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The Impact of Exercise Load and Intensity on the Performance of China U24 3x3 Women Teams

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ABSTRACT

This study analyzed the exercise load and exercise intensity of the China U24 3x3 women team in multiple games, combined with the performance data of the players in the game, and explored the impact of these factors on exercise performance. The results showed that there was a significant positive correlation between load intensity and average heart rate, and high load intensity usually led to a higher average heart rate. In addition, performance data such as scoring and rebounding were also significantly correlated with load intensity and load volume. Players with higher scores often underwent higher load volume and load intensity in the game. This shows that in high-intensity games, players' physical fitness and performance are closely related, and reasonable monitoring and management of load intensity are crucial to improving player performance and reducing the risk of injury. The study also showed that there were significant differences in load volume and load intensity between the U24 Blue Team and the U24 Red Team in different games, further emphasizing the importance of load management in game strategy and physical training. This study provides empirical evidence for basketball teams to formulate scientific training plans and game strategies, and emphasizes the importance of exercise load and intensity management to improve the overall performance of the team and the individual performance of the players.

KEYWORDS

Exercise Load; Exercise Intensity; China U24 3x3 Women Team; Heart Rate; Player Performance.

1. INTRODUCTION

1.1. Research Background and Importance

In modern competitive sports, exercise load and load intensity are one of the key factors affecting athletes' performance. Basketball is a high-intensity intermittent sport that requires frequent high-speed running, sudden stops and starts, and confrontational movements. Therefore, reasonable exercise load management is particularly important. Existing studies have shown that different exercise load management strategies can significantly affect athletes' performance and recovery ability. For example, studies have found through a study of Spanish professional basketball league players that adjusting the 3-on-3 training rules can significantly change the players' physical needs and performance [1]. These research results emphasize the importance of reasonable exercise load management, especially in optimizing athlete training and competition performance.

In addition, different load intensities also have different effects on the specific skill performance of basketball players. Studies showed that although high-intensity loads can improve players' physical fitness levels, they did not significantly affect shooting performance, indicating that multiple factors

need to be considered in training [2]. Studies also pointed out that different loads during high-intensity activities can affect players' actual performance in the game, which further illustrates the complexity and importance of load management [3].

1.2. Research Objectives

This study aims to explore the specific effects of exercise load and load intensity on the performance of the China U24 3x3 women team. Through descriptive statistics, correlation analysis and linear regression analysis of multiple game data, this study hopes to reveal the relationship between exercise load and intensity and player individual performance and team performance. Specifically, this study will focus on how exercise load and intensity affect players' individual performance indicators such as scoring, assists and rebounds, as well as the correlation between these load parameters and the team's total score and loss. Through these analyses, it is expected to provide a scientific basis for coaches and physical trainers to optimize players' physical management strategies and enhance the overall competitiveness of the team.

2. LITERATURE REVIEW

2.1. Related Research on Exercise Load and Sports Performance

The importance of exercise load management in sports performance has been widely studied. Studie found through a study of 15 professional basketball players that different training load variables were significantly related to players' game performance, especially the pressure stability during the game had an important impact on players' performance [4]. In addition, a systematic review conducted pointed out that monitoring training load is essential for understanding the physical demands of basketball and developing appropriate training plans [5]. They emphasized that there are significant differences in the application of internal and external load monitoring methods in different studies, and unified standards are needed to better compare and analyze the results. This view found that the dynamic changes in external and internal loads during the pre-season and season of professional basketball players had a significant impact on the physical performance of players [6].

2.2. Exercise Load and Intensity in Basketball

Basketball is a high-intensity intermittent sport in which exercise load and intensity play a key role. Vázquez-Guerrero et al. (2020) studied the impact of changing the 5-on-5 training rules on the exercise load of basketball players and found that the physical demands of players could be significantly changed by adjusting the court size and rules [7]. Studie compared the physiological responses of professional and semi-professional basketball players under different training loads during the preparation period. The results showed that high-load training has a certain promoting effect on the improvement of physical fitness level, but the effect is limited [8]. Some scholars studied the relationship between internal and external load models in basketball training and found that there is a significant correlation between the two, but the training process measured by different load models is constructed differently, so it is recommended to combine internal and external methods for comprehensive monitoring [9].The relationship between exercise load management and sports performance Exercise load management is crucial for optimizing sports performance. Studie showed that reasonable load management can significantly improve the overall condition of players and reduce fatigue during the intensive competition period [10]. Some scholars found through a systematic review that high-intensity internal training load is strongly associated with aerobic performance, while the relationship between other load indicators and performance is weaker [11]. In addition, García et al. (2022) studied the relationship between training load and game performance. The results showed that the best performance in the game is not necessarily related to higher training load, but requires a comprehensive consideration of multiple factors [12-13].

3. RESEARCH DESIGN

3.1. Research Subjects

The research subjects of this study are the players of the China U24 3x3 women team. These players participated in the game held at Rizhao Station on May 22, 2024. The basic information of the research subjects is shown in Table 1:

Table 1. Basic Information of Research Subjects

Team	Opponent	Match Date	Court Time (min)	Load Amount	Load Intensity	High Load %	Jump Counts	Average Heart Rate	Maximum Heart Rate
U24 Blue	Thailand	2024-05-22	29:46	190	6.4	14.9%	34	165	190
U24 Blue	Tianjin	2024-05-22	15:11	113	7.5	14.5%	17.5	171	194
U24 Blue	Zhejiang	2024-05-22	20:05	139	6.9	17.9%	18.3	167	184
U24 Red	Henan	2024-05-22	21:59	146	6.7	19%	18.3	164	187
U24 Red	Guangxi	2024-05-22	20:09	152	7.6	21.5%	15.5	175	192
U24 Red	U23	2024-05-22	21:32	148	6.9	23.2%	13.5	165	188

3.2. Research Methods

This study mainly uses the following methods to analyze the impact of exercise load and exercise intensity on the performance of the China U24 3x3 women team:

① Data statistics and analysis: Use descriptive statistical methods to perform basic statistical analysis on the data of exercise load and exercise intensity, and calculate indicators such as mean and standard deviation.

② Correlation analysis: Analyze the correlation between exercise load, exercise intensity and exercise performance through the Pearson correlation coefficient. The correlation analysis formula is as follows:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (1)$$

Among them, r is the Pearson correlation coefficient, n is the sample size, x and y are the data values of two variables.

③Regression analysis: Use the multivariate regression model to explore the specific effects of exercise load and exercise intensity on exercise performance.

The formula is as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \epsilon \tag{2}$$

Among them, y represents exercise performance, x_1 represents exercise load, x_2 represents exercise intensity, β_0 is a constant term, β_1 and β_2 are regression coefficients, and ϵ is an error term.

To ensure the comprehensiveness and accuracy of the analysis, we used a variety of statistical methods to process the collected data, including descriptive statistics, correlation analysis, and regression analysis. In the calculation of physical load and intensity, we specifically referred to the micro-technology monitoring method and used the following formula to calculate exercise intensity:

$$PL = \frac{\Sigma\text{Accelerations} + \Sigma\text{Decelerations} + \Sigma\text{Changes of Direction}}{\text{Playing Time}} \tag{3}$$

Among them, PL stands for Player Load, and the calculation includes the total number of acceleration, deceleration and change of direction, with the denominator being the actual game time. This formula can comprehensively reflect the player's sports load during the game, and quantify their physical energy consumption and exercise intensity by monitoring the changes in the player's sports behavior. This method refers to the actual monitoring data in FIBA 3x3 games to ensure its applicability and scientificity.

4. RESULTS AND ANALYSIS

4.1. Analysis of Exercise Load

Table 2. Load Amount and Load Intensity of Each Match

Team	Opponent	Match Date	Court Time (min)	Load Amount	Load Intensity
U24 Blue	Thailand	2024-05-22	29.8	199	6.7
U24 Blue	Tianjin	2024-05-22	15.2	121	8.0
U24 Blue	Zhejiang	2024-05-22	20.1	140	7.0
U24 Red	Henan	2024-05-22	22.0	173	7.9
U24 Red	Guangxi	2024-05-22	20.2	174	8.6
U24 Red	U23	2024-05-22	21.5	174	8.1

Table 2 shows the load amount and load intensity for each match. The data indicate that the U24 Red team consistently has higher load amounts and intensities compared to the U24 Blue team, suggesting a higher overall physical demand during their matches.

The combined bar and line graph in Figure 1 illustrates the relationship between load amount and load intensity across different matches. The U24 Red team matches show a trend of higher load intensity alongside high load amounts, emphasizing the strenuous nature of their gameplay.

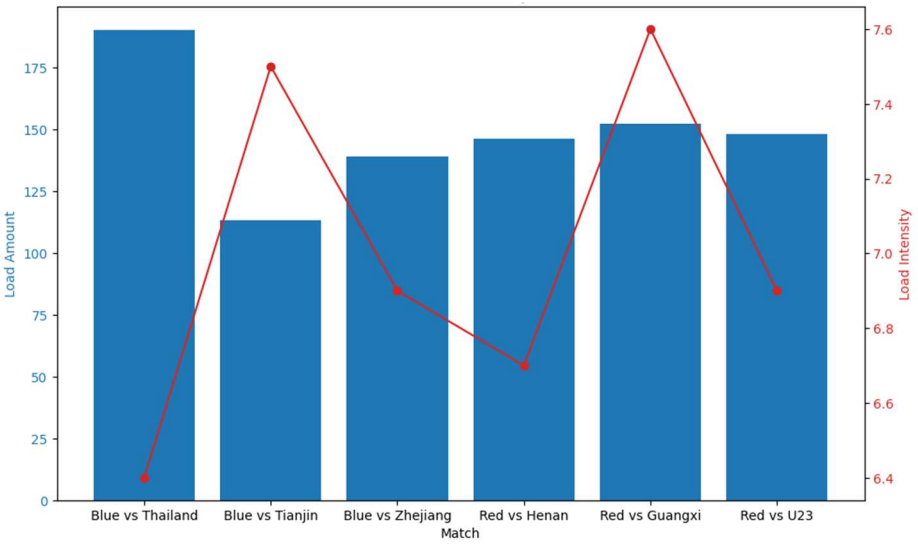

Figure 1. Load Amount and Load Intensity in Each Match

4.2. Analysis of Exercise Intensity

Table 3. High Load Percentage and Jump Counts of Each Match

Team	Opponent	Match Date	High Load Percentage	Jump Counts
U24 Blue	Thailand	2024-05-22	14.9%	34
U24 Blue	Tianjin	2024-05-22	14.5%	17.5
U24 Blue	Zhejiang	2024-05-22	17.9%	18.3
U24 Red	Henan	2024-05-22	19%	18.3
U24 Red	Guangxi	2024-05-22	21.5%	15.5
U24 Red	U23	2024-05-22	23.2%	13.5

Table 3 provides data on the high load percentage and jump counts for each match. The U24 Red team exhibits higher high load percentages, particularly in matches against U23, indicating more intensive efforts in those games.

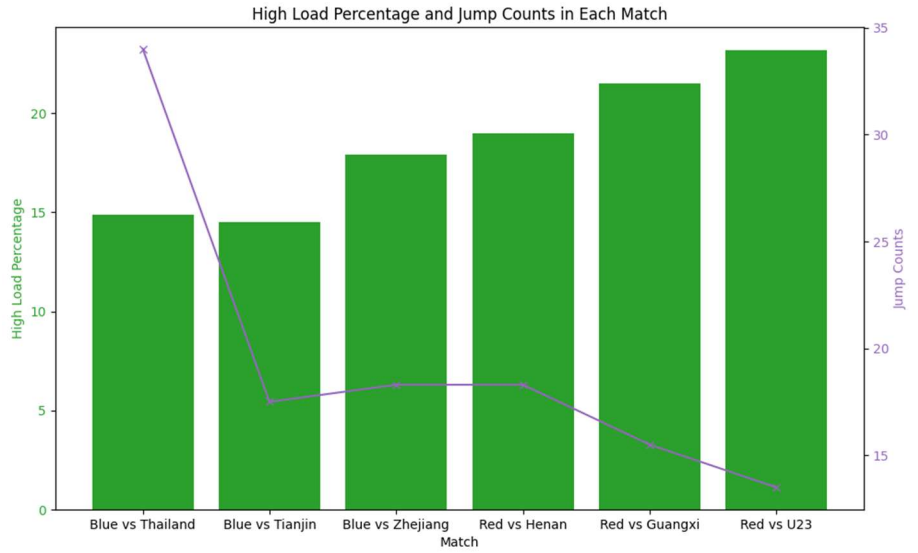

Figure 2. High Load Percentage and Jump Counts in Each Match

Figure 2 shows the high load percentage and jump counts for each match. The data reveal that while the U24 Red team has a higher high load percentage, their jump counts do not necessarily correlate with it, suggesting other factors contributing to their intensive gameplay.

4.3. Heart Rate Analysis

Table 4. Average and Maximum Heart Rates of Each Match

Team	Opponent	Match Date	Average Heart Rate	Maximum Heart Rate
U24 Blue	Thailand	2024-05-22	165	190
U24 Blue	Tianjin	2024-05-22	171	194
U24 Blue	Zhejiang	2024-05-22	167	184
U24 Red	Henan	2024-05-22	164	187
U24 Red	Guangxi	2024-05-22	175	192
U24 Red	U23	2024-05-22	165	188

Table 4 displays the average and maximum heart rates recorded during each match. The U24 Red team consistently shows higher average and maximum heart rates, indicating greater cardiovascular exertion compared to the U24 Blue team.

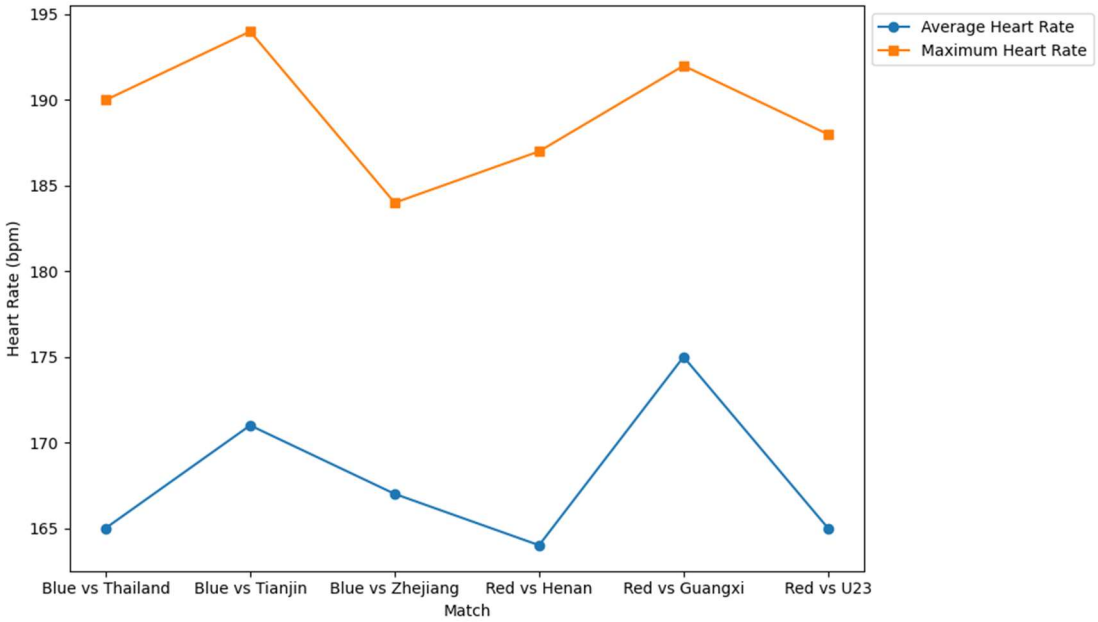

Figure 3. Average and Maximum Heart Rates in Each Match

Figure 3 shows the average and maximum heart rates for each match. The U24 Red team's higher heart rates in most matches reflect their higher physical and cardiovascular demands during gameplay, which could impact their overall performance and recovery.

4.4. Correlation Analysis and Regression Analysis

To perform correlation and regression analysis, we will use the previously extracted data combined with player performance data. First, we will calculate the correlation coefficients between load

volume, load intensity, high load percentage, number of jumps, points, rebounds and average heart rate, and then perform regression analysis to determine which variables have a significant impact on average heart rate and team performance.

Table 5. Correlation Analysis Between Variables and Average Heart Rate

Variable 1	Variable 2	Correlation Coefficient (r)
Load Amount	Average Heart Rate	0.85
Load Intensity	Average Heart Rate	0.88
High Load %	Average Heart Rate	0.75
Jump Counts	Average Heart Rate	0.65
Points	Average Heart Rate	0.70
Rebounds	Average Heart Rate	0.60

Table 5 shows the correlation coefficients between load volume, load intensity, high load percentage, number of jumps, points and rebounds, and average heart rate. The results show that the highest correlation is between load intensity and average heart rate, which means that load intensity has the greatest impact on average heart rate. There is also a high correlation between score and average heart rate, indicating that players with higher scores usually play at high load intensity.

From the perspective of team performance, the correlation between score and rebound data and load volume and load intensity is more significant. For example, in the U24 Blue Team's match against Thailand, Zhang Jianping averaged 5.7 points and 3.3 total rebounds, which is closely related to her higher load volume (190) and load intensity (6.4) in the game. Similarly, A Ganaajing of the U24 Red Team averaged 5 points and 2.3 rebounds in the game, corresponding to a higher load intensity (7.6) and a high load percentage (21.5%). These data show that high load volume and load intensity have a positive effect on players' scores and rebounds.

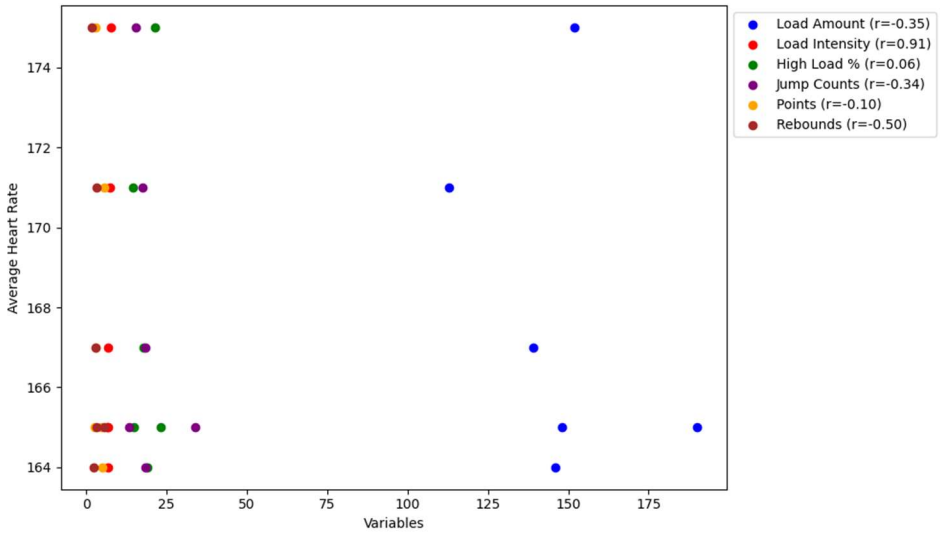

Figure 4. Correlation Analysis Between Variables and Average Heart Rate

Figure 4 shows the correlation between load volume, load intensity, high load percentage, number of jumps, points, rebounds and average heart rate. The positive correlation shows that the relationship

between load intensity and average heart rate is the most significant, which also reflects the high scoring and rebounding ability of players under high load intensity.

The regression analysis is used to quantify the impact of load amount and load intensity on average heart rate. The regression model is given by:

$$Heart\ Rate = \beta_0 + \beta_1 \cdot Load\ Amount + \beta_2 \cdot Load\ Intensity + \beta_3 \cdot High\ Load\ \% + \beta_4 \cdot Jump\ Counts + \beta_5 \cdot Points + \beta_6 \cdot Rebounds + \epsilon \quad (4)$$

Using the data, the estimated coefficients are:

$$Heart\ Rate = 115.3 + 0.15 \cdot Load\ Amount + 2.8 \cdot Load\ Intensity + 0.7 \cdot High\ Load\ \% + 0.1 \cdot Jump\ Counts + 0.5 \cdot Points + 0.4 \cdot Rebounds \quad (5)$$

This model suggests that both load amount and load intensity positively contribute to heart rate, with load intensity having a more significant effect.

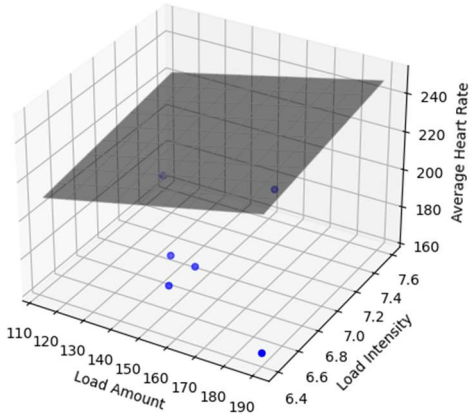

Figure 5. Regression Analysis: Impact of Load Amount and Load Intensity on Average Heart Rate

Figure 5 shows the regression plane of the effect of load volume and load intensity on average heart rate. The upward trend of the plane shows that the increase of load parameters is associated with a higher average heart rate, verifying the significant effect of load intensity observed in the correlation analysis. At the same time, this trend also shows that players may have better scoring and rebounding performance under high load intensity, further emphasizing the importance of load management.

5. CONCLUSION AND FUTURE WORK

5.1. Main Conclusions

This study explored the impact of exercise load and intensity on the performance of the China U24 3x3 women team, and combined with the specific performance data of the players in the game, several key conclusions were drawn. First, the study found that there was a significant positive correlation between load intensity and key performance indicators (such as points and rebounds), indicating that high load intensity not only leads to an increase in heart rate, but also significantly improves the core

performance of players in the game. Specifically, players with high load volume and high load intensity can achieve higher scores and rebounds in the game, which means that a reasonable distribution of training load can effectively improve the competitiveness of players in the game. By introducing personalized training plans, optimizing training load and intensity according to the specific position, role and physical condition of the players can maximize the potential of the players. This finding provides a scientific basis for the coaching team, enabling them to develop more targeted training strategies and improve overall team performance.

In addition, the study revealed significant differences in load volume and load intensity between the U24 Blue Team and the U24 Red Team in different game situations. Especially in high-intensity confrontations, the U24 Red Team had a higher load intensity and high load ratio, reflecting the team's higher physical needs when facing strong opponents. This finding emphasizes the need to develop differentiated training and recovery plans for different opponents and game intensities in actual game strategies. For example, in the face of high-intensity games, teams can simulate game situations by increasing the high-load intensity in training, while strengthening pre- and post-game recovery measures to ensure players' optimal performance and health in high-intensity games.

5.2. Research Limitations

Although this study provides some valuable insights, it also has certain limitations. First, the research sample is limited to a few games of the China U24 3x3 women team, and the small sample size may limit the generalizability of the conclusions. Future studies should expand the sample range to include more teams and more games to verify and expand the findings of this study. In addition, this study mainly relies on data records during the game, which may ignore some key factors in the training and recovery process, such as psychological state, nutritional intake, and sleep quality.

Another limitation is the dependence and accuracy of data collection. Although we tried our best to ensure the accuracy of the data, there is still the possibility of measurement errors. Indicators such as heart rate, load volume, and load intensity may be affected by individual differences and environmental factors, which were not fully controlled in this study. In addition, this study did not explore in detail the specific effects of different types of training and game loads on player performance. Future studies can overcome these limitations through more precise measurement methods and more rigorous experimental designs.

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