

Phase-Specific Effects of Menstrual Cycle Related Hormonal Fluctuations on Strength, Speed, Endurance, Perceived Exertion, and Recovery in Physically Active Women: A Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) -2020 Guided Systematic Review

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ABSTRACT

Background: Hormonal changes might also be able to cause variation in physical performance of women at different phase of menstrual cycle. The evidence is still inconclusive, and synthesis of recent research is required to define the influence of phases on strength, speed, and endurance.

Aim: The aim of the review was to systematically review evidence on variation of physical performance by phase in the menstrual cycle in women.

Methods: A systematic search in PubMed, Google scholar, Semantic scholar, and Scopus were performed to identify the studies that were published between 2020 and 2025. The studies that explored the phases of menstrual cycle regarding physical performance results were eligible. Non-English articles, non-peer-reviewed articles and year of study outside the defined period were all excluded. The inclusion criteria were met in 21 studies. The review was adjusted to PRISMA-2020, and the synthesis of findings was conducted in the form of a review.

Findings: Menstrual cycle was linked to the effect on physical performance and was mainly affected by hormonal changes. The strength performance was observed to rise at the late follicular phase, which is associated with higher estrogen concentrations possibly because of higher muscle protein synthesis and recovery. Contrastingly, the results of strength performance in the luteal phase, which is typified by high progesterone, were less consistent, some studies reported lower performance. The endurance performance showed a more consistent relationship with estrogen, and a number of them showed improvement in the follicular phase. Nevertheless, the results regarding Maximal oxygen uptake (VO₂max) were also varied with some studies showing no differences in phases. Luteal phase was associated with augmented lipid oxidation and protein breakdown that did not affect endurance regularly. The use of oral contraceptives seemed to dampen the hormonal changes and did not have much effect on performance. Patterns of recovery also depended on the phase in which they were measured, and the luteal phase associated with greater cortisol levels which might have influenced fatigue resistance.

Conclusion: The scientific grounds for influence of menstrual cycle phase on physical performance and training response are limited; however, those of strength, speed and endurance are highly variable and individual. Further studies should be carried out to explain the working mechanisms and give guidance for phase-based training protocols on female athletes.

Keywords: Menstrual Cycle; Female Athletes; Muscle Strength; Speed Performance; Endurance Performance; Hormonal Fluctuations; Estrogen; Progesterone; VO₂max; Perceived Exertion; Recovery; Training Adaptation.

1. Introduction

The connection between menstrual cycle and exercise performance in particular strength, speed, and endurance has been a topic of growing research concern, as the physiological changes in ovarian hormones and their possible effect on the athletic performance have attracted attention. In recent quality studies which employed rigorous menstrual phase monitoring and hormone tests, it has generally been found that objective measures of strength, speed and endurance do not vary significantly throughout the menstrual cycle in healthy women, but subjective measures such as perceived exertion and recovery do, particularly in menses (Delp et al., 2024; Vargas-Molina et al., 2022). Studies have revealed that strength, speed, and endurance are the important elements of athletic performance that can be influenced by the hormone changes during the cycle (Dragutinovic et al., 2024). Although this is the case, the influence of the menstrual cycle on these variables is not clearly known and the issue has not been explored into in various sports or types of performances. With the increasing number of women competing in

sports, there is a growing need to comprehend the impact of such natural biological changes and its effect on performance.

Menstrual cycle is a field that is not given much attention in sports science, and this has resulted in a gap in knowledge concerning the influence of the menstrual cycle on different training and competitions. Women athletes are occasionally recommended to use generic training programs that fail to recognize the special requirements of their bodies at various phases of menstrual cycle (Dragutinovic et al., 2024). This negligence towards differences in the performance due to the cycles may lead to the loss of the opportunity to optimize training, decrease the risk of injuries, and improve the overall performance.

The existing literature on the effects of the menstrual cycle on performance is widely disseminated. Isolated studies have concentrated on a specific component such as strength or endurance but hardly merge the two together to provide an in-depth perspective. Also, a large majority of the available studies lack a diverse sample of female athletes and thus are not as applicable (Rael et al., 2021). This review will analyze these gaps and synthesize research to get a better picture of the effect of menstrual cycle phases on athletic performance in various fields.

This review will attempt to integrate all the current studies conducted about strength, speed, and endurance during menstruation. This review will help to understand the issue of how female athletes can modify their training and performance plans to match the menstrual cycle more thoroughly, as it will reveal the trends, inconsistencies, and other areas that require additional exploration. Information about such patterns will assist athletes and coaches in coming up with their own plans on how they can perform best in the cycle.

1.1. Study Objectives

1. To systematically examine the current literature (2020-2025) on the exposure of physical performance to women's menstrual cycle phases.
2. To investigate the effects of various phases of the menstrual cycle on strength, speed and endurance in physically active women and female athletes.
3. To examine the influence of hormonal changes especially estrogen and progesterone on variation of performance during the menstrual cycle.
4. To compare objective measures of performance with subjective responses such as perceived exertion and recovery between phases of the menstrual cycle.
5. To identify discrepancies in research and/or study limitations in existing studies related to menstrual cycle-based changes in performance.
6. To present evidence-based direction for phase-specific training and performance planning for female athletes.

1.2. Research Problem

The female athletes have special issues regarding exercise performance because of menstrual cycle. The endurance, speed and strength can be influenced by hormonal fluctuations throughout the cycle (Rael et al., 2021). The role of these changes in effects on athletic performance has importance in designing improved training and recovery

programs. Nonetheless, the existing studies on the same issue are inconclusive, and there are still numerous gaps in the knowledge of such effects in various stages of the menstrual cycle (Willett et al., 2021).

1.3. Importance of the Topic

Menstrual cycle is a natural process, and women must undergo it; unfortunately, this process is neglected in sports science. The female athlete can also have changes in performance because of their menstrual cycle, which may affect training and performance in the field. The research into the influence of strength, speed, and endurance on performance will allow us to design individual training programs that improve performance and minimize the risk of injury at various stages of the cycle. This knowledge is crucial to coaches and sportspeople who want to achieve great performance.

1.4. Current Gaps

Little research has directly compared the strength, speed and endurance at the various phases of the menstrual cycle. A lot of the available research is either inconclusive or based on one type of performance and not all three. Moreover, a variety of female athletes is not always covered in many studies, and it is difficult to apply the results. This incomplete and uncoherent data leaves gaps in the knowledge of the actual effect of the menstrual cycle on performance.

Key gaps include the need for more research in elite athletes, long-term effects of phase-based training, and the impact of severe menstrual symptoms or hormonal contraceptive use on performance.

Table 1. Matrix showing the number of studies by topic and outcome category, used to identify evidence density and key research gaps in menstrual cycle–performance research.

Topic/Outcome	Endurance	Strength	Speed	Subjective measures	Supplementation
Objective performance	7	6	4	3	5
Subjective experience	2	2	1	6	2
Elite athletes	1	1	Gap	Gap	1
Hormonal contraceptive users	2	2	1	1	1
Dysmenorrhea/symptom burden	1	1	Gap	2	Gap

1.5. Aim of the Review

This review will aim at summarizing existing literature on the effect of menstrual cycle on the strength, speed, and endurance of female athletes. It will determine the trends, compare the findings with the results of the other studies and indicate the areas that require new studies. Through a synthesis of existing research, this review is expected to give a better insight into how female athletes can better optimize their training depending on the phases of their menstrual cycles.

1.6. Research Questions

This review seeks to answer several key questions.

1. What is the impact of the menstrual cycle to strength, speed and endurance among female athletes?

2. Which stages of the menstrual cycle impact performance?
3. Are there any reasons that can explain these changes?
4. To what extent can this information be used by athletes and coaches to enhance performance and training?

1.7. Review Design

This systematic review follows PRISMA-2020 guidelines and involves analyzing studies that examine strength, speed, and endurance in relation to the menstrual cycle. It was focus on studies that include female athletes of varying skill levels. Studies that meet the inclusion criteria will be critically assessed and compared to identify consistent findings and gaps in the research.

2. Methodology

2.1. Search Strategy

Table 2. Databases searched, keyword combinations, publication period (2020–2025), and study design filters used for identifying eligible studies on menstrual cycle phase and physical performance in women.

Databases used	PubMed	Google Scholar	Semantic Scholar	Scopus
Keywords	menstrual cycle menstrual phase follicular phase ovulation muscle maximal strength speed endurance VO2max	menstrual cycle menstrual phase follicular phase ovulation muscle strength sprint endurance VO2max	menstrual cycle menstrual phase follicular phase ovulation muscle strength speed endurance aerobic performance	TITLE-ABS-KEY (("menstrual cycle" OR "menstrual phase" OR "follicular phase" OR "luteal phase" OR ovulation OR estrogen OR progesterone) AND (women OR female OR athletes OR "physically active women") AND (strength OR "muscle strength" OR sprint OR speed OR endurance OR "aerobic performance" OR VO2max OR power)) AND PUBYEAR > 2020 AND PUBYEAR < 2025 AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTKEYWORD , "Female") OR LIMIT-TO (EXACTKEYWORD , "Human")))
Search period	2020-2025	2020-2025	2020-2025	2020-2025
Min. Citation	05	05	05	05
Research Design	Randomized Controlled Trial (RCT), Case Report, Animal Studies	RCT, Case Report, Animal Studies	RCT, Case Report, Animal Studies	RCT, Case Report, Animal Studies

2.2. Inclusion Criteria

The following criteria were used to include studies. Peer-reviewed journal articles that were published between 2020-2025 were only considered. The articles were required to be in the English language and be published in the well-known scientific journals. Randomized controlled trials (RCTs), studies of human experiment, control studies, and case reports were all eligible study designs. To guarantee the scientific relevance and impact of the articles that were included, articles that had more than five citations were taken in. Research was required to concentrate on the pertinent keywords with regards to the objective of the review. Journals were selected as sources that could be analyzed.

2.3. Exclusion Criteria

Studies published before 2020 were excluded. Articles that were not peer-reviewed including preprints were not considered. Publications which were not in English language were excluded. Non-journal literature including book chapters, book reviews, editorials, qualitative studies and conference proceedings was excluded. Studies without relevant keywords or not in accordance with the research objectives were excluded. Research that was conducted on non-human subjects was also excluded from the review.

2.4. Data Extraction

Database searching was done between 2000 and 2025 to identify a total of 1928 records. Following the elimination of 1289 records that were duplicates using the Mendeley software and the elimination of 247 records that had less than five citations, 392 records were left to be screened.

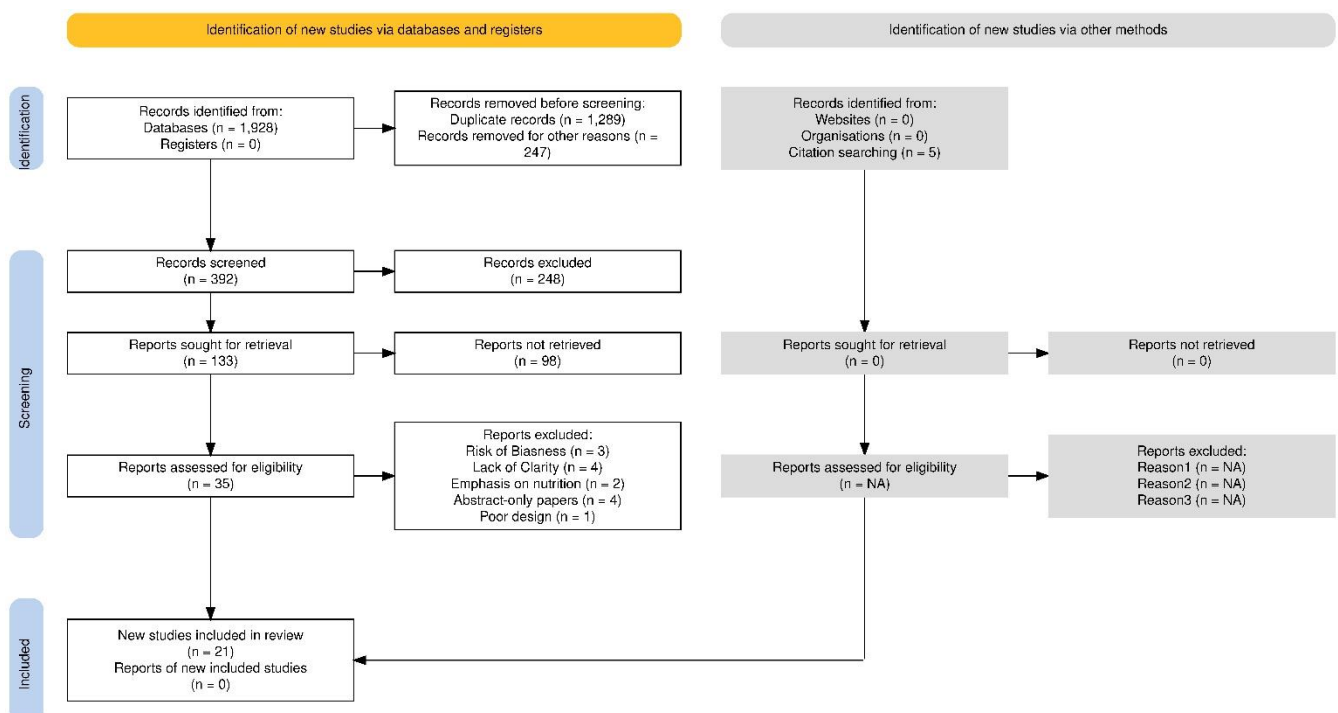










Figure 1. Flow diagram of literature search and study selection (PRISMA 2020) (Haddaway et al., 2022)

The screening of titles and abstracts was done, and 248 records were excluded based on the eligibility criteria. There were 133 records that were reported to be sought in a retrieval. Among these, 98 of them were not available because

of full texts that were unavailable. Consequently, 35 full-text reports were evaluated on the criteria of eligibility. Among them, 14 reports were not included due to the predetermined reasons: risk of bias (n = 3), ambiguity in methods or outcomes (n = 4), performance orientation (n = 2), abstract-only articles (n = 4), and poor design of the studies (n = 1), insufficient data, or non-English language. Lastly, the qualitative synthesis was comprised of 21 studies.

2.5. Main Findings (Claims and Evidence)

Table 3. Summary of major findings on the effects of menstrual cycle phase on physical performance, showing key claims, strength of supporting evidence, underlying reasoning, and corresponding reference studies included in the systematic review (2020–2025).

Claim	Evidence Strength	Reasoning	Papers
Menstrual phase does not significantly affect objective strength, speed, or endurance performance	 Strong	Multiple RCTs and crossover studies with robust hormonal verification show no significant differences	(Colenso-Semple et al., 2025; Delp et al., 2024; Garcia et al., 2023; Lee et al., 2024; Zainab et al., 2021)
Perceived exertion and recovery are worse during menses (early follicular phase)	 Moderate	Consistent findings in untrained women; subjective measures are more sensitive to phase and symptoms	(Delp et al., 2024; Garcia et al., 2023)
Caffeine supplementation is more ergogenic during the early follicular phase	 Moderate	RCTs show greater performance gains with caffeine in this phase	(Santana et al., 2022)
Citrulline-malate increases power-based performance during menstruation	 Moderate	Acute supplementation improves total work in short tasks during menstruation	(Gills et al., 2023)
Creatine supplementation may help offset high-hormone phase fatigue	 Moderate	Some evidence for improved fatigue resistance in luteal phase	(Cabre et al., 2024; Gordon et al., 2023)
Training during the follicular phase may be more effective for strength or symptom management in some women	 Moderate	Some studies suggest benefits, but evidence is mixed and limited by methodology	(Colenso-Semple et al., 2025; Ekenros et al., 2024; Zainab et al., 2021)
Menstrual phase does not affect muscle protein synthesis or breakdown in response to resistance exercise	 Strong	Stable isotope studies show no phase effect on muscle protein turnover	(Colenso-Semple et al., 2025)
Individual variability in menstrual cycle effects is high	 Moderate	Studies report substantial inter-individual differences in cycle length, symptoms, and performance response	(Colenso-Semple et al., 2025; Delp et al., 2024; Garcia et al., 2023)

2.6. Discussion

The menstrual cycle was found to be significant to physical performance, such as strength, speed or endurance with hormonal changes being an important factor. Estrogen and progesterone, among others, demonstrate different effects at different times of the cycle, especially, the follicular and the luteal phases. Studies show that strength performance can increase in the late follicular phase when estrogen peaks, and this might be caused by the effect of the hormone on muscle protein synthesis and recovery (Alfaro-Magallanes et al., 2022; Sung et al., 2022). On the other hand, strength performance in the luteal phase, which is high in progesterone, is less decisive with several studies showing diminished performance (Colenso-Semple et al., 2025). The association of estrogen and endurance performance is stronger and more regular, where a positive estrogen concentration during the follicular phase is associated with an increase in endurance, probably because of the effect of estrogen in facilitating the use of carbohydrates and glycogen within the body (Willett et al., 2021).

Nevertheless, the effects of the menstrual cycle on endurance are not so significant in other studies, especially with regard to VO₂max because there were no significant differences between phases (Hogwood et al., 2024). Moreover, the hormonal environment of the luteal phase encourages increased fat oxidation and protein breakdown, but these changes cannot produce significant changes on endurance performance among all athletes (Dragutinovic et al., 2024). The effects of oral contraceptives Pills (OCPs) also do not make matters easier, and the research indicates that the impact of contraceptives on endurance and strength performance is insignificant. Use of OCPs is found to suppress the hormonal changes that are characteristic of the natural cycle, which may lead to lessening the perceived effect on performance (McNulty et al., 2020).

Also, hormonal changes and recovery patterns have a complicated relationship, and luteal phase are linked to an increased level of cortisol, which can influence muscle recovery and fatigue resistance (Romero-Parra et al., 2020). These results suggest that the phases of menstruation cycle might affect training response, however, the precise effects of phases on the performance in terms of strength, speed, and endurance are inconsistent and can vary depending on the personal traits and the nature of the exercise done. Thus, although there are indications that training based on menstrual cycles may yield the best outcomes, additional research is still necessary to establish these relationships and identify the best training approaches to use by female athletes.

3. Conclusions

The objective of this systematic review was to compile the recent evidence (2020-2025) on whether the Menstrual Cycle (MC) phase affects the primary performance domains, namely strength, speed, and endurance in physically active women and female athletes, and what methodological shortcomings define the incongruent results. Overall, the considered studies point to the fact that menstrual phase has no significant impact on objective performance outcomes power, speed, and endurance when phases are strictly followed and/or hormonally checked. Conversely, subjective consequences (e.g., perceived exertion, recovery quality, and symptom burden) are more likely to deteriorate during menses/early follicular phase, which demonstrates the lack of correlation between performance capacity and perceived preparedness in physiological terms. There are signs also of possible phase-contingent

effects of supplementation (e.g., caffeine, citrulline-malate, and creatine) and mixed effects in support of follicular-phase-focused training effects, with huge inter-subject variation among studies.

Theoretically, these data would narrow down the endocrine-performance models by implying that the effects mediated by ovarian hormone variation on gross performance measures might be smaller than traditionally believed, whereas the effects mediated by them on perceptual, thermoregulatory, and recovery-related mechanisms are likely to be more consistent. Future studies ought to focus on longitudinal, sufficiently powered, phase-verified (including hormone measures), symptom severity and contraceptive status stratified, sport-specific results in high-performing athletes, and mechanistic studies to describe responder-nonresponder relationships. Major weaknesses of the evidence base include heterogeneity of protocols and results, poor representation of elite groups, variable classification or lack of specification of menstrual phase and poor representation of dysmenorrhea and other clinical variables. Overcoming these limitations will allow us to make more specific and personal recommendations. Taken together, this discussion contributes to the research by repositioning the effect of the menstrual cycle as specifically situational and person-specific and not necessarily performance detrimental, which contributes to a more responsive and athlete-focused approach to training and competition planning.

3.1. Future Research Directions

1. In future studies hormonal verification procedures (salivary or blood analysis) should be integrated to properly discriminate menstrual cycle phases.
2. Prospective longitudinal studies are needed to determine the performance response to phase-based training through multiple training cycles.
3. Further studies should be performed in other elite and sport technique populations to generalize data.
4. Research should also analyze those natural menstruating women and users of hormonal contraceptives separately from each group to avoid any confounding effects.
5. Special attention to the impact of MP-related symptoms (dysmenorrhea and fatigue) on training and competition performance is needed.
6. Subsequent studies should include both performance results and measures of physiology, psychology and recovery to help describe individual differences in performance responses.

Declarations

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Competing Interests Statement

The authors declare that they have no competing interests related to this work.

Consent for publication

The authors declare that they consented to the publication of this study.

Authors' contributions

All the authors took part in literature review, analysis, and manuscript writing equally.

Availability of data and materials

Supplementary information is available from the authors upon reasonable request.

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