



# Barrier, Booster, or Strength? A Text Mining–Enhanced Qualitative Inquiry into the Role of the Menstrual Cycle in Female Athletes' Performance

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Conflicts of Interest: The author has no conflict of interest to declare.

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Ethical Statement: It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.

(Date Of Received): 26.06.2025 (Date of Acceptance): 30.12.2025 (Date of Publication): 30.04.2026

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## Abstract

This study aims to examine the impact of the physical and emotional changes experienced by female athletes during the menstrual cycle on their sports performance. Qualitative data obtained from 346 Reddit comments were analyzed using digital text mining techniques. The research employed sentiment analysis (NRC and VADER), topic modeling (LDA) and word association analysis (Word2Vec), alongside interpretative phenomenological analysis (IPA) and traditional content analysis to deeply explore user experiences. The findings reveal that female athletes experience significant variations in energy levels, motivation, focus and physical capacity across different phases of the menstrual cycle. While some participants reported decreased performance during menstruation, others described enhanced strength and energy, referring to this as a form of "period power." The role of hygiene products and their practical usability in shaping performance outcomes was also emphasized. Additionally, the study draws attention to the potential effects of hormonal changes on injury risk. In this context, it concludes that the menstrual cycle affects sports performance not only physiologically but also psychologically. The results highlight the importance of developing individualized training strategies tailored to the phases of the menstrual cycle and to athletes' personal experiences.

**Keywords:** Female Athletes, Menstrual Cycle, Performance, Sentiment Analysis, Text Mining

**Engel mi, Performansı Artırıcı Bir Unsur mu, Yoksa Bir Güç Kaynağı mı? Kadın Sporcuların Performansında Menstrüel Döngünün Rolüne İlişkin Metin Madenciliği Destekli Nitel Bir İnceleme**

## Özet

Bu çalışma, kadın sporcuların menstrüel döngü sürecinde yaşadıkları fiziksel ve duygusal değişimlerin spor performansına etkisini incelemeyi amaçlamaktadır. Reddit'te yer alan 346 yorumdan elde edilen nitel veriler, dijital metin madenciliği teknikleri kullanılarak analiz edilmiştir. Araştırmada duygu analizi (NRC ve VADER), konu modelleme (LDA), kelime ilişkilendirme analizi (Word2Vec), yorumlayıcı fenomenolojik analiz (IPA) ve geleneksel içerik analizi yöntemleri birlikte uygulanmıştır. Bulgular, menstrüel döngünün farklı evrelerinde kadın

sporcuların enerji düzeyi, motivasyon, odaklanma ve fiziksel kapasitelerinde belirgin değişimler yaşandığını ortaya koymuştur. Bazı katılımcılar adet döneminde performans düşüşü bildirirken, bazıları bu dönemde güç ve enerjilerinin arttığını ve bunu “adet gücü” olarak tanımladıklarını ifade etmiştir. Hijyen ürünlerinin performans sonuçlarını şekillendirmedeki rolü ve pratik kullanılabilirliği de vurgulanmıştır. Ayrıca, hormonal değişimlerin sakatlık riskine olası etkilerine dikkat çekilmiştir. Sonuç olarak, menstrüel döngünün spor performansını yalnızca fizyolojik değil, aynı zamanda psikolojik açıdan da etkilediği; döngü evreleri ve sporcuların kişisel deneyimlerine göre bireyselleştirilmiş antrenman stratejilerinin geliştirilmesinin önemli olduğu belirtilmiştir.

**Anahtar Kelimeler:** Duygu Analizi, Kadın Sporcular, Menstrüel Döngü, Metin Madenciliği, Performans.

## INTRODUCTION

The relationship between the menstrual cycle and athletic performance is a multifaceted issue that encompasses both physiological and psychological dimensions. The levels of estrogen and progesterone during the follicular, ovulatory and luteal phases can affect female athletes' performance in various ways. Many female athletes report that their performance is impacted by the menstrual cycle, with symptoms such as fatigue, cramps and mood changes being more pronounced, especially during the early follicular and late luteal phases. Some studies suggest that adapting training to different phases of the menstrual cycle may enhance performance. Therefore, understanding the impact of the menstrual cycle on athletic performance is crucial for optimizing training strategies for female athletes.

Although many studies have examined the effects of the menstrual cycle on training and performance, the exact impact remains unclear. One study found that 51.1% of elite female runners and rowers in the United Kingdom acknowledged that their performance was influenced by the menstrual cycle [1]. Another study reported that 77% of elite athletes not using hormonal contraception experienced negative effects such as pain and mood swings during their menstrual cycles [2, 3], with similar observations supported by other studies [1, 4]. These symptoms, particularly abdominal pain and fatigue, can significantly limit training capacity. However, some studies have found no significant changes in performance parameters during menstruation, while others have reported noticeable fluctuations [5, 6].

There are studies that suggest specific training adaptations based on the phases of the menstrual cycle. For example, strength training during the follicular phase is believed to produce better results compared to the luteal phase, with greater increases in muscle strength and cross-sectional area during this period [7]. On the other hand, some researchers emphasize that current evidence does not clearly support the necessity of adapting training programs to the menstrual cycle and call for more research [8, 9].

Communication about menstrual health is an important issue between athletes and coaches. Many female athletes feel that they do not receive adequate support when sharing menstrual symptoms and this lack of communication may prevent them from fully expressing the challenges they face related to performance [10, 8].

In conclusion, while the potential impact of the menstrual cycle on athletic performance is increasingly recognized, the current evidence is still inconclusive. Most female athletes report performance changes during their menstrual cycle, but objective performance measurements do not consistently validate these perceptions. Therefore, more research is needed to develop scientifically-based guidelines for training and performance optimization in female athletes. In this regard, comprehensive studies addressing both physiological and psychological factors and integrating athletes' subjective experiences with objective data, are particularly important.

This study aims to fill this gap in the literature and contribute to the field. By combining text mining techniques with qualitative research methods, it seeks to examine the impact of female athletes' menstrual cycles on their training and performance through social media comments. In doing so, it is expected to contribute to the development of performance optimization strategies based on menstrual cycle awareness.

In the following sections, the data collection process, analysis methods and results will be presented in detail and the findings will be discussed in light of existing literature. Based on the results, practical

recommendations will be provided for female athletes, coaches and sports professionals regarding training programs and the management of expectations.

### Review of Literature

The menstrual cycle consists of three distinct phases: follicular, ovulatory and luteal. The hormonal fluctuations, particularly in estrogen and progesterone levels, during each phase can influence physical performance in various ways [2, 11]. Numerous studies suggest that many female athletes believe their performance is affected by their menstrual cycle [2]. However, there are differing perspectives on the extent of this impact. Some studies indicate that negative effects, such as pain and cramps experienced during the menstrual cycle, can impair performance [3]. Notably, menstrual symptoms are often more pronounced during the early follicular and late luteal phases, which can complicate an athlete's performance [12].

On the other hand, research addressing the effects of the menstrual cycle on performance from different perspectives presents varying findings. For example, some studies propose that the luteal phase may be more conducive to training and that endurance performance might actually improve during menstruation [7]. Furthermore, it is argued that adapting training programs to align with the menstrual cycle could enhance performance. In contrast, in another study, researchers observed that performance tends to be lower during the menstrual phase and similar findings were also reported in physical fitness assessments and other related research [13, 17, 21, 27]. These divergent results underscore the importance of developing individualized training programs that account for the menstrual cycle's impact on each athlete.

In addition to the physical aspects, the psychological dimensions of the menstrual cycle must not be overlooked. Many female athletes report experiencing mood changes in parallel with their menstrual cycle, which can negatively affect focus and motivation [14, 15]. Considering that these psychological effects can influence training adaptations and performance outcomes, fostering open communication is encouraged. Creating an environment where athletes feel comfortable discussing their menstrual health may facilitate better management of these challenges [16, 10].

Finally, incorporating menstrual cycle tracking into training routines can be beneficial for both athletes and coaches. Tracking the menstrual cycle can assist in adjusting training loads and recovery strategies more effectively, thereby optimizing performance [16, 1]. Such an approach could contribute to athletes achieving more efficient and balanced performance, both physically and psychologically.

Some studies examining the relationship between women's menstrual cycles and sports performance are presented in here. Kishali et al. [17], in a survey conducted among elite female athletes in Turkey, found that athletes who experienced pain during their menstrual cycle reported reduced pain during competitions and that their performance was not affected by their menstrual cycle. On the other hand, Brown et al. [2] demonstrated that athletes with a natural menstrual cycle experienced physical symptoms, mood disturbances and loss of motivation, which indeed affected their performance. Taim et al. [18] highlighted the prevalence of menstrual cycle disorders and symptoms among female athletes, noting that emotional symptoms were more pronounced during menstruation.

Wojtys et al. [19] found that ACL (anterior cruciate ligament) injuries were more common during the ovulatory phase and less frequent during the luteal phase in women, with birth control use reducing this effect. Julian et al. [20] observed a decrease in maximum endurance performance during the mid-luteal phase of the menstrual cycle but found no changes in jump and sprint performance. In contrast, Ronca et al. [21] did not observe worse performance during the luteal phase. Isenmann et al. [22], however, found that the menstrual cycle had no effect on strength performance.

Some studies indicate that the effects of the menstrual cycle on performance cannot be clearly determined. Meignié et al. [23] stated that no conclusive findings were reached regarding the magnitude and direction of the effects of the menstrual cycle on performance in elite athletes, while Quadagno et al. [24] discovered that the menstrual cycle did not affect the performance of female weightlifters and swimmers. Armour et al. [25] showed that menstrual pain and premenstrual symptoms led to fatigue and performance decline.

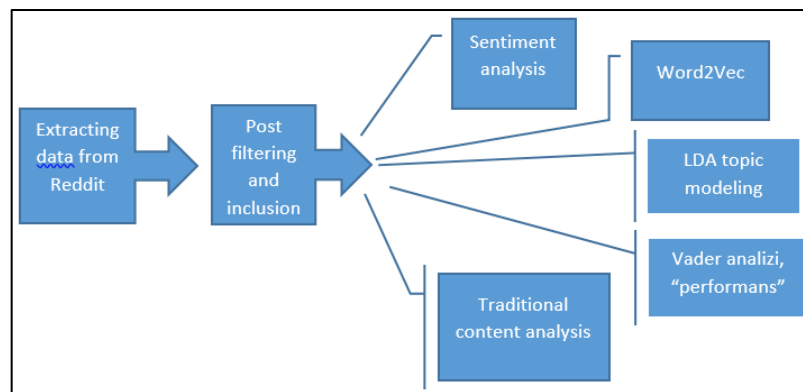
Ergin and Kartal [26] revealed that the menstrual cycle had a greater psychological impact on athletes. Findlay et al. [15] reported that the menstrual cycle negatively affected the performance of rugby players. Solli et al. [27] noted that female endurance athletes experienced changes in physical fitness and performance during different phases of the menstrual cycle, with the worst performance observed during menstruation. Cook et al. [28] found that high-performance female athletes showed more pronounced sal-T fluctuations during their menstrual cycle, which were associated with higher training motivation, a stronger sal-T response and increased neuromuscular power.

The relationship between the menstrual cycle and sports performance is a multifaceted topic that includes both physiological and psychological aspects. While many athletes report negative effects on their performance during certain phases, there is also evidence suggesting that training can be effectively adapted to align with the menstrual cycle to enhance performance. Most studies examining this relationship focus on quantitative research methods, such as surveys, physical measurement tests and systematic literature reviews. Although qualitative studies do exist, they are relatively fewer in number. However, no studies using newer methods such as text mining have been found. Therefore, this study aims to fill this gap in the literature and contribute to this field. The study seeks to examine social media comments on this topic by combining text mining techniques and qualitative research methods.

## METHOD

### Research Process

The data used in this study were collected from Reddit using the Python API wrapper. Using this method, 346 comments and 7,403 upvotes were gathered from three different posts discussing the impact of the menstrual cycle on performance. The data collection process was completed on February 2, 2025. The collected data were analyzed using a qualitative approach supported by digital text mining techniques. The qualitative analysis was conducted solely to support the findings from digital text mining and to identify prominent themes. The data were preprocessed using various text mining techniques to make them suitable for analysis. Subsequently, sentiment analysis was performed using the NRC (National Research Council Canada Emotion Lexicon) and VADER (Valence Aware Dictionary for Sentiment Reasoning) tools and the emotions in the comments were classified. Additionally, key topics were identified using LDA (Latent Dirichlet Allocation) topic modeling and Word2Vec analysis was conducted to explore how menstrual cycle-related terms interact with performance. A general summary of the methodology is presented in Figure 1.



**Fig. 1** Research Process

Figure 1 provides an overview of the research process. The analysis of Reddit comments regarding the relationship between the menstrual cycle and performance was conducted through several systematic stages. First, comments discussing how the menstrual cycle influences athletic performance were extracted from relevant Reddit posts. Following this, the collected posts were filtered to ensure that only those directly related to the topic were included in the dataset. After the data-cleaning process, sentiment analysis was performed using tools such as NRC and VADER to examine the emotional tone conveyed in the comments. This step enabled the identification of users' emotional tendencies and their overall attitudes toward the topic. In addition to sentiment analysis, LDA topic modeling was applied to identify the thematic structure of the comments, resulting in the identification of ten distinct topic clusters representing recurring themes.

Subsequently, a Word2Vec analysis was conducted to explore the semantic relationships between menstrual cycle-related terms—such as “period,” “cycle,” “PMS,” “menstruation,” “flow,” and “PMDD”—and the term “performance.” This analysis mapped the terms into a vector space to reveal how closely these concepts are associated and in what contextual environments they co-occur. Furthermore, VADER sentiment analysis was specifically applied to comments referencing “performance” to assess whether these comments expressed positive or negative sentiment. Finally, a traditional content analysis was carried out to identify major themes, repeated expressions and underlying patterns within the comments. This process allowed for the systematic categorization and interpretation of users’ perspectives, providing deeper qualitative insights into how the menstrual cycle is perceived to affect sports performance.

The process began by extracting comments related to the menstrual cycle and performance from Reddit. Subsequently, only relevant posts were filtered from the extracted data and the comments from these posts were included in the dataset. The collected data were processed with the following steps to make them suitable for text analysis: During the Text Cleaning phase, unnecessary punctuation marks were removed, the texts were converted to lowercase and stopwords were eliminated. In the Tokenization phase, the texts were split into words and each word was processed. Following this, in the Data Structuring phase, the comments were converted into a more structured format suitable for analysis.

Then, sentiment analysis tools like NRC or Vader were used to analyze the emotional tone and overall sentiment expressed in the comments. This analysis aimed to categorize the emotions and feelings in the comments, thus helping to gain deeper insights into users' attitudes and emotions regarding the topic. Next, LDA (Latent Dirichlet Allocation) topic modeling was applied to identify key terms in the comments and detailed analysis was conducted on 10 different topics related to these keywords. This process aimed to group the content of the comments and determine which keywords were associated with each group, thereby making the prominent themes in the comments clearer. Additionally, a Word2Vec analysis was conducted to determine the relationship between menstrual cycle-related terms such as "period," "cycle," "PMS," "menstruation," "flow," "PMDD," and the word "performance." This analysis placed the words in a vector space, helping to explore how these terms are semantically related to "performance." Finally, to determine whether comments related to the word "performance" expressed positive or negative sentiments, a Vader analysis was conducted and the impact of the menstrual cycle on sports performance in women was examined. To identify the prominent themes in the comments, a traditional content analysis method was applied, closely examining the content of the comments and categorizing the thoughts and emotions shared by users on the topic. This process allowed for the identification of recurring expressions, key terms and subtext, facilitating the emergence of fundamental themes and trends.

### **Population and Sample**

In this study, the population consists of Reddit users who actively share experiences, opinions and perceptions related to the menstrual cycle and athletic performance across relevant communities. From this broad population, a purposive sampling strategy was employed to select user comments that directly addressed the study focus. Accordingly, the sample comprises users who contributed comments to three specific Reddit posts that explicitly discuss the perceived effects of the menstrual cycle on sports performance, physical activity and cognitive functioning. These posts; "To all the female runners out there, do you ever feel like your running performance can be influenced by your cycle?", "Women's mental agility is better when they're on their period, new study finds" and "Women perform better in cognitive tests when menstruating, study finds" were selected because they contain rich, user-generated narratives directly aligned with the study's qualitative inquiry. All comments under these posts were screened and those that included explicit references to menstrual cycle phases, physical or cognitive performance and subjective experiences were included in the dataset. This approach ensured that the sample reflected naturally occurring, experience-based discourse from a diverse set of participants, allowing for a comprehensive text mining-supported qualitative analysis.

The data collected for this study consist of a total of 346 comments extracted from three different posts discussing the impact of the menstrual cycle on performance. The data collection was completed on February 2, 2025. The posts from which the comments were extracted have been categorized under the following headings:

- ✓ "To all the female runners out there, do you ever feel like your running performance can be influenced by your cycle?"
- ✓ "Women's mental agility is better when they're on their period, new study finds. Participants reacted quicker and made fewer errors during menstruation, despite believing their performance would be worse, according to the research."
- ✓ "Women perform better in cognitive tests when menstruating, study finds | 'Surprising' results in tests could change assumptions about female athletes' abilities during their period, says author."

The study group consists of Reddit users discussing the impact of the menstrual cycle on performance. Reddit is a platform with a wide global user base where active discussions take place on various topics. Therefore, Reddit was chosen for its ability to provide a space where users openly share personal experiences, offering candid and authentic opinions. The sample consists of 346 comments selected from three different posts, with these comments reflecting the users' experiences and perspectives. The reason for selecting these posts is their focus on the impact of the menstrual cycle on athlete performance. The participants exhibit diversity in terms of age, geographical location and level of sports-related activity, providing a wide range of views on the impact of the menstrual cycle on performance.

### **Data Collection Tools**

Data were automatically collected from Reddit through the Python Reddit API Wrapper. This tool effectively extracts comments from specific topics on Reddit and structures the text data to make it suitable for analysis. As a result, comments related to the topic are quickly obtained and can be integrated into the analysis process.

### **Sentiment Analysis**

In the sentiment analysis process, the NRC Emotion Lexicon and VADER analysis tools were used to evaluate the emotional tendencies in the comments. The NRC Emotion Lexicon scores specific emotions in each comment, categorizing them into emotional categories such as "Anger," "Anticipation," "Disgust," "Fear," "Happiness," "Sadness," "Surprise," and "Trust." VADER, a tool that is particularly effective for social media platforms and short texts, was used to determine the general emotional tendencies in Reddit comments. VADER analysis involved analyzing the positive and negative scores to assess the emotional intensity and content bias of the comments. This method allowed for a more comprehensive examination of the emotional content of the comments.

### **LDA Topic Modeling Analysis**

Latent Dirichlet Allocation (LDA) topic modeling analysis was applied to identify prominent themes in the Reddit comments. This method categorizes the comments into specific topic areas to understand users' interests, needs and concerns. LDA analysis uses the frequency of word co-occurrence in each comment to identify the topics that users focus on the most. The comments were broken down into their key components, grouped under relevant themes and key terms were identified. The results of the topic modeling were presented in the findings section to reveal the thematic points most emphasized by the users.

### **Word2Vec Analysis**

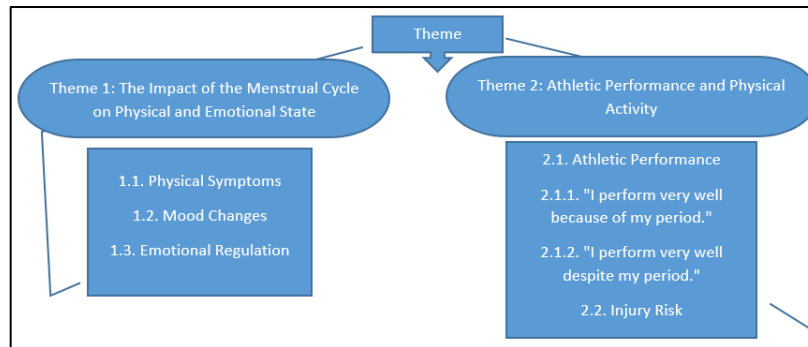
Word2Vec is a natural language processing (NLP) model used to represent words as mathematical vectors. This model transforms words into vectors to effectively capture the semantic relationships between words. It is used to explore similarities and relationships between words in large text datasets and represents meaningful connections in the text. In this study, Word2Vec analysis was conducted to determine the relationship between terms related to the menstrual cycle (e.g., "period," "cycle," "PMS," "menstruation," "flow," and "PMDD") and the word "performance." This analysis helps understand how these terms are semantically related to "performance" by placing the words in a vector space. It allows the exploration of the contexts in which these terms are used and reveals how menstrual cycle-related terms interact with or relate to performance.

## Interpretative Phenomenological Analysis (IPA)

In this study, the phenomenological analysis method, a qualitative analysis design, was used. Phenomenological analysis is a qualitative research method aimed at exploring and understanding the experiences of individuals. This approach is particularly rooted in the phenomenological philosophical traditions of Edmund Husserl and Martin Heidegger and it emphasizes the meanings individuals attach to their experiences. Phenomenological analysis aims to understand the essence of lived experiences and focuses on the detailed exploration of participants' experiences, independent of external interpretations. In this study, interpretative phenomenological analysis (IPA), a branch of phenomenological research, was used to deeply examine user experiences obtained from Reddit. The research aimed to understand participants' experiences from their own perspectives, considering the meanings of these experiences within context and alongside the researcher's interpretations. The qualitative data obtained through archival research were analyzed using IPA. IPA is a qualitative research methodology that explores how individuals make sense of their lived experiences. Developed in psychology, IPA draws from three fundamental philosophical traditions: phenomenology, hermeneutics and idiography. This combination allows researchers to delve deeply into participants' subjective experiences and interpret the meanings they attach to them. While phenomenological principles focus on the essence of experiences, hermeneutic approaches emphasize interpretation [29]. The idiographic nature of IPA prioritizes the unique contexts of each individual, leading to a deeper understanding of the experiences [30]. The phenomenon under consideration in this study is "women's sports performance during menstruation." Based on this phenomenon, the comments from women on the topic were examined.

## Traditional Content Analysis

In analyzing the comments, traditional content analysis was employed. The traditional content analysis process typically involves several key steps, including content selection, development of coding categories and the application of these categories to the analyzed content. Researchers generally start by identifying specific themes or variables that guide the coding process. Content analysis requires a comprehensive review of transcripts to determine the frequency of different themes and the context surrounding each theme. This approach not only quantifies the presence of themes but also takes into account their significance within a broader context, enabling a more detailed understanding of the data. The themes obtained from the traditional content analysis and the categories related to these themes are presented in Figure 2.



**Fig. 2** Themes and Categories

The identified themes and categories provide an overall view of women's experiences based on the comments. Under this theme, the comments from women are discussed in detail in the findings section.

## Ethical approval and institutional permission

The data used in this study were collected from the Reddit platform using an archival research method, which does not involve direct interaction with human participants. As the data were obtained from publicly accessible social media comments, ethical approval in accordance with the Declaration of Helsinki was not required. The study adhered to ethical standards by ensuring participant anonymity and using publicly available data.

## FINDINGS

### Quantitative Analysis Findings

#### LDA Topic Analysis Results

This visual represents the combination of word clouds for 10 different topics derived from an LDA model. Each "Topic" title in the visual displays the most frequently used words related to the respective topic. Each topic reflects users' thoughts on the impact of the menstrual cycle and menstrual periods on performance.

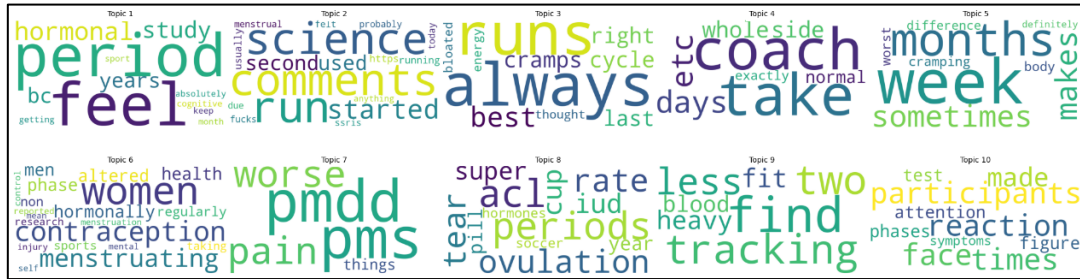


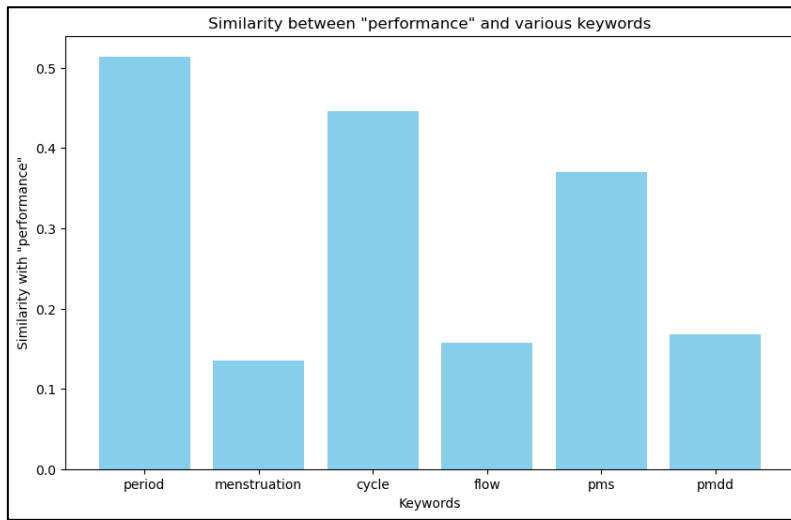
Fig. 3 LDA Analysis Results

Figure 3 shows how each topic reveals different experiences and perceptions related to the menstrual period. For example, some topics highlight participants' challenges with physical activities during their menstrual period and how they feel during this time, while other topics focus on discussions about coaches and training strategies. Words like "Pain," "PMS," and "Tracking" signal negative experiences, physical pain and emotional difficulties associated with the menstrual period, while terms such as "Coach" and "Comments" create awareness about how these experiences are managed. Keywords like "Period," "Women," and "Runs" reflect discussions on how the menstrual period affects sports performance. Participants express how the physical and emotional changes they experience during their menstrual period interact with training and performance, illustrating the challenges faced while engaging in sports during this time. The themes in the visual provide important data for understanding the relationship between the menstrual period and sports performance, showcasing the multifaceted impact of this period on athletes.

#### Word2Vec Analysis Results

In Figure 4, when we examine the similarity analysis based on the Word2Vec model, the relationship between "performance" and "period" holds the highest similarity score, suggesting a meaningful connection between the menstrual period and performance. This relationship indicates that women experience greater physiological and psychological effects during their menstrual period and these effects may influence their performance. A high similarity score of 0.514 strongly supports this relationship.

The similarity score of 0.4457 with the word "cycle" suggests that the menstrual cycle may also significantly impact performance. This implies that the hormonal changes during the menstrual cycle could affect both physical and mental performance. The similarity score of 0.3697 with "PMS" shows that premenstrual syndrome could be a factor influencing women's performance, indicating that mood, energy levels and other factors during this period may be important. Words like "Menstruation" (0.1355), "Flow" (0.1569) and "PMDD" (0.1683) have lower similarity scores, suggesting that the effects of menstruation, menstrual bleeding and premenstrual dysphoric disorder (PMDD) may be less pronounced or complexly related. This may mean that these factors vary in intensity and effect across different women.

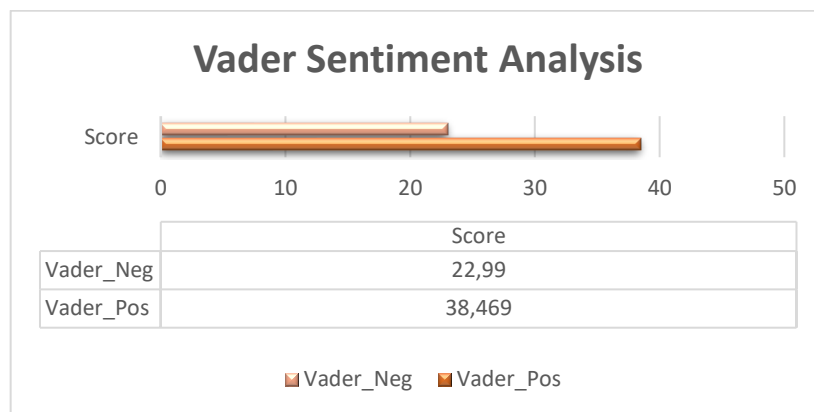


**Fig. 4** Word2Vec Analysis Results

In summary, this analysis based on the Word2Vec model shows that the factors related to the menstrual cycle and PMS have varying degrees of impact on sports and overall physical performance. This suggests that women's performance can be affected differently at different stages of the menstrual cycle.

**Sentiment Analysis Results**

The Vader sentiment analysis results shown in Figure 5 reveal that women's comments on sports performance during their menstrual period are divided into two extremes emotionally. According to these findings, some women stated that their menstrual period did not negatively affect their sports performance, while others made positive comments suggesting that this period actually enhanced their performance. However, the positive sentiment scores are dominant, supporting the view that the menstrual period has a positive impact on sports performance, which is consistent with the findings of the qualitative analysis. Although the graph reflects a balanced distribution of these two views, the higher number of comments with positive sentiments clearly indicates a trend that the menstrual period contributes positively to sports performance.



**Fig. 5** Vader Sentiment Analysis Results

Similar to the Vader sentiment analysis above, the NRC sentiment analysis also shows complex emotions that are closely related, as seen in Figure 6. Although the positive and negative sentiment scores are close to each other, the high score for the "Trust" emotion in the graph suggests that women may adopt a more positive and secure approach regarding their menstrual period. This could indicate that positive emotional interaction during sports leads to a positive impact on performance. The high levels of "Fear" and "Sadness" emotions suggest that physical discomfort and emotional challenges during the menstrual period may negatively affect sports performance. The "Surprise" emotion may stem from the impact it has on those who

do not believe that the menstrual period affects performance. The high level of "Fear" might create a sense of anxiety or reluctance to engage in sports due to pain and difficulty during the menstrual period. The high "Sadness" emotion suggests that a lack of motivation and negative emotional states may be more prominent during this time. The "Disgust" emotion could be associated with the physical discomforts experienced during menstruation, such as pain or bloating, which may cause reluctance to engage in sports. Although this emotion has a low score and is not as prominent, it can still be observed as a feeling associated with the menstrual period. The "Anticipation" emotion might reflect women's hopes and expectations about how they will feel before or during their menstrual period.

The "Fear" emotion has the highest score at 224 points. In the comments, fear is often associated with threat and uncertainty. These comments typically express negative situations and it has been observed that the context of these comments aligns with the stronger expression of fear. Hormonal changes in the luteal phase of the menstrual cycle can increase feelings of anxiety and fear. This phase may affect women's mood and negatively impact their mental and physical performance. For example, comments like "For me, it's just constant stress and fear" reflect the anxiety experienced during the PMS period and its effects on daily life.

The "Joy" emotion has a lower intensity with a score of 155. However, comments with high intensity of this emotion are often associated with positive experiences and a sense of relaxation. During the follicular phase of the menstrual cycle, when hormone levels stabilize, women may feel more happiness and positive energy. This may boost their performance as they feel more motivated and energetic. Comments like "I've been feeling so happy recently" suggest that higher happiness levels are felt during periods when hormones are balanced and mood is stable.

The "Sadness" emotion has a high intensity with a score of 223. This emotion is often associated with negative comments and experiences. Comments appear in contexts where individuals express disappointment, loss, or other sad situations. In the luteal phase of the menstrual cycle, the drop in estrogen and progesterone levels may trigger conditions such as depression, sadness and mood disturbances. Comments like "I feel like everything is going wrong right now" reflect times when hormonal changes negatively affect individuals.

The "Surprise" emotion has a lower score of 95 compared to other emotions, indicating that unexpected events rarely occur and surprise expressions are less emphasized. During the menstrual cycle, women may sometimes experience unexpected hormonal changes, which can lead to surprises. Particularly during the ovulation period, women may feel more energy and excitement. However, hormonal changes can also trigger unexpected emotional reactions. These surprises may suddenly affect physical and emotional performance. Comments like "Wow, I did not expect this at all!" reflect moments of encountering unexpected situations.

The "Trust" emotion has the highest score of 283, indicating that the commentators are sharing situations where they feel confident and secure. During the follicular phase of the menstrual cycle, when estrogen levels rise, trust may be higher. This can positively influence both physical and mental performance. Comments like "I trust this process" suggest that women feel more confident during periods when hormones are balanced and this confidence may enhance their performance.

The "Anticipation" emotion also has a high score of 250, indicating that individuals are expressing their hopes, excitement and expectations about future events. The ovulation period of the menstrual cycle is a time when energy and feelings of anticipation peak. Women may feel more motivated and experience higher anticipation, which can positively affect their performance. Comments like "I can't wait to see how this unfolds" reflect hopes and excitement for the future.

The "Disgust" emotion has a score of 134, which is lower than the other emotions. Comments expressing disgust or aversion are generally less frequent and these emotions tend to arise in more limited contexts. During the menstrual cycle, particularly during menstruation, some women may experience more feelings of disgust. This may be caused by physical discomforts and hormonal changes. The menstrual period is a time when women experience physical discomfort (e.g., pain, bloating) and hormonal changes, which may lead to negative feelings. Comments like "This just disgusts me" can be associated with discomforting physical and emotional situations.

Different stages of the menstrual cycle can determine women's emotional states and the effects of these emotions on performance. Fear and sadness are typically associated with hormonal changes in the luteal phase and performance may decline during this period. Happiness and trust are higher during the follicular phase and women may feel more energy and motivation during this time, boosting their performance. Anticipation and surprise are related to the ovulation period and this time may generate more excitement and motivation. Emotional changes throughout the menstrual cycle can influence both performance and overall mood. Being aware of these emotional fluctuations can help both individuals and researchers analyzing these emotions better understand how performance changes due to emotional shifts.

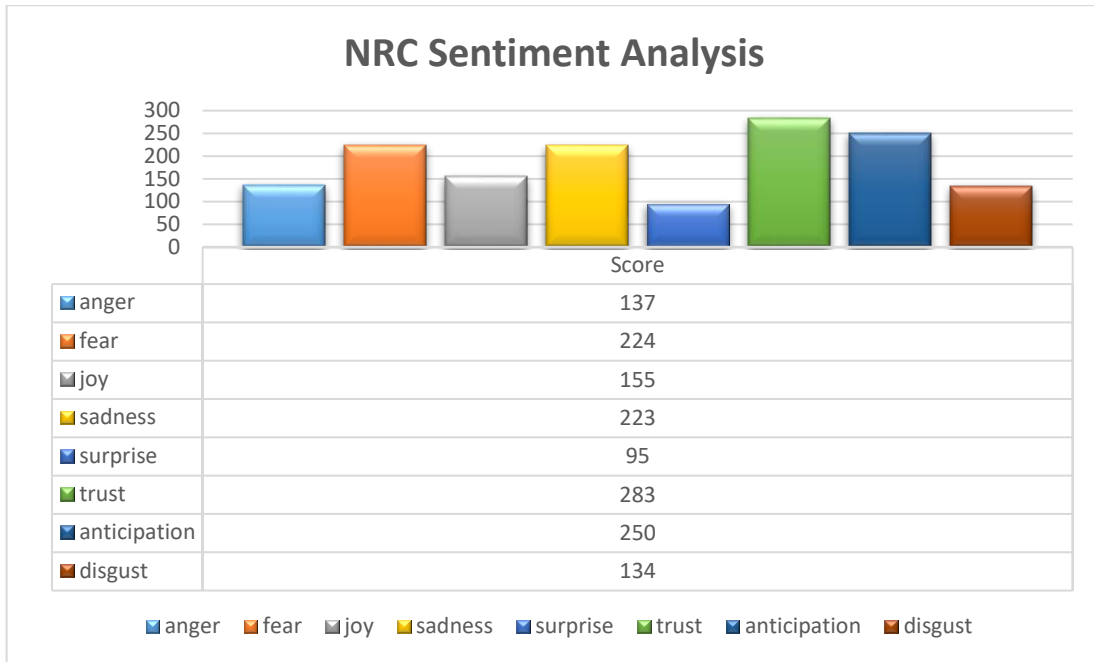


Fig. 6 NRC Sentiment Analysis Results

Figure 7 shows that most of the comments related to the word "performance" have a positive outlook, indicating that people generally have more positive thoughts about performance. Negative comments, on the other hand, are more limited and appear with low intensity in the texts. This result suggests that the topic of performance is typically associated with a good mood and positive emotional state.

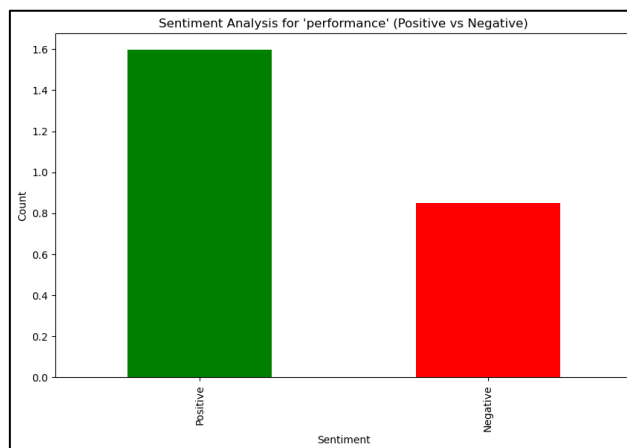


Fig. 7 Vader Analysis of Comments Related to the Word "Performance"

## Qualitative Analysis Findings

### *Theme 1: The Impact of the Menstrual Cycle on Physical and Emotional State*

#### Physical Symptoms

The physical symptoms experienced by women during their menstrual cycle are varied and these symptoms often negatively affect their daily lives and, particularly, their physical activity and sports performance. Many women report experiencing discomforts such as bloating, cramps and fatigue both before (in the premenstrual phase) and during their menstrual period. For example, some women report experiencing severe cramp pain before their period, while others specifically experience pain and discomfort in the lower abdomen and lower back. Additionally, fatigue is a common symptom that negatively impacts endurance and energy levels during physical activity. Mood swings, irritability and anxiety are also frequently reported, which further complicates physical performance. Interestingly, some athletes report experiencing a phenomenon known as "period strength" during their menstrual cycle, particularly in weightlifting and endurance sports, where they feel stronger or more capable during this period, rather than experiencing a decrease in physical performance. However, the general trend is that the week before menstruation and the first few days of menstrual bleeding are the most challenging periods, with many women performing below their usual capacity during this time.

The comments reveal a wide range of experiences regarding how different phases of the menstrual cycle affect physical performance. Several users reported that while menstrual cramps do not always prevent them from exercising, ovulation-related symptoms can be particularly disruptive. For example:

*"During my period or with cramps, I can still run, no problem. But on ovulation day or afterward, I feel bloated and my ovaries feel extremely tender and heavy. It feels like they might fall out! Fortunately, this only lasts for a day, but it's really painful while running."* (Upvotes: 2)

Many comments emphasized that the premenstrual phase is the most challenging period due to bloating, mood changes, fatigue and decreased motivation. Several users explained:

*"Some of us actually feel relief from PMS/PMDD when our period starts. For many, the toughest part of the cycle is the premenstrual phase."* (Upvotes: 1853)

*"I feel really bad in the days leading up to my period. Aside from bloating, I'm usually mentally in the best shape when my period starts."* (Upvotes: 47)

Others described severe pain during menstruation, which can significantly limit physical performance and overall daily functioning:

*"I vomit from pain during my period. Does it make me perform better in exams? No."* (Upvotes: 22)

*"But I have endometriosis and the pain really prevents me from focusing."* (Upvotes: 2)

*"I feel terrible before and during my period. Everything is extra hard because of fatigue and cramps."* (Upvotes: 5)

Some users reported observable physiological changes, such as variations in heart rate or energy levels:

*"My average heart rate spikes when I run just before my period."* (Upvotes: 12)

A few comments highlighted mixed experiences—while some women are capable of maintaining training performance, the pain can still be overwhelming:

*"I did a 800 PR during my period, but my cramps were so bad that they made me throw up during my training sessions, both before and during my period."* (Upvotes: 0)

Several users noted that severe bloating and fatigue immediately before menstruation significantly hinder exercise capacity:

*"Just before my period, I bloat up like a balloon, struggle to find energy to go to work and have back pain. If I exercise at all, it's just a light walk or gentle yoga. Running that day is really impossible. If I'm having a busy day, I don't want to run or exercise because I feel terrible and I also have cramps."* (Upvotes: 0)

Ovulation pain was also commonly mentioned as a barrier to physical activity:

*“When I try to run on ovulation day, I get horrible cramps. I plan my runs so they don’t coincide with those days.”* (Upvotes: 0)

*“Ovulation pain really affects my running. It feels like I can feel my swollen ovaries for a day or sometimes two and it’s not pleasant!”* (Upvotes: 2)

In addition, some individuals described muscle and abdominal cramps so intense that basic movement becomes difficult:

*“My legs and uterus cramp so severely that I can’t walk comfortably and I get breathless afterward.”* (Upvotes: 1)

Despite these challenges, a few users reported feeling physically stronger or more capable during certain phases, with improved performance either before ovulation or a few days after the onset of menstruation:

*“I have great runs before and after ovulation, but just before my period I feel so weak that I can’t run much until the 3rd day. But right after that, even while my period is ongoing, I’m ready to run.”* (Upvotes: 1)

Many participants highlighted that menstrual pain consistently interferes with exercise, regardless of medication:

*“My period cramps always seem to affect my exercise. It doesn’t matter if I take medicine, the pain doesn’t go away. The only thing I can do during a middle run or netball match is stop.”* (Upvotes: 1)

Some users reported intense bloating and abdominal discomfort even during routine activities such as morning runs:

*“When I went for a morning run, I felt my whole abdominal area was bloated and every step jolted and hurt.”* (Upvotes: 2)

The physical symptoms experienced by women during their menstrual cycle can directly impact their sports performance. Some women report being able to run despite cramps during their menstrual period, while experiencing bloating, heightened sensitivity and a feeling of heaviness in their ovaries during ovulation days. This can be painful while running, but it is generally described as a temporary condition that lasts for only one day. Many women state that they feel worse during the premenstrual phase due to bloating, fatigue and cramps, but mentally feel better once their period starts. However, some women report vomiting due to severe pain during their period, which negatively impacts their sports performance. Additionally, some women with conditions like endometriosis mention that pain prevents them from focusing and limits their physical activities. These physical challenges, particularly in endurance sports like running, make it more difficult and women often prefer lighter exercises during this time. On the other hand, some women report that running before and after ovulation is more comfortable and that they experience an improvement in their performance. However, severe cramps and fatigue during menstruation require athletes to plan their training sessions carefully during these periods.

### Mood Changes

The mood changes that female athletes experience during their menstrual cycle can have a significant impact on their overall well-being and performance. Many women report experiencing negative emotional states, such as irritability and anger, especially during the premenstrual phase, which can hinder focus and motivation. However, a noticeable improvement in mood and mental clarity is often observed when menstruation begins. These mood changes, especially during the premenstrual phase, can be accompanied by emotional symptoms like anxiety and stress due to fluctuations in hormone levels. Overall, the psychological effects of the menstrual cycle should be considered in training programs, as athletes may need more support during phases when they experience heightened emotional intensity. Furthermore, establishing open communication about these mood changes between athletes and coaches can have positive effects on training adaptations and performance outcomes.

The comments also highlight a considerable range of cognitive, emotional and motivational changes experienced during different phases of the menstrual cycle. Many users described significant mental fog, reduced concentration and decreased cognitive clarity during menstruation, which they felt directly impacted both exercise and academic performance. For example:

*"During my period, I can't think about ANYTHING... I can't even imagine taking a big exam, let alone doing an entire workout."* (Upvotes: 27)

Several users emphasized that the premenstrual phase triggers mood disturbances, irritability and emotional fluctuations, which affect their willingness and motivation to exercise. One user explained:

*"Before my period is probably the peak of my PMS. I'm usually in a worse mood... if I can actually get up and decide to run."* (Upvotes: 3)

Some comments referred to changes in energy balance and physiological needs, noting increased sleep and appetite during this time:

*"I'm tired and feel terrible! I think I sleep and eat more during this time, which might increase my cognitive performance."* (Upvotes: 2)

Other users pointed out that the days just before menstruation are marked by forgetfulness, insomnia and migraines, which collectively impair daily functioning and exercise capacity:

*"For me, it's the pre-period and the first 2–3 days. I'm extremely forgetful, have insomnia and get migraines during pre-period days."* (Upvotes: 1)

A subset of users expressed heightened anger and anxiety, reporting emotional dysregulation that complicates both athletic and cognitive performance:

*"I'm totally fueled by anger... anxiety also spikes seriously."* (Upvotes: 19)

Physical and emotional fatigue were frequently mentioned, with many women feeling depleted during their runs:

*"During my cycle, I feel like I'm running on empty when I run."* (Upvotes: 4)

Others described periods of low motivation and energy that led them to rest rather than exercise:

*"For three days, I just feel light and unmotivated... I just use those days to rest."* (Upvotes: 2)

Despite this, some users highlighted that running can be psychologically beneficial even with low energy levels:

*"I have no ambition during PMS and very little energy, but running during this period is extremely beneficial for my mental health."* (Upvotes: 5)

The comments also revealed fluctuations in perceived physical ability, with some women feeling heavy and restricted one week, yet light and capable the next:

*"My legs feel like they're stuck in concrete. Then, the next week, I feel like I could run forever."* (Upvotes: 5)

A few users reported paradoxical patterns in endurance and motivation:

*"During the days before my period, I can run the longest distances without getting tired. But usually, that's the time I feel the laziest."* (Upvotes: 6)

Several women described severe mental and physical exhaustion, expressing a desire to withdraw from activity entirely:

*"The only thing I want to do is hide under a blanket."* (Upvotes: 74)

*"I feel bloated and awful and it's like I have the mental capacity of a snail."* (Upvotes: 1)

Collectively, these comments illustrate how cognitive fog, emotional instability, motivational fluctuations and physical discomfort interact to shape women's performance and well-being across the menstrual cycle. Female athletes report experiencing a significant decrease in performance during certain

phases of the menstrual cycle due to physical and emotional symptoms. Particularly in the premenstrual phase and at the onset of menstruation, women have reported symptoms such as extreme fatigue, mental fog, forgetfulness, insomnia and migraines. These symptoms pose significant barriers to daily activities and sports performance. During menstruation, some women describe experiencing "brain fog" and "confusion," which make it difficult for them to focus and make decisions. Additionally, some participants have shared that they feel more irritable and anxious during their period, which negatively affects their motivation to engage in physical activities.

Some women find it difficult to perform physical activities such as running during their menstrual period, feeling utterly exhausted and opting for only light exercises. During the premenstrual phase and the first days of menstruation, women experience physical challenges such as a depletion of energy and heaviness in their muscles and joints, while their mood is typically negative. However, some women have shared that running and exercise, particularly in the premenstrual phase, are beneficial for their mental health, providing emotional relief despite the physical strain. During this time, women generally focus on resting and recovering their bodies, avoiding intense training and preferring periods of relaxation and physical rest.

### Emotional Regulation

Emotional regulation during the menstrual cycle varies significantly among women and many have noted an increase in emotional sensitivity during certain phases. In the premenstrual phase, mood changes such as irritability, anxiety, extreme sadness and emotional instability are common, with these emotional fluctuations often decreasing once menstruation begins. Some women have mentioned that their mood changes are linked to physical symptoms, particularly cramps and bloating, which affect their daily activities and make it difficult for them to perform tasks due to challenges like concentration difficulties and heightened stress sensitivity. However, once menstruation begins, some women experience emotional relief and their moods stabilize.

To cope with these emotional fluctuations, female athletes often turn to strategies such as exercising, maintaining regular sleep patterns, practicing stress management techniques and adjusting their diets. While some athletes focus more on rest during their period, others enhance their well-being by engaging in physical activities that promote the release of endorphins. The use of pain relief medications is also a common solution, while athletes plan their training according to their menstrual cycle to avoid physically demanding exercises and reduce performance losses. Some of the comments are as follows:

*"Personally, menstrual underwear like Thinx has been a game-changer for me. I usually wear black bike shorts (non-padded) and these underwear and I've run distances up to a half marathon without any issues. Of course, every body is different, but they've saved my life." (Upvotes: 24)*

*"Menstrual cups are the best for me during running, although sometimes I time my 3+ hour runs with a heavy flow and the cup fills up. Still, I love them because it's portable and I can check if I need to empty it or if there's any leakage. Cotton pads aren't great for long runs for me. I tried them once and the friction really hurt!" (Upvotes: 19)*

Female athletes report that the hygienic products they use during their menstrual cycle have a significant impact on their performance. Many women express the need for the products they use during exercise, especially in long-duration workouts, to provide comfort and security. For example, menstrual underwear like Thinx has provided significant convenience for some women; these products can be used comfortably during physical activity without the risk of leaks and do not hinder exercise. Women who have used such products and successfully run long distances, such as half marathons, emphasize how these products have greatly simplified their lives. Another popular option is menstrual cups. Menstrual cups provide greater efficiency during long runs and since they can be removed and checked in portable toilets, they are preferred by many users. However, the risk of menstrual cups filling up during extended use can create difficulties in timing some runs. Cotton pads, on the other hand, can be uncomfortable for many women during long runs because they may cause pain due to friction. These experiences highlight that the hygienic products women use during their menstrual cycle directly affect their sports performance and it is important for athletes to choose products based on personal preferences.

Products such as menstrual cups and special underwear play a crucial role in increasing the comfort of women who engage in physical activities during their menstrual period, making sports less strenuous and providing comfort. Although the menstrual period can be physically and emotionally challenging for women, these hygiene products make exercising more manageable. By using these products, women are able to increase both their physical comfort and psychological security, allowing them to be stronger, more motivated and more productive during their period. These hygiene products enable women to engage in sports activities with ease throughout their menstrual period, helping them navigate this time in a more controlled and comfortable manner.

Women highlight the life-changing benefits of these products, as seen in statements like "I recommend the menstrual cup" and "I can't live without my menstrual cup and Thinx!" These products are emphasized as essential tools for women during their menstrual period, especially when it comes to maintaining comfort and security during physical activities. Menstrual cups are seen as a perfect option for ensuring safe and comfortable exercise during the menstrual period, addressing the common concern of leakage during activities. Comments like "The menstrual cup is truly a game-changer" show how useful and beneficial these products are during sports activities.

The use of menstrual cups not only eliminates the concern of leaks but also provides comfort and practicality during long physical activities, such as running. For physical activities like running, the menstrual cup offers increased freedom of movement and a sense of security. Women who state, "I can't live without my menstrual cup and Thinx!", emphasize how these products allow them to feel more at ease and secure during exercise. These products offer significant convenience, especially for outdoor long-distance runs, as they can be easily removed at portable toilets and checked for leaks.

However, some women report that traditional hygiene products, particularly cotton pads, are not ideal during long physical activities. Comments such as "Cotton pads aren't good for long runs" and "I tried it once and it hurt due to friction!" indicate that these products are not suitable for athletes. Cotton pads can cause discomfort, friction and leaks, especially during long runs. In contrast, women who refer to "Thinx underwear as a game-changer" highlight the comfort and leak-free alternatives that these products provide during exercise. Special underwear, like Thinx, allows women to move freely during long-duration activities, such as running, with comfort and security throughout the menstrual period. One woman shared, "I usually wear black bike shorts (without pads) and this underwear and I've run half marathons without any issues," showing that these products are both durable and practical, even for long distances.

In conclusion, hygiene products for women who engage in sports during their menstrual period are essential tools that enhance their physical performance and make this period more efficient. Menstrual cups and Thinx products help women feel freer, more secure and more motivated, making it easier to exercise and improve performance during their menstrual cycle.

### ***Theme 2: Athletic Performance and Physical Activity***

#### **Athletic Performance**

***"I perform very well because of my period."***

Based on the comments provided, a number of factors have been identified that positively affect female athletes' performance. During certain phases of the menstrual cycle, particularly during menstruation, athletes report experiencing higher energy levels, increased motivation and enhanced focus. Many athletes feel physically stronger and more resilient during this period, allowing them to perform at a higher level. For example, in endurance sports like running, some athletes have reported achieving personal bests during their menstrual period. The increased energy during this time allows athletes to perform better both physically and mentally. In addition, some athletes report feeling more confident and motivated during their menstrual period, with this not only positively affecting their physical but also their mental performance. The emotional relief experienced at the start of menstruation helps female athletes feel mentally clearer and reduces their stress levels. This results in better concentration during competitions and training, as well as less distraction.

As the menstrual cycle approaches the luteal phase, some athletes have observed that they are able to handle their training loads more effectively and feel stronger and more resilient physically. This contributes

to the successful completion of training sessions and performance goals. Overall, the menstrual period not only provides physical strengthening but also contributes to mental balance and strength, thereby enhancing athletic performance.

Some users reported experiencing noticeably improved athletic performance, increased motivation and higher energy levels during their menstrual cycle—a pattern that contrasts common assumptions about physical decline during this period. These comments highlight that for certain women, menstruation can coincide with peak running performance, stronger endurance and enhanced psychological readiness.

Several users described experiencing their best runs during menstruation, often expressing surprise at how strong and energized they felt despite typical menstrual symptoms:

*“During my period, I always have my best runs. It feels like I have more energy than usual... every time I run, it turns out to be a great run.”* (Upvotes: 0)

Others similarly stated that the menstrual phase consistently aligns with their top performance levels, while the premenstrual week tends to hinder their athletic ability:

*“My period is my best time for running. The previous week completely ruins my performance.”* (Upvotes: 11)

Another user noted improved lifting capacity just before menstruation, suggesting that hormonal fluctuations may positively influence strength:

*“Right before my cycle, I can lift about 80–90% of my maximum weight.”* (Upvotes: 0)

Some users described a clear fluctuation pattern, with their weakest performance occurring one week before menstruation, followed by rapid improvement after bleeding begins:

*“A week before my period, my running times drop... After my period starts, I struggle with cramps, but after that, it feels like I’m FLYING.”* (Upvotes: 0)

A smaller yet notable group consistently performs better both before and during menstruation:

*“I’ve always performed better before and during my period.”* (Upvotes: 1)

Users also expressed feelings of increased confidence, determination and psychological strength during this time:

*“During that time, I feel more confident and full of determination.”* (Upvotes: 1)

Similarly, some emphasized increased physical energy:

*“I feel like I have more energy during my period.”* (Upvotes: 5)

Many participants recognized clear, recurring performance patterns that they actively take advantage of:

*“I know my best runs are during my period and I try to make the most of it.”* (Upvotes: 26)

For some women, ovulation and menstruation mark different performance peaks, with menstruation often bringing relief and renewed strength:

*“A week before my period, I have my worst runs... during ovulation, I have my best runs. But I’ve never run during my period.”* (Upvotes: 0)

Competitive athletes also provided examples of achieving personal records (PRs) directly during menstruation:

*“I set a PR and won a medal... then my period started an hour after the race.”* (Upvotes: 0)

*“I ran the Hood to Coast relay during my period and set PRs in 2 other legs.”* (Upvotes: 0)

Some users observed the same pattern emerging month after month:

*“Last month, I noticed that some of my best runs were during that time.”* (Upvotes: 1)

Others reported menstrual phases in which pain was minimal or absent, allowing for unexpectedly strong performance:

*"I'm on my period now... I ran much better yesterday and even this morning and I didn't have cramps."* (Upvotes: 1)

Several comments emphasized the empowering experience of recognizing menstrual-cycle-related performance benefits:

*"I've always thought my best runs were on the first day of my period... I'll say, 'I'm running so well because of my period.'" (Upvotes: 2)*

Some even noted long-term patterns of setting personal records during menstruation across different competitions:

*"Over the years, I've set many personal records during my period, including marathons."* (Upvotes: 5)

One user reflected on the lack of awareness regarding menstrual-cycle effects in strength training environments:

*"Only one of my coaches truly understood how the menstrual cycle impacts lifting ability."* (Upvotes: 5)

Collectively, these comments demonstrate that for many women, the menstrual phase can correspond with increased strength, motivation and athletic performance—countering widely held assumptions and highlighting the individualized nature of menstrual-cycle responses.

Female athletes report that their athletic performance during the menstrual cycle can vary significantly across different phases of the cycle. Some women feel more energetic and motivated during their period, performing better in running and other physical activities than expected. Throughout menstruation, some athletes express having more energy than usual, which helps them perform better while running. Specifically, on the first days of their period, some women report achieving better runs and feeling physically stronger. On the other hand, during the premenstrual phase, performance tends to decline, with symptoms like muscle fatigue and a heavy feeling in the legs becoming more prominent. Fatigue and physical discomfort during the premenstrual phase negatively impact women's running times and recovery, leading to lower performance during this period. However, in the days following menstruation, many women report feeling stronger and faster, leading to improved performance. In summary, female athletes experience periods of increased or decreased performance in line with varying energy levels and physical conditions during different phases of the menstrual cycle.

*"I perform very well despite my period."*

Athletic performance for female athletes can be significantly negatively impacted by a range of physical and emotional symptoms during the menstrual cycle. Many athletes report noticeable drops in their performance during certain phases of the cycle. Particularly in the premenstrual phase, women often experience symptoms like fatigue, weakness, leg pain, muscle stiffness and generally reduced energy. These symptoms cause athletes to perform at lower levels during physical activities and make exercises that they would normally do with ease more difficult. Many women report feeling heavy in their bodies and that they need to exert more effort, especially during long-duration endurance activities, which leads to a decline in performance.

When menstruation begins, physical symptoms can become more intense. Cramps and abdominal pain can cause significant discomfort while exercising, severely limiting physical performance. In endurance sports, such as running and swimming, these pains can directly affect performance. Additionally, the body's tendency to retain water during menstruation leads to bloating and general discomfort, further limiting movement capabilities. Along with the physical pain and discomfort, many women experience emotional symptoms such as a lack of motivation and poor focus. Irritability, anxiety and depressive moods can cause athletes to be less effective in training and competitions. These emotional difficulties can amplify the negative effects on physical performance because athletes may struggle to focus their efforts emotionally, which results in lower performance during training.

Overall, female athletes indicate that symptoms during the premenstrual and menstrual phases significantly hinder their performance, with their bodies working less efficiently during these periods and their psychological state reinforcing this. To manage these symptoms, it is necessary to carefully plan training programs, increase rest periods when needed and implement personal recovery strategies. Some of the comments are as follows:

Many users emphasized that even when cognitive performance remains stable or improves during certain phases of the menstrual cycle, physical performance often declines due to pain, fatigue, slower reaction times and reduced tolerance for exertion. This discrepancy between mental and physical functioning highlights the importance of evaluating menstrual-cycle effects beyond cognitive tasks alone.

Some users explicitly stated that cognitive performance does not translate into athletic performance, noting the key differences in physical demands:

*“Although women perform well cognitively, they often feel worse physically. Sports require as much (if not more) physical effort as cognitive effort.”* (Upvotes: 768)

Others pointed out that ease in cognitive tasks performed while sitting does not reflect the challenges of physical exertion during menstruation:

*“It’s strange to assume that a woman will perform better in sports simply because she does a mental task better while seated... cramps are less painful if one isn’t jumping, running, or physically exerting themselves.”* (Upvotes: 179)

Further illustrating this mismatch, one user shared an observation from a coach, noting that menstrual-cycle effects impair physical training far more than cognitive tasks:

*“A friend who coaches female runners noted that about a third of their normal training days will be negatively affected by their menstrual cycle. Cognitive abilities are different.”* (Upvotes: 3)

Many comments described physical slowing, reduced speed, heaviness in the legs and increased sensitivity to pain just before or during menstruation:

*“I play a contact sport and right before my period and the first few days, I’m slower and have a much lower pain tolerance.”* (Upvotes: 50)

Several users noted that while they may feel stable when resting, any physical movement dramatically worsens symptoms:

*“If I’m sitting completely still, I actually feel pretty good. Running or exercising makes everything worse immediately.”* (Upvotes: 35)

Others emphasized that athletic performance requires both physical and cognitive elements and cramps or pain diminish the physical side regardless of mental readiness:

*“Some physical sports may require a reasonable amount of cognitive activity, but knowing you’ll perform well mentally doesn’t help if you’re dealing with cramps or pain.”* (Upvotes: 4)

A large portion of users described clear performance declines 2–4 days before menstruation, including slower times, weaker endurance and an inability to maintain their usual pace:

*“About 2–4 days before my period, I struggle a lot and my average mile time increases by up to 30 seconds... my body just can’t find the rhythm.”* (Upvotes: 7)

Some shared severe disruptions to normal training, with even short distances becoming difficult:

*“Four days before my period, my 6 km run was a disaster... I couldn’t complete more than 2 km without stopping.”* (Upvotes: 2)

One of users summarized this relationship simply:

*“Running is definitely heavily affected by the menstrual cycle!”* (Upvotes: 2)

Beginners as well as experienced athletes noted major drops in energy and motivation before their period, leading some to pause training entirely:

*"I stopped running the week before my period because it felt almost impossible. My legs felt like lead... I give myself a break those days because it really made me feel bad."* (Upvotes: 2)

Others emphasized the interaction of cramps, side stitches, leg heaviness and slower pace, which forced them to reorganize their training cycle:

*"I feel exhausted, my body is tired... Running during my period is torture. I plan my hard runs weeks before or after and only do easy runs then."* (Upvotes: 3)

A smaller number described unusual patterns, such as feeling their worst after the menstrual phase ends:

*"I feel terrible the entire week after my period... I can't do any strenuous effort that whole week."* (Upvotes: 9)

Collectively, these comments demonstrate that while cognitive performance may remain stable or improve, physical performance is often significantly compromised by menstrual-cycle-related symptoms, particularly in the premenstrual and early menstrual phases.

For female athletes, the menstrual cycle can often negatively impact physical performance, while the effects on cognitive performance tend to be less noticeable. During certain phases of the menstrual cycle, women may feel physically weaker, which can lead to a decrease in performance during sports activities. Particularly in the premenstrual phase, many women report experiencing a heavy feeling in their legs, fatigue and a loss of speed. Endurance sports, such as running, become more challenging during this period because women often struggle to maintain their pace due to physical symptoms and pain. Cramps, muscle soreness and extreme fatigue in the legs reduce women's desire to exercise and lower their motivation. As a result, women typically prefer lighter exercises during this time, as engaging in more intense physical activity can exacerbate pain and lead to further performance decline. After the menstrual period, however, women tend to feel stronger and more energetic, allowing them to perform better in activities like running. These physical challenges before menstruation require athletes to plan their training and competitions accordingly to achieve more effective results.

### Injury Risk

The risk of injury for female athletes during their menstrual cycle is related to the effects of hormonal changes on the body. Specifically, during the luteal phase of the menstrual cycle, fluctuations in estrogen and progesterone levels can increase muscle flexibility, which can, in turn, raise the risk of injury. Participants have noted that these hormonal changes, combined with muscle fatigue and a loss of coordination, increase the likelihood of injury. Some athletes have shared that the fatigue and muscle pain they experience during menstruation lead to performance declines, prompting them to plan their training schedules according to their menstrual cycles. Symptoms such as a heavy feeling in the legs, muscle cramps and a decrease in joint mobility during menstruation are factors that can trigger a higher risk of injury. Some comments are as follows:

*"Women have a higher likelihood of injury during this time."* (Upvotes: 96)

*"Until ovulation, your hormones are hormonally optimized for performance, then your hormones become estrogen-dominant and your energy and strength decrease, but flexibility increases (which can raise the risk of injury)."* (Upvotes: 1)

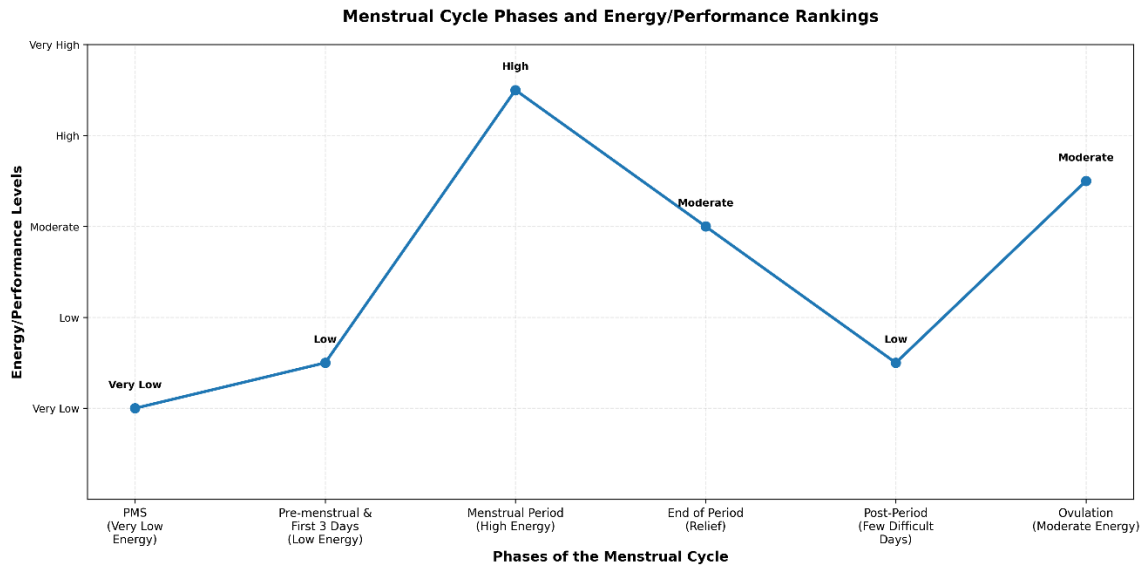
*"I have strained my back countless times during my menstrual period. The muscles contract during this time and it can be easy to overstretch them."* (Upvotes: 52)

*"I broke my foot and still managed to finish a race!"* (Upvotes: 1)

Hormonal changes during the menstrual cycle can influence injury risk. As estrogen becomes dominant in the luteal phase, flexibility in the body increases, making muscles and ligaments more stretched, which can increase the likelihood of injury. Additionally, as hormone levels rise, muscles become softer and more flexible, which can enhance mobility but also put greater strain on connective tissues and joints. The increased risk of injury during this period is linked to the excessive stretching of muscles and ligaments, making them more vulnerable to damage. Therefore, the physical effects of hormonal changes directly impact athletes' performance and injury risk.

## Phases of the Menstrual Cycle and Their Effects on Performance

Throughout the different phases of the menstrual cycle, women's energy and performance levels vary. In Figure 8, based on our data, these differences across the phases are visually represented.



**Fig. 8** Phases of the Menstrual Cycle

PMS (Very Low Energy) is the most challenging phase of the pre-menstrual period, characterized by a significant drop in energy levels. This phase is associated with physical symptoms such as fatigue, bloating and mood swings, leading to low motivation and a reduced performance capacity. According to our data, 1,967 people support this view. The Pre-Menstrual Period and the First 3 Days (Low Energy) is marked by hormonal fluctuations reaching their peak, during which women experience discomfort and fatigue, making physical activities more difficult. This view is supported by 112 people. Relief on the 3rd Day (Moderate Energy) occurs as the menstrual period progresses and women generally experience a sense of relief. As the worst symptoms, such as cramps and bloating, subside, there is a temporary increase in performance capacity. This view is supported by 90 people. Menstrual Period (High Energy) is described as the time when the highest performance levels are observed. Balanced energy levels due to hormonal changes lead to improved physical performance, a situation supported by 371 people. End of Menstruation (Relief, Moderate Energy) is when energy levels stabilize and overall mood and physical readiness improve, supported by 27 people. Post-Menstruation (A Few Difficult Days, Low Energy) refers to the few days after menstruation when energy levels are low. During the transition to the follicular phase, fatigue and emotional fluctuations may occur, supported by 10 people. Ovulation (Good Energy) is the period when energy levels peak and improvements in physical performance are reported. Higher estrogen levels lead to increased motivation and physical endurance, making this an ideal time for intense physical activity, supported by 14 people. In conclusion, the menstrual cycle is a multifaceted process that affects women's energy and performance. Understanding how hormonal changes influence physical and emotional states is essential for optimizing training strategies for female athletes and individuals.

## DISCUSSION AND CONCLUSION

The menstrual cycle significantly impacts women's energy and performance, with hormonal changes affecting both physical and emotional states. Understanding how these shifts influence athletes is crucial for optimizing training strategies for female athletes. The pre-menstrual phase, particularly PMS (Very Low Energy), is challenging due to fatigue, bloating and mood swings, which lead to reduced motivation and performance. The Pre-Menstrual Period and the first three days of menstruation (Low Energy) are marked by hormonal fluctuations that cause discomfort and fatigue. On the third day, women often experience relief and performance temporarily improves. The Menstrual Period (High Energy) brings higher energy levels, enhancing physical performance. As menstruation ends, energy levels and mood stabilize. Post-Menstruation

(Low Energy) refers to the days after menstruation, where energy levels are lower as women transition into the follicular phase. Ovulation (Good Energy) represents the peak of energy and performance, with increased motivation and endurance.

Research shows that women experience an increase in mental agility during their menstrual cycle, alongside physical challenges, often making fewer mistakes. This suggests that women may navigate this phase more efficiently and powerfully than other times. The statement "Sports is more than just cognitive" highlights that sport is both a mental and physical endeavor. Mental agility allows athletes to respond swiftly and effectively to challenges, facilitating better performance during different menstrual phases. Some women report, "I do my best runs during my period! It's like I have superpowers...", suggesting that their menstrual periods provide extra energy and motivation. This indicates that hormonal changes during the menstrual cycle can enhance performance and provide higher energy levels for certain women. Many feel stronger, both physically and mentally, during their menstrual period, which helps them perform better in activities like running.

For example, some women say, "I always do my best runs during my period" and "I ran the Hood to Coast race during my period and PR'd two other legs," showing that their performance peaks during their menstrual cycle. This suggests that their energetic and motivated state during menstruation leads to improved results in endurance activities like running. Comments like "I can run longer distances during my period" and "On the second day of my period, I did my best ultra run" indicate that for some women, menstruation not only enhances speed but also endurance. This phase becomes a time for pushing physical limits and achieving unexpected successes.

Many women report that the challenges at the beginning of their period diminish and performance improves afterward. Statements such as "I do my best runs after the first day of my period" and "The menstrual period is when I perform my best during runs" suggest that physical discomfort decreases over time, leading to higher energy and better performance. This aligns with a phenomenon where, in the later days of the menstrual cycle, women feel physically and mentally stronger.

The concept of "menstrual strength" emphasizes that women may not only feel physically stronger during menstruation but also mentally empowered, experiencing higher energy and endurance. Hormonal changes during this time contribute to greater resilience, motivation and goal orientation, boosting physical performance. Negative symptoms in the early days of menstruation are replaced by higher energy levels as hormonal balance is restored, enabling women to break personal records and elevate their performance. The menstrual period is, thus, not only a time of physical strength but also mental empowerment. This period allows women to move with better motivation and endurance, highlighting the importance of "menstrual strength" in optimizing performance.

Studies support a significant relationship between the menstrual cycle and performance [27, 28, 21]. This study emphasizes the impact of the menstrual cycle on female athletes' physical and emotional well-being. While many women experience physical symptoms such as bloating, cramps and fatigue that negatively affect daily life and sports performance, some athletes report experiencing "period strength," feeling stronger and more resilient during menstruation. However, the week before menstruation and the first few days of menstrual bleeding are typically the most challenging for female athletes, marked by a noticeable decrease in performance.

The study also explores the effects of mood changes during the menstrual cycle. Many women, particularly in the premenstrual phase, report irritability, anxiety and emotional fluctuations that hinder focus and motivation. Once menstruation begins, most women experience mental relief and clarity, improving their efficiency in physical activities. To cope with mood changes, athletes employ strategies such as exercise, sleep regulation, stress management and dietary adjustments. Additionally, hygienic products, like Thinx menstrual underwear and menstrual cups, provide comfort and security during exercise, allowing women to engage in physical activities with minimal hindrance.

The study also examines how hormonal changes during the menstrual cycle influence injury risk. Estrogen and progesterone fluctuations during the luteal phase increase muscle flexibility, which may raise the risk of injury due to overstretched muscles. These hormonal changes can increase injury likelihood and

affect performance. Athletes are encouraged to plan training according to their menstrual cycle to reduce injury risks. Sentiment analysis using tools like Vader and NRC revealed a mixed emotional landscape in women's comments regarding their menstrual cycle. While some experienced negative effects such as fatigue, pain and anxiety during the premenstrual phase, others reported energy boosts and mental clarity during menstruation. The dominance of positive emotion scores suggests that, at times, the menstrual cycle may positively impact performance, especially for those who experience emotional relief during menstruation, improving focus and concentration.

Studies on the menstrual cycle's impact on athletic performance explore how different phases affect performance. Some report performance differences between the follicular and luteal phases, although these differences are often not statistically significant and vary between individuals [31]. This inconsistency is echoed in studies such as Colenso-Semple et al. [31], where menstrual cycle effects on power performance or resistance training adaptation were not significantly found. Similarly, Simplicite et al. [6] concluded that performance remains stable across different menstrual phases despite some suggested effects.

Psychological factors, including mood swings and motivation, are emphasized in studies like Dam et al. [32], which suggest these can impact performance more than hormonal changes. Findlay et al. [15] reported that most athletes experience symptoms related to menstruation that negatively affect training. These psychological factors, combined with physical symptoms like dysmenorrhea, contribute to perceived performance variations across menstrual phases [32].

Physiological effects of the menstrual cycle are also notable. Ekenros [33] explored periodized training based on the menstrual cycle and suggested that understanding menstrual symptoms could improve training. Brown and Knight [14] highlighted that symptoms such as concentration loss and fatigue could hinder athletic performance. Güler [13] found a decline in volleyball players' performance during menstruation, while Lei et al. [34] noted environmental factors like heat stress could affect menstrual cycle performance. Kishali et al. [17] reported pain during menstruation but no significant change in performance during competitions. Similarly, Brown et al. [2] showed that athletes with natural menstrual cycles experienced physical symptoms and mood disturbances, which affected performance. Taim et al. [18] found that emotional symptoms were more common during menstruation, increasing during the first days of menstrual bleeding compared to the premenstrual phase.

Wojtys et al. [19] observed more ACL injuries during ovulation, with fewer injuries in the luteal phase. Julian et al. [20] reported a decline in endurance during the mid-luteal phase but no effect on sprint and jump performances, highlighting the importance of considering the menstrual cycle for endurance capacity monitoring.

Ronca et al. [21] suggested that performance differences could be better during menstruation and worse during the luteal phase, while Isenmann et al. [22] found that menstrual cycles did not affect strength performance in female strength athletes. Meignié et al. [23] found uncertain results regarding the relationship between menstrual cycle phases and sports performance in elite athletes. Similarly, Quadagno et al. [24] and Armour et al. [25] found no significant performance differences across menstrual cycle phases.

This study emphasizes that the impact of the menstrual cycle on female athletes' performance and emotional states can vary significantly. Both physical and psychological symptoms can sometimes have negative and at other times positive, effects on performance. Hormonal changes may increase the risk of injury and mood fluctuations can make it difficult to focus and maintain motivation. However, some athletes report experiencing "period strength," feeling stronger and more resilient during menstruation. To fully understand whether the menstrual cycle affects women's performance, it is necessary to analyze the different stages of the menstrual cycle in detail, as women often feel differently during different phases of their cycle. In general, the effects of the menstrual cycle on performance are shaped by individual differences, environmental factors and psychological states, leading to inconsistent and sometimes contradictory findings. These results suggest that further research is needed to better understand the impact of the menstrual cycle on sports performance.

## Limitations

The limitations of this study include the small sample size, which was limited to comments from three posts on Reddit. This limitation means the findings were derived from a specific platform with a small number of participants, making it difficult to generalize the results to the broader population. Additionally, the anonymous nature of Reddit comments may have led to results that reflect personal perspectives but cannot be generalized to a larger population. Another limitation is the lack of sufficient control over participants' demographic characteristics, frequency of exercise and physical health conditions. Future research involving larger and more diverse samples from various platforms will be crucial for better understanding the impact of the menstrual cycle on performance.

## Future Research Recommendations

Future research should use larger and more diverse samples to comprehensively examine the effects of the menstrual cycle on performance, controlling for demographic and biological factors and including participants from different age groups and sports disciplines. Long-term and experimental studies should also observe changes over time, exploring the interaction between physiological and psychological factors in greater detail. Additionally, comparing the effects of different training types and sports, supported by hormonal and biomarker analyses, will provide valuable insights. Research should also explore the effectiveness of training programs customized to the menstrual cycle. Objective data collection methods, such as physical performance tests and biometric measurements, will provide more accurate and reliable results. Such studies will help female athletes optimize their performance according to their menstrual cycle and offer valuable information to improve athlete health.

## Acknowledgments

The authors would like to thank the Reddit community for their valuable comments that made this study possible. No additional individuals have contributed to the research in a way that requires acknowledgment.

## Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Funding

Not funding. The authors report there are no competing interests to declare. This research was conducted without any financial or personal relationships that could have influenced the outcomes or interpretation of the results. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Data availability

Data is available on request from the corresponding author. The posts from which the comments were collected for this study are clearly specified in the methods section of our work. As Reddit is an open-access platform available to everyone, interested individuals can search for the three specific posts we focused on and access the comments directly on the platform.

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