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# A Systematic Literature Review on Menstruation Management and Suppression in Female Athletes Including Performance in Remote Environments

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**BACKGROUND**: This review aims to analyze general principles, current evidence and management options of menstrual management and suppression. It is aimed at those who are involved in sports participation with an additional focus on endurance events within remote environments and wish to further educate themselves on menstruation management, regardless of sex and/or gender.
**METHODS**: A systematic search was conducted using the Boolean method through the Scopus database and Google Scholar. A list of inclusion and exclusion criteria was formed along with a parallel search of resources. Results regarding the suppression or manipulation of menstruation were synthesized.
**RESULTS**: This review demonstrates that there is no "correct" way to manipulate menstrual cycles. The information has been collated and presented with considerations given to the challenges female athletes face.
**CONCLUSION**: Several challenges unique to female athletes, especially in remote environments, have been identified in this review. It is the responsibility of everyone involved in performing and managing female athletes to educate themselves and abolish the taboo of menstruation in sports performance. In doing so, we can encourage more females to participate, including adventurous activities in extreme environment.

## INTRODUCTION

Menstruation is a shared experience for females worldwide. Two-thirds of females in sport report that their menstrual cycle impacts their training and performance, which may explain why only 25% of women reported living an active lifestyle compared to 43% of men.[1,2]

It is important that those involved in managing athletes and sporting events, especially those such as expedition and endurance events, have confidence and a good understanding on managing menstruation in challenging environments, particularly as adventure travel is on the rise.[3] Ultra-marathons and endurance sports are becoming increasingly popular, particularly amongst females.[4] Endurance events such as ultra-marathons are frequently in remote and challenging environments, which pose their own unique challenges.[5] The Oxford Handbook of Wilderness and Expedition Medicine defines a remote area as an area where there is limited or no access to sophisticated medical services; therefore the responsibility lies with the expedition team for their own medical problems.[6] Females participating in endurance events are likely to encounter challenges with menstruation management if prior planning and preparation has failed to take place.

The BMJ Global Health published a wide agreement on the requirements for managing menstruation.[7] These requirements include the following:

- Access to clean material to absorb or collect menstrual blood that are acceptable to those who need them
- Ability to change these materials in safety and privacy with somewhere to dispose of or wash reusable supplies
- Ability to safely and privately wash with soap and water

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- Basic education on the menstrual cycle without judgement or fear
- Access to health information and care in order to make informed choices on menstruation

Considering the above criteria, one can appreciate the challenges that females may face in remote environments where there is limited infrastructure and water, sanitation and hygiene facilities (WASH). Those participating in expedition races and endurance events in remote environments will often be expected to manage their periods in small, shared spaces.[8] With only 35% of participants in outdoor activities, and 20% in mountain sports being female, we must challenge and address the gender gap.[9]

This review aims to identify menstruation challenges and shine light on management options, including suppression methods, during competitions, especially endurance sports in remote environments.

## METHODS

The Boolean method was used to conduct the literature search which included operator words such as "AND", "OR" and "NOT" to broaden and define the search.[10]

The preliminary search was conducted using the following terms in the Scopus database and Google Scholar between 2007 and 2022:

Delay* OR suppress*

AND

Menstruation OR period OR menses

AND

Contraception OR contraceptive pill OR oral contraceptive

The terms were searched within article titles, keywords and abstracts. 236 articles were initially identified, and titles and abstracts were screened to match the inclusion and exclusion criteria (Table 1). 38 articles were deemed to be relevant from the 236. Duplicate articles were identified along with those where full text was available in the English language. A total of 17 articles were shortlisted from the preliminary search.

**Table 1.** Inclusion and exclusion criteria

| *Inclusion Criteria* | *Exclusion Criteria* |
|---|---|
| Adult females >=18 years old | Females under 18 years old |
| Eumenorrhea | Studies related to menstrual suppression due to oligomenorrhoea or other pathology |
| Published from 2007 | Unavailable in the English language |
| Studies specific to endurance sport, expedition races or remote environments in the secondary search | |

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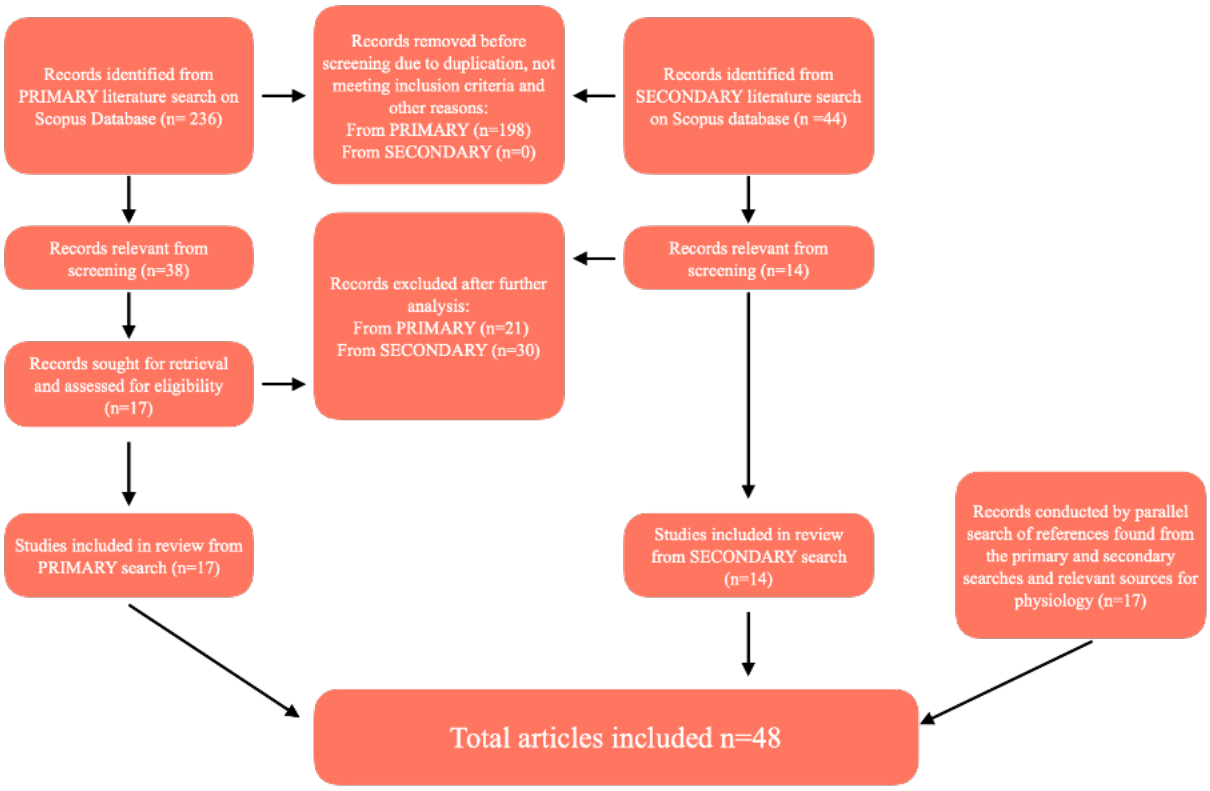


**Figure 1.** PRISMA flowchart

## RESULTS

*Pharmacology*

There are numerous contraceptive methods used to suppress and control menses. Menstrual suppression can be defined as the use of hormonal medication to reduce the volume of menses and in some cases, achieve amenorrhea.[12] Effective management of menstrual suppression requires familiarity with medication and understanding of the patient's reasoning according to The American College of Obstetrics and Gynecologists.[12] A summary of menstrual suppression methods can be viewed in Table 2.

With contraception, a constant dose of progestin ensures the endometrium is atrophic.[13] Therefore, the suppression of menses with hormones is a predicted outcome of the administration of exogenous hormones, rather than a pathological process. One study commented that there is no evidence to date that has proven that the use of hormonal contraception decreases sports performance or increases the risk of injury.[14] However, 20% of athletes in their study felt that hormonal contraception decreased their performance.[14]

It has been reported that a balanced dose of sex-hormones, as is seen with oral contraceptives, is thought to reduce the risk of anterior cruciate ligament injuries by up to 20%.[15,16] Anterior cruciate ligament injuries are 3-6 times more likely in females compared to males.[17] This is thought to be secondary to higher estrogen levels which fluctuate throughout the menstrual cycle.[18] However, it is important to note that others have determined no association between oral contraceptives and anterior cruciate ligament injury.[19,20]

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**Table 2**. Summary of menstrual suppression and manipulation methods, along with considerations for female athletes

| *Medication* | *Dosing* | *Amenorrhea* | *Side effects* | *Considerations for Female Athletes* | *Advantages* |
|---|---|---|---|---|---|
| ***COCP*** | See above for tailored regimes (usually 21/7) | 80% at 1 year of continuous use *Note reduced bleeding with successive cycles of continuous use | Menorrhagia Dysmenorrhea Unscheduled bleeding Mood changes Headaches | Compliance Breakthrough bleeding Increased risk of venous thromboembolism | Good evidence and long history and research into both cyclical and extended use Noninvasive Flexible regimes |
| ***Transdermal Patch*** | Weekly | 12% at 9-12 months | Skin irritation Menorrhagia Dysmenorrhea Unscheduled bleeding Mood changes Headaches | Adhesiveness of patch Breakthrough bleeding Increased risk of venous thromboembolism Risk of skin irritation | Weekly, perhaps better compliance than daily medication Less invasive |
| ***Norethindrone*** | Three times a day - orally | ~76% | Breast tenderness Mood changes Nausea Headaches | Compliance (dose is three times a day) – will lead to withdrawal bleeding Breakthrough bleeding | Suitable in those where estrogen is contraindicated Oral dose can be adjustable |
| ***DMPA Injection*** | 3 monthly injections | ~60% at 1 year ~80% at 5 years | Breast tenderness Mood changes Weight gain Nausea Headaches | Increased risk of fractures in prolonged use (decreased bone mineral density) Consideration if expedition >3months | 3 monthly injections |
| ***IUS*** | 5 yearly | ~50% at 6 months following insertion | Abdominal cramps Irregular menstrual cycles initially Breast tenderness Acne Mood changes | Potential increased risk of more complex urogenital infections Painful/invasive insertion | Good compliance due to frequency No estrogen side effects Lowest pregnancy rates |
| ***Implant*** | Small rod inserted usually in forearm, lasts for up to 3 years | 22% | Breast tenderness Mood changes Weight gain Irregular menstrual cycles | Breakthrough/continuous bleeding – often unpredictable | Good compliance due to frequency No estrogen side effects |

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**Table 3**. Use of extended versus cyclical combined oral contraceptives[13,21,35]

| *Regime* | *Risk of Withdrawal Bleeding* | *Advantages* | *Disadvantages* |
|---|---|---|---|
| ***Cyclic Regime - 21/7***<br>• *21 days of active estrogen and progesterone*<br>• *7 days of placebo pills or break* | • Withdrawal bleed during 7-day break<br>• Breakthrough bleeding 2.9% of unscheduled bleeding days | • Evidence that some females prefer a scheduled monthly bleed<br>• Lower rate of unscheduled breakthrough bleeding | • 7-day hormone free interval associated with heavy and painful bleeding<br>• Also associated with headaches and mood changes |
| ***Extended Regime - E.g., 42/7 or 84/7***<br>• *E.g., 84 days of continuous estrogen and progesterone*<br>• *7 days of hormone free interval* | • Withdrawal bleed during 7-day break<br>• Breakthrough bleeding 3.6% of unscheduled bleeding days | • Provides 4 menstrual bleeds per year to avoid endometrial hypertrophy<br>• Control over when the 7-day hormone free interval occurs (as long as intervals are no shorter than 21 days)<br>• Breakthrough bleeding can be managed by a "double up" pill from a spare pack and can be taken until bleeding resolves | • Evidence that estrogen levels increase more quickly in the 7-day hormone free interval, therefore a potential increased risk of ovulation<br>• Higher rate of breakthrough bleeding |

**Table 4**. Contraindications to estrogen use[21,35]

| *Contraindications to Estrogen Use* |
|---|
| History of breast cancer and other hormone-sensitive malignancies |
| Hepatobiliary disease |
| Any condition predisposing to thrombotic disease (Congenital hyper coagulopathies, obesity, smoking, significant immobility, pregnancy or recent childbirth) |
| History of thrombophlebitis, pulmonary embolisms or deep vein thrombosis |
| Cerebrovascular disease |
| Cardiovascular disease |
| Diabetes with vascular disease |
| Uncontrolled hypertension |
| Migraines with focal neurologic symptoms/aura |
| Smoking and age greater than 35 years |
| Pregnancy |

*Combined Oral Contraceptive Pill (COCP)*

The COCP is a frequently used method to suppress menstruation. It has a standard cycle of 21 days of medication: once daily pill, and a 7-day interval to induce a bleed each month.[21] It is important to note that this is endometrial shedding

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and not physiological menstruation. The first 14 days of the 21/7 cycle inhibits ovulation, whilst the second 14-day period maintains an-ovulation. Menstrual suppression usually occurs when the COCP is taken continuously, meaning there is no 7-day interval to induce a bleed.[12] However, recent evidence suggests that the standard 7 day hormone free interval is associated with increased hypothalamic-pituitary-ovarian axis activity, than a shorter interval of 3-4 days. Thus, the chance of pregnancy is less with a shorter interval.[21] It is also worth noting that spontaneous menstruation or pregnancy has been seen in up to 98% of women within 90 days of cessation after 6 months of continuous use.[21]

Although used frequently, there is a risk of "spotting" or breakthrough bleeding.[22] One study found that that 84% of women experienced breakthrough bleeding in the first 3 months of continuous cycling, but after 9 months this decreased to 28%.[23] The American College of Obstetrics and Gynecology supports the above evidence and also describes that breakthrough bleeding decreases in successive cycles.[12] Amenorrhea is achieved in 80% of females by 1 year of continuous use of the COCP.[24] Table 3 summarizes and compares the cyclic and extended COCP regimes.

Research has shown that 29% of female university students (n=340) who had been on recent international travel from the United States of America had experienced a contraceptive lapse (missed pills or inconsistency), including 50% of oral contraceptive pill users.[25] Not only would unexpected bleeding be an inconvenience, but poor compliance could lead to pregnancy. Another consideration with the COCP is the contraindications associated with estrogen within the medication.[13,21,35] See Table 4 for a summary of this.

Recent evidence has suggested there is a 3-3.5-fold increased risk in venous thromboembolism with COCP use.[21] In addition to this the Faculty of Sexual and Reproductive Health commented that the risk of developing venous thromboembolism was greatest in the first few months after initiating the COCP and in the first month of restarting after discontinuing.[21]

Given endurance events in extreme environments often include long distance travel to remote locations, it is reasonable to assume there may be a significant period of immobility, which also increases the risk of venous thromboembolism.[4] Therefore, expedition and endurance medics should ensure that this risk is communicated clearly to participants, particularly those also taking the COCP. Ensuring that participants mobilize, stay hydrated and use compression socks during prolonged periods of travelling or inactivity is vital to reduce venous thromboembolism risk.[26]

*Intravaginal Ring*

Similarly to the COCP, the intravaginal ring may also use a combination of estrogen and progesterone, although progesterone-only rings are also available for those with estrogen contraindications.[27] The intravaginal ring is a soft plastic ring that is placed into the vagina on the first day of menstruation for 21 days followed by a 7-day ring-free interval, where a bleed is experience that mimics menstruation.[28] Extended cycling can be used to induce amenorrhea, and reports have shown a reduction in bleeding and dysmenorrhea during continuous use.[29] Intravaginal rings act locally and bypass first pass metabolism in the liver, therefore fewer systemic side effects are reported, such as gastrointestinal disturbances.[27] However, vaginal discharge may increase, which could prove troublesome during sporting events.[30] One study reports that in vitro studies have demonstrated adherence of Candida yeasts to intravaginal rings, however clinical studies did not demonstrate this.[30] Expulsion of intravaginal rings have been reported, although overall rates were low, but was highest in the first cycle and decreased with subsequent cycles.[31] This highlights the importance of planning ahead, and athletes may want to consider trialing this method in good time before their sporting events.

*Progestin-Only Pills*

Norethindrone is a common oral progestin of choice for menstrual suppression. It works by inhibiting luteinizing hormone (LH) release from the anterior pituitary gland and downregulating estrogen receptors in the endometrium, limiting proliferation.[32] By weakly suppressing the hypothalamic-pituitary-adrenal (HPA) axis, fertility returns far quicker than other longer-term methods of contraception according to recent evidence.[32] The British National Formulary (BNF) states that 5mg should be taken three times a day for the postponement of menstruation and should be started 3 days prior to expected menstruation.[33] This could be difficult for those who do not track or

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have irregular menstrual cycles. The American College of Obstetrics & Gynecology state that the use of norethindrone at 5mg has amenorrhea rates of up to 76%.[12]

It is reported that 20% of women still experience bleeding despite the use of progestins[34]. This is not dissimilar to the COCP, with 10-18% of females experiencing breakthrough bleeding per cycle.[21] However, one benefit of norethindrone is that the dose can be increased if breakthrough bleeding occurs.[12]

A particular concern for endurance events and performance in extended competitions/extreme environments is medication compliance given the frequency of norethindrone. Noncompliance has a potential to lead to withdrawal bleeding.[32] For those who are at risk for venous thromboembolism or cardiovascular disease, norethindrone may be a more appropriate choice due to a reduced pro-coagulant effect compared to the COCP.[32]

*Transdermal Contraceptive Patch*

Transdermal combined contraceptive patches contain both estrogen and progesterone and are usually applied weekly for three weeks, with a patch-free week to induce bleeding.[21,35] Research into using an extended regime of twelve consecutive weeks followed by a patch free week showed no significant difference in satisfaction and adverse events compared to the standard regime.[13] Moreover, amenorrhea occurred in only 12% of females using an extended regime in another study, and unscheduled bleeding was common.[35]

Concerns have been raised with regards to the increased venous thromboembolism risk in those using extended transdermal patch regimes.[23] Applying a patch on a weekly basis may be impractical for participants, particularly if wearing multiple layers in a cold environment. There may be the additional challenges associated with water sports or sweating where patches may fail to adhere or fall off unnoticed, which could lead to unwanted bleeding or pregnancy.

*Long Acting Contraceptives*

The intrauterine system (IUS) is inserted into the uterus and releases levonorgestrel (a progestogen).[35] Evidence suggests that 50% of females develop amenorrhea within 6 months of insertion and up to 80% at 1 year following insertion.[35,36] It has been demonstrated that the IUS is the most effective method to reduce heavy menstrual bleeding by approximately 95% over six cycles.[37] Another study supported this through demonstrating that the IUS was superior to norethindrone in reducing menstrual bleeding.[38]

Tranexamic acid and mefenamic acid have also been suggested to help with breakthrough bleeding, but the reduction in bleeding compared to a placebo drug was minimal.[36] Expedition medics should consider counselling females using long term methods at the earliest opportunity prior to departure. If there is adequate time to prepare for an endurance event or competition that spans multiple weeks or months, the IUS should be strongly considered.

Depot medroxyprogesterone acetate (DMPA) is an intramuscular injectable (150mg) or subcutaneously (104mg) progesterone which is administered every 3 months.[24] It is reported that 60% of females develop amenorrhea within a year of 3 monthly DMPA injections and 80% within 5 years.[24] This is supported by another study who found that 62% of females developed amenorrhea within a year of use.[33] However, bleeding or spotting was common within the first month.[33]

Etonogestrel 68mg is a sub-dermal implant that is inserted into the upper arm and releases progesterone over 3 years.[12, 35] Data suggests that 22% of females experience amenorrhea but is associated with menstrual irregularities.[12] The study also commented that the etonogestrel implant is not a satisfactory method to cause menstrual suppression.[35]

*Gonadotrophin Releasing Hormone (GnRH) Analogues*

GnRH agonists are medications used to create a low estrogen state and subsequently lead to menstrual suppression.[12] These can be administered as intramuscular injections, subdermal implants or intranasally.[39] They are reported to have amenorrhea rates as high as 96%, however they should not be used long term as they cause a decrease in bone mineral density.[39] This could severely impact an athlete's performance and lead to injury.

## DISCUSSION

*Environmental, Physical and Psychological Challenges*

Firstly, it is important to acknowledge that there are many different types of endurance events in a wide range of environments. Many females may choose to suppress their menses and others may adapt their usual management strategies. Each environment comes with its own challenges and the

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review aims to discuss common menstrual related symptoms and challenges.

In developing countries and remote areas, there is a possibility of lack of infrastructure and toilet facilities along with lack of menstrual products and no means of disposal.[34] The unfamiliarity and absence of privacy associated with latrines or long drop toilets may increase anxiety.[40] In turn, this may mean that female athletes do not change sanitary products as frequently as they should which could cause an increased risk of infections such as toxic shock syndrome, fungal infections or other genitourinary infections.[22]

Sanitary products should not be disposed of in toilets or buried in the outdoors due to the pressure this puts on local waste disposal systems and impact on wildlife.[34,41] Females are therefore required to carry and contain these products safely to reduce the risk of infections. Products should be carried in sealed waterproof containers to avoid damage and/or contamination.[41]

Limited access to water may compromise personal hygiene which will also increase infection risk and potentially to the wider group.[22] With reusable products such as menstrual cups and sanitary towels becoming more popular within the Western World, consideration must be given to ensure these items are washed and stored correctly.[42] Table 5 compares the advantages and disadvantages of different sanitary products.

A cross-sectional study surveyed 22,823 females showed that a combination of products was used to manage menstruation with 69.7% using disposable sanitary products and 54.9% used reusable products.[42] The study demonstrates that many females use a combination of products based on the overlap in data results. One barrier that was identified to using reusable products was having to wash and dry products in shared or public spaces. There is a high possibility of sharing dormitories, tents or spaces during endurance events, particularly multi-day ultra-marathon and adventure races, which contributes to the difficulty of cleaning these products.

One study found that 70% of its participants (N=15,107) avoided social activities and chose clothing according to their cycle.[37] Another study showed that 75% of participants worried about "leaking" or bleeding through clothing whilst participating in sports.[1] Some individuals may feel uncomfortable in swimwear or shorts whilst menstruating and may increase psychological distress. Others may feel that wearing multiple layers makes changing sanitary products regularly challenging. There is evidence that this additional stress takes away the focus from the activity or sport.[37] Table 6 compares a variety of sport environments with various clothing considerations.

It is widely recognized that travel can disrupt a female's usual menstrual cycle and can cause periods to be lighter or heavier, longer, or shorter, more unpredictable or develop amenorrhea.[22] One study has shown that of regularly menstruating women hiking long distances for a duration of 78 to 210 days, 87% experienced menstrual changes.[43] Sleep, diet, alcohol, additional stresses and physical activity all have an impact on the severity and type of symptoms associated with the premenstrual phase.[44] It is worth noting that sleep disturbances and an unfamiliar diet are often experienced during endurance events therefore, as the evidence suggests, may exacerbate menstrual symptoms.

In addition to menstrual irregularities, dysmenorrhea, which is defined as pain during menses is common.[34] One study on the menstrual cycle function amongst athletes of various levels, demonstrated that 79% of female's (N=63) experienced abdominal cramps. Of these same athletes, 89% said that the physical and psychological symptoms associated with menstruation impacted their experience with sport.[1]

Another study divided its cohort (N=128) into those who avoid participating in physical activity (34%) due to menstruation and those who continue with usual physical activity (66%).[45] The average pain score for those that avoided physical activity was 5.27 and pain lasted 4.2 days, whilst those that were able to continue with participation averaged a score of 3.25 and pain duration was 1.76 days. Interestingly, this study showed a correlation between increased pain scores and duration of pain with an increased length in menstrual bleeding (4.43 in avoiders compared with 3.49 in non-avoiders).[45] These results demonstrate that females are likely to experience a combination of physical symptoms. It is also documented that somatic symptoms such as headaches, breast tenderness and abdominal bloating are linked with the luteal or premenstrual phase.[46]

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**Table 5**. Advantages and disadvantages of various sanitary products

| *Product* | *Advantages* | *Disadvantages* |
|---|---|---|
| ***Disposable Sanitary Towel*** | • Usually most accessible<br>• Easy to use | • Risk having to carry used products for a significant duration – risk contamination/infection<br>• Must carry multiple products as single use<br>• Risk not changing products frequent enough due to disposal issue<br>• Plastic materials can cause chaffing<br>• Not suitable for aquatic sports<br>• May dislodge leading to leaks |
| ***Tampons*** | • Relatively accessible<br>• Less irritation<br>• Generally, a longer wear time<br>• Discreet protection<br>• More compact | • Risk having to carry used products for a significant duration – risk contamination/infection<br>• Must carry multiple products as single use<br>• Risk not changing products frequent enough due to disposal issue – toxic shock syndrome<br>• Many not comfortable using internal products |
| ***Reusable Underwear*** | • Environmentally friendly<br>• Less of a burden on local waste disposal systems<br>• Participants won't have to carry as many products<br>• Comfortable and easily worn in the lead up and at the end of menses | • Will need adequate washing/drying facilities<br>• May cause chaffing or risk infection if urogenital environment is wet<br>• Not suitable for aquatic sports<br>• Chance of odor particularly if doing vigorous activity or in hot environments<br>• More awkward if need to change halfway through the day |
| ***Reusable Sanitary Towels*** | • Environmentally friendly<br>• Less of a burden on local waste disposal systems<br>• Participants won't have to carry as many products | • Will need adequate washing/drying facilities<br>• Not suitable for aquatic sports<br>• May dislodge leading to leaks |

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| | | |
|---|---|---|
| ***Menstrual Cups*** | • Environmentally friendly<br>• Less of a burden on local waste disposal systems<br>• Participants won't have to carry as many products<br>• Less irritation<br>• Longer wear time<br>• Reduced risk of toxic shock syndrome if used and cleaned correctly<br>• Discreet protection | • Correct cleaning procedure, usually requires clean or hot water<br>• Appropriate place needed to dispose of menstrual blood<br>• Can be difficult to insert or remove<br>• Can be difficult to find the correct size |

In addition to dysmenorrhea, heavy uterine bleeding, also known as menorrhagia, is reported in up to 30% of the population.[37] However, this could be difficult to measure given the individual's perception of a "normal" menses. For example, evidence suggests that menstruation is often described as "annoying" and "inconvenient", indicating the volume of menses is not necessarily proportional to the affect it may have on an individual.[1] Interestingly, one study found that oral contraceptives were the most frequently offered management for menorrhagia with 19% of participants reporting to have preferred the option of alternative management.[37]

Menorrhagia is the most common cause of iron deficiency anemia in females of reproductive age.[37] Anemia causes symptoms such as shortness of breath and fatigue, which may be troublesome during events. This may compromise performance and enjoyment.[47] Even without iron deficiency anemia, fatigue is a commonly reported symptoms associated with menstruation and the luteal phase of the menstrual cycle.[34, 45] One study recorded that fatigue lasted for an average of 2.82 days, which could be extremely disruptive to an expedition.[45]

It is widely recognized that high performing and elite athletes including ultra-marathon runners experience amenorrhea or the absence of menstruation as well as infrequent periods, known as oligomenorrhea.[46] This is explained by hypothalamic dysregulation associated with high levels of physical activity.[44] 50% of participants in one study experienced amenorrhea for at least 3 months.[1] Moreover, these athletes described that when they did experience menses, it was more painful and heavier compared to their regular cycle.[1]

It is also known that hormonal fluctuations associated with the menstrual cycle, influence mood and behaviors, particularly during the premenstrual or luteal phase.[48] The most common symptoms reported in one study was lack of motivation and low energy in the week leading up to menstruation.[1] This supports further research that reports the correlation between increased progesterone levels are associated with mood disturbances due to increased activity in the amygdala and hippocampus.[48] This can be described as premenstrual syndrome (PMS) and is extremely common, with up to 80% of female adolescents and adults reporting symptoms during this phase.[49] The study goes on to state that 3-8% of females suffer from a more severe form of PMS, names pre-menstrual dysphoric disorder (PMDD), which causes more severe and debilitating psychological symptoms.[49]

The impact of physical and psychological symptoms of menstruation is astonishing and challenges will arise in remote environments. The event itself is likely to pose as an additional stressor given individuals will be away from their usual support network and may not have access to their usual coping mechanisms. Given participants are at risk of reduced performance due to the challenges mentioned above; this may have a wider impact on a team where plans and routes may have to be altered. Ultimately this could cause friction and compromise relationships, particularly if there is lack of understanding between team members. Moreover, a participant may feel that they have no other option but to continue with the day's activities which is unlikely to be a pleasant or an enjoyable experience. In turn, this could affect an individual's perception and performance in events especially in extreme environments.

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**Table 6**. Sports performance environments and their clothing considerations[1,22]

| *Environment* | *Key Climate Considerations* | *Clothing* | *What does this mean?* |
|---|---|---|---|
| ***Altitude*** | Extremely variable | Potential of multiple layers including waterproofs<br>Use of ropes and harnesses<br>Potential for saturated clothing | Increased infection risk |
| ***Desert*** | Hot and dry | Potential for saturated clothing with sweat | Increased infection risk |
| ***Tropical/Jungle*** | Hot and wet | Saturated clothing | Increased infection risk<br>Not all sanitary products may be suitable due to the wet environment |
| ***Polar*** | Cold and dry | Multiple layers<br>Thick layers | Difficult changing sanitary products with multiple layers<br>Ensure skin is exposed as little as possible to environment |
| ***Water*** | Sports in the water e.g., diving or swimming vs sports on the water e.g., sailing or rowing | Wetsuits<br>Life jackets<br>Bathers | Not all sanitary products may be suitable<br>Some individuals may feel uncomfortable in swimwear whilst menstruation |

**Table 7**. Summary of the physical, psychological and environmental challenges during endurance events in extreme environments

| *Physical* | *Psychological* | *Environmental* |
|---|---|---|
| Dysmenorrhea | Depression or low mood | Clothing consideration |
| Menorrhagia | Anxiety | Sanitary product disposal |
| Oligomenorrhoea | Agitation/Irritation | Lack of water, sanitation and hygiene facilities |
| Headaches | Lack of motivation | Lack of privacy |
| Breast Tenderness | Stress | Suitability of certain sanitary products |
| Back Pain | | Climate |
| Gastrointestinal Changes | | |
| Fatigue | | |

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## CONCLUSION

Several challenges unique to female athletes, especially in remote environments, have been identified in this review. An overview of these can be seen in Table 7. By identifying the potential difficulties, those participating in and leading events can consider and prepare appropriate routes, clothing, medications, travel and sleeping arrangements to minimize discomfort.

It is apparent from this review that extended cycling of the COCP is the most popular option offered to females to manipulate their menstrual cycle. With a high percentage of women using the COCP, those prescribing the medication should ensure they are aware of the advantages and disadvantages of cyclic versus extended regimes.[21]

Many studies found that the IUS is more effective at reducing menstrual bleeding compared with the COCP.[37] Endurance events will often have a dramatic change to an individual's day-to-day routine, which may affect medication compliance. If longer term contraceptive methods are established within a timely manner, perhaps these methods are more reliable, particularly during longer events. In addition to this, waste from medication packaging will be reduced meaning less burden on local waste systems.

Pre-departure/pre-competition counselling and screening should include the risk of breakthrough bleeding with suppression methods.[12] Participants will therefore be prepared, and medication compliance may improve with increased understanding. It would be wise to advise those who opt for menstrual suppression methods to trial the medication prior to departure to avoid the risk of adverse effects in the wilderness, which may be difficult to manage.

Evidence suggests that females who have relations with those who have good understanding of menstruation, feel more supported.[50] This review has demonstrated that there is not one method that works for everyone, but by examining the evidence, we expand our knowledge which in turn will instill trust and confidence in athletes. This should increase consultation satisfaction and reduce anxiety amongst menstruating participants.

### Conflict of Interest Statement

The authors declare no conflicts of interest with the contents of this study.

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