (s) |
|---|---|---|---|---|---|---|---|
| T-Test | RSI | −0.51 | 0.260 | 0.237 | 11.57 | 0.002 | 0.59 |
| Illinois Agility | RSI | −0.42 | 0.179 | 0.154 | 7.18 | 0.011 | 0.78 |
| Arrowhead | RSI | −0.37 | 0.135 | 0.109 | 5.15 | 0.030 | 0.52 |

Note: Simple linear regression analyses were conducted separately for each change-of-direction (COD) performance variable. Only one predictor was entered into each model to align with the study objectives. β = standardized regression coefficient; $R^2$ = coefficient of determination; SEE = standard error of the estimate. Statistical significance was accepted at $p < 0.05$

## Discussion

Previous research has consistently demonstrated that sprint and change-of-direction (COD) performance are underpinned by distinct neuromuscular and mechanical demands. Contemporary frameworks of neuromuscular specificity suggest that performance indicators should be interpreted in relation to the task-specific requirements of force production, force absorption, and temporal constraints. In this context, drop jump–derived variables have been widely used to characterize lower-limb neuromuscular function; however, their relevance appears to differ depending on whether the performance task emphasizes maximal speed or rapid deceleration–reacceleration.

Accordingly, examining how different drop jump–derived metrics relate to sprint and COD performance may provide important insight into task-specific neuromuscular determinants in football players.

With respect to sprint performance, associations between vertical jump height and maximal sprint speed are well documented in the literature. In Division I track and field athletes, vertical jump height has demonstrated a strong positive relationship with maximal sprint speed over 60 m (r = 0.74), indicating that athletes with superior lower-limb explosive power attain higher running velocities during maximal sprinting (Bartosz et al., 2024). Similar evidence has been reported in elite sprinters, where countermovement and squat jump variables particularly jump height and flight time were significantly associated with sprint acceleration kinetics, supporting the use of vertical jump metrics as practical indicators of sprint-related neuromuscular capacity (He et al., 2025). Although these findings primarily emphasize acceleration-phase characteristics, they reflect underlying force–velocity capabilities that also contribute to maximal sprint performance.

In adolescent male football players, squat jump height emerged as the strongest predictor of both 35-m linear sprint time and agility performance after controlling for age and body composition, further highlighting the importance of lower-limb explosive strength for high-speed running tasks (França et al., 2022). Collectively, this body of evidence supports the interpretation that jump height, as an indicator of explosive power, plays a meaningful role in maximal sprint performance and is consistent with neuromuscular models emphasizing the force–velocity characteristics of the lower limbs in sprinting (Li et al., 2025).

In contrast, more recent evidence indicates that reactive strength–related variables exhibit phase-specific associations with sprint performance, contributing more strongly to acceleration than to maximal-speed capability. For example, unilateral reactive strength index (RSI) of the ankle plantar flexors has shown large correlations with 20 m sprint time and 10–20 m acceleration in team-sport athletes, underscoring the importance of rapid force production during the early acceleration phase rather than at top speed (Vecbērza et al., 2025). Similarly, horizontal and rebound-based RSI measures demonstrate small-to-moderate relationships with sprint split times across 100 m, suggesting that reactive strength supports sprinting performance but does not uniquely explain maximal velocity once other strength–power qualities are considered (Ciacci et al., 2024). Consistent with this interpretation, a recent meta-analysis reported only moderate associations between RSI and both acceleration and top speed, with stronger relationships observed for change-of-direction performance than for maximal linear sprinting, highlighting task- and phase-specific neuromuscular demands (Jarvis et al., 2022).

Contemporary biomechanical evidence further supports this distinction by differentiating the neuromuscular requirements of acceleration and maximal sprint speed. Initial acceleration appears to depend more heavily on the capacity to rapidly generate horizontal force, whereas maximal sprinting is more strongly related to overall force magnitude, vertical stiffness, and impulse production over very short ground contact times (Takai et al., 2025; Katsuge et al., 2025; Cabarkapa et al., 2025). This distinction may help explain why RSI and ground contact time were not retained as independent predictors of 40 m sprint performance in the present study once shared variance with concentric force and power variables was accounted for. Collectively, these findings reinforce the view that maximal sprint performance is more closely associated with concentric force and power output and the global force–velocity profile of the lower limbs than with rapid stretch–shortening cycle efficiency alone (Douglas et al., 2021; Takai et al., 2025).

In contrast to sprint performance, reactive strength index (RSI) emerged as the most consistent predictor of change-of-direction (COD) performance across all tested agility tasks, aligning with meta-analytic evidence demonstrating a large negative association between RSI and COD speed (r ≈ −0.57) (Chen et al., 2023). This finding is strongly supported by recent research highlighting the importance of reactive strength and stretch–shortening cycle (SSC) efficiency for agility and directional change ability, as COD tasks require rapid deceleration–reacceleration under short ground-contact constraints (Hornikova et al., 2021; Barrera-Domínguez et al., 2024). Specifically, COD performance in tasks involving 180° turns and shuttle-type maneuvers has been linked to an athlete's capacity to efficiently utilize the SSC, as reflected by higher RSI values (Šarabon et al., 2022). Empirical studies and systematic reviews consistently report that athletes with superior RSI demonstrate better performance in COD and agility tests (e.g., Illinois test, pro-agility, 505), and that training interventions shown to enhance RSI such as plyometric or combined balance plyometric training also lead to concurrent improvements in COD performance (Guo et al., 2021).

Spiteri et al. (2015) demonstrated that change-of-direction (COD) performance is strongly influenced by eccentric strength and an athlete's ability to tolerate high braking forces, particularly during rapid directional changes. More recent evidence has confirmed that eccentric capabilities and braking impulse explain a substantial proportion of variance in COD performance, especially during sharper cuts and at higher approach speeds (Smajla et al., 2022; Kurosaki et al., 2025). Reactive strength index (RSI) captures these neuromuscular characteristics by reflecting the efficiency of force absorption and reutilization during brief ground contact phases of fast stretch–shortening cycle actions and has been shown to exhibit large negative associations with COD speed in both meta-analytic and review evidence (Ramirez-Campillo et al., 2023). The present findings extend this body of literature by demonstrating that RSI remains a significant predictor across multiple COD tests with varying movement patterns. This supports its role, as highlighted in recent systematic reviews and task-specific investigations, as a robust indicator of agility-related neuromuscular capacity rather than merely a test-specific performance characteristic (Yamashita et al., 2024).

The absence of jump height as an independent predictor of change-of-direction (COD) performance is also consistent with more recent evidence indicating that countermovement jump (CMJ) height and related jump metrics display only moderate associations with COD outcomes and explain relatively small proportions of variance once sprint or strength-related variables are included in multivariate models (Suarez-Arrones et al., 2020; Gisladottir et al., 2024). Although jump height reflects maximal concentric power, COD performance requires rapid force modulation, eccentric control, and efficient stretch–shortening cycle function, which are more accurately indexed by reactive strength–based measures. Indeed, meta-analytic and systematic evidence indicates that reactive strength index (RSI) exhibits substantially stronger (large) negative associations with COD speed than vertical jump height per se (Nishiumi et al., 2023). The present findings therefore reinforce the view that these neuromuscular qualities are more effectively captured by RSI than by jump height alone.

Taken together, these findings support contemporary frameworks of neuromuscular specificity, which emphasize that performance indicators should be interpreted in relation to the mechanical and temporal demands of the task (Chua et al., 2025). Although jump height and reactive strength index (RSI) are derived from the same drop jump assessment, they represent distinct neuromuscular constructs with different performance relevance. Jump height primarily reflects maximal concentric force and power production, whereas RSI captures the efficiency of force absorption and reutilization under time-constrained stretch–shortening cycle conditions (Nishiumi et al., 2023). The present results empirically demonstrate that these constructs are differentially associated with sprint and change-of-direction performance, reinforcing the importance of aligning neuromuscular assessment metrics with the specific demands of each performance task.

From an applied perspective, these findings align with contemporary intervention and review evidence indicating that strength- and power-oriented training, including heavy or optimum-power resisted sprinting and resistance exercises, preferentially enhances maximal sprint performance (Haugen et al., 2019; Derakhti et al., 2021; Douglas et al., 2021). Collectively, the present results highlight the practical value of drop jump profiling for guiding evidence-based training decisions by distinguishing neuromuscular qualities relevant to sprint speed and change-of-direction performance in collegiate football players.

In contrast, plyometric and reactive training modalities appear particularly effective for improving change-of-direction (COD) ability, given their emphasis on rapid force absorption and reutilization (Nygaard Falch et al., 2019; Zheng et al., 2025). More recent meta-analytic evidence further suggests that combined complex or contrast training methods integrating high-load strength exercises with high-velocity plyometric actions can elicit the largest improvements in COD performance in many team-sport athletes (Lin, Yan, Xu et al., 2025; Lin, Yan, Zhang et al., 2025). Accordingly, practitioners should select both assessment metrics and training strategies that are closely aligned with the specific sprint and COD demands of their athletes.

### *Limitations*

The use of stepwise regression, although effective for identifying influential predictors, is inherently data-driven and sensitive to sample characteristics. As a result, the retained models may vary depending on the specific composition of the cohort, and the identified predictors should be interpreted as context-specific rather than universally generalizable (Babyak, 2004).

The present study was limited to male collegiate football players. Emerging evidence suggests that the relationships between jump performance and sprint or change-of-direction (COD) outcomes may differ across sex, maturation status, competitive level, and sport-specific demands (Dos' Santos et al., 2018; Falces-Prieto et al., 2022; Tingelstad et al., 2025). Therefore, caution is warranted when extrapolating the present findings to other athletic populations.

### *Practical Recommendations for Coaches*

From a practical perspective, the present findings suggest that drop jump–derived metrics should be interpreted in a task-specific manner when profiling football players. Jump height obtained from the drop jump appears most informative for understanding maximal sprint performance, reflecting underlying concentric force and power qualities relevant to high-speed running. In contrast, reactive strength index (RSI) provides a more meaningful indicator of change-of-direction (COD) ability, likely due to its representation of stretch–shortening cycle efficiency during rapid braking and re-acceleration tasks.

Importantly, the lack of meaningful associations between drop jump variables and short-distance sprint performance indicates that early-phase acceleration is influenced by neuromechanical factors not captured by vertical drop jump assessments alone. Coaches are therefore encouraged to evaluate sprint performance across multiple distances and avoid using a single jump-based metric as a proxy for all sprint qualities.

Collectively, these findings highlight the value of combining drop jump, sprint, and COD assessments to differentiate neuromechanical qualities underpinning maximal speed and directional change performance. Such an integrated testing approach may support more targeted training prescription, enabling practitioners to align strength-, power-, and plyometric-based interventions with the specific performance demands of their athletes.

## Conclusions

This study examined the associations between drop jump–derived variables and multidimensional sprint and change-of-direction (COD) performance in male collegiate football players using correlational and explanatory regression analyses. The primary finding supported task-specific neuromechanical specificity: drop jump–derived jump height emerged as the main explanatory indicator of maximal sprint performance (40 m), whereas reactive strength index (RSI) was the most consistent explanatory indicator of COD performance, being retained across the T-Test, Illinois Agility Test, and Arrowhead Agility Test models. Collectively, these results suggest that concentric power–related characteristics are more closely aligned with maximal linear sprint capacity, whereas SSC efficiency captured by RSI is more strongly aligned with braking–re-acceleration demands inherent to COD tasks.

In contrast, drop jump variables showed no significant associations with short-distance sprint splits (5 m and 10 m) or flying 20 m performance, indicating that early acceleration and maximal-velocity sprinting may depend on additional determinants not captured by vertical drop jump outcomes alone. From an applied perspective, drop jump profiling appears most informative when interpreted in a task-specific manner: jump height may support monitoring of maximal sprint-related power characteristics, whereas RSI may provide a practical neuromechanical indicator relevant to COD capacity across multiple movement patterns. Given the cross-sectional design, these findings should be interpreted as context-specific associations, and future studies should verify their robustness across sex, competitive level, and sport contexts.

Future research should extend these findings using longitudinal and intervention designs to determine whether improvements in jump height or RSI are accompanied by meaningful changes in sprint and COD outcomes. In addition, integrating kinetic and kinematic analyses may help clarify the mechanisms underpinning the observed task-specific performance relationships.

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