Indian endurance athletes' menstrual cycle: practices, knowledge, communication, health, and changes in perceptions across the phases

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Original Investigation

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ABSTRACT

Purpose: To describe menstrual cycle (MC)-related practices, knowledge, communication, and health in Indian endurance athletes, and to investigate the changes in their perception of sleep quality, readiness to train, training quality, fitness, and performance across the MC. **Methods**: Data of female Indian athletes (n = 96, age 22 [±3] y) competing in seven endurance sports at (inter)national and state level were collected using an online questionnaire. Friedman's rank sum test was used to assess changes in sleep quality, readiness to train, training quality, fitness, and performance across MC phases (i.e., during the bleeding phase, immediately after the bleeding phase, and just before the bleeding phase). **Results**: Most of the athletes showed poor MC-related practices and suboptimal knowledge and communication about the MC. Despite no clear signs of serious health conditions, many athletes (63.5%) experienced irregular bleeding phases, particularly during periods with high exercise intensity or high training volume (54.4%). Perceived sleep quality, readiness to train, fitness, performance, and the quality of high-intensity and strength training changed significantly throughout the MC ($p<0.001$), with a higher prevalence of a positive perception immediately after the bleeding phase. The perceived quality of low-intensity training did not change significantly throughout the MC ($p=0.244$). **Conclusions**: Knowledge and communication about the MC were found to be poor in Indian endurance athletes, who reported that the MC significantly influenced their sleep quality, readiness to train, training quality, fitness, and performance.

Keywords: hormonal fluctuations, hormonal contraceptives, follicular phase, luteal phase, training, performance.

INTRODUCTION

Female sex hormones fluctuate during the menstrual cycle (MC), and as these endogenous hormonal fluctuations have their effect beyond the reproductive system, they might also influence exercise performance.[1] A recent meta-analysis investigated the effect of the MC on exercise performance and concluded that performance might be trivially reduced during the early follicular phase i.e., the bleeding phase of the MC in naturally-menstruating women.[1] In addition, another meta-analysis indicated that oral contraceptive use (i.e., exogenous hormones), which suppresses the endogenous hormone production, might result in a slightly lower performance compared to having a natural MC.[2] Based on these findings, the authors of both publications recommend an individualized approach towards adjusting training and performance across the MC and the use of hormonal contraceptives (HCs).[1,2]

Several recent studies asked female athletes about their HC use, the reasons for using HC, their knowledge and communication about these topics, as well as their health and perceived effect of the MC on training and performance. Most athletes showed to have insufficient knowledge about their MC and its possible effects on training and performance,[3-5] and did not communicate about it with their coaches.[5,6] Although there is clearly a growing body of knowledge around MC-related practices, knowledge,[3,6] communication,[6] health,[7] and the effect of the MC on training and performance,[5] these investigations are all performed on athletes from the "western" population and comparable findings from the large South-Asian athletic population are non-existent.[8,9] As the South-Asian population is equivalent to about 25% of the world population, and the socio-cultural differences compared to western countries are large, it is of great interest to investigate these topics in South-Asian female athletes.

A larger heterogeneity in educational level is expected in South-Asian athletes compared to western athletes. A lower educational level and/or a large educational inequality might further hinder the communication on the MC and HC use,[10] and might be a reason why Indian athletes often face MC-related health problems.[11] Similarly, HC users could be more informed about their MC and might proactively try to manage the MC-related side effects. Therefore, the primary aim of this study was to describe MC-related practices, knowledge, communication, and health in Indian endurance athletes, and to investigate if these are associated with their age, educational level, and HC use.

Although previous studies showed western athletes to have limited knowledge and communication about their MC, they do experience its effects on their training and performance[5]. Despite the variation in definitions of MC phases[12], athletes mostly reported a lower training quality and performance during the bleeding phase, i.e. the early follicular phase[5,13,14]. In addition, the phase preceding the bleeding phase (most likely the mid to late luteal phase) was associated with premenstrual symptoms[5,14]. So far, similar studies have not been performed on Indian athletes, whose perceptions might differ due to differences in cultural experiences and awareness. Therefore, the secondary aim was to investigate changes in perceptions of sleep, readiness to train, training quality, fitness, and performance across the different phases of the MC.

METHODS

Participants

Indian female endurance athletes (n = 128) were invited to participate in the current study. In total 96 fulfilled the eligibility criteria (see Figure 1), which were: 1) participants had to compete at (inter)national or state level, 2) be between 18-35 years old, and 3) have a BMI < 25 kg/m^2. Participants engaged in seven different endurance sports (see Figure 1). Additional demographic information of the participants is presented in Table 1. All participants provided written informed consent and the study was evaluated and approved by the Institutional Ethics Committee (IEC) of Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI), India.

Insert Figure 1 about here

Methodology

The current study employed an observational design using an English online questionnaire, which was planned to be completed within 20 minutes. The questionnaire was designed based on a survey successfully employed before to acquire data regarding the MC among competitive endurance athletes[5] (details are presented in Table 2). In addition, the MC-related health section contained the Eating Attitude Test (EAT-26)[15], a 26-item with 6-point Likert scale screening which aids in the identification of an eating disorder (ED). Participants who scored 20 or more were classified as "Might have eating disorders" and participants who scored less than 20 were considered to have "No eating disorder". The questionnaire also contained questions about the athletes' perceptions of sleep quality, readiness to train, the quality of low intensity training (LIT), high intensity training (HIT), and strength training, and their perceived fitness and performance across three MC phases. These MC phases were defined with simple terms like "During your periods" (During) for the bleeding phase, "Immediately after your periods" (After) for the phase immediately after the bleeding phase and "Just before your periods" (Before) for the phase just before the bleeding phase. Participants could rate their perception as "Positive", "Negative", "Neither negative nor positive" (herein referred as "Neutral"). Three expert researchers evaluated and modified the questionnaire and eight randomly selected participants volunteered for piloting before the data collection. Clarification in respective regional languages was provided when needed to ensure uniform understanding.

Insert Table 1 about here

Statistical analysis

Predictor variables (age, educational level, and HC use) were categorized into binary groups to assess differences in MC-related practices, knowledge, communication, and health (dependent variables). Age subgroups were "younger athletes" (i.e., younger than or 21 years old) and "older athletes" (i.e., older than 21 years old); educational level was categorized into "graduate" ("Graduated", "Completed post-graduation", "PhD") and "undergraduate" ("Didn't

complete schooling", "Completed schooling", "In college"); and HC use status as current user and non-user. Relationships between subgroups and dependent variables were estimated with Fisher's Exact Test. Changes in athletes' perception of sleep quality, readiness to train, training quality, fitness and performance during the MC were assessed with Friedman's rank sum test. Pairwise comparisons between MC phases were assessed with pairwise Wilcoxon rank sum tests and the Bonferroni correction. The analysis was first performed for the HC users and non-HC users (see Figure 1) separately, but as the results did not differ between the two groups, they were combined. All statistical analyses were performed using R[16] with the package "stats"(version 4.0.3) and the figures were generated using the package "ggplot2" (version 3.3.2).

RESULTS

Menstrual cycle-related practices, knowledge, communication, and health

A large number of athletes responded that they currently did not keep track of their MC (54.2%), did not try to change their training (67.7%) and did not plan their training based on their MC (70.8%). Likewise, most athletes did not use medication to relieve symptoms related to their period during competition (81.2%) and did not use HC (87.5%). The majority of athletes referred that they could not name the different MC phases (68.8%); however, many of them were aware that it is not normal to miss their bleeding phase due to their training load (66.7%). In terms of MC-related communication, 41.7% of athletes indicated that they feel uncomfortable to talk to their coach about their MC-related problems and 42.7% indicated that it was more comfortable to approach a female coach than a male coach to discuss this topic (47.3% indicated that it was the same i.e., just as comfortable to approach a female or a male coach). With regards to health, two thirds of the athletes reported to experience early or delayed bleeding phases (63.5%). In addition, more than half noticed that their bleeding phase disappeared during periods with large amounts of high-intensity training or high training volume (54.4%). However, most athletes did not miss their bleeding phase for three consecutive months or longer (when not caused by pregnancy) during the previous 2 years (84.4%). Based on the EAT-26, half of the athletes might have had an ED (51%). In addition, 25% of athletes indicated to have had one or more bone fractures or bone injuries. Table 2 presents the results of the relationship between subgroups and MC-related practices, knowledge, communication, and health. Age sub-groups did not show any significant associations with the MC-related aspects investigated, although educational level and HC use did. A missing bleeding phase for at least three consecutive months in the past two years (not caused by pregnancy) occurred more often in athletes categorized in the undergraduate group compared to graduated athletes. A higher percentage of HC users reported to change their training in connection with their bleeding phase as well as to take pain medication to alleviate MC-related side effects during competition. A higher proportion of HC users showed a significantly better knowledge of the different MC phases. As aforementioned, most athletes did not experience a missing bleeding phase for at least three consecutive months in the past two years (besides pregnancy); however, a significantly higher number of HC users reported this compared to non-HC users.

Insert Table 2 about here

Changes in athletes' perceptions across the menstrual cycle phases

The perception of sleep quality and readiness to train changed significantly between MC phases ($\chi^2(2)=46.74, p<0.001$ and $\chi^2(2)=40.43, p<0.001$), showing a significantly higher number of athletes that experienced a positive perception in the phase "After" compared to the phases "Before" and "During", without a significant difference between "Before" and "During". No significant effect of MC phases was found on the perceived quality of LIT

($\chi^2(2)=2.82,p=0.244$), whereas an effect was found on the perceived quality of HIT ($\chi^2(2)=67.60,p<0.001$), as well as on strength training ($\chi^2(2)=59.86,p<0.001$). The perceived quality of HIT and strength training differed between all MC phases with the highest number of athletes experiencing positive perceptions in the phase "After". Athletes reported that their perception of fitness significantly changed over the MC ($\chi^2(2)=43.07,p<0.001$), just as their perceived performance ($\chi^2(2)=39.61,p<0.001$). Post hoc tests are presented in Table 3 and the change in perceptions between the different MC phases is visualized in Figure 1, 2 and 3.

Insert Table 3 about here

Insert Figures 2, 3, 4 about here

DISCUSSION

The purpose of this study was two-fold: 1) to describe MC-related practices, knowledge, communication, and health in Indian endurance athletes, and to investigate if these are associated with their age, educational level, and HC use; 2) to investigate changes in perceptions of sleep, readiness to train, training quality, fitness, and performance across the different phases of the MC. The main findings were as follows:

1) In general, Indian athletes showed poor MC-related practices and limited knowledge and communication about the MC, which might have resulted in menstrual disturbances.
2) MC-related practices, knowledge, communication, and health were not associated with age, whereas educational level was significantly associated with MC-related health and significant differences in practices, knowledge, and health were found between HC users and non-HC users.
3) Athletes' perception of sleep quality, readiness to train, training quality during HIT and strength training, as well as fitness and performance differed significantly between MC-phases, with most athletes indicating a positive perception in the phase immediately after menstrual bleeding for all these variables.

MC-related practices, knowledge, communication, health, and subgroup associations

Practices

Although the majority of athletes did not keep track of their MC (54.2%), did not alter their training due to MC-related side effects (67.7%), or plan their training based on their MC (70.8%), these percentages were lower than the ones found in western athletic samples[5,14]. Solli et al.[5] found that the majority of cross-country skiers and biathletes did not alter their training due to MC-related side effects (78%) nor planned their training according to their MC (93%). Additionally, Martin et al.[14] observed that only 4% of athletes from different sports refrained from exercise at a specific time within their MC, because of MC-related side effects. This could suggest that a higher number of Indian athletes planned their training accounting for their MC effects compared to the western population. Conversely, Indian athletes might have limited access to medications to cope with MC-related side effects, which might force them to plan and change their training schedule to a higher extent compared to western athletes.

Only 12.5% of our sample of Indian endurance athletes reported to use HC, which is remarkably different from recent studies showing that 40-70% of western athletes use HC[5,14,17]. This difference could be due to divergent cultural attitudes, overall lack of knowledge regarding HC, insufficient accessibility, and affordability of contraceptives in India[18,19].

Knowledge and Communication

Most Indian endurance athletes showed a lack of basic knowledge about the MC which agrees with western athletes[3-5]. In addition, a conspicuous number of athletes felt uncomfortable to talk to their coach about their MC-related problems and approximately 40% of athletes reported that the gender of the coach played a significant role, which is consistent with data from western athletic samples[5,6]. However, Indian athletes were slightly more likely to talk to their coach

about their MC (58%) compared to Norwegian athletes (27%)[5]. Improved communication with their coaches about their MC might positively influence the athletes' knowledge on this topic and their MC-related health[20].

Health

Many athletes (63.5%) experienced irregular bleeding phases, particularly during periods with a high amount of HIT and/or a high training volume, which is comparable to the prevalence of menstrual irregularities among western athletes (50% and above)[21,22]. The prevalence of irregular bleeding phases in Indian athletes might be biased, as more than half of the participants in the present study referred that they did not keep track of their MC. However, keeping track of only the start day of the bleeding phase may not require a structured MC tracking routine and thus not be regarded as "keeping track of your periods". So, the above finding might be sound despite this limitation of the questionnaire. Moreover, half of the Indian athletes participating in the current study were identified as having signs of EDs and it is well possible that a large proportion of them experienced low energy availability and hormonal disturbances, thereby affecting their MC-related health and possibly their training and performance [7]. The EAT-26 assesses the risk for EDs and does not replace a medical diagnosis. However, the prevalence of EDs risk in this population cautions about possible unhealthy practices and culture around food intake.

Associations

Graduate athletes reported less MC-related health problems than undergraduates, suggesting a possible association between educational level and MC-related health. On the other hand, undergraduate athletes were younger (see Figure 1) and thus more likely to experience menstrual irregularities, which are more common in the first years after menarche[23]. However, age was not significantly associated with MC-related knowledge, communication, and health. Therefore, these findings indicate that a higher educational level might translate into enhanced knowledge about the MC, which might in turn result in early identification of symptoms and improved MC-related health.

HC users seem to have a better knowledge about the MC, which might result in better awareness and a proactive approach towards their MC and its related side effects (e.g., changing their training, taking medications). However, HC users reported a higher incidence of missing bleeding phases compared to the non-HC users. Using HC makes it possible to regulate the occurrence of the bleeding phase and athletes could have taken advantage of it (e.g., by skipping bleeding phases when they occur around important training camps or competitions). The active management of the bleeding phase occurrence possibly explains the higher incidence of missed bleeding phases in HC users.

Changes in athletes' perceptions across the menstrual cycle phases

Similar changes in the perception of sleep quality, readiness to train, fitness, and performance were found across the MC. A significantly higher number of athletes reported a positive perception in the phase "After" compared to the phases "Before" and "During", while no significant difference occurred between the phases "Before" and "During". Although hormonal concentrations were not verified in the present study, it is likely that the phase "Before" corresponds to the mid- to late-luteal phase, the phase "During" to the early follicular phase, and the phase "After" to the late follicular phase. The decreased sleep quality both right before and during the bleeding phase could be ascribed to the MC-related side effects, as such side effects have been found to occur more in these phases[5]. In agreement with the present study, Baker and Driver[24] reported a lower subjective sleep quality over the three days preceding, and during the bleeding phase in young healthy women compared to the mid-follicular and early/mid-luteal phases. In addition, an investigation among young western endurance athletes showed altered sleep stages and impaired sleep efficiency during the bleeding phase[25].

The higher proportion of Indian athletes indicating a positive readiness to train in the phase "After" compared to the other two phases could be a consequence of the increased estrogen concentrations normally seen in the late follicular phase in naturally menstruating women. It could be speculated that the greater antioxidant capacity and protection from inflammation associated with higher estrogen levels might positively influence readiness to train[26]. However, no previous studies have looked at changes in readiness to train across the MC. Cook and colleagues[27] investigated training motivation across the MC in western naturally menstruating female athletes and reported an increase on day 14 of the MC compared to both day 5 and day 21, which corresponds to the findings of the current study. The decreased readiness to train found in the phases "Before" and "During" and the lower motivation to train[27] could be associated with an increased negative mood and/or other MC-related side effects, as has been found in western athletes[5].

In agreement with Solli et al.[5], most Indian athletes reported a positive perception of both fitness and performance in the phase "After". Moreover, most Indian athletes experienced distinct variation (positive or negative) in fitness and performance across the MC-phases, whereas a neutral perceived effect was highly prevalent among Norwegian skiers[5]. Additionally, a recent systematic review and meta-analysis concluded that performance might be trivially reduced during the early follicular phase compared to the other phases[1]. The higher prevalence of positive perceived fitness and performance in the phase "After" in our study could be associated with a better exercise performance, which possibly takes place when the estrogen/progesterone concentration ratio is higher, because of positive effects of estrogen on metabolism and oxidative stress[28]. However, hormone concentrations were not verified in the current study. Alternatively, a lower positive perception of fitness and performance in the phase "Before" and "During" could be mediated by the incidence of MC-related side effects[5,14].

The effect of MC phase on the perceived quality of different types of training showed various patterns. Whereas the perception of LIT did not show significant differences between MC phases, both HIT and strength training quality were perceived to be different between MC phases. HIT and strength training quality were perceived to be highest in the phase "After" and lowest in the phase "During". Several physiological variables related to training might be influenced by MC phases, such as exercise metabolism[28] as stated above. In addition, a higher growth hormone response, greater protein synthesis, and lower level of post-exercise creatine

kinase when the estrogen/progesterone concentration ratio is higher[29] point towards an enhanced potential for muscle strength, recovery, and growth during the mid- and late follicular phase, which is in agreement with the higher perceived strength training quality in the phase "After" observed in the current study. On the other hand, Rael et al.[30] showed that several cardiorespiratory parameters were not altered by the MC during a high-intensity interval running bout, despite increased ventilation and heart rate in the mid-luteal phase, which contradicts with the findings of the current study. However, it might be that the subjective perception might not match with objective measures of exercise and might instead be influenced to a higher extent by the increased incidence of MC-related side effects during the bleeding phase and the days before bleeding[5]. The absence of significant differences in the perceived LIT quality could possibly be attributed to the lower load of such training for endurance trained athletes.

The use of the questionnaire as a tool to measure changes in perceptions across the MC is subject to recall bias and differences in understanding and interpretation, which could have resulted in biased results. However, Indian endurance athletes showed similar patterns with regards to perceived measures throughout the MC compared to western athletes. Despite large interindividual variations, these recurrent patterns suggest that the influence of the MC on perceptions takes place in an analogous way across different populations. The analysis of longitudinal data of perceived sleep quality, readiness to train, training quality, fitness, and performance, as well as the verification of MC phases, could strengthen the findings of the present study."

Overall, the MC influenced perceived sleep quality, readiness to train, training quality, fitness, and performance in this sample of Indian athletes (both HC users n=12 and non-HC users n=84). The current study provides a point-of-departure for carrying out more research on athletic populations to further understand the changes in perceptions across MC phases. High quality research entailing thorough verification of MC and HC cycle phases is needed to confirm the current findings. Moreover, the link between subjective perceptions and possible physiological mechanisms behind the changes across the MC are not well understood. Additionally, further knowledge about the inter- and intra-individual variation in the influence of the MC on psychological and physiological well-being could assist athletes and their support staff in the individualization of training strategies.

Practical applications

1) *Bridging the communication gap*: Knowledge and communication about the MC was poor among Indian athletes. Improving the coach-athlete communication about the MC and HC use, irrespective of the coach's gender, could result in a training schedule accounting for the MC, which might have positive health, training, and performance outcomes.

2) *Increasing knowledge about the MC and its effects*: As the present study showed that a higher educational level was associated with improved knowledge about the MC and potentially better health outcomes, it is desirable that Indian athletes and their coaches are educated about the MC, its possible influence on training and performance, related side effects, and HC use.

3) *Addressing the changing perceptions across MC phases*: Considering the influence of MC phases on perceived sleep quality, readiness to train, training quality of HIT and strength training, fitness, and performance, monitoring the MC and its side effects in the training diary could potentially help optimize training, recovery, and performance in Indian athletes.

CONCLUSIONS

Most Indian endurance athletes did not keep track of their MC and did not plan their training according to their MC. In addition, a surprisingly low number used HC. Like western athletes, knowledge and communication about the MC were found to be poor in Indian endurance athletes. Besides, most Indian endurance athletes reported that the MC influenced their sleep quality, readiness to train, training quality, as well as fitness and performance. In general, sleep quality, readiness to train, training quality, fitness and performance were perceived better immediately after the bleeding phase.

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CAPTIONS

Table 1 |Participants' demographics.

Table2 |The results of the Fisher exact test investigating the association between age, educational level, and hormonal contraceptive (HC) use and menstrual cycle (MC)-related practices, knowledge, communication, and health.

Table3 |Post hoc test of athletes' perceptions of changes in sleep quality, readiness to train, training quality, fitness, and performance between menstrual cycle (MC) phases.

Figure 1 | Flow chart of the inclusion procedure and sample characteristics. Age is reported as median (interquartile range). * $p<0.001$.

Figure 2 |Athletes' perception of sleep quality (A) and readiness to train (B) over the menstrual cycle. *"Positive" perception in blue, "Neutral" in green and "Negative" in red.*

Figure 3 |Athletes' perception of the quality of Low-Intensity Training (LIT) (A), High-Intensity Training (HIT) (B) and strength training (C) over the menstrual cycle. *"Positive" perception in blue, "Neutral" in green and "Negative" in red.*

Figure 4 |Athletes' perception of fitness (A) and performance (B) over the menstrual cycle. *"Positive" perception in blue, "Neutral" in green and "Negative" in red.*

Table 1. Participants' demographics.

	Mean	*SD*
Age (years)	22	3
Body height (cm)	159.7	7.1
Body mass (kg)	52.0	7.1
BMI (kg/m^2)	20.4	2.1

BMI = body mass index.

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Table 2. The results of the Fisher exact test investigating the association between age, educational level, and hormonal contraceptive (HC) use and menstrual cycle (MC)-related practices, knowledge, communication, and health

		Age			Educational level			HC use		
		P-value	*OR*	*95% CI*	*P-value*	*OR*	*95% CI*	*P-value*	*OR*	*95% CI*
PRACTICES	Do you currently keep track of your periods?	0.100	2.068	0.851 - 5.126	0.539	0.736	0.303 - 1.775	0.060	4.139	0.945 - 25.467
	Have you tried to change your training due to side effects/problems in connection with your period?	0.273	0.571	0.211 - 1.485	0.192	1.863	0.716 - 5.046	**0.017***	5.198	1.250 - 25.922
	Are you presently planning your training with regards to your period?	0.826	0.896	0.332 - 2.374	1.000	0.967	0.365 - 2.581	0.323	1.881	0.426 - 7.706
	Do you take medication for your periods during competition?	0.307	0.557	0.155 - 1.803	0.117	2.575	0.769 - 10.139	< **0.001***	14.111	3.130 - 76.594
	Are you currently using any type of hormonal contraceptive?	0.128	2.770	0.678 - 13.583	0.214	2.831	0.647 - 17.389	-	-	-
KNOWLEDGE	Can you name the different phases of menstrual cycle?	0.277	1.642	0.633 - 4.316	0.827	1.156	0.446 - 3.046	**0.045***	3.655	0.897 - 16.184
	Do you think is it normal to miss your periods due to your endurance training schedule?	1.000	1.098	0.340 - 3.584	0.595	1.458	0.452 - 4.849	0.158	2.904	0.632 - 14.077
COMMUNICATION	Is it more comfortable to approach a female coach than a male coach regarding your period-related health problems?	0.408	0.667	0.269 - 1.626	0.148	1.920	0.784 - 4.821	0.351	2.043	0.510 - 8.887
	On your heaviest days, are you uncomfortable to talk to your coach about your period-related problems or training volume?	0.533	0.719	0.289 - 1.757	0.407	1.494	0.611 - 3.710	0.115	3.209	0.783 - 15.772
HEALTH	Do you experience early or delayed periods?	0.833	1.130	0.452 - 2.857	0.677	0.829	0.328 - 2.069	0.115	0.361	0.082 - 1.458
	In the past 2 years, have your periods stopped for 3 consecutive months or longer (besides pregnancy)?	0.261	2.058	0.589 - 7.739	**0.046***	4.045	0.989 - 23.996	**0.020***	5.153	1.078 - 23.507
	Have you experienced that your period (menstrual bleeding) disappeared during your high exercise intensity or high exercise volume sessions?	0.468	0.671	0.226 - 1.948	0.232	1.846	0.637 - 5.508	0.525	1.845	0.433 - 9.366
	EAT-26	1.000	0.991	0.411 - 2.392	0.219	0.561	0.229 - 1.353	0.357	0.480	0.098 - 1.960
	How many bone fractures or bone injuries have you experienced?	0.638	0.758	0.270 - 2.125	1.000	1.000	0.354 - 2.790	0.284	4.103	0.539 - 186.017

Data are presented with the exact p-value, OR = odds ratio, 95% CI = confidence interval. EAT-26: outcome of the eating attitude test.

Table 3. Post hoc test of athletes' perceptions of changes in sleep quality, readiness to train, training quality, fitness, and performance between menstrual cycle (MC) phases.

Sleep quality		
	After	*Before*
Before	**< 0.001**	-
During	**< 0.001**	0.440
Readiness to train		
	After	*Before*
Before	**< 0.001**	-
During	**< 0.001**	0.061
Low-intensity training (LIT)		
	After	*Before*
Before	0.250	-
During	1.000	0.430
High-intensity training (HIT)		
	After	*Before*
Before	**< 0.001**	-
During	**< 0.001**	**< 0.001**
Strength training		
	After	*Before*
Before	**< 0.001**	-
During	**< 0.001**	**0.003**
Fitness		
	After	*Before*
Before	**< 0.001**	-
During	**< 0.001**	0.160
Performance		
	After	*Before*
Before	**< 0.001**	-
During	**< 0.001**	0.160

During = during the bleeding phase, After = phase immediately after the bleeding phase, Before = phase just before the bleeding phase.

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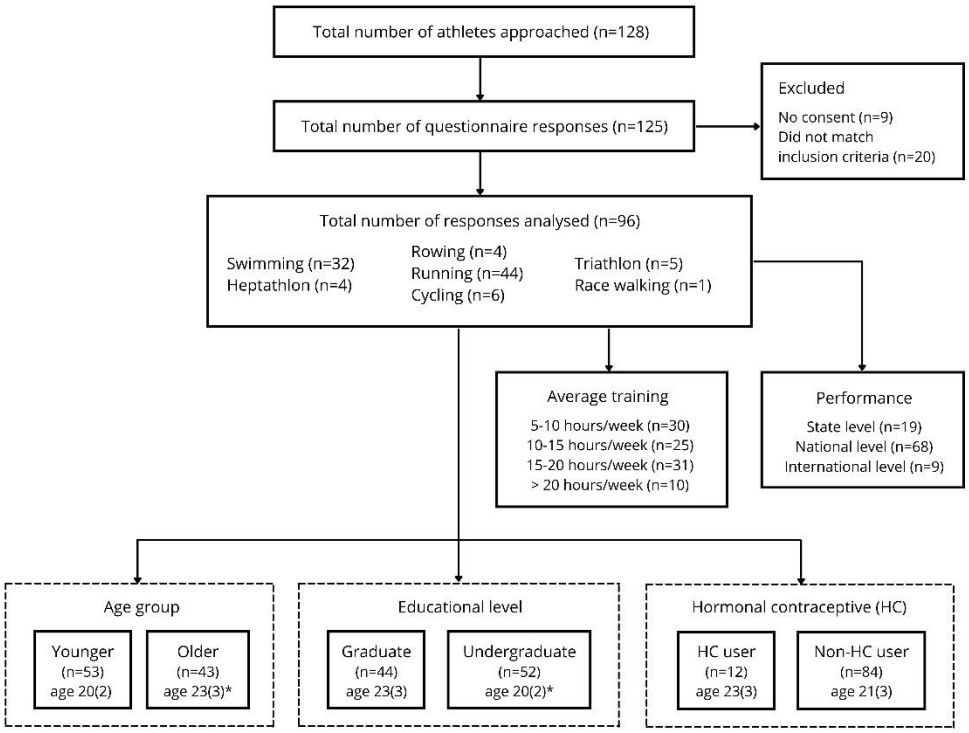
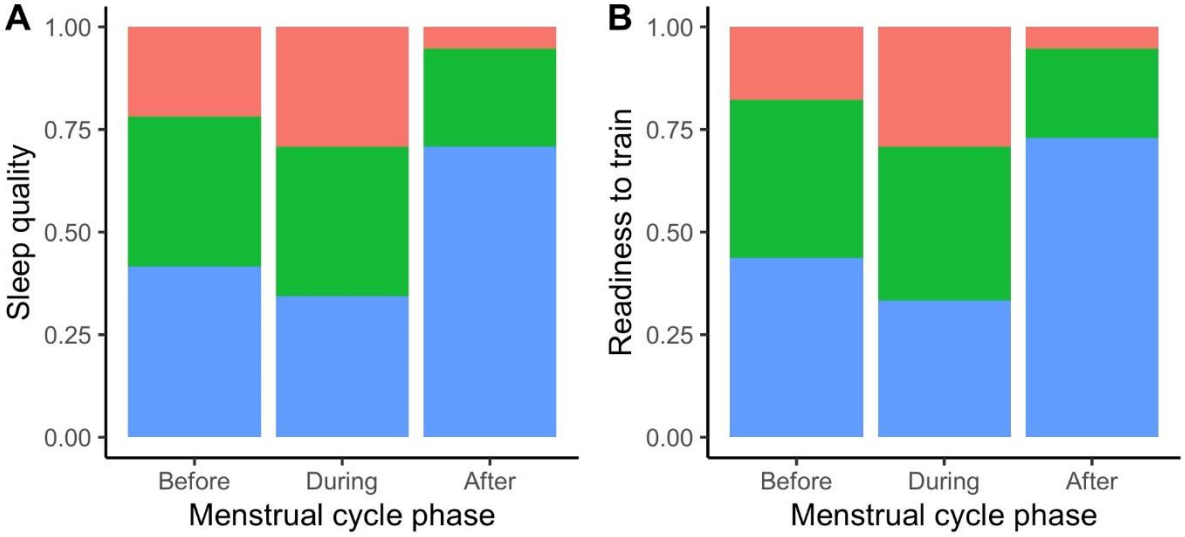
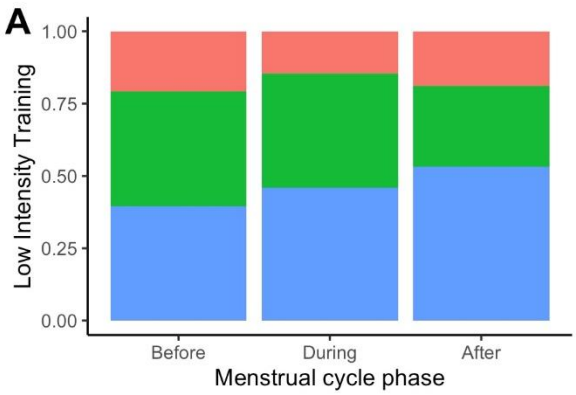
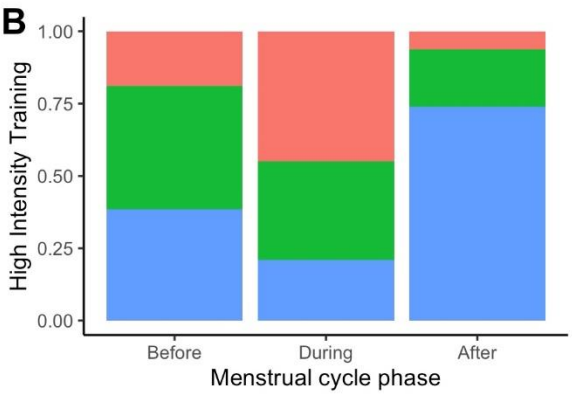
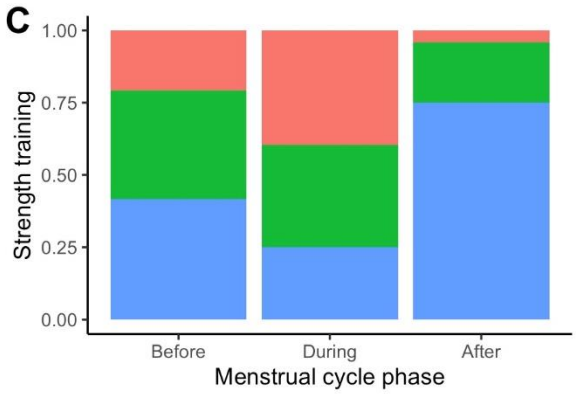

Total number of athletes approached (n=128)
Total number of questionnaire responses (n=125)
Excluded
No consent (n=9)
Did not match
inclusion criteria (n=20)
Total number of responses analysed (n=96)
Swimming (n=32)
Heptathlon (n=4)
Rowing (n=4)
Running (n=44)
Cycling (n=6)
Triathlon (n=5)
Race walking (n=1)
Average training
5-10 hours/week (n=30)
10-15 hours/week (n=25)
15-20 hours/week (n=31)
> 20 hours/week (n=10)
Performance
State level (n=19)
National level (n=68)
International level (n=9)
Age group
Younger
(n=53)
age 20(2)
Older
(n=43)
age 23(3)*
Educational level
Graduate
(n=44)
age 23(3)
Undergraduate
(n=52)
age 20(2)*
Hormonal contraceptive (HC)
HC user
(n=12)
age 23(3)
Non-HC user
(n=84)
age 21(3)


A
Sleep quality
1.00
0.75
0.50
0.25
0.00
Before
During
After
Menstrual cycle phase
B
Readiness to train
1.00
0.75
0.50
0.25
0.00
Before
During
After
Menstrual cycle phase







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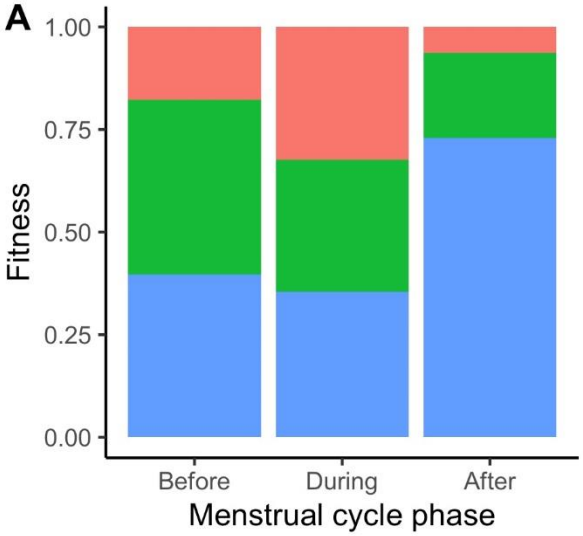

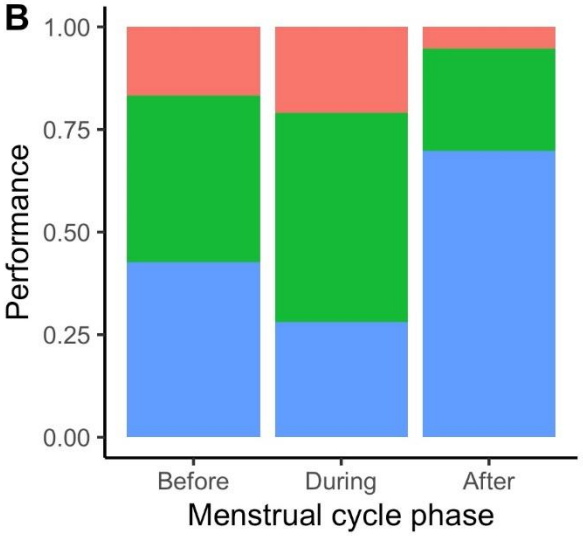

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