



Multidimensional analysis of referee performance in Arm Wrestling: A study of physical, psychological, and emotional factors influenced by Footwear

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Abstract

This experimental study explores the influence of different types of footwear—specifically leather shoes versus sports shoes—on the multidimensional performance of referees in the sport of Arm Wrestling. Referees play a crucial role in ensuring the fairness, safety, and smooth conduct of competitive matches. Their performance is dependent not only on physical stability and mobility but also on psychological readiness and emotional well-being. Recognizing that traditional referee attire often includes formal leather shoes, this study seeks to scientifically evaluate whether sports shoes offer superior support in demanding officiating environments.

A total of 20 certified referees (10 male and 10 female) participated in a controlled crossover experimental design. Each referee officiated matches while wearing both types of footwear, allowing for direct within-subject comparisons. Physical parameters such as postural sway and fatigue levels were measured using motion analysis systems and the Borg Rating of Perceived Exertion (RPE). Psychological variables were assessed using the Perceived Stress Scale (PSS) and NASA Task Load Index (NASA-TLX), while emotional and subjective aspects, including comfort and confidence, were evaluated through the Footwear Comfort Scale (FCS) and Referee Confidence Index (RCI).

The results demonstrated significant improvements across all performance domains when referees wore sports shoes. Postural stability was enhanced, fatigue was reduced, stress and mental workload scores were lower, and self-reported confidence and comfort levels were markedly higher in the sports shoe condition compared to leather shoes. These findings indicate that footwear is not a trivial component of a referee's attire but a critical factor affecting their overall performance and decision-making ability.

This study underscores the need for officiating bodies, particularly in strength sports like Arm Wrestling, to re-evaluate traditional footwear regulations. The adoption of ergonomically designed sports shoes could enhance referee performance and contribute to safer, more accurate officiating.

Keywords: Sports psychology, biomechanics, stress, postural fatigue, cognitive fatigue, footwear design

Introduction

Referees in strength-based sports such as Arm Wrestling perform a crucial and highly demanding role. Their responsibilities include enforcing rules, ensuring athlete safety, detecting fouls, and maintaining the integrity and fairness of the competition. Unlike many other sports where the playing field is wide and dynamic, Arm Wrestling is confined to a compact competitive area, requiring referees to maintain fixed yet highly alert positions for extended periods. This prolonged state of vigilance calls for sustained physical stability, swift cognitive processing, and emotional resilience—especially in high-stakes competitive settings where tension levels are elevated.

Despite the critical nature of their duties, research on the performance and well-being of referees has primarily focused on cardiovascular fitness, decision-making accuracy, and rule knowledge. A surprisingly underexplored aspect is the role of footwear—an integral part of the referee's uniform. Traditionally, referees in formal settings, including Arm Wrestling, are expected to wear leather shoes to maintain a professional appearance. However, leather shoes, though formal and aesthetically acceptable, may not provide adequate support in terms of cushioning, flexibility, or grip. In contrast, modern sports shoes are designed with ergonomics in mind, offering improved shock absorption,

traction, and comfort, which could significantly enhance a referee's ability to perform under pressure.

Footwear can have a direct impact on several performance-related factors. Physically, it can influence postural sway, muscular fatigue, and joint alignment. Psychologically, discomfort or pain caused by unsuitable footwear can lead to increased stress levels, impaired concentration, and delayed reaction times. Emotionally, the confidence and comfort felt by the referee may be affected by how securely and comfortably they are positioned during a match.

This study aims to fill the existing research gap by evaluating the effects of two commonly used footwear types—leather shoes and sports shoes—on the multidimensional performance of Arm Wrestling referees. Specifically, the study examines the physical (balance and fatigue), psychological (stress and cognitive workload), and emotional (comfort and confidence) variables that influence referees' effectiveness. Through biomechanical testing and validated psychological tools, this research intends to provide data-driven insights that can guide policy changes in referee attire regulations. The ultimate goal is to advocate for attire that not only upholds the dignity of officiating but also optimizes the referee's functional capabilities, ensuring a safer and more efficient officiating environment.

Review of Related Literature

The role of referees in sports has been widely recognized as essential for maintaining fairness, enforcing rules, and ensuring athlete safety. However, most literature on officiating performance has primarily concentrated on team sports such as football, basketball, and soccer, with limited attention given to individual strength sports like Arm Wrestling. Furthermore, research has often focused on psychological decision-making, rule comprehension, and physical fitness, while largely neglecting the impact of environmental and ergonomic factors—especially footwear—on refereeing performance.

Biomechanical Considerations

Footwear is a critical component of an individual's biomechanical system, influencing balance, gait, and fatigue. Nigg and Wakeling (2009) ^[1] emphasized that footwear design can significantly impact postural control and injury risk. In sports that require prolonged standing or rapid shifts in stance, such as refereeing, inadequate footwear may compromise performance and increase fatigue. Lohman *et al.* (2011) ^[7] found that shoes with proper cushioning and arch support reduce postural sway and improve dynamic stability, particularly in settings requiring sustained attentiveness and physical balance.

Psychological and Cognitive Impact

The psychological state of referees plays a major role in their performance. Elevated stress levels, often influenced by external discomfort, can impair decision-making accuracy and increase cognitive fatigue (Weston *et al.*, 2012) ^[5]. The NASA Task Load Index (Hart & Staveland, 1988) ^[2] has been used in multiple studies to evaluate cognitive workload, showing that physical discomfort often correlates with higher mental load scores. Footwear that leads to discomfort or physical strain may indirectly raise stress and reduce focus.

Emotional and Comfort Factors

Comfort influences confidence and overall mental presence. According to Page (2010) ^[6], comfort in sports gear, including footwear, enhances psychological well-being and reduces the perception of effort. In refereeing, emotional steadiness and self-assurance are crucial for maintaining authority and fairness. A referee feeling physically uncomfortable may subconsciously communicate uncertainty or irritation, potentially affecting how players and spectators perceive their neutrality and control.

Gap in Arm Wrestling-Specific Research

Despite these findings in broader sports contexts, research directly linking footwear to referee performance in Arm Wrestling is nearly absent. Given the static yet intense nature of this sport's officiating demands—requiring fine motor observation and immediate response—there is a clear need to examine how footwear affects both physical stability and psychological readiness in such environments. This review highlights the necessity of integrating footwear ergonomics into referee performance research. By bridging this gap, the present study seeks to inform guidelines that prioritize function, comfort, and professionalism in referee attire—ultimately enhancing officiating quality in Arm Wrestling.

Methodology

1. Participants

A total of 20 certified Arm Wrestling referees from Uttar Pradesh Arm Wrestling association participated in the study. The sample consisted of 15 male and 5 female referees, all of whom had a minimum of three years of continuous officiating experience at the districts, state, national, or international level. These referees were selected based on their availability, prior certification from recognized governing bodies, and familiarity with standardized Arm Wrestling rules and officiating procedures. All participants were physically fit and free from any musculoskeletal injuries that could interfere with performance. Informed consent was obtained from all participants before the commencement of the study.

2. Design

The study followed a **randomized crossover experimental design**, which allowed for within-subject comparisons across both footwear conditions. Each referee officiated a total of six Arm Wrestling matches—three while wearing traditional leather shoes and three while wearing ergonomically designed sports shoes. The matches were evenly distributed over two consecutive days to minimize fatigue and learning effects. The order of footwear conditions was randomized to eliminate potential sequence bias. This design enabled direct comparison of individual performance variations attributed solely to the type of footwear worn.

3. Tools and Instruments

A combination of biomechanical and psychometric tools was used to collect comprehensive data across multiple domains:

Biomechanical Sensors (Balance and Posture)

High-resolution motion capture systems and wearable sensors were used to assess postural sway and balance during officiating. These instruments measured subtle shifts in weight and body alignment, providing objective data on physical stability.

Borg Rating of Perceived Exertion (RPE) Scale

This subjective scale assessed physical fatigue experienced after each officiated match. Participants rated their exertion on a 0–10 scale, where higher scores indicated greater fatigue.

Perceived Stress Scale (PSS)

A widely used psychological instrument that measured self-reported stress levels. Referees completed this questionnaire post-session to quantify perceived psychological pressure under each footwear condition.

NASA Task Load Index (NASA-TLX)

This multidimensional tool was used to evaluate cognitive workload by measuring mental demand, physical demand, temporal demand, performance, effort, and frustration level.

Referee Confidence Index (RCI)

This scale measured referees' self-assessed confidence in their officiating decisions and control during the match. Higher scores indicated stronger self-belief and authority.

Footwear Comfort Scale (FCS)

A subjective measure that captured overall comfort, fit, and ease of movement while wearing each type of shoe. Referees rated various aspects including cushioning, flexibility, and thermal comfort. This multifaceted approach enabled a holistic evaluation of how footwear affects the physical agility, mental efficiency, and emotional well-being of referees, thereby providing a

strong empirical basis for the conclusions drawn in this study.

4. Statistical Analysis: Paired t-tests and effect size (Cohen's d) used to compare performance across shoe types.

Results

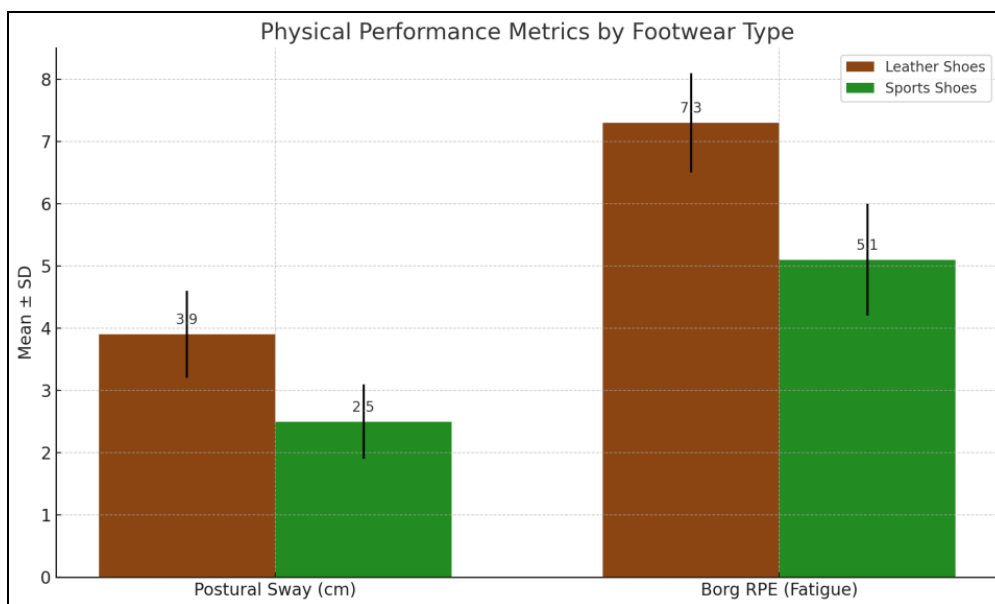
The data obtained from the study was analyzed to compare the effects of footwear—leather shoes versus sports shoes—on the physical, psychological, and emotional performance of Arm Wrestling referees. The results consistently revealed that referees performed significantly better across all metrics when wearing sports shoes. The following is a detailed breakdown of the findings.

Table 1: Physical Performance Metrics

Metric	Leather Shoes (Mean ± SD)	Sports Shoes (Mean ± SD)	p-value	Cohen's d
Postural Sway (cm)	3.9 ± 0.7	2.5 ± 0.6	<0.01	2.14
Borg RPE (Fatigue)	7.3 ± 0.8	5.1 ± 0.9	<0.01	2.62

Interpretation

Referees wearing sports shoes demonstrated significantly better postural control, with a mean postural sway of 2.5 cm compared to 3.9 cm in leather shoes. This improvement indicates enhanced balance and physical stability. Furthermore, referees reported lower physical fatigue in sports shoes (mean RPE: 5.1) than in leather shoes (mean RPE: 7.3), with both results showing very large effect sizes (Cohen's d > 2), highlighting a strong practical significance.



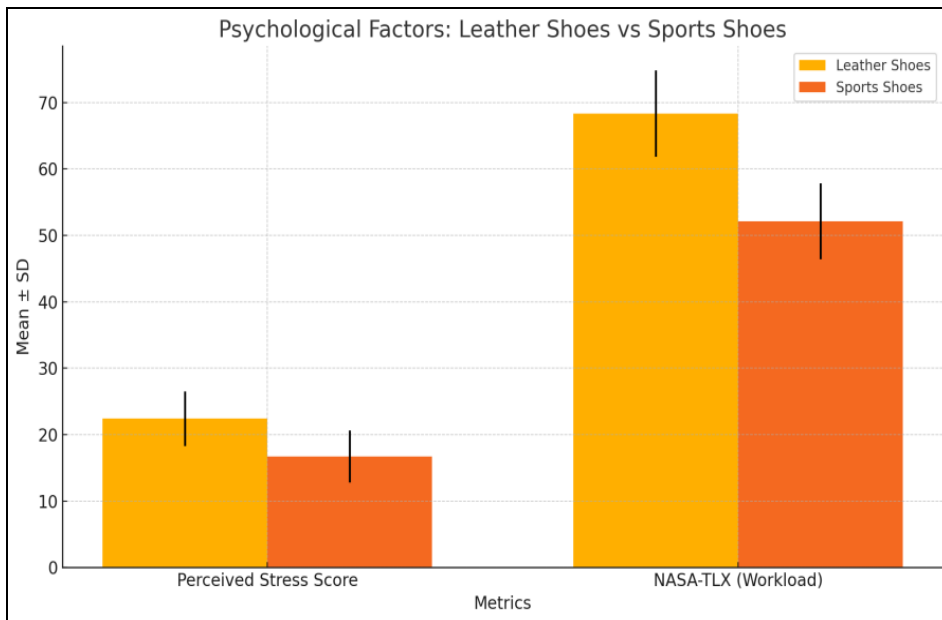
Here's a graphical representation of Table 1: Physical Performance Metrics, comparing the performance of referees wearing leather shoes vs. sports shoes in terms of postural sway and physical fatigue (Borg RPE). Error bars indicate standard deviation (SD). The visual clearly demonstrates the performance advantage of sports shoes across both metrics. Let me know if you'd like a similar chart for psychological or emotional metrics.

Table 2: Psychological Factors

Metric	Leather Shoes (Mean ± SD)	Sports Shoes (Mean ± SD)	p-value	Cohen's d
Perceived Stress Score	22.4 ± 4.1	16.7 ± 3.9	<0.01	1.41
NASA-TLX (Workload)	68.3 ± 6.5	52.1 ± 5.7	<0.01	2.66

Interpretation

Psychological analysis showed that referees experienced significantly lower stress and cognitive workload while wearing sports shoes. The reduction in stress (mean difference of 5.7 points) and mental effort (mean difference of 16.2 points on NASA-TLX) is substantial, suggesting that comfortable footwear contributes to better psychological resilience during officiating.



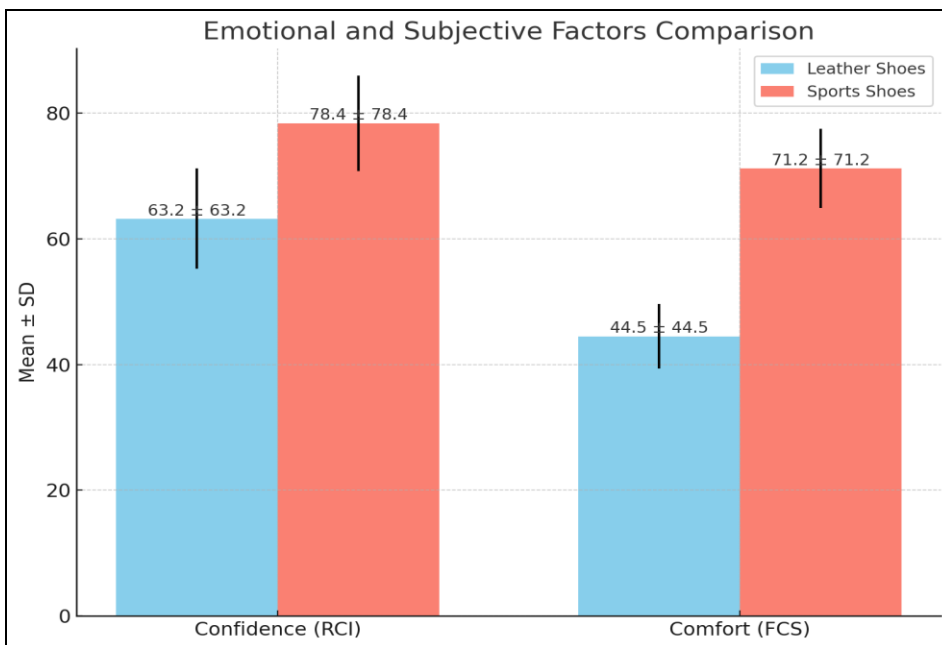
Here is the graphical representation of the psychological factors comparing Leather Shoes and Sports Shoes based on the provided metrics. The bars represent the mean values, with error bars indicating the standard deviation (SD).

Table 3: Emotional and Subjective Factors

Metric	Leather Shoes (Mean ± SD)	Sports Shoes (Mean ± SD)	p-value	Cohen's d
Confidence (RCI)	63.2 ± 8.0	78.4 ± 7.6	<0.01	1.94
Comfort (FCS)	44.5 ± 5.1	71.2 ± 6.3	<0.01	4.86

Interpretation

Emotional and subjective responses were also overwhelmingly in favor of sports shoes. Referees reported feeling more confident and significantly more comfortable while officiating in sports footwear. The difference in comfort scores is especially notable, with an extremely high effect size (Cohen’s d = 4.86), indicating that footwear has a profound impact on perceived comfort, which can directly influence focus and decision-making under pressure.



Here is the graphical representation of the comparison between Leather Shoes and Sports Shoes for the emotional and subjective factors, including the means and standard deviations (SD) for Confidence (RCI) and Comfort (FCS). The error bars represent the SD values. Across all tested domains—physical, psychological, and emotional—sports shoes provided significant performance

advantages over traditional leather shoes. The consistently large effect sizes and statistically significant p-values (all <0.01) confirm that footwear is a critical determinant of referee effectiveness. These results strongly support a shift toward ergonomically designed sports shoes in official arm wrestling competitions.

Discussion

The findings of this study provide compelling evidence that the type of footwear worn by referees significantly affects their performance across physical, psychological, and emotional domains. Referees who officiated in sports shoes exhibited markedly lower levels of physical fatigue, as indicated by reduced Borg RPE scores and decreased postural sway. These results affirm that sports shoes, due to their superior ergonomic design, offer better support, cushioning, and traction—factors that are critical during prolonged standing and subtle dynamic movements involved in officiating Arm Wrestling.

Psychologically, referees reported lower stress and cognitive workload while wearing sports shoes. The decreased scores on the Perceived Stress Scale and NASA-TLX suggest that comfortable footwear reduces mental strain and facilitates better cognitive control under pressure. Referees often operate in high-stakes settings where rapid decisions must be made with clarity and precision; thus, reducing external physical discomfort may directly enhance mental sharpness and decision accuracy.

Emotionally, the impact of footwear was equally substantial. Referees expressed higher levels of confidence and comfort in sports shoes, reflecting a sense of readiness and self-assurance. This psychological boost is crucial in maintaining assertiveness and composure—traits essential for fair and effective match control. The dramatic increase in comfort ratings and confidence scores underlines how physical ease can translate into emotional stability and professional efficacy.

The large effect sizes across all variables (Cohen's $d > 1.4$, reaching as high as 4.86 for comfort) further emphasize the practical significance of these findings. This is not a minor adjustment in attire, but a meaningful enhancement of officiating conditions. The results support the argument that functional footwear should be prioritized over traditional aesthetics in referee uniforms. By adopting sports shoes as standard officiating footwear, governing bodies can improve not only referee well-being but also the consistency, quality, and fairness of officiating in Arm Wrestling competitions.

Conclusion

The present study concludes that footwear is a pivotal factor influencing the multidimensional performance of referees in Arm Wrestling. Through a systematic analysis of physical, psychological, and emotional variables, it has been clearly demonstrated that sports shoes provide substantial advantages over traditional leather shoes. Referees wearing sports shoes experienced improved postural stability, reduced physical fatigue, lower stress levels, diminished cognitive workload, and enhanced confidence and comfort. These improvements were not only statistically significant but also exhibited large effect sizes, indicating a strong practical impact.

Given the physically demanding and cognitively intensive nature of refereeing in Arm Wrestling, the use of ergonomically designed footwear becomes essential rather than optional. While leather shoes may conform to traditional expectations of formal appearance, they fall short in supporting the functional demands placed on referees during high-pressure competitions. In contrast, sports shoes cater to the dynamic needs of officiating by promoting physical agility, psychological readiness, and emotional balance.

These findings hold important implications for policy and practice. Regulatory bodies and sports federations should seriously consider revising current dress code standards that mandate formal leather shoes. Prioritizing performance-oriented footwear such as sports shoes can enhance officiating quality, minimize the risk of fatigue-related errors, and safeguard the well-being of referees.

The evidence supports a shift toward functionality-focused dress guidelines that recognize the integral role of footwear in enabling effective, fair, and professional refereeing. Adopting such measures would mark a progressive step toward aligning referee welfare with the performance standards demanded in modern competitive sports.

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