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Coach and Athlete Perceptions of the Effects of the Menstrual Cycle on Female Athletic Performance

Erin Dietz
edietz@eagles.bridgewater.edu

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Erin Dietz

Department of Health and Human Sciences, Bridgewater College

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Dr. Tammy Sheehy

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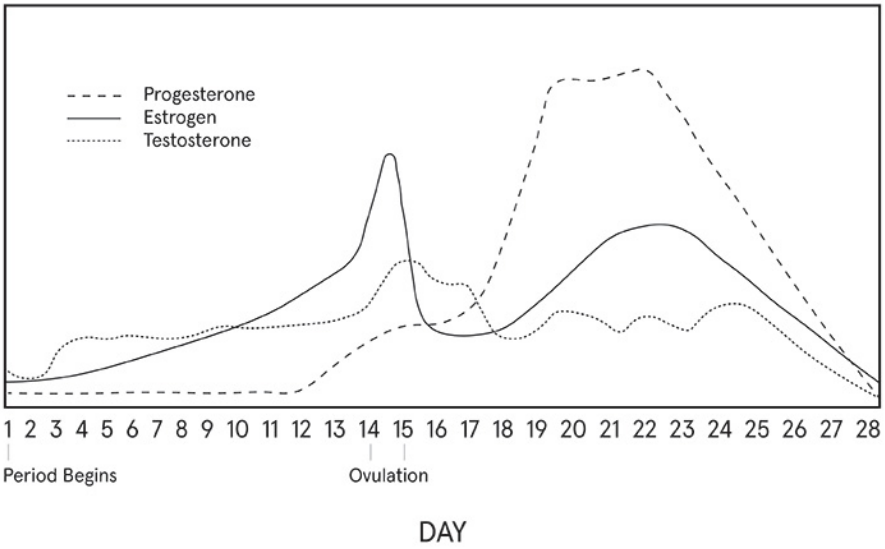
In 2018, the United Nations Children's Fund (UNICEF) released data stating that at least 26% of the global female population is of reproductive age and menstruating (UNICEF, 2018). Despite such prevalence in everyday life, especially for women, there is insignificant research on the topic. Female athletes in particular are an incredibly underrepresented population in the existing research, even though they could potentially be at increased risk for menstrual health complications.

A typical menstrual cycle in eumenorrheic individuals is 21-37 days in duration, with the mean duration standing at 28 days (Schmalenberger et al., 2021). It is generally understood that each cycle begins with menstruation during the follicular phase, followed by ovulation, and concludes with the luteal phase. Menstruation, often referred to as the "period" is a phase where the body is shedding the uterine lining and is typically associated with the most physical symptoms and lowest estrogen and progesterone levels (Schmalenberger et al., 2021). The follicular phase begins with menstruation and lasts until ovulation begins. Ovulation is a period in which the ovaries release the egg. Estrogen levels spike right before ovulation occurs, and levels out during the luteal phase (Schmalenberger et al., 2021). The luteal phase is the approximate 14-day period after ovulation where the body prepares for pregnancy, spiking in progesterone (Schmalenberger et al., 2021).

For the purposes of this study, menstruation will refer to the period where the body is actively shedding the uterine lining. Ovulation will refer to the spike in estrogen and subsequent release of the egg (see Figure 1). The follicular phase will be the period after menstruation and before ovulation, while the luteal phase will be the period between ovulation and menstruation.

Figure 1

Hormone Fluctuation During the Menstrual Cycle



Note. Booth, R., 2021.

Without comprehensive knowledge on the subject, menstruation has been largely neglected from training considerations, and rarely included in coaching education programs. Anecdotally, menstruation affects body composition, nutrition habits, mental states, and causes pain in most menstruating women. Each of these items are of importance to athletes, especially when it comes to high performance or elite sport. A lack of research on the topic could potentially put female athletes at higher risk for physical and psychological complications. For coaches, menstruation is almost never discussed in training programs, and therefore most coaches do not take the highly individualized cycle into consideration when creating practice or training plans for their athletes.

The purpose of the following literature review is to not draw definitive conclusions about the physiological or psychological effects of the menstrual cycle, but rather to present an overview of the existing body of research. The literature review will focus specifically on how

the menstrual cycle affects female athletes, physically and psychologically, in order to contextualize the results of the qualitative survey included in the study.

Literature Review

Physiological Responses

It is important to note that literature on the physiological impacts of the menstrual cycle on athletic performance is divisive at best. Though seemingly well-studied, the lack of standardization in research methods on the topic does little to aid further advances in knowledge. The menstrual cycle is a bodily function unique in each individual and can be affected by a number of genetic and lifestyle variables, complicating the ability to standardize research (Schmalenberger et al., 2021). Even among eumenorrheic women, there is considerable variation in each cycle that contributes to this issue (Fehring et al., 2006).

Most athletes perceive a drop in performance standards concurrent with the beginning of their menstrual period, but evidence for this is mixed. It is important to note that a vast majority of the existing body of research on menstrual health has been conducted on non-active populations, meaning there is a gap in knowledge about the menstrual cycle in female athletes, and an even bigger gap exists regarding research on elite female athletes (Pitchers & Elliot-Sale, 2019). Despite this, attempts have been made to homogenize research and create a body of acceptable literature on the physiological effects of the menstrual cycle on female athletes.

In 1968, Dr. Rudolf H. Moos of Stanford University developed the Menstrual Distress Questionnaire (MDQ). The questionnaire was designed to create “a standard method for assessing menstrual cycle symptomatology” and consists of 47 items pertaining to menstrual cycle symptoms to be used for understanding how menstruation affects an individual physiologically, as well as psychologically (Moos, 1968, p. 855). The MDQ tracks symptoms

throughout the cycle, including pre-menstrual and post-menstrual symptoms, as well as comparisons between the most recent menses and worst menses. Items regarding physical symptoms comprise about half of the questionnaire and provides unique insight into the most common physical symptoms experienced during menses, including cramps, fatigue, bloating, nausea, and headaches (Moos, 1968). The MDQ encouraged more research regarding the effects of the menstrual cycle on physical and mental health and gave way to a new field of research regarding menstrual health and athletic performance.

There are a number of ways to measure athletic performance, the most popular of which include isokinetic strength, flexibility, body composition, and aerobic capacity. Currently, there is no research to suggest that isokinetic strength, flexibility, or body composition change in a manner that can be connected to the menstrual cycle phase. One study found that throughout the menstrual cycle, there were no significant changes in quadricep strength or fatigability in any participants (de Jonge et al., 2001). Regarding body composition, there is little evidence that finds the menstrual cycle phases to impact overall body composition. A study using three different tests - bioelectrical impedance analysis, dual-energy x-ray absorptiometry, and air displacement plethysmography - found that across all three measures, there were no changes in body composition in any phase of the menstrual cycle (Hicks et al., 2017). Lastly, there is no evidence to suggest that flexibility is altered between cycle phases (Teixeira et al., 2012).

Among the many splits in literature, however, lies the issue of $VO2_{max}$ and whether aerobic capacity increases or decreases throughout various stages of the menstrual cycle. Lebrun et al. (1995) studied 16 female athletes during the early follicular and mid luteal phases (determined by basal body temperature) to determine if and how athletic performance changed during the menstrual cycle. Consistent with other research on the topic, results from the study

showed that there was no statistically significant difference between the phases with regards to body composition or isokinetic strength. $VO2_{max}$ values were found to be lower during mid luteal phase testing than during the early follicular phase, though statistically, the difference is of borderline significance (Lebrun et. al, 1995). The authors suggest that further research be conducted with a larger participant pool consisting of athletes with similar aerobic bases and include testing during the ovulatory phase when estrogen levels peak (Lebrun et al., 1995).

A second study regarding the running economy of trained female runners came to a similar conclusion. While there was little evidence that running economy at 55% VO2max was affected by menstrual phase, by 80% $VO2_{max}$, running economy was lower during the mid-luteal phase than in the early follicular phase (Williams & Krahenbuhl, 1997). Participants also showed a lower resting $VO2_{max}$ along with a higher ventilation rate in the mid luteal phase (Williams & Krahenbuhl, 1997). This change during the luteal phase is commonly associated with an increase in core body temperature. Athletes may perceive a higher level of exertion during exercise, increased heart rates, lower exercise efficiency, and higher ventilation rates as a result of the cardiovascular strain associated with this increased core temperature (Lebrun, 1993).

Smekal et al. (2007) concluded that luteal phase increases in body temperature did increase both ventilation rates and heart rates. In direct contrast to the findings of the 1995 Lebrun study, Smekal et al., (2007) determined that $VO2_{max}$ values did not change between the follicular and luteal phases. There also appeared to be no significant difference in maximal power output between the phases either (Smekal et al., 2007). Another study conducted by a team of researchers in Iran found that in both the early follicular and mid luteal phases presented no differences in $VO2_{max}$ values (Abdollahpor et al., 2013). Researchers also dispelled a possible

connection between increased ventilation rates and decreased $VO2_{max}$ levels (Abdollahpor et al., 2013).

One particular physiological concern associated with menstrual health and aerobic capacity is iron-deficiency anemia, which can have significant impact on athletic performance and overall well-being. According to the Center for Disease Control, the average menstrual period results in the loss of about two to three tablespoons or approximately 30mL to 45mL worth of blood (CDC, 2017). For women who experience menorrhagia (excessive bleeding during menses) this figure easily reaches over 80mL in blood loss during each period (Haynes et al., 1977). One study found evidence of iron-deficiency anemia in menstrual patients that lost 60mL of blood during menses and found the affliction to be common in menorrhagic patients who lost over 80mL (Hallberg et al.,1966). When an individual experiences an iron deficiency, the body cannot transport oxygen effectively, resulting in a decreased $VO2_{max}$ (Beard & Tobin, 2000). In general, females (especially athletes) exhibit a far greater risk of iron deficiency, potentially due to biological factors and self-imposed dietary restrictions (Beard & Tobin, 2000). What remains unclear from the current literature is whether iron deficiencies due to menstruation are a significant factor in varied $VO2_{max}$ levels during the menstrual cycle or if it is merely a coincidence. Anemia in female athletes is also a contributing factor to a medical phenomenon known as the Female Athlete Triad.

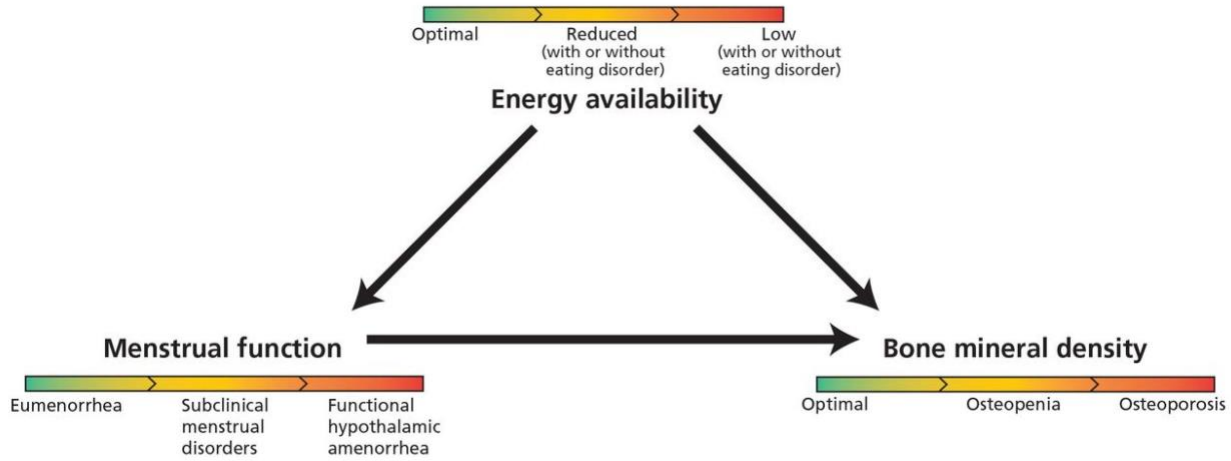
The Female Athlete Triad

The Female Athlete Triad is a medical disorder that encompasses the interrelated effects of amenorrhea, eating disorders, and osteoporosis (Torstviet & Sundgot-Borgen, 2005). Alone, any of these components present serious health risks to individuals of any population, and female

athletes are statistically more likely to experience all three, while also being the least researched group (Torstviet & Sundgot-Borgen, 2005).

Figure 12

The Female Athlete Triad



Note. Metha et al., 2018.

Female athletes are at increased risk to develop eating disorders, usually due to social pressures (see Figure 2). In sports where physique is a priority, or where uniforms are traditionally tight or revealing, athletes may be at an even higher risk than others. Pressure from coaches, teammates, and others could influence an athlete's perception of their body and weight and lead them to take extreme dieting measures (Hobart & Smucker, 2000). Similarly, external pressures to maintain a certain body image could lead to excessive training, which may lead to sudden changes in weight. Dramatic changes in body composition, especially a rapid drop in body fat is a major contributing factor to amenorrhea (absence of menses) (Hobart & Smucker, 2000). It is also known that female athletes already suffer from oligomenorrhea (irregular menstrual cycles) and amenorrhea can both be connected to high levels of intense athletic activity (Kishali et al., 2006). Existing research also suggests that females who engage in regular athletic activity early in life delay the onset of menarche from their peers who do not engage in

routine physical activity (Kishali et al., 2006). When menstrual function is compromised or non-existent, the natural fluctuation of estrogen is not able to take full effect, causing declined bone accretion rates (Gordon & Nelson, 2003). Alone, both nutritional deficiencies resulting from eating disorders and amenorrhea can contribute to decreases in bone density and early onset osteoporosis, which can lead to higher risk for fractures and other injuries (Hobart & Smucker, 2000). Identifying the risk factors and treating symptoms of the triad is vital in preventing long term health concerns.

Recent literature regarding this topic has started using the term Relative Energy Deficiency in Sport (RED-S) rather than the Female Athlete Triad (Mountjoy et al., 2014). Compared to the Female Athlete Triad, RED-S accounts for a wider range of factors that may affect energy deficiency, including energy expenditure, psychological factors, metabolic rates, and other considerations (Mountjoy et al., 2014). For the purpose of this study, the Female Athlete Triad was used to examine the relationship between menstruation and bone health, but it is important to note that more comprehensive research is being conducted on the syndrome.

Knee Injury Risk Due to Hormonal Fluctuation

Epidemiology reports have found that females suffer from a higher rate of incident for anterior cruciate ligament (ACL) and other knee ligament injury as compared to their male counterparts, especially female athletes in the sports of basketball and soccer (Agel et al., 2005). Historically, the discrepancy between males and females has been attributed to the natural anatomical difference, specifically hip kinesiology. Due to the development of secondary female sex characteristics in adolescence, the angle of the hip joint widens, leading to an altered range of motion and putting additional stress on the lower leg when jumping and landing (Imwalle et al., 2009). As such, female athletes are at a higher anatomical risk for catastrophic non-contact knee

injuries. A non-contact knee injury is any injury where no physical contact between athletes or other objects (i.e., landing, pivoting, side stepping, accelerating, decelerating) is involved in the injury mechanism (Yu & Garrett, 2007). Further, the body mass index (BMI) of an individual has also been connected to non-contact ACL injuries. One 2012 study of young military subjects found that increased BMI was a contributing risk factor for non-contact ACL tears (Evans et al., 2012). Subsequent research certifies these findings and conclude that female athletes almost invariably have a higher BMI than males which can be a significant factor in non-contact ACL tears (Mancini et al., 2021).

Only in recent years, however, has the frequency of non-contact knee ligament injuries in female athletes been studied and attributed to hormonal regulation throughout the menstrual cycle. It is well known and researched that hormonal regulation fluctuates throughout the menstrual cycle (Mihm et al., 2011; Owen, 1975; Silberstein & Merriam, 2000). Estrogen, the hormone responsible for the development of secondary sex characteristics in the female body and regulating the menstrual cycle, peaks and troughs dramatically between cycle phases. Clinical studies have shown that estrogen levels peak during ovulation. Higher estrogen levels contribute to increased bone and muscle density, while causing a simultaneous and dramatic increase in tendon and ligament laxity (Shultz et al., 2005). As such, it is not uncommon for most catastrophic ligament injuries, specifically ACL injuries, to occur during the ovulatory phase of the menstrual cycle.

The earliest research conducted on the relationship between non-contact ACL tears and the menstrual cycle found that of 28 participants representing the sports of basketball, soccer, and skiing, 16 individuals suffered an ACL tear during the ovulatory phase of their menstrual cycle (Wojtys, 1998). Wojtys et al. (1998) argued that the high rate of incident during the

ovulatory phase was directly attributable to the surge in estrogen levels, otherwise there would not be such a concentration of non-contact ACL injuries during this phase of the menstrual cycle. A few considerations arose from this study. The primary concern was that data was collected through a questionnaire. Subjects were asked to self-report on the phase of their menstrual cycle at the time of injury, rather than using blood sampling, saliva collection, or urinalysis to monitor hormonal levels to verify menstrual phase. As such, the study merely proved a trend in the data, not a scientific or statistical causation between ovulation and non-contact ACL tears (Wojtys, 1998). Further, retrospective analysis of the participants causes some to question the validity of the study. Beyond having a small participant pool, it has been argued that this study should not have included skiers, because the injury mechanism in skiing is not associated with the jumping, landing, and cutting mechanisms in the other studied sports (Hewett et al. 2007). Finally, the use of oral contraceptives (OC) was recorded, but not factored into data analysis or conclusions (Wojtys, 1998).

A follow-up study conducted in 2002 by the same team of researchers attempted to remedy the shortcomings of the initial study by using urinalysis as the primary method of data collection and increasing the participant sample size from 28 to 65 (Wojtys, 2002). Again, OC use was recorded however considered in a separate set of conclusions for this study. The findings of this second study supported the findings of the first with statistical analysis to verify the validity. Results showed that participants experienced non-contact ACL tears at unusually high rates of incidence during the ovulatory phase compared to an unexpectedly low frequency of injury during the luteal phase and menses (Wojtys, 2002). The study did include skiers in the participant pool, however in this version of the study, skiers were analyzed in comparison to other athletes. Limitations to this study exist, as the number of OC users (14) was far outweighed

by the number of non-OC using participants (51), and the discussion of skiing injuries as compared to athletes in the other represented sports was not subjected to statistical analysis (Wojtys, 2002).

A systematic review of research regarding the role of the menstrual cycle and non-contact ACL ruptures found that out of the seven selected studies (two of which were the aforementioned Wojtys et al., studies), all concluded that the menstrual cycle played a significant role in the increased epidemiology in female athletes (Hewett et al., 2007). Some variation exists between studies as to which specific phase of the menstrual cycle sees the highest risk for injury, though this may be explained by the highly irregular and individualized nature of menstrual cycles making it nearly impossible to categorize in a scientific manner. What can be concluded from the Hewett et al. (2007) review is that non-contact ACL ruptures occur at an exceptionally increased frequency when estrogen levels are high (particularly in the late follicular and ovulatory phases).

The Role of Oral Contraceptives

Oral contraceptive use plays an important role in hormone regulation throughout the menstrual cycle. Some research suggests that athletes using oral contraceptives limit their risk for non-contact ACL injuries. Studies have concluded that oral contraceptive pills decreased the risk of an ACL rupture from 18% to 20% (DeFroda et al., 2019; Herzberg et al., 2017). A second study confirmed this hypothesis, particularly when looking at the epidemiology for female ACL patients aged 15-19 years of age. The demographic experienced the highest rate of incident in all age groups studied, while simultaneously being the least likely to take oral contraceptives (Gray et al., 2016). It is important to acknowledge that other differences between the studied age

groups could contribute to the result (i.e., higher participation in performance level activity and bodily changes due to adolescence among the most significant).

These protections can be explained by the regulatory effect of oral contraceptives on hormone fluctuation. Most forms of hormonal contraceptives are a combination of estrogen and progesterone, with the exception of the "mini pill" which only contains progesterone (Jin, 2014). The form of synthetic estrogen, known as ethinyl estradiol, serves as a regulating hormone that prevents the normal surge in natural estrogen during the luteal phase (Rahr-Wagner et al., 2014). As previously discussed, this increase in estrogen levels puts female athletes at heightened risk for non-contact ACL ruptures, and it follows that a prevention or regulation provides some form of protection. Physiologically, there is no evidence to suggest that hormonal OC leads to any changes in range of motion in the knee joint (Lebrun, 1993).

When looking at how hormonal contraceptives affect overall athletic performance, Rechichi et al. (2009) found that VO2max was reduced by 5% to 15% across all menstrual cycle phases in athletes who use OC, confirming the findings of Lebrun (1993). Research regarding the effect of OC on ventilation rates and metabolism is incredibly sparse. While there is some indication that ventilation rates are higher during OC consumption, it appears that ventilation rate is more directly related to both the type and timing of OC consumption when compared to non-OC users (Rechichi et al., 2009). Isometric strength, metabolism, and body composition were all insignificantly impacted by OC use, and body composition followed the same pattern in research as ventilation rates, where the type of OC had more influence than users versus non-users (Martin & Elliott-Sale, 2016).

Research has almost exclusively been conducted on general populations, and therefore it is unknown whether these conclusions about the effect of hormonal contraceptives on athletic

performance are applicable to athletes. (Martin & Elliott-Sale, 2016). More research is needed to validate the existing literature.

Psychological Responses

Little consistency exists in determining how the menstrual cycle affects the physiology and athletic performance in female athletes. Despite this, many female athletes strongly perceive their performance to be negatively altered during menses (Stratham, 2020). In a 2021 narrative review, five studies were analyzed to determine how female athletes perceive their menstrual cycles to affect their athletic performance (Carmichael et al., 2021). All five articles found that over 50% of participating athletes reported feeling that certain phases of the menstrual cycle negatively affected their performance, specifically during the early follicular phase and late luteal phase (Armour et al., 2020; Ergin & Kartal, 2020; Findlay et al., 2020; Jacobson & Lentz, 1999; Solli et al., 2020). As previously discussed, physiological evidence to support these perceptions is divided, but that does not prove that the menstrual cycle does not still affect athletic performance.

Fatigue, decreased endurance, and decreased muscular strength are among the most commonly reported symptoms of menstruation regarding athletic performance (Armour et al., 2020). Solli et al. (2020) found that a majority of athletes participating in a study reported that their fitness and performance were the worst during their periods, yet only 8% felt well educated on the topic and only 27% communicated with their coaches about their cycle. Pain is also a limiting factor for menstruating athletes (Stevens et al., 2018). Cramping and lower back pain during menstruation often results in the alteration or cancellation of training plans, as well as a significantly decreased motivation to train (Brown et al., 2021). In scenarios where it is not possible to make personal accommodations for pain, like during competition, athletes may suffer

from poor performance because of the inverse relationship between menstrual pain and athletic performance (Findlay, 2020).

Female athletes also widely consider menstrual symptoms related to behavior and mood (i.e., increased irritability, anger, and depression) to be factors in their athletic performance (Ergin & Kartal, 2020). Dysmenorrhea, otherwise known as severe cramping and pain experienced during menses, has been reported as a menstrual symptom in a majority of women and is known to cause mood swings and negative mental effects associated with premenstrual syndrome (PMS) (Balik et al., 2014). Several studies have investigated the influence of mood states on athletic performance. The Profile of Mood States (POMS) was developed to determine how mood affects athletic performance (McNair et al., 1971). While the POMS provided a method for generally predicting an athlete's performance, it largely ignores individuality and changes in mood during exercise (Beedie et al., 2000). Terry (1995) posited that mood state prior to competition is a better predictive measure for performance, with positive mood states wielding more successful performances than negative mood states. Distractions of any sort, including distractions stemming from menstruation, lead to negative mood states that can have devastating impact on focus and emotional regulation during competition (Terry, 1995).

Other emotional and psychological factors can be adversely affected during menstruation. Most common amongst these is communication with coaches. In one study, 66% of interviewed athletes from two clubs in the English Women's Super League, the topflight of domestic soccer, said that they were more likely to be affected by criticism and feedback from coaches while menstruating (Read et al., 2021). A comprehensive study conducted on female swimmers revealed that while coach gender was not the only factor in comfort levels, most would be more comfortable sharing menstrual cycle information with a female coach than a male coach (Hyde

& Zipp, n.d.). Female coaches are able to draw on their own personal experiences to understand their athletes when it comes to menstrual health. Conversely, many male coaches lack education on the menstrual cycle or find it too taboo to discuss in a sporting environment (Pitchers & Elliott-Sale, 2019). Most female athletes feel that male coaches would not respect or understand their concerns, and therefore do not seek out conversations with them regarding menstrual health (Brown et al., 2020).

One of the biggest concerns identified by athletes regarding training during menstruation is leaking or flooding. Due to the stigma surrounding menstruation, many athletes are fearful of leaking during training or competition (Hyde & Zipp, n.d.). Sporting attire and uniforms often work against female athletes during menstruation, contributing to increased anxiety and paranoia. Many uniforms in female sport feature leotards, skintight shorts and spandex, or heavily feature the color white, causing athletes to worry about staining their clothes due to leaking (Brown et al., 2021). General stigmatization about menstruation and leaking has caused many women to express leaking as a traumatic experience associated with their periods (Findlay et al., 2020). The fear of leaking during sport has also been linked to the loss of control and a major contribution to feelings of anxiety for menstruating women (Lane & Francis, 2003) Distractions caused from paranoia associated with leaking are perceived by most athletes to limit their athletic performance (Brown et al., 2021).

Despite a lack of evidence to support or refute these perceptions, they are still meaningful from a psychological perspective. When an athlete feels as though their period prohibits them from performing to the best of their ability, they risk the development of a negative self-fulfilling prophecy, where the expectation of failure leads to actual failure (Weinberg & Gould, 2019). Self-fulfilling prophecies provide one explanation for why athletes may perceive themselves as

having poor performances during menstruation despite a significant body of evidence to support those claims.

Methods

Participants

Participants in this study included thirty-seven female athletes aged 18 to 22 (M_{age} = 19.35, *SD* = 1.05) and seven collegiate coaches (female *n* = 4, male *n* = 3). To be considered for participation in this study, both coaches and athletes had to have competed or been members of a team that competed at the NCAA Division III level during the 2021-2022 academic year. Coaches in this study filled head (*n* = 5) and assistant coach (*n* = 2) positions. The athletes were recruited from an NCAA Division III institution, representing the sports of basketball (*n* = 13), track and field (*n* = 9), soccer (*n* = 9), field hockey (*n* = 5), golf (*n* = 2), and cheerleading (*n* = 1). Three athletes represented two sports.

Measures

Demographics

The surveys were designed uniquely for the purposes of this study. Athletes and coaches filled out slightly different surveys in order to answer the research question. Both the coach and athlete version of the survey began with a brief demographic survey. In the athlete survey, the demographic section collected data on their age, the sport they participated in, and the gender of their coach. For the purposes of confidentiality, items asking for age and sport were kept from the coach survey. Demographic information collected from coaches included gender and coach description (head, assistant, or volunteer coach).

Athlete Menstrual Health and History

Athletes answered a section about their menstrual health and history. Included in this section were questions regarding the age of first menses, the regularity of the menstrual cycle as well as the presence of oligomenorrhea and amenorrhea, existence of potential reproductive system conditions such as PCOS and Endometriosis, the use of hormonal contraceptives, and whether or not the athletes track their menstrual cycle and how. In addition to those items, athletes were asked to record their most common physical menstrual symptoms. A list of the most common symptoms was derived from Moos' (1968) Mental Distress Questionnaire (MDQ) and included in the survey. Athletes were also allowed to enter in any additional symptoms they experience during menstruation.

Perceptions of the Physiological Effects of the Menstrual Cycle

Both surveys included sections on the perceptions of the physiological effects of the menstrual cycle. Five item matrices were used for this section, scored on a 5-point Likert scale, rating from "5 - strongly agree" to "1 - strongly disagree". Both matrices included items on perceptions on the effect of the menstrual cycle, perceptions of coach awareness on the effects of the menstrual cycle on athletic performance, and personal opinion towards the consideration of the menstrual cycle in individualized training plans. The coach matrix also included questions on whether athletes should track their menstrual cycles and whether athletes understand how the menstrual cycle affects athletic performance. Athletes answered items on whether or not they felt their coaches made appropriate accommodations or adjustments to training plans for menstruating athletes, and to what degree they feel "off" during exercise while menstruating. In addition to the five-item matrix, the athlete survey included an item on catastrophic ligament or tendon injuries and when in the menstrual cycle the injury occurred.

Perceptions of the Emotional Effects of the Menstrual Cycle

Similarly to the section on the perceptions of the physiological effects of the menstrual cycle, both versions of the survey included matrices to collect data on the perceptions of the emotional effects of the menstrual cycle. A four-item matrix was used in the athlete survey as opposed to a three-item matrix in the coach survey. The same 5-point Likert scale was used as before in both matrices. Both matrices asked participants whether they felt that menstruation was a taboo subject in their sport environment. The matrix from the coach survey included one item on the level of concern for mental and emotional health for athletes in general, and a second item on whether the menstrual cycle affects the mental and emotional states of athletes. The athlete survey contained items related to their individual comfort levels in sharing information on their menstrual cycle to both their coaches and athletic training staff, respectively. Athletes also answered an item on their sensitivity to receiving negative feedback while menstruating. One item was not included in the matrix but asked athletes to record their most frequent emotional or psychological symptoms during menstruation. Fashioned like the item on physical symptoms, the most common emotional symptoms from the MDQ (Moos ,1968) were provided, and athletes had an opportunity to input additional symptoms.

Athlete and Coach Education

The athlete and coach surveys included one item about seeking out future education on the topic, rated on a 5-point Likert scale. In the coach survey, the item was featured as a part of a three-item matrix, as opposed to the athlete survey where the item stood alone. Other items in the matrix included coach preparedness to discuss the effects of the menstrual cycle on overall health with their athletes and willingness to integrate menstrual cycle considerations as a part of individualized training plans upon further education.

Procedures and Data Analyses

Upon receiving institutional review board approval, the researcher used purposive and snowball sampling to recruit potential participants. Twelve head coaches from an NCAA Division III institution were contacted directly via email four times over the course of two weeks. The recruitment email contained links to both versions of the survey, a description of the project, and the researcher's contact information for questions or concerns. Coaches were asked to forward the email to the other members of their coaching staff, as well as to their athletes. In addition to the recruitment emails, the link for the athlete version of the survey along with a description of the study was shared with the Student Athlete Advisory Committee representatives from each team at the participating institution for distribution. Surveys were administered and open for two weeks for data collection.

After two weeks of data collection, the surveys were closed, and both the coach and athlete version of the survey were statistically analyzed using Statistical Product and Service Solutions (SPSS) v.28.0.1.1 statistical software. The scale averages were examined, and Pearson correlations were conducted across all variables to examine the relationships both between and within the coach and athlete responses.

Results

Statistical analyses were conducted in order to determine the perceptions of the effects of the menstrual cycle on female athletic performance. Data gathered from athletes was analyzed to find relationships between personal characteristics and experiences and perceptions on the effects of the menstrual cycle on their performance. Coach responses were analyzed to find correlations between their perceptions of athlete performance and the menstrual cycle.

Athlete Responses

Physical and Emotional Symptoms in Athletes

The most commonly reported physical menstrual symptoms were abdominal cramping (*n* = 25), lower back pain (*n* = 20), and headaches (*n* = 19). Commonly reported emotional and mental menstrual symptoms were heightened emotional states (*n* = 26) and changes in appetite/eating habits (*n* = 26).

Menstrual Health

A majority of athletes reported normal menstrual cycles (*n* = 21), but nine reported experiencing oligomenorrhea and four others reported experiencing amenorrhea. Only two athletes reported reproductive health issues such as Endometriosis or Polycystic Ovary Syndrome.

More athletes tracked their menstrual cycle (*n* = 20) than did not (*n* = 14). Of the athletes who did track their menstrual cycle, the use of a cell phone app was recorded as the most common method (*n* = 19). Of the athletes who reported taking hormonal contraceptives (*n* = 18), only one used an intrauterine device, while the others used oral contraceptives (*n* = 17). The remaining sixteen athletes did not use any hormonal contraceptives.

Injury

Eight athletes reported suffering from a catastrophic ligament or tendon injury, but only one identified that the menstrual cycle the injury occurred outside of menstruation. There were no relevant relationships with injury status.

Perceptions of the Effect of the Menstrual Cycle on Athletes

Out of all respondents, 82% agreed to some extent that they felt “off” while exercising during menstruation. As to how menstruation affects athletic performance, 62% agreed to some

extent that their performance was negatively affected. Regarding perceptions of the coach's awareness of the effects of the menstrual cycle on athletic performance and perceptions of the coach's ability to make appropriate training adjustments for menstruating athletes, athletes answered "strongly disagree" at 38% and 36%, respectively.

Table 1
Athlete Perceptions of the Physical and Psychological Effects of the Menstrual Cycle

Variable	*n*	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Age	37	19.35	1.05	–																	
2. Coach gender	37	1.54	0.50	-.11	–																
3. Age at first menses	33	13.09	1.42	-.07	.32	–															
4. Menstrual irregularities	34	2.35	0.87	.15	.27	.02	–														
5. Reproductive disorders	34	2.03	0.38	-.03	.08	.11	-.12	–													
6. Oral contraceptive	34	1.97	0.98	-.42*	-.21	-.15	-16	.08	–												
7. Cycle tracking	34	1.41	0.49	.22	.00	.04	-.07	-.22	-.10	–											
8. Menstrual cycle affects performance	34	3.47	1.17	.19	.15	-.07	.21	.23	.04	-.29	–										
9. Coach awareness of menstrual effects	34	2.29	1.30	.10	.23	-.10	.44	-.49**	-.13	.23	.03	–									
10. Coach adjustments in training plans	34	2.24	1.19	.16	-.05	-.15	.55**	-.60**	-.10	.19	-.04	.70**	–								
11. Menstruation as a training consideration	34	3.32	0.96	.21	.03	-.50**	.39*	.05	-.18	-.22	.26	.28	.14	–							
12. Feeling “off” during exercise	34	4.06	0.80	.29	.07	.05	.06	.09	-.18	-.06	.54**	.24	.05	.28	–						
13. Catastrophic injury	34	3.74	0.50	-.34*	-.16	-.05	-.19	.04	.16	.08	-.34	.16	.15	-.19	-.25	–					
14. Sensitivity to negative feedback	34	3.71	1.02	.12	.12	.41*	-.02	.10	-.48**	-.29	-.13	-.07	-.04	-.14	.09	-.10	–				
15. Communication with coach	34	2.29	1.49	.05	.00	-.07	.33	-.27	-.22	-.17	-.05	.35*	.46**	.18	-.09	.26	.23	–			
16. Communication with athletic trainer	34	2.12	1.18	.03	.05	-.17	.33	-.27	-.17	-.24	-.08	.38*	.46**	.33	-.13	.25	.05	.87**	–		
17. Taboo	34	3.21	1.02	-.17	-.26	-.08	-.25	.36*	-.05	.01	.14	-.33	-.26	-.01	.06	.05	-.14	-.23	-.26	–	
18. Desire for further education	34	1.91	0.82	.01	.04	.17	.48	-.27	.22	.39*	-.14	.22	.35*	-.41*	-.22	.23	-.07	.02	-.05	-.30.	–

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

A Pearson Correlation was run to examine potential relationships between athlete perceptions of the physical and psychological effects of the menstrual cycle (see Table 1). Several statistically significant relationships were found.

Four relationships were of statistical significance regarding athletes' perception of their coach's ability to make appropriate training adjustments for menstruating athletes. Perceived coach awareness was moderately positively correlated with the perception of the coach's ability to make appropriate adjustments to training plans for menstruating athletes, $r(34) = .70$, $p = <.001$. Experiences with oligomenorrhea and amenorrhea existed in moderately positive correlation with perceptions of the coach's ability to make training adjustments for menstruating athletes, $r(34) = .55$, $p = <0.001$. Reproductive health disorders were also moderately correlated to the coach ability to make adjustments to training plans, $r(34) = -.60$, $p = <0.001$. The relationship between coach communication and the perceived ability of the coach to make appropriate adjustments for menstruating athletes was moderately positive, $r(34) = .46$, $p = .006$.

Other significant correlations of note include the relationship between communication with the coach regarding menstrual symptoms and perceived coach awareness had a low positive correlation, $r(34) = .35$, $p = .041$. Comfort levels of communicating with coaches and athletic training staff had a highly positive correlation $r(34) = .87$, $p = <0.001$. Perceived coach awareness had a moderately negative correlation with experiences of reproductive health disorders, $r(34) = -.49$, $p = .003$. A moderately positive correlation was found between athletes who felt "off" while exercising during menstruation and poor athletic performance, $r(34) = .54$, $p = .001$.

Table 2

Coach Perceptions of the Physical and Psychological Effects of the Menstrual Cycle

Variable	*n*	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Gender	7	1.57	0.49	–												
2. Description	7	4.29	0.45	.55	–											
3. Menstrual cycle affects performance	7	2.14	0.99	-.46	.41	–										
4. Awareness of menstrual effects	7	2.29	1.03	-.32	-.48	.52	–									
5. Athlete awareness of menstrual effects	7	2.86	0.64	-.19	-.35	-.19	-.37	–								
6. Athlete tracking Cycles	7	2.14	0.83	-.55	-.11	.32	-.05	.58	–							
7. Menstruation as a training consideration	7	2.29	0.88	-.05	.15	.12	-.10	.58	.72	–						
8. I worry about emotional and mental health	6	1.17	0.37	-.63	-.32	.11	-.55	.78	.42	.32	–					
9. Menstruation effects on mental health	6	1.17	0.75	-.32	-.16	.54	-.55	.78	.58	.63	.80	–				
10. Menstruation as a taboo	6	3.33	1.25	-.38	-.47	.65	.00	.93**	.70	.76	.60	.84*	–			
11. Desire for further education	6	1.67	0.75	.16	.32	.54	.27	.00	.58	.63	-.40	.10	.30	–		
12. Preparedness for conversation	6	2.83	1.57	-.30	.30	-.18	-.91*	.00	.02	-.19	.62	.38	-.14	-.47	–	
13. Willingness to adjust training	6	2.00	1.15	.31	.31	.63	.18	.00	.48	.61	-.39	.19	.35	.97**	-.46	–

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Coach Responses

Coach perceptions of the physical and psychological effects of the menstrual cycle on athletes and their performance were analyzed using a Pearson Correlation (see Table 2). Perceptions of menstruation as taboo in the sporting environment had three highly correlated relationships. The perceptions of the effects of menstruation on mental and emotional health was highly positively correlated to the perception of menstruation as taboo in the sports environment, $r(6) = .84$, $p = .038$. The relationship between perceptions of menstruation as taboo and coach perceptions of whether athletes were aware of the effects of the menstrual cycle on athletic performance was also highly positively correlated, $r(6) = .93$, $p = .008$. Willingness for coaches to make training adjustments for menstruating athletes after proper education is highly positively correlated to the desire to pursue education on the subject, $r(6) = .97$, $p = < .001$.

Discussion

The purpose of this study was to determine the perceptions of female athletes and their coaches on the physiological and psychological effects of the menstrual cycle on athletic performance. Measures of athletic performance were not a feature of the study; therefore, it is not possible to determine from this research how physiology such as aerobic capacity, isokinetic strength, body composition, or joint laxity may change during the different phases of the menstrual cycle. Rather, this study set out to examine how athletes perceive menstruation affects them physically and mentally, and to what extent those perceptions in athletes and their coaches impact athletic performance and training environments. Based on the results, it is reasonable to conclude that the menstrual cycle does have a psychological impact on athletic performance to some degree. Two main themes arose from the results of this study: the difference between coach

and athlete perceptions, and the cyclical nature of poor communication between coaches and athletes.

The differing perceptions between coaches and athletes can be seen in two specific instances. The first of these is the difference between perceived self-awareness and the awareness of the other studied group. Generally, both coaches and athletes indicated that they believed that they had a solid understanding of how menstruation affected female athletic performance, yet neither population perceived the other to be as knowledgeable on the subject with similar levels of conviction.

Other examples of the differences in perception between athletes and coaches is the perception of menstruation as taboo in the training environment. It should be noted that there was no strong explicit indication from either participant population that menstruation was seen as taboo in their respective sport environments, but coach responses showed less strong opinions that menstruation was, in fact, taboo. While athletes did not universally believe that menstruation was taboo in their training environment, other perceptions indicated that this was the case. Most athletes perceived their coaches to be promoting or engaging in behaviors that reinforced the taboo. Such examples of this can be seen in the athletes' strong perception that coaches were not making appropriate training adjustments for menstruating athletes, the perception that coaches were generally unaware of the effects of the menstrual cycle, and their own unwillingness to communicate menstrual considerations with their coaches. The coach-athlete dyad will always be susceptible to conflict due to differences in opinion and other interpersonal factors, usually due to poor communication (Wachsmuth et al., 2017; Kerwin et al., 2011, Culver, 1999).

Differing perceptions between coaches and athletes contributes to the second theme found in the results: the cyclical nature of poor communication regarding menstrual health. Because

athletes felt that coaches were undereducated and unwilling to make changes to training plans, they withheld information regarding their menstrual symptoms or concerns from the coaches. When athletes do not communicate these considerations, then it is unreasonable to expect coaches to make appropriate decisions and adjustments to training plans. As with any injury or health concern, coaches cannot make adjustments if they are unaware that an athlete is in pain or struggling. Ultimately, this lack of communication becomes a cycle where coaches do not make the changes athletes feel is necessary because they are simply unaware, and in turn, athletes simply feel more inclined to keep their concerns to themselves.

Open communication between coaches and athletes is proven to enhance athletic performance and better general wellbeing in athletes (Davis et al., 2019). One previous study has also concluded that athlete perceptions of coach knowledge can serve as barriers to communication between athletes and coaches and contribute to the development of poorly designed training plans (Kristiansen et al., 2012). This is supported by the results of the present study. While coach gender was not a statistically significant factor in the perceptions of the athletes in this study, there is still evidence to suggest that gender affects overall communication in the coach-athlete dyad (Norman & French, 2013). The barrier to communication regarding menstrual health and symptoms could potentially increase the risk of a female athlete to develop the Female Athlete Triad and other serious health issues. In 2014, the International Olympic Committee deemed the syndrome to be more expansive than previously thought and adopted the use of the term Relative Energy Deficiency in Sport (Mountjoy et al., 2014). The new terminology allows for the inclusion of more athletes who experience energy deficiency, which is something that concerns all coaches regardless of sport or athlete gender, but still impacts female athletes with greater incidence. While menstrual health is highly sensitive in nature,

coaches can help break the cycle of poor communication and protect their athletes by starting these conversations with their athletes.

The reported symptomatology of the athletes, while not immediately apparent, provides reasoning that menstruation affects athletic performance. As previously discussed, perceptions of pain are a factor in athletic performance (Stevens et al., 2018). Abdominal cramping, lower back pain, and headaches were the most commonly reported menstrual symptoms in participants and can cause athletes to need to make alterations to training plans or experience a lack of motivation in training (Brown et al., 2021). Alterations to training plans are not inherently negative or detrimental to athletic performance, however there are scenarios in which athletes and coaches cannot make accommodations. Most athletes are unable to adapt those changes in training to competition, and menstruating athletes may be forced to compete while in pain or uncomfortable (Findlay, 2020).

Emotional symptoms, especially those affecting mood states, are incredibly valuable to understanding how menstruation affects athletic performance as well. As previously noted, mood can act as an indicator for athletic performance (McNair et al., 1971). When athletes suffer from heightened mood states and emotional volatility, they may lose the ability to self-regulate their arousal levels and feel out of control during training or competition. One indicator of this perceived lack of control is the concern over excessive bleeding or leaking during menstruation. Worries over leaking during exercise cause natural distractions in athletes, who feel the need to constantly check their clothing or have paranoia about the social stigma associated with excessive bleeding (Brown et al., 2021). Athlete responses indicated that paranoia over menstrual leaking and flooding had a somewhat significant relationship with the perception of athletic performance in this study.

Other findings from the study did not support the existing literature. There was not enough conclusive evidence based on the regularity of the menstrual cycle (oligomenorrhea and amenorrhea) or reproductive system health (endometriosis and PCOS) to suggest they impact athletic performance beyond their relationship with the perceived ability of the coach to make training adjustments. Over half of the athletes reported using oral contraceptives, but there were no significant connections to be made between oral contraceptives and injury prevention or perceptions of athletic performance. Both users and nonusers of oral contraception were equally likely to feel that menstruation affects athletic performance. Further, athletes who did suffer from a catastrophic ligament or tendon injury largely were unable to identify during which phase of the cycle their injury occurred. This does not allow the present study to confirm existing literature on the prevalence of non-contact ACL ruptures during ovulation as compared to other phases of the menstrual cycle.

Limitations

Some limitations to this study exist. First, the population studied was very small in this study, and as a result, the statistical analyses may not be entirely accurate. The use of self-reporting measures also limits the accuracy of the study. Due to the sensitive nature of the topic, participants may have unintentionally withheld information or exaggerated their responses, despite participant confidentiality. A lack of diversity in the participant population is another limitation to be considered. All of the participants came from the same Division III NCAA institution. Athlete participants represented only six sports. The inclusion of participants from other sports and participants from other institutions would improve the accuracy of the results.

Methodology also limited the study to some extent. While survey results allowed for statistical analysis to determine relationships between participant perceptions, it did not allow for

extensive understanding of the perceptions of each individual participant. Semi-structured interviews may have allowed for better identification and analysis of themes between participants. Data collection was also limited by time. The study was conducted over the course of two weeks due to time constraints. Extending the period of time for data collection could have increased sample size.

Additionally, the present study did not include any measure of changes in athletic performance. There was no collection of data on athletic performance to support or reject coach and athlete perceptions. Collecting data on athletic performance, the menstrual cycle, and injuries over the course of a sport season could help to reduce the effects of self-reporting by athletes and provide more accurate data overall.

Practical Implications and Recommendations

More research is needed to understand the effects of the menstrual cycle within the context of athletic performance overall. Without more conclusive evidence on how physiology changes throughout the menstrual cycle, especially when it comes to aerobic capacity, it is unreasonable to expect coaches and athletes to make changes to their normal training routines. It is, however, in the best interest of the athletes that further research be conducted on the menstrual cycle and athletes. Additional research should include more diverse populations, especially in the athlete population. More information is needed on how menstruation affects athletes across different ages, ethnicities, and levels of sport.

For this specific topic, further research should be conducted in conjunction with measures of athletic performance throughout the cycle in order to determine if athlete and coach perceptions align with physical evidence. The reasoning for this being, if future research finds that there are no changes on athletic performance related to the menstrual cycle, more effort can

be spent trying to understand where these perceptions originate. Understanding why athletes feel a certain way about menstruation can help coaches and sport psychology consultants break down the communication barriers and start rooting out the self-fulfilling prophecies that are hindering athletes.

Lastly, menstrual health and education should be a feature in coach education programs in the future. Results from this study showed that perceived coach education and awareness reduced behaviors that perpetuate the idea of menstruation as taboo for athletes. Across all levels of sport where athletes are affected by menstruation, especially in youth sport, even a basic education on how the cycle works and how to start conversations about menstruation can go a long way in creating a healthy and open training environment.

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