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1 **Physical activity and the menstrual cycle: A mixed-methods study of**
2 **women's experiences.**

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12 **Physical activity and the menstrual cycle: A mixed-methods study of**
13 **women's experiences.**

14 The menstrual cycle is an important biological process in women that is
15 associated with a range of physical symptoms, which can shape how women
16 think, feel, and participate in activities of daily life. This study employed a
17 mixed-methods design to investigate adult women's physical activity throughout
18 the menstrual cycle. One hundred and twenty-eight participants completed online
19 questionnaires that explored events of the menstrual cycle (e.g., bleeding, pain,
20 fatigue) and physical activity. Semi-structured interviews with 21 questionnaire
21 respondents unpacked individual experiences of physical activity throughout the
22 menstrual cycle. From the questionnaire data, 44 participants were categorised as
23 avoiders and 84 as non-avoiders of physical activity due to menstrual events.
24 Avoiders of physical activity reported longer periods, heavier menstrual flow,
25 higher levels of fatigue and pain compared to non-avoiders. Interviews revealed
26 that avoidance of physical activity ranged from complete avoidance to adaptation
27 (e.g., types of exercise). Reasons for avoidance and adaptation of physical
28 activity included menstrual symptoms, personal thoughts, and concerns about
29 other people's views of the period. The present study findings emphasise the
30 importance of recognising women's individual perspectives and established
31 societal norms in addition to physical symptoms in order to better understand and
32 normalise physical activity throughout the menstrual cycle.

33 Keywords: menstruation; period; questionnaire; interview; symptoms; avoidance;
34 self

35 **Introduction**

36 The menstrual cycle is a natural process in women's reproductive years that represents a
37 highly individual and personal experience (Brantelid et al., 2014). The start of every
38 menstrual cycle is marked by the period, also known as menstruation, which can lead to
39 symptoms, such as bleeding (Santer et al., 2007, 2008), pain (Chen & Hu, 2019), mood
40 changes (Samy et al., 2019), lethargy and fatigue (Bruinvels et al., 2016). The
41 symptoms can extend beyond the period and throughout the entire menstrual cycle and
42 affect how women feel and think about their bodies (Chrisler et al., 2015; Spadaro et al.,
43 2018). How women feel, think, and act is framed further by normative expectations,
44 stereotypes, and myths about the menstrual cycle (Kowalski & Chapple, 2000; Marván
45 et al., 2006). A combination of menstrual symptoms, women's thoughts and feelings,
46 and social norms could contribute to changes in activities of daily life (Brantelid et al.,
47 2014; Chen et al., 2016; Houston et al., 2006).

48 The most commonly reported menstrual symptoms represent painful cramps
49 (dysmenorrhea) and tiredness (Schoep et al., 2019), as well as heavy bleeding
50 (Bruinvels et al., 2016). On days of the period, the burden of these symptoms has been
51 shown to prevent women from participating in daily activities (Schoep et al., 2019). For
52 instance, 43% of adolescent women avoided aspects of daily life due to menstrual
53 events (e.g., bleeding and pain) of which 21% missed at least one in 30 school days
54 (Houston et al., 2006). Similarly, 64% of adult women missed an average of 2.6
55 workdays per month due to severe menstrual bleeding and pain (Fourquet et al., 2010).
56 Aside from the severity of menstrual symptoms, women's behaviour changes could be
57 shaped by upbringing (Marván & Molina-Abolnik, 2012), education (Stubbs, 2008), and
58 media coverage (e.g., advertisements) (Spadaro et al., 2018). Presentations of the period
59 as a matter of secrecy led women to be vigilant, self-conscious, and selective of daily

60 activities they undertook and avoided (Johnston-Robledo & Chrisler, 2013). Beyond
61 daily activities, however, limited studies have investigated how women experienced and
62 perceived the menstrual cycle and its impact on sporting performance (Findlay et al.,
63 2020; Moreno-Black & Vallianatos, 2005). A study conducted by Moreno-Black and
64 Vallianatos (2005) with first-year students, who had a history of sport participation,
65 found that women associated menstruation with shame and therefore disguised any
66 associated signs (e.g., sanitary product). The participants were concerned and anxious
67 about the visibility of menstruation (e.g., through leakage) and subsequent, negative
68 public attention. Such negative connotations were perpetuated by comments from
69 parents, teammates, and coaches of young women (Moreno-Black & Vallianatos, 2005).
70 Similarly, Findlay et al.'s (2020) study with international rugby players demonstrated
71 that athletes were highly aware and, at times, worried about the impact of their
72 menstrual symptoms on performance. Although severe symptoms, such as
73 dysmenorrhea, limited the participants during strenuous exercise (e.g., high intensity
74 training), the athletes had established coping strategies (e.g., by accepting their
75 menstrual experience or adapting to it), they had sought advice from medical
76 professionals to manage menstrual symptoms, and spoke to trusted others to process
77 their experiences of the menstrual cycle (Findlay et al., 2020). There remains no
78 comparison, however, how physical activity in a non-athlete population might be
79 affected by not only menstrual symptoms, but also women's individual experiences and
80 social understandings of the menstrual cycle.

81 Identifying that there is no extent data on the menstrual impact of physical
82 activity, broader comparisons could be made with examples from the effect of
83 pregnancy, adult life transitions, and body awareness on physical activity. In physically
84 active women, who adapted routines throughout pregnancy, decisions whether to

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85 participate in physical activity and, if so, to which extent, depended on the nature and
86 severity of pregnancy-related symptoms (e.g., nausea, fatigue, backache), as well as
87 women's perceptions of their own pregnancy and social expectations regarding physical
88 activity throughout pregnancy (Cioffi et al., 2010). Women self-managed the type,
89 intensity, and amount of physical activity they undertook, thoroughly evaluating
90 societal expectations, information received from health professionals, and myths that
91 relatives and friends shared with them (Cioffi et al., 2010). Similarly, a survey with
92 14,779 women aged 18–23 years showed that marriage and motherhood, both
93 significant transitions in adult life, put pressure on the time available for physical
94 activity and led to an increase in inactivity (Brown & Trost, 2003). Comparably, body
95 consciousness and the awareness of social norms regarding a desirable body image led
96 women to avoid physical activity (Markland, 2009). The perceived pressure to look a
97 certain way and comparisons to other women in physical activity settings reduced
98 already deflated levels of body satisfaction and affected drop out from physical activity
99 (Pridgeon & Grogan, 2012). This drop out is concerning as it has been shown that
100 physical activity could have a positive effect on dysmenorrhea (Dehnavi et al., 2018)
101 and self-esteem (Zamani Sani et al., 2016).

102 Within the United Kingdom (UK), 15% fewer women than men aged 16-34
103 meet aerobic exercise guidelines and 47% of young adult women undertake no
104 structured exercise compared to 32% of men (NHS Digital, 2017). Barriers to physical
105 activity are multifactorial and the lower level of daily physical activity in women could
106 be attributed to numerous factors. It is however impossible to discount that the
107 menstrual cycle, known to influence other aspects of daily life (e.g., school [Houston et
108 al., 2006], work attendance [Fourquet et al., 2010]), may account in part for lower
109 physical activity in women compared to men. One approach to determining whether

110 physical activity is impacted by the menstrual cycle is to combine quantitative and
111 qualitative methodology and facilitate a holistic understanding of the quantifiable (e.g.,
112 pain and flow) and the personal (e.g., experiences and perceptions) (Santer et al., 2007;
113 2008). Within the context of limited qualitative studies in athletic populations (Findlay
114 et al., 2020; Moreno-Black & Vallianatos, 2005), there remains no broader analysis of
115 physical activity and the menstrual cycle in the general population. The aim of this
116 study was therefore to, (1) quantify events of the menstrual cycle and self-reported
117 physical activity avoidance in women and (2) understand women's lived experiences of
118 physical activity throughout the menstrual cycle. The use of mixed methodology was
119 envisaged to aid an in-depth understanding of the multi-faceted factors affecting
120 physical activity throughout the menstrual cycle, which could usefully inform physical
121 activity recommendations and agendas. We hypothesise based on the avoidance of
122 school (Houston et al., 2006), work (Fourquet et al., 2010) and elite athlete training
123 commitments (Findlay et al., 2020), that women in the present study will show
124 avoidance of physical activity as a result of menstrual events.

125

126 **Methodology**

127 ***Design***

128 The authors utilised a mixed-methods design for the purpose of which they adopted a
129 pragmatic research positioning in line with Morgan (2007). Within this view, emphasis
130 is on (1) drawing on the strengths of quantitative and qualitative methods, (2) following
131 an abductive research process, and (3) acknowledging intersubjectivity. In the present
132 study, quantitative research methods were utilised to quantify the extent to which
133 women experienced menstrual symptoms and participated in physical activity while the

134 use of qualitative research methods gave insight into the different ways in which
135 individual experiences of the menstrual cycle affected women's physical activity. By
136 working back and forth between quantitative and qualitative components of this study,
137 the authors followed an abductive research process in line with Morgan (2007). Finally,
138 equal value was placed on the worldviews of the research team members, who
139 recognised and accepted that their individual interpretations about "one world" might
140 differ (Morgan, 2007). In doing so, the authors sought to aid the development of the
141 research (Sandelowski, 2000) and the comprehensiveness of the study findings
142 (O'Cathain, 2010).

143 A questionnaire was developed to examine the frequency and extent of
144 menstrual events as well as self-reported physical activity throughout the menstrual
145 cycle. Semi-structured interviews explored in-depth women's individual experiences
146 and meanings of physical activity and the menstrual cycle (Creswell et al., 2010).
147 Figure 1 visualises how the quantitative and qualitative components were prepared,
148 utilised, and integrated.

149 To ensure research quality, the researchers employed traditional and alternative
150 criteria (Bryman et al., 2008) and aligned their thinking with the integrative framework
151 by Tashakkori and Teddlie (2008). For design quality, focus was on the suitability and
152 adequacy of research design and methods, on whether the study components flowed in a
153 sound manner, and whether the strategies for data analysis were appropriate to meet the
154 research aims. To achieve interpretive rigor, it was of importance to engage in critical
155 debate and to seek interpretive agreement in the research team, to ensure distinctiveness
156 of interpretations, and adequate integration of quantitative and qualitative results.
157 Finally, the transferability of quantitative and qualitative results into other contexts and

158 participant groups was prioritised over rigid emphasis on generalisability or context-
159 dependence of the study results (see discussion).

160

161 Insert figure 1 here.

162

163 ***Participants***

164 Following ethical approval from the Institution Review Board, participant recruitment
165 took place via social media (Twitter and Facebook) and leaflets, which were distributed
166 at fitness centres affiliated to the authors' universities by the research team. The authors
167 sought to gain a broad understanding of physical activity and the menstrual cycle from
168 women in the generic population, however, equally adopted a purposeful recruitment
169 strategy, as only women of menstruating age were eligible for participation (Collins,
170 2010). This approach proved successful as patterns were later observed in the data
171 gathered from the study participants. The recruitment process led to a sample of 128
172 women of multiple races and ethnicities (27.9 (7.5) years, 1.65 (0.06) m, 63.2 (12.2) Kg,
173 Table 1), who completed the online questionnaire. Through the questionnaire, 82 of 128
174 participants provided consent to be contacted for further research participation and of
175 these, 38 shared their contact information (email address).

176 The 38 questionnaire respondents, who had provided contact details, were then
177 invited to a follow-up interview and 21 women took part in interviews. All of whom
178 completed the online questionnaire first and then participated in an interview. Interview
179 invitations and interviews themselves were led by the principal author, one of the
180 female researchers on the team, to facilitate the establishment of rapport and trust

181 (Miller, 2017), which was considered important to intimate discussions about the
182 menstrual cycle (Dempsey et al., 2016). Interviews were conducted at times and
183 locations that were not only convenient, but also facilitated comfort between her and the
184 participants. Everyone, who stepped forward for an interview, was interviewed and as
185 the final interviews were arranged, saturation had been reached and the research team
186 were confident to halt data collection (Beitin, 2012).

187

188 ***Data collection***

189 *Questionnaire*

190 For the purpose of this research, participants completed a questionnaire about their
191 menstrual cycle duration, menstrual flow, pain or discomfort, and lethargy, combined
192 with questions related to exercise avoidance and self-reported physical activity status.
193 All aspects of the questionnaire were completed online (Jisc, UK). Informed consent
194 was obtained via a compulsory drop down selection at the start of the questionnaire,
195 which was presented following a participant information page. Those who responded to
196 “I do not provide consent for my answers to be used in research” were directed to an
197 exit page of the questionnaire. All questions required a compulsory answer, however
198 two participants selected “not applicable” for their self-reported body mass, which is
199 therefore presented from N = 126. The questionnaire was developed adopting aspects of
200 previous studies that had reported menstrual symptoms, including items from the
201 Menstrual Bleeding Questionnaire (3 items, Matteson et al., 2015), assessment of
202 menstrual pain (1 item, Larroy, 2002), and menstrual flow heaviness (1 item, Fraser et
203 al., 2015).

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204

205 Participant demographics

206 Participants completed drop-down selections for age (yrs), height and body mass.

207 Options were given for the height in metres and feet and inches, and for body mass in

208 kg and lbs.

209

210 Hormonal contraceptive

211 Participants were given the option of seven choices related to their use of hormonal

212 contraceptive, from “none” to different forms of hormonal contraceptives, such as oral

213 contraceptive pill (including type and exogenous hormone dosage), patch, injection, or

214 intrauterine devices. For the purpose of data analysis, they are classified as: “None” if

215 they use no form of hormonal contraceptive, “Pill” if they use any form of oral

216 contraceptive, and “non-oral contraceptive” if they use any form of indwelling, injected

217 or cutaneous hormonal contraceptive.

218

219 Menstrual events

220 Participants were asked “Over the last three months, roughly how many days on

221 average has your period lasted?”; these data are reported in the present results as “length

222 of period”. In addition, participants completed a calendar style grid for the symptoms

223 experienced throughout the month for: “bleeding”, “spotting”, “discomfort, cramps or

224 pain” and “lethargy and fatigue”. Within the questionnaire, each of these menstrual

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225 symptoms contained a more detailed description. Participants were instructed to select
226 the days of the month when these symptoms normally occur, with specific reference to
227 the previous month. The frequency of each symptom was summed throughout the
228 month and is presented below as the number of days each symptom occurs during a
229 menstrual cycle (days/MC). Although reliability data is available on retrospective recall
230 for some elements of the menstrual cycle, for instance 80% of women are able to recall
231 their last period date with two days of accuracy (Wegienaka & Baird, 2005) and
232 menstrual cycle length is underestimated by one day compared to using prospective
233 logging (29.4 and 30.9 days, respectively [Small et al., 2007]), the reliability of
234 recalling period length as described above is not presently reported. There is however,
235 “excellent agreement” between daily compared to 1-month recall for menstrual
236 symptoms of bleeding heaviness and pain (Matteson et al., 2015), with the risk of recall
237 bias on these specific elements of the Menstrual Bleeding Questionnaire being
238 described by those authors as “not a problem”. It should also be noted that 52% of our
239 participants self-reported that they tracked their menstrual and pre-menstrual events
240 through an App or diary, and 88% reported that they were somewhat or very confident
241 that they “can accurately recall [their] menstrual cycle dates and pre-menstrual
242 symptoms”.

243

244 Heavy or normal menstrual bleeding

245 Participants were classified as “heavy” menstrual bleeders based on the selection of two
246 or more of the following symptoms, consistent with Fraser et al. (2015): 1) a need for
247 double sanitary products (e.g., tampons and towels) at the same time, 2) a need for
248 frequent changes of sanitary towels or tampons (every two hours or less, or 12 sanitary

249 items per day), 3) bleeding through sanitary products onto clothes or bedding, and 4) the
250 presence of large clots within period blood. A final option of “none of the above” was
251 also included. Participants reporting one or none of the above symptoms were classified
252 as “normal” menstrual bleeders (Fraser et al., 2015). These terminologies are consistent
253 with the International Federation of Gynecology and Obstetrics (FIGO) systems for
254 nomenclature of symptoms of normal and abnormal uterine bleeding (Fraser et al.,
255 2011). Despite the accepted terminology and classification of heavy menstrual bleeding,
256 there is presently no reliability data available for the classification of “heavy menstrual
257 bleeding” as established by Fraser et al. (2015). Concurrent validity has however been
258 previously reported based on menstrual symptom severity being higher in women who
259 are classified as experiencing heavy compared to normal menstrual bleeding (Matteson
260 et al., 2015), with daily and monthly flow scores showing excellent agreement ($\rho =$
261 0.82, Matteson et al., 2015).

262

263 Pain

264 Participants were provided with a numerical scale from 0-10 (Larroy, 2002), where 0
265 was labelled “no pain”, 5 was labelled “moderate pain” and 10 was labelled “worst
266 possible pain”. Within the questionnaire, a visual analogue scale was also provided
267 under “more info”. Participants were classified into “mild pain” if pain was between 1
268 and 3, “moderate pain” between 4 and 7 points, and “severe pain” between 8 and 10
269 points (Kural et al., 2015). Due to there being insufficient “avoider” participants (see
270 below) falling within the “no pain” category, the “no-pain” and “mild pain” were
271 compressed into a “no-to-mild pain” category representing all participants reporting
272 pain of ≤ 3 . Analysis of menstrual pain was conducted based on both continuous data

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273 from the numerical scale (termed pain severity, Table 1), and pain classification.

274

275 Avoidance

276 Participants were asked “In the last 3 months, which, if any, of the following activities
277 have you avoided or postponed due to menstrual events or discomfort?” with the
278 options provided of “social activities”, “work or university”, “playing sport, going to the
279 gym, or other physical activities” and “none”. An open text option of “other” was also
280 provided. Where these included recreational activities such as “swimming”, “walking”
281 or “hiking” they were categorised in the “physical activity” avoidance response if this
282 was not already marked in the affirmative. Due to the focus of the present study,
283 participants were classified as “avoiders” and “non-avoiders” based on whether they
284 had reported to have previously avoided physical activity due to the events of the
285 menstrual cycle. The impact of menstrual symptoms on physical activity avoidance was
286 based on similar single question components of absenteeism from work and school
287 (Fourquet et al., 2010; Houston et al., 2006).

288

289 Physical activity

290 Self-reported physical activity status was assessed based on the following criteria:
291 sedentary (walking less than 20 mins a day); slightly active (walk over 20 mins per
292 day); moderately active (undertake at least 20 mins of moderate physical activity per
293 day); very active (undertake 40 mins of moderate intensity physical activity per day);
294 athlete (high intensity exercise 5+ days a week). For the purpose of subsequent analysis,

295 as there were fewer than five participants within the sedentary and athlete categories,
296 the groups were condensed with their closest categories. The physical activity
297 classifications were therefore: sedentary-to-low activity, moderately active, high
298 activity-to-athlete. Despite retrospective recall having known limitations for accurately
299 quantifying daily physical activity (Lee et al., 2011), a single item physical activity
300 question is a valid approach for the purposes of participant classification as adopted in
301 the present study (Milton et al., 2013; Schechtman et al., 1991), with high test-retest
302 reliability ($r = 0.82$, Milton et al., 2011).

303

304 *Interviews*

305 Semi-structured interviews were conducted to (1) expand on the data obtained from
306 questionnaires (O’Cathain, 2010), (2) to facilitate the generation of new ideas that might
307 not have emerged from the sole use of quantitative methodology, and (3) to uncover the
308 subtleties underpinning participant perceptions ‘in diverse and enriched ways’ (Smith &
309 Sparkes, 2016, p. 3). They were useful to cover aspects important to the inquiry, while
310 rendering the flexibility to pose impromptu questions that encouraged participants to
311 express thoughts freely (Brinkmann & Kvale, 2018).

312 In this study, 21 interviews were conducted, of which seven took place face-to-
313 face and 14 via video call (FaceTime or WhatsApp). Prior to interview participation, the
314 women gave written consent to voluntary interview participation, to audio recording of
315 interviews, to transcription of these audio recordings, and to the use of anonymised,
316 direct quotes in published work (e.g., conference presentations, journal articles).
317 Interviews were informed by an interview guide, which outlined topics of interest and
318 example questions. Following a summary by the principal author of the purpose of

319 interviews, conversations then focused on understanding women's physical activity
320 throughout the menstrual cycle (Warren, 2012). Interview questions explored how the
321 participants felt on days before, during, and after the period, what the participants'
322 physical activity looked like throughout the menstrual cycle, how participants felt about
323 themselves throughout the menstrual cycle, how menstrual symptoms, self-perceptions,
324 and social situations shaped physical activity on days of the period, and why the
325 participants thought, felt, and acted in certain ways. Participants were prompted to
326 expand on initial thoughts with questions, such as "How did this make you feel?",
327 "Why do you think this way?" or "Can you give me an example?" Interviews were
328 audio-recorded and transcribed by the principal author for further interpretation
329 (Davidson, 2009).

330

331 ***Data analysis***

332 *Questionnaire*

333 All quantitative analyses were performed using IBM SPSS Statistics 24 software.
334 Where appropriate (i.e. ratio data), parametric assumptions of normal distribution were
335 confirmed using Shapiro-Wilk's test ($p>0.05$) in all dependent variables, except for
336 height in both avoiders and non-avoiders ($p<0.05$). Group comparisons were made
337 using independent t-tests with equal variance (Levene's, $p>0.05$) in all dependent
338 variables, other than pain (days/MC), fatigue (days/MC), and spotting (days/MC)
339 (Levene's $p<0.05$). For comparison of group differences in height, the Mann-Whitney U
340 test was performed. All data are presented as mean (SD), with group differences
341 reported as: p , 95% confidence interval (CI) and effect size (d).

342 Nominal data was assessed using Chi-square associations for classifications of
343 pain, flow, contraception, and physical activity. Participants were grouped as avoiders
344 or non-avoiders, with subsequent post-hoc analysis performed if the Chi-square reached
345 significance ($p < 0.05$, for pain and flow). As only two classification were made for flow,
346 no post hoc was necessary. Whereas for pain, there were three classifications (no-mild,
347 moderate, and severe), in this instance cell-wise residual analysis was performed
348 (Garcia-Perez & Nunez-Anton, 2003), with the level of significance adjusted for the
349 three sub-classifications. For the nominal variables, a significant outcome of Chi square
350 is described as a significant association rather than a group difference based on previous
351 recommendations (Field, 2013; McHugh, 2013; Scott et al., 2013).

352

353 *Interviews*

354 Thematic analysis was utilised to identify patterns in the interview data and make sense
355 of their meaning (Braun et al., 2016). The principal author read anonymised interview
356 transcripts recurrently to define codes, which constituted of links between data and
357 ideas, and themes that helped identify commonalities and distinctions (Nowell et al.,
358 2017). She recognised this phase as an active process of meaning making and adopted
359 an iterative approach by working “back and forth” between interview data, preliminary
360 themes, and interpretations (Braun et al., 2016). Analytical questions included “What do
361 the participants’ physical activity routines look like?”, “How do menstrual events affect
362 the participants’ physical activity? Why is this so?”, “How do the participants think and
363 feel about factors affecting physical activity? Why do they think and feel in certain
364 ways?” To strengthen the credibility of interpretations, the principal author liaised with
365 members of the research team, who acted as critical friends and discussed

366 interpretations, prompted reflection, and explored interpretive avenues (Smith &
367 McGannon, 2018). In the latter stages of analysis and write-up, the dialogues also
368 explored opportunities to integrate the insights gained from questionnaires and
369 interviews to develop rich discussions of physical activity and the menstrual cycle.

370

371 **Results**

372 *Questionnaire results*

373 Of the 128 responders, 44 participants (34%) were classified as “avoider” and 84
374 participants (66%) were classified as “non-avoider” based on whether they had avoided
375 playing sport, going to the gym, or other physical activities due to their menstrual
376 events or discomfort.

377

378 *Participant demographics*

379 There was no significant difference in age, height or body mass between avoiders and
380 non-avoiders (Table 1).

381

382 *Menstrual characteristics*

383 Compared to non-avoiders, avoiders had periods that lasted 0.65 days longer ($t(126) = -$
384 $2.34, p < 0.05, CI [0.10, 1.20], d = 0.40$, Table 1). In terms of specific menstrual
385 symptoms, compared to non-avoiders over the course of a menstrual cycle, avoiders had
386 0.94 more days of bleeding ($t(126) = -2.464, p < 0.05, CI [0.18, 1.71], d = 0.46$), 0.98

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387 more days of fatigue ($t(126) = -4.769, p < 0.01, CI [1.30, 3.61], d = 0.33$) and 2.44 more
388 days of pain ($t(126) = -4.191, p < 0.01, CI [1.28, 3.61], d = 0.84$, Table 1). There was no
389 difference in days of spotting between avoiders and non-avoiders (Table 1).

390 Pain severity (numerical scale) was 62% higher in avoiders than non-avoiders
391 ($t(126) = -4.116, p < 0.01, CI [1.09, 2.96], d = 0.78$, Table 1). There was no significant
392 association between contraception use and physical activity avoidance ($X^2 (2, N = 128)$
393 $= 2.06, p = 0.35$); with 61% and 57% using no form of hormonal contraceptive, 18.2%
394 and 11.9% using non-oral contraceptive, and 20.5% and 31% using some form of oral
395 contraceptive pill, in avoiders and non-avoiders, respectively.

396 There was no significant association between physical activity classification and
397 avoidance ($X^2 (2, N = 128) = 2.73, p = 0.26$), with 20.5% avoiders and 11.9% non-
398 avoiders being sedentary or low physical activity, 54.5% avoiders and 51.2% non-
399 avoiders being active, and 25% avoiders and 36.9% non-avoiders being very active or
400 athlete.

401 There was a significant association between pain classification and avoidance
402 ($X^2 (2, N = 128) = 14.5, p < 0.01$). Post hoc revealed that significantly less avoiders were
403 in the “no-to-mild” pain classification (20.5%) than non-avoiders (52.4%, $p < 0.01$).
404 Similar participant numbers were found for avoiders and non-avoiders in the moderate
405 pain classification (59.1% avoiders, and 41.7% of non-avoiders), and in the severe pain
406 classification (20.5% of avoiders and 6% of non-avoiders, $p < 0.04$, no significant
407 difference at the adjusted $\alpha = p < 0.017$).

408 There was a significant association between menstrual flow and avoidance
409 ($X^2 (1, N = 128) = 22.3, p < 0.01$), 63.6% of avoiders were classified as heavy flow,
410 compared to 21.4% of non-avoiders. Similarly, 36.4% of avoiders were classified as
411 normal flow compared to 78.6% of non-avoiders.

412

413 Insert table 1 here.

414

415 *Interview results*

416 Following on from the questions posed throughout the data analysis, the results explore
417 women's experiences and management of physical activity as well as factors affecting
418 physical activity throughout the menstrual cycle, including menstrual symptoms,
419 personal perspectives, and social expectations. Throughout this section, pseudonyms
420 were used to protect the identity of participants.

421

422 *Periods and physical activity: Realities and experiences*

423 The women, who took part in interviews, spoke openly about the menstrual cycle and
424 shared personal experiences. Although participants referred to the period as the
425 menstrual cycle phase that had the greatest impact on physical activity, they equally
426 recognised the value of physical activity when coping with menstrual symptoms. It
427 became apparent that their perspectives were informed by an understanding of the
428 effects that physical activity had on physical and mental health. For instance, Val, Lisa,
429 and Elaine explained:

430 I think exercise has been a big help with my mental health. Even going for a walk.
431 I'll consciously do it because it makes me feel better. I feel lazy and more bloated
432 if I don't move much. (Val, Non-avoider)

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433 I think it's good for your longer term health. I know that people say exercise helps
434 with your periods. (Lisa, Avoider)

435 I think to begin with I was quite emotional because I wasn't active. With being
436 more consistently physically active, my mood swings are not bad at all. (Elaine,
437 Non-avoider)

438 Not only did the participants recognise the benefits of physical activity, but they also
439 sought to undertake it in everyday life. These women reported continuous physical
440 activity throughout the menstrual cycle and, in their recollections, demonstrated an
441 instilled sense of commitment. As an example, Olivia (Non-avoider) described why she
442 pushed herself to exercise:

443 I force myself to do things. I'm very active, so I tend to stay physically active. I
444 thank myself afterwards. It makes things better, especially the cramping and
445 sluggishness. All I want to do is tuck up in a ball on my bed. So forcing myself to
446 go to the gym is worth it because I do feel so much better after.

447 Sharing a perception of the period as something that should not limit activities of
448 everyday life, some of the participants felt as though they had no reason to skip the
449 gym. As a former professional dancer, Ava expected herself to commit to physical
450 activity even on days of the period. Throughout her career as a professional dancer, she
451 had developed a strong sense of commitment to routine training, which she had
452 transferred into her approaches to physical activity (Stephan, 2003). Holding high
453 expectations of herself, Ava (Non-avoider) differentiated the period from health
454 problems or injuries and explained:

455 There's no injury or pain that's preventing me from going. I just feel unwell. I'd
456 rather not go when I'm too tired or something is wrong with me. I think, "Okay
457 well at least you went and maybe don't go another time." There's no actual
458 physical reason for me not to go. It's a subjective feeling.

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459 Likewise, Nina (Non-avoider) described that she sought continuity in her routines:

460 I usually have a day at the start of my period, when I'm a bit off. If I planned a
461 session, I would do it and leave it behind me. I'm keen to follow my routines
462 because I don't think that my periods are strong enough. There is no need for me to
463 change things. I'm always challenging my brain whether I need to change
464 something or whether I can try it.

465 It is noteworthy that the above-presented data extracts stem from interviews with
466 women, who described their menstrual symptoms as manageable and therefore did not
467 feel the need to avoid physical activity. Many participants, however, did describe
468 avoidance of behaviours; either of physical activity environments (e.g., the gym) or of
469 exercises (e.g., abdominal work) and types of exercise (e.g., cardiovascular training).
470 The majority of conversations in this context therefore focused on the adaptations made
471 to maintain some level of physical activity. None of the participants scheduled
472 avoidance of physical activity due to menstrual events. Rather, symptoms had to be
473 managed *in situ* and often left the participants feel unable to follow their "normal"
474 physical activity routines. As an example, Willow (Non-avoider) changed her workouts
475 to avoid the frustration she associated with not being able to perform the way she would
476 on days when she did not have the period. She explained:

477 On my period, I don't feel like my workouts are as productive. I will swap what I
478 do. I tend to focus more on upper body to avoid the annoyance I have if I have a
479 bad session and I'd probably stay away from cardio.

480 For Hannah (Avoider), the first day of the period usually meant avoiding physical
481 activity completely:

482 Sometimes I get home from work on the first day and think, "Forget it, not this
483 week", and just stay at home. Then on later days, when I do decide to go for a run

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484 or do exercise, I wouldn't put as much effort in. I'd choose an easier class rather
485 than a more intense one.

486 For Scarlett and Harper, the discomfort of using sanitary products led them to alter
487 routines:

488 I do a lot of running and I don't really do that when I'm on my period. The
489 sensation feels weird, so I stick to weight bearing exercises. The feeling's not there
490 as much when I do that. I don't wear tampons because I find them uncomfortable,
491 so I wear sanitary towels and I always wonder, "Oh have they moved?" ... it's
492 about where the pad is and it can get sore. It doesn't stop me but instead of doing
493 half an hour, I might only do ten minutes of cardio. Or I'd sit on a bike instead of
494 running because it's not moving as much. (Scarlett, Non-avoider)

495 I'd go to the gym, but perhaps not do cardio. Because of my injured knee, I can't
496 run and sitting on a bike with a pad or tampon is really uncomfortable. That would
497 ruin my gym session. So, sessions don't last as long. I probably do more upper
498 body than lower body. I don't think I do abs when I'm on my period. Especially
499 crunches or sit-ups when you've got a pad on. It's not nice at all. (Harper, Avoider)

500

501 *Symptoms, self, and social – Factors shaping physical activity*

502 Interview participants recalled a variety of factors affecting the ways in which they
503 managed physical activity throughout the menstrual cycle. Their suggestions broadly
504 related to the symptoms associated with the period, to perceptions of self, and to social
505 expectations.

506 The most prominent influence on women's physical activity routines was the
507 perceived severity of menstrual symptoms. Although the types of symptoms, their
508 duration, and occurrence varied, they commonly included abdominal cramps, headaches

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509 and backaches, leg pains, lethargy and fatigue. The following data extracts are examples
510 of the symptoms described by interview participants:

511 I suffer most with sciatica-type leg pain. I'm extremely lethargic to the point where
512 it's almost debilitating. Migraines as well, feeling dizzy and muggy. (Piper,
513 Avider)

514 Normally I'm an energetic person, but when it's that time I'm tired. I can be
515 moody, but it's mainly tiredness. I don't feel I have my normal amount of energy.
516 (Hannah, Avider)

517 My body changes completely. When I put on a pair of trousers that are normally
518 loose, they're tighter. My stomach feels heavy. And the fatigue! (Mary, Avider)

519 There were a couple of times, where I woke up in the morning and planned to go
520 for a run, but then the cramps were so bad that I couldn't get out of bed. (Olivia,
521 Non-avoider)

522 In addition to feeling physically unwell, many participants also spoke of a heightened
523 sense of self-consciousness. The period affected how women thought about themselves
524 and how they felt in their own skin. Interestingly, these perceptions were not only
525 limited to those who avoided (certain aspects of) physical activity, but were also shared
526 by those who made efforts to maintain activity levels throughout the menstrual cycle.
527 As an example, Harper (Avider), described:

528 You're not your usual self. You just feel you're on the period. For me it's at the
529 start, but at that point, it's always there that thought. Just like hyper aware of it.

530 For Val and Caroline, feelings of consciousness led them to carefully select clothes
531 worn in physical activity environments. The participants recalled, respectively:

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532 I'm really conscious if I wear shorts or if my leggings are see through or thinking
533 whether I've leaked. I'm more aware of what I do and how that might look. (Val,
534 Non-avoider)

535 I suppose with netball, I am conscious of what to wear because of the small shorts
536 and dresses that we have to wear. I always wear a tampon over a towel and
537 underwear that keeps everything in check. I actually saw a girl at netball a couple
538 of years ago. You could see her pad through the shorts and I felt bad for her but
539 nobody said anything. (Caroline, Non-avoider)

540 Beyond the sense of self-awareness, the perceived expectations others might have about
541 menstrual events, shaped women's physical activity routines. Interview participants
542 commonly referred to worries of being "found out" by others, recalled an awkwardness
543 surrounding periods, and described subsequent discomfort in certain physical activity
544 environments. For example, Lisa and Scarlett preferred to avoid the gym on days of
545 heavier flow due to concerns over how others might react if they discovered the reasons
546 for which they did not adhere to usual routines:

547 The gym is a social place for me. I know a lot of people. They would know I
548 wasn't on top form. My PT would say, "Why are you lifting this today?" I
549 wouldn't wanna turn around, "I feel shit because of my period." I don't know how
550 he would handle that, what his feelings would be. That's where I suppose that
551 taboo comes in because I wouldn't go, "I'm taking it easy today because I'm on
552 my period." Even though I say I talk about periods, I guess I don't because I'd
553 rather avoid telling them that I was going easy because of my period. (Lisa,
554 Avoider)

555 In the first days when I'm heaviest, I feel embarrassed. I don't want other people to
556 know. I'm scared that if I get out of the pool, blood is gonna run down my leg. I'm
557 worried what other people would say. Especially with men in the gym. Someone
558 might put me down and I wouldn't wanna go to the gym anymore. (Scarlett, Non-
559 avoider)

560 Other participants perceived pressure to maintain their attendance at training sessions

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561 and believed there were expectations for women to carry on “as normal” regardless of
562 discomfort due to menstrual events. For Hannah and Harper, playing netball was not
563 only important at a personal level, but also in a social context (Weiss, 2015). It was
564 therefore to be continued throughout the menstrual cycle. The participants’ perceptions
565 of expectations and understandings that teammates and coaches might hold shaped their
566 dedication to the sport (Weiss et al., 2010). They explained:

567 With netball, you’ve got to go. There’s no choice. In my netball team, if you don’t
568 train, you don’t get played at the match. You’ve got that pressure. Also we pay for
569 training and matches, so you don’t want to waste money by not going. (Hannah,
570 Avoider)

571 When I played netball, I couldn’t turn around to the team and say, “I can’t play.
572 I’m on my period.” Someone might say, “I’m on my period too and I’m playing.”
573 Especially in a team of girls. You can’t let them down when they all know how it
574 feels. (Harper, Avoider)

575 Similarly, Mila and Nina believed that it was expected of women to disguise any signs
576 of menstrual events. In Mila’s (Non-avoider) words:

577 When I’m on the period I don’t want anyone to find out I’m not feeling hundred
578 percent. Maybe I complain to a female co-worker or friend but I would never,
579 even, if I called in sick, I wouldn’t admit it’s period-related. I would say I am not
580 well. I think the expectation to carry on as usual is always there.

581 Nina (Non-avoider) explained:

582 Nobody ever told me that I need to hide my tampon when I go to the loo at the
583 gym, but I do it. Because I think, other people aren’t as relaxed as me about
584 periods. We don’t talk about them. If we do, it’s awkward.

585

586 **Discussion**

587 This mixed-methods study utilised an online questionnaire to quantify events relating to
588 the menstrual cycle and physical activity as well as semi-structured interviews to
589 explore women's lived experiences of physical activity throughout the menstrual cycle.
590 The discussion draws together quantitative and qualitative results to provide rich
591 interpretations of the questionnaire and interview data (O'Cathain, 2010).

592 In the present study, the majority of women who completed the questionnaire
593 (84 of 128 women – Table 1) were categorised as non-avoiders of physical activity due
594 to events of the menstrual cycle. Interview data revealed that the participants recognised
595 the importance of physical activity and the benefits it brought to their lives. Through
596 experiences in their upbringing, education, and employment, they had learned about the
597 advantages of physical activity, which in turn affected their experiences of and
598 commitment to physical activity throughout the menstrual cycle. Consistent with the
599 knowledge that the present participants possessed, previous research has shown that
600 connections existed between people's awareness of physical activity recommendations
601 and their actual levels of physical activity (Plotnikoff et al., 2011). Those who knew
602 about health recommendations tended to be more physically active in everyday life
603 compared to those, who did not possess this level of understanding (Fredriksson et al.,
604 2018). This was so especially when individuals knew not only about guidelines, but also
605 about the health benefits associated with moderate physical activity (Heinrich et al.,
606 2011). Interview data in the present study revealed that the participants had actually
607 experienced positive post-workout effects on days of the period, for instance, uplifted
608 emotional state, reduced pain, and increased feelings of accomplishment. This finding is
609 in line with studies illustrating that exercise could alleviate menstrual symptoms (e.g.,
610 backaches – Chen & Hu, 2019) and enhance mental wellbeing throughout the menstrual

611 cycle (Kanojia et al., 2013). Physical activity has also been considered as a
612 complementary treatment for dysmenorrhea (Samy et al., 2019) as it reduced the
613 duration and severity of menstrual cramps (Dehnavi et al., 2018; Kannan et al., 2015).

614 In partial agreement with our hypothesis, one third of questionnaire respondents
615 (44 of 128 participants) were categorised as avoiders of physical activity due to
616 menstrual events (Table 1). This could be attributed to these avoiders having more
617 severe menstrual symptoms, including longer periods, higher levels of pain and fatigue,
618 and heavier flow as reflected in the questionnaire data. Despite the potential bias of
619 menstrual recall (as discussed in detail in the methods) the qualitative data confirmed
620 that women could not overlook menstrual events (e.g., bleeding and pain) and when
621 considering whether to avoid physical activity, interviews revealed that the participants
622 evaluated the severity of menstrual symptoms. For instance, symptoms that the women
623 perceived as severe (e.g., migraines and abdominal pain) led the participants to avoid
624 physical activity completely. This complete avoidance is comparable to recurrent school
625 absence in adolescent women who suffered from dysmenorrhea (Houston et al., 2006).
626 In adult women, missing university or workdays represented a common self-
627 management strategy for painful periods (Chen et al., 2016). The present study
628 participants confirmed that the period had to be managed (e.g., sanitary products) and
629 taken into account in physical activity routines (e.g., types of exercises). The women in
630 this research described the days of the period as limiting their ability to function as what
631 they perceived “normal” for themselves. In particular, a combination of physical
632 symptoms, lacking “energy” and motivation made it more challenging for the
633 participants to perform physical activity as normal. These findings resonate with studies
634 on the impact of the menstrual cycle on physical performance, such as through anaemia
635 from heavy menstrual bleeding (Bruinvels et al., 2016), higher body temperature during

636 exercise in the luteal phase (De Jonge & Janse, 2003), and lower fatigue resistance in
637 the pre-menstrual phase (Ansdell et al., 2019).

638 The present study participants, however, did not necessarily avoid all forms of
639 physical activity on days of the period (a nuance not captured within the questionnaire).
640 Although the questionnaire data showed no significant relationship between physical
641 activity classification and avoidance, interviews were particularly useful to make sense
642 of this observation and to unpack the subtleties underpinning women's reports of
643 physical activity avoidance due to menstrual events without necessarily being less
644 physically active overall. Indeed, interviews uncovered aspects of physical activity
645 adaptation that have been previously unreported. Some of the participants, who reported
646 to avoid physical activity, did not avoid all forms of activity and instead, changed
647 exercise routines, used alternative physical activity or made up for missed physical
648 activity on days when they felt less affected by menstrual symptoms. Often, it was
649 about adapting routines depending on the perceived severity of menstrual symptoms and
650 levels of discomfort, consistent with previous work showing adaptations to activities of
651 daily life due to menstrual symptoms (Kennett et al., 2016). The selective avoidance
652 and modification of physical activity was routine to some participants and could reflect
653 women's knowledge about the benefits of physical activity to their health, physical
654 wellbeing, and mood (Fredriksson et al., 2018). Similar to women who selectively
655 avoided tasks in the workplace (e.g., meetings) due to reduced concentration, patience,
656 and efficiency (Brantelid et al., 2014), some of the present interview participants only
657 avoided physical activity that caused discomfort (e.g., lower body workouts), while
658 continuing more manageable activities (e.g., walking and upper body workouts), when
659 they believed that they could maintain some level of activity. This selective avoidance
660 of physical activity is comparable to reports of adaptation as a way to maintain physical

661 activity levels in other populations, such as pregnant women suffering from backaches
662 (Cioffi et al., 2010) as well as individuals suffering from chronic fatigue syndrome
663 (Larun & Malterud, 2011) and migraines (Buse et al., 2012).

664 Aside from the menstrual symptoms, our qualitative findings demonstrated how
665 self-perceptions and perceptions of social expectations influenced physical activity.
666 Interviews revealed that the participants had concerns about leakage of blood, product
667 use, and pain management in the presence of other people in physical activity
668 environments. Similar to women, whose commitment to exercise suffered from
669 heightened body consciousness in physical activity environments (Pridgeon & Grogan,
670 2012), several women in the present study described a heightened sense of self-
671 awareness on days of the period that led to careful selection of clothes and exercises.
672 Comparably, heightened consciousness in public spaces was previously described in
673 women, who felt their bodies did not conform to predefined norms of femininity, such
674 as female bodybuilders in the presence of casual gym visitors, in public (Shilling &
675 Bunsell, 2009), and when sharing photos of their physique on social media (Marshall et
676 al., 2019). In the present study, the perceptions of self in physical activity environments
677 were closely connected to concerns over what others might say if they found out about
678 women's menstrual events. Sensations, such as bleeding, pain, and fatigue, associated
679 with the period in particular, were to be "dealt with" in private. This persisted even
680 though the interview participants had reframed their own views of menstrual events and
681 felt comfortable to talk about them (Lee, 2002). The participants believed, however, that
682 upbringing and societal norms of the period in particular as something shameful and
683 embarrassing led women to silence and conceal (signs of) the period (e.g., blood and
684 sanitary product) (Chrisler et al., 2015; Spadaro et al., 2018). The concerns of women in
685 the present study about how others might react to signs of the period point towards

686 social stigma surrounding menstrual events that led women to avoid and adapt physical
687 activity (Johnston-Robledo & Chrisler, 2013; Kowalski & Chapple, 2000). Such stigma
688 surrounding exercise during the period has been similarly reported in overweight
689 individuals (Vartanian & Novak, 2011), people with mobility impairments (Mulligan et
690 al., 2017), and the LGBTQ+ community (Herrick & Duncan, 2018) undertaking
691 physical activity.

692 Due to the paucity of data on the impact of the menstrual cycle on physical
693 activity, in order to test our proposed hypothesis, it was necessary to construct the
694 components of the questionnaire from a number of different sources. These sources
695 have been acknowledged throughout the methods section including recall of menstrual
696 symptoms (Matteson et al., 2015), menstrual pain (Larroy, 2002), menstrual flow
697 heaviness (Fraser et al., 2015), avoidance (Fourquet et al., 2010), and physical activity
698 (Milton et al., 2011). Through adopting these previously validated components of the
699 questionnaire, we can state our main finding that physical activity avoiders have
700 heavier, longer, and more painful periods, despite the limitation that no assessment of
701 reliability or validity has been performed on the entirety of the questionnaire. It is
702 important to note however, that based on the nuanced responses from the interviews,
703 emphasising adaptation, over avoidance, future questionnaires on physical activity
704 within the menstrual cycle should be validated for both avoidance and adaptation.

705 In developing our questionnaire, our aim was to identify whether physical
706 activity avoidance could be attributed to menstrual symptoms. There are a wide range of
707 demographic co-variables that are unreported in the present study including education,
708 employment status, religious background, socio-economic level and ethnicity (e.g.,
709 Mondragon & Txertudi, 2019). As the area of physical activity avoidance due to
710 menstrual symptoms is underreported in general, our aim was to provide the first

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711 overview of the impact of the menstrual cycle on physical activity. In future studies, the
712 prevalence of physical activity avoidance may therefore be different to the present
713 study, if presented based on some of these demographic groupings.

714 Our study demonstrated that binary measures of physical activity, such as those
715 utilised in the present questionnaire, miss the nuances that underpin avoidance
716 behaviours. The use of quantitative and qualitative methodology was therefore
717 particularly useful to developing nuanced views of factors affecting physical activity,
718 which included, but were not exclusive to, menstrual symptoms. Other important
719 considerations that shaped women's physical activity related to perceptions of "self"
720 and social expectations about menstrual events; two areas that need to be confronted in
721 greater depth. Future research might therefore seek to employ qualitative methodology
722 to understand women's self-presentations (e.g., Goffman, 1956) and the role of social
723 stigma (e.g., Goffman, 1963) in physical activity environments. The participants in the
724 present study understood the importance of physical activity to maintain a healthy
725 lifestyle and they enjoyed being physically active. We acknowledge, however, that the
726 limited sample size and volunteer nature of interview participation could be considered
727 limitations of this study. Although comparable sample sizes were suggested in
728 methodological texts (Onwuegbuzie & Collins, 2007) and mixed-methods research
729 investigating the menstrual cycle (Moreno-Black & Vallianatos, 2005) and voluntary
730 interviews were conducted to ensure ethical research practice (e.g., Hammersley &
731 Traianou, 2012), we recognise that our decisions might have resulted in unreported
732 differences between the present participants and those, who did not volunteer for
733 interview participation. As with the limitations of the questionnaire outlined above, a
734 worthwhile line of inquiry would therefore be to investigate how other demographic
735 groups approach physical activity throughout the menstrual cycle. In particular, the

736 impact that the combination of menstrual symptoms, self-perceptions, and social norms
737 might have on physical activity warrants further research attention. In this context, it
738 would be of interest to explore women's familiarity with their own menstrual cycle and
739 to unpack their typical involvement in physical activity in order to understand how
740 differences among women in these areas might affect their management of physical
741 activity throughout the menstrual cycle.

742 In conclusion, the present study suggests that menstrual events are complex,
743 individual, and personal to the women experiencing them (e.g., Brantelid et al., 2014).
744 The results demonstrated that women did not simply avoid all physical activity. Rather,
745 they adapted physical activity depending on their distinct experiences of the menstrual
746 cycle. This insight into the multi-faceted effects that the menstrual cycle could have on
747 women's physical activity is pertinent to practitioners in the field. Creating safe spaces
748 for women who wish to speak about how their physical comfort, personal thoughts, and
749 perceptions of social norms might affect physical activity is important. Efforts in
750 academic and practitioner fields could contribute to normalising conversations about the
751 menstrual cycle (Johnston-Robledo & Chrisler, 2013; Kowalski & Chapple, 2000) and
752 support physical activity throughout the menstrual cycle in women of all ages and
753 abilities.

754

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1044 **Tables**

1045 Table 1. Mean (SD) participant characteristics and menstrual cycle symptoms taken
 1046 from the questionnaire.

	All	Avoider	Non-avoider
N	128	44	84
Age (yrs)	27.9 (7.5)	28.2 (8.0)	27.2 (7.3)
Height (m)	1.65 (0.06)	1.65 (0.06)	1.65 (0.06)
Body mass (kg)	63.2 (12.2)	61.9 (12.8)	63.8 (11.8)
Length of period (days)	4.64 (1.80)	5.07 (1.11)*	4.42 (2.04)
Bleeding (days/MC)	3.81 (2.10)	4.43 (2.07)*	3.49 (2.05)
Spotting (days/MC)	1.51 (1.80)	2.02 (2.37)	1.24 (1.35)
Fatigue (days/MC)	2.82 (2.99)	4.43 (3.45)†	3.45 (2.34)
Pain (days/MC)	2.60 (2.87)	4.20 (3.60)†	1.76 (1.95)
Pain severity (numerical scale)	3.95 (2.80)	5.27 (2.41)†	3.25 (2.75)

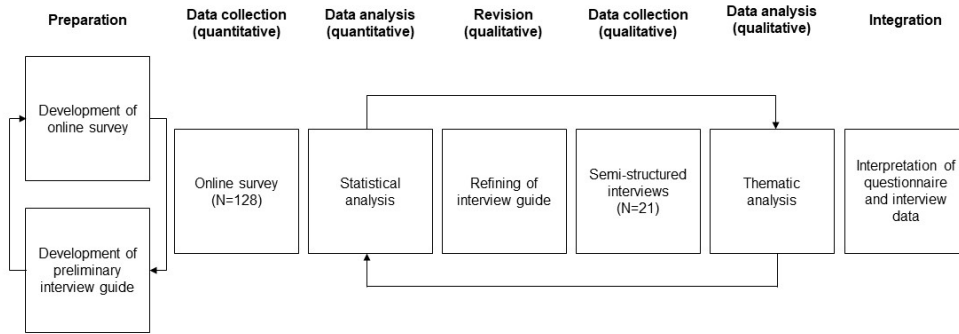
1047 MC, menstrual cycle. *denotes significant difference from non-avoider ($p < 0.05$),

1048 †denotes significant difference from non-avoider ($p < 0.01$).

1049

1050 **Figures**

1051 Figure 1. Overview of study design (adapted from Ivankova, 2014)



1052