

Assessing validity of agility and change of direction tests in soccer players: A factor analysis

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Abstract

Introduction: This study investigated the construct validity of commonly used change of direction and agility tests in elite soccer players through exploratory and confirmatory factor analyses. Change of direction tasks involve preplanned movement patterns, whereas agility tasks require reactive responses to external stimuli, indicating greater perceptual–cognitive demand and a more complex integration of motor and decision-making processes. Despite this conceptual distinction, both constructs are frequently assessed using similar field-based tests, raising questions about their discriminant and construct validity. **Methods:** Sixty-six high-performance soccer players completed a comprehensive testing battery consisting of four change of direction tests, four agility tests, and three linear sprint tests (5, 10, and 15 m). All tests were administered under standardized conditions. Data were analyzed using exploratory factor analysis to identify underlying latent structures, followed by confirmatory factor analysis to evaluate model fit and construct coherence. **Results:** Exploratory factor analysis identified four factors: Speed, change of direction, T-test, and agility. Speed and change of direction tests demonstrated strong and distinct factor loadings, supporting their validity as independent physical performance constructs. In contrast, agility tests did not consistently load onto a single factor, with only the Y-test demonstrating a meaningful loading. Confirmatory factor analysis supported these findings, indicating good model fit for speed and change of direction constructs, but poor fit for agility. **Discussion:** These findings suggest that commonly used agility tests may not adequately capture agility as a unified construct. The results highlight the need for more ecologically valid and cognitively demanding assessments that better reflect perception–action coupling. From an applied perspective, these limitations may affect test selection and neuromuscular monitoring strategies within soccer injury risk management frameworks. Overall, this study reinforces the importance of construct validation in performance testing and calls for a critical reassessment of current agility assessment tools in elite soccer.

Keywords: Construct validity; Perceptual-cognitive processes; decision-making; specificity; sports performance.

Introduction

Team sports such as soccer are characterized by continuous interaction with an opposing team, in which success depends on the ability to invade the opponent's territory while simultaneously preventing scoring opportunities (Young et al., 2015). Within this dynamic context, maintaining ball possession and responding effectively to defensive pressure are essential determinants of performance. To meet these demands, players must rely on key physical qualities such as agility (AG) and change of direction (COD), which underpin many decisive actions in match play.

Agility, in a sport-specific definition, is described as “a defined change of velocity or direction by the ball-carrier in response to an opponent,” highlighting its contextual and interactive nature in competitive environments and emphasizing the integration of physical and perceptual components (Rayner et al., 2022). This perspective underscores the importance of perceptual–cognitive processes and decision-making under pressure. In contrast, change of direction refers to the “ability to execute sudden changes of direction” in preplanned conditions (Chaouachi et al., 2012), reflecting a more mechanically driven performance component. Although conceptually distinct, both constructs are frequently assessed using similar field-based protocols.

Beyond performance, the relevance of AG and COD is evident in injury prevention. Soccer is associated with a high incidence of lower limb injuries, generating significant health and economic burdens (O. B. A. Owosye et al., 2020; Wong & Hong, 2005). In youth populations, the increasing prevalence of concussions and anterior cruciate ligament injuries highlights the importance of addressing modifiable risk factors such as neuromuscular control, asymmetries, and fatigue (Mandorino et al., 2023; Watson et al., 2019). In this context, valid and reliable assessment tools are essential for guiding the prescription and monitoring of multicomponent

preventive programs in both club and school settings (Beato et al., 2021; Nimphius et al., 2018; O. B. A. Owuoye et al., 2020). From a performance perspective, AG and COD are critical determinants in invasion team sports and are often used for talent identification, player selection, and performance prediction (Miller, 2017). Previous research has shown that these qualities can differentiate between athletes of varying competitive levels (Chaouachi et al., 2012; Wong & Hong, 2005), with evidence derived primarily from descriptive and comparative studies across age groups, sexes, and performance standards (Pojskic et al., 2018; Silva et al., 2020; Trajković et al., 2020; Yıldız & Fidan, 2018). These findings suggest that AG and COD are not only relevant indicators of performance capacity but may also reflect underlying differences in neuromuscular and perceptual–cognitive profiles between athletes. Consequently, the accurate differentiation between these constructs is essential for optimizing player profiling, training prescription, and long-term athlete development. However, these studies implicitly assume that the tests employed accurately reflect the constructs they intend to measure.

Despite the widespread use of AG and COD tests, there is a notable lack of evidence supporting their construct validity. Current research has predominantly focused on identifying performance differences and evaluating training interventions, often without establishing whether the measurement instruments adequately capture the multidimensional nature of these constructs. Given that both AG and COD involve complex interactions between physical, technical, and perceptual components, it is essential to determine whether commonly used tests truly reflect these underlying dimensions. Ensuring validity is critical, as test scores should meaningfully represent the specific qualities being assessed.

Validity refers to the degree to which evidence and theory support the interpretation of test scores for a given purpose (Kerlinger & Lee, 2002). Within this framework, construct validity is particularly relevant, as it examines whether theoretical concepts are accurately represented by the measurement instruments. Factor analysis provides a robust methodological approach to evaluate construct validity by identifying latent structures and determining the extent to which tests align with specific factors. In practice, no single gold-standard test exists for assessing COD or AG. Commonly used COD tests include the Illinois Agility Test, T-test, L-test, and 505 test (Stewart et al., 2014), while agility assessments incorporating perceptual components include the Y-test, Reactive Agility Test, Stop-and-Go Test, and 5 Shuttle Run Test. A systematic review reported that, although no definitive standard exists, approximately 75% of studies employ the Y-test to assess agility (Morral et al., 2020). Additionally, previous validation efforts have primarily relied on known-group comparisons, demonstrating differences between athletes of varying performance levels (Gabbett & Benton, 2009; Green et al., 2011; Lockie et al., 2014; Pojskic et al., 2018), but have not fully addressed the internal structure of these tests. Moreover, some studies have attempted to support the conceptual independence of COD and AG through correlational approaches, reporting low-to-moderate associations between preplanned and reactive tasks, thereby suggesting that these qualities may represent distinct constructs (Carvajal et al., 2025). However, such evidence remains indirect and does not permit examination of the underlying latent structure of these constructs, highlighting the need for more robust analytical approaches. Furthermore, neuromuscular training programs that include strength, eccentric loading, balance, plyometrics, and dynamic stabilization have been shown to reduce injury risk, particularly in youth populations (Emery & Meeuwisse, 2010; Van Beijsterveldt et al., 2012). However, the ability to detect meaningful changes resulting from such interventions depends on the validity of the assessment tools used (Beato et al., 2021; O. B. A. Owuoye et al., 2020).

Therefore, this study aims to evaluate the construct validity of commonly used AG and COD tests by examining their underlying factor structure. Specifically, exploratory and confirmatory factor analyses were applied to determine whether these tests represent distinct or overlapping constructs in high-performance soccer players. By clarifying the structural relationships among these tests, this study seeks to contribute to a more precise conceptualization of AG and COD within applied sport settings. It is hypothesized that, although AG and COD are theoretically distinct, commonly used agility tests may not consistently reflect a unified construct, potentially leading to redundancy and limitations in performance assessment. Such limitations may have practical implications for test selection, performance monitoring, and the design of targeted training interventions in elite soccer.

Methods

A quantitative, observational, cross-sectional design was used to examine the construct validity of commonly used change-of-direction (COD), agility (AG), and linear speed tests among high-performance soccer players in Costa Rica. Construct validity was evaluated by analyzing the test battery's underlying factorial structure using exploratory factor analysis (EFA), followed by confirmatory factor analysis (CFA) to assess the stability and adequacy of the identified constructs.

This experimental approach enabled the simultaneous assessment of multiple performance tests under standardized conditions, thereby identifying shared and distinct latent performance domains. To reduce potential sources of bias, all testing procedures were standardized, the test order was randomized, and environmental conditions were kept consistent across sessions.

Participants Sixty-six active soccer players from Costa Rica's high-performance division, representing four teams, participated in the study. Subjects should not have had any active injury or have suffered any injury in the

last three months. Participants continued their usual team training throughout the study period. The research was approved by an ethics committee and conducted in accordance with the principles outlined in the Declaration of Helsinki (World Medical Association, 2025). All participants provided informed consent, including the risks and benefits associated with participation. Once these points were explained to the participants, they were invited to participate in the study by signing the informed consent form. Participants or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Measurement procedures

Players were assigned a randomized, individualized order for the administration of all performance tests included in the study. Testing was conducted across three sessions, each separated by an eight-day interval to minimize residual fatigue. During the first session, body composition was assessed using electrical impedance. In the second session, participants completed the change of direction (COD; $n = 4$) and linear speed tests ($n = 3$), while agility (AG; $n = 4$) tests were performed during the third session.

All testing sessions were conducted at the beginning of the teams' regular training schedule and took place on the athletes' habitual training field. Prior to testing, participants completed a standardized 15-minute warm-up consisting of linear and multidirectional movements, as well as joint mobility exercises.

Before each test, standardized instructions were provided, and the task was demonstrated. Participants were allowed two familiarization trials, followed by two recorded attempts; the best performance was retained for analysis. A three-minute passive recovery period was provided between attempts. Test order followed the preassigned randomized sequence, and the same protocol (instruction, familiarization, and execution) was applied consistently across all tests. Participants were instructed to refrain from vigorous physical activity for at least 30 minutes prior to testing and to wear their usual competition footwear and sportswear. To facilitate adherence to the randomized test order and ensure accurate data recording, each participant was provided with a visual identifier indicating the predefined test-execution sequence.

Body Composition

Players' body composition was assessed using the InBody 120 impedance instrument (BridgePower Inc, CA 90703, USA). This instrument performs ten impedance measurements using two different frequencies (20 kHz, 100 kHz) in each of the five segments (right arm, left arm, torso, right leg, and left leg). It provides the best measurement precision among portable instruments. The data obtained included weight, height, body fat, and muscle percentage.

Execution Time Measurement

The test execution time was measured using SmartSpeed photocells from the FUSION-SPORT brand (AUS). Depending on the test, the photocells were placed either at the beginning or end of the course. Additionally, the Reactive Light Training System FITLIGHT was used. The system comprises wireless LED lights and is marketed as a patented and fully programmable sensor.

Tests to Evaluate Change of Direction

Within the construct of change of direction, four tests were conducted: the Illinois Agility Test (reliability of $r = 0.89$), the 505 Test (reliability of $r = 0.88$), the T-test (reliability of $r = 0.95$), and the L-run (reliability of $r = 0.94$) (Stewart et al., 2014).

Tests to Evaluate Agility

For the AG construct, the following tests were employed: the Y-shaped test with a reliability of 0.86 (Dugdale et al., 2020), the Reactive Agility Test with a reliability of 0.88 (Sheppard et al., 2006), the Stop and Go Test with a reliability of 0.81 (Sekulic et al., 2014), and the 5 Shuttle Run Test with a standardized protocol (Popowiczak et al., 2016).

Speed Test

The speed test was conducted over a distance of 15 meters, recording partial times at 5 and 10 meters, as well as the total test time. Subjects started 45 cm from the starting line and began the test at their discretion (Figure 1).

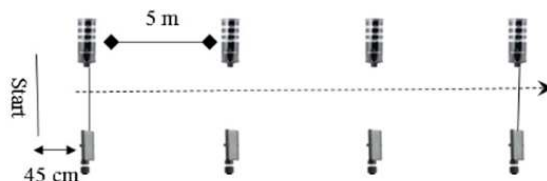


Figure 1. Schematic representation of the test setup. Distances between timing gates and starting position are indicated.

Statistical Analysis This study used test scores for each construct and analyzed them using Exploratory Factor Analysis (EFA). Subsequently, the EFA result was subjected to Confirmatory Factor Analysis (CFA). The factorial analysis model was applied using the maximum likelihood extraction method and a varimax rotation. SPSS V.24 and RStudio v.2.4.4 programs were used for this analysis.

Results

Body Composition Participants had the following average anthropometric characteristics: age, 18.34 years; height, 174.12 cm; weight, 68.74 kg; and body fat percentage, 12.88%. The tests conducted on the players yielded the scores in Table 1.

Table 1. Results of change of direction, agility, and speed tests (mean $\pm$ standard deviation, $n = 66$).

Test	Mean (s)	SD
COD		
Test 505	4,213	0,251
T-test	8,939	0,797
Illinois Test	14,901	0,674
L Run Test	8,56	0,526
Agility		
Y test	2,802	0,20
Reactive Agility	1,551	1,131
Stop and Go	17,254	2,885
5 Shuttle run	19,562	1,959
Speed		
Speed 5m	1,038	0,058
Speed 10m	1,767	0,077
Speed 15m	2,406	0,096

Because speed and COD tests cluster into distinct and robust factors, their use as outcomes or predictors in neuromuscular strategies (particularly those involving strength and eccentric exercises) can guide decisions about progression and return to play. In these settings, a lower incidence of injury has been documented when programs integrate strength and motor control components (Darragi et al., 2024).

Exploratory Factor Analysis

For this factorial analysis, all tests were employed, including those for the AG construct ($n = 4$), the change-of-direction construct ($n = 4$), and the speed construct ($n = 3$). The factorial analysis model used the maximum likelihood extraction method and a varimax rotation. A Kaiser-Meyer-Olkin (KMO) measure of 0.663 was obtained, indicating that the analysis is viable, while the results of Bartlett's test were: $\chi^2 = 362.044$, $df = 55$, $p = 0.001$, indicating that the samples come from populations with the same variance. The following total explained variance and factorial load distribution were obtained (Table 2).

Table 2. Total Explained Variance of EFA ($n = 66$)

Total Explained Variance									
Factor	Initial Eigenvalues			Sum of Squares of Extraction Loadings			Sum of Squares of Rotation Loadings		
	Total	% variance	% cumulative	Total	% variance	% cumulative	Total	% variance	% cumulative
Speed	3,861	35,102	35,102	3,486	31,694	31,694	2,768	25,160	25,160
CD	1,558	14,168	49,269	1,254	11,401	43,096	1,675	15,229	40,389
T-test	1,389	12,627	61,897	1,076	9,784	52,880	1,192	10,835	51,224
AG	1,085	9,860	71,757	0,810	7,363	60,243	0,992	9,020	60,243

Table 3 displays how the first three factors explain 51% of the variance, and the AG factor does not reach a total value greater than 10%, which may indicate that it is not a significant factor.

Table 3. Distribution of factorial loads for each estimator.

Rotated Factor Matrix				
	Factor			
	1	2	3	4
Speed 10m	0,977	0,097	0,189	-0,015
Speed 15m	0,923	0,216	0,173	0,037
Speed 5m	0,75	0,227	0,042	-0,081
IllinoisTest	0,339	0,864	0,104	-0,356
LrunTest	0,049	0,653	-0,005	0,045
Shuttlerun	0,209	0,395	0,335	0,028
T505	0,231	0,388	0,189	0,281
Ttest	0,211	0,15	0,927	0,271
StopandGo	0,08	-0,074	0,174	0,666
Ytest	0,353	0,246	-0,274	0,375
RAg	-0,095	0,001	0,029	0,345

The distribution of factorial loads reveals the grouping of four theoretical constructs: 1, speed; 2, change of direction; 3, T-test; and 4, agility. Upon analysing the results, it was determined that the T-test, which was theoretically designed to measure change of direction, actually measured a factor or element different from that measured by the tests of the other constructs. The emergence of the T-test as a distinct construct from the study requires attention. This test can measure essential elements of team sports that are not assessed by other tests,

such as lateral and backward movements commonly observed in these sports. The distribution of factorial loads shows that the speed tests were grouped into a single factor. In contrast, the change-of-direction estimators were grouped with the 5 Shuttle Run Test for the change-of-direction construct, which should have been grouped theoretically with the AG tests. The remaining tests were grouped under a single factor for the AG construct. The low factorial loads (< 0.4) indicate that these are low estimators and do not accurately represent the corresponding factor, resulting in non-significant estimators.

Confirmatory Factor Analysis

The confirmatory factor analysis model indicates the validity of the exploratory factor analysis. Based on the EFA results and the grouping of estimators for each factor, the model to be confirmed is specified. Therefore, the CFA was instructed to use the Weighted Least Square Mean and Variance Adjusted Estimators. Once the data estimation method was established, the EFA-based model was run. The results indicated that the model is significant. The statistical test of the model yielded a score of 56.916, with degrees of freedom ($df = 32$) and $p = 0.004$. Initially, the model had the following statistics: 4157.541 ($df = 45$, $p = 0.001$). Comparing the two tests yields CFI = 0.994 and TLI = 0.991. Additionally, the root mean square error of approximation (RMSEA) was 0.109, with a 90% confidence interval from 0.051 to 0.155; the p -value for $RMSEA \leq 0.05$ was 0.027. Among the constructs, the estimators for each construct are significant in the Speed and Change of Direction variables. In contrast, for AG, only the Y-test estimator is significant. Descriptive statistics for the latent variables are presented in Table 4.

Table 4. Latent Variables and Values ($n = 66$).

Construct	Test	Estimate	SE	z	p
Agility	Reactive Agility	1.000	—	—	—
	Stop-and-Go Test	0.306	0.266	1.151	0.250
	Y-Agility Test	1.141	0.427	2.671	0.008
Change of Direction	L Test	1.000	—	—	—
	5–0–5 Shuttle Run	1.264	0.242	5.216	<0.001
	505 Test	1.307	0.269	4.850	<0.001
	Illinois Test	1.974	0.384	5.139	<0.001
Speed	10-m Sprint	1.000	—	—	—
	15-m Sprint	1.041	0.059	17.648	<0.001
	5-m Sprint	0.829	0.045	18.274	<0.001

AFC indicates that the model is significant according to the model test. While the CFI and TLI statistics indicate very good fits (>0.95), the RMSEA indicates poor fit ($p < 0.05$). This is likely because the factor labeled AG is not a significant factor (Hu & Bentler, 1999). Additionally, an improvement in the change between the initial and proposed models suggests that the analysis is appropriate. The theoretically proposed constructs within the model show significant variance only for Speed ($Var = 0.914$, $p < 0.001$) and Change of Direction ($Var = 0.219$, $p = 0.001$). In contrast, the AG construct is not statistically significant ($Var = 0.148$, $p = 0.192$), suggesting it is invalid. This analysis also provides the best estimator for each construct. In the Speed construct, the best estimator is the 15m speed test, with a factor loading of 1.0 and a measurement error of 0.01. The best estimator for the Change of Direction construct is the Illinois Test, with a factor loading of 0.96 and a measurement error of 0.15. In the case of the non-significant AG construct, only the Y-test is significant, with a factor loading of 0.44 and a measurement error of 0.81, making this test less valid due to its high error rate (Figure 2).

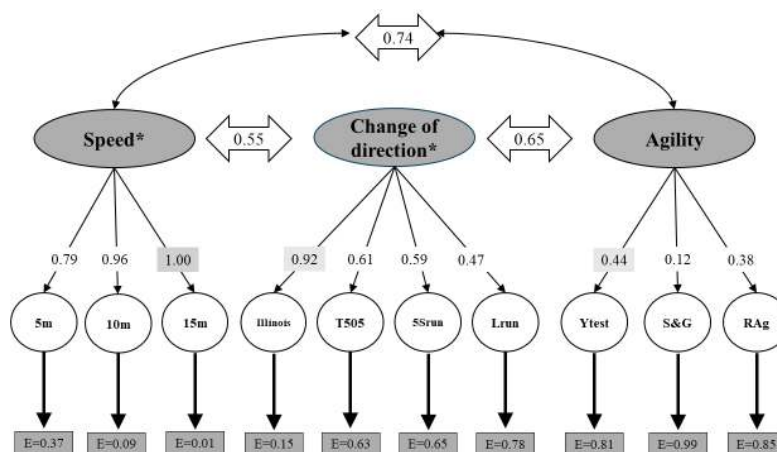


Figure 2. Confirmatory factor analysis model showing standardized factor loadings and error variances for speed, change of direction (COD), and agility (AG) tests. (*): statistically significant latent constructs. 5 m, 10 m, and 15 m: sprint distances; Illinois: Illinois change of direction test; 505: 505 change of direction test; 5Srun: 5-m shuttle run; Lrun: L-run test; Ytest: Y-agility test; S&G: Stop-and-Go test; RAg: Reactive Agility test. (Author's creation).

Because speed and COD tests cluster into distinct and robust factors, their use as outcomes or predictors in neuromuscular strategies (particularly those involving strength and eccentric exercises) can guide decisions about progression and return to play. In these settings, a lower incidence of injury has been documented when programs integrate strength and motor control components (Emery & Meeuwisse, 2010).

Discussion and Conclusions

This study aimed to establish the construct validity of the most commonly used tests in the literature for variables of Change of Direction and Agility. Variable speed demands characterize the tests employed in this study. Although the goal is to complete the course as quickly as possible, changes of direction require continuous adjustments to both speed and trajectory.

This aligns with the recent definition of agility proposed by other studies (Rayner et al., 2022), which emphasizes the ability to adapt to environmental conditions through movement and change. Depending on the angle of the turn, participants must modulate their speed, resulting in phases of maximal, submaximal, and moderate velocity throughout the test.

The theoretical literature examining the relationship between change of direction (COD) and Agility (AG) generally concludes that these constructs are distinct (Morrall et al., 2020). However, this conclusion is predominantly conceptual and lacks empirical validation. Moreover, such reviews often assume construct validity for the tests used to assess COD and AG, without critically evaluating their measurement properties.

Construct validity was assessed through Exploratory and Confirmatory Factor Analyses. Consistent with previous studies (Stewart et al., 2014), which focused exclusively on COD tests to evaluate their validity, the present analysis identified a single-factor solution accounting for 89.52% of the total variance. These findings are consistent with prior research and support the construct validity of the COD measures employed in this study (Stewart et al., 2014). A related study grouped COD tests into a single latent factor, providing evidence of substantial construct validity. However, the T-test exhibited negative loadings on both identified factors, suggesting that it is not an appropriate measure of the COD construct. These findings align with the results of the present study, which further distinguish between speed and COD as separate constructs. Specifically, the T-test demonstrated weak or no association with other validated COD measures, thereby confirming its limited utility as an indicator of COD. Another study incorporated linear speed tests to differentiate between pure speed and speed involving directional changes. Consistent with the findings of the present investigation, that study reported that speed tests loaded onto a separate factor, distinct from the COD construct (Salaj & Markovic, 2011). This supports the conceptual and empirical distinction between linear speed and change-of-direction performance.

All COD tests are loaded onto a single latent factor, except for the 5 Shuttle Run Test. Although this test is theoretically designed to assess Agility (AG)—given its inclusion of perceptual and decision-making components— it demonstrated a stronger loading on the COD factor.

This finding suggests that, in practice, the 5 Shuttle Run Test primarily captures change-of-direction ability rather than true agility. The result highlights a potential mismatch between the test's theoretical intent and its empirical behavior, underscoring the need for more precise operationalization of AG constructs in test design.

In contrast to previous studies Carvajal-Espinoza & Salazar-Rojas, 2024; Salaj & Markovic, 2011; Sporis et al., 2010, the present research includes an analysis of the Agility (AG) construct. Based on the literature review, no prior studies have conducted this type of factorial analysis specifically focused on AG. The results indicate that the AG tests employed—namely, the Y-test, Reactive Agility Test, and Stop & Go Test—loaded onto a single latent factor.

However, this factor did not reach statistical significance, suggesting that the observed grouping may be attributable to random variation rather than reflecting a coherent underlying construct. Furthermore, none of the tests emerged as significant indicators of the factor, except the Y-test. The strong loading of the Y-test suggests that it may effectively capture key aspects of the theoretical AG construct. In contrast, the non-significant loadings on the Reactive Agility and Stop & Go tests suggest that these instruments may lack sensitivity to the AG construct or may assess dimensions that are either peripheral to or distinct from it (Kline, 2011).

While previous studies have relied solely on exploratory factor analysis, the present study extends the methodological approach by incorporating confirmatory factor analysis, offering a more rigorous and comprehensive evaluation of construct validity. Factor analysis is a critical tool in construct validation, as it assesses the extent to which different measures represent the same underlying construct and the accuracy with which they do so (Kerlinger & Lee, 2002).

The findings indicate that COD tests load significantly onto a single latent factor, with all individual tests serving as significant indicators of the construct. In contrast, AG tests did not demonstrate construct validity and failed to load meaningfully onto a common factor. This suggests that these tests are not valid measures of agility and may instead capture unrelated or heterogeneous components. Consequently, the results raise questions about the theoretical foundations and measurement accuracy of tests traditionally used to assess agility.

Relationship Between Test Validity and Program Effectiveness

The results confirm the construct validity of speed and COD, while calling into question the coherence of an AG construct with currently available tests. This finding is relevant for prevention, given that the dosage

and progression of neuromuscular components (including eccentric exercises, balance, plyometrics, and strength) should be monitored using change-sensitive outcomes associated with the appropriate factor. Otherwise, program evaluation could underestimate their benefits or fail to detect residual risks (Beato et al., 2021; O. B. A. Owoeye et al., 2020). In this sense, the significant injury reductions observed in young populations through neuromuscular training, remarkably when eccentric strength and balance are included, suggest linking its follow-up to tests with a clear COD load, rather than resorting to AG batteries of limited validity (Darragi et al., 2024; Emery & Meeuwisse, 2010). Based on the test battery employed in this study, no empirical evidence was found to support the coherence of agility (AG) as a latent construct. In contrast, speed and change of direction (COD) emerged as well-defined and independent performance domains, as supported by both exploratory and confirmatory factor analyses. These findings highlight the importance of critically reassessing commonly used performance tests and of avoiding assumptions about their construct validity in the absence of appropriate structural validation.

The results emphasize the relevance of confirmatory analytical approaches, such as factor analysis, to ensure that performance assessments accurately represent the constructs they are intended to measure. Without rigorous construct validation, the interpretability and reliability of test outcomes remain limited, potentially compromising both scientific conclusions and applied decision-making in sport performance contexts. Finally, consolidating the construct validity of speed and COD assessments provides a necessary foundation for their use in performance monitoring and applied training settings. Valid measurement instruments are a prerequisite for the effective implementation and evaluation of neuromuscular, strength, and eccentric-based training programs that have previously demonstrated reductions in injury incidence and severity in soccer populations (Emery & Meeuwisse, 2010; O. Owoeye et al., 2017). In this regard, the appropriate selection of tests aligned with clearly defined constructs may enhance the evaluation of preventive and rehabilitation-oriented interventions in soccer.

Practical Applications

The present findings have relevant implications for performance monitoring and training program design in soccer. The clear construct validity of speed and change-of-direction (COD) tests supports their use as outcome measures to monitor neuromuscular adaptations associated with targeted training interventions, such as eccentric strength, balance, plyometric, and multidirectional strength exercises. Using tests that load consistently on well-defined constructs enables practitioners to more accurately detect meaningful changes over time and evaluate the effectiveness of training programs. In contrast, the lack of a coherent agility construct within the current testing battery suggests that commonly used agility tests may not provide reliable information for monitoring reactive performance capacities.

Relying on tests with limited construct validity could lead to misinterpretation of training effects or an underestimation of residual neuromuscular deficits. From an applied perspective, practitioners should prioritize speed and COD assessments when monitoring neuromuscular performance and should cautiously interpret results from agility tests until more valid, ecologically valid assessments are available. Within injury risk management frameworks, these findings may also inform test selection strategies. Given the strong association between COD performance and neuromuscular control demands, monitoring COD outcomes may be particularly relevant when implementing preventive programs that emphasize eccentric strength and balance components, especially in youth soccer settings.

Limitations

Several limitations should be acknowledged when interpreting the results of this study. Although the internal validity of the design was robust, the sample consisted of 66 high-performance soccer players from Costa Rica, which may limit the generalizability of the findings to other competitive levels or populations. Differences in training exposure, competitive demands, and developmental characteristics could influence the factorial structure of performance tests in other contexts. Additionally, the agility tests included in this study may not fully capture the multidimensional nature of agility, which integrates both physical change of direction and perceptual–cognitive responses. The absence of an established gold standard for agility assessment further complicates the validation of these tests. Therefore, caution is warranted when extrapolating these findings to female athletes, amateur adult populations, or non-controlled environments such as school or academy settings, where training loads and maturational profiles may differ substantially.

Future Research

Future research should prioritize the development and validation of agility tests that better reflect the ecological and cognitive demands of sport-specific performance. The lack of a valid, clearly defined agility assessment limits experimental investigation of agility and accurate, longitudinal monitoring of its development.

An additional line of investigation could explore whether certain tests, such as the Y-test, assess a distinct perceptual–cognitive component rather than agility as traditionally defined. This hypothesis could be examined through correlational or experimental studies comparing Y-test performance with validated measures of visual reaction time or decision-making speed. Clarifying the underlying constructs measured by these tests would contribute to a more precise classification of performance assessments in soccer and enhance their practical utility.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used generative AI tools exclusively to improve the clarity and quality of the language. No AI tools were used for data analysis, interpretation of results, or generation of scientific content. All analyses were conducted by the authors, who take full responsibility for the content of the publication.

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