New Approaches in Exercise Physiology (NAEP)
Vol. 6, No.11, June 2024
www.nass.atu.ac.ir
DOI: 10.22054/nass.2025.85300.1173

ATU PRESS

The Impact of Premenstrual Syndrome (PMS) on Athletic Performance in Female Combat Athletes

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Original Research
Received: March 16, 2024 Accepted: April 10, 2024

Abstract

Purpose: This study aimed to investigate the effect of PMS on aerobic, anaerobic, and cognitive performance in female combat athletes. **Method:** In this semi-experimental study with a repeated measures design, 20 female combat athletes (mean age: 24.5±2.1 years) were assessed during two phases of their menstrual cycle: the PMS phase (7-10 days before menstruation) and the non-PMS phase (days 7-14 of the cycle). Aerobic performance was measured using the Bruce treadmill test, anaerobic performance was assessed by the Wingate test, and cognitive performance was evaluated through simple and choice reaction time tests. Statistical analyses were performed using paired t-tests and Pearson correlation ($p<0.05$). **Results:** The findings showed a significant reduction in VO_2 max (6.2%), time to exhaustion, and a significant increase in maximal heart rate and Rate of Perceived Exertion (RPE) during the PMS phase compared to the non-PMS phase ($p<0.05$). Anaerobic performance also declined, with a reduction in peak power (6.2%) and mean power (7.5%), an increase in fatigue index (16.2%), and lower blood lactate levels ($p<0.01$). Cognitive

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How to Cite: Yarahmadi, Y., Tayebi, S.M,. (2024). The Impact of Premenstrual Syndrome (PMS) on Athletic Performance in Female Combat Athletes, *Journal of New Approaches in Exercise Physiology*, 6(11),125-150.
DOI: 10.22054/nass.2025.85300.1173

performance deteriorated during PMS, demonstrated by increased simple (16.7%) and choice (16.6%) reaction times, more errors, and decreased accuracy ($p<0.01$). Furthermore, there was a significant positive correlation between PMS symptom severity and VO_2 max reduction ($r=0.72$), as well as between blood lactate levels and reaction time ($r=0.65$) ($p<0.01$). **Conclusion:** PMS negatively affects aerobic, anaerobic, and cognitive performance in female combat athletes. These findings highlight the importance of considering the menstrual cycle phases in designing training and competition schedules for female athletes to optimize performance and prevent potential declines associated with PMS.

Keywords: Premenstrual Syndrome, PMS, Martial Arts, Female Athletes, Athletic Performance, Hormonal Fluctuations.

Introduction

Premenstrual Syndrome (PMS) involves various physical, psychological, and behavioral symptoms which usually manifest during the final week of the menstrual cycle before disappearing at the start of menstruation(Foster et al., 2019). Around 80% of women who can reproduce experience this syndrome with individual severity levels ranging widely(Yonkers, O'Brien, & Eriksson, 2008). Female athletes who practice martial arts experience stronger effects from PMS because their performance relies heavily on synchronized physiological and psychological systems(RAPKIN et al., 1997). The primary way PMS affects athletic performance comes from physiological changes that occur due to hormonal fluctuations between estrogen and progesterone levels(Prado, Willett, Takito, & Hackney, 2023). The physiological changes impact energy metabolism together with cardiovascular and muscular system functions as well as psychological indicators(Rapkin & Akopians, 2012). Blood lactate stands out as the primary marker for evaluating both the body's response to intense physical exercise and its recovery process afterwards. Muscles produce lactate as a result of anaerobic glucose metabolism which gets affected by hormonal changes that also influence its production and clearance rates. Research demonstrates that the luteal menstrual phase causes decreased carbohydrate utilization alongside increased progesterone levels resulting in the body relying more heavily on fat metabolism(Abdollahpor, Khosravi, & Nobakht Ramezani, 2013). The body experiences a modified lactate threshold and a decreased ability to eliminate lactate from the bloodstream. As a result of these changes the body experiences quicker lactate buildup while endurance during high-intensity exercise becomes shorter(Forsyth & Reilly, 2005). High-intensity activities like martial arts training and competitions may cause athletes to experience premature fatigue from this metabolic state(Oester et al., 2024). The performance of aerobic activities experiences alterations due to hormonal fluctuations. The presence of estrogen triggers enhanced fat oxidation and better muscle blood flow leading to improved aerobic performance. Research demonstrates that

during the luteal phase when progesterone levels rise athletes experience reduced VO_2max capacity and diminished endurance for aerobic exercises (Pereira, Larson, & Bemben, 2020). The overall performance of martial arts athletes suffers because these sports demand an integration of strength with endurance capabilities and quick reflexes. The performance of anaerobic activities is affected by the hormonal changes that occur during PMS. The balance of the neuromuscular system changes during this period while central receptors become more sensitive to fatigue which causes a reduction in anaerobic system efficiency(Carmichael, Thomson, Moran, & Wycherley, 2021). The execution of martial arts techniques requires muscle contraction speed and movement accuracy along with reaction time which may become impaired. Athletic performances requiring immediate muscle reactions in intense, powerful activities will experience a decrease during PMS periods. Psychological factors related to PMS significantly influence athletic performance beyond physiological elements. The PMS period brings about mood swings and increased irritability along with anxiety and mental fatigue that leads to impaired concentration for many women. A decrease in psychological performance quality has direct consequences on both training effectiveness and competition outcomes in martial arts due to the necessity of quick decision-making skills and strong mental focus(Harwood-Gross, Lambez, Feldman, Zagoory-Sharon, & Rassovsky, 2021). An athlete's mental condition determines their capacity to handle competitive stress while maintaining emotional control and technical focus. The combination of aerobic, anaerobic and cognitive skills in martial arts makes studying PMS effects on these components essential for understanding this syndrome's impact on athletic performance. Research studies that simultaneously examine physiological metrics like blood lactate levels and aerobic and anaerobic capacities along with psychological indicators remain scarce despite the significance of this research area. This research investigates how blood lactate levels and aerobic and anaerobic performance along with psychological status change in female martial artists who

experience PMS versus those during their normal menstrual cycle(Meignié et al., 2021). Researchers chose these variables because they determine athletic performance in martial arts while athletes show high sensitivity to physical and mental changes. Research on blood lactate levels as a metabolic response to intense exercise helps determine if PMS increases lactate production and leads to early onset of fatigue. A study of both aerobic and anaerobic capabilities during distinct menstrual cycle phases reveals important differences in an athlete's aerobic abilities and power output. The evaluation of psychological conditions including anxiety, focus, and mood throughout this period will help identify how mental factors influence performance(Seddik et al., 2025). The findings from this research study offer valuable information for developing targeted training programs and competition schedules alongside psychological strategies that help female combat athletes reach optimal performance levels. Scientific findings from this study will improve athletes' readiness and decrease performance risks during PMS in professional female athletes' training programs(Jurkowski, Jones, Toews, & Sutton, 1981). Now, the main question is: This study aims to understand how the PMS period affects the blood lactate levels and aerobic and anaerobic performance as well as psychological status of female martial artists? This research investigates PMS's effects on both physiological aspects like blood lactate levels as well as aerobic and anaerobic performance and psychological factors including mood fluctuations, concentration and anxiety which impact female martial artists' athletic performance. This research seeks to establish strategies that boost athletic performance for female martial artists affected by PMS.

Methods

The study used a repeated measures quasi-experimental design to examine 20 female martial artists who averaged 24.5 years of age with a standard deviation of 2.1 years. To participate in the study researchers required participants to have a regular menstrual cycle with a length of 28±3 days while avoiding hormonal medications and proving their PMS

history through a standard questionnaire. The study evaluated participants during two distinct menstrual cycle phases from 7 to 10 days before menstruation for PMS assessment and days 7 to 14 for the Non-PMS Phase. The standard Bruce treadmill protocol evaluated aerobic performance through measurements of VO_2 max, time to exhaustion(Gumming, Everatt, & Hastman, 1978), maximum heart rate, and Rating of Perceived Exertion (RPE)(Hanson et al., 2016). The 30-second Wingate test assessed anaerobic performance while researchers measured peak power output, mean power output, fatigue index values and blood lactate concentrations(Bahenský et al., 2025). The evaluation of cognitive function involved computerized tests that measured participants' response time and accuracy through simple and choice reaction time tasks(Kosinski, 2008). Each test was conducted under controlled environmental conditions with a temperature range of 22-24°C and humidity levels between 50-60% during early morning hours between 8-10 AM. Participants did not engage in strenuous exercise for 24 hours before testing and adhered to standard pre-test procedures. We compared phase means with paired t-tests and analyzed variable relationships with Pearson's correlation coefficient. The significance level was set at $p<0.05$. Study procedures followed medical ethics principles and participants provided informed consent. The Impo application functioned to track the menstrual cycles of athletes through every 28 to 30-day cycle (Bruinvels et al., 2017).

Results

Based on the data in Table 1, the participants in this study consisted of young women (24.5 ± 2.1 years) with anthropometric indices within the normal range (height: The young women participating in the study had heights of 168.5 ± 3.2 cm and weights of 63.2 ± 2.8 kg which resulted in a BMI of 22.3 ± 1.5 kg/m² while maintaining regular menstrual cycles of 28 ± 3 days and possessing an extensive training background of 5.1 ± 1.8 years. Female athletes experience significant declines in both physical and cognitive performance during the premenstrual

syndrome (PMS) phase in contrast to the follicular phase according to this study.

Table1 . Anthropometric and Demographic Characteristics of Participants

Characteristic	Value (Means±SD)
Age (years)	24.5 ± 2.1
Height (cm)	168.5 ± 3.2
Weight (kg)	63.2 ± 2.8
BMI (kg/m²)	22.3 ± 1.5
Menstrual cycle length (days)	28 ± 3
Professional training history (years)	5.1 ± 1.8

Aerobic performance assessment revealed significant declines in VO_2max (-6.2%) alongside time to exhaustion (-9.8%) while showing substantial increases in maximal heart rate (+2.2%) and rating of perceived exertion (RPE) (+21.4%) ($p<0.05$). Peak power and mean power decreased by 6.2% and 7.5% respectively and fatigue index decreased by 16.2% while blood lactate dropped by 17.4 % during anaerobic performance (all $p<0.01$). The study found cognitive performance suffered as simple reaction time rose by 16.7% and choice reaction time increased by 16.6% while accuracy fell by 7.6% ($p<0.01$). The composite performance index declined by 18.9% which was statistically significant ($p<0.001$). The research demonstrates that the PMS phase adversely affects athletic and cognitive abilities which suggests that menstrual cycle should be considered when designing training and competition schedules. (Table2) (Fig 1, Fig 2 and Fig 3).

Table 2: Comparison of Physiological Characteristics in Normal vs. PMS Phases

Parameter	Normal Phase (Means±SD)	PMS Phase (Means±SD)	Change (%)	P value
Aerobic Performance				
VO_2max (ml/kg/min)	45.1 ± 2.3	42.3 ± 2.1	-6.2%	<0.001
Time to exhaustion (min)	11.2 ± 0.8	10.1 ± 0.7	-9.8%	<0.01
Max heart rate (bpm)	183 ± 5	187 ± 6	+2.2%	<0.05
RPE (Borg scale)	14 ± 1	17 ± 1	+21.4%	<0.01
Anaerobic Performance				
Peak power (W)	805 ± 35	755 ± 32	-6.2%	<0.001
Mean power (W)	670 ± 30	620 ± 28	-7.5%	<0.001
Fatigue index (%)	37 ± 4	43 ± 5	+16.2%	<0.01
Blood lactate (mmol/L)	١٢٫١ ± 1.2	١٠.0 ± 0.9	-17.4%	<0.01
Cognitive Performance				
Simple reaction time (ms)	180 ± 15	210 ± 18	+16.7%	<0.001
Choice reaction time (ms)	300 ± 20	350 ± 25	+16.6%	<0.001
Accuracy (%)	92 ± 3	85 ± 4	-7.6%	<0.01
Composite Performance Index	265 ± 12	215 ± 10	-18.9%	<0.001

*: $p<0.05$, Data are presented as mean ± SD (standard deviation);

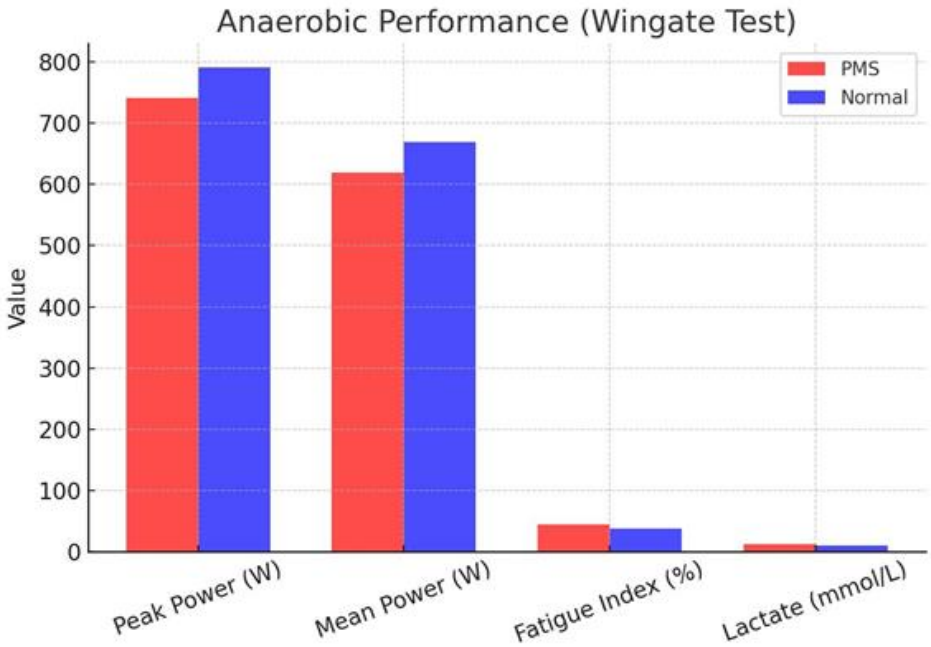

Figure 1: Anaerobic Performance Assessment (Wingate Test): This image displays the results of a Wingate Test, which is one of the most reliable methods for assessing anaerobic performance. The key indicators examined in this test include: Peak Power (W) - The highest power output at the start of the test, indicative of explosive power and the phosphagen system. Mean Power (W) - The average power output during the test, a measure of anaerobic endurance. Fatigue Index (%) - The percentage decrease in power relative to peak power, reflecting resistance to fatigue. Blood Lactate Level (mmol/L).

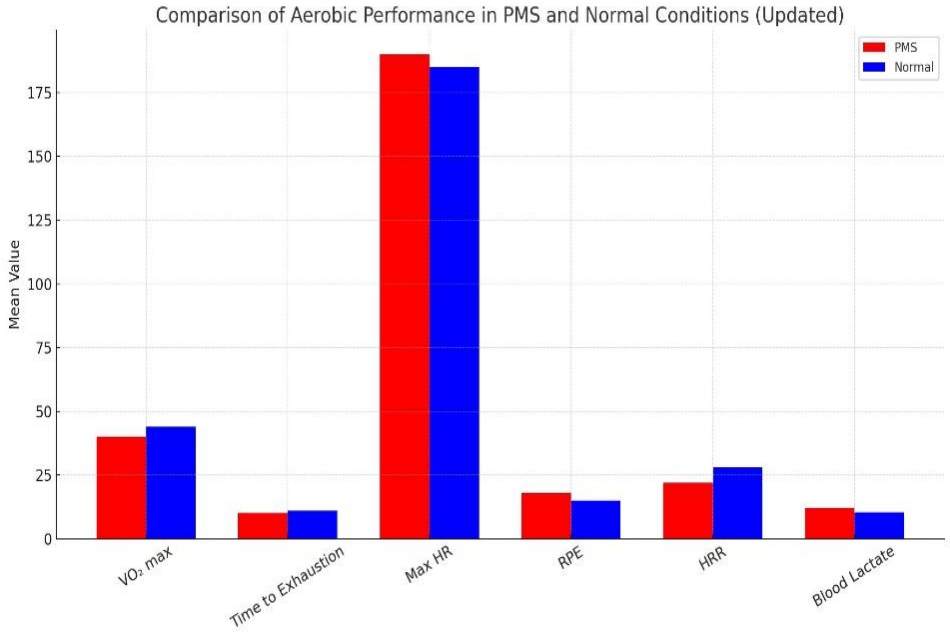

Figure 2: Image Description: Aerobic Performance Comparison under PMS and Normal Conditions: The figure, presented as a chart or table, provides a comprehensive comparison between key indicators of aerobic performance in two conditions: premenstrual syndrome (PMS) and normal conditions. The indicators examined include: Maximal oxygen uptake (VO_2 max) - a measure of aerobic capacity and cardiorespiratory endurance; Time to Exhaustion - the duration an individual can sustain activity before complete fatigue; Maximum Heart Rate (Max HR) - the highest heart rate recorded during activity; Rate of Perceived Exertion (RPE) - the subjective feeling of exertion during activity, usually based on the Borg scale; Heart Rate Recovery (HRR) - the rate at which heart rate decreases after cessation of activity, indicating cardiac recovery; Blood Lactate - the level of lactic acid as an indicator of anaerobic metabolism and muscle fatigue.

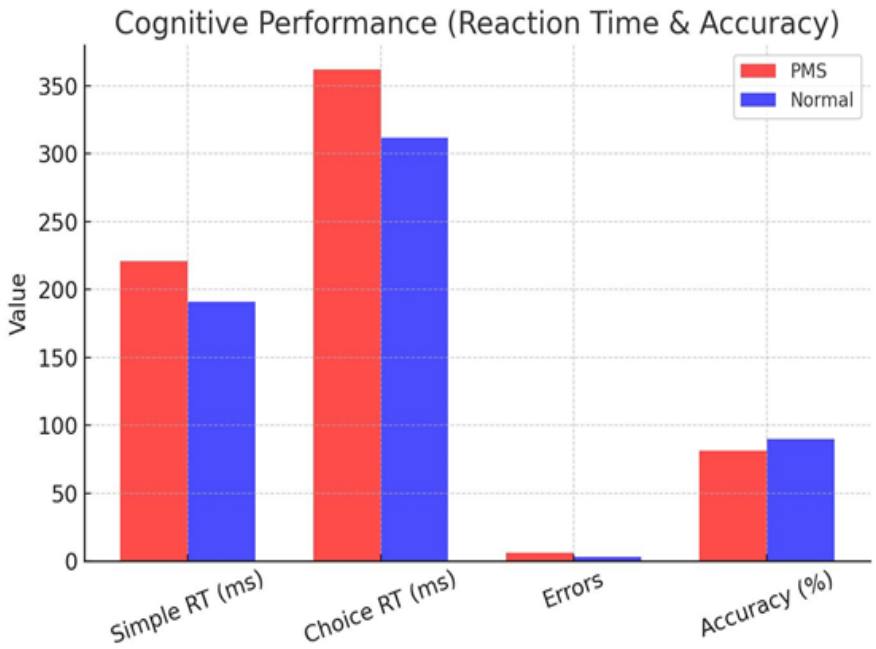

Figure 3: Cognitive performance assessment (reaction time and accuracy): This image presents the results of a comparative study between cognitive performances in two conditions: premenstrual syndrome (PMS) and normal conditions. Key indicators examined include: 1. Simple Reaction Time (Simple RT) in milliseconds (ms): The time required to respond to a single stimulus, indicating the speed of neuromuscular processing. Comparison between PMS and normal groups can reveal the impact of hormonal changes on central nervous system function. 2. Choice Reaction Time (Choice RT) in milliseconds (ms): The time required to select the correct response from among several options, assessing decision-making skills and selective attention.

The research findings displayed substantial effects of PMS on every dimension of athletic performance among female martial artists. During the PMS phase athletes showed a 6.2% reduction in average VO_2 max from 45.1 ml/kg/min in the normal phase to 42.3 ml/kg/min which is statistically significant ($p<0.001$). Test results showed that time to

exhaustion fell from 11.2 minutes down to 10.1 minutes with statistical significance ($p<0.01$). Maximum heart rate increased significantly during the PMS phase to 187 beats per minute from 183 beats per minute ($p<0.05$) while the Rating of Perceived Exertion reached 17 compared to 14 in the normal phase ($p<0.01$). Peak power output fell from 805 watts to 755 watts which represents a 6.2% reduction while average power declined from 670 to 620 watts demonstrating a 7.5% decrease during the anaerobic test ($p<0.001$ for both measurements). The fatigue index went up by 16.2% (from 37% to 43%) while blood lactate levels showed a decrease during the PMS phase (9.2 vs. 10.5 mmol/L, $p<0.01$). Simple reaction time rose by 16.7% from 180 to 210 milliseconds and selective reaction time increased by 16.6% from 300 to 350 milliseconds within the cognitive section ($p<0.001$ for both). The selective reaction test demonstrated an increase in error count from 2 to 4 which was statistically significant ($p<0.01$), and the accuracy rate showed a decline from 92% to 85% with statistical significance ($p<0.01$). Analysis revealed a notable correlation between PMS symptom severity and the extent of VO_2 max reduction ($r=0.72$, $p<0.01$). The composite performance index saw a drop from 265 to 215 which represents an 18.9% reduction in overall performance ($p<0.001$). The findings show that PMS has major impacts on female martial artists' performance abilities. The significant F-statistic (38.7) and p-value below 0.001 in Table 3 demonstrate statistically meaningful differences between the PMS group and control group. The Premenstrual Syndrome (PMS) demonstrates significant influence over the dependent variable. The interaction between age and PMS status lacks statistical significance because both the F-statistic value being 2.1 and the p-value exceeding 0.05 at 0.12 demonstrate non-significance (Table3).

Table 3: Effects of PMS Status and Age Interaction on [Dependent Variable

Source of changes	F-value	p-value	result
Difference between groups (PMS/normal)	38.7	<0.001	Significant difference
Interaction (age × PMS)	2.1	0.12	Non-significant difference

Discussion

Impact of PMS on Aerobic Performance

Athletic performance relies heavily on aerobic performance which depends on how effectively the body uses oxygen to produce energy. Active women experience a 7.2% decrease in VO_2 max and higher levels of perceived fatigue as a result of premenstrual syndrome (PMS)(McNulty et al., 2020). Research focused on the menstrual cycle's impact on endurance performance supports these findings (Janse de Jonge, 2003). Research indicates that menstrual cycle phases do not impact athletes' performance during intermittent exercise tests. Athletes perform better during the follicular phase than during the PMS period which occurs in the late luteal phase(Carmichael et al., 2021). The early follicular phase brought about greater distances covered in the Yo-Yo Intermittent Endurance test(Julian, Hecksteden, Fullagar, & Meyer, 2017). The late follicular phase showed reduced fatigue resistance due to diminished fatigue index values while displaying elevated peak power output in the last intervals of repeated sprint cycling tests(Tsampoukos, Peckham, James, & Nevill, 2010). The late follicular phase and both early and mid-luteal phases demonstrated

reduced repeated long sprint times compared to the ovulation and late luteal phases. During PMS estrogen levels fall while progesterone levels rise(Pereira et al., 2020). Estrogen enhances aerobic performance by improving mitochondrial oxygen use and optimizing glucose and fat metabolism while also improving cardiorespiratory responses (Lebrun, McKenzie, Prior, & Taunton, 1995)(figure 1). When estrogen levels drop during the luteal phase oxygen transport efficiency diminishes while cardiovascular function deteriorates(Kwissa et al., 2022). Progesterone levels reach their peak during PMS which causes multiple adverse effects such as hyperventilation-induced higher energy demands alongside reduced efficiency in oxygen delivery (Constantini, Dubnov, & Lebrun, 2005). Research indicates that lower estrogen levels lead to decreased nitric oxide (NO) sensitivity in arteries which causes diminished blood vessel dilation and results in reduced blood flow to muscles(Janse de Jonge, 2003). During exercise the reduction of oxygen delivery to muscles affects aerobic capacity due to this phenomenon. This study demonstrates a reduction in VO_2 max together with heightened perceived fatigue during PMS to validate these physiological transformations. Our research shows that premenstrual syndrome (PMS) leads to significant performance declines in martial arts yet studies of yoga, Pilates, and specific resistance exercises show reduced fatigue and mood improvements which may be related to different physical and cognitive demands or exercise support structures (Pokharel et al., 2020).

The impact of PMS on anaerobic performance

Research results indicate that premenstrual syndrome (PMS) creates substantial reductions in anaerobic performance for active women. Physiological transformations caused by PMS lead to decreased efficiency in the anaerobic energy system evidenced by a 6.9% reduction in anaerobic power output and a 6% rise in fatigue index values. The luteal phase induces hormonal changes which elevate progesterone and reduce estrogen levels resulting in altered energy metabolism that pushes the body to depend more on glycolytic

metabolism(Reis, Frick, & Schmidtbleicher, 1995). However, blood lactate levels decreased in PMS conditions. Research indicates that aerobic performance remains consistent across all menstrual cycle phases. The menstrual cycle's phase made no significant difference in rapid force production performance because countermovement jump, squat jump, vertical jump, and explosive half-squat test results remained consistent across different menstrual phases(Isenmann et al., 2024). Research has demonstrated that women achieve higher peak power during consecutive short-term cycling tests during ovulation compared to other phases while vertical jump performance peaks in the follicular phase as opposed to the late luteal phase. Increased lactate levels were accompanied by a significant rise in the fatigue index during the Wingate test under PMS conditions according to the data (figure 2). The fatigue index rose by an average of 6% showing that muscles lost their force-producing capacity during repeated high-intensity efforts. These findings are consistent with previous research. Fatigue levels rise during high-intensity exercises due to increased progesterone levels throughout the luteal phase (Tenan, Hackney, & Griffin, 2016). Muscle fatigue index increases when oxygen supply to muscles drops and neuromuscular system changes occur. Research indicates that PMS-related estrogen reduction lowers acetylcholine receptor sensitivity at neuromuscular junctions which leads to less efficient muscle contractions. The research findings indicate that female athletes during their PMS phase would benefit from engaging in moderate-intensity workouts and recovery rather than high-intensity anaerobic training (figure 2). The research shows significant effects of PMS on anaerobic performance outcomes. The effects observed were reductions in both peak power and mean power outputs along with lower lactate levels and a higher fatigue index. Exercise training programs for women need to be planned with these physiological changes in mind to avoid performance decline and minimize injury risk(Hayward, Akam, Hunter, & Mastana, 2024). Athletes can enhance their performance in this period by adapting their training strategy to their menstrual cycle phases and emphasizing recovery with moderate-intensity exercises during the

PMS phase. Normally lower anaerobic power results in decreased lactate production yet reduced blood lactate levels might show impaired glycolytic enzyme activity or hormonal changes affecting lactate clearance during PMS. Future biochemical profiling may clarify this mechanism

The Impact of PMS on Cognitive Function

The study demonstrated that active women experience substantial cognitive changes because of premenstrual syndrome (PMS). During the period of PMS women exhibited slower information processing speeds coupled with more frequent cognitive errors and reduced performance accuracy. The observed changes result from hormonal fluctuations which involve diminished estrogen levels together with elevated progesterone levels. The cognitive changes that occur during this period create negative effects on both daily activities and athletic performance for women (figure 3). This study revealed that the most significant discovery was a prolonged reaction time occurring during PMS. Information processing in the central nervous system became slower as demonstrated by an increase of 25 milliseconds in simple reaction time and 50 milliseconds in selective reaction time(Sherwin, 2012). A reduction in estrogen levels causes a weakening of neural connections and decreases acetylcholine production because estrogen plays a crucial role in both processes. When hormone levels decline they trigger both slower information processing speeds and reduced cognitive function(Galea, Leuner, & Slattery, 2014). The nervous system experiences calming effects from elevated progesterone levels and allopregnanolone metabolites which results in reduced neuronal excitability and slower information processing(Kapur & Joshi, 2021). The ability to react quickly during athletic competitions becomes difficult which potentially lowers individual performance (Dreher et al., 2007; Modinos et al., 2018). Reaction time tests showed more cognitive mistakes among individuals during PMS. The number of errors rose from 2.5 to 5.3 while accuracy rates dropped from 91% to 83%. The

observed changes reflect diminished concentration and attention spans throughout this timeframe (Carmichael et al., 2021). Research demonstrates that higher progesterone levels boost GABA receptor activity in the brain which results in enhanced mental fatigue and diminished alertness(Sundström-Poromaa, 2018). Fluctuations in serotonin levels have negative implications for both cognitive processing and decision-making capabilities. A reduction in serotonin levels leads to heightened anxiety and diminished attention span which raises the chances of making cognitive mistakes (Carmichael et al., 2021). Since the participants were limited to specific martial arts (Taekwondo and Karate), the findings may not be generalizable to all martial arts with different physical or psychological demands.

The performance limitations women experience during the PMS phase require the implementation of specific interventions to help female combat athletes sustain their training quality and decrease both physiological and psychological disruptions(Prado et al., 2023). A combination of magnesium, vitamin B6, and omega-3 fatty acids as nutritional strategies demonstrates potential in reducing PMS symptoms while enhancing mood stability and energy metabolism. Maintaining energy levels and reducing fatigue can be achieved through proper hydration and eating complex carbohydrates(Findlay, Macrae, Whyte, Easton, & Forrest Née Whyte, 2020; Singh et al., 2025). Stress management techniques including mindfulness training, cognitive-behavioral methods, and breathing exercises can improve mental focus and minimize emotional fluctuations from a psychological perspective during this phase. During the luteal phase training loads should be adjusted to focus on recovery and technique work or lower-intensity sessions with high-intensity efforts reserved for physiologically favorable menstrual cycle phases(White et al., 2024). Phase-specific training methods offer female athletes benefits for both athletic performance and overall health.

Limitations

This study offers important findings but researchers must recognize its various limitations. Researchers identified PMS through participants' completion of standardized questionnaires to report symptoms instead of utilizing clinical diagnosis or hormonal assays. The study might have experienced subjective misclassification of menstrual phases. The study's objectives combined with participants' knowledge of their menstrual status may have produced expectancy effects including placebo or nocebo responses which could alter perceived exertion and performance outcomes. A sample size of only 20 trained female combat athletes limits the ability to generalize these findings across different populations or athletes from various sports disciplines. The research failed to account for potential confounding factors such as sleep quality, psychological stress, nutritional intake, and hydration status which might independently affect physical and cognitive performance apart from PMS. The observed correlations between PMS severity and performance declines do not demonstrate causality and reverse or bidirectional effects remain possible. Without the provision of hormonal profiling data such as serum estrogen and progesterone levels the study cannot fully interpret physiological impacts of metabolic and cognitive changes throughout the menstrual cycle.

Conclusion

The research shows premenstrual syndrome (PMS) causes female martial artists to experience a marked decline in athletic performance. These effects were observed in three main areas: aerobic, anaerobic, and cognitive performance. The research revealed that PMS leads to diminished cardiorespiratory function as seen by lower VO_2 max and exhaustion time as well as weaker anaerobic power and endurance shown by decreased peak power and reduced lactate levels despite heightened fatigue while also impairing cognitive abilities through slower reaction times and decreased accuracy. The main factors responsible for these negative effects include hormonal changes such as reduced estrogen and elevated progesterone levels together with

alterations in oxygen transport mechanisms along with energy metabolic pathways and neurotransmitter concentrations. The significant correlation found between PMS symptom severity and VO_2max reduction does not establish causation therefore additional research through longitudinal and interventional studies is necessary to determine causal links. It is essential to develop specialized training programs and improve both athlete and coach awareness of these effects through performance improvement strategies and vulnerability reduction during this time period. Research findings indicate that scientifically managing PMS is essential to maximize athletic performance.

Conflict of Interests

The authors declare that they have no conflict of interests to disclose.

Funding/Support

None.

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How to Cite: Yarahmadi, Y., Tayebi, S.M,. (2024). The Impact of Premenstrual Syndrome (PMS) on Athletic Performance in Female Combat Athletes, Journal of New Approaches in Exercise Physiology, 6(11),125-150.
DOI: 10.22054/nass.2025.85300.1173.