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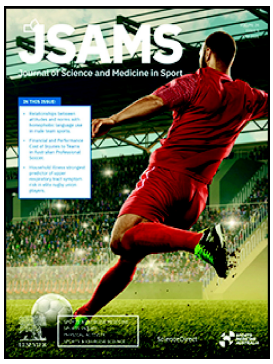

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Improving Menstrual Health Literacy in Sport

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Abstract

Menstrual health represents a state of complete physical, mental, and social well-being in relation to a woman's menstrual cycle. From a health literacy perspective, knowledge acquisition and expertise are dependent upon the degree to which an individual can find, access, understand, critically analyse, and apply health information. Therefore, menstrual health literacy (MHL) can be used to describe the state of knowledge acquisition and expertise specific to menstrual health-related issues. Menstrual health literacy is low among female athletes, their coaches, and practitioners, and few evidence-informed education or implementation strategies exist to improve MHL in sport. Moreover, athletes seldom discuss their menstrual cycles or hormonal contraceptive (HC) use with their coaches, despite experiencing menstrual symptoms and/or disturbances and perceiving their menstrual cycles/HC use to affect performance. Barriers to communication about menstrual cycle- and HC-related topics include a perceived lack of knowledge among athletes, coaches, and practitioners, concerns about how conversations on these issues will affect interpersonal relationships, and a lack of formal and informal discussion forums. While evidence relating to the effects of menstrual cycle phase and HC use on training and performance is currently limited, with existing studies often lacking methodological rigour, impactful steps can still be made to support female athletes. This cornerstone review highlights the current state of MHL among athletes, coaches, and practitioners, and provides recommendations for improving MHL in sport.

Keywords: communication; education; health outcome model; knowledge; menstrual cycle; female athlete

Background

Women are underrepresented in sport and exercise science literature, with a recent analysis reporting that only 34% of participants across 5,261 studies were women (1). Moreover, 31% of the studies did not include women, while only 6% did not include men. Consequently, there is an evident lack of research specifically designed to investigate the physiology of the menstrual cycle and hormonal contraceptive (HC) use in female athletes, the aetiology of common menstrual disturbances within this population, and how the menstrual cycle and HC use affect training, performance, and health (2, 3). This information deficit contributes to low *menstrual health literacy* (MHL) among female athletes, their coaches, and practitioners (e.g., sports scientists, medical staff, physiotherapists, nutritionists, psychologists, etc.).

Menstrual health literacy can be viewed as a subcomponent of health literacy that pertains specifically to menstrual health, which is a state of complete physical, mental, and social well-being in relation to a woman's menstrual cycle (4). Health literacy is defined as "the cognitive and social skills which determine the motivation and ability of individuals to access, understand, and use information in a way that promotes and maintains good health" (5). From a Health Outcomes Model perspective (6), health literacy can be viewed as having three sequential literacy domains along which an individual progresses as they acquire more skills: *functional literacy* (the ability to find, access, and understand health-related information), *interactive literacy* (the ability to extract information from health information and apply health-related knowledge, and the ability to engage with healthcare professionals/public health initiatives), and *critical literacy* (the ability to access, critically analyse, and apply health information from a wide range of sources).

Coaches and practitioners supporting female athletes are required to understand the menstrual cycle and HC use to help enhance their athletes' MHL. Hence, coaches and practitioners must ensure that their own MHL is adequate for their scope of influence. Communication is important for the improvement of MHL, yet athletes have expressed a reluctance to talk to their coaches about their menstrual cycles and HC use (7-11). Further, coaches and practitioners have reported lacking the confidence to have meaningful and consistent conversations with female athletes about how the menstrual cycle affects training, performance, and health (12, 13). Specific barriers to communication between athletes, coaches and practitioners include the perception of the menstrual cycle and HC use as uncomfortable and taboo topics (11, 14, 15), a lack of evidence-informed and sport-specific menstrual health education strategies (12, 13), the sex of the coach (7, 8, 11), and sociocultural considerations (15).

The purposes of this cornerstone review were to: 1) briefly outline the physiology of the menstrual cycle and HC use, common menstrual disturbances, and how the menstrual cycle and HC use affect training, performance, and health; 2) highlight the current state of MHL among athletes, coaches, and practitioners; 3) recommend strategies to improve MHL in sport.

Female Hormonal Cycles

The Menstrual Cycle and Menstrual Disturbances

Knowledge of hormonal cycle physiology allows athletes, coaches, and practitioners to have a common vocabulary when communicating about the menstrual cycle and HC use. Between puberty and menopause, women with a eumenorrheic menstrual cycle experience fluctuations in the female sex hormones oestrogen and progesterone over a 21–35-day cycle, which is often divided into the early follicular, late follicular, ovulatory and luteal phases (16, 17). Approximately half of exercising women who naturally menstruate experience menstrual disturbances (18), which, if left untreated, can have negative long-term consequences for reproductive health, bone health, cardiovascular health, and iron status (19). Menstrual disturbances can be categorised as subtle/subclinical (i.e., luteal-phase defects and anovulation) and severe/clinical (i.e., oligomenorrhea and functional hypothalamic amenorrhea) (17, 18, 20). Common menstrual disturbances are summarised in **Table 1**. For an overview of natural variations in ovarian hormone profiles with and without menstrual disturbances, the reader is referred to Brown et al. (21) and Allaway et al. (20).

Table 1: Definitions of common menstrual disturbances

Menstrual Disturbance	Definition
Luteal phase deficiency	Short luteal phase length (< 10 days) and/or an inadequate luteal phase or a mid-luteal phase blood progesterone concentration < 16 nmol/L (17).
Anovulation	The absence of ovulation due to an insufficient increase in luteinizing hormone (i.e., ovulation cannot be detected using a urinary ovulation test) (17, 18).
Oligomenorrhea	A menstrual cycle lasting 35–90 days (17, 18), leading to fewer than 9 cycles in a year.
Primary amenorrhea	The failure to reach menarche by 15 years of age, despite the development of secondary sex characteristics (e.g., breast development) (22), or by age 14 years when no secondary sex characteristics are present (17).
Secondary amenorrhea	The absence of menstruation for three or more consecutive menstrual cycles in a non-pregnant woman who has passed menarche (23).
Functional hypothalamic amenorrhea	Either primary or secondary amenorrhea, depending upon the context.

Hormonal Contraceptive Use

Exogenous hormone (e.g., HC) use alters the endogenous ovarian hormonal profile in women. In general, HC use suppresses endogenous oestradiol and progesterone concentrations and provides an exogenous source of at least one synthetic oestrogen and progestin, or progestin only. The specific effect on the ovarian hormone profile, however, depends upon the type of HC used (e.g., oral pills, implants, injections, intrauterine devices [IUDs]/coils, vaginal rings, contraceptive transdermal patches, etc.) and the chemical formulation of the HC (17). Female athletes may use HC for birth control, to manage menstrual symptoms, heavy bleeding and/or irregular cycles, and to avoid menstruation during competitions and/or at all (24-26). Notably, oral HC users do not experience a menstrual bleed (i.e., menstruation) but rather a withdrawal bleed during the break from synthetic hormone provision, which can mask menstrual disturbances. Alternative HC methods (e.g., IUDs, implants, injections) or continuous use of oral HCs (e.g., skipping pill-free days or a placebo-pill week) results in unbroken suppression of endogenous reproductive hormones, which may even present as an absence of the withdrawal bleed.

The prevalence of HC use in female athletes varies between sports and countries. Two recent studies reported that 63–68% of Swedish and Norwegian athletes competing in 57 different sports used HCs (25, 26). The prevalence of HC use was lower (~50%) among UK-based athletes competing in 24 different sports (27). In Australia, ~47% of elite female athletes competing in the 2016 Rio Olympics used an oral HC (28), compared to 58% (113 out of 195 athletes) at the Tokyo Olympic or Paralympic games (29). In comparison ~33% of women competing in various football codes used HCs (12), with a markedly lower prevalence of HC use (12.5%) reported in competitive Indian endurance athletes (10).

Effects of Female Hormonal Cycles on Training and Performance

Recent studies have shown that 50–57% of Australian and 49–71% of Norwegian female athletes perceive their menstrual or HC cycles to negatively affect their training and/or performance (11, 30), with effects most often perceived as worst in the late luteal phase (i.e., just before the start of menstrual bleeding) and early follicular phase (i.e., during menstrual bleeding). A narrative review of the acute effects of menstrual cycle phase on aerobic, anaerobic, and strength performance reported that 20 of the 35 included studies concluded no significant influence on performance (31). McNulty et al. (3) concluded from their systematic review and meta-analysis that exercise performance might be trivially worse in the early follicular phase of naturally menstruating women compared with all other phases of the menstrual cycle. A related systematic review and meta-analysis investigating the effects of oral HC use reported that performance was consistent across the pill cycle, but that HC use might result in a trivial reduction in performance compared to natural menstruation (2). Thompson et al. (32) identified three studies in their systematic review where resistance training performed in the follicular phase was superior to luteal or non-phase-based training, and one study showing no beneficial effect of follicular phase-based training. Finally, Colenso-Semple et al. (33) collated the findings from five systematic reviews and meta-analyses and concluded no clear effects of menstrual-cycle phase on acute strength performance or adaptations to resistance training. In summary, research investigating how the menstrual cycle and HC use affect training and performance have produced equivocal results, largely due to variability within and between studies and low-quality research practices, which stems from methodological issues such as small sample sizes, a lack of menstrual-cycle phase verification, and different concentrations of exogenous hormones in HC pills (16, 17). Until more high-quality research is available, athletes, coaches, and practitioners are advised to take an individual approach to monitoring the symptoms of female hormonal cycles and how they affect training and performance. This can be achieved by tracking the menstrual cycle to increase awareness of time points of reduced or enhanced performance, as well as the presentation of

pre-menstrual symptoms, such as menstrual cramps, and the absence of symptoms or menstrual bleeding (2, 3).

Menstrual Health Literacy in Sport

What is Menstrual Health Literacy?

From a health literacy perspective (5), MHL is dependent upon the degree to which an individual has the skills to access, understand, and use information in a way that promotes and maintains good menstrual health. As with health literacy, MHL can be viewed as having three sequential literacy domains (*functional*, *interactive,* and *critical* literacy) along which an individual progresses as they acquire more menstrual health-related knowledge and skills (6). Menstrual health knowledge and health-seeking behaviours are low among adolescents and young women worldwide, independent of geographic, economic, and cultural boundaries (34). Common barriers to seeking support to manage menstrual health include women thinking that their menstrual symptoms are normal and tolerable, feeling embarrassed and concerned that general healthcare providers would not offer help, preferring to self-manage symptoms, being unaware of treatment options, and having limited resources to access healthcare (35). Further, menstruation is often perceived as shameful (36) or dirty and impure (37), seldom discussed (7), or viewed as an issue to be managed by women and girls only (38). Since sampling methods used to recruit study participants are more likely to attract volunteers who feel comfortable and/or have an interest in menstrual health, MHL is likely worse than is currently reported in the literature.

Few sport and exercise science studies to date have investigated MHL in athletes, coaches, and/or practitioners beyond menstrual health knowledge (i.e., *functional* literacy), which is potentially related to the underrepresentation of women in this field of research (1, 39). Consequently, *interactive* and *critical* MHL in athletes, coaches and/or practitioners has not been widely explored, and few tools exist to evaluate these literacy domains. This represents an important area for future research. For this reason, our overview of the literature focuses mainly on menstrual health knowledge (i.e., *functional* literacy) in athletes, coaches and practitioners and the barriers to menstrual health-related communication among these stakeholders (i.e, *interactive* literacy).

Menstrual Health Literacy among Athletes

Functional MHL is low among athletes, who typically perceive themselves to have poor knowledge of how the menstrual cycle affects their health and performance. In a study by von Rosen et al. (8), 26% of athletes in a mixed cohort of national representatives in team and individual sports perceived their knowledge to be poor/very poor, and ~69% of the cohort were unable to name the different phases of the menstrual cycle. Another study reported that only 8% of elite female endurance athletes have sufficient knowledge about how the menstrual cycle affects their training and performance (11). In a group of elite female Australian athletes, the mean knowledge score achieved on a menstrual cycle and HC questionnaire was 5 (range: 2–8) out of a possible 14, with greater age, HC use, identifying as an individual athlete, and having a higher education level associated with greater menstrual knowledge (40). Female athletes also perceive their coaches to have low levels of menstrual cycle knowledge, although they rate female coaches' knowledge higher than males' (8, 11). Aizawa et al. (41) evaluated the difference in behaviour change stages six months after a menstrual management education programme was administered to 21 female Japanese soccer players. The proportion of players in the preparation (19% vs. 33%), action (4.8% vs. 28.6%), and maintenance (4.8% vs. 14.3%) stages increased, indicating that the menstrual health education programme positively changed athletes' menstrual management

behaviours. To provide a more holistic overview of MHL in athletes, coaches and practitioners, future research could go beyond evaluating menstrual health knowledge (i.e., *functional* literacy), and explore broader aspects of health literacy. This could include menstrual management behaviours, confidence in communicating about the effects of the menstrual cycle on performance (i.e., *interactive* literacy), and the ability to critically appraise menstrual health information in a sporting context (i.e., *critical* literacy).

Menstrual Health Literacy among Coaches

Coaches require a sufficient level of sport specific MHL to ensure that they can confidently and accurately communicate with their female athletes and colleagues about the effects of the menstrual cycle and HC use on training, performance and health. However, both female and male coaches perceive the lack of high-quality research in this area as a barrier to facilitating evidence-informed discussions with their athletes (13, 42). The coach's sex may affect MHL, with female high-school coaches reported to be more aware of the long-term negative health consequences of low energy availability and its relationship with the Female Athlete Triad and menstrual disorders compared with their male counterparts (43). However, female coaches do not necessarily have good MHL purely due to their own personal experiences of how the menstrual cycle influences performance and health. For example, a female coach's experience of her own menstrual cycle may differ substantially from the experiences of the athletes they are coaching in the number and severity of symptoms, length of cycle, and/or the use of HCs to limit and/or manage symptoms (44). Male coaches of female athletes report feeling that they lack the requisite knowledge of how the menstrual cycle impacts performance and health (12). Specifically, Clarke et al. (12) identified five themes relating to what 15 male coaches of elite female team-sport athletes wanted to know about the menstrual cycle: 1) how training needs to be managed; 2) how physical performance is impacted; 3) what the medical and dietary considerations are; 4) when and how they should communicate with athletes; and 5) how athletes are affected psychologically and emotionally. However, these themes could differ based on the sport evaluated (e.g., team vs. individual sports) and they only represent the topics that the male coaches were consciously aware of. The so-called "unknown unknowns" may need to be identified by an expert panel, and the need for an organisational-level (e.g., National Sporting Organisation [NSO]) approach has been highlighted to enhance coach awareness and knowledge of the menstrual cycle's effects on training, performance, and health (12, 13, 45). In addition to lacking menstrual health knowledge, coaches may not know how to discuss these topics with their female athletes, even when coach-athlete relationships are strong (13). In summary, poor MHL among coaches is related to a lack of menstrual cycle-related knowledge required to adequately support females (44, 46), which is at least partly due to the limited evidence upon which to base educational materials. As well as improving basic knowledge (*functional* literacy), further research is required to evaluate *interactive* (e.g., menstrual-related communication skills and behaviours) and *critical* MHL among female and male coaches.

Menstrual Health Literacy among Practitioners

The menstrual cycle represents an important indicator of female athlete health (22). Consequently, practitioners should possess the skills to effectively access, critically analyse, and apply menstrual health information in sport-specific settings. Low MHL among practitioners, including poor knowledge and/or communication skills, could limit the level and quality of support that can be provided to female athletes and their coaches, thereby compromising athletes' long-term health (44). While practitioners may receive more formal education about the impact of female hormonal cycles on performance and health than coaches, comprehensive, sport-specific information on menstrual health topics is lacking in many professional development pathways (42). Practitioners also lack clarity about what falls within their scope of practice, with many not perceiving it as their responsibility to advise athletes, coaches, or parents on menstrual health topics (46). Athletes consider medical practitioners (e.g., sports doctors, general practitioners [GPs], and gynaecologists) to have superior menstrual cycle expertise than other members of their support team (8, 9, 14, 42, 47). Athletes also prefer engaging with medical practitioners for menstrual cycle-related advice or treatments (8, 9, 13, 14). However, even when access to medical support is available, guidance may be inappropriate. For example, in a focus group study of Dutch athletes one respondent identified concerns that a GP treated the absence of menstruation with HCs to "induce it [menstruation]", while another GP suggested that HC use should be avoided because "your body should do that [menstruate] on its own" (48). Swedish athletes also perceive advice provided by GPs to be generic, rather than tailored to elite sporting contexts (13). Meanwhile, many elite British athletes described feeling frustrated at receiving contradictory and uncertain contraception advice from different doctors, and feeling dissatisfied with discussions around symptoms and chronic effects of HC use on performance and health (44). Such contradictory information may reflect a difference of opinion about the effects of HC use in sport among medical practitioners. However, some athletes perceive this lack of agreement as highlighting a need for more specific education for medical practitioners working with female athletes (13, 48), which is a view shared by practitioners themselves (46).

Communication as a Barrier to Menstrual Health Literacy

Effective communication between female athletes, coaches, and practitioners enables discussions about how the menstrual cycle affects the athlete's training, performance, and health. Despite this, a survey of 1086 Norwegian and Swedish female athletes revealed that more than 75% chose not to discuss menstruation with their coaches (8). In comparison, a thematic analysis of 1195 German team and individual athletes revealed that 54% were willing to discuss their menstrual cycle with their coach, although only 45% perceived this as useful (7). A thematic analysis of focus groups interviews with elite Swedish cross-country skiers and their coaches identified *knowledge*, *interpersonal* and *structural* barriers to athlete-coach communication about female hormonal cycle issues (13). The authors proposed the following 4-phase cyclical working model to improve menstrual cycle communication among athletes, coaches, and practitioners: 1) *evaluation* of menstrual health knowledge, the athlete-coach relationship quality, and current communication pathways); 2) *education* about female-specific physiology, delivered by a specialist with relevant knowledge and experience; 3) *focus-group discussions* to allow athletes, coaches, and practitioners to exchange perceptions and experiences; 4) *follow-up* to develop a long-term plan for improving MHL in athletes, coaches, and practitioners. In summary, female athletes, coaches, and practitioners require well-developed *interactive* MHL, which involves the skills to extract menstrual health information from existing resources and apply this knowledge by engaging with others (6). While female athletes may be willing to discuss how their menstrual cycle affects their performance and health, further work is required to overcome the barriers to interpersonal communication between athletes, coaches, and practitioners. Improving the

availability and quality of evidence-based educational materials and formal and informal menstrual educational support may improve all stakeholders' MHL, subsequently improving their confidence and competence when discussing the menstrual cycle (i.e., progressing from *functional* to *interactive* and even *critical* MHL domains).

Recommendations for Improving Menstrual Health Literacy in Sport

A systematic, evidence-based approach to developing intervention strategies to improve MHL in sport is necessary. Intervention mapping is one such method that involves an iterative, six-step path to identify and mitigate a problem (49). The completion of all steps provides a blueprint for designing, implementing, and evaluating an intervention strategy. The six steps below are therefore recommended to enhance stakeholders' (i.e., athletes', coaches', and practitioners') MHL in sport:

1. Assess the problem to identify what needs to change
2. Detail the intervention strategy's objectives and outcomes
3. Detail the intervention strategies to address determinants of MHL
4. Organise intervention strategies into a cohesive programme plan
5. Develop a programme implementation plan
6. Generate an evaluation plan to evaluate the programme effectiveness

Supplementary materials are provided in Tables S1–S6 as examples of how intervention mapping may be used to increase stakeholder MHL in sport.

Step 1: Assess the problem to identify what needs to change

Step 1 involves performing an assessment of the problem to identify what needs to change to improve MHL for each stakeholder. Three key deficiencies identified in this cornerstone review, which need to be addressed to improve MHL in sport, include:

(i) A lack of high-quality research into how the menstrual cycle and HC use affect female athlete training, performance, and health

(ii) Low *functional* MHL among stakeholders

(iii) Limited interpersonal communication between stakeholders about the menstrual cycle and HC use (i.e., *interactive* MHL)

These three problems are related, since a lack of high-quality research (i) has a direct impact upon *functional* MHL (ii), which subsequently affects the level of interpersonal communication (i.e., *interactive* MHL) between athletes, coaches, and practitioners (iii). Furthermore, the specific needs of stakeholders may differ, depending on the sporting context and environment. Therefore, individual needs assessments are recommended in each sporting environments. Methods to improve the quantity and quality of research investigating the effects of the menstrual cycle and HC use on training, performance and health have already been presented (17). Therefore, we discuss how intervention mapping can be used to improve points (ii) and (iii). As it can take up to 17 years to translate research into practice (50), athletes, coaches, and practitioners would benefit from effectively implementing the research that is already available into practice.

Step 2: Detail the intervention strategy's objectives and outcomes

In step 2, the intervention strategy's objectives and outcomes are outlined and a logic model of the problem and change scenario is developed. To address the determinants of MHL in sport, in relation to the three deficiencies outlined in step 1, intervention strategies should aim to:

(i) Increase the amount of high-quality research into how the menstrual cycle and HC use affect female athlete training, performance, and health

(ii) Increase *functional* MHL among stakeholders

(iii) Facilitate interpersonal communication (i.e., *interactive* MHL) between stakeholders about the menstrual cycle and HC use

Again, addressing (i) in this example should help with (ii), which should contribute to solving (iii). After an individualised needs assessment in step 1, the specific intervention strategy's objectives and outcomes identified may differ from those listed above.

Step 3: Detail the intervention strategies to address determinants of MHL

Step 3 involves determining appropriate intervention strategies to address individual, socioeconomic, sociocultural, and environmental determinants contributing to low stakeholder MHL in sport. Intervention strategies should be grounded in behaviour change theory (see Kok et al. (51) for a taxonomy of behaviour change theories) and several strategies may be required to address a single determinant. Intervention strategies targeting multiple levels of the stakeholders' environments (e.g., personal, interpersonal, organisational, and societal) will maximise the chance of the programme achieving its intended aim. A MHL education programme is one example of a strategy to increase menstrual health knowledge in sport and should include activities that empower stakeholders to develop competencies in *functional*, *interactive,* and *critical* MHL domains.

Step 4: Organise intervention strategies into a cohesive programme plan

Step 4 involves developing a programme plan to coordinate strategies to improve MHL in sport. If the objectives are to improve menstrual health knowledge and facilitate communication in sport, then a menstrual health education programme may achieve this aim. Programme designers should be aware that sports coaches and practitioners acquire knowledge from three types of learning activities: formal (e.g., certified education programmes), non-formal (e.g., conferences, seminars, presentations, workshops, and clinics offered outside the formal system), and informal (e.g., previous experience as an athlete, informal mentoring, practical delivery experience, interaction with peer coaches and athletes) (52, 53). A menstrual health education programme should therefore include a diverse range of formal, non-formal, and informal education opportunities to develop both *functional* and *interactive* MHL. Co-designing a sport-specific menstrual health education curriculum with health experts and educational designers will help to ensure materials are accurate, engaging, and target a diversity of learning needs. Here, a Delphi panel may help to build consensus among experts (e.g., sports doctors, gynaecologists, etc.) regarding the topics that should be included in a menstrual health education curriculum, and the pedagogical or andragogical methods required to engage each stakeholder (see (54) for an example). Action research may also be used to engage stakeholders (i.e., athletes, coaches, and practitioners) in the programme design, to ensure the content offered by health experts and educational designers is relevant to the sporting context and environment (55). Many coaches believe that the formal education offered by NSOs do not meet their learning needs (56) and in recent years, typically informal social learning (i.e., learning from discussing experiences with peers) has been recognised as a preferred method of coach/practitioner learning (57). Formal learning activities can be enhanced by engaging stakeholders in virtual or face-to-face Communities of Practice (56), thereby promoting social learning opportunities to improve MHL and apply menstrual health knowledge in practice.

Three papers to date have identified activities to improve MHL in sport, or topics that could be included in a sport-specific menstrual health education programme. Findlay et al. (9) proposed the following, with the aim of optimising female athlete health, well-being, and performance: 1) providing menstrual health education, 2) having a menstrual health champion, such as an athlete who has high MHL and is willing to discuss the menstrual cycle with others, 3) menstrual health profiling, where athletes undergo a comprehensive menstrual health assessment that is reviewed and updated annually, 4) daily monitoring of cycle phases and symptomatology. However, no information was provided about what should be included in an education programme. In comparison, concept mapping was used by Clarke et al. (12) to suggest three focus areas for coach education in relation to the menstrual cycle: 1) training and performance, 2) medical and dietary information, 3) communication and psychology. To overcome barriers to communicating about the menstrual cycle, Höök et al. (13) proposed using focus group discussions with athletes and their support teams, separately and together, after providing sport-specific menstrual health education. While further research is required to develop more high-quality sport-specific menstrual health education content, some excellent educational resources have already been developed by NSOs and research groups (Table 2).

Table 2: Examples of menstrual health information and educational resources from National Sport Organisations and research groups.

Country	Sport-Focused Menstrual Health Resources
Australia	Australian Institute of Sport: Female Performance & Health Initiative
Austria	https://www.femaleathlete.at/ (in German)
Ireland	SHE Research Group[1]: Menstrual Health Education Sport Ireland: Go with the Flow – Menstrual Cycle and the Female Athlete (webinar)
New Zealand	Sport New Zealand: Itsmymove High Performance Sport New Zealand: WHISPA[2]
Norway	https://sunnidrett.no/den-kvinnelige-utovertriaden/ (In Norwegian)
Sweden	Safe Parasport: The Female Para Athlete (in Swedish)
Switzerland	https://swissolympic.ch/athleten-trainer/frau-spitzensport (in German)
United Kingdom	Sport Scotland: Working with Female Athletes EIS: Supporting the Developing Female Athlete UK Coaching: Menstrual Cycle Series
USA	Female Athlete Science and Translational Research – Female Athlete Education

1: Sport, Health, and Exercise Science Research Group, Technological University of the Shannon.
2: Healthy Women in Sport: A Performance Advantage

Step 5: Develop a programme implementation plan

In step 5, an implementation plan is developed to ensure the programme is relevant and useable by stakeholders (49). Here, determinants (barriers and facilitators) of the programme's reach (i.e., how well stakeholders engage with the programme), adoption, implementation, and maintenance are identified, along with the individuals and groups who will be responsible for educational delivery at all levels of an individual's lived environment (e.g., personal, interpersonal, organisational, community, and societal levels). Here, the eight Ophelia (Optimising Health Literacy and Access) principles may help to guide programme implementation (58), where programme outcomes and performance objectives are formally stated. Formal sport-specific menstrual health education should be delivered by experts (e.g., practitioners with expertise in how the menstrual cycle and HC use affect athlete performance and health). Furthermore, educational delivery should be age appropriate, promote accessibility, and cater for diverse learning needs (59). Online, open access delivery of sport-focused menstrual health education is likely to improve programme reach to stakeholders at all performance levels, from participation to elite. Another advantage of online education is that materials can be accessed at the user's leisure and can be periodically reviewed, refined, and updated by experts. However, online educational delivery methods should be designed to allow stakeholders to develop more than just *functional* literacy (i.e., knowledge) by promoting interpersonal connection and social learning (i.e., to develop learners' *interactive* and *critical* literacy skills) (59). To improve *interactive* and *critical* MHL among stakeholders, formal education should be supplemented with activities and opportunities that promote informal discussion, develop trust and rapport, and encourage critical analysis (60).

Step 6: Generate an evaluation plan to evaluate the programme effectiveness

The effectiveness of sport-specific menstrual health education strategies can be evaluated using a Health Outcomes Model approach (6) to determine the extent to which stakeholders have progressed along the MHL continuum (i.e., from *functional* to *critical* MHL). First, baseline MHL should be evaluated using a validated, sport specific MHL questionnaire. As far as we know, no such questionnaire exists, thus further research is needed to address this. In lieu of a validated tool, a general menstrual health knowledge questionnaire could be used to determine stakeholders' baseline MHL (see Roux et al. (61) for MHL questionnaire examples). Second, changes in MHL from baseline should be assessed after the educational intervention and re-assessed at an appropriate time interval to determine retention. Third, the success of the MHL education strategy could be formally assessed using the RE-AIM (Reach, Effectiveness, Adoption, Implementation, Maintenance) sport-setting matrix (62). Fourth, stakeholder feedback should be sought to improve the quality and accessibility of educational materials. This may be achieved by gathering anonymous feedback on the programme's effectiveness and via stakeholder focus group interviews.

Conclusion

Menstrual health literacy is low among female athletes, coaches, and practitioners. The most common deficits in MHL seem to be a lack of menstrual health knowledge, and a lack of interpersonal communication between stakeholders to openly discuss the effects of menstrual cycles and HC use on an athlete's training, performance, and health. A key reason for low MHL among these stakeholders is a lack of sport-specific, evidence-informed education strategies and support structures to increase menstrual health knowledge and improve communication in relation to female hormonal cycle. Furthermore, research investigating MHL in sport and exercise science has focused predominantly on evaluating *functional*, rather than *interactive* and *critical* MHL. To address these issues, we recommend using a six-step implementation science approach to design, implement, and evaluate education strategies to improve stakeholder MHL in sport.

Finally, we reiterate the call for more high-quality research into how the menstrual cycle and HC use affects female athletes' training, performance and health, since this research forms the knowledge upon which to base educational strategies.

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