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Recreational Female Athletes' Understanding of and Perceived Impact of the Menstrual Cycle on Physical Performance, Mood, and Sleeping Behaviour

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Abstract: This study aimed to examine female recreational (FRC) athletes' knowledge of the menstrual cycle and their perception of how each phase affects their performance, mood, and sleep. One hundred and sixty-four (n = 164) FRC athletes completed an online survey. The questionnaire employed was based on previously validated questionnaires and consisted of three different sections: (a) knowledge about the menstrual cycle, (b) menstrual cycle symptoms, and (c) menstrual cycle and performance. The results indicated that 70.1% of the surveyed FRC athletes were not knowledgeable regarding the phases of the menstrual cycle, with 55.5% being ignorant of the specific hormones released during the cycle. Furthermore, 37.8% perceived that their performance was sometimes affected during the early follicular phase, with the main symptoms being physical fatigue (17.9%) and a more irritable mood (25.9%). In addition, 19.5% of the FRC athletes reported sleeping disturbances, and 20.4% described changes in sleep quality during menstruation. Lastly, 11.9% of the FRC athletes reported suffering from a combination of mood swings, sleeping problems, bloating or stomach issues, breast tenderness, headaches, and fatigue prior to menstruation. The results of this study provide valuable insights into how FRC athletes experience the menstrual cycle, which can help RC athletes and trainers better understand their needs and support them in achieving optimal performance.

Keywords: exercise; menstrual cycle; mood; performance; sleep; survey

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1. Introduction

Despite the continuous marginalisation of women in sport science and the significant anatomical, physiological, and endocrine divergence between male and female athletes, most training methodologies are derived from studies utilising men [1,2]. One of the most fundamental dissimilarities between females and males is the menstrual cycle (MC), which ranges from 21 to 35 days. The cycle is divided into three distinct phases, namely, the follicular, ovulatory, and luteal phases, which impact cardiovascular, respiratory, metabolic, and neuromuscular domains and may influence athletic performance [3–6]. The four hormonal markers that play a pivotal role in the cycle are follicle-stimulating hormone (FSH), luteinising hormone (LH), oestrogen (E2), and progesterone (P4) [7,8].

Studies in exercise science that involve women may not account for changes in hormones or conduct tests when hormone levels are low, thus minimising any potential effects [9]. In the early phase of the follicular cycle, both P4 and E2 levels are low; however, halfway through the follicular cycle, E2 concentrations rise, reach a peak in the late follicular cycle, and strongly drop before ovulation, defined as the day after an LH surge has occurred [2]. In the midst of the cycle, the maturing follicle ovulates, with ovulation being stimulated by a sudden enhancement in LH and an increase of 0.5 °C in body temperature.

Once ovulation is completed, the cycle continues into the luteal phase, which is characterised by the breakdown of the ruptured follicle, which causes the ovum to compose the corpus luteum. Consequently, P4 levels rise 12 to 20 times, as do E2 levels. However, both steroid hormones reach a plateau during the mid-luteal phase, and both start decreasing during the late luteal phase. Once P4 levels fall, the reversion of the endometrium occurs, leading to the beginning of a new cycle [2]. Nevertheless, these hormonal oscillations that occur due to the MC have generated a major debate in the literature on whether they influence athletic performance and fitness among females [6].

Women perform and compete in different sporting events throughout the various phases of the MC despite the continuous change in the profile of female steroid hormones [9]. The availability of information on the MC is necessary for today's culture, given the growing media attention and interest in the MC among athletes, enabling female athletes to make the best decision for their health and athletic performance [10]. The balance of steroid hormones, if disrupted, may influence numerous parameters, ranging from fatigue and sleep disturbances to mood disorders (i.e., excitement and depression) [11]. Consequently, these variables could alter training responses, adaptability, and overall performance [12]. The action of E2 on skeletal muscle is still being investigated. However, recent studies have established that E2 levels positively correlate with muscle mass [13–15]. In addition, several pieces of evidence illustrate that E2 has a positive effect on muscle regeneration after injury [16]. As for P4 and its effect on skeletal muscle, these aspects remain unknown; however, recent research has found that high amounts may increase protein catabolism [17]. Specifically, the luteal phase is linked with the premenstrual period, which is often associated with premenstrual syndrome (PMS), in which different symptoms (e.g., changes in sleep patterns, anxiety, fatigue, and water retention) might cause distress and negatively alter physical, behavioural, and psycho-emotional productivity [10,18].

Since mood may positively or negatively affect performance, understanding psychological characteristics is essential for understanding athletic performance. For instance, goal planning, achieving goals, and mental practice are some of the sport psychology interventions and constructs that have been quantified to improve athletic performance [19]. In addition, a negative mood may interfere with one's motivation to participate in exercise, which may quicken the onset of exercise fatigue [12]. In a systematic review with a meta-analysis, it has been indicated that a favourable subjective response among athletes is shown when the ovarian hormones present an increase in concentration levels compared to phases with lower concentrations [20]. Interestingly, a decrease in amino acid levels and enhanced nitrogen utilisation during the luteal phase have been observed [21,22]. In addition, cyclical changes in serotonin during the luteal phase have been noticed, and these changes are associated with an increased appetite, food cravings, and excess calorie intake [23–25]. Hence, these biochemical fluctuations imply nutrient utilisation is affected by sex hormone fluctuations between phases [26].

Sleep is a behaviour considered essential for the maintenance of physical and mental health [27]. Nonetheless, studies have consistently established that sleep disturbances are more frequent among women than men. Specifically, females are 1.3 to 1.8 times more likely to report sleeping problems (e.g., interrupted and inadequate sleep, lower sleep quality, and struggling to fall and stay asleep) [28–30]. In turn, these problems may negatively impact performance (e.g., in relation to strength) [31], enhance perceived effort, provoke changes in mood (e.g., decreased motivation) [32], induce changes in cognitive processing ability (e.g., executive function), and/or precipitate a decline in motor skills [33]. Research evaluating healthy females in which hormone concentrations were measured across the menstrual cycle found sleep fragmentation around the ovulation phase through the mid-luteal phase is proportional to the preceding ratio of the increase in P4 concentrations. Thus, females with no sleep disturbance in comparison to women who experience such a difficulty might present differences due to the variability in the surge in P4 [34]. As research has indicated, during the follicular phase (days 1–14 of the menstrual cycle), in which

E2 levels are high, sleep quality and duration could be better compared to said parameters in the luteal phase (days 15–28 of the cycle), in which P4 levels are high [35].

Hence, this study aimed to establish FRC athletes' knowledge of the MC and their perception of how each phase affects their performance, mood, and sleep. It was hypothesised that the RC athletes would be knowledgeable about the MC and that they would perceive that their performance was mostly affected before and during menstruation; mood would be perceived as worse pre-menstruation, and sleeping behaviour would be worse during the ovulation phase and luteal phase.

2. Methods

2.1. Participants

One hundred and sixty-four female RC athletes (that is, individuals that are healthy and have a regular level of sports participation) with a mean age of (Mean ± St. Dev. 30.56 ± 9.41 years) from different countries (Cyprus, Greece, Ireland, and the United Kingdom) completed an online survey in English. The participants were recruited through social media and via word-of-mouth and did not receive any compensation for their participation in the study. After being briefed on the study's purpose and significance, RC athletes agreed to have their data used for research purposes. Ethical approval was obtained from the ethics committee of Cyprus (EEBK EP 2022.01.290), and the study was carried out in accordance with the Declaration of Helsinki.

In addition, RC athletes were selected because they were a relatively easy sample to recruit in comparison to elite or professional athletes. The questionnaire was developed using Google Forms, and only the principal investigator had access to the responses. The questionnaire was based on previously validated questionnaires [5,36–39] and consisted of three different sections: (a) knowledge about the menstrual cycle, (b) menstrual cycle symptoms, and (c) MC and performance. Females utilising oral contraceptives (OCs) (n = 21) were excluded from the MC questions regarding performance and mood symptoms and were only included in the sleep-related questions as women's sleep patterns do not clinically change with OC utilisation [13,14]. Females with irregular MC were included in all parts of the study. Furthermore, females (n = 19) who did not participate in any form of exercise or were injured were included only in the questions concerning knowledge of the menstrual cycle.

2.2. Statistical Analysis

The statistical software SPSS 28.0 for Windows (SPSS Inc., Chicago, IL, USA) was used to analyse the results, for which descriptive statistics presented as frequencies (proportion) were utilised.

3. Results

Responses (Table 1) were received from 164 FRC athletes (age: 30.56 ± 9.41 years, height: 164.9 ± 5.02 cm, weight: 65.8 ± 10.09 kg) in relation to 12 different activities (Figure 1). Five FRC athletes did not respond to the questions about performance, mood, and sleeping behaviour due to not exercising and/or menstruation not occurring.

Other activities were as follows: acrobatics, volleyball, martial arts, high-intensity interval training, weightlifting, boxing, roller skating, and football.

Table 1. Menstrual cycle and knowledge.

Do You Know the Phases of the MC?	**Participants (*n*) 164**	**Percent (%) 100**
Yes	49	29.9
No	115	70.1
How many phases do you know?	Participants (*n*) 164	Percent (%) 100
0	115	70.1
1	1	0.6
2	12	7.3
3	6	3.7
4	30	18.3
Do you know the four basic hormones of the MC?	Participants (*n*) 164	Percent (%) 100
Yes	18	11.2
I know some of them	55	33.5
No	91	55.5
How many hormones do you know?	Participants (*n*) 164	Percent (%) 100
0	91	56
1	12	7.3
2	38	23.2
3	6	3.7
4	16	9.8

MC: Menstrual cycle.

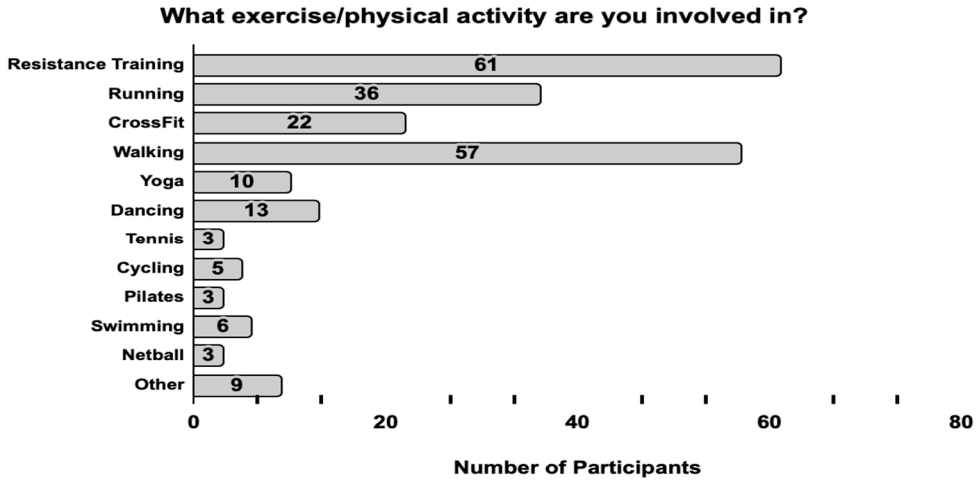

Figure 1. The activities the female RC athletes participated in.

3.1. Menstrual Cycle and Knowledge

Table 1 presents the FRC athletes' knowledge of the MC. One hundred and sixty-four female RC athletes (healthy sports participants) responded to the questions, out of which 29.9% answered 'yes' regarding whether they were aware of the phases of the MC and 70.1% responded 'no'. Furthermore, 11.2% were aware of the four basic hormones. In addition, 56% of the RC athletes did not know any of the hormones involved in the MC, whereas 9.8% were aware of four hormones.

3.2. Menstrual Cycle and Performance

Table 2 presents the MC and its influence on performance during its different phases (menstruation, follicular, ovulation, and luteal). The participants' most common answer when asked, "Do you feel that your menstruation affects your performance?", was "Sometimes", with a correspondence of 37.8%, equivalent to 54 out of 143, followed by 'usually', with a prevalence of 25.2%, corresponding to 36 out of 143; 'always', with a value of 19.6%; 'rarely', with an 11.1% occurrence; and 'never', with a prevalence of 6.3% (Figure 2). Moreover, out of the four menstruation symptoms about which the athletes were queried, 17.9% of the RC athletes experienced only 'physical fatigue (e.g., fatigue, decreased strength, decreased aerobic capacity)', 11.4% endured 'mental fatigue (e.g., lack of motivation, lack of concentration, etc.)', 9.8% felt that 'pain from menstruation' influenced their performance, and 2.4% suffered from 'sleeping problems (e.g., lack of sleep, low quality, and restlessness). Nonetheless, the participants responded with 1–4 more symptoms influencing their performance (Figure 3).

Table 2. Menstrual cycle and performance.

Do You Feel Comfortable Training during Your Period?	**Participants (*n*) 143**	**Percent (%) 100**
Yes	58	40.6
No	34	23.8
Sometimes	51	35.7
How would you describe your performance during ovulation?	Participants (*n*) 143	Percent (%) 100
I always feel strong, motivated, and ready to push myself	20	14.0
I usually feel strong, motivated, and ready to push myself	42	29.4
I sometimes feel strong, motivated, and ready to push myself	54	37.8
I rarely feel strong, motivated, and ready to push myself	12	8.4
I feel weak, unmotivated, and not ready to push myself	15	10.5
Do you believe your mood affects your performance?	Participants (*n*) 143	Percent (%) 100
Yes	88	61.5
Sometimes	30	21.0
Maybe	22	15.4
No	3	2.1

The participants' most prevalent answer when asked "how would you describe your performance during ovulation?" was "I sometimes feel strong, motivated, and ready to push myself", with an occurrence of 37.8%, corresponding to 54 out of the 143 participants. When the RC athletes were asked 'if they feel comfortable training during their menstruation', 58 out of 143 responded "yes", equivalent to 40.6%. Additionally, the participants were asked "if they believe that mood affects performance", with the most common response being "yes", equivalent to 61.5%, followed by "sometimes", corresponding to 21.0%; "maybe", equivalent to 15.4%; and "no", with an occurrence of 2.1%.

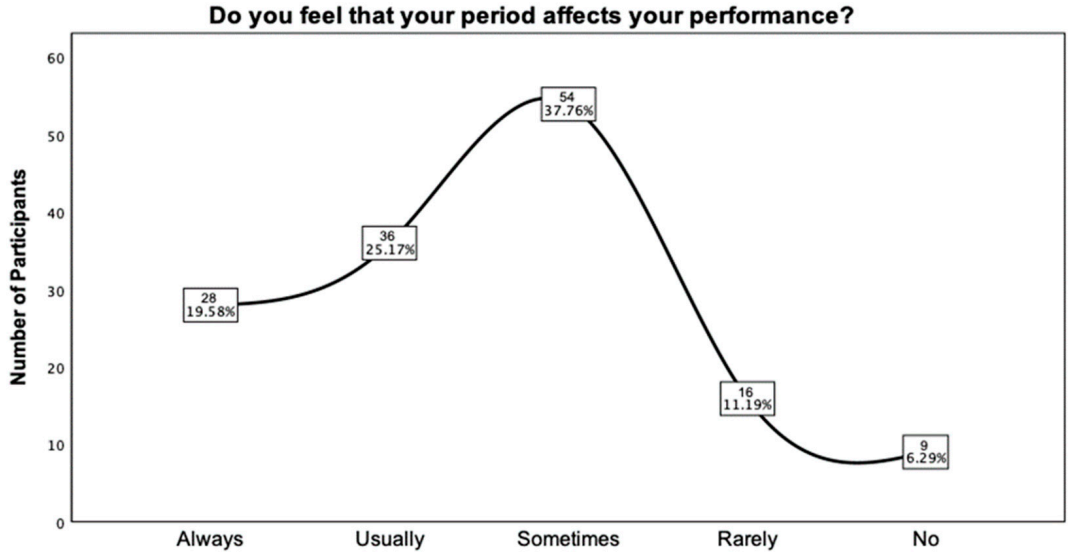

Figure 2. RC athletes' perceived impact of menstruation on their performance.

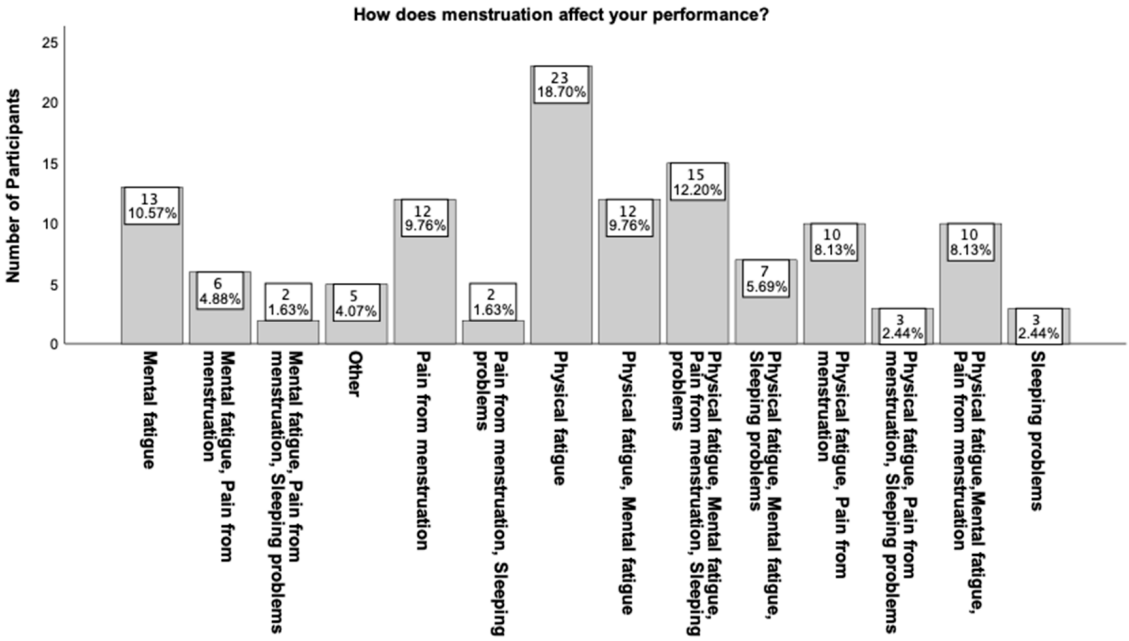

Figure 3. The perceived impact of menstruation on performance.

3.3. Menstrual Cycle and Symptoms

The most common feeling in the affected RC athletes' group was irritation (25.9%), followed by feeling calm (18.5%). The participants reported that two or more symptoms were likely to be present during menstruation, with 9.6% feeling anxious, irritated, and sad and 8.9% perceiving themselves as irritated and sad. In addition, of the six pre-menstruation symptoms examined, the most prevalent was the combination of mood swings, sleeping problems, bloating/stomach issues, breast tenderness, headaches, and fatigue, corresponding to 11.9%, followed by mood swings, bloating/stomach issues, breast tenderness, headaches, and fatigue, amounting to 8.9%, and mood swings, bloating/stomach issues, breast tenderness, and fatigue, amounting to 7.4% (Table 3).

Table 3. Menstrual cycle and symptoms.

How Would You Describe Your Symptoms Prior to Menstruation?	Participants (*n*) 135	Percent (%) 100
Bloating/Stomach issues	4	3.0
Bloating/Stomach issues, Breast tenderness	4	3.0
Mood swings, Bloating/Stomach issues, Breast tenderness	4	3.0
Mood swings, Bloating/Stomach issues, Breast tenderness, Fatigue	10	7.4
Mood swings, Bloating/Stomach issues, Breast tenderness, Headaches, Fatigue	12	8.9
Mood swings, Bloating/Stomach issues, Fatigue	8	5.9
Mood swings, Bloating/Stomach issues, Headaches, Fatigue	4	3.0
Mood swings, Breast tenderness	6	4.4
Mood swings, Fatigue	9	6.7
Mood swings, Sleeping problems, Bloating/Stomach issues, Breast tenderness	3	2.2
Mood swings, Sleeping problems, Bloating/Stomach issues, Breast tenderness, Fatigue	7	5.2
Mood swings, Sleeping problems, Bloating/Stomach issues, Breast tenderness, Headaches, Fatigue	16	11.9
Mood swings, Sleeping problems, Bloating/Stomach issues, Fatigue	5	3.7

Regarding the RC athletes' responses to the question "Do you have any sleeping disturbances during the MC?", out of the 154 participants, 29.9% did reported that they did not experience disturbances, while 19.5% reported disturbances during menstruation (Figure 4). Furthermore, regarding sleeping quality, 26.1% perceived that their sleep quality did not change during their MC, while 20.38% perceived that their sleep quality changed during menstruation (Figure 5).

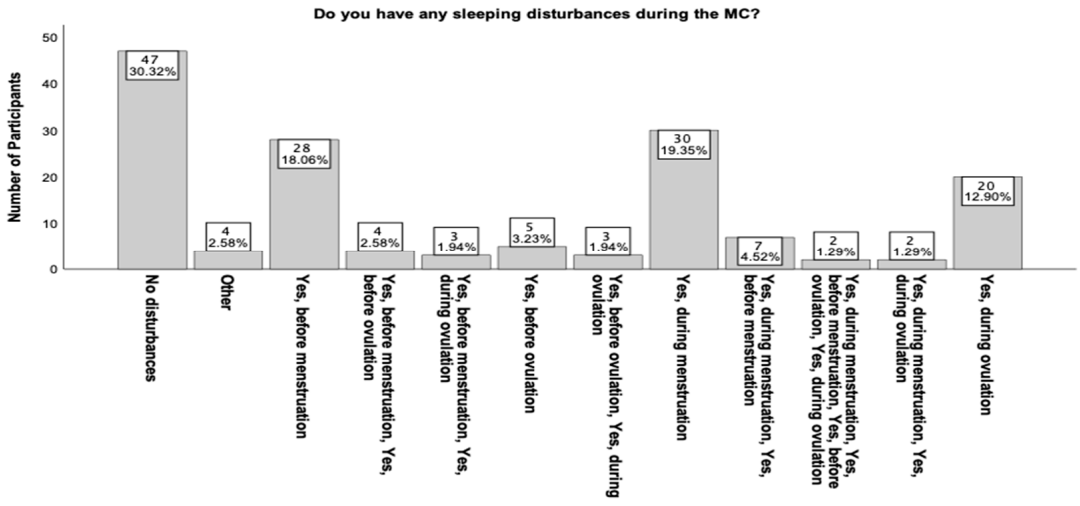

Figure 4. RC athletes' perceived impact of MC on sleep disturbances.

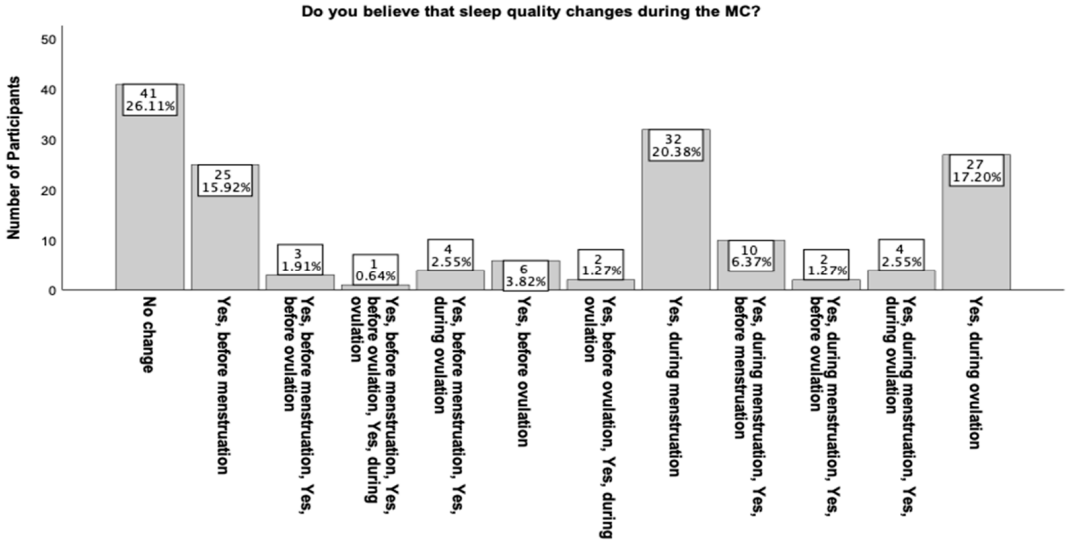

Figure 5. RC athletes' perceived impact of MC on sleep quality.

4. Discussion

This study aimed to identify FRC athletes' understanding and perceived impact of the MC on physical performance, mood, and sleeping behaviour. One of the main findings of this study was that 70.1% of the interviewed FRC athletes were not knowledgeable regarding the phases of the MC. In addition, 55.5% were ignorant of the specific hormones involved in the MC. It might be assumed that the general population and elite female athletes better understand menstruation and how the cyclic fluctuations that govern the MC have critical biological importance for the female body, considering how menstruation is a vital sign of a woman's health [40].

Female sex hormone levels in eumenorrheic women can vary by more than 100% over a 24 h period [41] due to the complex regulation of these hormones and the feedback mechanisms of the body [42]. In this study, 37.8% of the RC athletes perceived that, during the early follicular phase, their performance was sometimes affected by menstruation, with the most attributed symptom being physical fatigue (17.9%) and a more irritable mood being observed (25.9%). In addition, 19.5% of females reported experiencing sleeping disturbances, and 20.4% reported changes in sleeping quality during menstruation.

As mentioned, three distinct hormonal environments have been identified during the MC hormones' cycling fluctuations: the early follicular phase, distinguished by low E2 and P4 concentrations (menstruation); the late follicular phase (ovulation), characterised by high E2 and low P4 concentrations; and the luteal phase, in which elevated levels of E2 and P4 are present [2]. However, these three phases neglect the hormonal fluctuations interrupting the transitions, which can be fast and large in magnitude, thus creating a dramatic fluctuation in the hormonal milieu of a female and, therefore, challenging the maintenance of homeostasis [43]. For instance, transitioning from the follicular phase to the luteal phase correlates with peak levels of FSH and LH [43]. Hence, hormonal fluctuations may be the reason some perceive that their performance is influenced by menstruation.

More than 90% of regularly menstruating women who exercise experience MC symptoms (e.g., menstrual cramps, fatigue, changes in mood, and lower back pain), and 80% stated that their symptoms are interrelated with performance decreases in every cycle [34]. Notably, these symptoms are as prevalent among the general population as they are among elite athletes [34]. Negative menstrual symptoms need to be alleviated for all women [44].

Furthermore, in this study, based on their subjective perceptions, 11.9% of the RC athletes reported suffering from mood swings, sleeping problems, bloating or stomach issues, breast tenderness, headaches, and fatigue before menstruation. Specifically, 18.5% noted sleeping disturbances before menstruation, and 15.9% perceived that the quality of their sleep changed. In the premenstrual phase, which is associated with the luteal

phase, a vital hormone reduction has been noted, which has typically been neglected in sport science studies [44]. However, it is usually during this phase and the menstruation phase where the observation of negative MC symptoms is more prevalent, enhancing the probability of necessary exercise recovery, changes to training, and performance [32]. In addition, studies have shown a reduced mental tolerance during exercise (i.e., a high rating of perceived exertion, RPE) in the luteal phase due to body temperature, high levels of P4, and cortisol [43]. Thus, if not managed proactively, stress associated with training load and/or other causes of stress both physiologically and physically could lead to the formation of the 'perfect storm' of excess fatigue and underperformance, especially among elite female athletes whose training loads can be intense [45].

In addition, 37.8% of the RC athletes perceived that they sometimes felt strong, motivated, and ready to push themselves' during the late follicular phase, which is correlated with ovulation. As for sleeping disturbances, 13.0% of the RC athletes believed that disturbances were more prominent during ovulation, while 3.2% believed they were more prominent before ovulation. Also, 17.2% of the RC athletes perceived that their sleeping quality changed during ovulation, while 3.8% perceived that this was the case before ovulation. Research evaluating healthy females in which hormone concentrations were measured across the menstrual cycle found that sleep fragmentation around the ovulation phase through the mid-luteal phase is proportional to the preceding ratio of the increase in P4 concentrations. As a result, sleep fragmentation can be partly responsible for poorer performance via limiting physiological responses, decreasing motivation, and inducing a lack of efficiency in cognitive processes [29]. However, in this research, the RC athletes' sleep fragmentation was not prevalent in the ovulation phase, but 29.9% of these females perceived having no sleeping disturbances in all phases, and 26.1% believed their sleeping quality did not fluctuate. That said, the differences in sleeping disturbances might be attributed to the variability in the surge in P4 [46].

Nonetheless, these findings are based on RC athletes and may not be applicable to professional athletes. It is vital to acknowledge the substantial inter-individual and sometimes intra-individual differences in bleeding patterns, cycle durations, symptom variety, severity, and timing [43,47]. Publicly available information on the MC will allow women to make better decisions with respect to health and athletic performance [48–50]. It will open channels of communication between athletes, coaches, and medical personnel [51]. Understanding female physiology may help to reduce the use of OCs, which are not free of side effects [52–54].

5. Conclusions

It has been noted that both female athletes and their coaches have a limited overall understanding of the effects of MC and OCs on training and performance. These results provide insight into how FRC athletes experience MC symptoms, constituting knowledge that can, in theory, help improve their performance [55]. These findings may help coaches and trainers address the specific needs of women athletes, e.g., by adding rest periods or altering training loads during the luteal phase of the MC [46]. However, a one-size-fits-all approach does not work [56], and impediments to open communication, such as discomfort with discussing the topic, still exist [57]. It is possible that different sports may be differently affected. More research is encouraged.

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