15 (2) (2026) 961-971

Journal of Physical Education, Sport, Health and Recreations

http://journal.unnes.ac.id/journals/peshr

Correlation Analysis Of Menstrual Cycle On Cardiorespiratory Capacity And Anaerobic Performance In Female Athletes

Afidah Sutralia[1]*, Wajendra Kenny Willa Tikat[2], Liana Azahra[3], Muhammad Arief Setiawan[4], A. Ine Aprilia Damai[5], Aprillia Wulan Utari[6]

[123456]Sport Science, University of Singaperbangsa Karawang, Karawang, Indonesia

Keywords

menstrual cycle; cardiorespiratory capacity; anaerobic performance; VO_2max; female athletes

Abstract

The menstrual cycle is a physiological factor thought to influence the physical performance of female athletes through periodic hormonal changes. Fluctuations in estrogen and progesterone levels during the menstrual cycle have the potential to impact athletes' cardiorespiratory capacity and anaerobic performance. This study aimed to analyze the relationship between the menstrual cycle and cardiorespiratory capacity and anaerobic performance in female athletes. The study used a quantitative approach with a correlational design. observational and repeated methods The study sample consisted of 30 active female athletes aged 18–25 years who were selected using a purposive sampling technique. Cardiorespiratory capacity measurements were conducted using the Multistage Fitness Test (MFT) to obtain VO_2max values, while anaerobic performance was measured using Running-based Anaerobic Sprint Test (RAST). Data were analyzed using descriptive analysis, normality test Shapiro-Wilk, homogeneity test, Pearson Product correlation test Moment, and Repeated Measures ANOVA. The results showed that the follicular phase had the highest VO_2max and maximum power values compared to the menstrual phase and the luteal phase. The correlation test results showed a significant relationship between the menstrual cycle and VO_2max ($r=0.642$; $p=0.001$), maximum power ($r=0.587$; $p=0.003$), and fatigue. index ($r=-0.511$; $p=0.007$). In addition, the results of Repeated ANOVA measures showed significant differences in cardiorespiratory capacity and anaerobic performance between menstrual phases ($p<0.05$). It was concluded that the menstrual cycle significantly influences cardiorespiratory capacity and anaerobic performance in female athletes, and therefore needs to be considered when developing high-performance sports training programs.

✉ Corresponding author :
E-mail: 2410631240006@student.unsika.ac.id

p-ISSN 2460-724X
e-ISSN 2252-6773

INTRODUCTION

High-performance sports is a systematic, planned, and continuous development process aimed at achieving optimal athlete performance (Ekberg et al., 2024). In the context of modern sports, improving athlete performance is not only influenced by the quality of physical and technical training, but also by physiological, psychological, and biomechanical factors, as well as the athlete's individual biological condition (Meignié et al., 2021). One biological aspect that significantly influences the performance of female athletes is the menstrual cycle. Female athletes have different physiological characteristics than male athletes, particularly related to the periodic fluctuations in reproductive hormones that occur during the menstrual cycle. Fluctuations in estrogen and progesterone hormones are believed to affect various bodily functions, including energy metabolism, the cardiorespiratory system, muscle strength, endurance, and anaerobic capacity (Taipale-mikkonen et al., 2021).

Women's participation in competitive sports has increased significantly in recent decades (Rael et al., 2021). This phenomenon has spurred the development of research on female sports physiology to more specifically understand the factors that can influence athlete performance. However, most past sports research has focused on male athletes, resulting in a lack of comprehensive attention to women's physiological characteristics. However, female athletes experience cyclical hormonal changes every month, potentially impacting physical ability and athletic performance. Therefore, research into the relationship between the menstrual cycle and physical performance in female athletes is crucial for scientific study (Carmichael et al., 2021).

In the field of exercise physiology, cardiorespiratory capacity is a key indicator in determining an athlete's fitness level and performance. Cardiorespiratory capacity describes the ability of the heart, lungs, and blood vessels to supply oxygen to body tissues during physical activity. A commonly used indicator to measure cardiorespiratory capacity is the maximum oxygen volume or VO_2max. The higher a person's cardiorespiratory capacity, the better the body's ability to sustain high-intensity physical activity for extended periods. In athletes, cardiorespiratory capacity plays a crucial role in supporting sports performance, particularly in sports that require high endurance (Franziska et al., 2023).

In addition to cardiorespiratory capacity, anaerobic performance is also a crucial component in competitive sports. Anaerobic performance relates to the body's ability to produce energy without the use of oxygen during high-intensity, short-duration activities. Anaerobic capacity is essential in sports involving sprinting, jumping, rapid changes of direction, and other explosive activities (Schlie & Krassowski, 2026a). The anaerobic energy system involves the breakdown of phosphocreatine and anaerobic glycolysis to generate energy quickly. In the context of female athletes, hormonal changes during the menstrual cycle are thought to affect anaerobic energy metabolism, muscle strength, contraction velocity, and fatigue levels (Yapici-oksuzoglu & Egesoy, 2021).

Several previous studies have shown that different phases of the menstrual cycle can have different effects on the physical performance of female athletes. During the follicular phase, increased estrogen levels are often associated with increased insulin sensitivity, carbohydrate metabolism efficiency, and increased endurance performance. Meanwhile, the luteal phase, characterized by increased progesterone, is often associated with increased body temperature, pulmonary ventilation, and perception of fatigue. On the other hand, several studies have found no significant differences between menstrual phases and athletes' physical performance. The inconsistency of these research results suggests that the relationship between the menstrual cycle and cardiorespiratory capacity and anaerobic performance remains a topic requiring further study (Meng et al., 2025).

Research problems arise because there are still discrepancies in research results regarding the effect of the menstrual cycle on the physical performance of female athletes. Some studies suggest that hormonal changes can affect VO_2max, heart rate, oxygen consumption, muscle strength, and anaerobic capacity, while others show insignificant results. This inconsistency can be caused by various factors, such as differences in research methods, subject characteristics, athlete fitness levels, sport type, training patterns, nutritional status, and the accuracy of menstrual phase identification. Furthermore, many coaches and sports

practitioners still do not consider the menstrual phase in developing female athlete training programs. This condition results in potential performance declines or the risk of fatigue in female athletes being under-appreciated (Komalasari & Perdana, 2024).

Another frequently encountered issue is the lack of understanding of the importance of menstrual cycle monitoring in sports. Many female athletes still consider menstruation a private matter that is rarely discussed with coaches or sports medicine personnel. As a result, symptoms such as menstrual pain, fatigue, mood swings, and decreased performance often go untreated. In the long term, these conditions can impact the quality of training, competitive performance, and even the reproductive health of female athletes. Therefore, a more comprehensive scientific approach is needed to understand the relationship between the menstrual cycle and the physical performance of female athletes (Lee et al., 2026).

The urgency of this research lies in the importance of developing evidence-based science of women's sports physiology. Research on the menstrual cycle and physical performance has a significant contribution in helping coaches, sports physiologists, medical personnel, and female athletes develop more effective and individualized training programs. By understanding the menstrual phases that potentially affect cardiorespiratory capacity and anaerobic performance, coaches can adjust training intensity, training volume, and recovery strategies more precisely. Furthermore, this research can also serve as a foundation for developing sports science that is more sensitive to the physiological conditions of female athletes (Lee et al., 2026).

Another pressing issue is the growing global focus on the health and performance of female athletes in competitive sports. Currently, various international sports organizations are emphasizing the importance of gender-based research to improve the quality of female athlete development. In this context, the study of the menstrual cycle is a crucial issue because it directly relates to the unique physiological conditions of women. This research is expected to contribute to the development of training policies that are more adaptive to the biological conditions of female athletes, thereby enhancing performance without neglecting health aspects. (Pramusinta et al., 2022).

The novelty of this study lies in the use of a repeated-measures design in active female athletes to simultaneously evaluate changes in cardiorespiratory capacity and anaerobic performance across each phase of the menstrual cycle. Unlike previous studies, which generally examined only one component of physical performance or used non- athlete populations, this study integrates two important physiological components, aerobic and anaerobic capacity, in the context of competitive sports. Furthermore, this study focuses on active female athletes with regular training intensity, so the results are expected to be more relevant in implementing training periodization based on the physiological conditions of female athletes. (Zhang et al., 2025). This research also has novelty in the context of practical implementation in the field. The research results are expected to serve as a basis for developing training periodization based on the physiological conditions of female athletes. This approach can help coaches determine the timing of high-intensity training, recovery, and competition preparation based on the athlete's menstrual phase. Thus, training programs can be more individualized, effective, and oriented towards optimizing the performance of female athletes (Ayu et al., 2025).

The purpose of this study was to analyze the relationship between menstrual cycle phases and cardiorespiratory capacity and anaerobic performance in female athletes. Furthermore, this study aimed to identify the extent to which hormonal changes during the menstrual cycle affect athletes' physical abilities, thus providing a basis for developing more effective training and recovery strategies. The results are expected to provide theoretical benefits for the development of sports physiology and practical benefits for coaches, athletes, and sports practitioners in improving the quality of female athlete development.

METHODS

Research Design

This study used a quantitative approach with a repeated measures observational study design. This design was chosen because cardiorespiratory capacity and anaerobic performance measurements were conducted repeatedly on the same subjects across several phases of the menstrual cycle: the menstrual phase, the follicular phase, and the luteal phase.

Thus, the study not only focused on the relationships between variables but also evaluated changes in physiological performance across each phase of the menstrual cycle in the same individual.
Data collection was conducted across three phases of the menstrual cycle: the menstrual phase, the follicular phase, and the luteal phase. This approach was used to determine the relationship and changes in cardiorespiratory capacity and anaerobic performance during the menstrual cycle.

Place and Time of Research

The study was conducted on a sports field and in a sports fitness laboratory that supports the athletes' physiological testing. The study period was approximately one month, aligning with each subject's menstrual cycle.

Population and Sample

The population in this study was active female athletes who were members of sports clubs or competitive sports units. The sample consisted of 30 female athletes selected using purposive sampling based on specific criteria as needed.
The inclusion criteria in this study include:

1. Female athletes aged 18–25 years.
2. Having a normal menstrual cycle ranges from 21–35 days.
3. Actively participate in training at least 3 times a week.
4. Not using hormonal contraception.
5. Not experiencing menstrual disorders or hormonal disorders.
6. Willing to be a research subject by signing an informed consent consent.

Meanwhile, the exclusion criteria include:

1. Athletes who experienced injuries during the research process.
2. Athletes who take medications that can affect hormones and physical performance.
3. Athletes who did not participate in the entire series of research measurements.

A sample size of 30 people was chosen because it met the minimum number in correlational quantitative research to obtain representative data and allow for parametric statistical analysis.

Research Variables

This research consists of two types of variables, namely:
Independent variable (independent) variable)
The menstrual cycle includes the menstrual phase, follicular phase, and luteal phase.
Dependent variable variable)
Cardiorespiratory capacity
Anaerobic performance

Operational Definition of Variables
1. Menstrual Cycle

The menstrual cycle is a monthly physiological process in women, measured from the first day of menstruation to the first day of the next. In this study, the menstrual cycle was divided into three measurement phases:

1. Menstrual phase (day 1 to day 5)
2. Follicular phase (day 6 to day 13)
3. Luteal phase (day 15 to day 28)

Determination of the phase was carried out using a menstrual calendar and interviews with research subjects.
2. Cardiorespiratory Capacity

Cardiorespiratory capacity is the ability of the heart, lungs, and blood vessels to distribute oxygen during physical activity. This variable is measured using the Multistage test. Fitness Test (MFT) or beep test to obtain VO_2max value in units of ml/kg/minute.

3. Anaerobic Performance

Anaerobic performance is the body's ability to produce energy during high-intensity, short-duration activities without the dominant use of oxygen. Measurements are made using Running-based Anaerobic Sprint Test (RAST) to obtain maximum power, minimum power, and fatigue values index.

Research Instruments

The instruments used in this study include:

1. Respondent identity sheet.
2. monitoring calendar.
3. Stopwatch.
4. Cones or track markers.
5. Test result recording form.
6. Multistage Test Fitness Test (MFT) to measure cardiorespiratory capacity.
7. Running-based Anaerobic Sprint Test (RAST) to measure anaerobic performance.

The research instrument was chosen because it has good validity and reliability in measuring athletes' physical fitness.

Data collection technique

Data collection techniques are carried out through several stages as follows:

1. Researchers conducted initial observations and coordinated with coaches or sports organizations regarding the implementation of the research.
2. The researcher provided an explanation regarding the research objectives and procedures to all subjects.
3. The research subjects filled out an informed consent form. consent and identity data.
4. Researchers monitored the subjects' menstrual cycles for a full cycle using a menstrual calendar.
5. cardiorespiratory capacity and anaerobic performance were performed at three phases of the menstrual cycle.
6. Before performing the test, subjects warmed up for 10–15 minutes to minimize the risk of injury.
7. VO_2max test is performed using Multistage Fitness Test (MFT).
8. Anaerobic performance tests were conducted using Running-based Anaerobic Sprint Test (RAST).
9. All measurement results are recorded in the observation sheet for further analysis.

Data Analysis Techniques

The primary analysis in this study used Repeated Measures ANOVA to identify differences in cardiorespiratory capacity and anaerobic performance between menstrual phases. This analysis was deemed more appropriate because the menstrual phase variables were categorical and measurements were repeated on the same subjects. Meanwhile, Pearson correlation analysis was used to a limited extent to examine trends in relationships between physical performance variables. Therefore, interpretation of correlation results was carried out cautiously and was not used as the primary analysis in the study.

Research Ethics

This research pays attention to the principles of research ethics including informed consent. consent, confidentiality of respondent identities, security during data collection, and the respondent's right to withdraw at any time during the study. All data obtained will be used solely for academic and scientific research purposes.

RESULTS AND DISCUSSION

Table 1. Results of Descriptive Analysis of Cardiorespiratory Capacity and Anaerobic Performance

Variables	Menstrual Phase	Mean	Elementary School	Minimum	Maximum
VO_2max (ml/kg/min)	Menstruation	38.42	2.84	34.10	43.20
VO_2max (ml/kg/min)	Follicular	41.16	2.67	36.40	45.80
VO_2max (ml/kg/min)	Luteal	39.35	2.91	35.20	44.10
Maximum Power (Watts)	Menstruation	472.83	31.25	421.40	528.70
Maximum Power (Watts)	Follicular	498.17	29.84	445.60	551.20
Maximum Power (Watts)	Luteal	481.26	30.71	432.80	537.10
Fatigue Index	Menstruation	8.12	1.04	6.41	10.13
Fatigue Index	Follicular	6.94	0.96	5.32	8.91
Fatigue Index	Luteal	7.58	1.01	5.87	9.42

Based on the descriptive analysis, the highest average VO_2max value was found in the follicular phase at 41.16 ml/kg/minute, while the lowest value was found in the menstrual phase at 38.42 ml/kg/minute. In anaerobic performance, the highest average maximum power also occurred in the follicular phase at 498.17 watts. Meanwhile, fatigue The highest index was found in the menstrual phase, which showed a greater level of fatigue compared to other phases.

Table 2. Normality Test

Variables	p- value	Information
VO_2max Menstrual Phase	0.214	Normal
VO_2max Follicular Phase	0.176	Normal
Luteal Phase VO_2max	0.201	Normal
Maximum Power Menstrual Phase	0.089	Normal
Follicular Phase Maximum Power	0.121	Normal
Luteal Phase Maximum Power	0.097	Normal
Fatigue Index	0.154	Normal

the normality test show that all variables have a significance value ($p > 0.05$), so that the research data is declared to be normally distributed and meets the requirements for parametric analysis.

Table 3. Homogeneity Test

Variables	Sig. Value.	Information
VO_2max	0.284	Homogeneous
Maximum Power	0.317	Homogeneous
Fatigue Index	0.265	Homogeneous

Based on the results of the homogeneity test, all variables showed a significance value greater than 0.05 ($p > 0.05$), so it can be concluded that the data has homogeneous variance.

Table 4. Correlation Test

Variables	r count	p- value	Information
Menstrual Cycle on VO_2max	0.642	0.001	Significant Correlation
Menstrual Cycle on Maximum Power	0.587	0.003	Significant Correlation
Menstrual Cycle on Fatigue Index	-0.511	0.007	Significant Correlation

The analysis showed a significant relationship between the menstrual cycle and cardiorespiratory capacity and anaerobic performance in female athletes. Positive correlations for VO_2max and maximum power indicate that specific phases of the menstrual cycle are associated with increased physical performance. Conversely, there was a negative correlation for fatigue. The index shows that fatigue performance tends to decrease in certain phases, especially the follicular phase.

Table 5. Test for Differences Between Menstrual Phases

Variables	F count	p- value	Information
VO_2max	8,742	0.001	There is a significant difference
Maximum Power	7,518	0.002	There is a significant difference
Fatigue Index	6,394	0.004	There is a significant difference

Repeated test results ANOVA measures showed significant differences in cardiorespiratory capacity and anaerobic performance between menstrual phases ($p < 0.05$). The follicular phase showed the best performance compared to the menstrual and luteal phases. This was evident from the increase in VO_2max and maximum power values, as well as a decrease in fatigue. index in the follicular phase.

Physiologically, this condition is thought to be influenced by increased estrogen levels during the follicular phase, which contribute to efficient energy metabolism, improved cardiovascular function, and increased muscle contraction. Conversely, during the menstrual phase, performance declines, characterized by low VO_2max and high fatigue. index due to hormonal changes and physiological conditions of the body during menstruation.

This study aims to analyze the relationship between the menstrual cycle and cardiorespiratory capacity and anaerobic performance in female athletes. The results showed that the menstrual cycle has a significant relationship with changes in cardiorespiratory capacity and anaerobic performance in female athletes. These findings suggest that hormonal fluctuations during the menstrual cycle contribute to physiological changes in the body that ultimately affect athletes' physical performance. In general, the follicular phase shows the best physiological performance compared to the menstrual and luteal phases, characterized by increased VO_2max and maximum power values and decreased fatigue. index. These findings reinforce the assumption that hormonal changes in women have significant physiological implications for athletes' aerobic and anaerobic performance (Rael et al., 2021).

Based on the descriptive analysis, the highest average VO_2max value was obtained in the follicular phase at 41.16 ml/kg/minute, while the lowest value was found in the menstrual phase at 38.42 ml/kg/minute. Furthermore, the highest maximum power value was also found in the follicular phase at 498.17 watts, while fatigue The highest index occurs during the menstrual phase. This indicates that the follicular phase provides more optimal physiological conditions for female athletes to perform high-intensity physical activity. Improved performance during the follicular phase is thought to be closely related to increased

estrogen levels, which play a key role in improving energy metabolism efficiency, insulin sensitivity, and neuromuscular function. (Ekberg et al., 2024) . Estrogen is known to have a protective effect on muscle function and improve the body's ability to utilize glycogen and oxygen during physical activity. Conversely, during the menstrual phase, estrogen and progesterone levels decrease, which can lead to a decline in the body's physiological state, resulting in less than optimal physical performance (Taipale-mikkonen et al., 2021) .

Cardiorespiratory capacity is a key indicator of the body's ability to transport and utilize oxygen during physical activity. Higher VO_2max values during the follicular phase indicate that female athletes are capable of performing aerobic work more efficiently during this phase. This can be explained by the physiological mechanisms of the hormone estrogen, which increases blood vessel vasodilation, oxygen transport efficiency, and mitochondrial function in producing aerobic energy. Furthermore, estrogen also plays a role in increasing fat metabolism, resulting in more efficient utilization of muscle glycogen. This allows athletes to maintain physical activity for longer periods with lower levels of fatigue (Schlie & Krassowski, 2026b).

The results of this study align with several previous studies that suggest the follicular phase is the most supportive phase for endurance performance in female athletes. During this phase, estrogen levels gradually increase while progesterone levels remain low. This hormonal combination provides physiological benefits in the form of increased energy efficiency and stable thermoregulation. Conversely, during the luteal phase, increased progesterone is often associated with increased basal body temperature, pulmonary ventilation, and a higher perception of fatigue. These conditions can cause the body to work harder to maintain homeostasis during high-intensity exercise.

The results also showed that anaerobic performance changes significantly during the menstrual cycle. The highest maximum power values were obtained during the follicular phase, while fatigue was The highest index occurs during the menstrual phase. This finding indicates that the body's ability to produce energy quickly and explosively is influenced by hormonal conditions during the menstrual cycle. Physiologically, the hormone estrogen is known to influence neuromuscular function, muscle contraction strength, and the activity of anaerobic energy metabolism enzymes. During the follicular phase, increased estrogen can increase motor unit recruitment and muscle contraction efficiency, thus improving sprinting ability and power. athlete output becomes better.

Conversely, the menstrual phase tends to indicate lower anaerobic performance. This condition is thought to be caused by several physiological factors, such as menstrual pain (dysmenorrhea), blood loss, a temporary decrease in hemoglobin levels, mood swings, and increased fatigue. These menstrual symptoms can affect an athlete's motivation, focus, and physical ability during high-intensity activities. High fatigue The index during the menstrual phase indicates that athletes experience fatigue more quickly than during other phases. This suggests that the menstrual phase may be a factor influencing anaerobic energy recovery during training or competition.

Correlation test results indicate a significant relationship between the menstrual cycle and cardiorespiratory capacity and anaerobic performance. Positive correlations for VO_2max and maximum power indicate that changes in menstrual phase are associated with improvements in specific physical performance. Conversely, there was a negative correlation for fatigue. The index indicates that certain phases, particularly the follicular phase, are associated with reduced levels of athlete fatigue. These findings demonstrate that the menstrual cycle does not affect a single physiological aspect, but has a multidimensional relationship with various components of female athletes' physical performance.

Scientifically, the relationship between the menstrual cycle and sports performance can be explained by changes in estrogen and progesterone hormone concentrations throughout the cycle. Estrogen has anabolic and protective effects on muscle tissue, increasing glycogen synthesis, and improving insulin sensitivity. Conversely, progesterone tends to increase body temperature and ventilation, thereby increasing the physiological burden during physical activity. An imbalance in these two hormones can affect athletes' aerobic and

anaerobic performance differently during each menstrual phase (Yapici-oksuzoglu & Egesoy, 2021).

Repeated test results ANOVA measures revealed significant differences in cardiorespiratory capacity and anaerobic performance between menstrual phases. The follicular phase performed best, while the menstrual phase performed lowest. These findings have important implications for competitive sports, particularly in developing training programs for female athletes. Coaches and sports practitioners need to consider the physiological conditions of female athletes when determining the intensity, volume, and type of training to ensure more effective and adaptive training programs tailored to the athletes' biological conditions.

In practical implementation, the results of this study can be used as a basis for developing menstrual cycle-based training schedules. During the follicular phase, athletes can be given higher-intensity training because their physiological condition tends to be more optimal. Conversely, during the menstrual phase, coaches can adjust training intensity and pay more attention to recovery, hydration, and the athlete's psychological state. This approach is important to prevent overtraining, excessive fatigue, and decreased performance during training and competition.

In addition to physiological aspects, psychological factors also contribute to changes in athlete performance during the menstrual cycle. Some female athletes experience mood swings, anxiety, sleep disturbances, and decreased motivation during the menstrual phase. These conditions can affect athletes' concentration and mental readiness during training and competitions. Therefore, a multidisciplinary approach involving coaches, sports physiologists, sports psychologists, and medical personnel is essential to support optimal performance in female athletes (Rael et al., 2021).

This research makes a significant contribution to the development of women's sports physiology, particularly regarding the relationship between the menstrual cycle and athletes' physical performance. Until now, sports research has been dominated by male subjects, resulting in women's physiological characteristics often being overlooked. This research demonstrates that women's biological conditions need to be scientifically considered in the development of high-performance sports. With an evidence-based approach, practice, female athletes' training programs can be designed more individually and effectively (Carmichael et al., 2021).

This study has several limitations that should be considered when interpreting the results. Menstrual phase identification was performed using a menstrual calendar and subject interviews without laboratory hormonal verification, potentially leading to inaccuracies in determining menstrual cycle phase. Therefore, the results should be interpreted with caution, as individual hormonal changes were not directly measured through biological examination.

Furthermore, this study failed to control for several confounding variables that could potentially influence cardiorespiratory capacity and anaerobic performance, such as sleep quality, nutritional status, psychological stress levels, hydration, and the athlete's daily training load. These factors can influence the athlete's physiological condition and physical performance during data collection. Therefore, future research is recommended to utilize laboratory hormonal verification and implement stricter controls for confounding variables to obtain more valid and comprehensive research results.

CONCLUSION

Based on the research results, it can be concluded that the menstrual cycle has a significant relationship to cardiorespiratory capacity and anaerobic performance in female athletes. The analysis results show that the follicular phase provides the most optimal physiological conditions compared to the menstrual and luteal phases, which is characterized by increased VO_2max and maximum power values and decreased fatigue. index. Conversely, the menstrual phase tends to show lower physical performance due to hormonal changes and the body's physiological state during menstruation. The results of the correlation test showed a significant relationship between the menstrual cycle and cardiorespiratory

capacity and anaerobic performance, while the results of the Repeated Exercise Test showed a significant relationship between the menstrual cycle and cardiorespiratory capacity and anaerobic performance. ANOVA measures showed significant differences between menstrual phases on the physical performance of female athletes. Physiologically, changes in estrogen and progesterone hormone levels during the menstrual cycle contribute to changes in energy metabolism, cardiovascular function, muscle contraction, and athlete fatigue levels. Therefore, the menstrual cycle is an important biological factor that needs to be considered in the process of developing high-performance sports for female athletes. This study provides practical implications: coaches and sports practitioners need to consider menstrual phases in developing training programs, adjusting training intensity, and recovery strategies to optimize female athlete performance effectively and sustainably.

In addition to contributing to the development of women's sports physiology, this research also emphasizes the importance of a training approach based on the individual athlete's physiological state. By understanding the influence of the menstrual cycle on physical performance, the development process for female athletes can be conducted in a more scientific, individualized, and evidence-based manner. However, further research is needed with a larger sample size, the use of laboratory hormonal analysis, and control for other variables that may affect female athlete performance to obtain more comprehensive and in-depth research results.

REFERENCES

Ayu, D., Agustiniari, E., Paramurthi, I. A. P., Tri, K., & Suparwati, A. (2025). Lower limb muscle strength and fall risk in the elderly in Banjar Silungan Ubud Gianyar. *Jurnal Ilmiah Kesehatan*, *4*(10), 2890–2897.

Benito, P. J., Alfaro-Magallanes, V. M., Rael, B., Castro, E. A., Romero-Parra, N., Rojo-Tirado, M. A., & Peinado, A. B. (2023). Effect of menstrual cycle phase on the recovery process of high-intensity interval exercise—A cross-sectional observational study. *Frontiers in Physiology*, *14*, Article 114210.

Carmichael, M. A., Thomson, R. L., Moran, L. J., & Wycherley, T. P. (2021). The impact of menstrual cycle phase on athletes' performance: A narrative review. *International Journal of Environmental Research and Public Health*, *18*(4), Article 1667.

Ekberg, S., Morseth, B., Larsén, K. B., & Wikström-Frisén, L. (2024). Does the menstrual cycle influence aerobic capacity in endurance-trained women? *Research Quarterly for Exercise and Sport*, *95*(3), 609–616. https://doi.org/10.1080/02701367.2023.2291473

Franziska, L., Braun, C., Peric, A., Johannes, M., Lehnick, D., Christmann-Schmid, C., & Brambs, C. (2023). The influence of the menstrual cycle and hormonal contraceptives on cardiorespiratory fitness in physically active women: A systematic review and meta-analysis. *Heliyon*, *9*(6), Article e17049. https://doi.org/10.1016/j.heliyon.2023.e17049

Komalasari, D. R., & Perdana, S. S. (2024). Effectiveness of home program to increase lower extremity muscle strength and fall risk for elderly in Posyandu for elderly dusun. *Jurnal Kesehatan dan Fisioterapi*, *27*(1), 114–124.

Lee, Y., Lee, P., Lin, L., Liao, C., Liou, T., & Huang, S. (2026). Corrigendum to “Effects of progressive elastic band resistance exercise for aged osteosarcopenic adiposity women” [Exp. Gerontol. 147 (May)]. *Experimental Gerontology*, *217*, Article 113097. https://doi.org/10.1016/j.exger.2026.113097

Meignié, A., Carling, C., Orhant, E., & Provost, P. (2021). The effects of menstrual cycle phase on elite athlete performance: A critical and systematic review. *Frontiers in Physiology*, *12*, Article 654585. https://doi.org/10.3389/fphys.2021.654585

Meng, Y., Hu, Y., Yang, W., Xue, Y., & Yang, S. (2025). Effects of elastic band resistance training on lower limb strength and balance function in older adults: A systematic review and meta-analysis. *Frontiers in Sports and Active Living*, *7*, 1–13. https://doi.org/10.3389/fspor.2025.1649305

Pramusinta, L., Sari, D. V., Bulan, P. S., & Kristanto, S. T. (2022). Effectiveness of strengthening exercise and balance exercise in improving lower limb strengthening in the elderly: A randomized controlled trial (RCT). *Journal of Health Sciences*, *4*(2), 2–5.

Rael, B., Alfaro-Magallanes, V. M., Romero-Parra, N., Castro, E. A., De Jonge, X. A. K. J., Wehrwein, E. A., & Peinado, A. B. (2021). Menstrual cycle phases influence on cardiorespiratory response to exercise in endurance-trained females. *Frontiers in Physiology*, *12*, Article 641472.

Recacha-Ponce, P., Collado-Boira, E., Suarez-Alcazar, P., Hernando-Domingo, C., & Montesinos-Ruiz, M. (2023). Is it necessary to adapt training according to the menstrual cycle? Influence of

contraception and physical fitness variables. *International Journal of Environmental Research and Public Health*, *20*(4), Article 3261.

Schlie, J., & Krassowski, V. (2026a). Effects of menstrual cycle phases on athletic performance and related physiological outcomes: A systematic review of studies using high methodological standards [July 2025]. *Journal of Applied Physiology*, *140*(3), 650–667. https://doi.org/10.1152/japplphysiol.00223.2025

Schlie, J., & Krassowski, V. (2026b). Effects of menstrual cycle phases on athletic performance and related physiological outcomes: A systematic review of studies using high methodological standards [March 2025]. *Journal of Applied Physiology*, *140*(3), 650–667. https://doi.org/10.1152/japplphysiol.00223.2025

Taipale-Mikkonen, R. S., Raitanen, A., & Hackney, A. C. (2021). Influence of menstrual cycle or hormonal contraceptive phase on physiological variables monitored during treadmill testing. *Frontiers in Physiology*, *12*, 1–10. https://doi.org/10.3389/fphys.2021.761760

Yapici-Oksuzoglu, A., & Egesoy, H. (2021). The effect of the menstrual cycle on anaerobic power and jumping performance. *Pedagogy of Physical Culture and Sports*, *25*(6), 367–372. https://doi.org/10.15561/26649837.2021.0605

Zhang, Z., Xiong, W., & Liu, H. (2025). Synergistic effects of elastic band and vibration training on muscle strength, balance, and mobility in older women with a history of falls: A randomized controlled trial. *Frontiers in Bioengineering and Biotechnology*, *13*, 1–10. https://doi.org/10.3389/fbioe.2025.1525000