International Journal of Asian Social Science Research; Vol.2, No.6; 2025
E-ISSN: 3006-2179 P-ISSN：3006-754X
DOI: https://doi.org/10.70267/ijassr.250206.5862
Published by: Zeus Press

Double-edged Sword: Challenges and Opportunities for the Fairness of Female Athletes in the Era of Artificial Intelligence

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Abstract

The penetration of artificial intelligence (AI) technology in the sports field is reshaping athletes' training, evaluation, media presentation, and commercial value with unprecedented depth and breadth. However, this technological innovation is not value-neutral and may have divergent effects on athletes of different genders. This article explores the dual impact of AI on fairness for female athletes. By analyzing existing literature, this study identifies algorithmic discrimination from historical data bias, AI-driven media stereotypes, and ethical risks from biometric monitoring as primary challenges. Conversely, AI also presents significant opportunities to counteract bias through objective performance analysis, personalized training tailored to female physiology, and enhanced fan engagement. We conclude that to ensure AI promotes gender equality in sports, proactive interventions in algorithm design, data governance, and ethical standards are imperative.

Keywords

artificial intelligence, gender equality, algorithmic bias, data ethics, women's sports

1. Introduction

Sport has long been regarded as an arena that reflects and shapes social values. Although female athletes have made great strides in the past few decades, gender inequality remains deeply ingrained in terms of pay, media exposure, resource allocation, and more. With the widespread use of artificial intelligence (AI)-including technologies such as machine learning, computer vision, and big data analytics-in the sports industry, a central question has emerged: Will AI be a catalyst for exacerbating these inequalities, or will it become a powerful tool for promoting equity? Many experts worry that if left unregulated, AI may amplify existing biases in sports (Ahmed, 2023). This article will deeply analyze the dual impact of AI on the fairness of female athletes from multiple dimensions such as algorithm bias, media presentation, and physiological data monitoring, combined with existing academic literature.

2. Challenges: How AI exacerbates unfairness for female athletes

2.1 Algorithmic bias and data discrimination

The core of an artificial intelligence system is data, and the fairness of its decision-making depends heavily on the quality and representativeness of the training data. In the field of sports, there is a serious gender bias

in historical data, which is termed the "data gap" (Taylor, 2023).

2.1.1 Significant disparities in data availability

Men's sports have a longer history and are more commercialized, accumulating massive amounts of competition data, athlete physiological data, and media coverage data. In contrast, the data sets for women's sports are far inadequate in both quantity and dimension (Yang, 2023). When AI models (such as those used to evaluate player potential or commercial value) are trained primarily on male-dominated data, their evaluation criteria and weights will naturally tilt towards the characteristics of male athletes (Klebnikov, 2024).

2.1.2 Bias in performance evaluation

AI-driven performance analysis systems may fail to accurately identify and evaluate the unique physiological and tactical characteristics of female athletes due to biases in training data. For example, a tactical analysis AI trained predominantly on data from male football players may not correctly evaluate the value of different running patterns and space utilization strategies in women's football, thus underestimating the performance level of female athletes (Topple and Dite, 2024). This directly affects their selection, contract negotiations, and compensation.

2.1.3 Vicious cycle of commercial value assessment

AI models used to predict the commercial value of athletes (such as for endorsement contracts) often analyze metrics like media exposure and social media influence. Since the exposure rate of female athletes in traditional media is already low, AI can learn and reinforce this pattern, predicting lower commercial value for them. This may lead sponsors to reduce investment, further diminishing their visibility and creating a vicious cycle that is difficult to break (Klebnikov, 2024). This study argues that this cycle not only reflects historical inequities but also, through the algorithm's "self-fulfilling prophecy" effect, risks cementing deep-seated structural gender biases in the sports business landscape.

2.2 Media representation and reinforcement of stereotypes

AI is changing the way content is created and distributed, but it may also become an efficient amplifier for spreading gender stereotypes.

2.2.1 Risks of automated content generation

AI can automatically generate match highlights, press releases, and social media posts. Without conscious intervention by algorithm designers, AI may learn and replicate biases existing in traditional media-for example, focusing more on female athletes' appearance and family life rather than their athletic prowess. One study found significant linguistic biases in media depictions of male versus female athletes, and AI-driven news generation tools could replicate these biases on a large scale (Pratt, 2024).

2.2.2 Algorithmic recommendation systems exacerbating the "filter bubble"

Recommendation algorithms on social media and news platforms are designed to maximize user engagement. Studies suggest that content that genders or sexualizes female athletes can sometimes achieve higher interaction rates. In pursuit of clicks, algorithms may prioritize promoting such content, thereby reinforcing an objectified view of female athletes rather than recognizing their identity as professional athletes (Pratt, 2024).

2.3 Physiological data monitoring and ethical risks

Wearable devices and biosensors allow coaches and teams to track athletes' physiological status with unprecedented precision. For female athletes, this presents both an opportunity and unique risks.

2.3.1 Misuse of sensitive data such as menstrual cycle

AI-enhanced training systems for female athletes can integrate menstrual cycle data to optimize training and nutrition plans, which represents a scientific advance (Falkingham, 2023). However, this highly sensitive personal data can become a basis for discrimination if misused. For instance, clubs or sponsors might use this data to assess an athlete's "state stability," potentially putting them at a disadvantage in contract negotiations.

This poses serious risks of privacy invasion and employment discrimination (Holden and Edelman, 2021). This paper emphasizes that this potential for discrimination based on physiological characteristics is a distinct and severe challenge uniquely faced by female athletes in the AI era.

2.3.2 Lack of data ownership and transparency

The ownership of the vast amounts of data generated by athletes through wearable devices is often ambiguous (Novy-Williams, 2023). In the absence of a transparent and robust regulatory framework, female athletes may lack control over how their personal data is used, analyzed, and shared by AI systems, leaving them in a vulnerable position within power structures.

3. Opportunities: How AI can promote fairness for female athletes

3.1 Objective evaluation and talent identification

The strength of AI lies in its ability to process complex data objectively, potentially overcoming subjective biases (whether conscious or unconscious) that human coaches may harbor (Topple and Dite, 2024).

3.1.1 Unbiased assessment based on biomechanics

Through computer vision and sensors, AI can perform precise biomechanical analysis of athletes' techniques, movement efficiency, and energy expenditure (Vickery and Aylwin, 2023). This performance-centric evaluation method can reduce the influence of irrelevant factors like gender, nationality, or appearance, providing a fairer platform for assessing female athletes' competitive abilities.

3.1.2 Discovering undervalued talent

Traditional scouting systems can be limited by geography and existing networks. AI-powered big data analytics can scan lower-league or youth competitions globally, identifying promising female athletes through data models. This can help uncover talent that might otherwise remain overlooked due to lack of resources or exposure.

3.2 Personalized training and injury prevention

Sports science research has long suffered from a "male-default" approach, with most studies focusing on male subjects, leading to a lack of data-supported training and medical protocols for female athletes (Yang, 2023). AI offers the potential to change this landscape.

3.2.1 Training programs designed for female physiology

AI systems can integrate various physiological parameters, including hormonal cycles, to tailor training loads, nutrition, and recovery strategies for female athletes (Felton, 2024). This not only helps maximize their athletic performance but also aids in preventing injuries more common in women (e.g., higher ACL injury risk). This represents a paradigm shift away from the outdated view of treating women as "small men" towards a truly personalized, scientific training approach, a revolutionary opportunity AI brings to women's sports science.

3.3 Enhancing exposure and fan engagement

AI technology can help women's sports bypass traditional media "gatekeepers" and connect directly with audiences.

3.3.1 Automated content creation and distribution

AI can automatically generate high-quality match highlights, data visualizations, and player-specific content, distributing them effectively to potential fans via social media platforms. For instance, AI platforms like WSC Sports are already being used to create highlights for women's football, significantly boosting content output and audience engagement (Daktronics, 2022).

3.3.2 Creating immersive viewing experiences

Using AI and augmented reality (AR) technologies, broadcasters can offer more interactive and data-rich viewing experiences for women's sports, such as displaying real-time player speed, shot success rates, etc. This enhances the entertainment value and appeal of the competitions, potentially attracting a broader viewer base (Vickery and Aylwin, 2023).

4. Conclusion and recommendations

This study demonstrates that AI's impact on fairness for female athletes is fundamentally dualistic. On one hand, unregulated AI systems risk exacerbating existing gender inequalities in sports through data bias, algorithmic discrimination, and ethical breaches. On the other hand, if deployed responsibly, AI can become a powerful tool for advancing gender equity by enabling objective assessment, providing personalized support, and increasing media visibility.

Our analysis suggests that the trajectory of AI will be determined by human choices, not technological determinism. To steer AI toward a positive outcome, we propose the following recommendations:

Ensure Data Inclusivity: Sports organizations and tech companies must invest resources in actively collecting and curating high-quality data on women's sports to bridge the pervasive "data gap."

Promote Algorithmic Transparency and Accountability: Institutions developing and deploying AI systems should enhance transparency, explain decision-making logic, and establish accountability mechanisms for discriminatory outcomes.

Establish Robust Data Ethics Norms: Clear industry standards and regulations must be defined for the collection, use, and ownership of athlete biometric data, with special provisions to protect the sensitive health information of female athletes.

Foster Interdisciplinary Collaboration: AI developers, sports scientists, athletes, coaches, and ethicists need to collaborate closely to ensure technology is designed and applied to serve the well-being and fair competition for all athletes.

In conclusion, technology itself is neutral; its value orientation is dictated by human design and application. In the AI era, securing equitable opportunities for female athletes is not merely a technical challenge but a profound social and ethical responsibility.

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Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

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