

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

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Original Investigation

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4 **ABSTRACT**

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

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24

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

27 INTRODUCTION

28

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

39 Several recent studies asked female athletes about their HC use, the reasons for using
40 HC, their knowledge and communication about these topics, as well as their health and
41 perceived effect of the MC on training and performance. Most athletes showed to have
42 insufficient knowledge about their MC and its possible effects on training and performance,³⁻⁵
43 and did not communicate about it with their coaches.^{5,6} Although there is clearly a growing
44 body of knowledge around MC-related practices, knowledge,^{3,6} communication,⁶ health,⁷ and
45 the effect of the MC on training and performance,⁵ these investigations are all performed on
46 athletes from the “western” population and comparable findings from the large South-Asian
47 athletic population are non-existent.^{8,9} As the South-Asian population is equivalent to about
48 25% of the world population, and the socio-cultural differences compared to western countries
49 are large, it is of great interest to investigate these topics in South-Asian female athletes.

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

58 Although previous studies showed western athletes to have limited knowledge and
59 communication about their MC, they do experience its effects on their training and
60 performance⁵. Despite the variation in definitions of MC phases¹², athletes mostly reported a
61 lower training quality and performance during the bleeding phase, i.e. the early follicular
62 phase^{5,13,14}. In addition, the phase preceding the bleeding phase (most likely the mid to late
63 luteal phase) was associated with premenstrual symptoms^{5,14}. So far, similar studies have not
64 been performed on Indian athletes, whose perceptions might differ due to differences in cultural
65 experiences and awareness. Therefore, the secondary aim was to investigate changes in
66 perceptions of sleep, readiness to train, training quality, fitness, and performance across the
67 different phases of the MC.

68 **METHODS**

69 *Participants*

70 Indian female endurance athletes (n = 128) were invited to participate in the current study. In
71 total 96 fulfilled the eligibility criteria (see Figure 1), which were: 1) participants had to
72 compete at (inter)national or state level, 2) be between 18-35 years old, and 3) have a BMI <
73 25 kg/m². Participants engaged in seven different endurance sports (see Figure 1). Additional
74 demographic information of the participants is presented in Table 1. All participants provided
75 written informed consent and the study was evaluated and approved by the Institutional Ethics
76 Committee (IEC) of Ramakrishna Mission Vivekananda Educational and Research Institute
77 (RKMVERI), India.

78

79 *Insert Figure 1 about here*

80

81 *Methodology*

82 The current study employed an observational design using an English online questionnaire,
83 which was planned to be completed within 20 minutes. The questionnaire was designed based
84 on a survey successfully employed before to acquire data regarding the MC among competitive
85 endurance athletes⁵ (details are presented in Table 2). In addition, the MC-related health section
86 contained the Eating Attitude Test (EAT-26)¹⁵, a 26-item with 6-point Likert scale screening
87 which aids in the identification of an eating disorder (ED). Participants who scored 20 or more
88 were classified as “Might have eating disorders” and participants who scored less than 20 were
89 considered to have “No eating disorder”. The questionnaire also contained questions about the
90 athletes’ perceptions of sleep quality, readiness to train, the quality of low intensity training
91 (LIT), high intensity training (HIT), and strength training, and their perceived fitness and
92 performance across three MC phases. These MC phases were defined with simple terms like
93 “During your periods” (During) for the bleeding phase, “Immediately after your periods”
94 (After) for the phase immediately after the bleeding phase and “Just before your periods”
95 (Before) for the phase just before the bleeding phase. Participants could rate their perception
96 as “Positive”, “Negative”, “Neither negative nor positive” (herein referred as “Neutral”). Three
97 expert researchers evaluated and modified the questionnaire and eight randomly selected
98 participants volunteered for piloting before the data collection. Clarification in respective
99 regional languages was provided when needed to ensure uniform understanding.

100

101 *Insert Table 1 about here*

102

103 *Statistical analysis*

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

109 complete schooling", "Completed schooling", "In college"); and HC use status as current user
110 and non-user. Relationships between subgroups and dependent variables were estimated with
111 Fisher's Exact Test. Changes in athletes' perception of sleep quality, readiness to train, training
112 quality, fitness and performance during the MC were assessed with Friedman's rank sum test.
113 Pairwise comparisons between MC phases were assessed with pairwise Wilcoxon rank sum
114 tests and the Bonferroni correction. The analysis was first performed for the HC users and non-
115 HC users (see Figure 1) separately, but as the results did not differ between the two groups,
116 they were combined. All statistical analyses were performed using R¹⁶ with the package
117 "stats"(version 4.0.3) and the figures were generated using the package "ggplot2" (version
118 3.3.2).

119 **RESULTS**

120

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

122 A large number of athletes responded that they currently did not keep track of their MC
123 (54.2%), did not try to change their training (67.7%) and did not plan their training based on
124 their MC (70.8%). Likewise, most athletes did not use medication to relieve symptoms related
125 to their period during competition (81.2%) and did not use HC (87.5%). The majority of
126 athletes referred that they could not name the different MC phases (68.8%); however, many of
127 them were aware that it is not normal to miss their bleeding phase due to their training load
128 (66.7%). In terms of MC-related communication, 41.7% of athletes indicated that they feel
129 uncomfortable to talk to their coach about their MC-related problems and 42.7% indicated that
130 it was more comfortable to approach a female coach than a male coach to discuss this topic
131 (47.3% indicated that it was the same i.e., just as comfortable to approach a female or a male
132 coach). With regards to health, two thirds of the athletes reported to experience early or delayed
133 bleeding phases (63.5%). In addition, more than half noticed that their bleeding phase
134 disappeared during periods with large amounts of high-intensity training or high training
135 volume (54.4%). However, most athletes did not miss their bleeding phase for three
136 consecutive months or longer (when not caused by pregnancy) during the previous 2 years
137 (84.4%). Based on the EAT-26, half of the athletes might have had an ED (51%). In addition,
138 25% of athletes indicated to have had one or more bone fractures or bone injuries. Table 2
139 presents the results of the relationship between subgroups and MC-related practices,
140 knowledge, communication, and health. Age sub-groups did not show any significant
141 associations with the MC-related aspects investigated, although educational level and HC use
142 did. A missing bleeding phase for at least three consecutive months in the past two years (not
143 caused by pregnancy) occurred more often in athletes categorized in the undergraduate group
144 compared to graduated athletes. A higher percentage of HC users reported to change their
145 training in connection with their bleeding phase as well as to take pain medication to alleviate
146 MC-related side effects during competition. A higher proportion of HC users showed a
147 significantly better knowledge of the different MC phases. As aforementioned, most athletes
148 did not experience a missing bleeding phase for at least three consecutive months in the past
149 two years (besides pregnancy); however, a significantly higher number of HC users reported
150 this compared to non-HC users.

151

152 *Insert Table 2 about here*

153

154 **Changes in athletes' perceptions across the menstrual cycle phases**

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

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

167

168 *Insert Table 3 about here*

169 *Insert Figures 2, 3, 4 about here*

170 **DISCUSSION**

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

176 1) In general, Indian athletes showed poor MC-related practices and limited knowledge
177 and communication about the MC, which might have resulted in menstrual disturbances.

178 2) MC-related practices, knowledge, communication, and health were not associated with
179 age, whereas educational level was significantly associated with MC-related health and
180 significant differences in practices, knowledge, and health were found between HC users and
181 non-HC users.

182 3) Athletes' perception of sleep quality, readiness to train, training quality during HIT and
183 strength training, as well as fitness and performance differed significantly between MC-phases,
184 with most athletes indicating a positive perception in the phase immediately after menstrual
185 bleeding for all these variables.

186

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

188 *Practices*

189 Although the majority of athletes did not keep track of their MC (54.2%), did not alter their
190 training due to MC-related side effects (67.7%), or plan their training based on their MC
191 (70.8%), these percentages were lower than the ones found in western athletic samples^{5,14}. Solli
192 et al.⁵ found that the majority of cross-country skiers and biathletes did not alter their training
193 due to MC-related side effects (78%) nor planned their training according to their MC (93%).
194 Additionally, Martin et al.¹⁴ observed that only 4% of athletes from different sports refrained
195 from exercise at a specific time within their MC, because of MC-related side effects. This could
196 suggest that a higher number of Indian athletes planned their training accounting for their MC
197 effects compared to the western population. Conversely, Indian athletes might have limited
198 access to medications to cope with MC-related side effects, which might force them to plan
199 and change their training schedule to a higher extent compared to western athletes.

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

204

205 *Knowledge and Communication*

206 Most Indian endurance athletes showed a lack of basic knowledge about the MC which agrees
207 with western athletes³⁻⁵. In addition, a conspicuous number of athletes felt uncomfortable to
208 talk to their coach about their MC-related problems and approximately 40% of athletes reported
209 that the gender of the coach played a significant role, which is consistent with data from western
210 athletic samples^{5,6}. However, Indian athletes were slightly more likely to talk to their coach

211 about their MC (58%) compared to Norwegian athletes (27%)⁵. Improved communication with
212 their coaches about their MC might positively influence the athletes' knowledge on this topic
213 and their MC-related health²⁰.

214

215 *Health*

216 Many athletes (63.5%) experienced irregular bleeding phases, particularly during periods with
217 a high amount of HIT and/or a high training volume, which is comparable to the prevalence of
218 menstrual irregularities among western athletes (50% and above)^{21,22}. The prevalence of
219 irregular bleeding phases in Indian athletes might be biased, as more than half of the
220 participants in the present study referred that they did not keep track of their MC. However,
221 keeping track of only the start day of the bleeding phase may not require a structured MC
222 tracking routine and thus not be regarded as “keeping track of your periods”. So, the above
223 finding might be sound despite this limitation of the questionnaire. Moreover, half of the Indian
224 athletes participating in the current study were identified as having signs of EDs and it is well
225 possible that a large proportion of them experienced low energy availability and hormonal
226 disturbances, thereby affecting their MC-related health and possibly their training and
227 performance⁷. The EAT-26 assesses the risk for EDs and does not replace a medical diagnosis.
228 However, the prevalence of EDs risk in this population cautions about possible unhealthy
229 practices and culture around food intake.

230

231 *Associations*

232 Graduate athletes reported less MC-related health problems than undergraduates, suggesting a
233 possible association between educational level and MC-related health. On the other hand,
234 undergraduate athletes were younger (see Figure 1) and thus more likely to experience
235 menstrual irregularities, which are more common in the first years after menarche²³. However,
236 age was not significantly associated with MC-related knowledge, communication, and health.
237 Therefore, these findings indicate that a higher educational level might translate into enhanced
238 knowledge about the MC, which might in turn result in early identification of symptoms and
239 improved MC-related health.

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

248

249

250 **Changes in athletes' perceptions across the menstrual cycle phases**

251 Similar changes in the perception of sleep quality, readiness to train, fitness, and performance
252 were found across the MC. A significantly higher number of athletes reported a positive
253 perception in the phase “After” compared to the phases “Before” and “During”, while no
254 significant difference occurred between the phases “Before” and “During”. Although hormonal
255 concentrations were not verified in the present study, it is likely that the phase “Before”
256 corresponds to the mid- to late-luteal phase, the phase “During” to the early follicular phase,
257 and the phase “After” to the late follicular phase. The decreased sleep quality both right before
258 and during the bleeding phase could be ascribed to the MC-related side effects, as such side
259 effects have been found to occur more in these phases⁵. In agreement with the present study,
260 Baker and Driver²⁴ reported a lower subjective sleep quality over the three days preceding, and
261 during the bleeding phase in young healthy women compared to the mid-follicular and
262 early/mid-luteal phases. In addition, an investigation among young western endurance athletes
263 showed altered sleep stages and impaired sleep efficiency during the bleeding phase²⁵.

264 The higher proportion of Indian athletes indicating a positive readiness to train in the
265 phase “After” compared to the other two phases could be a consequence of the increased
266 estrogen concentrations normally seen in the late follicular phase in naturally menstruating
267 women. It could be speculated that the greater antioxidant capacity and protection from
268 inflammation associated with higher estrogen levels might positively influence readiness to
269 train²⁶. However, no previous studies have looked at changes in readiness to train across the
270 MC. Cook and colleagues²⁷ investigated training motivation across the MC in western naturally
271 menstruating female athletes and reported an increase on day 14 of the MC compared to both
272 day 5 and day 21, which corresponds to the findings of the current study. The decreased
273 readiness to train found in the phases “Before” and “During” and the lower motivation to train²⁷
274 could be associated with an increased negative mood and/or other MC-related side effects, as
275 has been found in western athletes⁵.

276 In agreement with Solli et al.⁵, most Indian athletes reported a positive perception of
277 both fitness and performance in the phase “After”. Moreover, most Indian athletes experienced
278 distinct variation (positive or negative) in fitness and performance across the MC-phases,
279 whereas a neutral perceived effect was highly prevalent among Norwegian skiers⁵.
280 Additionally, a recent systematic review and meta-analysis concluded that performance might
281 be trivially reduced during the early follicular phase compared to the other phases¹. The higher
282 prevalence of positive perceived fitness and performance in the phase “After” in our study
283 could be associated with a better exercise performance, which possibly takes place when the
284 estrogen/progesterone concentration ratio is higher, because of positive effects of estrogen on
285 metabolism and oxidative stress²⁸. However, hormone concentrations were not verified in the
286 current study. Alternatively, a lower positive perception of fitness and performance in the phase
287 “Before” and “During” could be mediated by the incidence of MC-related side effects^{5,14}.

288 The effect of MC phase on the perceived quality of different types of training showed
289 various patterns. Whereas the perception of LIT did not show significant differences between
290 MC phases, both HIT and strength training quality were perceived to be different between MC
291 phases. HIT and strength training quality were perceived to be highest in the phase “After” and
292 lowest in the phase “During”. Several physiological variables related to training might be
293 influenced by MC phases, such as exercise metabolism²⁸ as stated above. In addition, a higher
294 growth hormone response, greater protein synthesis, and lower level of post-exercise creatine

295 kinase when the estrogen/progesterone concentration ratio is higher²⁹ point towards an
296 enhanced potential for muscle strength, recovery, and growth during the mid- and late follicular
297 phase, which is in agreement with the higher perceived strength training quality in the phase
298 “After” observed in the current study. On the other hand, Rael et al.³⁰ showed that several
299 cardiorespiratory parameters were not altered by the MC during a high-intensity interval
300 running bout, despite increased ventilation and heart rate in the mid-luteal phase, which
301 contradicts with the findings of the current study. However, it might be that the subjective
302 perception might not match with objective measures of exercise and might instead be
303 influenced to a higher extent by the increased incidence of MC-related side effects during the
304 bleeding phase and the days before bleeding⁵. The absence of significant differences in the
305 perceived LIT quality could possibly be attributed to the lower load of such training for
306 endurance trained athletes.

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

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

326

327 **Practical applications**

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

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

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

341

342 **CONCLUSIONS**

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

350

351

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452 **CAPTIONS**

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455 **Table 1** |Participants' demographics.

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

460

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

463

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

466

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

469

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

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

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Table 1. Participants' demographics.

	<i>Mean</i>	<i>SD</i>
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.

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

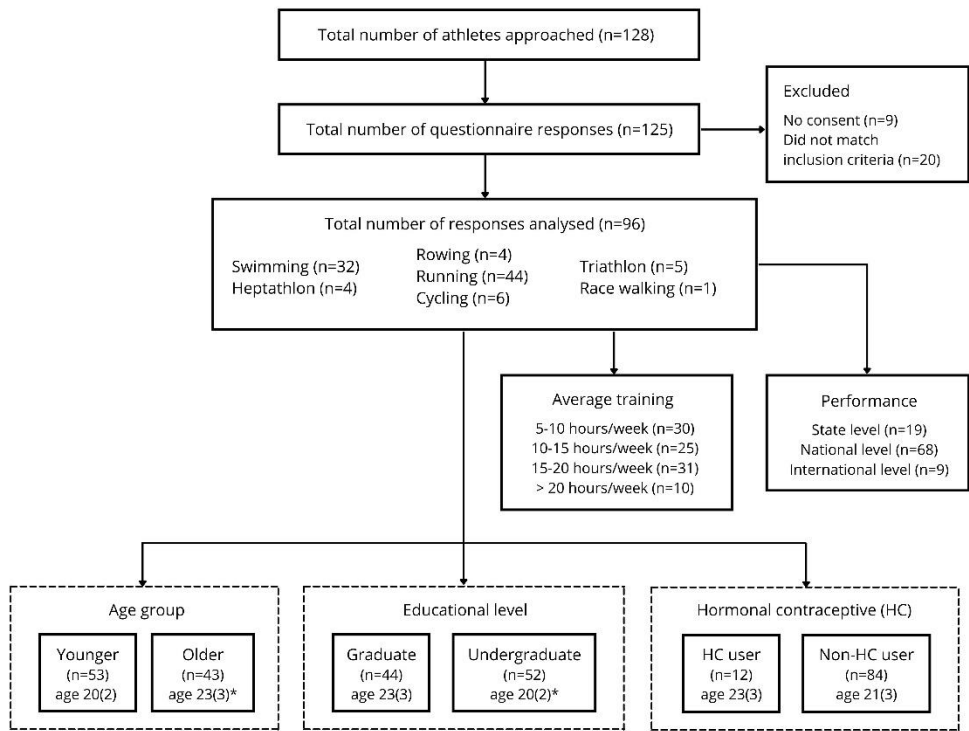
		Age			Educational level			HC use		
		P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI
PRACTICES	Do you currently keep track of your periods?	0.100	2.068	0.851 - 5.126	0.539	0.736	0.303 - 1.775	0.060	4.139	0.945 - 25.467
	Have you tried to change your training due to side effects/problems in connection 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.

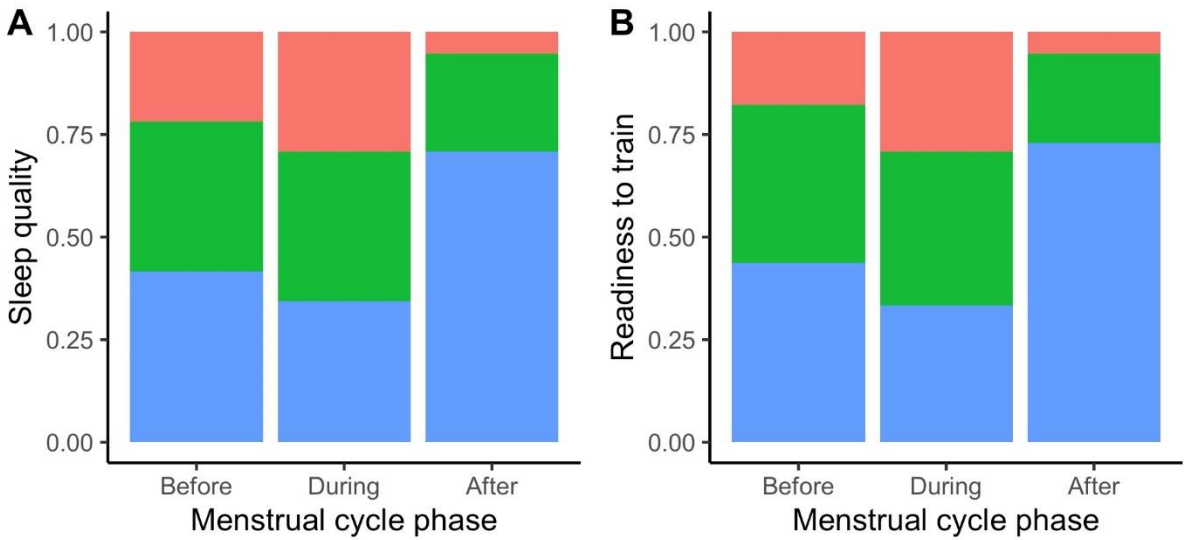
Table 3. Post hoc test of athletes' perceptions of changes in sleep quality, readiness to train, training quality, fitness, and performance between menstrual cycle (MC) phases.

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

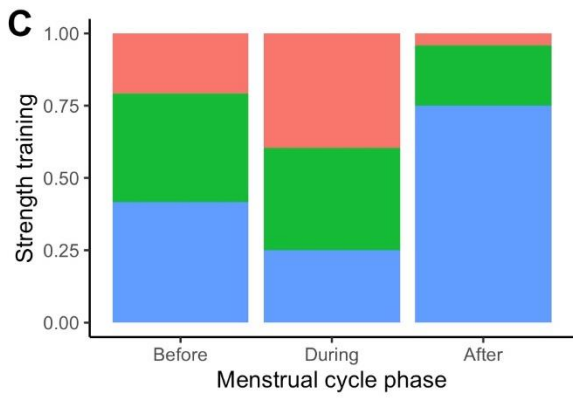
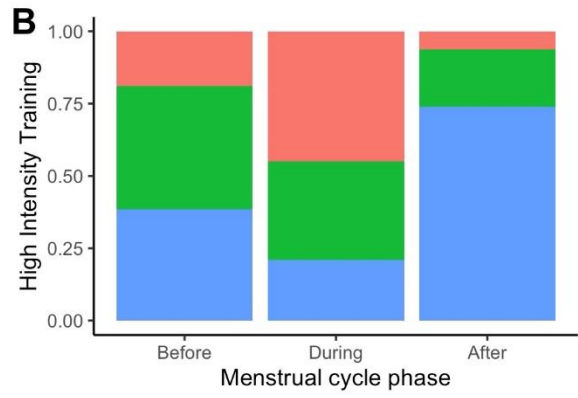
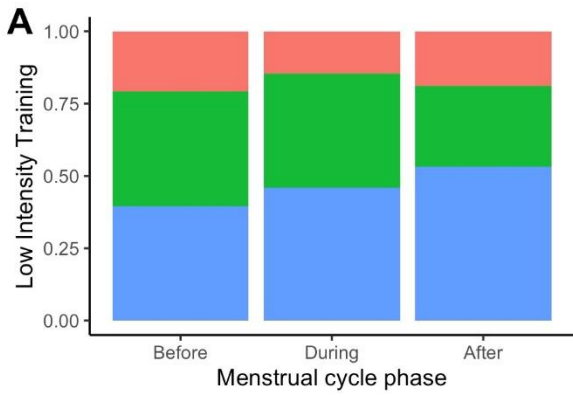
During = during the bleeding phase, After = phase immediately after the bleeding phase, Before = phase just before the bleeding phase.



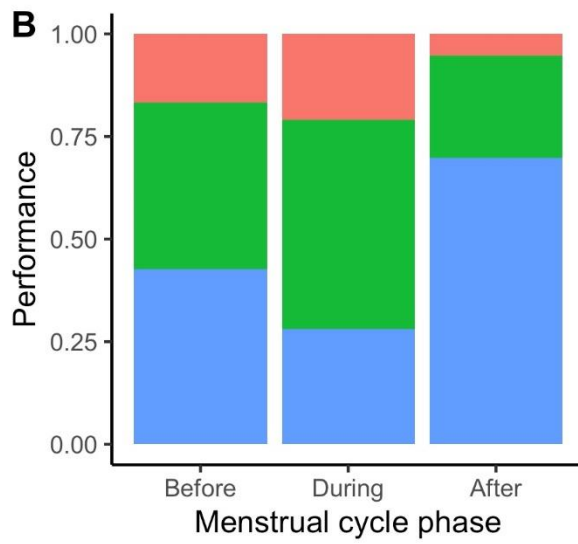
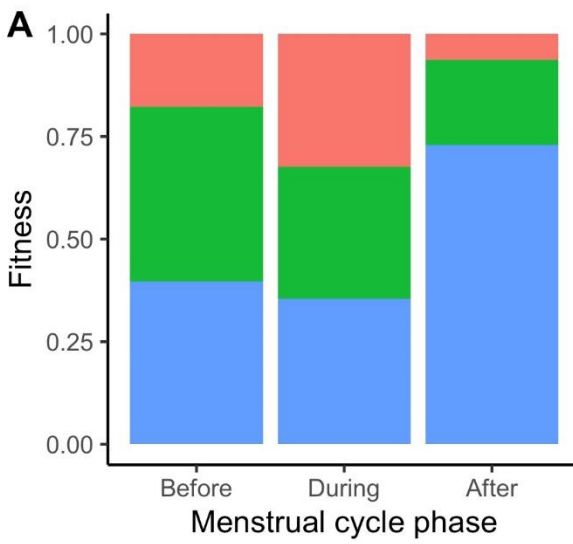
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