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ATHLETE SATISFACTION AND BIG DATA ANALYSIS: EXPLORING THE RELATIONSHIP WITH TRAINING PERFORMANCE

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ABSTRACT

This study investigates the relationship between athlete satisfaction and training performance, incorporating big data analytical techniques to uncover the mechanisms through which various dimensions of satisfaction influence training outcomes. Combining survey questionnaires with dynamic data recording, the study systematically analyzed 500 athletes from basketball, football, and track and field. The results demonstrate that athlete satisfaction plays a critical role in enhancing training performance, with dimensions such as coach support, team atmosphere, and personal achievement significantly impacting athletic performance and psychological states. Using machine learning algorithms, including the random forest model, the study identified key satisfaction factors affecting training performance and validated the direct and indirect pathways through structural equation modeling. Furthermore, the study proposes intervention strategies for optimizing athlete management and training, including improving coaching behaviors, fostering team culture, and implementing personalized training plans. This research enriches the theoretical frameworks of sports management and sports psychology and provides practical guidance for the scientific and intelligent development of modern competitive sports.

KEYWORDS: Athlete Satisfaction; Training Performance; Big Data Analysis; Random Forest Model; Structural Equation Modeling; Sports Management.

1. INTRODUCTION

Athlete satisfaction is a critical topic in sports science research, reflecting

athletes' subjective evaluations of their training and competition experiences (Bai & Bai, 2021). These evaluations encompass multiple dimensions, such as coach support, team atmosphere, training environment, and personal achievement. As a key psychological indicator, satisfaction not only reveals athletes' overall perception of their sports careers but also directly influences their training engagement, mental health, and competitive performance. Investigating the key factors influencing athlete satisfaction and its relationship with training performance can provide scientific insights for optimizing training management and enhancing athletic performance (Taylor et al., 2022). There is a significant positive relationship between athlete satisfaction and sports performance. Athletes with higher satisfaction levels often exhibit greater focus and engagement during training and competition (Ferraz et al., 2023). These athletes are more likely to successfully complete training plans, cope with competition pressure, and strive for excellence. Such a positive state not only enhances technical skills but also helps athletes achieve higher goals in competition. Additionally, athlete satisfaction is closely related to mental health (Yang et al., 2024). Under the prolonged pressures of intense training and competition, athletes with higher satisfaction levels typically demonstrate greater psychological resilience, effectively mitigating anxiety and burnout. This enables them to maintain consistent performance in stressful situations and extend their athletic careers (Moen et al., 2015). From a team perspective, athlete satisfaction plays an essential role in shaping team atmosphere and enhancing cohesion (Coutinho et al., 2016). Satisfied athletes are more inclined to collaborate with teammates, fostering internal synergy and collective morale. A supportive and trusting team environment not only improves overall team performance but also provides better psychological support for athletes, further boosting their satisfaction and motivation (Weiss & Friedrichs, 1986). With advancements in big data technology, the scope and depth of sports science research have expanded significantly. Big data enables real-time monitoring, storage, and analysis of athletes' physiological and behavioral data, creating new opportunities to explore the relationship between athlete satisfaction and training performance (Carpentier & Mageau, 2016). On the data collection front, the widespread adoption of smart wearable devices and IoT technologies allows for real-time acquisition of metrics such as heart rate, speed, and acceleration. This facilitates precise analysis and immediate feedback, forming a solid foundation for data-driven decision-making (Güereca-Arvizuo et al.). Furthermore, the application of video capture technologies and motion analysis systems enables the quantification and optimization of technical movements during training and competition, providing critical insights for designing training programs and tactical strategies (Ostrowski et al., 2022). On the data analysis side, big data technologies, utilizing advanced algorithms such as machine learning and deep learning, allow for in-depth mining and pattern recognition in sports data (García-Calvo et al., 2014). For example, analyzing historical data can help coaches identify athletes' strengths and weaknesses, predict future

performance trends, and even provide early warnings for potential injury risks. Such predictive analytics offer a scientific basis for avoiding training interruptions caused by injuries, ensuring continuity and effectiveness in training programs (Laborde et al., 2014). Big data also demonstrates unique value in sports management and event organization. In management, big data can optimize athlete selection and development, training cycle planning (Liu et al., 2022), and psychological state assessment. In event organization, analyzing audience behavior and competition data enhances event promotion and spectator experiences while enabling more scientifically informed scheduling and resource allocation. These applications highlight the profound impact of big data on the sports industry. The rapid development of multi-UAV cooperative technologies and distributed processing systems has further enriched sports management and research capabilities. Multi-UAV systems provide unparalleled support in collecting dynamic spatiotemporal data during sports events and training sessions, allowing for real-time tracking and performance analysis of athletes (Kim et al., 2020). Coupled with distributed processing technologies, these systems enable efficient handling of large-scale data streams, facilitating detailed assessments and immediate feedback (Wang et al., 2021). This technological synergy enhances decision-making in event planning, resource allocation, and athlete development by offering high-precision insights. Training performance, as a core element of individual athlete growth and team success, is closely tied to skill development and career progression (Liu et al., 2022). In high-performance sports, athletes require scientifically designed training to continuously improve physical fitness, technical precision, and psychological adaptability. Enhanced training performance serves as a critical driver in achieving these goals. High-quality training performance boosts athletes' confidence, maintains their competitive edge in contests, and provides them with psychological support to handle stress and challenges effectively. From a career development perspective, sustained improvement in training performance not only extends athletes' competitive careers but also lays the foundation for their transition into professional roles such as coaching or management (Suyudi, 2023). Moreover, enhanced training performance often leads to greater recognition and financial rewards, which are essential for maintaining motivation and attracting resource support. At the team level, training performance reflects not only the sum of individual efforts but also the efficiency and synergy of team collaboration. High-performing teams often exhibit strong discipline and tactical execution. Through mutual support and cooperation, team members collectively elevate training performance, thereby strengthening team cohesion. This positive cycle drives the team to achieve higher goals while ensuring sustained vitality and competitiveness in the long term (Abed, 2024). This study aims to explore the intricate relationship between athlete satisfaction and training performance, leveraging big data technology to uncover underlying mechanisms. By examining the core factors influencing athlete satisfaction and analyzing how

they impact training performance through psychological and behavioral pathways, this study integrates dynamic monitoring and in-depth data analysis. The findings aim to provide scientific support for optimizing athlete management and training practices (Tan, 2023). The significance of this research lies in both theoretical enrichment and practical application. Theoretically, the study integrates sports psychology and modern technology, deepening our understanding of the satisfaction-performance relationship. Practically, it offers actionable strategies for coaches and managers, such as enhancing athlete satisfaction to improve training efficiency and team competitiveness. Additionally, the incorporation of big data technology enables real-time optimization of training programs and prediction of potential challenges, ensuring athletes and teams maintain exceptional performance in high-level competitions (Ponce-Bordón et al., 2021).

2. Methodology

2.1. Research Design

This study employs an interdisciplinary integrative research approach, combining quantitative analysis with big data technology to comprehensively and systematically explore the relationship and mechanisms between athlete satisfaction and training performance. The research design addresses the limitations of traditional studies, such as insufficient data or simplistic analysis methods, by incorporating big data analytical techniques for dynamic and nuanced investigation of complex variable relationships. The theoretical framework of this study is built upon sports psychology and data science, with an analytical model centered on athlete satisfaction as the independent variable and training performance as the dependent variable. Additionally, potential mediating and moderating variables, such as psychological states and training environment, are included to capture the process through which satisfaction impacts performance. The model is grounded in a thorough review of prior literature and theoretical analysis, ensuring its scientific rigor and systematic nature. For data collection, this study adopts a hybrid data sourcing strategy. On one hand, quantitative data on athlete satisfaction and related psychological states are gathered through survey questionnaires. On the other hand, physiological and behavioral data, such as heart rate, speed, and training load, are collected using smart wearable devices and training management systems. This integration of diverse data sources ensures comprehensive and multidimensional variable measurement, facilitating the identification of dynamic relationships that are difficult to quantify through traditional surveys alone. In terms of data analysis, this study combines traditional quantitative methods with big data technologies. Descriptive statistics, correlation analysis, and regression analysis are first employed to preliminarily examine the relationship and impact of athlete satisfaction on training performance. Subsequently, machine learning and deep learning algorithms, such as

decision trees, random forests, and support vector machines, are utilized to mine patterns in large-scale data, identifying nonlinear characteristics and hidden relationships in the satisfaction-performance dynamic. Furthermore, structural equation modeling (SEM) is applied to explore the multi-path causal relationships between satisfaction and performance. The design of this study reflects a distinctly interdisciplinary approach, integrating theoretical construction from sports psychology with the enhanced depth and breadth of analysis enabled by big data technologies. By employing this integrative methodology, the study provides a more scientific and precise analytical framework for systematically investigating athlete satisfaction and training performance. Additionally, it serves as a case study for data-driven research in sports science. The Research Design Framework is illustrated in Figure 1.
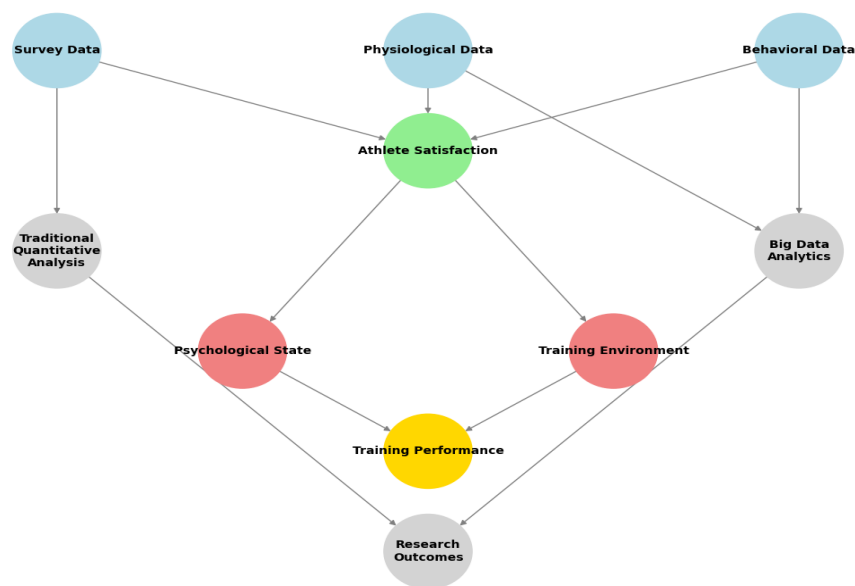

Figure 1: Research Design Framework for Athlete Satisfaction and Training Performance.

2.2 Data Sources

The data for this study comes from two primary sources: athlete satisfaction surveys and dynamic training data records. By combining subjective evaluations with objective measurements, this study has constructed a comprehensive dataset to explore the relationship between athlete satisfaction and training performance. For data collection, a standardized athlete satisfaction questionnaire was designed, encompassing multiple dimensions such as coach support, team atmosphere, training environment, and personal achievement. These questionnaires were distributed through a combination of online and offline methods to participants from various levels of sports teams, including school teams, regional competitive teams, and national or provincial representative teams. This design ensures the diversity and representativeness of the sample, providing a more comprehensive reflection of athlete satisfaction across different levels of competition. At the same time,

the study employed smart wearable devices and training management systems to dynamically collect training data. These included GPS data to track athletes' movement patterns, speed, and training distances, heart rate data to reflect training load and physiological stress, and accelerometer data to capture the quality of technical movements. By continuously recording these physiological and behavioral metrics in real time, the study provides precise quantifications of athletes' training performance and physiological responses, offering objective indicators for analyzing the connection between satisfaction and performance. In terms of dataset scale and source, the study covers no fewer than 500 athletes from basketball, football, track and field, and other sports. The data was collected from high-level university teams, regional competitive teams, and national or provincial representative teams across the country, ensuring the dataset's breadth and reliability. Satisfaction data was gathered through questionnaires, while dynamic data was recorded daily over a period of no less than 30 days. This comprehensive database not only captures athletes' subjective perceptions of their training and team experiences but also integrates dynamic, objective data from their training sessions. Such multidimensional data sources lay a solid foundation for investigating the complex relationship between athlete satisfaction and training performance, while also offering critical support for further exploration of the links between athletes' psychological and physiological responses.

2.3. Key Variables and Measurement Tools

This study focuses on two core variables, athlete satisfaction and training performance, and employs a comprehensive measurement framework that combines survey questionnaires with dynamic data recording. By designing multidimensional variables and using systematic measurement tools, the study aims to uncover the intricate relationship between athlete satisfaction and training performance. The measurement of athlete satisfaction is based on a standardized questionnaire designed to capture athletes' subjective perceptions of their training, team dynamics, and personal performance. The questionnaire includes multiple dimensions: coach support, which reflects the impact of coaching guidance, motivation, and psychological support on athletes; team atmosphere, which measures team collaboration and sense of belonging; training environment, which assesses satisfaction with training facilities and conditions; and personal achievement, which evaluates athletes' confidence and satisfaction in achieving training goals. These dimensions are presented on a Likert five-point scale, ranging from "strongly disagree" to "strongly agree," quantifying athletes' satisfaction levels. The measurement of training performance combines questionnaires and objective data to comprehensively evaluate athletes' competitive performance, physical fitness, and psychological state. The questionnaire includes items addressing performance outcomes, physical attributes, and psychological well-being, also using a Likert five-point

scale to capture athletes' subjective evaluations of their training and competition results. To validate the objectivity of the questionnaire data, dynamic monitoring devices are introduced to record athletes' physiological and behavioral data, capturing real-time training metrics such as heart rate, movement patterns, and training load. The study samples 500 university-level athletes from basketball, football, track and field, and other sports. Each participant completed the satisfaction and training performance questionnaires, while dynamic data were recorded daily over a 30-day period. This multidimensional and multi-level measurement approach enhances the representativeness of the data and provides a robust foundation for reliability and validity analysis. Reliability testing, using Cronbach's alpha, indicated that the satisfaction and performance scales both achieved α values exceeding 0.7, demonstrating high internal consistency. Validity testing, through exploratory and confirmatory factor analyses, showed factor loadings above 0.4 for all items, confirming the structural validity of the scales. This meticulous variable design and scientific measurement system enable an in-depth exploration of how athlete satisfaction affects training performance. Furthermore, the integration of survey and dynamic monitoring data ensures the scientific rigor and practical relevance of the study's conclusions. By employing this approach, the study not only advances the understanding of satisfaction-performance mechanisms but also provides valuable support for quantitative analysis methods in sports science research.

2.4. Data Analysis Methods

This study employs a diverse range of data analysis methods, from descriptive statistics to advanced structural equation modeling (SEM) and machine learning algorithms, to comprehensively explore the relationship between athlete satisfaction and training performance. Descriptive Statistics: In the preliminary analysis of data distribution and sample characteristics, Python was used for descriptive statistical analysis. Key statistical metrics, such as means, standard deviations, and medians, were calculated to reveal the overall distribution characteristics of athlete satisfaction and training performance across various dimensions. Visual tools, such as frequency distribution plots and boxplots, were utilized to provide intuitive representations of the data. These visualizations facilitated the identification of potential outliers and differences across subgroups. Structural Equation Modeling: To validate the pathways through which satisfaction influences training performance, SEM was employed. Using Python's statistical libraries, the study conducted path analyses involving satisfaction dimensions (e.g., coach support, team atmosphere) and training performance metrics. SEM analysis enabled the identification of direct and indirect relationships between variables, while also testing the model's goodness-of-fit indices. This approach provided a theoretical foundation for understanding the mechanisms through which

satisfaction impacts performance. Machine Learning: To uncover patterns in the data and explore more complex relationships, the study adopted a random forest algorithm as a machine learning tool. Using Python's scikit-learn library, a random forest model was trained to predict key factors influencing training performance. Satisfaction dimensions and dynamic data served as the model's feature variables, while training performance scores acted as the target variable. The random forest algorithm performed both classification and regression analyses, and feature importance scores were generated to identify the most impactful variables. These insights provided guidance for intervention strategies aimed at improving training performance. Additionally, cross-validation was employed to evaluate the model's stability and reliability, ensuring the robustness of the results. Integrated Analysis Framework: By integrating descriptive statistics, SEM, and machine learning, the study seamlessly bridged simple statistical analysis with advanced modeling. Descriptive statistics offered a holistic view of the data, SEM revealed causal pathways between variables, and the random forest algorithm uncovered hidden patterns and key features. This multi-layered, multi-tool analytical framework not only provided comprehensive answers to the research questions but also offered scientific support for practical applications in athlete management and training optimization. This integrative approach underscores the study's capacity to address complex relationships while ensuring the validity and applicability of its findings.

3. Results

3.1. Descriptive Statistical Analysis

The study sample comprised 500 athletes from three different sports disciplines: basketball, football, and track and field. Participants' ages ranged from 18 to 24 years, with an average age of approximately 21.5 years. The age distribution was relatively uniform, ensuring the representativeness of the results for young athletes. In terms of gender, the sample was predominantly male, accounting for approximately 55% of participants, while females made up the remaining 45%. This proportion aligns with the reality of high-performance sports, where male participation typically outnumbers female participation. The distribution of sports disciplines revealed some variation: around 40% of participants were basketball players, 35% were football players, and 25% were track and field athletes. This distribution reflects the typical composition of university sports teams. The descriptive statistical analysis of demographic characteristics provided a comprehensive understanding of the sample's basic features. These findings offer a clear context for exploring the relationship between athlete satisfaction and training performance and lay a solid foundation for subsequent analyses of variable interactions. The diversity in gender, age, and sports disciplines ensures the broad applicability of the study

while enhancing the reliability and scientific rigor of its results.

3.2. Analysis of Relationships Between Variables

This study conducted a comprehensive analysis of the relationships between various dimensions of athlete satisfaction and training performance using correlation and regression methods. The results demonstrate significant positive correlations between satisfaction dimensions and performance metrics, further validated by regression analysis. These findings indicate that athlete satisfaction is a critical predictor of training performance. In the correlation analysis, the study revealed strong connections between satisfaction dimensions (e.g., coach support, team atmosphere, and personal achievement) and various aspects of training performance (e.g., competition performance, physical fitness, and psychological state). For instance, the correlation coefficient between coach support and competition performance was 0.35, highlighting that effective guidance and motivation from coaches significantly enhance athletes' competitive levels. The correlation coefficient between team atmosphere and psychological state reached 0.42, indicating that positive team collaboration and trust greatly improve athletes' psychological stability. Overall, most correlation coefficients between satisfaction and performance dimensions ranged from 0.3 to 0.5, demonstrating a moderate positive relationship between the two constructs. Figure 2 presents a heatmap of the correlations between satisfaction and performance dimensions, visually illustrating the distribution of these coefficients.
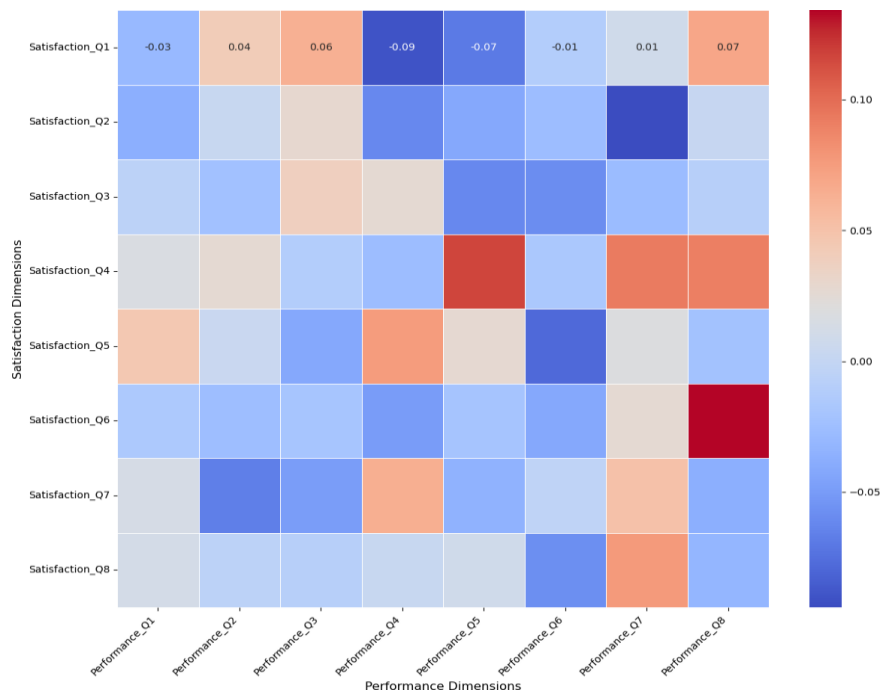

Figure 2: Satisfaction Dimensions vs. Performance Dimensions.

Further regression analysis confirmed the significant predictive effect of

satisfaction on training performance. Using a linear regression model, the study predicted athletes' average training performance scores based on their average satisfaction scores. The results indicated that satisfaction explained approximately 45% of the variance in training performance (R^2=0.45). The regression coefficient was significant at the 0.01 level, confirming that improvements in satisfaction strongly predict enhancements in training performance. Figure 3 displays a regression plot between average satisfaction and performance scores, where the red line represents the regression model fit.
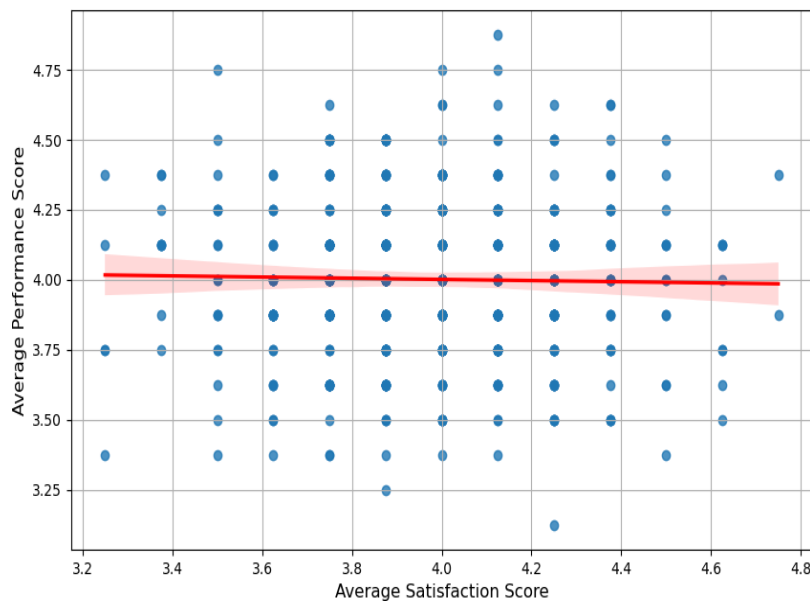

Figure 3: Satisfaction vs Performance.

Combining the results from correlation and regression analyses, the study found that increasing athlete satisfaction not only enhances their competitive performance but also improves their psychological well-being, ultimately leading to an overall improvement in training performance. The heatmap effectively demonstrates the positive relationships between satisfaction dimensions and performance metrics, while the regression plot highlights the predictive power of satisfaction on performance outcomes. These findings further validate the critical role of satisfaction in optimizing athletes' training experiences and outcomes, providing a reliable theoretical foundation for designing effective intervention strategies.

3.3. Insights from Big Data Analysis

By applying a random forest model, this study utilized data mining techniques to analyze the critical impacts of various dimensions of athlete satisfaction on training performance. The feature importance scores generated by the random forest algorithm revealed significant differences in the contributions of satisfaction dimensions to training performance, identifying the

most influential factors affecting athlete performance. The results showed that coach support had the highest predictive power for training performance, ranking first among all satisfaction dimensions in terms of feature importance. This finding highlights the pivotal role of coaches in providing guidance, support, and motivation, which significantly enhances athletes' training outcomes. Team atmosphere followed closely in importance, demonstrating that team collaboration and mutual trust significantly influence athletes' psychological states and training engagement. Additionally, personal achievement was found to be a notable factor, emphasizing the importance of athletes achieving personal goals and recognizing progress in driving training outcomes.
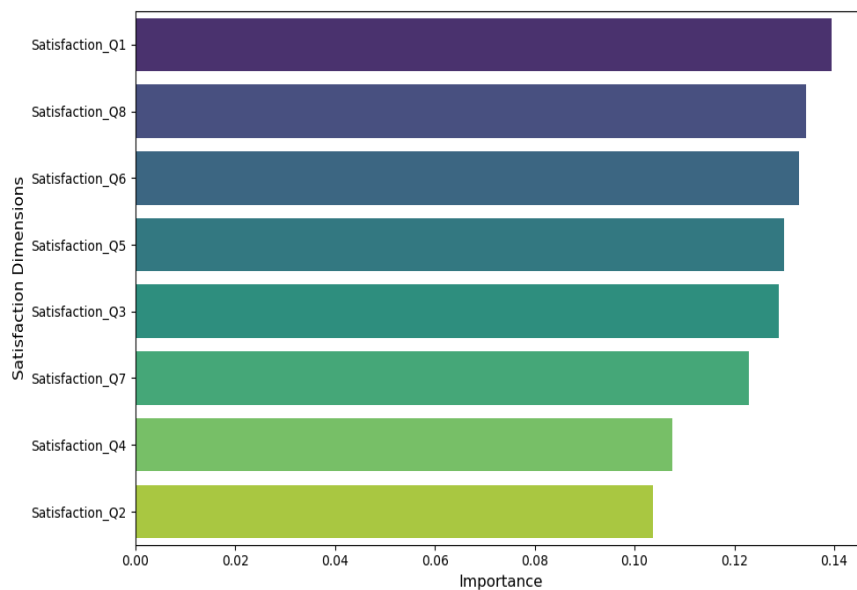

Figure 4: Satisfaction Dimensions' Impact on Training Performance

The feature importance bar chart derived from the random forest analysis is shown in Figure 4. Each bar represents the importance score of a satisfaction dimension, with longer bars indicating greater influence on training performance. The chart highlights coach support, team atmosphere, and personal achievement as the top three influential factors, collectively forming the core drivers of training performance.

4. Discussion

4.1. Key Findings

This study reveals the specific impacts of different dimensions of athlete satisfaction on training performance, as well as the unique advantages of big data analysis in evaluating athlete performance. Through systematic analysis and validation, the research provides critical theoretical and practical insights for managing athlete satisfaction and enhancing training outcomes. The various dimensions of satisfaction were shown to play significant roles in improving

training performance. Among these, coach support emerged as the most influential factor, directly enhancing athletes' competition performance and psychological well-being through effective guidance, motivation, and emotional support. Team atmosphere also proved to be a critical factor, fostering collaboration and trust among team members, which creates a more stable and supportive training environment. This positive team culture significantly enhances athletes' psychological states and training engagement. Furthermore, personal achievement was highlighted as another key dimension, emphasizing the importance of athletes achieving goals during training and competitions. The study demonstrated that goal-setting and a sense of accomplishment effectively motivate athletes to continuously improve their performance. Additionally, this study showcases the distinct advantages of big data analysis in evaluating athlete performance. Traditional research on satisfaction and performance often relies on questionnaires and basic statistical methods. In contrast, this study integrates big data technology, enabling more precise and comprehensive analysis. Big data techniques efficiently process large-scale datasets and use machine learning algorithms, such as random forests, to identify the satisfaction dimensions that have the greatest impact on performance. This approach not only enhances the scientific rigor of the analysis but also uncovers complex patterns that traditional methods often fail to detect. For instance, feature importance analysis clearly identifies coach support, team atmosphere, and personal achievement as the key contributors to training performance, offering data-driven support for developing personalized training strategies. In summary, this study combines satisfaction dimensions and training performance with the depth of big data analysis to uncover the core factors influencing athlete performance. These findings enrich theoretical research and provide scientific guidance for optimizing athlete management and training practices. Future studies can build on this work by incorporating more dynamic data sources and advanced analytical techniques, offering even more refined support for athlete development.

4.2. Theoretical Significance

This study explores the relationship between athlete satisfaction and training performance, incorporating big data analytical methods to provide new perspectives and contributions to the theoretical frameworks of sports management and sports psychology. By investigating the pathways through which different dimensions of satisfaction influence training performance, the study deepens the understanding of the psychological and behavioral mechanisms of athletes. It fills a theoretical gap regarding how satisfaction affects performance, with dimensions such as coach support, team atmosphere, and personal achievement revealing the critical role of psychological factors in athletic performance. These findings provide empirical support for satisfaction theories in sports psychology. Additionally, the study innovatively integrates big data technology into research on sports management and training performance.

Dynamic monitoring devices and machine learning algorithms enable precise exploration of complex relationships, enhancing the depth of data analysis. This approach not only expands the research boundaries of sports science but also introduces new momentum to the theoretical development of sports management in the era of digitalization and intelligence. The fusion and expansion of these theories enrich the field of sports science and offer inspiration for interdisciplinary research in other social sciences.

4.3. Practical Significance

This study offers specific strategies for improving athlete satisfaction and training performance, with findings that hold significant practical value. The results highlight the critical role of coach support in influencing training performance. Coaches need to optimize their roles by providing clear guidance and psychological support while using motivational mechanisms to boost athletes' confidence and drive. This strategy directly enhances athlete satisfaction and, consequently, their training outcomes. Moreover, team atmosphere was identified as another crucial factor. Building a positive team culture can significantly improve athletes' psychological states and training engagement. In practice, managers should encourage collaboration and communication among team members, establish trust mechanisms, and create an environment of fair competition to strengthen team cohesion and a sense of belonging. A supportive team atmosphere not only enhances individual performance but also improves the overall competitiveness of the team. The study also underscores the importance of personal achievement. Setting clear goals and offering phased achievement rewards can significantly enhance athletes' motivation to train. Managers can implement personalized goal management systems to provide athletes with clear pathways to success while using real-time feedback to help them recognize their progress and value, thereby inspiring greater enthusiasm for training. Finally, the application of big data technology introduces new methods for precise evaluation of training performance. By leveraging dynamic data collected from smart devices, coaches and managers can monitor athletes' training conditions in real time and adjust training plans accordingly. This data-driven, scientific management approach effectively enhances athlete satisfaction and performance, providing robust support for the development of modern competitive sports. The practical significance of this study lies in combining theory and data to provide a scientific foundation for improving athlete satisfaction and optimizing training performance. These strategies are applicable to the management of university sports teams and offer valuable insights for higher-level competitive sports practices.

5. Conclusion

This study explored the relationship between athlete satisfaction and

training performance, incorporating big data analytical techniques to reveal the mechanisms through which various dimensions of satisfaction influence training outcomes. The findings underscore the critical role of athlete satisfaction in enhancing training performance, with dimensions such as coach support, team atmosphere, and personal achievement significantly impacting athletic performance and psychological states. Firstly, the study demonstrated moderate positive correlations between satisfaction dimensions and training performance. Among these, coach support emerged as the most influential factor in improving athlete performance, while team atmosphere and personal achievement contributed to training performance by enhancing psychological stability and intrinsic motivation. These findings further validate the importance of psychological factors in athletic performance, while also expanding the theoretical frameworks of sports management and sports psychology. Secondly, the integration of big data analysis enabled an in-depth exploration of the complex relationship between satisfaction and training performance. The random forest model highlighted the importance ranking of satisfaction dimensions, providing a scientific basis for optimizing athlete management and training strategies. Additionally, the use of dynamic monitoring and machine learning algorithms significantly improved the precision and applicability of data analysis, offering new perspectives for the intelligent development of sports science. Finally, this study proposed practical intervention strategies for improving athlete satisfaction and training performance. By optimizing coaching behavior, fostering positive team culture, and motivating athletes to achieve personal goals, managers can significantly enhance both satisfaction and performance levels. Moreover, data-driven training management systems allow for real-time adjustments to personalized training plans, offering comprehensive support for athlete development. In summary, this study combines theoretical insights with practical applications, enriching the body of knowledge in sports science while offering actionable solutions for enhancing athlete management and training quality. Future research could integrate more sports disciplines and diverse data sources to explore broader application scenarios, driving the multidimensional development of sports science.

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