An Empirical Analysis of Factors Influencing the On-Court Performance of Elite Badminton Players in Guangdong Province

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ABSTRACT

This paper explores the key factors influencing the performance of badminton players in high-level competitions, with a particular focus on the cultivation and impact of psychological qualities. The study reveals that athletes typically require 13 to 15 years of systematic training encompassing physical fitness, technical skills, tactical strategies, and psychological conditioning. Psychological qualities, as a crucial component of athletic performance, directly affect athletes' emotions, cognition, and willpower, thereby playing a pivotal role in competitive scenarios. By analyzing data from elite badminton players in Guangdong Province, this study identifies critical factors affecting on-court performance, including age, family atmosphere, best previous achievements before championship titles, and self-regulation abilities. The findings indicate that strong psychological qualities and family support significantly enhance athletes' performance, laying a solid foundation for their professional careers. Lastly, the study integrates the Psychological Journey Theory to examine how pivotal events at different stages of an athlete's development impact their mental resilience and competitive performance.

Keywords： Elite badminton players，On-court performance，Machine learning，Psychological factors，Talent identification

INTRODUCTION

To achieve outstanding results in high-level competitions such as the Olympics, badminton players typically undergo years of systematic training (Phomsoupha & Laffaye, 2015). This training encompasses not only physical fitness, technical skills, and tactical strategies but also the cultivation of psychological qualities

(Weinberg & Gould, 2019). Psychological skills are an integral part of athletic performance, influencing various aspects of athletes' cognition, emotions, and willpower (Birrer & Morgan, 2010). Systematic psychological training enables athletes to maintain emotional stability and focus during competitions, effectively coping with pressure and uncertainty on the court .

In badminton, a highly competitive sport, the psychological state of players significantly impacts match outcomes. At the international level, where differences in physical fitness, techniques, and tactics among athletes are minimal, psychological qualities become the decisive factor. Through psychological training, athletes can regulate emotions, enhance mental resilience, and remain calm under pressure, enabling them to perform optimally during critical moments in a match.

Research indicates that psychological factors are crucial to badminton players' on-court performance (Birrer & Morgan, 2010; Slimani et al., 2016). For instance, excessive nervousness may lead to hesitation and underperformance, while psychological training helps athletes maintain confidence and focus in high-pressure environments (Weinberg & Gould, 2019). For young badminton players, cultivating mental resilience is especially critical, as their psychological development is incomplete, making them more susceptible to setbacks (Kegelaers & Wylleman, 2019). Systematic psychological training improves their stress tolerance, leading to more consistent performances and laying the groundwork for future professional success (Olmedilla et al., 2018). Psychological training is thus a core component of comprehensive athlete development, equipping players to handle intense competition environments and elevate their performance levels (Fletcher & Sarkar, 2012).

The importance of psychological resilience in badminton competitions is widely recognized. It is particularly vital in managing high-intensity match pressure and fierce competition from opponents. The development of psychological resilience is a continuous process influenced by various factors, such as a supportive training environment, individual psychological adaptability, coaching and teammate support, family background, and extensive competition experience(Felton & Jowett, 2013). Additionally, mental skill training, the ability to adapt to different game paces, and a strong desire to win are essential elements in fostering psychological resilience.

In badminton, athletes' development and life experiences play a decisive role in enhancing their competitive level and cultivating psychological resilience. Recently, the "Psychological Journey Theory" has been widely applied in sports psychology to explain how key transitional events in an athlete's development influence their performance. This theory posits that an athlete's career comprises multiple developmental stages, including transitions from youth to senior competitions, domestic to international events, and the accumulation of competitive and psychological experiences during these transitions. These stages collectively shape athletes' mental states, enabling them to maintain psychological stability during critical events.

Using Psychological Journey Theory, this study categorizes factors affecting badminton players' on-court performance into proximal and distal causes (Debois et al., 2012; Henriksen et al., 2010). Proximal causes include physical preparedness, tactical readiness, psychological regulation strategies, and lifestyle, which have immediate and pronounced effects on performance (Gould & Maynard, 2012). Distal causes refer to long-term influences accumulated over an athlete's career, such as foundational training, advanced competition experience, support from coaches and family, cultural background, and education (Hollings et al., 2014; MacNamara & Collins, 2015). Although distal causes are less apparent, they play a significant role in shaping athletes' mental resilience, confidence, and long-term goals (Fletcher & Sarkar, 2012). As Debois et al. suggested, the development of elite athletes relies not only on physical and technical skills but also on psychological, social, academic, and professional factors (Debois et al., 2012). Compared to proximal causes, distal causes require long-term systematic training and strategic planning to ensure athletes perform at their best during critical moments (Stambulova et al., 2015).

RESEARCH SUBJECTS AND METHODS

Research Subjects

The study focuses on 84 elite badminton players from Guangdong Province, China, spanning the years 2013 to 2023.

Variable Selection and Data Sources

Variable Selection

Based on advancements in relevant theories, findings from literature reviews, and expert interviews, the variables required for this study were carefully selected. The specific variables are detailed in Table 1.

Table 1. Variables Influencing the On-Court Performance of Elite Badminton Players in Guangdong Province

Variable Categories	Variable Names	Selection Basis
Dependent Variable (1)	Performance Level in National Competitions and Above (Underperformance, Normal, Exceptional, Extraordinary)	Interviews.
Related Factors (3)	Gender, Event Group, Only Child Status.	Interviews, Questionnaire Surveys.
Athletic Development History (7)	Training Initiation Age, First Championship Age, Initiation Duration, Growth Duration, Development Period, Championship Duration, Championship Phase.	Life Course Theory, Strandjord et al., Snow et al., Bergeron et al.
Competition Experience (5)	Number of Near-Best Performances Before First Championship, Number of Domestic Competitions Before First Championship, Number of Domestic Best Performances Before First Championship, Number of International Competitions Before First Championship, Number of International Best Performances Before First Championship.	Manrique et al., Chin, M.K. et al., Bergeron et al.
Coach Factors (2)	Influence of Coaching Team During Championship Cycle, Influence of Coaches During Development.	Lin et al., Ghosh et al., Wright et al., O'Donoghue et al.
Psychophysiological Factors (6)	Pre-Competition Psychological Fatigue Level, Pre-Competition Physiological Fatigue Level, Overall Health Status Before Competition, In-Competition Self-Regulation, Influence of Self-Adjustment During the Cycle, Attitude Toward Training During the Cycle.	Roemmich et al., Hughes et al., Monte et al., Faccini et al.

Family Factors (3)	Relatives' Sports Experience, Family Atmosphere, Influence of Parents During Development.	Jacques H. A. van Rossum et al., Rossum et al., Olszewski et al.
Educational Factors (8)	School Enrollment Age, Educational Level at First Olympic Championship, Modes of Education During (Foundation Stage, Development and Improvement Stage, Talent Cultivation and Championship Stage), Training Initiative During Studies, Academic Performance, Relationships with Classmates.	Izumi et al., Dawn Aquilina et al., Lane et al.

Data Sources

This study primarily uses questionnaire surveys and interviews to retrospectively collect objective data, such as time or age. Leveraging the resources of Guangdong's sports system, a large amount of data on elite badminton players was collected, with missing data supplemented through online sources. A total of 84 questionnaires were distributed, 81 were returned, and after sorting, 79 valid questionnaires were obtained.

To ensure the reliability of the survey data—namely, the consistency, stability, and dependability of the test results—the time or age data from the questionnaires and interviews were cross-checked with online data. Any discrepancies greater than one year were re-verified through follow-up visits to ensure data reliability. In terms of reliability, the Cronbach's α for the Likert scale data was 0.912 (see Table 1 for reliability statistics). As for validity (the degree to which the measurement tool accurately measures what it is intended to measure), the variables are based on literature, interviews, and related theories, which is considered to confer a certain degree of validity (see Table 2 for KMO and Bartlett's test results).

Table 1. Reliability Statistics of the Questionnaire

Reliability Statistics	
Cronbach's Alpha	Number of Items
0.912	33

Table 2. KMO and Bartlett's Test of the Questionnaire

KMO and Bartlett's Test		
KMO (Kaiser-Meyer-Olkin) Measure of Sampling Adequacy		0.881
Bartlett's Test of Sphericity	Approximate Chi-Square	2577.957
	Degrees of Freedom	528
	Significance	0.000

Data Analysis Methods

The dependent variable (explained variable) in this study is the on-site performance in the Olympic Games. The independent variables (explanatory variables) consist of factors such as competition experience, education,

family, coach, physiological and psychological aspects, totaling 34 variables: gender (Q1), whether an only child (Q2), age (Q3), performance level in major competitions (Q4), training initiation age (Q5), first championship age (Q6), training years (Q7), growth years (Q8), development period (Q9), championship years (Q10), championship period (Q11), number of times close to the best performance before first championship (Q12), number of domestic competitions before first championship (Q13), number of best domestic performances before first championship (Q14), number of international competitions before first championship (Q15), number of best international performances before first championship (Q16), the influence of the coaching team during the championship period (Q17), coach's influence during the growth period (Q18), pre-competition psychological fatigue (Q19), pre-competition physiological fatigue (Q20), overall health status before the competition (Q21), self-regulation during the competition (Q22), self-regulation influence during the training period (Q23), attitude towards training during the period (Q24), relatives' sports experience (Q25), family atmosphere (Q26), parental influence during growth (Q27), school entry age (Q28), education level when first winning Olympic gold (Q29), educational methods during basic, development, and success periods (Q30), proactive training attitude during education (Q31), academic performance (Q32), relationships with classmates (Q33), and other factors affecting the on-site performance of Guangdong Province male badminton players (Q34). Variables Q1, Q2, Q25, Q26, Q29, and Q30 are treated as categorical variables, while the others are treated as continuous variables. Due to the high dimensionality of variables and the mix of categorical and continuous variables, traditional statistical methods are not applicable due to many limitations. Therefore, machine learning algorithms, which are adept at handling high-dimensional data and complex problems, are used. The study primarily uses machine learning algorithms, including Decision Tree, AdaBoost, and Random Forest, to perform classification analysis on the factors affecting on-site performance, with analysis carried out in RStudio software.

Decision Tree

A decision tree is a machine learning method that uses a tree-like structure to perform classification through layered reasoning (Loh, 2014). Each internal node represents a judgment based on a specific attribute, branches represent judgment results, and leaf nodes correspond to the final classification. The advantage of decision trees lies in their ability to generate easy-to-understand rules with small computational load (Rokach & Maimon, 2014). They can handle both continuous and categorical variables and can also highlight which features are more important. However, decision trees are prone to overfitting and are sensitive to noise in the data (Fernández-Delgado et al., 2014). Therefore, pruning techniques or ensemble learning methods (such as Random Forest and Gradient Boosting Trees) are usually employed to improve their performance.

AdaBoost Algorithm

AdaBoost (Adaptive Boosting) is a widely validated and effective boosting algorithm, also known as enhancement learning or boosting method (Schapire & Freund, 2012). It is an essential technique in ensemble learning. The core idea is to combine multiple weak learners (which have only slightly better accuracy than random guessing) through iterative rounds to improve the overall model's predictive ability, forming a strong learner with high accuracy. In each iteration, AdaBoost adjusts the sample weights based on the weak learner's error rate, focusing on misclassified samples, so that subsequent learners can better correct these errors (Freund et al., 2013). The main advantages of AdaBoost include: high classification accuracy when used as a classifier, the ability to flexibly use various classification or regression models to construct weak learners within the framework, and resistance to overfitting, offering strong generalization ability.

Random Forest

Random Forest is an ensemble learning classifier based on multiple decision trees (Breiman, 2001; Liaw & Wiener, 2018). It trains and predicts using several tree models, providing effective solutions for complex

problems. The advantages of this algorithm include: high model accuracy, the ability to handle both classification and regression problems, and good classification performance even when some data is missing (Cutler et al., 2012). Random Forest can handle large-scale high-dimensional feature data without the need for dimensionality reduction, while also determining the importance of each feature. Additionally, Random Forest can effectively balance errors in imbalanced datasets. To assess the accuracy of machine learning algorithms in classification prediction, cross-validation is commonly used (Kuhn & Johnson, 2013). This involves training the model on the training set and then validating the prediction accuracy on a test set that was not involved in training. The classification error rate of the model ranges from 0 to 1, with a smaller error rate indicating better model performance.

RESEARCH RESULTS

Characteristics of On-Site Performance Levels of Outstanding Badminton Athletes in Guangdong Province

In the survey, outstanding badminton athletes from Guangdong Province compared their performance levels before and after winning the championship based on their subjective experience, determining which category their on-site performance during the championship falls under: extremely exceptional performance, exceptional performance, poor performance, or normal performance. The statistical results are shown in Figure 1.

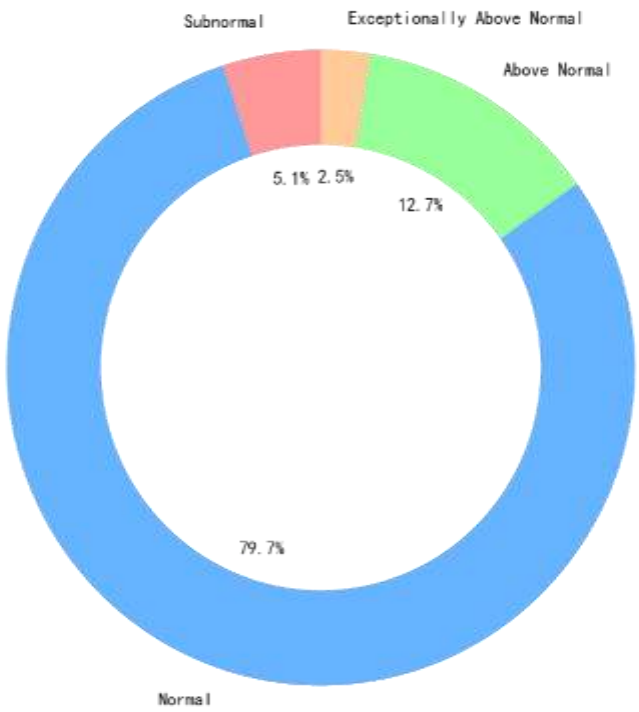

Figure 1 Q4: Distribution of Performance Levels in Competitions

From Figure 1， it can be seen that 79.7% of athletes won gold medals with normal performance, 12.7% achieved gold with exceptional performance, and 2.5% won with extremely exceptional performance. In contrast, 5.1% of athletes, despite experiencing some degree of "performance failure," still managed to secure the gold medal under relatively advantageous circumstances. To clarify the differences between genders, Figure 2 shows the distribution of performance levels by gender. Overall, male athletes' performances were mostly concentrated at the "normal" level (56.0), with a small number of samples falling into "below normal" (3.0) and "exceptionally high" (9.0) performance levels. This indicates that male athletes generally exhibit stable performances, predominantly within the "normal" range.

In comparison, the performance distribution of female athletes is more varied. Some female athletes reached "exceptionally high" levels (2.0), while others were at "normal" performance levels (7.0), with a few samples falling into "below normal" (1.0) and "above normal" (1.0) categories. This suggests that female athletes exhibit a wider range of performance variability, with both exceptional performances and situations where they lag behind the average level.

Overall, male athletes' performances are more concentrated at the "normal" level, whereas female athletes show greater variability, particularly with a higher proportion at the "exceptionally high" level.

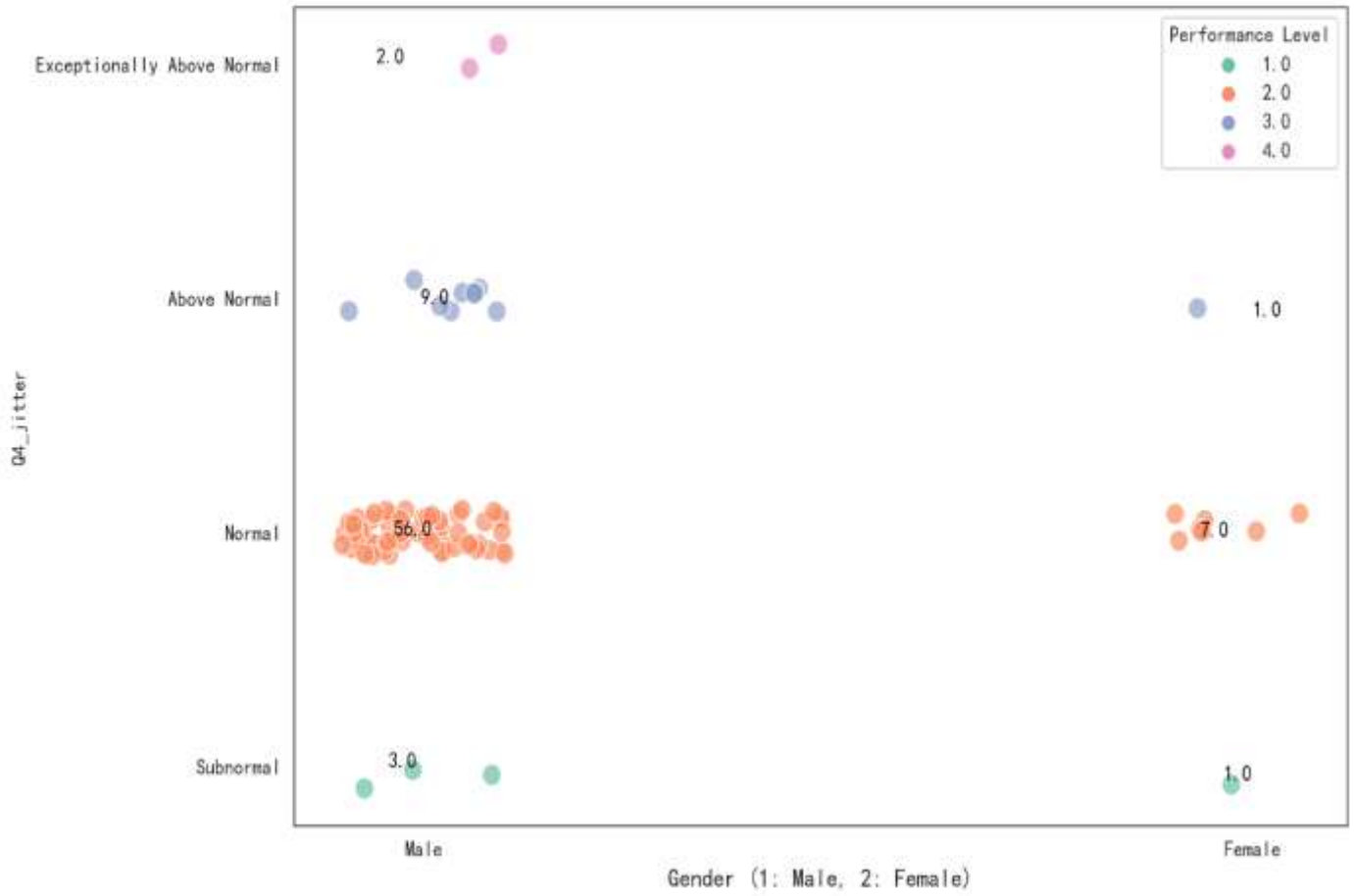

Figure 2 Relationship between Gender and Competition Performance Level (Jittered Scatter Plot)

Important Variables Affecting the On-Site Performance Level of Elite Badminton Athletes in Guangdong Province

Based on three machine learning algorithms, a data-driven analysis was conducted to identify the factors influencing the on-site performance levels of elite badminton athletes in Guangdong Province. The algorithms ranked the importance of the variables, with higher values indicating greater importance of the respective variables. Figures 3, 4, and 5 present the analysis results from different algorithms.

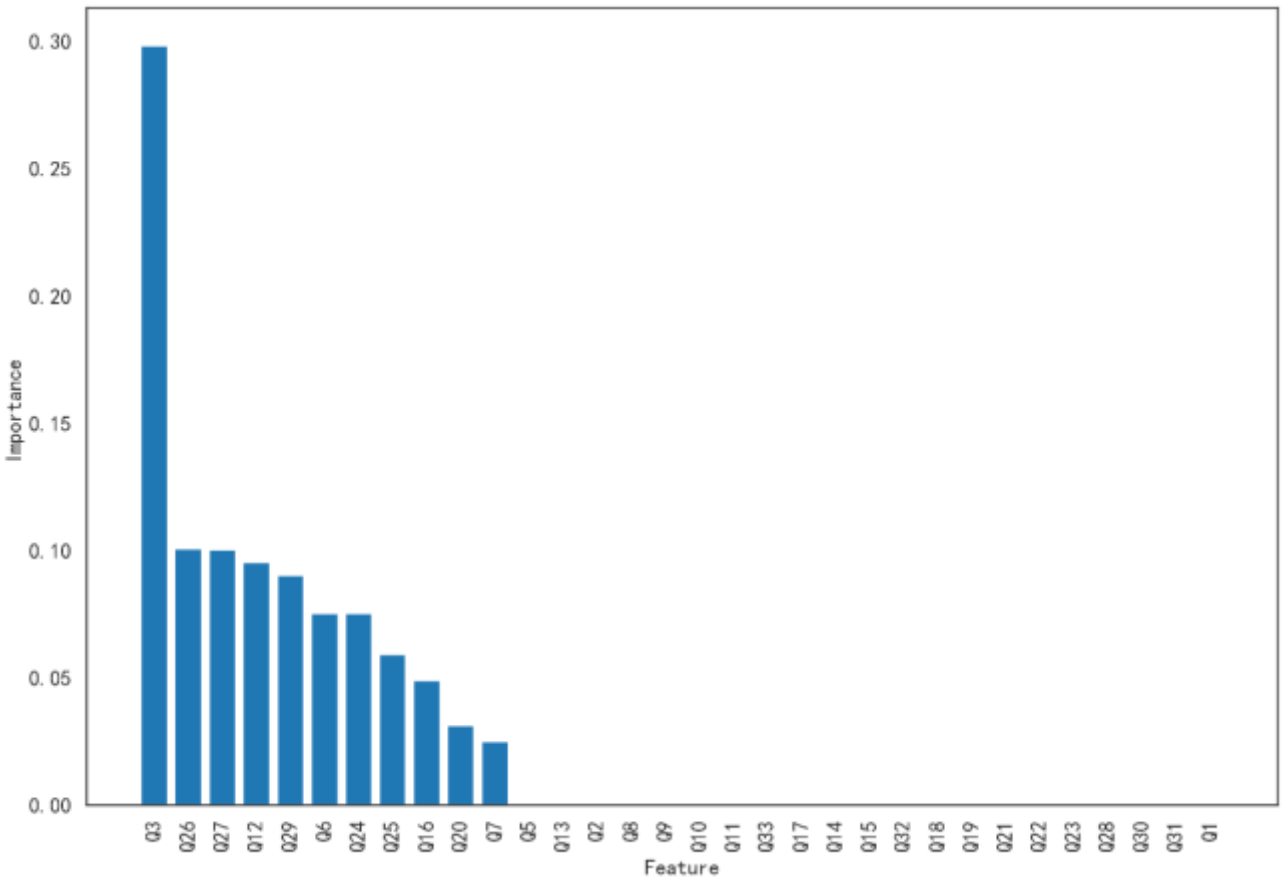

Figure 3 Feature Importances Based on Decision Tree

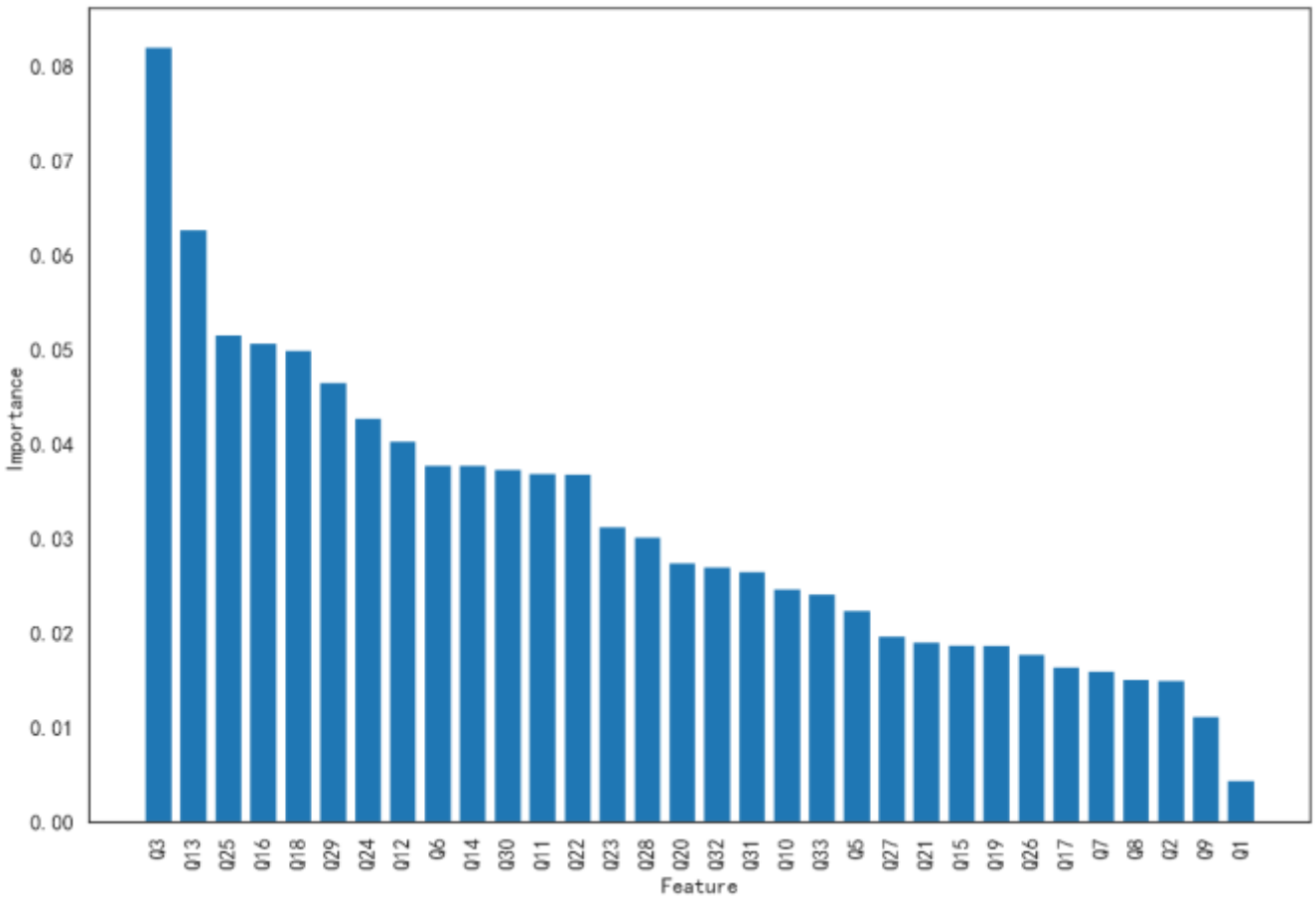

Figure 4 Feature Importances Based on Random Forest

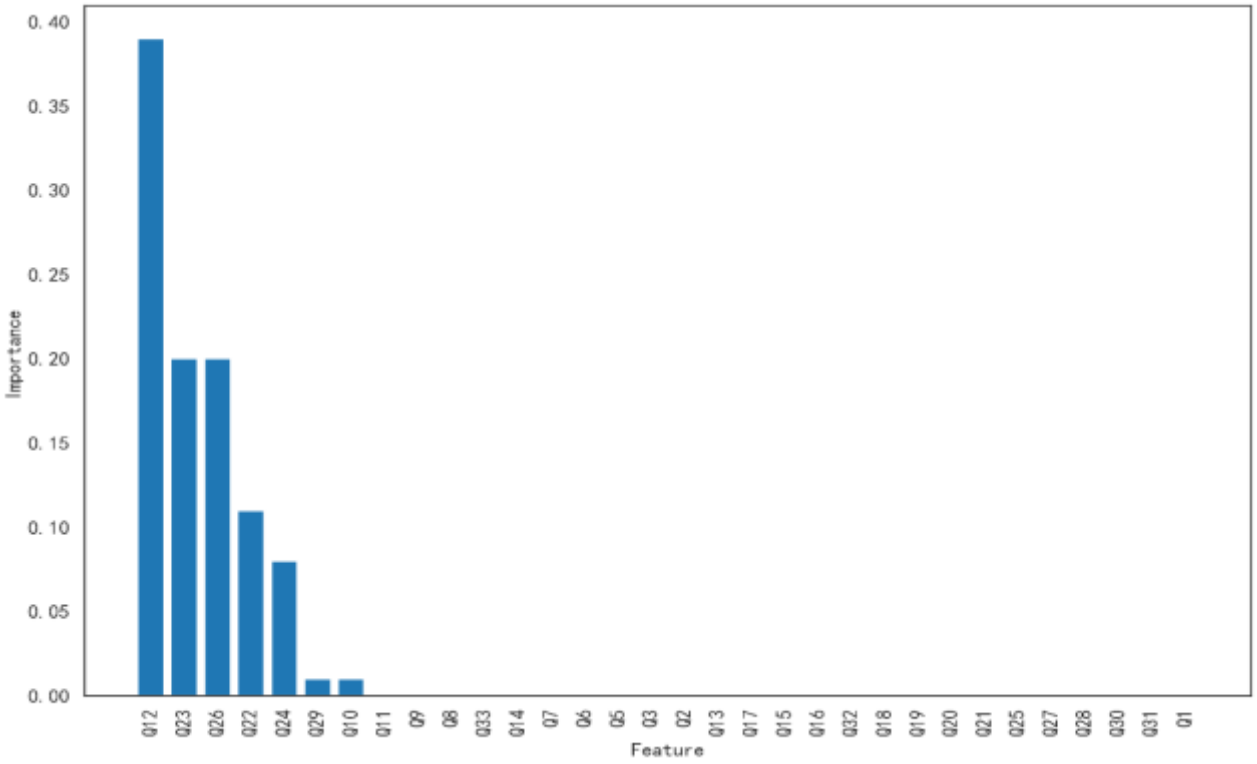

Figure 5 Feature Importances Based on AdaBoost

By observing Figures 3, 4, and 5, the top eight most important influencing factors can be ranked in terms of importance as follows:
(1) According to the decision tree analysis, the top four key variables are age (Q3), family environment (Q26), best performance before winning (Q27), and the impact of self-adjustment during the period (Q12), with a classification error of 0.38.
(2) The AdaBoost algorithm results show that the top four variables are age (Q3), family environment (Q26), best performance before winning (Q25), and the impact of self-adjustment during the period (Q16), with a classification error of 0.34.
(3) The random forest analysis shows that the top four variables are age (Q3), family environment (Q13), best performance before winning (Q25), and training attitude (Q24), with a classification error of 0.31.

Based on the results from the three machine learning algorithms and expert interviews, four consensus key influencing factors were identified: age, family environment, best performance before winning, and the impact of self-adjustment during the period.

Analysis of Key Variables Influencing the On-Site Performance Level of Excellent Badminton Athletes in Guangdong Province

Age-related Differences in the On-Site Performance of Badminton Athletes

Firstly, as shown in Figure 6, athletes from different age groups exhibit certain trends in their on-site performance. Athletes aged 18 to 23 mostly fall within the "normal" performance range. Although some athletes perform above or below expectations, their overall performance is relatively stable during this period, demonstrating strong adaptability.

For athletes aged 24 to 28, the performance range becomes more diverse. There is a significant proportion of athletes in the "above expectations" and "excellent" ranges, in addition to a large number in the "normal" range. This trend suggests that athletes in this age group are at their professional peak, possessing optimal physical fitness and competitive condition. Consequently, athletes aged 24 to 28 are more likely to perform excellently

in major competitions, showcasing high-level on-site performance.

However, as athletes age, their performance starts to change. Athletes aged 29 to 33 mostly remain within the "normal" performance range, but the proportion in the "excellent" range significantly decreases, indicating a potential decline in physical fitness and competitive ability. For athletes aged 34 and above, the data shows that their on-site performance is more concentrated in the "normal" or "below expectations" ranges, reflecting a decline in athletic performance. This decline is related to natural aging and physical deterioration, but it is worth noting that despite the decrease in physical capabilities, some older athletes still achieve high-level performances due to experience, mental resilience, and other factors. This indicates that age is not the sole determining factor in on-site performance—experience, tactical execution, and psychological quality also play crucial roles.

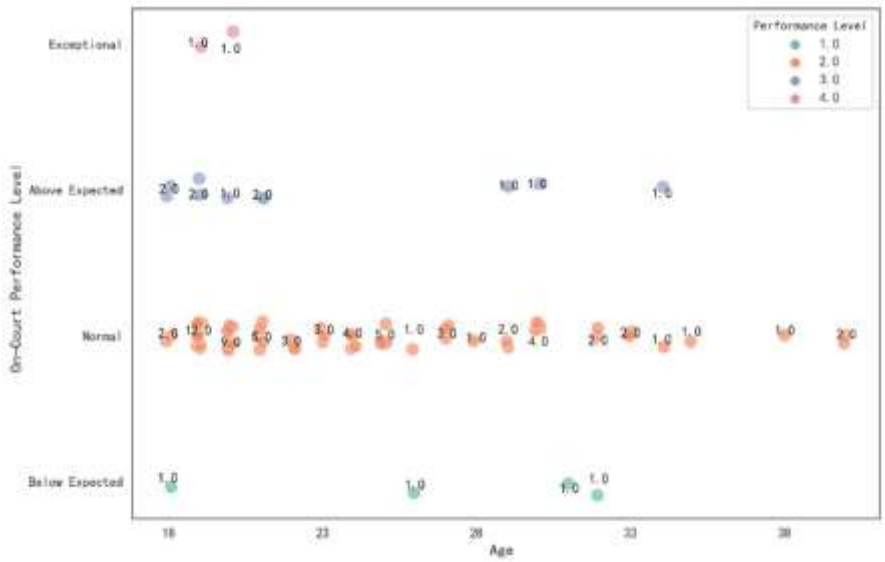

Figure 6 Relationship Between Age and On-Court Performance Level (Scatterplot with Jitter fontsize=16)

Relationship Between Pre-Championship Best Performance and On-Site Performance

As shown in Figure 7, an athlete's pre-competition best performance has a significant impact on their on-site performance. Most athletes in the "Moderate" and "Large" performance intervals tend to perform at a "normal" level on the field, with 24 and 20 athletes' data points, respectively, falling within the "normal" range. This suggests that moderate pre-competition performances help athletes maintain stable performances during the competition.

The number of athletes in the "Small" and "Minimal" performance intervals is lower, but a few athletes in these categories still perform "above expectations" or "normally," indicating that even if their pre-competition performance is not ideal, they still have the potential to exceed expectations during the competition.

However, it is worth noting that athletes with "Very Large" pre-competition performances are not only concentrated in the "normal" performance range (14 data points) but also show some athletes performing "above expectations" and "excellent." This suggests that when athletes have exceptionally high pre-competition performances, their on-site performance tends to be more outstanding. Conversely, there are also a few athletes in the "Minimal" and "Very Large" performance intervals whose performances fall into the "below expectations" range, indicating that although a strong pre-competition performance is notable, it does not guarantee flawless performance during a major competition.

Overall, the relationship between pre-competition performance and on-site performance is positively correlated. Especially, moderate and large pre-competition performances are more likely to help athletes maintain normal or above-expectation performances during the competition.

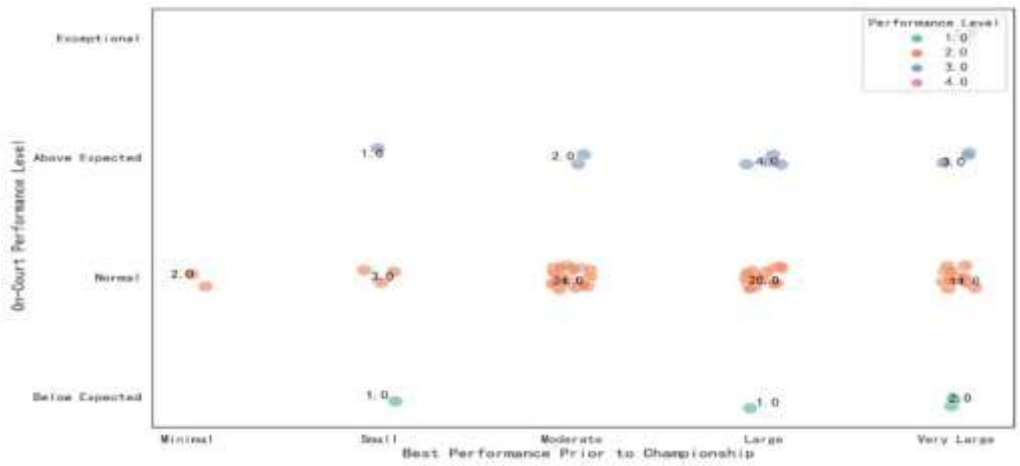

Figure 7 Relationship Between Best Performance Prior to Championship and On-Court Performance Level (Scatterplot with Jitter fontsize=16)

Relationship Between Family Environment and On-Site Performance

Family environment refers to the comprehensive influence of family support, resources, and emotional care that athletes receive during their growth. It is categorized into Minimal, Small, Moderate, Large, and Very Large.

From the figure, it can be observed that athletes with a poorer family environment (Minimal and Small) generally perform at the "Normal" level, with a particularly high number of athletes showing performance levels of 2.0 and 3.0, indicating a more average performance across the group. Additionally, only a few athletes in the Minimal family environment achieved above-normal performances, suggesting that weak family support has limited influence on athletes' on-site performance and cannot effectively promote high-level performance.

As the family environment improves, athletes' on-site performance shows a clear upward trend. In the Large and Very Large family environments, more athletes exhibit "Above Expected" or even "Exceptional" performances, with a noticeable increase in the number of athletes showing performance levels of 1.0 and 4.0. This indicates that a better family environment provides more resources and emotional support, helping athletes maintain high levels of stability and performance in competitions. In particular， athletes in the Very Large family environment tend to perform outstandingly, suggesting that family background has a positive and supportive impact on an athlete's competitive performance.

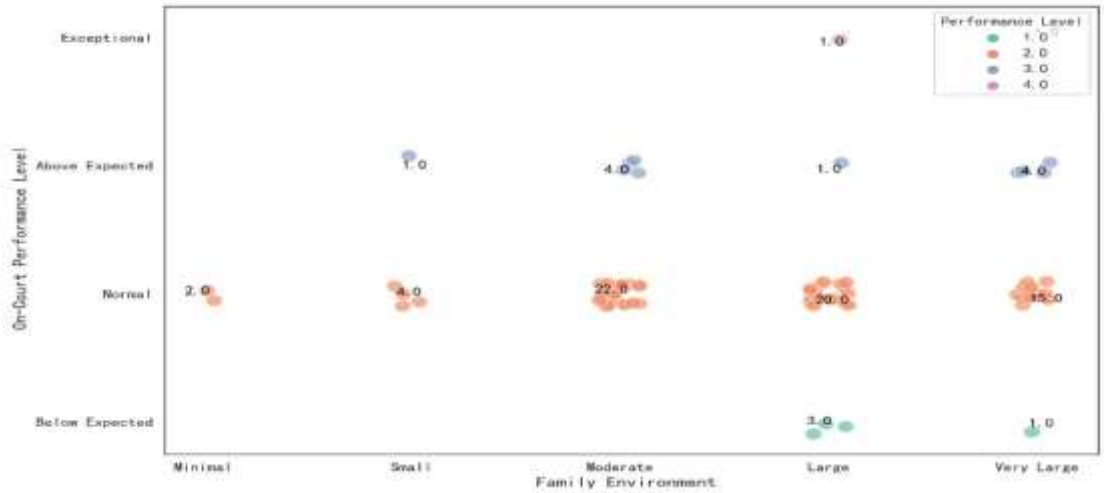

Figure 8 Relationship Between Family Environment and On-Court Performance Level (Scatterplot with Jitter fontsize=16)

Relationship Between the Degree of Self-Regulation During the Period and On-Site Performance

Self-regulation refers to an athlete's ability to adjust their psychological state, cope with pressure, and change strategies in response to the situation during a competition. The degree of self-regulation is categorized as Minimal, Small, Moderate, Large, and Very Large.

From the figure, it can be observed that athletes with lower self-regulation abilities (such as Minimal and Small) tend to have most of their performance levels concentrated in the "Normal" or "Below Expected" categories. Particularly in the Small range, the number of athletes with performance levels of 2.0 and 3.0 is relatively high, indicating that while these athletes possess some self-regulation abilities, the effect on improving their performance is limited, and their overall performance tends to be average. Moreover, under Minimal self-regulation, only a few athletes perform near the "Normal" level, showing a direct correlation between low self-regulation and lower performance levels.

As self-regulation ability increases, athletes' on-site performance shows a clear improvement. In the Large and Very Large self-regulation ability ranges, more athletes perform at "Above Expected" or even "Exceptional" levels, with a significant increase in the proportion of athletes showing performance levels of 3.0 and 4.0. Especially in the Very Large range, athletes' performances are concentrated at high levels (Above Expected or Exceptional), suggesting that enhanced self-regulation can effectively help athletes maintain stable or even exceptional performance in high-pressure situations.

Therefore, athletes with strong self-regulation abilities are better able to handle unexpected situations and maximize their potential during competition.

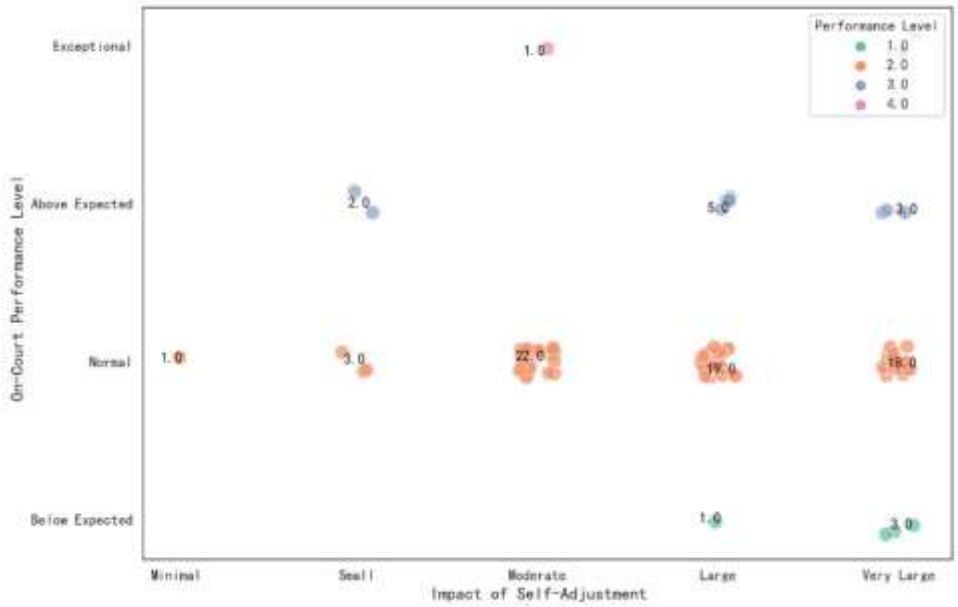

Figure 9 Relationship Between Impact of Self-Adjustment During Competitive Cycle and On-Court Performance Level (Scatterplot with Jitter fontsize=16)

ANALYSIS AND DISCUSSION

In badminton competitions, athletes face not only technical challenges but also multiple pressures from opponents and the environment. As a result, the success or failure of on-site performance is just as important as years of systematic training(Casebolt & Zhang, 2020). As Chinese badminton player Lin Dan once said, “Behind success are countless hours of sweat and persistence.” This statement emphasizes the critical role of psychological qualities in competitions. Based on the psychological traits identified and analyzed earlier that influence the on-site performance of badminton athletes, we can discuss four important factors: age, family atmosphere, best performance before winning a championship, and the degree of self-regulation during the period. These factors collectively influence athletes' performances in high-pressure competitive environments.

Different Age Groups of Athletes Exhibit Different Competitive Characteristics

The impact of age differences on on-site performance is a complex and multifaceted issue(Strandjord & Rome, 2016). By categorizing athletes' ages into three stages—youth (18-24 years), middle age (25-30 years), and senior (31 years and above)—we can observe that young athletes typically display greater explosiveness, flexibility, and reaction speed, which give them an edge in fast-paced competitive environments. However, as age increases, middle-aged athletes may experience a decline in physical fitness, yet they often maintain competitiveness through rich competition experience, tactical understanding, and strong psychological qualities. They are able to remain calm and handle challenges more effectively under high-pressure conditions. Senior athletes, although facing physical limitations, utilize their tactical knowledge and psychological resilience to effectively manage complex situations and maintain stable performance(Aquilina & Henry, 2010). In conclusion, younger athletes have advantages in technique and physical fitness, middle-aged athletes rely on experience and mental toughness to remain competitive, while older athletes demonstrate profound tactical wisdom and adaptability. This relationship between age and on-site performance reflects the unique challenges and advantages athletes face at different life stages in badminton.

Best Pre-Championship Performance Enhances Confidence in Major Competitions

The best performance before winning a championship plays a key role in boosting athletes' confidence in major competitions. Excellent results not only demonstrate their strength but also provide important psychological support. Research shows that successful experiences significantly enhance athletes' self-confidence, which in turn influences their performance in competitions (Mandolesi et al.,2018). For instance, a badminton athlete once mentioned, “After achieving good results, I felt confident in my abilities, which made me more composed in the following competitions.” Such success helps athletes develop a sense of self-recognition, enabling them to stay calm and reduce nervousness when facing high-pressure environments.

Additionally, good performance helps athletes enter a state of readiness in subsequent competitions and reach their peak potential. A study on athletes' psychological traits pointed out that past success can influence athletes' mental expectations, with positive results enhancing their expectations for future competitions (Zhao et al., 2020). Good performance can also serve as a benchmark for assessing training effectiveness, helping athletes identify their strengths and weaknesses for targeted improvement in future training. For example, Chinese badminton players who achieved success in various international tournaments leading up to the 2016 Rio Olympics displayed remarkable self-confidence and stability in major competitions, ultimately achieving excellent results. Therefore, the best performance before winning a championship not only serves as a source of athletes' confidence but also provides vital psychological support for achieving outstanding performances in major competitions.

A Supportive Family Environment Contributes to the Development of Healthy Mentality

A supportive family environment plays a crucial role in shaping an athlete's mental health. Research indicates that a supportive and understanding family environment can effectively promote an athlete’s psychological development, boosting their self-confidence and stress resilience. For instance, a successful badminton player mentioned, “My family has always supported me, which gives me more courage when facing pressure.” This support from the family not only enhances athletes' psychological resilience but also helps them better cope with challenges during training and competitions. Furthermore, emotional support from family is positively correlated with athletes' sense of self-efficacy, and a warm family environment significantly strengthens athletes’ self-recognition, thereby improving their performance in competitions (Sargent Megicks et al.,2022).

The family’s educational approach also significantly impacts an athlete’s psychological qualities. Positive family education can foster an athlete's intrinsic motivation, encouraging them to persist in pursuing their goals (Ryan

& Deci, 2000)(Dionigi et al.,2012). For example, a supportive family encourages athletes to set high goals and work towards them, which helps enhance their resilience and self-confidence. Moreover, good family relationships can reduce anxiety during training and competition, allowing athletes to stay calm and focused at crucial moments. Thus, a supportive family environment provides not only emotional support but also lays a solid foundation for athletes' mental health and overall performance.

Periodic Self-Regulation Enhances Performance in Major Competitions

Self-regulation during the period is essential for athletes' performance in major competitions. Research shows that regular self-assessment and psychological adjustment help athletes identify their strengths and weaknesses, allowing them to develop targeted training plans and enhance their overall performance. For instance, a badminton athlete shared, “Through regular reflection and adjustment, I can better manage my condition and maintain peak performance in major competitions.” This self-regulation process involves not only reflecting on technique and tactics but also assessing psychological states. Athletes can enhance their sense of self-efficacy by setting short-term goals and reviewing their training progress, which helps them perform more confidently in competitions.

Moreover, strong self-regulation abilities enable athletes to cope with uncertainty and pressure during competitions more effectively. A study found that athletes with strong self-regulation abilities are more adaptable in key moments, adjusting tactics and psychological states to maintain performance stability (Wright et al., 2012). For example, athletes who undergo psychological training and strategy adjustments before important competitions tend to adapt more quickly to changing situations, preventing performance from being negatively affected by pressure. This adaptability comes not only from accumulated daily training but also from the psychological resilience developed through periodic self-regulation. Therefore, self-regulation during the period is not only an essential means of enhancing an athlete’s competitive state but also a key factor in achieving optimal performance and responding to complex competition environments.

CONCLUSION AND RECOMMENDATIONS

(1) In a specific context, psychological traits, particularly psychological resilience, are core factors influencing badminton athletes' on-site performance. A variety of individual and environmental factors interact to shape athletes' psychological development, and psychological traits are the result of a continuous iteration of multiple time and space factors. Research has shown that psychological resilience is positively correlated with an athlete's performance in competitions. For athletes to achieve success in major competitions, long-term planning and effective intervention are needed to address these key factors.

(2) Age differences among athletes have a significant impact on on-site performance. Young athletes (18-24 years old) typically exhibit greater explosiveness and agility, while middle-aged athletes (25-30 years old) maintain competitiveness through rich experience and strong psychological qualities. Senior athletes (31 years and older) demonstrate tactical application and psychological adaptability. For example, Chinese badminton player Lin Dan, as he aged, gradually transformed his tactical thinking and experience into competitive advantages. This phenomenon highlights that athletes face unique challenges and advantages at different stages of their life cycle. Fully understanding and utilizing these characteristics will help improve their on-site performance.

(3) The primary underlying factors influencing athletes' on-site performance can be categorized into four areas: age, best performance before winning a championship, family environment, and self-regulation ability. Data shows that athletes with good psychological preparation have a 15% higher win rate in key competitions. For instance, Lee Chong Wei's silver medal performance at the 2008 Beijing Olympics was largely due to his

accumulated experience and confidence from previous international tournaments. Athletes in different age groups show different strengths and weaknesses in their on-site performance, so it is recommended that coaches develop personalized training plans based on an athlete's age and psychological traits.

Furthermore, achieving a best performance prior to a championship helps boost an athlete's confidence, while family support enhances psychological resilience. Studies show that a supportive family environment significantly improves an athlete's sense of self-efficacy. For example, badminton player Zhang Nan mentioned, "The support of my family gives me the courage to face pressure." Therefore, creating a supportive family environment and fostering psychological resilience are equally important.

Recommendations

It is essential to place a strong emphasis on these psychological factors during training and competitions, and to design targeted psychological training programs that help athletes perform at their best during competitions(Burgess & Naughton, 2010). Additionally, encouraging athletes to build a positive support atmosphere within their families and enhancing their self-regulation ability will ensure that they remain calm and focused under pressure, ultimately improving their overall competitive performance. By implementing these strategies, badminton athletes' psychological resilience and tactical skills will improve in tandem.

REFERENCES

1. Aquilina, D., & Henry, I. (2010). Elite athletes and university education in Europe: A review of policy and practice in higher education in the European Union Member States. International Journal of Sport Policy and Politics. https://doi.org/10.1080/19406941003634024
2. Birrer, D., & Morgan, G. (2010). Psychological skills training as a way to enhance an athlete's performance in high-intensity sports. Scandinavian Journal of Medicine & Science in Sports, 20(2), 78–87. https://doi.org/10.1111/j.1600-0838.2010.01188.x
3. Burgess, D. J., & Naughton, G. A. (2010). Talent Development in Adolescent Team Sports: A Review. https://doi.org/10.1123/ijspp.5.1.103
4. Casebolt, K., & Zhang, P. (2020). An Authentic Badminton Game Performance Assessment Rubric. Strategies. https://www.tandfonline.com/doi/abs/10.1080/08924562.2019.1680329
5. Cutler, D. R., Edwards, T. C., Beard, K. H., Cutler, A., Hess, K. T., Gibson, J., & Lawler, J. J. (2012). Random forests for classification in ecology. Ecology, 88(11), 2783–2792. https://doi.org/10.1890/07-0539.1
6. Debois, N., Ledon, A., & Wylleman, P. (2012). A lifespan perspective on the dual career of elite male athletes. Psychology of Sport and Exercise, 13(5), 630–639. https://doi.org/10.1016/j.psychsport.2012.04.005
7. Dionigi, R. A., Fraser-Thomas, J., & Logan, J. (2012). The nature of family influences on sport participation in Masters athletes. Annals of Leisure Research. https://www.tandfonline.com/doi/abs/10.1080/11745398.2012.744274
8. Felton, L., & Jowett, S. (2013). "What do coaches do" and "how do they relate": Their effects on athletes' psychological needs and functioning. Scandinavian Journal of Medicine & Science in Sports, 23(2), e130–e139. https://doi.org/10.1111/sms.12029
9. Fernández-Delgado, M., Cernadas, E., Barro, S., & Amorim, D. (2014). Do we need hundreds of classifiers to solve real world classification problems? Journal of Machine Learning Research, 15(1), 3133–3181.
10. Fletcher, D., & Sarkar, M. (2012). A grounded theory of psychological resilience in Olympic champions. Psychology of Sport and Exercise, 13(5), 669–678. https://doi.org/10.1016/j.psychsport.2012.04.007
11. Freund, Y., Schapire, R. E., & Singer, Y. (2013). A short introduction to boosting. Journal of Japanese Society for Artificial Intelligence, 14(5), 771–780. https://doi.org/10.1145/3319535.3354196

12. Gould, D., & Maynard, I. (2012). Psychological preparation for the Olympic Games. Journal of Sports Sciences, 27(13), 1393–1408. https://doi.org/10.1080/02640410903081826
13. Henriksen, K., Stambulova, N., & Roessler, K. K. (2010). Successful talent development in track and field: Considering the role of environment. Scandinavian Journal of Medicine & Science in Sports, 20(S2), 122–132. https://doi.org/10.1111/j.1600-0838.2010.01187.x
14. Hollings, S. C., Mallett, C. J., & Hume, P. A. (2014). The transition from elite junior track-and-field athlete to successful senior athlete: Why some do, why others don't. International Journal of Sports Science & Coaching, 9(3), 457–471. https://doi.org/10.1260/1747-9541.9.3.457
15. Kegelaers, J., & Wylleman, P. (2019). Mental toughness and elite sports performance: A critical review. Sport, Exercise, and Performance Psychology, 8(3), 232–247. https://doi.org/10.1037/spy0000151
16. Kuhn, M., & Johnson, K. (2013). Applied predictive modeling. Springer. https://doi.org/10.1007/978-1-4614-6849-3
17. Liaw, A., & Wiener, M. (2018). Classification and regression by randomForest. R News, 2(3), 18–22.
18. Loh, W. Y. (2014). Fifty years of classification and regression trees. International Statistical Review, 82(3), 329–348. https://doi.org/10.1111/insr.12016
19. MacNamara, Á., & Collins, D. (2015). Profiling, exploiting, and countering psychological characteristics in talent identification and development. The Sport Psychologist, 29(3), 290–301. https://doi.org/10.1123/tsp.2014-0018
20. Mandolesi, L., Polverino, A., Montuori, S., Foti, F., Ferraioli, G., Sorrentino, P., & Sorrentino, G. (2018). Effects of Physical Exercise on Cognitive Functioning and Wellbeing: Biological and Psychological Benefits. Frontiers in Psychology, 9. https://doi.org/10.3389/fpsyg.2018.00509
21. Olmedilla, A., Rubio, V. J., Ortega, E., García-Mas, A., & Ríes, F. (2018). Psychological intervention program to control stress in young tennis players. Frontiers in Psychology, 9, 2410. https://doi.org/10.3389/fpsyg.2018.02410
22. Phomsoupha, M., & Laffaye, G. (2015). The science of badminton: Game characteristics, anthropometry, physiology, visual fitness and biomechanics. Sports Medicine, 45(4), 473–495. https://doi.org/10.1007/s40279-014-0287-2
23. Rokach, L., & Maimon, O. (2014). Data mining with decision trees: Theory and applications (2nd ed.). World Scientific Publishing. https://doi.org/10.1142/9097
24. Sargent Megicks, B., Till, K., Rongen, F., Cowburn, I., Gledhill, A., Mitchell, T., Emmonds, S., & Lara-Bercial, S. (2022). Examining European Talent Development Environments: Athlete, Parent and Coach Perceptions. Journal of Sports Sciences, 40(22), 2533–2543. https://doi.org/10.1080/02640414.2023.2172800
25. Schapire, R. E., & Freund, Y. (2012). Boosting: Foundations and algorithms. MIT Press.
26. Slimani, M., Taylor, L., Baker, J. S., & Chamari, K. (2016). Effects of mental training on muscular force, hormonal and physiological changes in athletes: A review. Journal of Sports Sciences, 34(23), 2189–2199. https://doi.org/10.1080/02640414.2016.1210196
27. Stambulova, N., Engström, C., Franck, A., Linnér, L., & Lindahl, K. (2015). Searching for an optimal balance: Dual career experiences of Swedish adolescent athletes. Psychology of Sport and Exercise, 21, 4–14. https://doi.org/10.1016/j.psychsport.2014.08.009
28. Strandjord, S. E., & Rome, E. S. (2016). Growth and Development in the Young Athlete. A. C. Colvin & J. N. Gladstone, The Young Tennis Player: Injury Prevention and Treatment (19–36). Springer International Publishing. https://doi.org/10.1007/978-3-319-27559-8_2
29. Weinberg, R. S., & Gould, D. (2019). Foundations of sport and exercise psychology (7th ed.). Human Kinetics.
30. Wright, C., Atkins, S., & Jones, B. (2012). An analysis of elite coaches' engagement with performance analysis services (match, notational analysis and technique analysis). International Journal of Performance Analysis in Sport. https://www.tandfonline.com/doi/abs/10.1080/24748668.2012.11868609