Research Article

Adolescent Football and Footwear Awareness: Association of Stud Configuration with Foot and Ankle Health Among Players Training on Artificial Turf

Deepakram Thulasiraman[*1], Vignesh Kumar R[2], Siva Prasanth S[3], Paul Therattil[4]

[1]*Assistant Professor, MBBS, MD Sports Medicine, PGDSM (IOC), Department of Sports Medicine, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu, India, E-mail: deepakram707@gmail.com, ORCID: 0000-0002-6171-1127
[2]Senior Resident, MBBS, MD Sports Medicine, Department of Sports Medicine, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu, India, E-mail: deerajsingh06@gmail.com, ORCID: 0009-0001-6511-1575
[3]Senior Resident, MBBS, MD Sports Medicine, FIRM, Department of Sports Medicine, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu, India, E-mail: sivasaba94@gmail.com, ORCID: 0009-0000-6331-5673
[4]Senior Resident, MBBS, MD Sports Medicine, Department of Sports Medicine, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu, India, E-mail: mpt4695@gmail.com, ORCID: 0009-0007-2605-054X

Abstract

Artificial turf is widely used in competitive football, yet players frequently train in boots designed for natural grass, creating a potentially important footwear–surface mismatch. This cross-sectional study examined associations of boot category and stud configuration with self-reported foot and ankle outcomes in 103 adolescent male football players training exclusively on artificial turf. Participants completed the Foot and Ankle Outcome Score (FAOS), and their routinely used boots were classified by two trained sports physiotherapists. Fifty-two players used artificial-turf (AT) boots and 51 used firm-ground (FG) boots. Overall FAOS was substantially higher in the AT group than in the FG group (85.4 ± 14.6 vs. 59.6 ± 24.1; mean difference 25.9, 95% CI 18.0–33.7; $p < .001$; Hedges' $g = 1.29$), with consistently higher scores across all five domains. Exploratory analysis also showed higher overall FAOS among circular-stud than bladed-stud users (85.4 ± 14.6 vs. 64.5 ± 22.5; $p < .001$). Surface-appropriate AT-boot use was strongly associated with better foot and ankle symptoms, function, and quality of life. These findings support greater footwear–surface awareness while providing a clear rationale for prospective injury-surveillance and biomechanical studies.

Keywords: sports medicine; athletic footwear; synthetic playing surface; soccer; self-reported function; FAOS.

Introduction

Artificial turf is widely used in football because it offers durability, predictable maintenance, and year-round availability. At the same time, football has a substantial burden of lower-extremity symptoms and injuries, and the interaction between footwear and the playing surface is a potentially modifiable contributor to mechanical loading (Murphy et al., 2003; Thomson et al., 2015).

Boot outsole configuration influences traction, pressure distribution, and resistance to rotation during acceleration, cutting, and pivoting. Firm-ground (FG) boots are principally designed for natural grass, whereas artificial-turf (AT) boots generally use a larger number of shorter studs intended for synthetic surfaces. Experimental and observational work suggests that stud shape and distribution can influence plantar loading and rotational traction (DeBiasio et al., 2013; Queen et al., 2008). However, biomechanical plausibility does not itself establish that a particular boot prevents injury.

Players may select boots according to availability, cost, comfort, or appearance and may use the same pair on different surfaces. Evidence concerning the self-reported foot and ankle status of Indian players using different boot categories on artificial turf remains limited. The Foot and Ankle Outcome Score (FAOS) provides domain-specific measures of symptoms, pain, activities of daily living, sport and recreation function, and foot- and ankle-related quality of life (Golightly et al., 2014; Shazadeh Safavi et al., 2019).

The primary objective of this study was to compare overall and domain-specific FAOS scores between players using AT boots and those using FG boots while training exclusively on artificial turf. A secondary objective was to describe stud type and placement and explore FAOS differences according to stud configuration. It was hypothesized that AT-boot users would report higher FAOS scores than FG-boot users.

Material & Methods

Participants

This cross-sectional study included 103 adolescent male outfield football players aged 10-19 years. Participants were recruited through convenience sampling with support from the Tamil Nadu Football Association between January and May 2026. Eligibility criteria included at least five years of structured football training, a minimum training duration of 10 hours per week, and regular training exclusively on artificial turf. Goalkeepers were excluded because of their distinct movement and loading demands. Players who had undergone surgery during the preceding six months or had a diagnosed neurological or metabolic disorder were also excluded.

Measures

Height was measured using a portable stadiometer, and body mass was measured using a calibrated digital body-composition scale. Body mass index was calculated as body mass in kilograms divided by height in metres squared (kg/m²). Training history, playing position, and relevant musculoskeletal history were documented during a sports-medicine assessment.

Foot and ankle status was assessed using the English-language version of the Foot and Ankle Outcome Score (FAOS). The instrument contains 42 items across five domains: symptoms (7 items), pain (9 items), activities of daily living (17 items), sport and recreation function (5 items), and foot- and ankle-related quality of life (4 items). Items are scored using five-point Likert scales. Raw scores are transformed to a 0–100 scale, with higher scores indicating fewer symptoms and better function. Domain scores were analysed separately. An overall descriptive FAOS score was calculated by combining the responses to all 42 items and transforming the aggregate score to a 0–100 scale.

For descriptive purposes, overall FAOS scores were categorised using a prespecified operational threshold: scores ≤74 were classified as lower scores and scores ≥75 as higher scores. This categorisation represented attainment of at least 75% of the maximum possible score and was not interpreted as a validated diagnostic or injury cut-off.

Procedures

Participants attended prescheduled assessments at the Sports Medicine Laboratory of Saveetha Medical college and Hospital. A sports-medicine physician performed anthropometric measurements, vital assessment, musculoskeletal screening, and documentation of training history. Participants completed the paper-based FAOS independently. Clarification of instructions was provided when required without influencing their responses.

Each participant brought the football boots routinely used for training. Two sports physiotherapists with podiatry expertise jointly examined every pair of boots. Boot category was determined using the manufacturer's designation and outsole characteristics. AT boots were identified by multiple short studs designed for artificial turf, whereas FG boots were identified by longer studs designed primarily for firm natural-grass surfaces. Predominant stud type was classified as circular, bladed, conical, or mixed. Stud placement and duration of boot use were also recorded. Any disagreement between the assessors was resolved through discussion and consensus. Boot category and stud type were treated as distinct variables. The primary comparison was AT versus FG boots, while comparisons according to stud type were treated as secondary exploratory analyses.

Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 25. Continuous variables are presented as mean ± standard deviation (SD), while categorical variables are presented as frequency and percentage. Welch's independent-samples t-test was used to compare overall and domain-specific FAOS scores between the AT- and FG-boot groups because it does not assume equal group variances. Between-group mean differences were reported with 95% confidence intervals (CIs), and effect sizes were calculated using Hedges' g. Effect sizes were interpreted as small (0.20), moderate (0.50), or large (≥0.80).

All tests were two-sided, and statistical significance was set at $p < .05$. Complete-case analysis was performed, and

no missing values were imputed. Comparisons between circular- and bladed-stud groups were treated as secondary exploratory analyses; players using conical or mixed studs were excluded from these comparisons.

Results

The analysis included 103 male adolescent outfield football players aged 10–19 years. The mean age was 15.08 ± 2.15 years, mean height was 164.5 ± 10.2 cm, mean body weight was 55.8 ± 9.4 kg, and mean body mass index (BMI) was 20.6 ± 2.8 kg/m². Mean training duration was 10.05 ± 3.17 hours per week. Wingers represented 52.4% of the sample. Participant characteristics are summarised in Table 1.

Table 1. Physical Characteristics and Playing Positions of Adolescent Football Players

Variable	Mean ± SD / Frequency (%)
Age (years)	15.08 ± 2.15
Height (cm)	164.5 ± 10.2
Weight (kg)	55.8 ± 9.4
BMI (kg/m²)	20.6 ± 2.8
Training hours/week	10.05 ± 3.17
Playing position: Defender	14 (13.6%)
Playing_position: Forward	23 (22.3%)
Playing position: Left winger	28 (27.2%)
Playing position: Midfielder	12 (11.7%)
Playing position: Right winger	26 (25.2%)

Fifty-two players (50.5%) used AT boots and 51 (49.5%) used FG boots. Circular studs were observed in 52 players, bladed studs in 20, conical studs in 16, and mixed configurations in 15. Boot and stud characteristics are summarised in (Table 2). Boot category and stud type were not treated as interchangeable classifications.

Table 2. Football Boot Type, Stud Type, and Placement

Boot characteristic	Frequency (%)
Boot category: Artificial turf boot	52 (50.5%)
Boot category: Firm ground boot	51 (49.5%)
Stud type: Bladed	20 (19.4%)
Stud type: Circular	52 (50.5%)
Stud type: Conical	16 (15.5%)
Stud type: Mixed	15 (14.6%)
Stud placement: Lateral midfoot	14 (13.6%)
Stud placement: Medial rearfoot	23 (22.3%)
Stud placement: Overall	52 (50.5%)
Stud placement: Toes	4 (3.9%)
Stud placement: Toes and midfoot	10 (9.7%)
Total participants	103 (100.0%)

Across the full sample, mean domain scores ranged from 70.80 ± 25.27 for pain to 77.68 ± 24.66 for quality of life. Sixty-two players (60.2%) had a reported descriptive overall score ≤74, and 41 (39.8%) had a score ≥75 (Table 3).

Table 3. FAOS Summary Scores and Distribution

FAOS domain / score range	Mean / frequency	Standard deviation / percent
Symptoms	73.417	24.6177
Pain	70.796	25.272
Activities of daily living	71.466	24.6353
Sport and recreation	74.612	25.7028
Quality of life	77.68	24.6637
FAOS score ≤ 74	62	0.602
FAOS score ≥ 75	41	0.398
Total	103	1
Note. FAOS = Foot and Ankle Outcome Score; SD = standard deviation.		

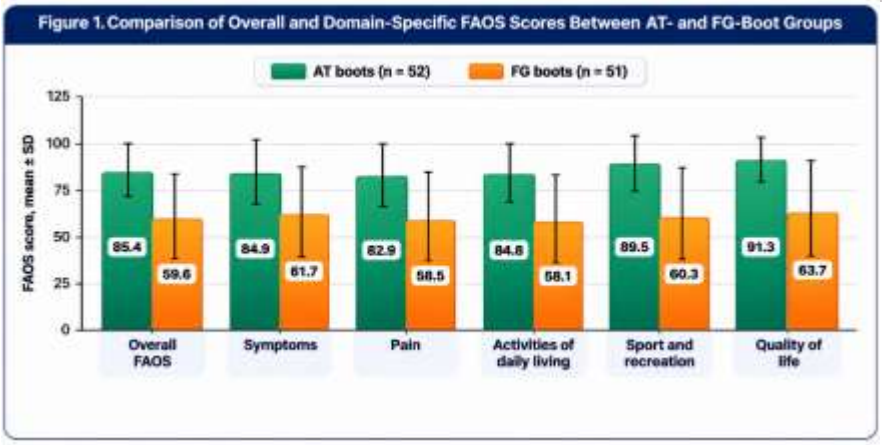
The AT group had a higher mean overall FAOS than the FG group (85.44 ± 14.64 versus 59.59 ± 24.11; mean difference 25.85, 95% CI 18.02–33.69; Welch t = 6.56; p < .001; Hedges' g = 1.29). Mean scores were also higher in the AT group for symptoms, pain, activities of daily living, sport and recreation function, and quality of life. The estimated between-group effects were large across all domains (Table 4). These unadjusted cross-sectional comparisons describe associations and do not establish that boot type caused the observed score differences.

Table 4. Unadjusted FAOS Comparisons Between AT- and FG-Boot Groups

FAOS measure	AT boots (n = 52) Mean ± SD	FG boots (n = 51) Mean ± SD	Mean difference (95% CI)	Welch t	p	Hedges' g
Overall FAOS	85.44 ± 14.64	59.59 ± 24.11	25.85 (18.02–33.69)	6.56	< .001	1.29
Symptoms	84.87 ± 17.55	61.75 ± 25.43	23.12 (14.55–31.69)	5.36	< .001	1.05
Pain	82.88 ± 17.44	58.47 ± 26.19	24.41 (15.68–33.14)	5.56	< .001	1.09
Activities of daily living	84.62 ± 15.30	58.06 ± 25.22	26.56 (18.36–34.75)	6.45	< .001	1.27
Sport and recreation	88.46 ± 15.42	60.49 ± 26.50	27.97 (19.45–36.49)	6.53	< .001	1.28
Quality of life	91.35 ± 11.58	63.75 ± 26.68	27.60 (19.49–35.72)	6.79	< .001	1.34
Note. AT = artificial turf; FG = firm ground; FAOS = Foot and Ankle Outcome Score; CI = confidence interval; SD = standard deviation. Values are unadjusted.						

(Figure 1) shows consistently higher mean overall and domain-specific FAOS scores in the AT-boot group than in the FG-boot group.

Figure 1. Comparison of Overall and Domain-Specific FAOS Scores Between AT- and FG-Boot Groups



In the exploratory stud-configuration analysis, players using circular studs had a higher mean overall FAOS than players using bladed studs (85.44 ± 14.64 versus 64.45 ± 22.54; mean difference 20.99, 95% CI 9.81–32.18; Welch t = 3.86; p < .001; Hedges' g = 1.21). The circular-stud group also had higher mean scores across all five FAOS domains (Table 5). This comparison included only circular- and bladed-stud users; players using conical or mixed studs were excluded. Because all circular-stud users wore AT boots, the observed association cannot be separated from boot category.

Table 5. Exploratory FAOS Comparisons Between Circular- and Bladed-Stud Groups

FAOS measure	Circular studs (n = 52) Mean ± SD	Bladed studs (n = 20) Mean ± SD	Mean difference (95% CI)	Welch t	p	Hedges' g
Overall FAOS	85.44 ± 14.64	64.45 ± 22.54	20.99 (9.81–32.18)	3.86	< .001	1.21
Symptoms	84.87 ± 17.55	66.00 ± 24.30	18.86 (6.65–31.08)	3.17	.004	0.95
Pain	82.88 ± 17.44	63.60 ± 26.17	19.28 (6.26–32.30)	3.05	.005	0.95
Activities of daily living	84.62 ± 15.30	63.05 ± 22.89	21.56 (10.17–32.96)	3.89	< .001	1.21
Sport and recreation	88.46 ± 15.42	63.50 ± 23.96	24.96 (13.09–36.83)	4.33	< .001	1.36
Quality of life	91.35 ± 11.58	69.50 ± 23.09	21.85 (10.65–33.04)	4.04	< .001	1.39

Note. FAOS = Foot and Ankle Outcome Score; CI = confidence interval; SD = standard deviation. Comparisons are exploratory and unadjusted.

Discussion

Among adolescent male football players who trained exclusively on artificial turf, AT-boot use was associated with higher overall and domain-specific FAOS scores than FG-boot use. The largest observed differences concerned sport and recreation function and foot- and ankle-related quality of life. Because the study was cross-sectional and footwear was not assigned, these findings represent associations rather than evidence of causation or injury prevention.

The findings are biomechanically plausible. Stud geometry and distribution can modify plantar loading and rotational resistance during cutting movements (DeBiasio et al., 2013; Queen et al., 2008). Previous work has also emphasized that the footwear–surface interface is complex and that boot design may affect mechanical demands (Kulessa et al., 2017; Thomson et al., 2015). The present results extend that literature by documenting self-reported foot and ankle differences within a group exposed to the same broad training-surface category.

The separation of boot category from stud shape is important. Although all AT-boot users in this sample had circular studs, FG boots included bladed, conical, and mixed configurations. Consequently, the AT-versus-FG comparison cannot be interpreted simply as a circular-versus-bladed comparison. Stud-type findings should be viewed as secondary and exploratory because the subgroup sizes were unequal and potential confounding was not controlled.

These findings may have practical relevance for sports-medicine teams and coaches. Asking athletes which boots they routinely use and explaining manufacturer-designated surface categories are low-burden components of footwear education. Nevertheless, clinical recommendations should also consider fit, comfort, playing position, prior injury, boot condition, turf properties, and individual preference. Prospective surveillance is required before claiming that a particular configuration reduces injury incidence.

This study should be interpreted in light of several methodological considerations. Its cross-sectional design supports identification of associations but does not establish their temporal direction or causality. FAOS provides a multidimensional assessment of self-reported foot and ankle health but does not represent clinically diagnosed or time-loss injuries. Footwear selection was not randomized, and differences in prior injury, playing position, training exposure, socioeconomic factors, boot age, comfort, or other characteristics may have influenced the results. The study focused on male adolescent outfield players from one region, providing a clearly defined athletic sample while limiting generalisability to other populations. Surface generation and mechanical properties were not measured, and the analyses were unadjusted with multiple FAOS-domain comparisons. Important strengths include assessment of players exposed to the same broad training-surface category, direct inspection of routinely used footwear, and application of a multidomain foot and ankle outcome measure.

Future studies should prospectively record training and match exposure and clinically verified injuries, measure footwear–surface traction and plantar pressure, document previous injury and boot characteristics in greater detail, and use multivariable analyses or randomized crossover designs where feasible.

Conclusion

Among 103 adolescent male football players who trained exclusively on artificial turf, those wearing surface-appropriate AT boots reported better overall foot and ankle health and function than those wearing FG boots. The greatest differences were seen in sport and recreation function and foot- and ankle-related quality of life. Players using circular studs also had better FAOS scores than those using bladed studs, although this finding was closely linked to boot category.

These findings highlight the practical importance of matching football boots to the playing surface. Educating players, coaches, and sports-medicine professionals about surface-appropriate footwear may be a simple and low-cost strategy for improving foot and ankle comfort, function, and sporting participation.

Author Contributions

Conceptualisation: Deepak Ram Thulasiraman. Methodology: Deepak Ram Thulasiraman. Formal analysis: Siva Prasanth S. Investigation: Vignesh Kumar R. Data curation: Vignesh Kumar R. Writing – original draft: Deepak Ram Thulasiraman. Writing – review and editing: Paul Therattil. All authors reviewed and approved the final manuscript.

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Disclosure statement

The authors declare that they have no conflicts of interest.

AI use disclosure

Generative artificial intelligence was used solely to assist with language editing, grammar, formatting, and consistency checking. It was not used to generate research data, perform the original statistical analysis, create scientific findings, or generate references. All authors reviewed the manuscript and take full responsibility for its accuracy and content.

Compliance with national requirements

The study procedures complied with the applicable laws and ethical requirements of the country in which the research was conducted.

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