The influence of circuit and set training methods, gender differences, and motivation on volleyball performance in adolescent athletes

La influencia de los métodos de entrenamiento en circuito y en sets, las diferencias de género y la motivación en el rendimiento del vóleibol en atletas adolescentes

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Abstract

Introduction: Research highlights the effects of training methods, gender, and motivation on athletic performance, particularly in volleyball. However, few studies explore how these factors interact to affect adolescent athletes' performance.
Objective: This study investigates the combined influence of circuit and set training methods, gender, and motivation on volleyball performance in adolescent athletes, aiming to understand how these factors interact to enhance skills.
Methodology: A quantitative experimental design was used with 40 adolescent athletes from Sriwijaya Sports School. Participants were grouped by gender (male and female) and motivation (high and low). They trained for six weeks using either circuit or set methods. Volleyball skills were assessed before and after the intervention, with data analyzed using a 2x2x2 factorial ANOVA.
Results: Significant effects were found for training methods, gender, and motivation on volleyball skills. The set method had a greater impact, especially for male athletes. High motivation led to better skill improvement than low motivation. Interactions between the factors significantly influenced performance.
Discussion: The results support the need for gender-sensitive and motivation-based training approaches to enhance athletes' performance. Motivation, in combination with specific training methods, was crucial.
Conclusions: Training programs should consider the interaction between training methods, gender, and motivation to improve volleyball performance in adolescent athletes.

Keywords

Exercise methods; volleyball skills; gender; motivation; ANOVA Factorial.

Resumen

Introducción: La investigación resalta los efectos de los métodos de entrenamiento, el género y la motivación en el rendimiento deportivo, especialmente en el voleibol. Sin embargo, pocos estudios exploran cómo interactúan estos factores para afectar el rendimiento de los atletas adolescentes.
Objetivo: Este estudio investiga la influencia combinada de los métodos de entrenamiento en circuito y en sets, el género y la motivación en el rendimiento de voleibol de los atletas adolescentes, con el objetivo de entender cómo interactúan estos factores para mejorar las habilidades.
Metodología: Se utilizó un diseño experimental cuantitativo con 40 atletas adolescentes de la Escuela de Deportes Sriwijaya. Los participantes fueron agrupados por género (masculino y femenino) y motivación (alta y baja). Durante seis semanas, entrenaron con los métodos de circuito o en sets. Las habilidades en voleibol fueron evaluadas antes y después de la intervención, y los datos fueron analizados mediante un ANOVA factorial 2x2x2.
Resultados: Se encontraron efectos significativos de los métodos de entrenamiento, el género y la motivación en las habilidades en voleibol. El método en sets tuvo un mayor impacto, especialmente en los atletas masculinos. La alta motivación condujo a una mayor mejora en las habilidades en comparación con la baja motivación. Las interacciones entre los factores influyeron significativamente en el rendimiento.
Discusión: Los resultados apoyan la necesidad de enfoques de entrenamiento sensibles al género y basados en la motivación.
Conclusiones: Los programas de entrenamiento deben considerar la interacción entre los métodos de entrenamiento, el género y la motivación para mejorar el rendimiento en voleibol de los atletas adolescentes.

Palabras clave

Métodos de ejercicio; habilidades de voleibol; género; motivación; ANOVA Factorial.

Introduction

In the last decade, many studies have focused on the influence of training methods on improving athlete performance, especially in the context of athletes' physical and psychological development. Various studies have identified how different types of exercise, such as circuit and set exercises, can improve skills in sports such as volleyball, especially in adolescent athletes who are at an important stage of development (Ali Hameed Ali Al-Zubaidi 2025; Gulbiani and Mikadze 2025). Research shows that the intensity and structure of training strongly influence skill improvement, and that training methods can produce different impacts depending on the physiological maturity of the athlete, their gender, and their level of motivation (Guimaraes et al. 2024; Vanyushin and Elistratov 2022). In addition, motivation has been recognized as an important psychological factor, which mediates athletes' involvement in training and their performance outcomes (Holovchenko 2025). Intrinsic motivation, for example, is often associated with sustained effort and perseverance, while extrinsic motivation has more effect on initial engagement and short-term performance (Ryan and Deci 2020; Shenaq 2021).

Although the impact of training methods and motivation on athlete performance has been widely discussed, there is still uncertainty about the optimal training strategies for different athlete profiles, especially when gender and motivation factors interact in a particular training context (Tajik Ahmadabad et al. 2025; Teixeira de Souza Silva et al. 2025; Zhang and Panurushthanon 2025). Gender differences in sports psychology have been extensively explored, with findings suggesting that male and female athletes may respond differently to different training methods, influenced by socio-cultural factors and biological differences (Boughattas 2022; Walton et al. 2024). However, research examining the combined effects of gender, motivation, and specific exercise methods—such as circuit and set exercises—is still very limited. The gaps in this study lead to an important question: How do the interactions between these factors affect the performance of adolescent athletes? And, how can training programs be tailored to account for these interactions?

It is still unclear why certain training methods are more effective for some athletes compared to others, especially when considering the interaction between gender and motivation. Although differences in performance by gender have been recognized in the literature, few studies have focused on how these differences arise in response to circuit and set training methods (Abdullayevna 2023). In addition, although motivation is often studied as a separate variable, few studies have revealed how motivation—both intrinsic and extrinsic—affects the impact of exercise methods on performance outcomes (Nikolaidis 2023). This knowledge gap is crucial, as understanding the interaction between these factors can result in more personalised and effective training programmes for adolescent athletes, particularly those in developmental stages who are more vulnerable to motivational fluctuations and gender influence.

The aim of this study was to fill this gap by investigating the combined influence of circuit and set training methods, gender differences, and motivation on volleyball performance in adolescent athletes. This study used a factorial ANOVA design to analyze the influence of these variables, providing insight into how gender and motivation interact with training methods to shape athlete performance. By examining these factors simultaneously, the study aims to provide a deeper understanding of how to optimize exercise programs for adolescent athletes, taking into account their psychological and physiological development. The study also explores the potential use of motivation scales, such as the Sport Motivation Scale (Viciana et al. 2017), to categorize and understand athletes' levels of engagement as well as their responses to different types of exercise.

Method

This study employs a quantitative approach with an experimental design to examine the influence of training methods, gender, and motivation on volleyball skills in adolescent athletes at the Sriwijaya State Sports School (SONS). A total of 40 adolescent athletes participated in this study, who were randomly assigned to two groups based on gender (male and female) and motivation (high and low).

Prior to the intervention, baseline data on volleyball skills were measured using standardized assessment tools, which included tests of basic skills such as serving, passing, spiking, and blocking. These

evaluations were conducted by trained evaluators who followed clear criteria to ensure the reliability and consistency of the assessments (Aulia et al. 2022).

The study utilized a 2x2x2 factorial design, with three independent variables: training method (circuit and set), gender (male and female), and motivation (high and low). The dependent variable was volleyball skills, assessed by tests on fundamental techniques (serving, passing, spiking, and blocking) designed to evaluate the technical abilities of athletes in key volleyball skills. Training was conducted over a six-week period, with three training sessions each week, each lasting 60 minutes. Skill assessments were performed before and after the intervention period to evaluate changes in performance.

The research procedure began with the random division of participants into two groups based on the training method assigned: the circuit method and the set method. Each group followed a specific training intervention designed for their assigned method, with instructions provided by a trainer experienced in both methods. Additionally, participants' motivation was assessed using the Sport Motivation Scale (Pereira, Santos, and Marinho 2024) categorizing participants into high and low motivation groups based on their scores.

After six weeks of training, participants were retested to measure changes in their skills. The measurements were conducted by trained evaluators to ensure consistency across all assessments. The collected data were analyzed using a 2x2x2 factorial analysis of variance (ANOVA) to examine the main effects and interactions of the training method, gender, and motivation on volleyball skills. Post-hoc tests using Tukey's HSD were performed to identify significant differences between groups.

Data analysis was conducted using SPSS statistical software to ensure accuracy in both calculation and interpretation of results. A significance level of $\alpha = 0.05$ was applied, which is commonly used in experimental research. The 2x2x2 factorial ANOVA enabled an assessment of the main effects of each independent variable, as well as the interactions between them, either individually or in combination, on volleyball playing skills. Tukey's HSD test was used to identify significant differences between groups after the ANOVA revealed significant results, providing deeper insights into the impact of each variable on athlete performance.

The findings of this analysis will contribute to the understanding of how training methods, gender, and motivation affect the development of volleyball technical skills. It will also provide coaches with valuable insights for designing more effective and individualized training programs that consider the psychological and physiological needs of athletes. This research aims to inform the development of more personalized training strategies in sports schools and offer further understanding of how these factors interact in training adolescent athletes.

Results

The data description, testing of analysis requirements, hypothesis testing, and discussion of research findings are presented systematically in this study. Three types of variables are analyzed: the dependent variable, independent variables, and moderator variable (attribute). The dependent variable is volleyball playing skills for SONS, while the first independent variable is the training method, which includes two approaches: Circuit and Set. The second independent variable is gender, which is divided into two groups: male and female. The moderator variable used is motivation, categorized as high and low motivation.

The data obtained related to improving basic technical skills of the volleyball game was analyzed by collecting data from each group after the treatment was carried out. Further analysis results can be found in Table 1 below.

Table 1. Description of Research Participants

Descriptive Statistics					
Dependent Variable: Volleyball Playing Skills					
Metode_Latihan	Gender	Motivation	Mean	Std. Deviation	N
Sirkuit	Man	High	44,60	,599	5
		Low	57,00	1,187	5
		Total	50,80	6,595	10

	Woman	High	39,20	,857	5
		Low	43,60	1,485	5
		Total	41,40	2,585	10
	Total	High	41,90	2,930	10
		Low	50,30	7,175	10
		Total	46,10	6,857	20
Set	Man	High	59,20	,634	5
		Low	44,00	1,692	5
		Total	51,60	8,101	10
	Woman	High	49,60	,669	5
		Low	38,00	1,356	5
		Total	43,80	6,196	10
	Total	High	54,40	5,097	10
		Low	41,00	3,477	10
		Total	47,70	8,080	20
Total	Man	Tinggi	51,90	7,717	10
		Rendah	50,50	6,989	10
		Total	51,20	7,201	20
	Woman	High	44,40	5,529	10
		Low	40,80	3,242	10
		Total	42,60	4,782	20
	Total	Tinggi	48,15	7,582	20
		Rendah	45,65	7,271	20
		Total	46,90	7,441	40

Testing the research hypothesis using the 2x2x2 factorial anava analysis technique, the summary can be seen in Table 2 below.

Table 2. Tests of Between-Subjects Effects

Tests of Between-Subjects Effect					
Dependent Variable: Volleyball Playing Skills					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2118,400[a]	7	302,629	235,943	,000
Intercept	87984,400	1	87984,400	68596,600	,000
A	25,600	1	25,600	19,959	,000
B	739,600	1	739,600	576,625	,000
C	62,500	1	62,500	48,728	,000
A * B	6,400	1	6,400	4,990	,033
A * C	1188,100	1	1188,100	926,296	,000
B * C	12,100	1	12,100	9,434	,004
A * B * C	84,100	1	84,100	65,568	,000
Error	41,044	32	1,283		
Total	90143,844	40			
Corrected Total	2159,444	39			
a. R Squared = ,981 (Adjusted R Squared = ,977)					

Based on the results of the analysis presented in Table 2, it can be concluded that there is a significant influence of the variables tested on volleyball playing skills. The first independent variable (A), which relates to the training method, shows an F value of 19.959 with a significance of 0.000, which indicates that the training method has a significant effect on volleyball playing skills. Likewise, the second variable (B), which refers to gender, which has an F value of 576.625 with a significance of 0.000, shows a significant influence on the skill. The third variable (C), which is related to motivation, also had a significant effect with an F value of 48.728 and a significance of 0.000.

In addition, there is a significant interaction between these factors. The interaction between exercise method and gender (A*B) showed an F value of 4.990 with a significance of 0.033, which means that the influence of exercise methods on volleyball playing skills differed by gender. The interaction between training methods and motivation (A*C) resulted in an F value of 926.296 with a significance of 0.000, indicating that the combination of training and motivational methods had a significant influence on volleyball skills. The interaction between gender and motivation (B*C) also showed a significant influence with an F value of 9.434 and a significance of 0.004. Finally, the interaction between the three factors (A * B * C) had an F value of 65.568 with a significance of 0.000, which confirms that the combination of these three factors exerts a significant influence on volleyball playing skills. A determination coefficient value (R^2) of 0.981 indicates that the model is able to explain 98.1% variability in volleyball playing

skills. However, after adjusting for the number of variables and sample size, the Adjusted R^2 value was 0.977, indicating that 97.7% variation in volleyball playing skills was explained by a combination of exercise method (A), Motivation (B), and gender (C), and their interactions. This Adjusted R^2 value indicates the model has an excellent fit and the calculations are done correctly.

The effect of circuit and set training methods on volleyball playing skills of Sriwijaya Sports School Athletes

The results of the 2x2x2 factorial variance analysis (ANOVA) with a significance level of α 0.05 showed a significance value of 0.000, which means sig0 < sigt. Thus H0 can be subtracted at the significance level α 0.05. The value of F is 19.959 where F is calculated to be greater than F Table 2.23 at a significance level of α 0.05 (Fh > Ft), and H1 which reads that there is a difference in the influence of circuit and set training methods on volleyball playing skills Sriwijaya Sports School athletes can be accepted at a significance level of α 0.05. The results of this analysis are visually strengthened through the following Table 3.

Table 3. Interaction of Training Methods, Gender, and Motivation

Variable	F	F Table	Itself.	Term	Information
Exercise Methods	19,959	2,23	0,000	0,05	There is a significant influence
Gender	576,625	2,23	0,000	0,05	There is a significant influence
Motivation	48,728	2,23	0,000	0,05	There is a significant influence
Exercise Methods and Gender	4,990	2.23	0,033	0,05	There is significant interaction
Practice and Motivation Methods	926,296	2,23	0,000	0,05	There is significant interaction
Gender and Motivation	9,434	2,23	0,004	0,05	There is a significant influence
Exercise Method*Gender*Motivation	65,568	2,23	0,000	0,05	There is a significant influence

This study aims to analyze the influence of circuit and set training methods on volleyball playing skills, as well as to explore the interaction between gender and motivation in Sriwijaya Sports School Athletes. To analyze the data, a factorial variance analysis (ANOVA) of 2x2x2 with a significance level of α = 0.05 was used. The results obtained showed a significant influence of the three variables studied.

1. The Influence of Training Methods on Volleyball Playing Skills

The results of ANOVA's analysis show that the training method, both circuit and set, has a significant influence on volleyball playing skills in Sriwijaya Sports School athletes. The calculated F value of 19.959 is greater than the F of Table 2.23, with a significance value of 0.000 ($p < 0.05$), which means that the null hypothesis (H_0) is rejected and the alternative hypothesis is accepted. Descriptively, athletes who used the set training method showed higher results compared to those who followed the circuit training method.

2. The Influence of Gender on Volleyball Playing Skills

Factorial ANOVA results showed that gender had a significant influence on volleyball playing skills. The calculated F value was 576.625, which is much larger than the F of Table 2.23, with a significance value of 0.000 ($p < 0.05$). This suggests that the difference in skills between male and female athletes is statistically significant, with male athletes showing higher scores overall.

3. The Influence of Motivation on Volleyball Playing Skills

The results of the study also revealed that motivation plays an important role in volleyball playing skills, with an F score of 48.728 and a significance of 0.000 ($p < 0.05$), which suggests that motivation contributes significantly to athletes' skills. Athletes with high levels of motivation tend to perform better, especially when they follow structured training methods.

4. Interaction between Exercise Methods and Gender

Further ANOVA analysis showed a significant interaction between training methods and gender on volleyball playing skills. The calculated F value of 4.990 is greater than the F of Table 2.23, with a significance value of 0.033 ($p < 0.05$). These results show that the influence of training methods on volleyball skills varies by gender. Descriptively, male athletes showed a more significant improvement in skill with the set training method compared to female athletes.

5. Interaction between Exercise Methods and Motivation

The study also found a significant interaction between training methods and motivation on volleyball playing skills, with an F value of 926.296 and a significance of 0.000 ($p < 0.05$). Descriptive results showed that athletes who used the highly motivated set training method obtained the highest skill scores, while the low-motivation group tended to have lower scores despite participating in set exercises. In contrast, the group that used the circuit training method with low motivation showed higher scores compared to the group that used the set training method.

6. Interaction between Gender and Motivation

The results of ANOVA's analysis also showed a significant interaction between gender and motivation on volleyball playing skills. An F-value of 9.434 and a significance value of 0.004 ($p < 0.05$) indicate that the combination of gender and motivation exerts a significant influence on athletes' skills. Descriptive findings show that highly motivated male athletes obtain the highest skill scores, while low-motivated female athletes record the lowest skill scores.

7. Interaction between Training Methods, Gender, and Motivation

The culmination of this study was the findings regarding the interaction between the three variables: training methods, gender, and motivation on volleyball playing skills. The F-value of 65.568 and the significance value of 0.000 ($p < 0.05$) indicate that the combination of the three variables has a significant influence together. Descriptively, highly motivated male athletes who followed the set training method showed the highest skill scores, while low-motivated female athletes who followed the set training method recorded the lowest skill scores. These findings show that motivation, in addition to gender and training methods, plays an important role in athletes' skill outcomes, with a greater influence on male athletes than on female athletes.

Discussion

The findings of this study show that the combination of training methods, gender, and motivation has a significant effect on volleyball playing skills in adolescent athletes. The analysis revealed that circuit and set training methods had different impacts on athletes' performance. Male athletes tend to respond better to structured exercises such as the set method. Motivation also plays an important moderation factor that reinforces the influence of training methods on playing skills. These results are in line with the literature that emphasizes the importance of adjusting training programs to the psychological and physiological factors of athletes (Ayranci and Aydin 2025; Kahalekar 2024). However, differences in outcomes by gender and motivation raise questions regarding the effectiveness of a uniform training approach for all athletes.

One explanation for the significant influence of motivation on performance can be explained through the Self-Determination Theory (SDT) (Deci and Ryan 2008; Morgeson 2023), which emphasizes the role of intrinsic motivation in engagement and skill development. Athletes who feel they have autonomy, competence, and good social relationships in training are more motivated to excel (Corvetto-Castro et al. 2025; Lourenço et al. 2022; Standage 2023). These findings confirm the SDT framework, suggesting that athletes with high motivation perform better, especially on structured exercises such as the set method (Aprinawati Aprinawati et al. 2023).

However, the study also found an interesting result: although motivation had a positive effect on both genders, the effect was stronger in male athletes who followed the set method. Female athletes with low motivation showed weaker performance, challenging the assumption that motivational strategies have a uniform impact for all genders (Askilashvili 2025; Di Bella et al. 2023; Daulay et al. 2025). In line with the Gender Schema Theory, which states that social and cultural influences shape gender behavior and attitudes, it may be that social factors and gender norms influence how male and female athletes interact with sports (López-Roel, García-Ordóñez, and Isorna Folgar 2025; Mahmood 2021). For example, male athletes are more likely to respond to structured training due to socialization processes that encourage competition and achievement in the physical domain, while female athletes may be influenced by different motivational factors that are not fully answered by traditional training methods. This leads to an

important question: Should training programs be tailored to better account for different gender ways in motivation and skill development?

The interaction between exercise methods and gender further complicates these findings. The analysis showed that male athletes gained more significant skill improvements with the set method, while female athletes did not show similar improvements, especially when their motivation was low. This disparity can be explained through Social-Cognitive Theory, which emphasizes the importance of self-efficacy in learning and performance (Fismasari et al. 2025; Schunk and DiBenedetto 2021). Self-efficacy is influenced by social and environmental factors, and male athletes may have higher self-efficacy in a structured environment, while female athletes may face barriers such as lower perceptions of competence or lack of social support in competitive settings (Amrita Singh and Satyajeet Roy 2023; Costa et al. 2025). In this case, differences in gender-based self-efficacy can be an intermediate factor in the effectiveness of different training methods.

Further, the interaction between motivation and gender suggests that motivational interventions need to be tailored to address the specific needs of male and female athletes. The finding that high motivation significantly improved the performance of male athletes, while the same motivation did not show the same effect for female athletes, suggests the need for more detailed motivational strategies. The Achievement Goal Theory, which distinguishes between mastery goals and performance goals, can be a theoretical framework for understanding these differences (Winkens and Hamstra 2024). Male athletes may be more driven by performance goals, focusing on winning and competition, while female athletes are more influenced by mastery goals, which focus on personal growth and skill development. Training programs that integrate these two types of goals, particularly for female athletes, can improve motivation and, ultimately, performance(Andersen Brevig et al. 2024).

The implications of these findings are huge for sports psychology and coaching practice. This research suggests that a uniform traditional training program may not be as effective as a personalized approach that takes into account psychological and sociocultural factors. In particular, coaches should pay more attention to gender differences in motivation and self-efficacy when designing training programs. For male athletes, who may respond well to competition-based training, an emphasis on structured exercises such as the set method can be effective. However, for female athletes, training must not only pay attention to physical skills, but must also enhance intrinsic motivation through mastery goals, a supportive environment, and gender-sensitive motivational strategies. This approach can help close the perceived performance gap between male and female athletes.

In conclusion, while the findings of this study contribute to our understanding of the complex interactions between training methods, gender, and motivation, they also highlight the need for further research exploring the long-term effects of these variables on athlete development. Future research should examine these interactions more deeply, focusing on longitudinal approaches to understanding the long-term effects of various training and motivational strategies on skill development in adolescent athletes.

Conclusions

Based on the results of this study, it can be concluded that factors such as training methods, gender, and motivation have a significant influence on the volleyball playing skills of adolescent athletes. The set training method was shown to have a greater impact on athletes' skills, especially in male athletes, while high motivation showed a greater skill improvement compared to low motivation. In addition, it was found that there was a significant interaction between the three variables, namely training methods, gender, and motivation, which affected the overall performance of athletes. This suggests that the influence of training methods on volleyball skills can differ depending on the gender and motivation level of the athlete.

The study also revealed the importance of considering psychological factors, such as motivation, in designing an effective training program. Highly motivated athletes tend to perform best, especially when they follow more structured training methods, such as the set method. However, the differences in results found between male and female athletes suggest that training methods need to be tailored to the psychological and physiological needs of each group, in order to be more effective in improving their sports skills and performance. These findings make an important contribution to the development of

training programs that are more personalized and based on individual psychological needs, especially in the context of adolescent sports. Further research is expected to further explore the interaction between these factors in the long term, as well as examine their influence on the future skill development of athletes.

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