Comparison of balance, agility and speed of football players playing on natural grass and artificial turf

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ABSTRACT

Background: Football is a dynamic sport that requires players to exhibit superior levels of balance, agility, and speed, which are crucial for optimal performance, quick directional changes, and injury prevention. Among the many external factors influencing these abilities, the type of playing surface—whether natural grass or artificial turf—plays an important role. Natural grass, traditionally used in football, provides a softer and more irregular surface, while artificial turf offers durability, uniformity, and consistent traction. However, the mechanical differences between these surfaces, such as stiffness, shock absorption, and energy return, may significantly affect athletic performance. As artificial turf usage increases globally due to its maintenance and weather-resistant advantages, understanding its influence on physical performance parameters is essential. Limited studies have holistically compared balance, agility, and speed across both surfaces, making it necessary to explore their interrelationship to guide training and match preparation strategies.

Objectives: The primary objective of this study was to compare the balance, agility, and speed of football players performing on natural grass and artificial turf. The study further aimed to identify whether one surface provided a significant advantage over the other in these key physical performance domains and to evaluate any surface-specific adaptations influencing player performance.

Methods: This comparative observational, cross-sectional study was conducted in Karad and included a total of 100 male football players aged between 18 and 35 years, all of whom had a minimum of two years of competitive football experience. Participants were selected using a convenience sampling method and divided into two equal groups of 50 players each: one group tested on natural grass and the other on artificial turf. Ethical approval and informed consent were obtained prior to data collection.

Each participant underwent three standardized tests:

1. Y-Balance Test – used to measure dynamic balance for both right and left lower limbs by recording reach distances in the anterior, posteromedial, and posterolateral directions.
2. Agility T-Test – administered to assess agility and change-of-direction speed by timing participants through a set pattern of sprints, side shuffles, and backpedals.
3. 30-Meter Sprint Test – performed to evaluate linear sprint speed, recording the best of two timed sprint attempts.

All tests were conducted under controlled environmental conditions, and standardized warm-up procedures were followed to ensure uniformity. Data were statistically analyzed using the t-test, with a significance level set at $p < 0.05$.

Results: The study revealed that the Y-Balance Test results for both right and left limbs showed no significant difference between players performing on artificial turf and those on natural grass ($p > 0.05$). This indicates that the type of surface does not substantially influence dynamic balance, which is likely more dependent on intrinsic neuromuscular control and proprioceptive feedback mechanisms. Similarly, the 30-Meter Sprint Test results demonstrated no statistically significant difference ($p > 0.05$), although players on artificial turf showed slightly faster average sprint times, suggesting that surface type does not markedly affect straight-line running speed under well-maintained conditions.

However, the Agility T-Test results showed a significant difference between the two groups ($p = 0.0049$). Football players tested on artificial turf completed the agility test faster than those on natural grass, indicating superior performance in rapid, multidirectional movement. The uniform traction and consistent firmness of artificial turf likely provide biomechanical advantages, enhancing push-off force, reducing slippage, and improving acceleration and deceleration efficiency. Conversely, the slight irregularities of natural grass may contribute to minor instability, influencing agility performance.

Conclusion: The findings of this study demonstrate that while balance and speed remain largely unaffected by the type of playing surface, agility performance is significantly enhanced on artificial turf. This suggests that artificial turf

may provide more favorable mechanical conditions for movements requiring rapid directional changes and stability. From a practical standpoint, these insights are valuable for coaches, sports scientists, and physiotherapists, as they can tailor training programs according to surface type. Artificial turf may be preferable for agility-focused drills, while both surfaces remain equally suitable for balance and sprint training. Additionally, understanding surface-related biomechanical variations can contribute to injury prevention strategies and performance optimization in football players.

Keywords: Football, Balance, Agility, Speed, Artificial Turf, Natural Grass, Sports Performance, Surface Comparison, Dynamic Stability

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INTRODUCTION

Football, as the most widely played and viewed sport globally, demands exceptional physical and cognitive performance from its athletes. Core physical attributes such as balance, agility, and speed are vital for success in this sport, as they enable players to perform explosive actions, quickly change direction, and maintain stability under high-pressure, game-like conditions. These attributes are not only fundamental to performance but also to injury prevention and long-term athletic development. The unique and evolving nature of the sport continually challenges players to adapt their movement patterns and physical responses to different external conditions—most notably, the type of playing surface[1].

Historically, football has been predominantly played on natural grass fields, which offer a relatively soft and irregular surface. However, the increasing global installation of artificial turf—due to its durability, reduced maintenance requirements, and ability to withstand various weather conditions—has introduced new variables into the athlete performance equation. While artificial turf aims to replicate the feel and function of natural grass, its different mechanical properties—such as surface stiffness, energy return, traction, and grip can significantly affect how athletes move, stabilize, and accelerate during play[1].

Speed, defined as the ability to move the body or its parts quickly from one point to another, is a key factor in both offensive and defensive football play. Fast players can outrun opponents, close down space, and capitalize on scoring opportunities. However, studies have shown that sprint performance may vary depending on the surface, with athletes sometimes achieving faster sprint times on artificial turf due to its firm base and consistent traction[2]. Conversely, the surface may also increase the risk of muscle fatigue or altered movement mechanics due to reduced shock absorption.

Closely linked with speed is agility, the ability to rapidly change direction while maintaining control and balance. In football, agility is critical during tackles, feints, and positional adjustments. It is a complex physical ability that incorporates neuromuscular control, coordination, strength, and cognitive decision-making. Research comparing agility performance on natural grass and synthetic turf suggests that surface type can influence an athlete's ability to decelerate, pivot, and re-accelerate[3]. These surface-induced differences may impact player effectiveness, especially during high-intensity or reactive tasks.

Balance, the often-overlooked foundation of athletic movement, is essential for controlling the body's position in both static and dynamic contexts. It allows athletes to recover from contact, land safely from jumps, and maintain postural alignment during rapid movements. Balance is heavily dependent on proprioceptive input, sensory-motor integration, and lower-limb strength, all of which may be affected by the firmness and compliance of the surface underfoot[4]. Artificial turf, for instance, may offer greater surface predictability but less proprioceptive variability, which could influence balance training outcomes and real-time postural responses during competition.

Moreover, training interventions such as balance, strength, and plyometric exercises are known to improve speed and agility, with balance training having a direct positive effect on dynamic movement performance[4]. However, whether these improvements are equally transferred across surface types remains an area requiring further investigation. Training on one type of surface and competing on another may lead to performance inconsistencies or neuromuscular adaptations that do not fully translate[5].

In-season strength and power development are also influenced by environmental factors, including playing surface[5]. The translation of strength gains into sport-specific performance may be mediated by the friction and energy return properties of the surface. For example, athletes might exhibit greater power output on a firm, consistent turf but experience more natural joint loading and ground interaction on grass. These biomechanical variances have implications not only for performance but also for long-term joint health and injury prevention.

Furthermore, contemporary sports science emphasizes the importance of contextual performance analysis. It is no longer sufficient to evaluate an athlete's speed or agility in isolation; the environment in which the

athlete performs must also be considered[6]. Factors such as footwear-surface interaction, weather conditions, and surface maintenance can all influence physical test outcomes and gameplay metrics. Therefore, comparing physical attributes across playing surfaces must be done with controlled protocols to ensure valid and meaningful interpretations[7].

Despite an increase in research examining performance metrics in football, few studies have holistically assessed how balance, agility, and speed interact across different playing surfaces. Most research tends to focus on individual parameters such as sprinting speed or agility drills, without considering the interrelationship among the three and how they might be differentially influenced by surface properties.

Given the global shift toward the use of artificial turf in football training and competition—especially at the collegiate and professional levels—it is critical to assess how this transition impacts the core performance dimensions of balance, agility, and speed. Understanding these effects can inform training program design, surface selection decisions, injury prevention strategies, and equipment choices (such as footwear). Additionally, it can assist coaches and sports scientists in tailoring performance assessments and interpreting athletic data with greater ecological validity

MATERIALS AND METHODS:

This study followed a comparative observational design, adopting a cross-sectional approach to evaluate the differences in balance, agility, and speed among football players who regularly play on natural grass and artificial turf. The sampling technique employed was convenience sampling, and the study was conducted in Karad. The sample size was determined using the formula $n = [(Z\alpha + Z\beta)^2 + 3]$, where $Z\alpha = 1.9$, $Z\beta = 1.28$, and $c = 0.5 \ln\{(1 + r)/(1 - r)\}$, with $r = 0.70$, yielding a total sample size of 100 participants.

The study population comprised male football players aged 18 to 35 years, who had been actively participating in competitive football for a minimum of two years. Participants were required to be in good physical health, without any acute or chronic injuries affecting the lower limbs within the past six months. Additionally, players with known neurological or musculoskeletal disorders that could influence balance, agility, or speed were excluded. Players with less than two years of competitive experience or without regular exposure to either natural grass or artificial turf during training or matches were also excluded from the study.

The materials used included a consent form and a data collection sheet to record demographic information and test results.

For outcome measurement, three standardized tests were employed. Balance was assessed using the Y-Balance Test, which evaluates dynamic postural control. Agility was measured using the Agility T-Test, designed to assess multidirectional movement efficiency. Finally, speed was evaluated through the 30-Meter Sprint Test, which measures sprinting performance over a short distance. These outcome measures collectively provided a comprehensive comparison of balance, agility, and speed performance between players training and competing on natural grass versus artificial turf surfaces.

Statistical analysis:

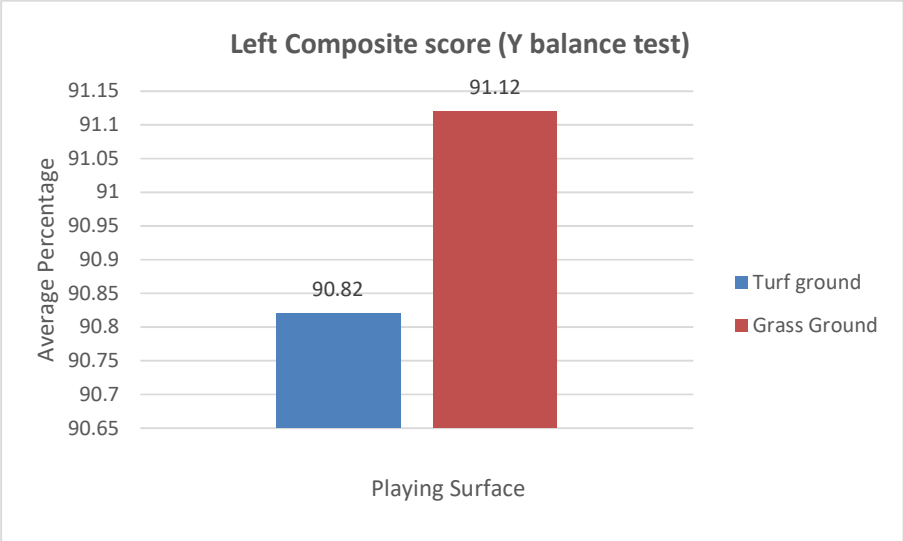
The collected data were analysed by a statistician using the SPSS 26.0 software.

RESULTS:

Table No: 1. Comparison of Left Leg Composite Score (Y Balance Test) Between Turf and Grass Football Players

Surface Type	Mean Composite Score	t-value	p-value	Significance ($p < 0.05$)
Artificial Turf	90.82			
Natural Grass	91.12	-0.33484	0.73846	Not Significant

Graph No: 1 Left Leg Composite Y Balance Test Scores – Turf vs. Grass Players

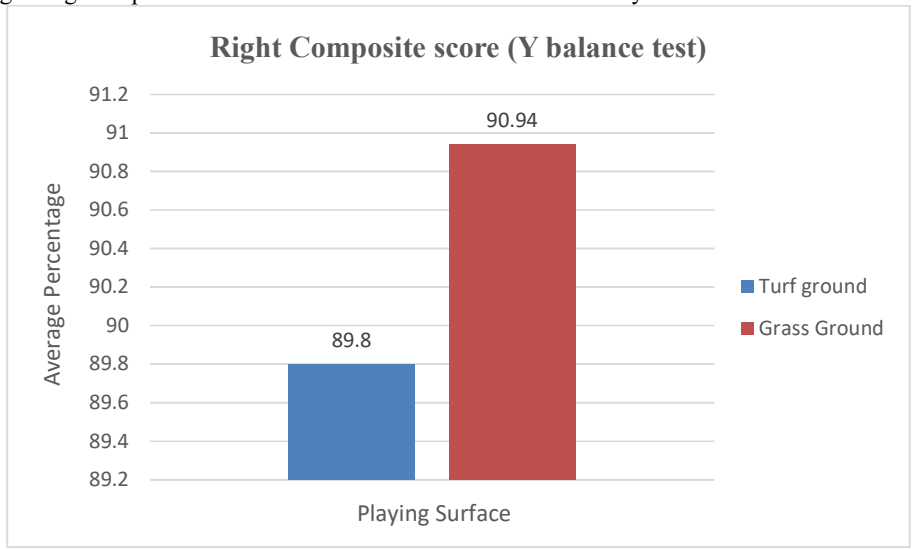


Interpretation: The comparison of left leg composite scores on the Y Balance Test between football players playing on artificial turf and natural grass showed a mean score of 90.82 for turf players and 91.12 for grass players. A t-test was conducted to determine if this difference was statistically significant. The results showed a t-value of -0.33484 and a p-value of 0.73846, which is greater than 0.05. The difference in mean scores is not statistically significant, indicating that playing surface (turf vs. grass) does not have a significant impact on left leg dynamic balance performance in football players based on the Y Balance Test

Table No: 2. Comparison of Right Leg Composite Score (Y Balance Test) Between Turf and Grass Football Players

Surface Type	Mean Composite Score	t-value	p-value	Significance ($p < 0.05$)
Artificial Turf	89.80			
Natural Grass	90.94	1.33118	0.186219	Not Significant

Graph No: 2. Right Leg Composite Y Balance Test Scores – Turf vs. Grass Players

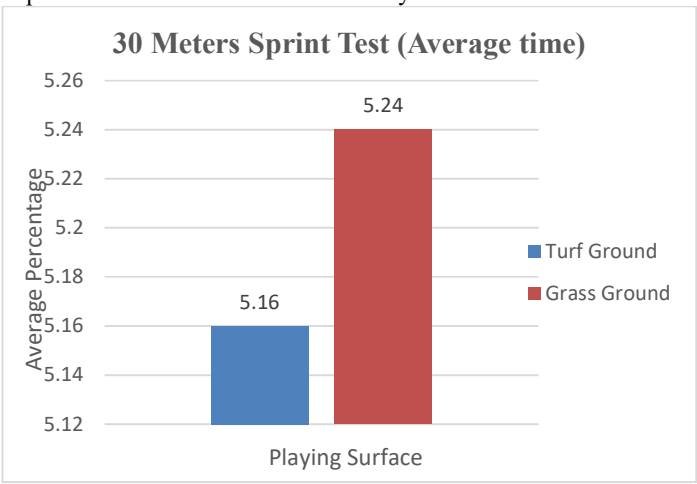


Interpretation: The comparison of right leg composite scores on the Y Balance Test between football players playing on artificial turf and natural grass revealed a mean score of 89.8 for turf players and 90.94 for grass players. A t-test was conducted to determine whether this difference was statistically significant. The test produced a t-value of 1.33118 and a p-value of 0.186219. Since the p-value is greater than 0.05, the result is not statistically significant. This suggests that there is no significant difference in right leg balance performance between turf and grass football players.

Table No: 3 Comparison of 30-Meter Sprint Performance Between Turf and Grass Football Players

Surface Type	Mean Composite Score	t-value	p-value	Significance ($p < 0.05$)
Artificial Turf	89.80			
Natural Grass	90.94	1.33118	0.186219	Not Significant

Graph No: 3. 30-Meter Sprint Test Times – Turf vs. Grass Players

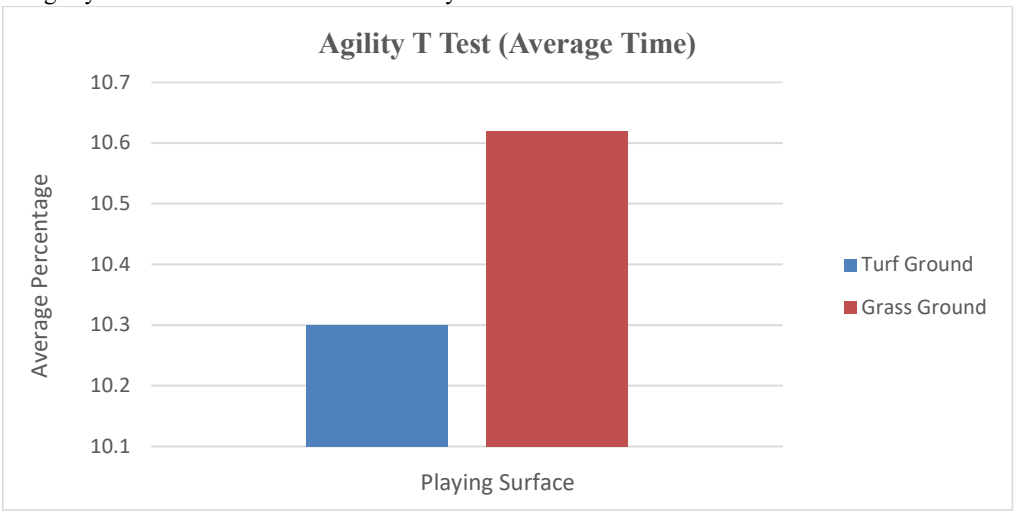


Interpretation: A comparison of 30-meter sprint times between football players on artificial turf and natural grass revealed a mean sprint time of 5.16 seconds for turf players and 5.24 seconds for grass players. A t-test was performed to evaluate the significance of this difference. The results showed a t-value of -0.99494 and a p-value of 0.322217. Since the p-value is greater than 0.05, the result is not statistically significant. This suggests that there is no meaningful difference in sprint performance between players on turf and those on grass surfaces over 30 meters.

Table No: 4. Comparison of Agility T-Test Performance Between Turf and Grass Football Players

Surface Type	Mean Agility Time (seconds)	t-value	p-value	Significance ($p < 0.05$)
Artificial Turf	10.30			
Natural Grass	10.62	2.87843	0.004907	Significant

Graph No: 4. Agility T-Test Times – Turf vs. Grass Players



Interpretation: The Agility T-Test was conducted to compare agility performance between football players on artificial turf and natural grass. The results showed a mean time of 10.3 seconds for turf players and 10.62 seconds for grass players. A t-test was performed to assess the statistical significance of this difference. The analysis yielded a t-value of 2.87843 and a p-value of 0.004907. Since the p-value is less than 0.05, the result is statistically significant. This indicates that players on

artificial turf performed significantly better (faster) in the Agility T-Test compared to those on natural grass. The surface appears to have a positive impact on agility performance.

DISCUSSION:

This study aimed to compare the balance, agility, and speed of male football players on two different playing surfaces: natural grass and artificial turf. With the growing use of artificial turf fields across various levels of football, from amateur to professional, there is an increasing need to understand how this synthetic surface impacts key performance metrics. While artificial turf offers certain logistical advantages, such as reduced maintenance and consistent playing conditions, the implications on athletic performance particularly in terms of balance, agility, and speed require careful examination.

Balance Performance, The Y Balance Test was used to evaluate dynamic balance in the participants, focusing separately on the right and left lower limbs. The test is well-recognized for assessing an individual's ability to maintain postural control while reaching in multiple directions, which simulates the demands placed on athletes during play. The composite scores for both legs were marginally higher in players tested on natural grass compared to those on artificial turf. Specifically, the left leg showed mean composite scores of 91.12 (grass) versus 90.82 (turf), while the right leg scores were 90.94 (grass) and 89.8 (turf).

However, the p-values for both comparisons (0.73846 for left and 0.186219 for right) indicated no statistically significant difference. these findings suggest that dynamic balance, as measured by the Y Balance Test, is not significantly affected by the type of surface. This is consistent with the idea that balance is more influenced by internal factors such as proprioception, neuromuscular coordination, and limb dominance rather than external environmental conditions like surface type. The even and stable nature of both artificial turf and maintained natural grass likely minimized any impact surface might have had. In other words, when surfaces are well-prepared and free of hazards or irregularities, they do not meaningfully alter balance performance in trained athletes.

Speed Performance, the 30-meter sprint test was employed to assess speed in a straight-line sprint scenario. Sprinting speed is a crucial component of football performance, influencing offensive breaks, defensive chases, and overall game dynamics. The average sprint time for athletes on artificial turf was 5.16 seconds, slightly faster than the 5.24 seconds recorded for those on natural grass. However, the t-test yielded a p-value of 0.322217, signifying no significant statistical difference. These results indicate that while artificial turf may offer slightly better sprint times, the advantage is not large enough to be considered statistically or practically significant in this study's context. One possible explanation is that sprinting in a straight line for 30 meters may not be heavily influenced by surface friction or firmness when both surfaces are in good condition. Additionally, footwear compatibility with both types of surfaces might have played a role in minimizing performance variability.

Agility Performance, Agility, measured through the Agility T-Test, revealed the only statistically significant difference among the three performance variables assessed. The test involves forward sprints, side shuffles, and backpedalling all of which demand quick changes in direction and efficient body control. The players on artificial turf had a significantly faster average completion time (10.3 seconds) compared to those on natural grass (10.62 seconds), with a p-value of 0.004907. This notable difference implies that artificial turf may offer biomechanical advantages in activities requiring frequent direction changes. The surface's uniformity and higher friction coefficient may allow athletes to push off more effectively during lateral and backward movements, reducing slippage and enhancing traction. Moreover, the firm and consistent underfoot feel of artificial turf likely contributed to better energy transfer during rapid decelerations and accelerations.

In contrast, natural grass even when well-maintained may introduce slight inconsistencies in texture and resistance, potentially affecting foot placement and reducing the efficiency of directional changes. This could be particularly relevant in wet or slightly uneven conditions, though all tests in this study were conducted under controlled environmental settings.

Practical Implications, the findings of this study offer valuable insights for coaches, athletes, facility managers, and sports scientists. For balance and speed training, surface type may not be a critical consideration, provided the surfaces are even and well-maintained. However, when designing agility drills or planning competitive events that rely heavily on quick directional changes, artificial turf could provide a performance advantage.

It is also important to consider that while artificial turf may enhance agility, it has been associated in some literature with a higher incidence of certain types of injuries, such as non-contact ligament injuries. Therefore, while the surface may promote performance in specific domains, it also necessitates appropriate training, footwear adaptation, and injury prevention strategies.

STRENGTH OF THE STUDY:

This study's strength lies in its comparative design and use of standardized, validated tests—the Y-Balance Test, Agility T-Test, and 30-Meter Sprint Test—which ensured objective evaluation of balance, agility, and speed. A well-defined sample of trained football players and controlled testing conditions enhanced the reliability of results. The study also provides practical insights valuable for coaches and physiotherapists in optimizing training and surface selection for improved performance and injury prevention.

LIMITATIONS OF THE STUDY:

1. Convenience Sampling: Participants were selected through convenience sampling, which may limit the generalizability of the results to a broader population.
2. Environmental Control: Although the tests were performed in consistent conditions, factors such as slight surface moisture or temperature variation might have subtly influenced performance.
3. Surface Quality: Only one type of artificial turf and one type of natural grass surface were used. Differences across turf brands or poorly maintained grass fields were not explored.
4. Subjective Measurement Tools: The use of handheld stopwatches may have introduced minor human error in timing the sprint and agility tests.

FUTURE RECOMMENDATIONS:

1. Use Artificial Turf for Agility Training: Since agility performance was better on artificial turf, coaches may consider using turf surfaces for agility drills and training when available.
2. Balance Training on Both Surfaces: Given no significant differences in balance scores, balance training can be effectively conducted on either surface.
3. Surface Standardization in Testing: For researchers and trainers, it is important to use a consistent playing surface during performance assessments to avoid variability in results.
4. Further Research with Elite Players: Future studies should include elite or professional-level athletes to explore if surface effects become more pronounced at higher levels of play.
5. Explore Injury Risk: Additional research should examine injury rates on different surfaces to complement performance findings with safety considerations.
6. Include Female Athletes: Including female football players in future studies can help identify any gender-specific differences in performance relative to surface types.

CONCLUSION:

The primary objective of this study was to assess and compare the effects of playing surfaces—natural grass and artificial turf—on the balance, agility, and speed of male football players. Based on the results obtained from the Y Balance Test, Agility T-Test, and 30-Meter Sprint Test, it can be concluded that the type of surface plays a limited role in influencing certain aspects of football performance, while significantly affecting others. **Balance outcomes**, both for the right and left lower limbs, did not show any meaningful difference between players on turf and grass. This indicates that surface characteristics may not strongly influence dynamic balance abilities in football players, especially when both types of surfaces are of good quality and maintained well. The findings suggest that balance is more dependent on neuromuscular control, limb strength, and proprioceptive awareness, rather than the surface on which the test is performed. In terms of **speed**, although players on artificial turf recorded slightly faster sprint times, the difference was not statistically significant. This implies that over short distances like 30 meters, sprinting ability remains fairly consistent regardless of whether the surface is artificial or natural. It may also indicate that surface firmness and grip, although important, might not substantially alter linear sprint performance when both surfaces are adequately maintained.

However, the most notable difference was observed in **agility performance**. Players tested on artificial turf showed significantly better results in the Agility T-Test compared to those on natural grass. This suggests that artificial turf may provide a more supportive and predictable surface for performing complex movement patterns involving quick direction changes, side shuffles, and backpedalling. The uniformity and traction of turf likely offer a biomechanical advantage for agility tasks, making it more favourable for training or testing drills requiring quick multi-directional movement. Overall, the study highlights that while natural grass and artificial turf offer comparable environments for tasks involving balance and straight-line speed, artificial turf may provide a performance edge in agility-based movements. These insights can be valuable for coaches, athletes, and sports facilities in designing training sessions and selecting appropriate surfaces based on specific performance goals.

Ethics Statement

The study received approval from the Institutional Ethical Committee of XXX, Karad (Protocol Number 346/2024-2025).

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Conflict of interest

The authors declare that they have no conflicts of interest related to this article.

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