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# Prevalence and Frequency of Menstrual Cycle Symptoms in Exercising Females and Their Perceived Impact on Exercise Performance

A thesis presented in partial fulfilment of the requirements for the degree of

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in

Sport and Exercise

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# Abstract

**Background:** Menstrual cycle symptoms (MCS), experienced by up to 93% of females, can negatively impact quality of life. Yet research investigating the impact of these symptoms on exercise/sport performance is still in its infancy and is largely focused on the elite athletic population. Furthermore, many studies do not account for the fact that 43% - 57% of females do not have a natural menstrual cycle (MC) and are using hormonal contraception (HC). Further investigation is needed to examine the impact of the potential perceived negative effects associated with MCS and HC use on physical performance in exercising females.

**Objectives:** Identify and compare the prevalence and frequency of MCS in naturally menstruating (NM) females and females using HC. Identify and compare the perceived impact of MCS or HC side effects on exercise/sport performance and participation in NM females and females using HC.

**Methods:** Two hundred exercising females (age 26 ± 6 years) participated in this study. Participants completed an online questionnaire which was an amalgamation of four independent validated surveys, including, the International Physical Activity Questionnaire – short form (IPAQ) to assess physical activity levels, the Reproductive Status Questionnaire for Menstrual Cycle Studies to assess MC status, the STRAVA x FitrWomen Survey to evaluate prevalence and frequency of MCS and their effect on exercise/sport participation, and the Exercise and Menstruation in Australia Questionnaire to assess perceived impact on exercise/sport performance. After data cleaning to remove incomplete responses, 182 participants were included in the final analysis. For each participant, total number, and frequency of MCS were added based on a Likert scale to receive a menstrual cycle index (MSi) score. Correlations between MSi and likelihood of missing exercise sessions and likelihood of reporting positive, neutral, or negative training outcomes were assessed.

**Results:** Participants were 54.4% NM and 45.6% HC users, with the oral contraceptive pill (OCP) being the most used (23.6%) form of HC. The most prevalent MCS for both groups were, changes in mood/increased irritability, bloating/increased gas, stomach cramps, cravings/increased appetite, and increased tiredness/fatigue. MSi score did not differ significantly between NM females and HC users ($p = 0.435$). MSi score was weak - moderately correlated to and increased likelihood of missing training in both NM females ($p < 0.001$, $r = -0.372$) and HC users ($p = 0.003$, $r = -0.322$). MSi score was also weak – moderately correlated to an increased likelihood of reporting negative training outcomes in NM females ($p = 0.002$, $r = -0.310$) but not HC users ($p = 0.296$, $r = -0.116$). NM participants were more likely ($P < 0.001$) to report negative training outcomes than HC users. Whereas HC users were more likely ($P < 0.001$) to report no changes to their training performance.

**Conclusion:** Results from this study demonstrate that MCS are very common in exercising females, with no difference in prevalence or frequency between NM females and HC users. The large prevalence of MCS and associations to negative training outcomes and missing training sessions would suggest greater education and awareness on managing and reducing the risk of MCS is imperative to improve the wellbeing and exercise performance of females.

# Acknowledgements

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I would like to thank everyone who helped with the advertisement of the study by sharing the questionnaire with their networks. I would also like to thank everyone who participated in this study for providing their time to contribute to this research.

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# List of Abbreviations

| Abbreviation | Term |
|---|---|
| MC | Menstrual cycle |
| MCS | Menstrual cycle symptoms |
| MSi | Menstrual Cycle Index |
| NM | Naturally menstruating |
| HC | Hormonal contraception |
| IUD | Intrauterine device |
| OCP | Oral contraceptive pill |
| LARC | Long-acting reversible contraception |
| HMB | Heavy menstrual bleeding |
| GABA | Gamma-Aminobutyric Acid |
| LEA | Low energy availability |
| MVPA | Moderate to vigorous intensity aerobic physical activity |
| MSA | Muscle strengthening activity |

# Chapter One: Purpose

## 1.0 Introduction

Over the past three decades there has been a marked increase in the number of females participating in sport and exercise (Fink et al., 2015). Specifically, in elite sport, the percentage of women competing at the Olympic Games increased from 26% in Seoul 1998 to almost 49% in Tokyo 2020, with many of the larger delegations in Tokyo bringing more than 50% female athletes (de Santana et al., 2022; Houghton et al., 2017). The influence of the Olympic Games is immense, demonstrated in 2006 when sport and physical activity participation in British females increased by one million after the London 2012 Olympic bid was won in 2005 (Department for Digital, Culture, Media, and Sport, 2012).

Despite observed increases in female sport and exercise participation, a large proportion (48.3%) of the New Zealand population still do not meet the Ministry of Health physical activity guidelines for 2.5 hours of moderate to vigorous activity per week, with females less likely (48.3%) to meet these guidelines than men (55.3%) (Ministry of Health, 2020). In addition, only 23.5% of Americans meet the World Health Organisation's 'Global Recommendations on Physical Activity for Health' which advises regular moderate to vigorous intensity aerobic physical activity (MVPA; e.g. walking running, cycling) and muscle-strengthening activity (MSA; e.g. strength/resistance training), with females again less likely to meet these combined guidelines (Bennie et al., 2019). Discrepancies between female and male exercise participation can be attributed to females experiencing a greater number of perceived barriers to exercise (Hickey et al., 2017; Rosselli et al., 2020). In particular, the female menstrual cycle (MC) is a major perceived barrier to exercise participation and optimal

physical performance (Armour et al., 2020; Bruinvels et al., 2021; Ergin et al., 2020; Findlay et al., 2020; Solli et al., 2020).

The female MC involves the cyclic fluctuation of oestrogen and progesterone which produces physiological and psychological changes that are proposed to impact exercise performance (Carmichael et al., 2021). However, the literature is both limited and conflicting, and studies do not report clear consistent outcomes of MC phase on objectively measured exercise performance (McNulty et al., 2020). Conversely, studies analysing perceived performance find that females consistently report their physical performance to be relatively worse during the late luteal and early follicular phase when menstrual cycle symptoms (MCS) are commonly experienced (Carmichael et al., 2021; Solli et al., 2020).

Up to 90% of females experience MCS which can negatively impact their wellbeing and quality of life, ranging from minor inconveniences to debilitating symptoms (Kaunitz, 2000; Mauvais-Jarvis et al., 2013). Common MCS include, stomach cramps, lower back pain, bloating, gastrointestinal issues, tiredness/fatigue, agitation/irritability, decreased motivation, and distraction (Brown et al., 2021; Bruinvels et al., 2021; Clarke et al., 2021). Recent studies found 50% to 85% of athletes experience perceived negative training and competition outcomes due to MCS (Armour et al., 2020; Ergin et al., 2020; Findlay et al., 2020; Solli et al., 2020). Specifically, athletes reported greater fatigue, decreased endurance, and reductions in strength, speed, and agility (Armour et al., 2020). Furthermore, females who experience a greater number and frequency of MCS were noted to be more likely to change or miss an exercise training or event/competition (Bruinvels et al., 2021). Existing studies on how MCS impact exercise/sport are almost exclusive to the elite athletic population (Armour et al., 2020; Ergin et al., 2020; Findlay et al., 2020; Solli et al., 2020). However, most exercisers are recreational

therefore it is imperative studies take place in this demographic to help increase female participation rates and overall wellbeing (Doohan et al., 2023).

Not all females have a natural MC and as many as 93% will use hormonal contraception (HC) in their lifetime (Philipson et al., 2011). The most common reported reasons for HC use are to prevent pregnancy, to control the menstrual bleeding date, and to reduce menstrual pain (Clarke et al., 2021; Martin et al., 2018). Exercise/sport performance and participation is reported to benefit from HC use due to reductions in the psychological burden of the MC (Cabre et al., 2023). Despite this studies have also reported negative side effects from HC use, including, weight gain, fatigue, and poor mood, which may negatively impact exercise performance. (Brown et al., 2021; Cabre et al., 2023; Elliot-Sale et al., 2020). However, current literature is limited to OCP use and no studies have exclusively investigated the impact of other HC methods on exercise/sport performance and participation, leaving females unable to make informed decisions (Elliot-Sale et al., 2020; Heyward, et al., 2022; Martin et al., 2018).

The current understanding of the impact of HC and the MC on exercise/sport is poor, and no recommendations exist to help females navigate the challenges that can arise (McNulty et al., 2020). Further research is warranted in the general exercising population to uncover how MCS and HC impacts participation and exercise performance (Doohan et al., 2023). In addition, research is needed to investigate the exclusive impact of all methods of HC on exercise/sport as studies like this have not yet been conducted (Henderson et al., 2020). Advancing our knowledge of MCS and HC side effects and the perceived impact on exercise/sport is essential to help improve exercise participation, athletic performance, and thus the health and wellbeing of females (Larsen et al., 2020).

## 1.1 Aims

To improve exercise performance and participation in females it is crucial to understand what impeding factors exist in relation to the MC and HC. The overall purpose of this study is to investigate females' perceived impact of the MC and HC on their exercise/sport performance and participation.

### 1.1.1 Objectives

1. Determine the prevalence and frequency of MCS commonly experienced by exercising females who are naturally menstruating (NM) or using HC.
2. Compare the prevalence and frequency of MCS between NM females and females using HC.
3. Determine how reported MCS and side effects from HC are perceived to impact sport/exercise performance.
4. Compare the perceived impact of MCS between NM females and HC users on exercise/sport performance.

### 1.1.2 Hypothesis

1. The frequency of MCS experienced will be higher in NM females compared to females using HC.
2. The perceived negative impact of MCS on exercise/sport performance will be greater in NM females than females using HC.
3. HC will be reported to have equally positive and negative impacts on sport/exercise.

## 1.2 Structure of thesis

The thesis begins by introducing what is currently known about how the MC and HC impacts sport/exercise, and the key areas for further research. This is followed by chapter two which is a comprehensive review of the current literature. Chapter two details the physiological processes involved in the MC, the impact of MC phase on objective measures of performance, the impact of MCS on perceived performance, and the impact of HC on perceived performance. Chapter three is the manuscript of the study which includes an introduction, methodologies, results summary, and discussion of the findings. Finally, chapter four summarises the study, including the strengths, limitations, practical insights for exercising females, and future directions for studies investigating the MC, HC, and exercise/sport.

## 1.3 Researcher's Contributions

**Table 1.1: Summary of Researcher's Contributions to the Study**

| Author | Contribution to Thesis |
|---|---|
| Hannah Wilton<br>MSc Student Sport and Exercise | Primary author of thesis<br>Designed research<br>Applied for ethics<br>Participant recruitment<br>Statistical analysis<br>Interpretation of results |
| Dr Claire Badenhorst<br>Primary Supervisor<br>Senior Lecturer School of Sport, Exercise and Nutrition | Assisted in ethics application<br>Assisted in participant recruitment<br>Assisted in statistical analysis<br>Assisted in interpretation of results<br>Revised and approved thesis |

# Chapter 2: Literature Review

## 2.0 The Menstrual Cycle

The female reproductive system involves the cyclic biphasic fluctuation of endogenous sex hormones in preparation for the possibility of fertilization and implantation of a pregnancy (Mihm et al., 2011). In humans, this physiological process is known as the menstrual cycle (MC) and is primarily recognised by periodic vaginal bleeding (menses) (Thiyagarajan et al., 2021). The first menses (menarche) occurs on average at 12.5 years old, approximately 2-2.5 years after the onset of puberty (Diaz et al., 2006; Eveleth et al, 2017). However, ~95% of females will experience menarche up to three years before or after the average age (Eveleth et al, 2017). Significant differences in the age at menarche are the result of genetic, socioeconomic, and environmental factors (Yermachenko, et al., 2014). Females are capable of presenting with a biphasic MC until menopause (≥ 12 months of amenorrhea resulting from the permanent cessation of ovarian function) which typically occurs between the age of 45-55 years (Greendale et al., 1999; Landgren et al., 2004). The median MC length (number of days between the onset of one menses and the onset of the subsequent menses) is 28 days and the average menses duration is 3-5 days (Thiyagarajan et al., 2021; Mihm et al., 2011). However, normal variations in MC and menses duration are highly prevalent between and within premenopausal females (Thiyagarajan et al., 2021; Beshay et al., 2017). A normal MC length can vary between 21-35 days, while the duration of menses can vary between 1-8 days in a healthy female (Elliott-Sale et al., 2021; Thiyagarajan et al., 2021). The MC is tightly controlled by the hypothalamic-pituitary-ovarian axis which modulates the fluctuating secretion of sex hormones through both negative and positive feedback systems (Beshay et al., 2017; Thiyagarajan et al., 2021). The key sex hormones that display distinct fluctuations throughout the MC are oestrogen, progesterone, luteinizing hormone (LH), and follicle-

stimulating hormone (FSH). These hormonal variations (figure 1) define each unique MC phase (McNulty et al., 2020). Subsequently, the MC is comprised of two main phases, the follicular phase, and the luteal phase. Each phase can be further divided into the early and late follicular phase, ovulatory phase, and mid luteal phase, with phases numbered 1 – 4 respectively (figure 1) (Elliot Sale et al., 2021). The following sections will detail the physiology of each MC phase.

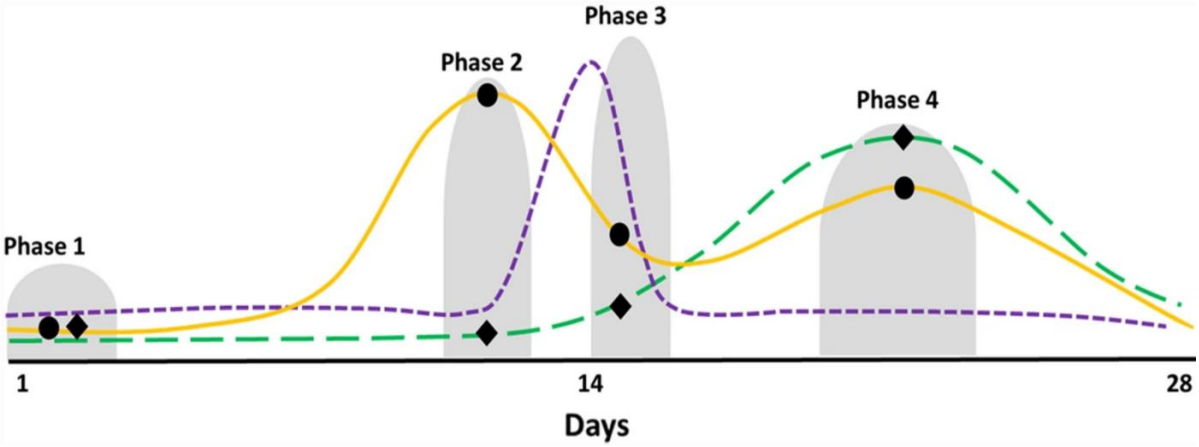


*Figure 2.1 Hormonal Fluctuations Across the Average 28-day Menstrual Cycle. The yellow line represents oestrogen, the purple dash line represents luteinising hormone, and the green dash line represents progesterone. The black diamonds represent the mean concentration of progesterone at each phase and the circles represent the mean concentration of oestrogen at each phase.*

### 2.0.1 Phase One: Early Follicular

Day one of the MC is defined by the onset of menstrual bleeding and marks the beginning of the follicular phase (Elliott-Sale et al., 2021). The drop in progesterone and oestrogen when implantation does not occur, initiates spontaneous decidualisation of the endometrial cells, which subsequently enables menses (e.g., menstrual bleeding) to ensue (Thompson et al., 2019). From the onset of menses up until approximately day 5, oestrogen and progesterone levels remain low (Beshay et al., 2017; Thompson et al., 2019). This is known as phase 1 or the early follicular phase (figure 1) (Elliott-Sale et al., 2021). The low concentration of

oestrogen and progesterone removes the negative feedback on the hypothalamus resulting in increased secretion of FSH and LH from the pituitary gland (Gougeon, 2010).

### 2.0.2 Phase Two: Late Follicular

The rise in FSH stimulates multiple ovarian follicles to grow and develop, however, typically one follicle becomes dominant and continues to mature while the others regress (Gougeon et al., 2010). Oestrogen is produced by the developing ovarian follicles, with its secretion triggered when FSH binds to granulosa cells (Gougeon et al., 2010). As the dominant follicle matures, increasing levels of oestrogen are secreted causing a steady rise in this hormone's concentration from the mid-late follicular phase (Thompson et al., 2019). In the latter half of this phase, oestrogen levels peak, a hormonal profile that classifies the late follicular phase or phase 2 (figure 1) (Elliott-Sale et al., 2021). During the follicular phase, the rising oestrogen levels support the proliferative phase of the endometrium where the endometrial lining thickens, new glands are developed, and blood supply is increased (Thompson et al., 2019). It is worth noting that oestrogen has been identified as a modulator of several biological activities over the female's lifespan, including but not limited to reproductive organ development, bone modelling, cardiovascular system, and the neuroendocrine system functioning (Lee et al., 2012). Progesterone remains low for the entire duration of the follicular phase and is secreted in small amounts by the adrenal glands during this time (Judd et al., 1992).

### 2.0.3 Phase Three: Ovulatory Phase

Oestrogen concentrations must exceed 200pg/ml for 24-48 hours to successfully facilitate positive feedback on the pituitary gland triggering the release of LH (Reed et al., 2015). The increase in LH causes the dominant ovarian follicle to break and release a mature egg (ovum) (Thompson et al., 2019). This event is called ovulation and occurs mid cycle, at approximately

day 14 based on the average 28-day cycle. Phase 3 or the ovulatory phase (figure 1) lasts 24-36 hours post ovulation (Elliott-Sale et al., 2021). During this phase oestrogen rapidly drops to a moderate level and progesterone remains low but slightly higher than phase 1 (Elliott-Sale et al., 2021).

### 2.0.4 Phase Four: Mid Luteal Phase

After ovulation has occurred, the follicle which released the ovum morphs into a mass of cells called the corpus luteum, a temporary endocrine gland which secretes progesterone and oestrogen in a pulsatile manner for the remainder of the luteal phase (Judd et al., 1992). As the luteal phase progresses large increases in progesterone and moderate increases in oestrogen occur (Thompson et al., 2019). Phase 4 or the mid luteal phase (figure 1) is evident approximately 7 days after ovulation (Elliott-Sale et al., 2021). At this point the concentration of progesterone is at its highest and oestrogen levels are higher than phase 1 and 3 but lower than phase 2 (Elliott-Sale et al., 2021). High levels of progesterone and moderate oestrogen during the luteal phase support the secretory phase of the endometrium where glands secrete nutrients and glycogen into the endometrium in preparation for possible implantation (Thiyagarajan et al., 2021). If a fertilised ovum implants in the endometrium the corpus luteum will be maintained and high progesterone and oestrogen levels will continue, thus supporting a pregnancy (Thiyagarajan et al., 2021). However, if implantation does not occur progesterone and oestrogen rapidly drop, commencing a new cycle beginning with menses (Thompson et al., 2019).

## 2.1 Menstrual Cycle Phase and Athletic Performance

The fluctuating hormonal profiles during the MC result in different physiological and psychological effects which are proposed to impact athletic performance (Carmichael et al.,

2021). However, current literature in this area is both limited and conflicting, and further studies are required to better understand how MC phases impact sport/exercise performance (Carmichael et al., 2021). A recent meta-analysis found the effect of MC phase on physical performance to be inconclusive, and large between-study variance and low-quality evidence highlighted the need for further research to improve our understanding (McNulty et al., 2020). The current research on physiological and psychological changes during each MC phase and the subsequent impact on aerobic, anaerobic, and strength performance will be discussed in the following sections.

### 2.1.1 Menstrual Cycle Phase and Muscle Strength

Some evidence exists for variations in muscle strength over the MC (Carmichael et al., 2021). Several studies show that maximal voluntary isometric force for handgrip, quadriceps, or hamstring strength is significantly increased in the late follicular phase or at ovulation when compared with other MC phases (Bambaeichi et al., 2004; Gordon et al., 2013; Pallavi et al., 2017; Rodrigues et al., 2019; Sarwar et al., 1996). In addition, when females trained one leg predominantly in the follicular phase and the other leg predominantly in the luteal phase over 10 sessions, the leg trained in the follicular phase saw a greater increase in maximal isometric force, muscle diameter, and type II muscle fibre diameter (Sung et al., 2014). However, when muscle strength was measured across a range of loads (20 – 80% 1RM) using velocity, force, and power of a half squat to give greater practical implications, researchers found no significant differences in muscle performance across the different MC phases (Romero-Moraleda et al., 2019). These results are in-line with several studies that have also reported no significant differences in muscle strength across the MC phases (Arazi et al., 2019; Köse, 2018; Lebrun et al., 1995; Romero-Moraleda et al., 2019). Observations of strength increases may be attributed to enhanced neuromuscular activation during the mid-late follicular phase and during ovulation

due to possible neuroexcitatory effects of oestrogen and inhibitory effects of progesterone (Inghilleri et al., 2004; Smith et al., 2002). However, it is uncertain whether this translates into a practical setting, with research suggesting that the neuroexcitatory effects of oestrogen did not result in greater maximal strength output (Ansdell et al., 2019). The current evidence suggests muscle strength may be improved during the mid-follicular and ovulatory phase; however, more high-quality studies are necessary to be certain. Future studies should also focus on analysing strength across the MC in practical settings, so findings are more relevant to real life training.

### 2.1.2 Menstrual Cycle Phase and Anaerobic Performance

The majority of studies examining anaerobic performance reported that MC phase had no impact (Julian et al., 2017; Kishali et al., 2004; Romero-Moraleda et al., 2019; Smirniotou et al., 2004; Somboonwong et al., 2015). Only a small number of studies have observed significant differences in anaerobic performance across MC phases, however, the results are conflicting, with studies observing performance peaks in both the follicular and luteal phase (Cook et al., 2018; Guo et al., 2005; Tasmektepligil et al., 2010). Cook and colleagues (2018) observed that peak power in repeated 6-second cycle ergometer sprints was significantly increased at ovulation. Participants in this study also reported higher levels of motivation mid-cycle which could be an influencing factor in the observed increase in performance noted in this study. Inference from previous research investigations suggested that motivation and mood may vary across the MC with higher motivation and mood observed in the follicular phase than the luteal phase (Prado et al., 2021; Sundström-Poromaa, 2018). Perceived physical and mental fatigue during exercise has been reported to be significantly greater in the luteal phase (Freemas et al., 2021; Li et al, 2020; Pallavi et al, 2017) which may contribute to reductions in physical performance. The progesterone withdrawal at the end of the luteal phase results in increased

Gamma-Aminobutyric Acid (GABA) activity which may contribute to mood changes observed in the second half of the MC, prior to commencement of menses (Kapur et al., 2021). Therefore, it is possible that fluctuations in psychological state across the MC may impact one's ability to push through the physical discomfort of exercise. However, research is still limited, and psychological state can vary greatly among individuals due to various lifestyles and stressors (Carmichael et al., 2021). The current evidence suggests that anaerobic performance, including explosive power movements, is not likely to be affected by MC phase (Carmichael et al., 2021). Future research should simultaneously analyse objective and perceived performance to uncover how psychological state across the MC can impact anaerobic performance.

### 2.1.3 Menstrual Cycle Phase and Aerobic Performance

Most studies report no significant differences in aerobic performance across MC phases (Carmichael et al., 2021). However, a small number of studies found that aerobic performance was better in the mid-luteal phase compared to other MC phases (Dokumacı et al., 2019; Greenhall et al., 2020; Shakhlina et al., 2019). Elevated core body temperature (0.3º–0.7ºC) in the luteal phase due to progesterone's thermogenic effects may contribute to an increase in aerobic performance (Giersch et al., 2020). However, there is still insufficient evidence to determine if this core body temperature rise affects skin temperature, sweat rate, or exercise heart rate and thus physical performance (Giersch et al., 2020). Previously, Julian et al., (2017) reported that in elite soccer players YoYo intermittent endurance test performance was considerably lower during the mid luteal phase compared to the early follicular phase. Similarly, Freemas et al. (2021) found that aerobic exercise performance was worse in the mid luteal phase along with participants reporting a more negative mood state pre-exercise and increased ratings of fatigue during this phase. Inconsistencies in study results may be attributed

to disparities in defining each MC phase within and between studies that have been included in these research comparisons (McNulty et al., 2020).

A recent review concluded that all aspects of physical performance remain consistent between the MC phases, however performance may be marginally reduced in the early follicular phase when negative menstrual cycle symptoms (MCS) are commonly experienced (McNulty et al., 2020). MSC can have negative physical and psychological effects and are associated with reduced physical performance (Takeda et al., 2015). Although the effect of MC phase on objectively measured performance remains uncertain, studies analysing perceptions towards performance find that females consistently report their performance to be relatively worse during the late luteal phase and during menses, which is when MCS are most prevalent (Carmichael et al., 2021).

## 2.2 Menstrual Cycle Symptoms and Athletic Performance

Up to 90% of the general female population experience MCS which may negatively impact their wellbeing (Mauvais-Jarvis et al., 2013). Similarly, in exercising females, 81% report experiencing at least one MCS 'often' (Bruinvels et al., 2021). Common MCS include stomach cramps, heavy bleeding, digestive issues, tiredness/fatigue, poor mood, and other negative psychological symptoms (Brown et al., 2021; Bruinvels et al., 2020; Clarke et al., 2021). MCS that are not the result of underlying medical conditions and may be influenced by hormonal changes (Schneider-Thoma et al., 2019), overproduction of prostaglandins (Guo et al., 2013), inflammation (Puder et al., 2006), and deficits in serotonergic and GABA systems (Yonkers et al., 2018). Risk factors for these physiological changes include psychological stress, poor sleep quality, high body mass index (BMI), and poor diet and lifestyle habits (Grady-Weliky, 2003; Karaman, 2012). MCS are perceived to be a detriment to athletic performance, with 50% to 85% of naturally menstruating (NM) female athletes reporting negative training and

competition outcomes due to MCS (Armour et al., 2020, Ergin et al., 2020, Findlay et al., 2020, Solli et al., 2020). Specifically, greater fatigue, decreased endurance, and reductions in strength, speed, and agility have been reported (Armour et al., 2020). MCS that contribute to athletic performance detriments are most frequently reported by athletes during their menstrual phase (Solli et al., 2020). Furthermore, many women report having to change/miss their exercise sessions or sport training/competition due to MCS (Armour et al., 2019; Bruinvels et al., 2021; Doohan et al., 2023). As such, MCS appear to be a major perceived barrier to exercise participation and optimal athletic performance (Armour et al., 2019; Bruinvels et al., 2021; Doohan et al., 2023; Solli et al., 2020). However, current research investigating MCS and performance is almost exclusive to the athletic population (Armour et al., 2020, Ergin et al., 2020, Findlay et al., 2020, Solli et al., 2020), and only a few studies have involved the general exercising female (Bruinvels et al., 2021; Doohan et al., McNulty et al., 2023). Further research in exercising females is therefore imperative to add to the knowledge which may help reduce barriers to exercise participation and optimise female health and wellbeing. The following sections will discuss commonly reported MCS and the current evidence regarding their impact on exercise/sport participation and performance.

### 2.2.1 Dysmenorrhea

Dysmenorrhea refers to cramping in the lower part of the abdomen or pelvis which causes mild to severe pain (De Sanctis et al., 2016). Primary dysmenorrhea is defined as menstrual pain in females without an underlying medical condition, occurring shortly before or at the onset of menses and lasting one to three days (French, 2005). Primary dysmenorrhea occurs in 50-90% of pre-menopausal females and is thought to be the result of a hypersecretion of prostaglandins which causes uterine contractions and ischemia, leading to pain (Armour et al., 2020; Bernardi et al., 2017; Carroquino-Garcia et al., 2019; Grandi et al., 2012; McKenna et al., 2021).

Secondary dysmenorrhea is menstrual pain that is associated with an underlying medical condition or pelvic pathology such as endometriosis, adenomyosis, ovarian cysts, pelvic inflammatory disease, or infection (Harada, 2013; McKenna et al., 2021). Dysmenorrhea can be a debilitating condition as approximately 3-33% of females rate their menstrual pain as severe on a visual analogue scale (McKenna et al., 2021; Bernardi et al., 2017). Dysmenorrhea contributes to decreased quality of life and can result in restriction of daily activities (De Sanctis et al., 2016). Furthermore, 51-81% of females with dysmenorrhea report their menstrual pain impedes their ability to participate in sport and exercise activities (Al-Kindi et al., 2011; Banikarim et al., 2000; Sidi et al., 2016). Research is clear that dysmenorrhea may hinder sport/exercise participation, however, the impact on perceived performance is relatively unknown. Amour et al., (2020) investigated aspects of perceived performance, but this was exclusive to elite athletes Therefore, it is of interest to uncover how dysmenorrhea impacts perceived performance outcomes in the general exercising female.

### 2.2.2 Heavy Bleeding

Menorrhagia, or heavy menstrual bleeding (HMB) is arbitrarily defined as excessive menstrual blood loss >80 mL per cycle (Janssen et al., 1995). However, the definition has since been changed to include "excessive menstrual blood loss that physically, emotionally, socially and financially affects the quality of life of women and can be seen by itself or with other symptoms" (Sriprasert et al., 2017, p.2). Perceived HMB is highly prevalent in exercising women, with 22.3-54.1% of women self-reporting HMB (Armour et al., 2020; Bruinvels et al., 2016a; Bruinvels et al., 2016b; Karlsson et al., 2014). A further 91% of exercising females that experience HMB felt that it impacted their ability to perform sport and fitness activities (Bitzer et al., 2013). Among elite athletes HMB is a common concern, with 33% self-reporting HMB and a further 67% perceiving HMB to impair their athletic performance (Findlay et al., 2020).

In addition, 40% of athletes in Amour et al. (2020) were concerned they might bleed through their clothes/uniform during training and almost half (49.2%) were worried about bleeding through on game/competition day. Moreover, the excessive blood loss due to HMB increases susceptibility to iron deficiency and is associated with greater levels of fatigue (Karlsson et al., 2014). In Armour et al. (2020) athletes reporting heavy menstrual bleeding (29.7%) were more likely to report high levels of fatigue. HMB may therefore negatively impact athletic performance through feelings of distraction, worry, and heightened fatigue (Armour et al., 2020; Findlay et al., 2020). Although HMB is highly prevalent in the general exercising female, research has been almost exclusive to elite athletes, therefore it is important to understand how HMB impacts sport/exercise participation and performance in exercising females (Bitzer et al., 2013; Amour et al, 2020).

### 2.2.3 Digestive Symptoms

On average, females report experiencing negative gastrointestinal (GI) symptoms more frequently than men, which is postulated to be due to the relationship between the gut, brain, and female sex hormones (Anbukkarasu et al., 2021). Common GI symptoms include loose stools, constipation, bloating, pain/discomfort, and nausea (Brown et al., 2021; Bruinvels et al., 2021). Up to 73% of females without GI dysfunction or disease report experiencing at least one GI symptom in the pre-menstrual and menses phases only (Bernstein et al., 2014; Moore, 1998). Furthermore, 50% of females with irritable bowel syndrome (IBS) report an increase in symptoms during the pre-menstrual and menses phases (Moore, 1998). GI symptoms may be influenced by the spike in prostaglandins at the end of each cycle, which results from the sudden drop in sex hormones (Bernstein et al., 2014). Prostaglandins contract uterine smooth muscle and my impact the GI tract due to its proximity (Bernstein et al., 2014). Currently no research has investigated the exclusive impact of MC-related GI symptoms on exercise

performance, rather previous studies have looked at the collective impact of all types of MCS on performance (Amour et al., 2020; Brown et al., 2021; Bruinvels et al., 2021).

### 2.2.4 Fatigue

Perceived fatigue is defined as difficulty initiating and/or completing voluntary physical or cognitive tasks (Chaudhuri et al., 2004). Perceived fatigue is consistently reported to be heightened during the mid-late luteal phase and menstrual phase, but physical fatigue may not be affected (Carmichael et al. 2021; Li et al., 2020). Heightened perceived fatigue may be due to the psychological burden of MCS (Li et al., 2020). Furthermore, fatigue in the luteal phase may be due to diminished sleep quality which can be a consequence of the rise in core body temperature as a result high progesterone levels (Romans et al., 2015). Fatigue is unfavourable for athletes and exercising individuals as it decreases readiness to train and perform (Turner et al., 2016). In Armour et al., (2020) the most common reasons for athletes perceiving the MC to negatively impact their performance was "I fatigue more easily" (44%) and "my energy levels are different" (43%). In addition, fatigue and participation in sport/exercise appear to be inversely related in recreationally active women (Bruinvels et al., 2021). Further research is needed to determine if perceived fatigue correlates to a decrease in physical performance and participation in exercising females from a range of sport and exercise modes.

### 2.2.5 Psychological Symptoms

Many studies report that females experience increased negative mood states in the late luteal and menses phases (Angst et al., 2001; Bowen et al., 2011; Freemas et al., 2021; Lane et al., 2003). Commonly reported negative moods include worry, distraction, depressed mood, irritability, tearfulness, emotional, and reduced motivation (Freemas et al., 2021; Solli et al., 2020; Bruinvels et al., 2021). Negative mood states may be the result of higher levels of

progesterone in the luteal phase which enhances the activity of GABA, an inhibitory neurotransmitter (Gilfarb et al., 2022; Kapur et al., 2021). Furthermore, negative psychological symptoms may interfere with the motivation to participate in exercise (Hardy et al., 2021). In addition, negative mood and low motivation may accelerate the onset of exercise induced fatigue (Matta Mello Portugal et al., 2013) and reduce the ability to maintain exercise intensity (Sims et al., 2018). It is therefore suggested that exercise performance and participation may be reduced in the late luteal and menses phases due to these psychological factors (Freemas et al., 2021). However, research on MC-related psychological effects and exercise is still in its infancy and specific performance detriments are not yet well understood. Future research to understand how mood symptoms impact perceived and actual physical performance in exercising females is necessary.

## 2.3 Hormonal Contraception

Not all females have a natural MC and as many as 93% will use hormonal contraception (HC) in their lifetime (Philipson et al., 2011). HC is an umbrella term that refers to any type of exogenous hormones that alters endogenous endocrine function and prevents pregnancy (Rivera et al., 1999). Currently 43% of Australian women use HC (Skiba et al., 2019), with a similar proportion reported in recreational athletes (40%) (Armour et al., 2020). HC use is reported to be slightly higher in elite athletes at approximately 50-57% (Larsen et al., 2020; Martin et al., 2018; Nolan et al., 2022; Oxfeldt et al., 2020). HC are administered by a variety of different methods, with oral contraceptive pills (OCP) being the most used (64%), followed by long-acting reversible contraceptives (LARC) i.e., intrauterine devices, implantable rods, and injectable contraceptives (27%) (Skiba et al., 2019).

### 2.3.1 Hormonal Contraception and Exercise/Sport Performance

HC are not only used to prevent pregnancy but are also widely used to reduce negative MCS (Clarke et al., 2021; Martin et al., 2018). MCS are considered a burden and HC are often prescribed to ease symptoms and increase quality of life (Wong et al., 2009; Yonkers et al., 2008). Another benefit of HC is the ability to predict and manipulate menstrual bleeding date, especially if using the OCP (Martin et al., 2018). This is likely why HC use is higher in athletes as 67% of athletes using the OCP reported manipulating their menstruation date for convenience (Oxfeldt et al., 2020). The ability for athletes to skip their period if it will clash with a competition/game reduces the perceived burden/worry from MCS and therefore may aid in improved performance (Elliott-Sale et al., 2018). Other reported positive effects of HC include, "lighter flow", "feeling faster", and better skin (Parker et al., 2022).

Aside from the positive implications of HC, a growing body of literature highlights the potential negative side effects of HC use (Brown et al., 2021; Cabre et al., 2023; Clarke et al., 2021). Commonly reported side effects include, weight gain, water retention, headaches, tiredness/fatigue/lethargy, irritability, anxiety, and feeling excessively emotional, with the most common side effect being mood disturbances (Brown et al., 2021; Cabre et al., 2023; Heather et al., 2021; McNulty et al., 2023). It has been noted that exogenous oestrogen exhibits a greater affinity for oestrogen receptors and is significantly more powerful than endogenous oestrogen (Bennink, 2004), which may contribute to the aetiology of HC side effects. Despite this, the potential impacts of HC side effects on physical performance outcomes are not well researched. In Clarke et al. (2021), 41% of athletes had chosen to discontinue HC use at some point due to experiencing perceived negative side effects. However, this study did not investigate the specific aspects of performance which the athletes' believed were negatively impacted. Furthermore, several studies have investigated the prevalence of perceived side effects from

HC but not how females believe these impact their exercise/sport performance or participation (Armour et al., 2020; Clarke et al., 2021; Martin et al., 2018; Nolan et al., 2022). In one study, greater prevalence, and severity of symptoms in both NM females and those using OCP was associated with perceived negative training outcomes such as increased fatigue, decreased motivation, missing a session, and worse performance (McNulty et al., 2023). However, this study was limited to OCP users and did not include other forms of HC, therefore further research is warranted to analyse the effect of other forms of HC.

When looking at objective measures of performance, studies that involve low-dose, monophasic OCP show no impact on strength performance (Elliot et al., 2003; Sarwar et al., 1996) or endurance performance (Joyce et al., 2013; Myllyaho et al., 2021). Conversely, studies using triphasic OCP resulted in reduced endurance performance and increased fat mass, highlighting the importance of considering HC type and composition during analysis (Lebrun et al., 2003; Suh et al., 2003). As such, there is a need for future research to compare the impact of different formulations of OCP on exercise/sport performance.

A 2020 review which aimed to examine the effects of IUD use on exercise and athletic performance in females uncovered no studies which fit the inclusion criteria, highlighting the need for research in this area (Henderson et al., 2020). Existing studies have either investigated the effect of OCP on physical performance or the combined effect of all HC methods (Elliot-Sale et al., 2020; Heyward et al., 2022; Martin et al., 2018). From 1999 – 2017 self-reported IUD use in America increased by 0.81% per year, whilst OCP use decreased by 0.49% per year (King et al., 2021). With trends in increasing IUD use it is imperative that research explores the exclusive impact of this HC method on exercise/sport performance and participation.

On average, athletes using HC experience a lower prevalence of perceived symptoms than NM females (Martin et al., 2018; Nolan et al., 2022). However, recent research by McNulty et al.

(2023) found no difference in symptom prevalence and severity between NM females and those using HC. Athletes using OCP have been shown on average to experience less negative performance outcomes (i.e., fatigue, mood, concentration, power, match-play) than NM females (Heyward, et al., 2022). However, these results are exclusive to rugby union players using OCP. Additionally, research by Cabre et al., (2023) suggested that the benefits of HC for exercise performance outweighed the negative physiological side effects. In contrast, a meta-analysis by Elliot-Sale et al., (2020) concluded that OCP use may result in slightly inferior exercise performance on average when compared to non-HC users, which could be attributed to perceived negative side effects. However, most studies (87%) in this analysis were graded as moderate, low, or very low quality and any reductions in performance due to HC were inconclusive (Elliot-Sale et al., 2020). It is difficult to accurately compare studies that involve different forms of HC as their varying physiological effects may impact sport/exercise performance differently. Future studies should analyse HC methods separately to uncover their individual impacts on physical performance whilst comparing to NM females to determine differences from non-HC users.

## 2.4 Conclusion

Negative symptoms resulting from the MC or HC use are commonly reported and can be a detriment to female athletic performance, participation, and general wellbeing (Mauvais-Jarvis et al., 2013). Whilst there have been large advancements in the literature over the past decade, several gaps remain regarding the MC and its impact on physical performance (Doohan et al., 2023). Most research is in high performing athletes and limited to certain sports, therefore more studies are warranted in the general exercising female population and across a range of sport and exercise modes (Armour et al., 2020, Ergin et al., 2020, Findlay et al., 2020, Solli et al., 2020). Furthermore, most research on HC is exclusive to the OCP and as a result we know little

about the impact of other HC methods on sport/exercise performance (Henderson et al., 2020). It is imperative to investigate these gaps in the literature so that better menstrual health monitoring can occur, with the aim of ultimately improving female sport/exercise performance and wellbeing. Exercising females are currently not able to make an informed decisions about their athletic performance when choosing a HC method (Larsen et al., 2020). Understanding the impact of each different HC method on physical performance will add to the knowledge that clinicians and females can use to choose the best contraception for the individual. Furthermore, understanding MCS and HC symptomology will advance our understanding of barriers to exercise to ultimately aid in improving exercise participation in females.

# Chapter 3: Manuscript

## 3.0 Abstract

**Background:** Menstrual cycle symptoms (MCS), experienced by up to 93% of females, can negatively impact quality of life. Yet research investigating the impact these symptoms may have on exercise/sport performance is still in its infancy and is largely focused on the elite athletic population. Furthermore, many studies do not account for the fact that 43% - 57% of females do not have a natural menstrual cycle (MC) and are using hormonal contraception (HC). Further investigation is needed to examine the impact of the potential perceived negative effects associated with MCS and HC use on physical performance in exercising females.

**Objectives:** Identify and compare the prevalence and frequency of MCS in naturally menstruating (NM) females and females using HC. Identify and compare the perceived impact of MCS or HC side effects on exercise/sport performance and participation in NM females and females using HC.

**Methods:** 200 exercising females (age 26 ± 0) participated in this study. Participants completed an online questionnaire which was an amalgamation of four independent validated surveys, including, the International Physical Activity Questionnaire – short form (IPAQ) to asses physical activity levels, the Reproductive Status Questionnaire for Menstrual Cycle Studies to asses MC status, the STRAVA x FitrWomen Survey to evaluate prevalence and frequency of MCS and their effect on exercise/sport participation, and the Exercise and Menstruation in Australia Questionnaire to assess how MCS impact performance in training and competition. After data cleaning to remove incomplete responses, 182 participants were included in the final analysis. For each participant, total number, and frequency of MCS were added based on a Likert scale to receive a menstrual cycle index (MSi) score. Correlations were tested between

MSi and likelihood of missing exercise sessions and likelihood of reporting positive, neutral, or negative training outcomes.

**Results:** Participants were 54.4% NM and 45.6% HC users, with the oral contraceptive pill (OCP) being the most used (23.6%) form of HC. The most prevalent MCS for both groups were, changes in mood/increased irritability, bloating/increased gas, stomach cramps, cravings/increased appetite, and increased tiredness/fatigue. MSi score did not differ significantly between NM females and HC users ($p = 0.435$). MSi score was weak - moderately correlated to and increased likelihood of missing training in both NM females ($p < 0.001$, $r = -0.372$) and HC users ($p = 0.003$, $r = -0.322$). MSi score was also weak – moderately correlated to an increased likelihood of reporting negative training outcomes in NM females ($p = 0.002$, $r = -0.310$) but not HC users ($p = 0.296$, $r = -0.116$). NM participants were more likely ($P < 0.001$) to report negative training outcomes than HC users. Whereas HC users were more likely ($P < 0.001$) to report no changes to their training performance.

**Conclusion:** Results from this study demonstrate that MCS are very common in exercising females, with no difference in prevalence or frequency between NM females and HC users. The large prevalence of MCS and associations to negative training outcomes and missing training sessions would suggest greater education and awareness on managing and reducing the risk of MCS is imperative to improve the wellbeing and exercise performance of females.

## 3.1 Introduction

As many as 93% of females report experiencing negative physiological and psychological symptoms related to their menstrual cycle (MC) (Mauvais-Jarvis et al., 2013; Bruinvels et al., 2020; Findlay et al., 2020). Common menstrual cycle symptoms (MCS) include stomach cramps, lower back pain, gastrointestinal problems, tiredness/fatigue, poor mood, and

decreased motivation (Brown et al., 2021; Bruinvels et al., 2020; Clarke et al., 2021). MCS can hugely impact a female's quality of life, ranging from minor inconveniences to debilitating symptoms (Kaunitz, 2000). In recent studies, 50-84.6% of athletes reported negative training and competition outcomes due to MCS (Armour et al., 2020, Ergin et al., 2020, Findlay et al., 2020, Solli et al., 2020). Specifically, greater fatigue, decreased endurance, and reductions in strength, speed, and agility have been reported (Armour et al., 2020). Furthermore, females who experience a greater number and frequency of MCS are more likely to change/miss exercise training, miss a sporting event/competition, miss work/lectures, and report an increased need to use pain medication (Bruinvels et al., 2021). The highest number of MCS are reported to occur during menstrual bleeding (Carmichael et al., 2021) and most athletes report their worst fitness (47%) and performance (30%) during this phase of their cycle (Solli et al., 2020). Research in this area is currently limited to the athletic populations, therefore it is imperative to investigate the impact of MCS in general exercising females to improve their participation in sport and exercise and ultimately support the attainment of improved wellbeing.

Not all females are naturally menstruating and as many as 93% of women will use hormonal contraception (HC) within their lifetime (Philipson et al., 2011). Hormonal contraception is an umbrella term that refers to any type of exogenous hormones that alters endogenous endocrine function and prevents pregnancy (Rivera et al., 1999). In addition to its use as a contraceptive, HC may also be used due to its ability to reduce period pain, cramps, and bloating, and to predict and manipulate the commencement of menstrual bleeding date (Clarke et al., 2021; Martin et al., 2018). Currently 43.2% of (Australian) women use HC (Skiba et al., 2019), with a similar proportion reported in (Australian) recreational athletes (40%) (Armour et al., 2020). HC use is reported to be slightly higher in elite athletes at approximately 50-57% (Larsen et al., 2020; Martin et al., 2018; Nolan et al., 2022; Oxfeldt et al., 2020). This discrepancy in prevalence between elite athletes and the general population may be due to the importance elite

athletes place on the ability to manipulate their MC for the purposes of training/competition (Martin et al., 2018).

Aside from the positive implications HC can have on MCS, females frequently report perceived negative side effects from HC use including weight gain, fatigue/lethargy, mood swings, and depression/anxiety (Cabre et al., 2023; Clarke et al. 2021; Brown et al., 2021). However, reported side effects vary between different HC methods and between individual experiences (Larsen et al., 2020). In research by Clarke et al. (2021), 41% of athletes had chosen to discontinue HC use at some point due to perceived negative side effects. However, this study did not investigate whether athletes perceived their performance was negatively impacted. Similarly, several other studies have also investigated the reported side effects of HC in athletes, and none to date have detailed how the perceived side effects impact sports performance (Armour et al., 2020; Martin et al., 2018; Nolan et al., 2022). Recently McNulty et al. (2023) reported that greater prevalence and severity of symptoms in both NM females and those using OCP was associated with perceived negative training outcomes such as increased fatigue, decreased motivation, missing a session, and worse performance. However, this study was limited to OCP users, and currently very little research exists for other methods of HC (Henderson et al., 2020). Therefore, while using HC to manipulate cycles or mitigate negative MCS may be appealing to some females, the consequences of HC-perceived side effects on exercise and sport performance remains unclear (Elliott-Sale et al., 2018).

Interestingly, the research by McNulty et al. (2023) found no difference in symptom prevalence and severity between NM females and those using HC. Such results would align with those of Clarke et al. (2021), who found that the number of female football athletes that reported missing/altering training/competition due to MCS was similar in HC users (16%) and NM individuals (18%). In contrast, Nolan et al. (2022) found that in female powerlifters and rugby

players and HC users reported less MCS (40%) than their NM teammates (83.5%). However, it should be noted that these findings are exclusive to high-performing athletes, and as such the applicability of these findings to the general population of exercising and recreationally active females remains to be investigated.

Recreationally active and exercising females are underrepresented in the current research which investigates the impact MCS and HC side effects have on sport/exercise performance. The current study will therefore not only investigate how athletes perceive to be impacted but also how the general population of recreationally active females may perceive to be impacted by MCS and HC use. Current literature on HC side effects and sport/exercise performance has only analysed the effect of the OCP, therefore the current study intends to investigate the perceived impact of various HC methods on sport and exercise performance.

## 3.2 Methodology

This study was a cross-sectional study conducted in exercising females, including those recreationally active up to elite athletes. Data collection commenced in March 2023 and concluded in September 2023.

### 3.2.1 Participants and Recruitment

A purposive sampling strategy was used to reach the target population of exercising females. Recruitment took place through advertising on social media and through email contacts, utilising the networks of Dr Claire Badenhorst (supervisor), and Hannah Wilton. The study was promoted through the social media platforms of various tertiary education providers across New Zealand, women's fitness clubs, and the New Zealand Institute of Health and Fitness Hamilton (NZIHF).

Data was collected from participants via an online survey hosted on Qualtrics (Qualtrics, Seattle, Washington, United States of America). A link to the survey was provided when advertising and directed those interested to the study information sheet. After reading the information sheet, the individual was required to provide informed consent before proceeding with the survey.

Participants were included if they had the reproductive structures and hormones that would meet the classification of the biological sex female, aged 18 – 40 years, proficient in English, and provided sufficient details to compare exercise participation to the Ministry of Health (MOH) exercise guidelines of > 2 ½ hours of moderate or > 1 ¼ hours of vigorous planned exercise per week. Athletes (elite and age group) were also included in the study if they exceeded the MOH exercise guidelines. Participants were either NM (not using HC for more than 3 months) or using a form of HC at the time when the questionnaire was completed. The types of HC included in this study were oral contraceptive pills (OCP), hormonal intrauterine devices (IUD, Mirena), hormonal implants (Rods), contraceptive patches, contraceptive vaginal rings, and hormonal injections. Participants using a copper IUD were classified as NM as this is a non-hormonal contraceptive method. Participants were excluded if they were pregnant, breastfeeding (women breastfeeding and using HC were included), or post-menopause.

The current study received ethics approval by the Massey University Human Ethics Committee: Northern, Application NOR 22/53.

### 3.2.2 Study Design

The survey used in this study was an amalgamation of four previously used questionnaires to ensure that sufficient data was collected to answer the study objectives. The first was the

validated International Physical Activity Questionnaire – short form (IPAQ) (Craig et al., 2003), used in previous research to evaluate level of physical activity. The second was the Reproductive Status Questionnaire for Menstrual Cycle Studies, recommended for assessing the MC status of female participants and allows the MC to be studied in a standardized manner (Schmalenberger et al., 2021). The third was the STRAVA x FitrWomen Survey (Bruinvels et al., 2020), used in previous research to evaluate the prevalence and frequency of menstrual cycle symptoms and their effect on exercise/sport performance and participation. The fourth questionnaire was the Exercise and Menstruation in Australia Questionnaire (Armour et al., 2020), used in previous research to assess how MCS affected athletes' training and performance. Additional general demographic questions were included, including, age, weight, height, and ethnicity. The amalgamated survey was piloted on two females who met the inclusion criteria and minor amendments were made to improve the readability of the survey before data collection took place.

### 3.2.3 Statistical Analysis

Statistical analysis was carried out using IBM SPSS Statistics 29 for Windows (IBM Corporation, Armonk, NY, USA). All descriptive statistics are presented in Table 3.1 as mean ± standard deviation (SD). The prevalence and frequencies of each MCS are presented in Figure 3.1 for NM females and Figure 3.2 for HC users. Participants could select whether they experienced a MCS often, sometimes, rarely, or never. Frequencies are reported in the results as ‘often’ representing the most commonly experienced symptom and total representing the overall frequency of the reported symptom (determined from the amalgamation of often, sometimes, and rarely responses). To calculate MSi score for each participant, a Likert scale was used based on the reported frequency of each symptom; ‘often’ was given 3 points, ‘sometimes’ 2 points, ‘rarely’ 1 point and ‘never’ 0 points. The sum of the total points for each

participant was their MSi score. Independent samples t-tests were used to determine any differences in MSi scores between the NM and HC groups, copper IUD users and females without the copper IUD or HC, and between OCP and hormonal IUD users. Spearman's correlation coefficient was used to determine if MSi score was correlated to the likelihood of missing training/competition and the likelihood of reporting negative, positive or neutral training/competition outcomes. Interpretation of Spearman's correlation coefficient was based off guidelines from Akoglu., (2018). Chi Squared test was used to determine if the likelihood of reporting a negative/positive/neutral training outcome was more likely in NM females or HC users. Significance was determined at $p < 0.05$.

## 3.3 Results

### 3.3.1 Participant Characteristics

A total of 200 survey responses were received, of which 18 were excluded due to being incomplete, therefore, 182 participants were included in the final analysis. Table 3.1 summarises the characteristics of the participants. Sample size calculations indicated that 176 participants per group was necessary for this project to infer statistical significance, however, time constraints limited the ability to achieve this. The average age of participants was 26 ± 6 years, average height 168 ± 7 cm, and average weight 67 ± 11 kgs. In the NM group average age of menarche was 13 ± 2 years, average MC length was 29 ± 3 days, average menses length was 5 ± 1 days, and 14 (15.4%) were previously diagnosed with a gynaecological condition. HC use prevents the determination of a natural MC length and menses length, therefore data related to MC features was not collected for participants using HC. The majority of participants (n = 155, 93.9%) met or exceeded the MOH physical activity guidelines. Participants spent an average of 70 ± 56 minutes doing vigorous activity and an average of 69 ± 79 minutes of

moderate activity on days when physical activity participation was completed. Just over half of participants (N = 99, 58.9%) indicated they were a competitive athlete.

**Table 3.1: Summary of descriptive data**

| Descriptives | Contraception Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Natural | Copper IUD | Total Natural MC | OCP | Hormonal IUD | Injection | Implant | Total HC | Total |
| Participants (n, %) | 84, 46.2% | 15, 8.2% | 99, 54.4% | 43, 23.6% | 30, 16.4% | 7, 3.8% | 3, 1.6% | 83, 45.6% | 182 |
| Age (mean ± SD) years | 26 ± 6 | 26 ± 6 | 26 ± 6 | 24 ± 5 | 27 ± 7 | 23 ± 4 | 27 ± 5 | 25 ± 6 | 26 ± 6 |
| Weight (mean ± SD) kgs | 67 ± 12 | 67 ± 9 | 67 ± 12 | 66 ± 11 | 67 ± 9 | 67 ± 9 | 75 ± 7 | 67 ± 10 | 67 ± 11 |
| Height (mean ± SD) cm | 168 ± 7 | 168 ± 8 | 168 ± 7 | 167 ± 6 | 168 ± 5 | 161 ± 11 | 178 ± 2 | 167 ± 7 | 168 ± 7 |
| Age at Menarche (mean ± SD) years | 13 ± 2 | 13 ± 1 | 13 ± 2 | | | | | | 13 ± 2 |
| MC Length (mean ± SD) days | 29 ± 3 | 27 ± 2 | 29 ± 3 | | | | | | 29 ± 3 |
| Menses Length (mean ± SD) days | 5 ± 1 | 6 ± 1 | 5 ± 1 | | | | | | 5 ± 1 |
| Diagnosed with gynaecological condition (n, %) | 13, 16.7% | 1, 7.7% | 14, 15.4% | | | | | | 14, 15.4% |
| Meets PA Guidelines (n, %) | 72, 94.7% | 14, 93.3% | 86, 94.5% | 35, 94.6% | 25, 92.6% | 6, 85.7% | 3, 100% | 69, 93.2% | 155, 93.9% |
| Vigorous activity on active days (mean ± SD) minutes | 74 ± 65 | 66 ± 23 | 73 ± 61 | 58 ± 29 | 75 ± 69 | 68 ± 28 | 75 ± 32 | 66 ± 48 | 70 ± 56 |
| Moderate activity on active days (mean ± SD) minutes | 78 ± 99 | 78 ± 39 | 78 ± 92 | 66 ± 73 | 50 ± 32 | 49 ± 26 | 50 ± 14 | 58 ± 57 | 69 ± 79 |
| Recreationally Active (n, %) | 35, 37.2% | 8, 54.0% | 43, 39.8% | 22, 44.7% | 13, 37.0% | 2, 28.6% | 3, 100% | 40, 42.7% | 83, 41.1% |
| Competitive athlete (n, %) | 49, 62.8% | 7, 46.0% | 56, 60.2% | 21, 55.3% | 17, 63.0% | 5, 71.4% | 0, 0.0% | 43, 57.3% | 99, 58.9% |
| Athlete weekly training hours (n, %) | | | | | | | | | |
| 1-3 hours | 10, 28.8% | 3, 42.9% | 13, 23,6% | 9, 47.4% | 2, 13.3% | 3, 60.0% | 0, 0.0% | 14, 35.9% | 27, 28.7% |
| 4-7 hours | 9, 18.8% | 2, 28.6% | 11, 20.0% | 6, 31.6% | 6, 40.0% | 1, 20.0% | 0, 0.0% | 13, 33.3% | 24, 25.5% |
| 8-12 hours | 20, 41.7% | 0, 0.0% | 20, 36.4% | 2, 10.5% | 3, 20.0% | 1, 20.0% | 0, 0.0% | 6, 15.4% | 26, 27.7% |
| 12-19 hours | 6, 12.5% | 2, 28.6% | 8, 14.5% | 2, 10.5% | 3, 20.0% | 0, 0.0% | 0, 0.0% | 5, 12.8% | 13, 13.8% |
| 20 + hours | 3, 6.3% | 0, 0.0% | 3, 5.5% | 0, 0.0% | 1, 6.7% | 0, 0.0% | 0, 0.0% | 1, 2.6% | 4, 4.3% |

### 3.3.2 Prevalence and Frequency of Menstrual Cycle Symptoms

Figure 3.1 displays the type and frequency of MCS in the NM group and Figure 3.2 displays the type and frequency of MCS in the HC group. The most commonly reported symptom (at all frequencies) for NM females was stomach cramps (97%), whereas for HC users the most common symptom was both stomach cramps (98%) and changes in mood/irritability (98%). The symptom that was experienced 'often' for NM females was mood/increased irritability (54.5%), whereas for HC users it was again both stomach cramps (47.5%) and changes in mood/irritability (47.5%).

Overall, the prevalence and frequencies of reported MCS were very similar in NM females and HC users, with the top five most common MCS the same for both NM females and HC users. However, a few symptoms were reported at a greater frequency in the NM group. Of note though, the percentage of females experiencing stomach cramps and increased tiredness/fatigue were comparable in both NM females and HC users. The symptoms "changes in mood/increased irritability", "bloating/increased gas", and "cravings/increased appetite" were all reported to be experienced more frequently in NM than HC users.

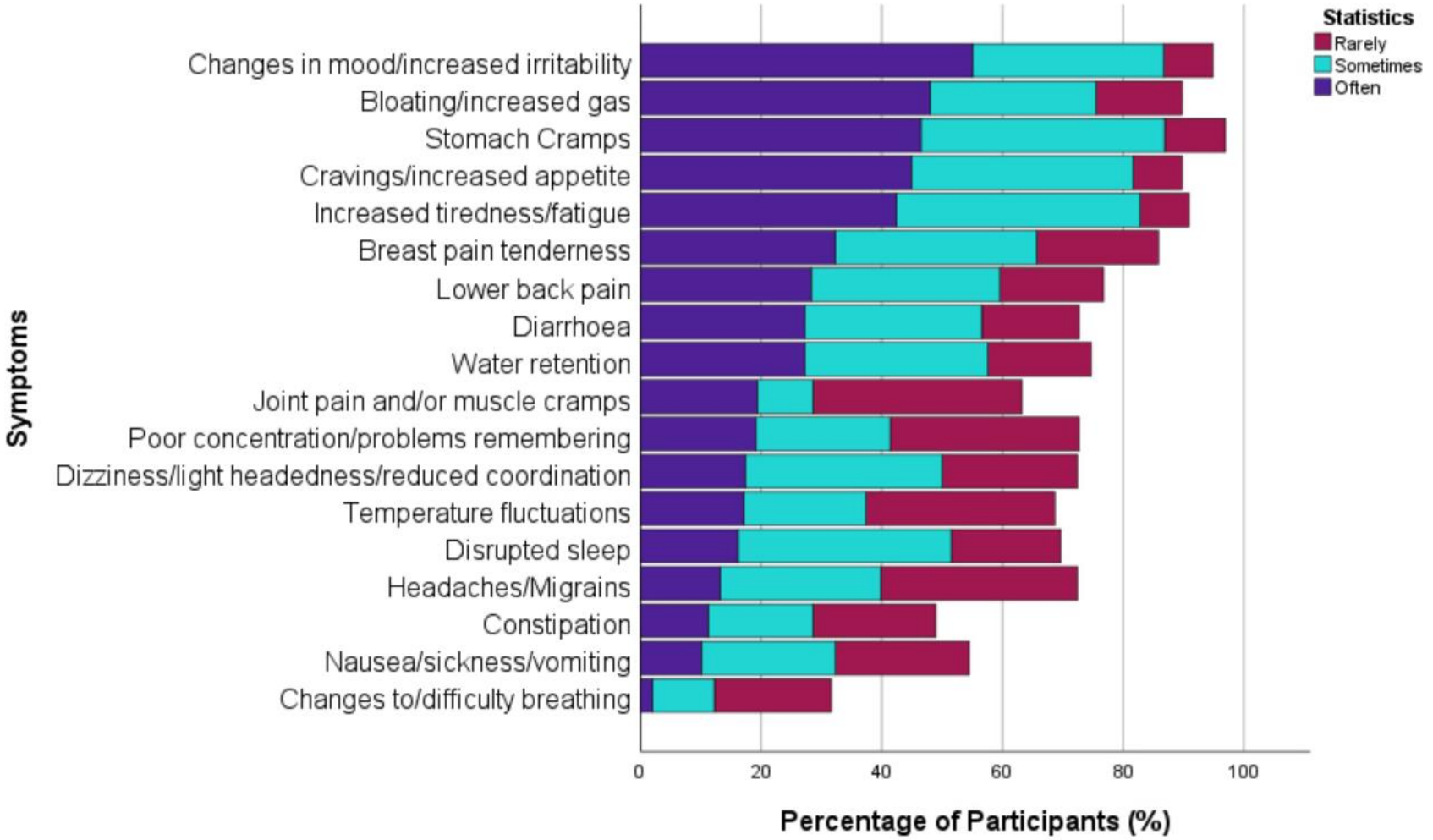


***Figure 3.1:*** *Stacked bar chart of the menstrual cycle symptoms experienced by exercising women who are naturally menstruating (n = 99) and the frequency of occurrence of symptoms.*

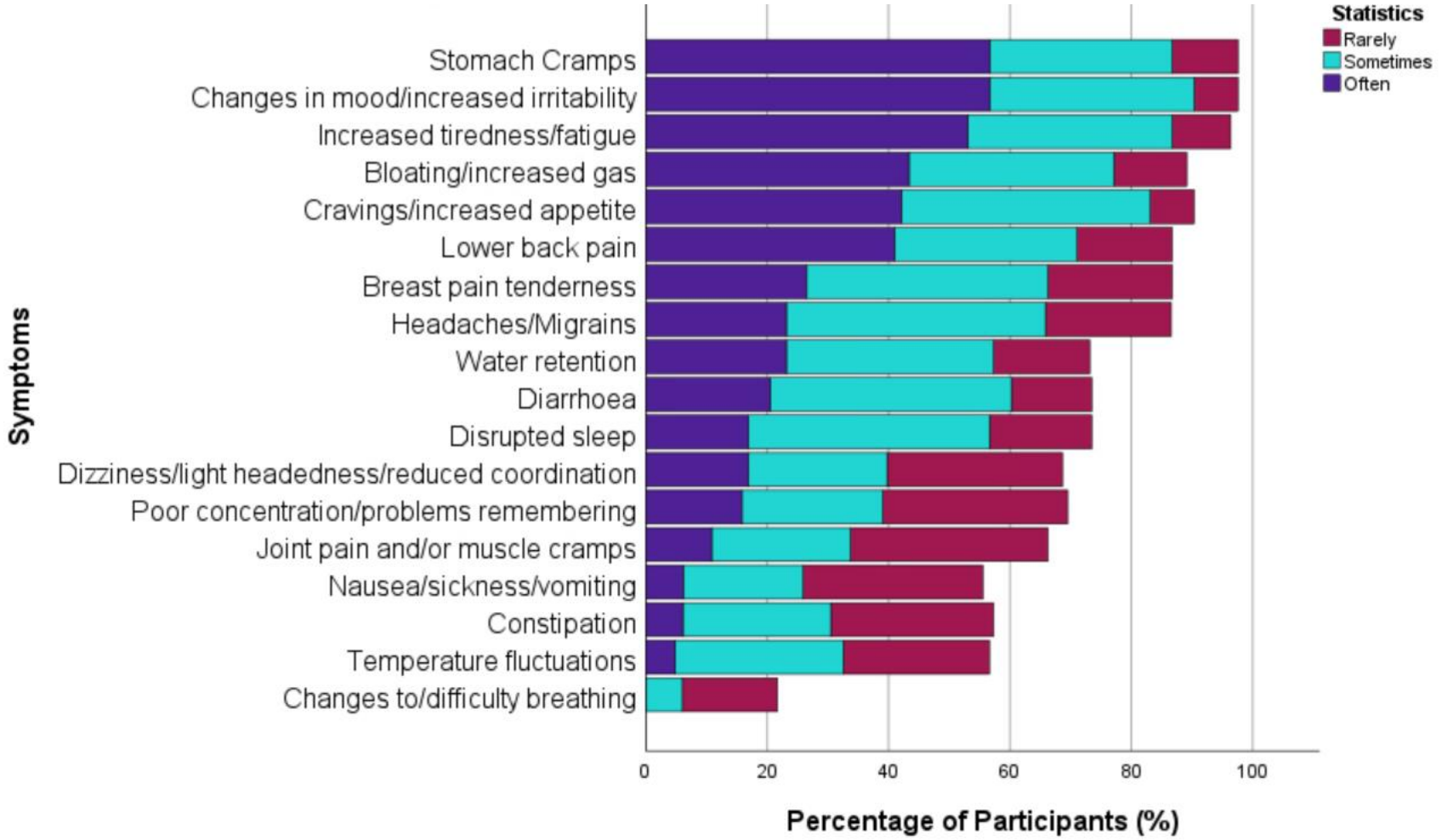


***Figure 3.2:*** *Stacked bar chart of the menstrual cycle symptoms experienced by exercising women taking hormonal contraception (n = 83) and the frequency of occurrence of symptoms.*

### 3.3.3 Menstrual Cycle Index and Association to Training Outcomes

Table 3.2 presents the MSi scores of participants by menstrual cycle status and contraception method. There was no significant difference between NM females and HC users ($p = 0.435$). When subcategories of NM females and HC type were identified, there was no significant differences in MSi score between NM and copper IUD groups ($p = 0.196$), or OCP and hormonal IUD groups ($p = 0.372$).

**Table 3.2:** MSi scores and contraception method of participants

| | | **MSi Score** |
|---|---|---|
| **Contraception Method** | Natural | 28 ± 1 |
| | Copper IUD | 30 ± 2 |
| | Total Natural MC | 28 ± 1 |
| | OCP | 27 ± 1 |
| | Hormonal IUD | 31 ± 2 |
| | Injection | 25 ± 4 |
| | Implant | 28 ± 1 |
| | Total HC | 28 ± 1 |
| | Total | 28 ± 1 |

In the NM participants a weak – moderate ($r = - 0.372$), yet significant ($p < 0.001$) correlation was found between MSi score and increased likelihood of missing a training session. This weak – moderate correlation between MSi and increased likelihood of missing training was also observed in the HC users ($r = -0.322$, $p = 0.003$).

In the NM participants a significant ($p = 0.002$) weak – moderate ($r = - 0.310$) correlation was found between MSi score and the likelihood of reporting negative training outcomes. However, in the HC users no significant correlation was found ($P = 0.296$, $r = -0.116$).

### 3.3.4 Perceived Impact of Menstrual Cycle Symptoms or Hormonal Contraception on Training Outcomes

NM participants were significantly more likely ($p < 0.001$) to report that their training was negatively impacted by their MC compared to HC users. Participants using HC were significantly more likely ($p < 0.001$) to report that their HC made no difference to their training compared to NM participants. There was no significant difference in the likelihood of HC use or MC in the reporting of positive training outcomes between groups.

Reported negative training outcomes from NM females are presented Figure 3.3 and reported negative training outcomes from HC users are presented in Figure 3.4. The top three types of negative impacts on performance were the same for NM females and HC users, however at greatly different percentages. It was much more common for NM females to report adverse impacts on their energy levels from their MC compared to HC users (48.5% and 12% respectively). Similarly, NM females reported that they "fatigue more easily/my endurance is less" more commonly than HC users (45.5% and 12% respectively). Finally, it was also more common for NM females to report feeling "not as strong/can't lift as much weight" compared to HC users (37.4% and 10.8% respectively).

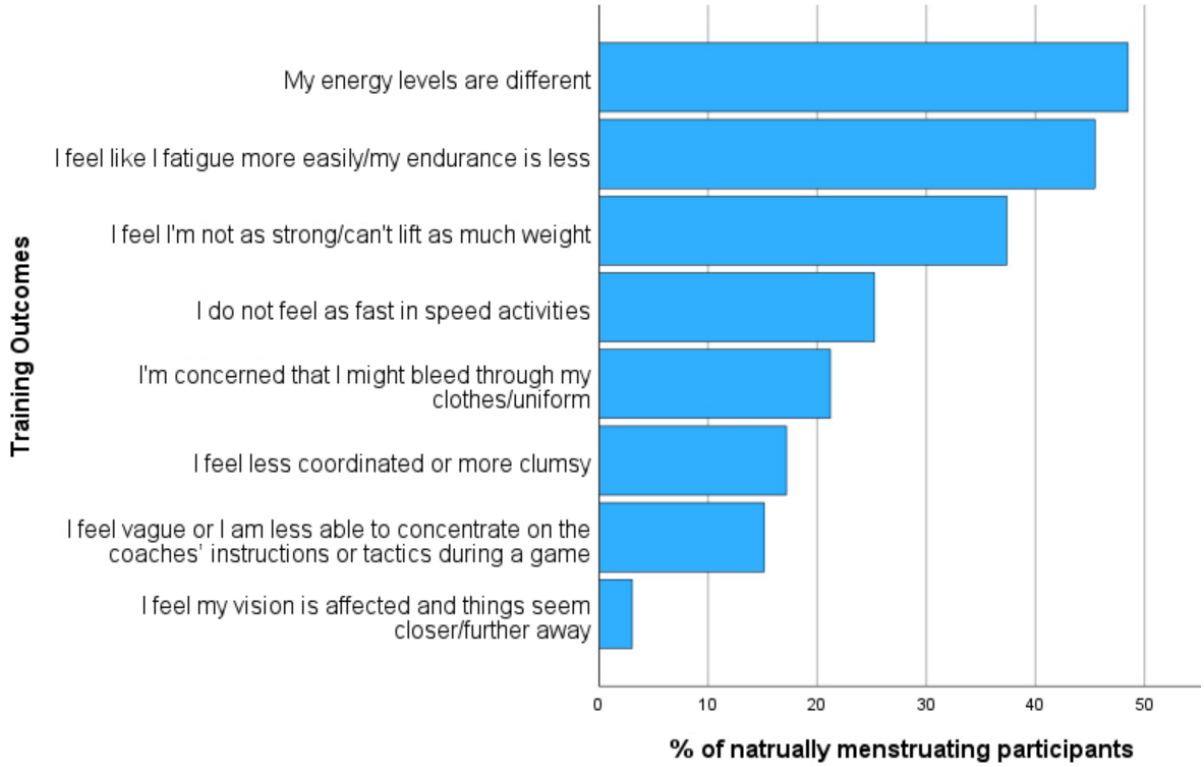


***Figure 3.3:*** *Bar chart of reported negative training outcomes from the menstrual cycle in naturally menstruating exercising females (n = 99).*

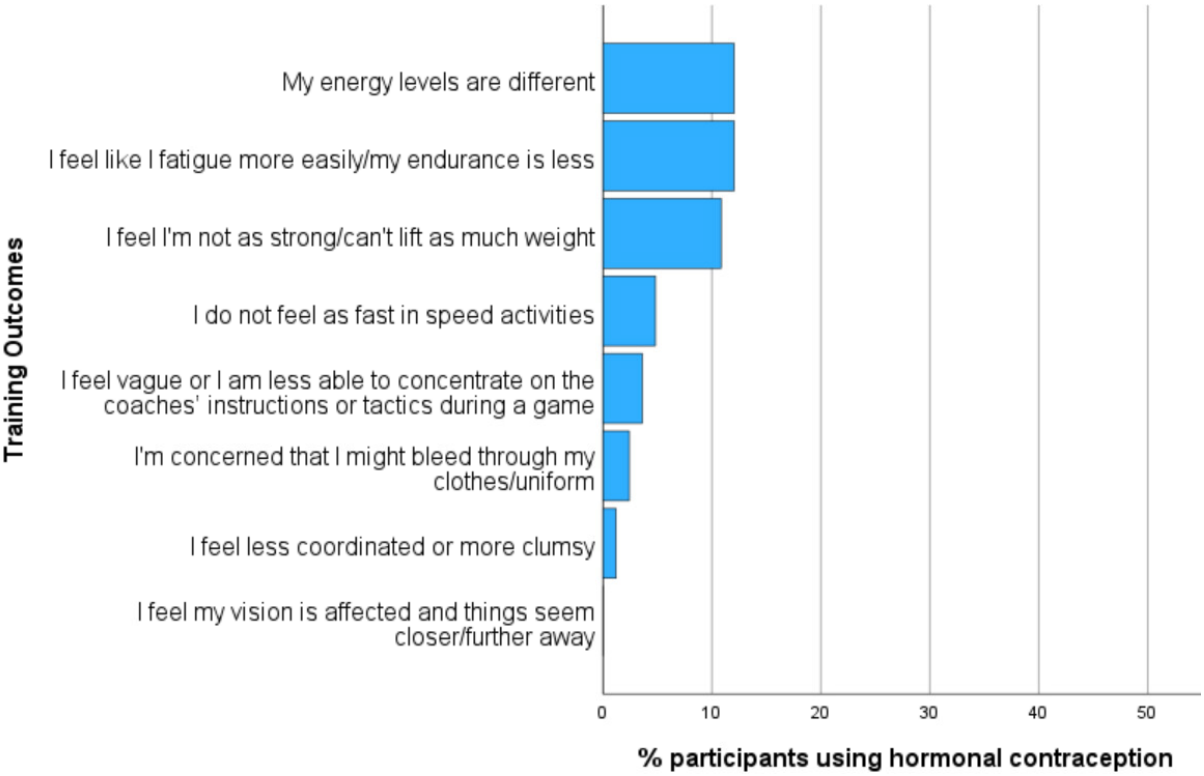


***Figure 3.4:*** *Bar chart of reported negative training outcomes from the menstrual cycle in exercising females using hormonal contraception (n = 83)*

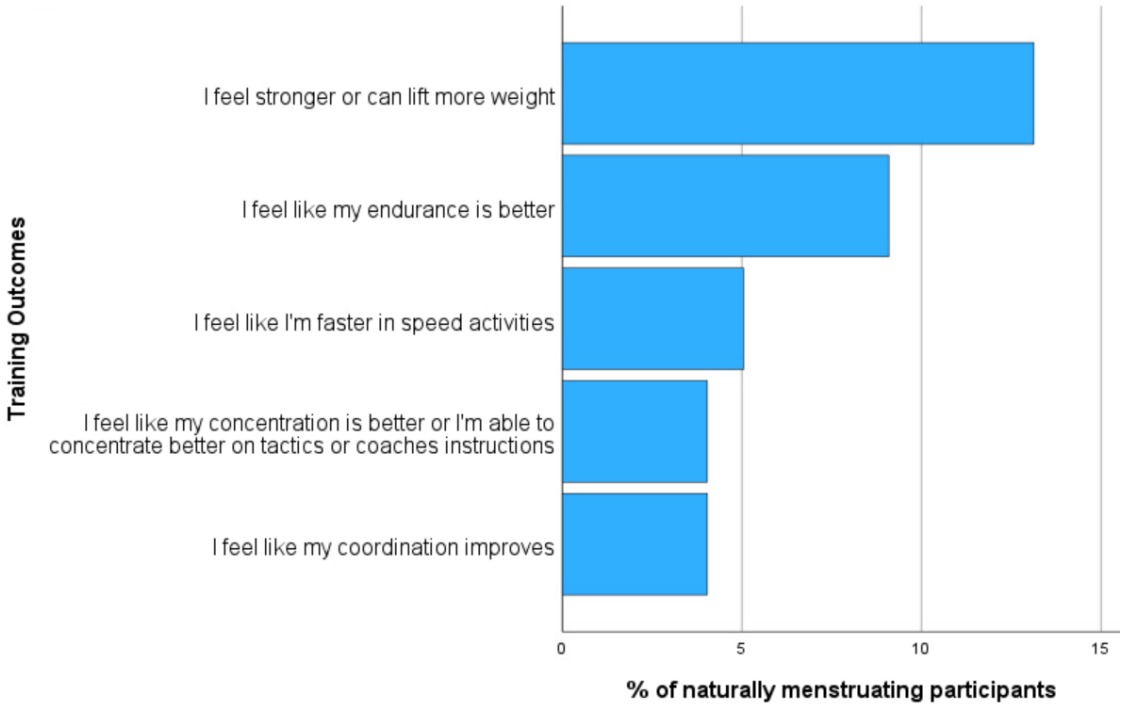


***Figure 3.5:*** *Bar chart of reported positive training outcomes from the menstrual cycle in naturally menstruating exercising females (n = 99)*

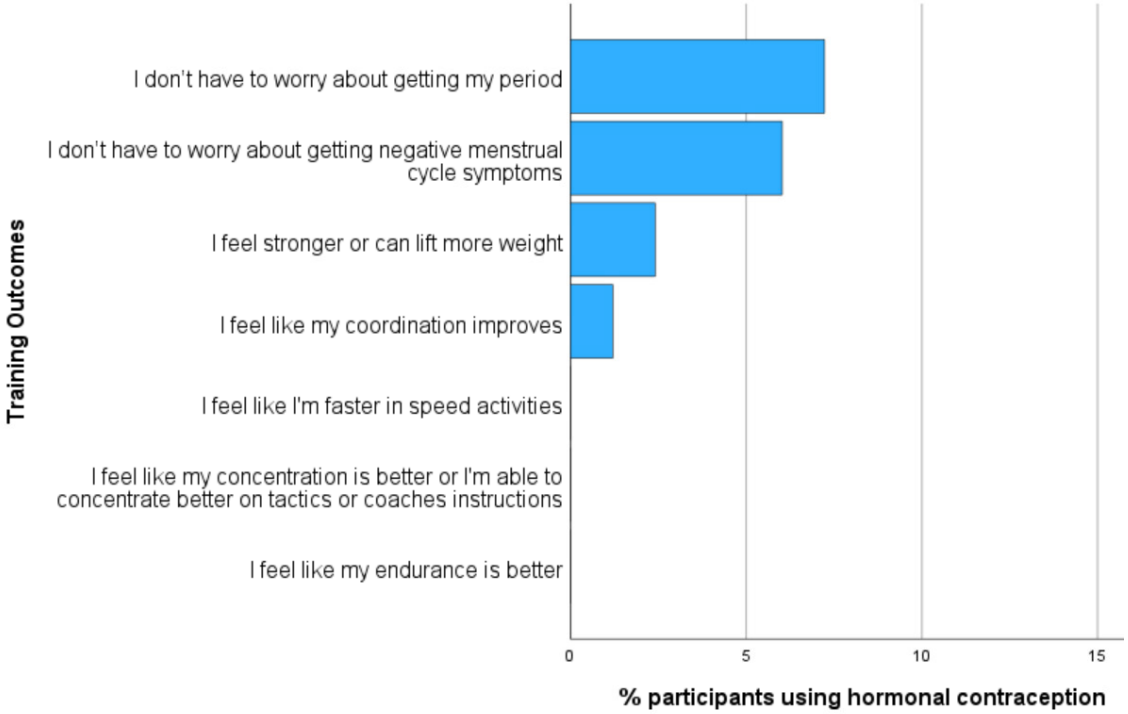


***Figure 3.6:*** *Bar chart of reported positive training outcomes from hormonal contraception in exercising females (n = 83)*

## 3.4 Discussion

The purpose of this study was to identify and compare the type and prevalence of MCS in NM females and HC users and their perceived impact on exercise participation and performance. Results demonstrated that a large proportion of exercising females experience MCS. However, there was no significant difference in the overall prevalence and frequency of MCS between NM females and HC users. Experiencing a greater number and frequency of MCS was associated with an increased likelihood of missing an exercise session (all participants) and reporting negative training outcomes (NM females only). In the current study 46% of participants were using HC which is similar to previous reports which has suggested HC use in the active female population may range from 40% - 57% (Armour et al., 2020; Larsen et al., 2020; Martin et al., 2018; Nolan et al., 2022; Oxfeldt et al., 2020; Skiba et al., 2019). The current study is one of the first to use the MSi tool to compare MCS in NM females and various types of HC users.

### 3.4.1 Prevalence and Frequency of Menstrual Cycle Symptoms in Exercising Females

Results found that 89% of participants reported experiencing at least one MCS 'often' which was similar to the 81% reported in Bruinvels et al. (2021), although their study didn't include HC users. The average MSi score within the current study (28) is higher than previously reported (22.9) (Bruinvels et al., 2021). An outcome that may be due to the lower sample size of the present study in comparison to the previous research. However, the results do align with previous studies where 77% - 93% of participants reported experiencing MCS to some degree (Doohan et al., 2023; Findlay et al., 2020; Martin et al., 2018). Previous research has been exclusive to mostly elite athletes (Ergin et al., 2020; Findlay et al., 2020; Solli et al., 2020) or the general exercising female (Bruinvels et al., 2021; McNulty et al., 2023;), whereas the

current study included all active females from general exercisers to elite athletes, including recreational athletes which have been largely misrepresented in the literature. A recreational athlete may have a small training load or a training load similar to that of a competitive athlete, therefore including all active females and analysing data with respect to training hours is more representative of the female population as a whole. Our findings contribute to the growing body of literature that suggests an alarming number of recreationally active and athletic females are experiencing MCS.

When comparing NM participants to the HC users, MSi scores were not significantly different. When further broken down into sub-categories of HC type there were also no significant differences in MSi. This aligns with findings from McNulty et al. (2023), which found no difference in MSi score between NM females and OCP users. Clarke et al. (2021) also noted that symptom prevalence did not significantly differ between NM females and HC users. In contrast, Heyward et al. (2022) found that NM females reported a significantly greater frequency of back pain, nausea, and sore breasts compared to OCP users. The current study was not exclusive to OCP users as in Heyward et al. (2022) and McNulty et al. (2023), and instead included four methods of HC in the final analysis. Our study was also the first to compare the prevalence and frequency of MCS between different HC methods with results suggesting that no method was superior in reducing MCS. Although, sample size was much lower for the less common HC methods, thus future research should address this by recruiting adequate sample sizes for each HC group. The current body of research regarding MCS and HC use is mostly limited to OCP users as this is currently the most utilised form of HC (Skiba et al., 2019). However, with increasing rates of females using other HC methods such as the IUD (King et al., 2021), our results are an important addition to the literature.

The similarities in MCS between NM females and HC users may raise questions about the efficacy of using HC with the sole intention of reducing MCS. A previously reported reason on why females choose to use HC is for their ability to reduce MCS (Clarke et al., 2021). However, as the current study has demonstrated, females are experiencing a similar prevalence and frequency of MCS regardless of whether they use HC or not. Although, it is important to note that the current study did not collect data on the intensity of MCS which is a key factor in the level of impact they have on daily activities.

The MC is a vital sign of health (Harber., 2011) where the presence of negative MCS and irregular cycles may indicate issues such as low energy availability (LEA) and hormonal dysfunctions (Heikura et al., 2022). Attempting to resolve symptoms through HC use without addressing potential underlying causes may prolong health issues and manifest into even more problematic symptoms in the future (Beddig et al., 2019). Proposed mechanisms for MCS include hormonal changes (Schneider-Thoma et al., 2019), overproduction of prostaglandins (Guo et al., 2013), inflammation (Puder et al., 2006), and deficits in serotonergic and GABA systems (Yonkers et al., 2018). Risk factors for these physiological changes which may be at the root of MCS include, psychological stress, poor sleep quality, high body mass index (BMI), and poor diet and lifestyle habits (Grady-Weliky, 2003; Karaman, 2012). With results suggesting no difference in MCS prevalence and frequency between HC users and NM individuals, education may be warranted for females to understand interactions between their MCS and health, and the necessary action steps for improvement regardless of whether or not they use HC.

### 3.4.2 Impact of Menstrual Cycle Symptoms and Hormonal Contraception Side Effects on Exercise Participation and Performance

A higher MSi score was associated with a greater likelihood of missing training in both NM females and HC users. This result aligns with findings from Bruinvels et al., (2021). Similarly, Kolić et al. (2021) found that avoidance of exercise due to MCS was associated with longer periods, heavier menstrual flow, and higher levels of pain and fatigue compared to females who didn't avoid exercise due to MCS. Although, it should be noted that this previous analysis focused on intensity of symptoms which the current study did not include. Both previous studies were only completed in NM females whereas, the current study included HC users. The current results add to the gap in the literature highlighting that not only NM females, but HC users may also have a greater likelihood of missing training if they have a greater prevalence and frequency of MCS.

A stronger association between MCS and exercise participation may have been found if data on symptom intensity was collected, however the current MSi score tool only accounted for prevalence and frequency. Intensity of symptoms is likely a key influencing factor in missing an exercise session. In research by Orhan et al., (2018) a higher intensity of menstrual pain was associated with greater negative impacts on academic performance and exercise participation. It is apparent that females could experience the same type and prevalence of MCS, while experiencing largely different intensities and discomfort, and therefore perceive greatly different impacts on their daily exercise and daily activities. This highlights the large difference in how females experience MCS and the importance of gathering the right information when assessing female menstrual health and perceptions. Previous research noted that daily symptom monitoring may be an effective way to accurately monitor symptoms and provide solutions better tailored to the individual (McNulty et al., 2023). This may be practical in an elite athlete

setting where females have access to a team of health professionals that can provide tailored advice, but this resource may not be readily available to the recreationally active or exercising individual. In the absence of increased access to health care support, real time tracking of MCS to identify key time points and daily impacts may be valuable for an individual to share with medical professionals at a later date.

A higher MSi score was associated with a greater likelihood of reporting negative training outcomes in NM females but not in HC users. This is similar for NM females yet different for HC users in previous research which found greater MCS frequency and severity was associated with a perceived reduction in exercise performance in NM females and OCP users (McNulty et al., 2023). The previous study only included OCP as opposed to the four different HC methods analysed in the present study. Regardless the results suggest that prevalence and frequency of MCS is associated with negative training outcomes in NM females but not HC users. The current study did not collect data on symptom intensity, and HC is likely to reduce the intensity of MCS which provides a possible reasoning as to why prevalence and frequency did not impact training outcomes in HC users. Our results add to the limited body of literature of MCS and perceived impact on exercise performance. Subsequently, these results cumulatively raise the importance for the need for research and greater awareness around lifestyle habits and interventions which may mitigate the perceived adverse impact of MCS on exercise and daily living (Hashim et al., 2019).

It is interesting that even though both NM and HC groups experienced a very similar prevalence and frequency of MCS, NM participants were more likely ($P < 0.001$) to report negative training outcomes from MCS compared to HC users. These differences may be due to differences in intensity of MCS experienced, as suggested by previous research (Orhan et al., 2018) and would result in more negative exercise outcomes in NM females. Therefore, MCS

intensity as well as frequency of negative training outcomes should be explored in future research. Observed differences in the reporting of negative outcomes may also be attributed to societal perceptions of the MC, where it is widely seen and reported to be a burden (Stubbs, 2008). This typical sociocultural negative view of the MC may have impacted participants reports when asked about the impact exercise performance and should be considered in future studies.

From the results, most females using HC perceived their HC to have a positive (12%) or neutral impact (73.5%) on their exercise performance. The most common positive training outcomes reported by HC users were "I don't have to worry about getting my period" and "I don't have to worry about getting negative menstrual cycle symptoms". This aligns with previous research where commonly reported reasons for HC use were to reduce the perceived negative impacts of the MC (Clarke et al., 2021). From these results it may appear that HC users experience less performance detriments, however, it is noted that perceived performance and objective performance can differ greatly depending on the mindset of the individual (Lourenço et al., 2022). Sociocultural perceptions of the MC and HC may be the primary factor in determining ones' perceived impact on their exercise performance and as such should be considered in future research.

## 3.5 Conclusion

In conclusion, the majority of exercising females experience MCS, and 89% experience at least one MCS 'often". Prevalence and frequency of MCS do not significantly differ between NM females and HC users. A higher MSi score was associated with a greater likelihood of missing training in both NM females and HC users. A higher MSi score was associated with a greater likelihood of reporting negative training outcomes, but only in NM females. NM females were more likely to report negative training outcomes and HC users were more likely to report

neutral training outcomes. From the results it is clear that MCS negatively impact the participation and performance of exercising females and highlights the need for greater awareness around symptom management and prevention. Future research should analyse intensity of MCS and investigate objective measures of performance in comparison to perceived performance.

# Chapter 4: Conclusion

## 4.1 Achievement of Aims and Hypotheses

The overall aim of the research was to determine the type and frequency of menstrual cycle symptoms (MCS) experienced by exercising females and their perceived impact on exercise participation and performance, whilst also investigating any differences between NM females and HC users.

A large proportion of exercising females reported experiencing MCS suggesting that this continues to be a significant health issue within the female population. The overall prevalence and frequency of MCS was not significantly different between NM females and HC users. Despite these similarities in experienced symptoms, NM females were significantly more likely to report negative training outcomes compared to HC users. Greater prevalence and frequency of MCS was associated with being more likely to miss an exercise training session. Greater prevalence and frequency of MCS was also associated with being more likely to report negative training outcomes in NM females but not in HC users.

Menstrual cycle symptoms were highly prevalent and frequently experienced in exercising females, with a large number of participants (89%) experiencing at least one MCS ‘often’. This

reinforces the current body of literature which suggests 77% - 93% of exercising females (recreational to elite) experience MCS at any frequency (Bruinvels et al., 2021; Doohan et al., 2023; Findlay et al., 2020; Martin et al., 2018). Further awareness and education may be necessary for exercising females to learn how they can reduce the perceived negative impacts of MCS.

It was hypothesised that NM females would report a greater frequency of MCS compared to HC users. It was initially expected that HC users would experience less frequent MCS because of a common societal perception of HC's being able to minimise the prevalence of MCS (Clarke et al., 2021). However, results revealed no significant difference in the overall prevalence and frequency of MCS in NM females and HC users. A similar result was previously observed in McNulty et al. (2023) where the frequency and severity of MCS did not significantly differ between exercising NM females and OCP users. The current study adds to this body of literature and confirms that these results also exist in users of different methods of HC not just the OCP. Previous research has identified that risk factors for MCS include, psychological stress, poor sleep quality, high body mass index (BMI), and poor diet and lifestyle habits (Grady-Weliky, 2003; Karaman, 2012). It is possible that these risk factors have a greater influence on the prevalence and frequency of MCS than HC use, however, this was not considered as part of this investigation.

Overall MCS were observed to have a negative impact on perceived sport/exercise performance. Greater prevalence and frequency of MCS was associated with an increased likelihood of missing an exercise training session in both NM females and HC users. Greater prevalence and frequency of MCS was also associated with being more likely to report negative training outcomes in NM females but not in HC users. It is unclear why the prevalence and frequency of MCS were not associated with reporting negative training outcomes in HC users.

Future research should analyse the intensity of symptoms and the sociocultural perceptions that participants hold of the MC and HC to see if these are contributing factors to how individuals perceive them to impact their participation and performance in sport and exercise.

Results from our study indicate that NM females perceived their MCS to have a greater negative impact on their exercise/sport performance than HC users, supporting our initial hypothesis. Despite similarities in the prevalence and frequency of MCS, we observed that NM females were significantly more likely to report negative training outcomes than HC users. This is possibly due to potential differences in the intensity of MCS between NM females and HC users. Previous research has noted that a higher intensity of menstrual pain is more likely to be associated with greater negative impacts on academic performance and exercise participation (Orhan et al., 2018). Future research should investigate the intensity of MCS along with frequency to gain a greater understanding of potential differences between NM females and HC users and whether this is a predictor of perceived negative impacts on sport and exercise performance.

Our final hypothesis was that HC users would report equally positive and negative impacts on sport/exercise from their HC. This was not true as most HC users did not report negative outcomes and instead, the majority reported positive (12%) or neutral impacts (74%) on their exercise performance. A possible influencing factor when reporting training outcomes may be the impact of the typical sociocultural negative view of the MC and the typical positive view of HC as an effective method of alleviating MCS. Personal beliefs around the MC and HC should also be investigated in future research to see if they correlate to perceptions of performance outcomes when MCS are present.

## 4.2 Strengths

To the best of our knowledge, this is the first study to investigate the prevalence and frequency of MCS using the MSi tool in NM females and a range of different HC users (not only OCP users).

A strength of this study is the inclusion of four different HC methods in the analysis, where most previous research was exclusive to OCP users. This is particularly important due to increasing rates of IUD use in the United States of America, therefore similar to our study future research may need to consider other HC types to ensure results and outcomes support a greater proportion of females (King et al., 2021). Furthermore, we were able to compare the MCS experienced between HC methods which is an analysis that is currently limited in the literature and provides some preliminary results for future research investigations.

Another strength of this study was the inclusion of all different levels of exercising females from recreational exercisers to athletic females. The majority of previous research in the space has focused on elite athletes whereas athletic females and recreational athletes have been largely underrepresented in the literature. Elite athletes, although important are only a minority of the population and findings cannot always be transferred to the general exercising public. Therefore, the current study provides insight into the impact of MCS for all levels of active females.

A final strength of this study was the utilisation of an online questionnaire for data collection. The online format reduces physical and logistical barriers to participation therefore increasing the likelihood of participation and aiding in the recruitment of a larger sample size. Participants were able to complete the questionnaire in a place of their choosing and on a personal device, methods that support the reduction of any perceived stigma or judgement and increase the

likelihood of truthful answers. Furthermore, online questionnaires allow for a wide geographical reach which allows results to represent a greater proportion of the population.

## 4.3 Limitations

Several limitations are associated with using an online survey for data collection. Firstly, we were only able to receive just over half (57%) of our target sample size in time for analysis. This impacts the validity of the findings when applying them to the entire population of exercising females in New Zealand and other westernised countries. Secondly, self-selection bias may contribute to individuals participating in the study more readily when it is a topic of interest. Therefore, females who have a greater interest or awareness of MCS in the MC and HC would have been more likely to participate in the study. It is possible that females who participated in the study may have previously or recently experienced a greater number of MCS and HC side effects themselves, whilst females who do not experience symptoms may have been less interested in participating in the study. This could have slightly skewed results in the direction of a greater proportion of females experiencing MCS or HC side effects and negative outcomes. Lastly, data may be subject to recall bias due to the questionnaire being retrospective and self-reported. Because participants had to rely on memory when reporting symptoms and experiences this allows for potential inaccuracies in data collection, therefore results should be interpreted with caution.

Another significant limitation of this study was that it did not account for which phase of the MC participants were in whilst reporting. It is known that females experience the greatest frequency and severity of symptoms during their menstrual phase (McNulty et al., 2023). Therefore, the phase that participants were in at the time of completing the questionnaire could have influenced their responses. If participants were in their menstrual phase (or just after) at the time of reporting this would have allowed their responses to be more accurate compared to

if they were in their late follicular or mid-luteal phases. However, the MC phase may have been difficult data to gather as MC knowledge is low in a large proportion of females therefore, many participants may not have been able to report which phase they were in (Larson et al., 2020; Szűcs et al., 2017).

A final limitation of this study was that the questionnaire and MSi tool used did not account for MCS severity/intensity. Collecting data on symptom intensity may have aided in analysis when investigating why NM females were more likely to report negative training outcomes despite both groups having a similar prevalence and frequency of symptoms. A possible reason for NM females reporting greater negative training outcomes may have been due to experiencing a greater intensity of MCS, even though prevalence and frequency were the same as HC users.

## 4.4 Recommendations and Future Directions for Research

Given the high proportion of exercising females experiencing MCS, it is evident that it is still a prevalent issue that has the potential to negatively impact exercise participation and performance and therefore the wellness of females in New Zealand and globally.

- To gain more accurate data, future research should have participants report symptoms in real-time over the duration of their cycle, rather than retrospectively. This will eliminate recall bias and allow for a more accurate analysis representing exactly when symptoms are occurring.
- Understanding differences between HC methods with regards to MCS and the impact on exercise will aid females when choosing a HC method that best suits them. Future research should recruit adequate sample sizes for each HC method to accurately compare MCS and the impacts on exercise.

- Future research should collect data on symptom intensity/severity. This will allow the full magnitude of MCS to be observed and will aid a better understanding of the perceived impact on exercise participation and performance.
- Future research should compare data on subjective and objective measures of performance when assessing the impact of MCS. As perceived performance is not always representative of actual physical performance.
- Future research should gather data on participants' sociocultural views of the MC and HC as this is a potential influencing factor when reporting on the impact that MCS have on exercise performance.
- Ethnicity, cultural, and social factors influence the MCS which females experience. Understanding this influence better could help identify unique barriers for a broader range of exercising females, therefore this should be a consideration for future research.
- Healthcare professionals should encourage patients to complete real-time tracking of MCS so that treatment and interventions can be better tailored to the individual.
- The Ministry of Health New Zealand should implement schemes to promote awareness of the potential for MCS to impact quality of life. In addition, improved education should be provided around the risk factors for MCS and actionable lifestyle changes females can make to improve symptoms regardless of NM or HC use.

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# Appendices

## Appendix A: Participant Information Sheet and Questionnaire

# The menstrual cycle, hormonal contraception, and exercise performance

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Start of Block: Block 1

Information Sheet

**The menstrual cycle, hormonal contraception, and exercise performance: Invitation to participate**

We would like to invite you to participate in this research project which will be conducted as part of the requirements to complete a Master of Health Science degree. This project will be asking you about your menstrual cycle or hormonal contraception, and if you feel that it impacts your exercise and sport performance.

Please read the information sheet before deciding if you would like to participate.

For more information, please contact the lead researcher
Hannah Wilton
Master of Health Science Student
School of Sport, Exercise, and Nutrition
College of Health
Massey University
**Email:** [redacted]

**Why are we doing this research?**

Many females experience menstrual cycle symptoms which they feel affects their ability to participate in and perform well during exercise/sport. Some symptoms females may experience include, abdominal pain/cramps, headaches/migraines, lower back pain, joint pain, increased tiredness/fatigue, changes in mood, bloating, breast tenderness etc. In females who use hormonal contraception, commonly reported symptoms include headaches, feeling emotionally flat, or excessively emotional. According to research, the more menstrual cycle symptoms a female experiences the more likely she is to change or miss her exercise session or sport training/competition. The goal of this study is to investigate how menstrual cycle symptoms, or hormonal contraception impacts exercise/sport performance and participation in females. Having a better understanding of the menstrual cycle or hormonal contraceptive symptoms will help females,

coaches, and practitioners better monitor their symptoms and improve exercise/sport performance and participation.

**Who are we looking for?**

- Healthy females between the ages of 18-40 years
- Not menopausal
- Not currently pregnant or breastfeeding or have been in the past 12 months
- Regularly participate in > 2 ½ hours of moderate intensity exercise **OR** 1 ¼ hours of vigorous intensity exercise per week (for example: a gym workout, an exercise class, running, sport practice/competition).
- Proficient in English.

**If you are using hormonal contraception which stops you from having a period you can still participate in the study.**

**What is going to happen?**

Once you have read the information sheet and if you are happy to participate, the research team will ask you to provide informed consent. You will then be automatically directed to the online questionnaire. Please complete the questionnaire in your own time and on a personal device to ensure your privacy. This survey will ask you questions about your general health, menstrual cycle, contraception use, and how you believe these impact on your exercise performance. We will also ask you about your age, ethnicity, height, weight, medical history, physical activity levels, sporting participation, reproductive health, menstrual cycle symptoms, and hormonal contraceptive use.

***The questionnaire will take approximately 10-20 minutes to complete.***

***Please only begin when you can allow at least 20 minutes of your time to complete the questionnaire.***

**Data Management**

The data collected for this project will only be used for this project and no individual or personal data will be identified. Only the research team (staff and student) will have access to the data. Responses will be anonymous and stored under a survey number. This is to maintain the confidentiality of the data and store it securely. The results of this project will be presented as group averages. No individual data will be identified from the presented results. The overall summary of the results may be published or presented at conferences or seminars/workshops to academic and general population audiences. Any raw data from this project will be retained in secure storage for 10 years. After which it will be destroyed. All participants will be invited to an online conference if they wish to get a summary of the results.

**Participants Rights**

You are under no obligation to accept this invitation. Should you choose to participate, you have the right to:

- Ask the researchers questions. Please make sure you ask any questions about the study before

commencing the questionnaire

- Withdrawal from the study may occur at any time whilst answering the survey questions (you cannot withdraw your data from the analysis after your full survey response has been submitted).

- Be given access to a summary of the project findings after project completion

**What are the benefits and risks of taking part in this study?**

You will have access to a summary of the results via an online conference. We do recognise that there are some potential psychological risks associated with participation. These include, but are not limited to, feeling uncomfortable, embarrassed, ashamed, distressed etc. when answering some of the questions. To reduce any discomfort:

- We ask that you complete the questionnaire on your personal device, in your own time, in your own private place of choosing (e.g. at home). This gives you the privacy to complete this data entry in a space that you feel comfortable in.

- All data collected will be stored in password-protected computers and folders. Data will only be accessed by the research team. Data will be stored under survey ID and no personal information will be stored.

- Any of the presented/reported results will be averages of the study's results. No individual data will be identified.

**Project Contacts:**
If you have any questions regarding this study, please do not hesitate to contact either of the following people for assistance:

Hannah Wilton
[redacted]

Dr Claire Badenhorst (School of Sport, Exercise, and Nutrition) C.Badenhorst@massey.ac.nz (09)414 0800

Ethics Committee Approval Statement:

This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application NOR 22/53. If you have any concerns about the conduct of this research, please contact A/Prof Fiona Te Momo, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800, x 43347, email humanethicsnorth@massey.ac.nz.

Consent Having read the information sheet, do you consent to participate in this study?

- ○ Yes (1)
- ○ No (2)

*Skip To: End of Survey If Having read the information sheet, do you consent to participate in this study? = No*

**End of Block: Block 1**

**Start of Block: Demographics and contraception**

Introduction The following series of questions will ask you about your age, gender, reproductive organs, and contraceptive use.

PLEASE NOTE: You will only be able to progress forward through the questionnaire. Please take the time to read each question carefully as you cannot go back to change previous answers.

Q1 How old are you?

_____

Q2 How do you describe your gender identity? Please select ONE

- ○ Male/man (1)
- ○ Female/women (2)
- ○ Non-binary (3)
- ○ Genderfluid (4)
- ○ Other, please specify (5) _____

Q3 What was your assigned sex at birth? Please select ONE

- ○ Male (1)
- ○ Female (2)
- ○ Intersex (3)

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Q4 Since we are interested in knowing the kinds of hormones your body is making will you tell us which reproductive organs you currently have? Please select ONE

- ○ I have reproductive organs consistent with female biological sex: ovaries and a uterus (1)
- ○ I have reproductive organs consistent with male biological sex (including at least one testicle) (2)
- ○ I was born with a combination of both “male” (testes, penis) and “female” (ovaries, uterus) reproductive organs (3)
- ○ I have one ovary and uterus (the other ovary was removed or never developed) (4)
- ○ I do not have any ovaries, but I have a uterus (the ovaries were removed or never developed) (5)
- ○ I have no reproductive organs whatsoever (they were removed or never developed) (6)

---

Q5 Are you currently using any of the following forms of contraception?

- ○ Implant (1)
- ○ Injection (2)
- ○ Hormonal intrauterine device (IUD) e.g. Marina (3)
- ○ Non-hormonal copper coil (IUD) (4)
- ○ Vaginal ring (5)
- ○ Oral contraceptive pill (6)
- ○ Oestrogen patch (7)
- ○ None (8)
- ○ Other (please specify) (9) _____

End of Block: Demographics and contraception

Start of Block: Menstrual cycle

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Menstrual cycle The next section will ask about your menstrual cycle to help us know more about your reproductive status.

PLEASE NOTE: You will only be able to progress forward through the questionnaire. Please take the time to read each question carefully as you cannot go back to change previous answers.

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q6 Do you have a regular menstrual period that occurs about once per month (usually about every 20 to 40 days)? Please select YES or NO

- ○ No (1)
- ○ Yes (2)

*Skip To: Q8 If Do you have a regular menstrual period that occurs about once per month (usually about every 20 t... = No*

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q7 How many days is your menstrual cycle (day one being the start of menstrual bleeding and the end of the cycle is the day before your next monthly bleed starts)? NOTE: The average is 28 days.

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q8 How old were you when you first started menstrual bleeding (age in years)?

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q9 Have you been diagnosed with any gynaecological conditions or any medical conditions that you know affect your hormones? Please select all that apply

- ☐ polycystic ovarian syndrome (PCOS) (1)
- ☐ endometriosis (2)
- ☐ premature ovarian failure (3)
- ☐ exist prolactin production (4)
- ☐ endometrial polyps or fibroids (5)
- ☐ adenomyosis (6)
- ☐ bleeding disorder (7)
- ☐ pelvic inflammatory disorder (8)
- ☐ ovarian cysts (9)
- ☐ none of the above (10)
- ☐ other menstrual related dysfunction (please specify) (11)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q10 Did you have any pain below your belly button with your period in the last three periods?

- ○ Yes, with every period (1)
- ○ Yes, with most periods (two of the last three periods) (2)
- ○ Yes, occasionally (one of the last three periods) (3)
- ○ No (4)

*Skip To: Q14 If Did you have any pain below your belly button with your period in the last three periods? = No*

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q11 When is the pain occurring? (Select all that apply)

- ☐ Just before my period starts (1)
- ☐ First day of my period (2)
- ☐ Second day of my period (3)
- ☐ Third day of my period and beyond (4)
- ☐ All of my period (5)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q12 When you have pain with your period, how intense is it, on average? 10 being extremely painful and 0 being no pain at all

0 1 2 3 4 5 6 7 8 9 10

| | |
|---|---|
| 1 () |  |

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q13 When menstruating, do/did you take any form of medication to relieve pain from menstrual cycle related symptoms?

- ○ Yes, regularly (every cycle) (1)
- ○ Yes, occasionally (every few cycles) (2)
- ○ Yes, rarely (3)
- ○ No, never (4)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q14 Do you think you have heavy bleeding? This could be a very long period (more than 7 days), having to change your tampon or pad every two hours or less during the day, or having 'flooding' where you bleed more than your pad or tampon can contain

- ○ Yes (1)
- ○ No (2)
- ○ Not Sure (3)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q15 How many days do you experience visual menstrual bleeding?

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)
- ○ 6 (6)
- ○ 7 (7)
- ○ >8 (8)

**End of Block: Menstrual cycle**

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**Start of Block: Menstrual cycle and exercise**

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Introduction The next series of questions are related to how your menstrual cycle impacts your exercise performance.

PLEASE NOTE: You will only be able to progress forward through the questionnaire. Please take the time to read each question carefully as you cannot go back to change previous answers.

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q16 Throughout your menstrual cycle do/did you experience any of these symptoms (please select all that apply):

| | Often (1) | Sometimes (2) | Rarely (3) | Never (4) |
|---|---|---|---|---|
| Stomach cramps (1) | ○ | ○ | ○ | ○ |
| Headaches/migraines (2) | ○ | ○ | ○ | ○ |
| Lower back pain (3) | ○ | ○ | ○ | ○ |
| Joint pain and/or muscle cramps (4) | ○ | ○ | ○ | ○ |
| Nausea/sickness/vomiting (5) | ○ | ○ | ○ | ○ |
| Diarrhoea (6) | ○ | ○ | ○ | ○ |
| Constipation (7) | ○ | ○ | ○ | ○ |
| Increased tiredness/fatigue (8) | ○ | ○ | ○ | ○ |
| Dizziness/light headedness/reduced coordination (9) | ○ | ○ | ○ | ○ |
| Disrupted sleep (10) | ○ | ○ | ○ | ○ |
| Water retention (11) | ○ | ○ | ○ | ○ |
| Changes in mood/increased irritability (12) | ○ | ○ | ○ | ○ |
| Cravings/increased appetite (13) | ○ | ○ | ○ | ○ |
| Poor concentration/problems remembering (14) | ○ | ○ | ○ | ○ |
| Changes to/difficulty breathing (15) | ○ | ○ | ○ | ○ |
| Temperature fluctuations (16) | ○ | ○ | ○ | ○ |
| Bloating/increased gas (17) | ○ | ○ | ○ | ○ |

| | | | | |
|---|---|---|---|---|
| Breast pain tenderness (18) | ○ | ○ | ○ | ○ |
| Other (please specify) (19) | ○ | ○ | ○ | ○ |

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q17 Do you think your training (such as running, going to the gym, sports practice etc.) is affected by your menstrual cycle?

- ○ yes - affected negatively (1)
- ○ yes - affected positively (2)
- ○ no - I don't notice any difference (3)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*And Do you think your training (such as running, going to the gym, sports practice etc.) is affected... = yes - affected negatively*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

*And Do you think your training (such as running, going to the gym, sports practice etc.) is affected... = yes - affected negatively*

Q18 What particular parts of your training are affected negatively (select all that apply)?

- ☐ I feel I'm not as strong/can't lift as much weight (1)
- ☐ I feel less coordinated or more clumsy (2)
- ☐ I feel like I fatigue more easily/my endurance is less (3)
- ☐ I feel vague or I am less able to concentrate on the coaches' instructions or tactics during a game (4)
- ☐ I feel my vision is affected and things seem closer/further away (5)
- ☐ I do not feel as fast in speed activities (6)
- ☐ My energy levels are different (7)
- ☐ I'm concerned that I might bleed through my clothes/uniform (8)
- ☐ other (please specify) (9)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*And Do you think your training (such as running, going to the gym, sports practice etc.) is affected... = yes - affected negatively*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

*And Do you think your training (such as running, going to the gym, sports practice etc.) is affected... = yes - affected negatively*

Q19 When during your cycle are these negative effects occurring (please select all that apply)?

- ☐ When I'm on my period (1)
- ☐ Just before my period (2)
- ☐ Just after my period (3)
- ☐ In the middle of my cycle around ovulation (4)
- ☐ Any other time (5)
- ☐ Never considered it (6)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*And Do you think your training (such as running, going to the gym, sports practice etc.) is affected... = yes - affected positively*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

*And Do you think your training (such as running, going to the gym, sports practice etc.) is affected... = yes - affected positively*

Q20 What particular parts of your training are affected positively (select all that apply)?

- [ ] I feel stronger or can lift more weight (1)
- [ ] I feel like my coordination improves (2)
- [ ] I feel like my endurance is better (3)
- [ ] I feel like my concentration is better or I'm able to concentrate better on tactics or coaches instructions (4)
- [ ] I feel like I'm faster in speed activities (5)
- [ ] other (please specify) (6)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*And Do you think your training (such as running, going to the gym, sports practice etc.) is affected... = yes - affected positively*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

*And Do you think your training (such as running, going to the gym, sports practice etc.) is affected... = yes - affected positively*

Q21 When during your cycle are these positive effects occurring (please select all that apply)?

- [ ] When I'm on my period (1)
- [ ] Just before my period (2)
- [ ] Just after my period (3)
- [ ] In the middle of my cycle around ovulation (4)
- [ ] Any other time (5)
- [ ] Never considered it (6)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q22 Do/did you ever miss or change your exercise training as a result of your menstrual cycle or related symptoms?

- ○ Yes, frequently (every cycle) (1)
- ○ Yes, sometimes (every few cycles) (2)
- ○ Yes, rarely (3)
- ○ No, never (4)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q23 Do you think your performance on ‘game day’ or competition day is affected by your menstrual cycle?

- ○ Yes, affected negatively (1)
- ○ Yes, affected positively (2)
- ○ No, I don't notice any difference (3)
- ○ Not applicable, I don't have a competition day (4)

*Skip To: End of Block If Do you think your performance on ‘game day’ or competition day is affected by your menstrual cycle? = Not applicable, I don't have a competition day*

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*And Do you think your performance on ‘game day’ or competition day is affected by your menstrual cycle? = Yes, affected negatively*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

*And Do you think your performance on ‘game day’ or competition day is affected by your menstrual cycle? = Yes, affected negatively*

Q24 What particular parts of your performance on competition day are affected negatively (select all that apply)?

- ☐ I feel I'm not as strong/can't lift as much weight (1)
- ☐ I feel less coordinated or more clumsy (2)
- ☐ I feel like I fatigue more easily/my endurance is less (3)
- ☐ I feel vague or I am less able to concentrate on the coaches' instructions or tactics during a game (4)
- ☐ I feel my vision is affected and things seem closer/further away (5)
- ☐ I do not feel as fast in speed activities (6)
- ☐ My energy levels are different (7)
- ☐ I'm concerned that I might bleed through my clothes/uniform (8)
- ☐ other (please specify) (9)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*And Do you think your performance on 'game day' or competition day is affected by your menstrual cycle? = Yes, affected negatively*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

*And Do you think your performance on 'game day' or competition day is affected by your menstrual cycle? = Yes, affected negatively*

Q25 When during your cycle are these negative effects occurring (please select all that apply)?

- ☐ When I'm on my period (1)
- ☐ Just before my period (2)
- ☐ Just after my period (3)
- ☐ In the middle of my cycle around ovulation (4)
- ☐ Any other time (5)
- ☐ Never considered it (6)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*And Do you think your performance on 'game day' or competition day is affected by your menstrual cycle? = Yes, affected positively*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

*And Do you think your performance on 'game day' or competition day is affected by your menstrual cycle? = Yes, affected positively*

Q26 What particular parts of your performance on competition day are affected positively (select all that apply)?

- ☐ I feel stronger or can lift more weight (1)
- ☐ I feel like my coordination improves (2)
- ☐ I feel like my endurance is better (3)
- ☐ I feel like my concentration is better or I'm able to concentrate better on tactics or coaches instructions (4)
- ☐ I feel like I'm faster in speed activities (5)
- ☐ other (please specify) (6)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*And Do you think your performance on 'game day' or competition day is affected by your menstrual cycle? = Yes, affected positively*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

*And Do you think your performance on 'game day' or competition day is affected by your menstrual cycle? = Yes, affected positively*

Q27 When during your cycle are these positive effects occurring (please select all that apply)?

- ☐ When I'm on my period (1)
- ☐ Just before my period (2)
- ☐ Just after my period (3)
- ☐ In the middle of my cycle around ovulation (4)
- ☐ Any other time (5)
- ☐ Never considered it (6)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? = None*

*Or Are you currently using any of the following forms of contraception? = Non-hormonal copper coil (IUD)*

Q28 Do/did you ever miss a race/event/competition as a result of your menstrual cycle or related symptoms?

- ○ Yes, frequently every cycle (1)
- ○ Yes, sometimes every few cycles (2)
- ○ Yes, rarely (3)
- ○ No, never (4)

**End of Block: Menstrual cycle and exercise**

**Start of Block: Hormonal Contraception**

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Introduction  The next series of questions will ask about your menstrual cycle, hormonal contraception and the impact on your exercise performance.

PLEASE NOTE: You will only be able to progress forward through the questionnaire. Please take the time to read each question carefully as you cannot go back to change previous answers.

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception?  != None*

*And Are you currently using any of the following forms of contraception?  != Non-hormonal copper coil (IUD)*

Q29 How old were you when you first started menstrual bleeding (age in years)?

_____

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception?  != None*

*And Are you currently using any of the following forms of contraception?  != Non-hormonal copper coil (IUD)*

Q30 Have you been diagnosed with any gynaecological conditions or any medical conditions that you know affect your hormones? Please select all that apply

- ☐ polycystic ovarian syndrome (PCOS) (1)
- ☐ endometriosis (2)
- ☐ premature ovarian failure (3)
- ☐ exist prolactin production (4)
- ☐ endometrial polyps or fibroids (5)
- ☐ adenomyosis (6)
- ☐ bleeding disorder (7)
- ☐ pelvic inflammatory disorder (8)
- ☐ ovarian cysts (9)
- ☐ none of the above (10)
- ☐ other menstrual related dysfunction (please specify) (11)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q31 Did you have any pain below your belly button with your period in the last three periods?

- ○ Yes, with every period (1)
- ○ Yes, with most periods (two of the last three periods) (2)
- ○ Yes, occasionally (one of the last three periods) (3)
- ○ No (4)

*Skip To: Q35 If Did you have any pain below your belly button with your period in the last three periods? = No*

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q32 When is the pain occurring? (Select all that apply)

- ☐ Just before my period starts (1)
- ☐ First day of my period (2)
- ☐ Second day of my period (3)
- ☐ Third day of my period and beyond (4)
- ☐ All of my period (5)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q33 When you have pain with your period, how intense is it, on average? 10 being extremely painful and 0 being no pain at all

0 1 2 3 4 5 6 7 8 9 10

| | |
|---|---|
| 1 () |  |

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q34 When menstruating, do/did you take any form of medication to relieve pain from menstrual cycle related symptoms?

- ○ Yes, regularly (every cycle) (1)
- ○ Yes, occasionally (every few cycles) (2)
- ○ Yes, rarely (3)
- ○ No, never (4)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q35 Do you think you have heavy bleeding? This could be a very long period (more than 7 days), having to change your tampon or pad every two hours or less during the day, or having 'flooding' where you bleed more than your pad or tampon can contain

- ○ Yes (1)
- ○ No (2)
- ○ Not Sure (3)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q36 Throughout your menstrual cycle do/did you experience any of these symptoms (please select all that apply):

| | Often (1) | Sometimes (2) | Rarely (3) | Never (4) |
|---|---|---|---|---|
| Stomach cramps (1) | ○ | ○ | ○ | ○ |
| Headaches/migraines (2) | ○ | ○ | ○ | ○ |
| Lower back pain (3) | ○ | ○ | ○ | ○ |
| Joint pain and/or muscle cramps (4) | ○ | ○ | ○ | ○ |
| Nausea/sickness/vomiting (5) | ○ | ○ | ○ | ○ |
| Diarrhoea (6) | ○ | ○ | ○ | ○ |
| Constipation (7) | ○ | ○ | ○ | ○ |
| Increased tiredness/fatigue (8) | ○ | ○ | ○ | ○ |
| Dizziness/light headedness/reduced coordination (9) | ○ | ○ | ○ | ○ |
| Disrupted sleep (10) | ○ | ○ | ○ | ○ |
| Water retention (11) | ○ | ○ | ○ | ○ |
| Changes in mood/increased irritability (12) | ○ | ○ | ○ | ○ |
| Cravings/increased appetite (13) | ○ | ○ | ○ | ○ |
| Poor concentration/problems remembering (14) | ○ | ○ | ○ | ○ |
| Changes to/difficulty breathing (15) | ○ | ○ | ○ | ○ |
| Temperature fluctuations (16) | ○ | ○ | ○ | ○ |
| Bloating/increased gas (17) | ○ | ○ | ○ | ○ |

| | | | | |
|---|---|---|---|---|
| Breast pain tenderness (18) | ○ | ○ | ○ | ○ |
| Other (please specify) (19) | ○ | ○ | ○ | ○ |

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q37 How long have you been using your current type of contraception?

- ○ Less than six months (1)
- ○ 6-12 months (2)
- ○ 1-2 years (3)
- ○ 2-5 years (4)
- ○ More than 5 years (5)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q38 What are the main reasons for you using this type of contraception? Please select all that apply

- ☐ Avoidance of pregnancy (1)
- ☐ I want to be able to skip or shift my period (2)
- ☐ Making my cycle more regular (3)
- ☐ To initiate cycles (4)
- ☐ To avoid having my period (5)
- ☐ Avoid/reduce period pain (6)
- ☐ Acne/skin problems (7)
- ☐ To reduce the heaviness of my bleeding (8)
- ☐ To reduce any emotional changes (feeling angry or sad) (9)
- ☐ To reduce other PMS symptoms e.g. breast tenderness, nausea (10)
- ☐ Other (please specify) (11)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q39 Do you think your exercise training (such as running, going to the gym, sports practice etc.) is/was affected by your contraception?

- yes - affected negatively (1)
- yes - affected positively (2)
- no - I don't notice any difference (3)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

*And Are you currently using any of the following forms of contraception? != None*

*And Do you think your exercise training (such as running, going to the gym, sports practice etc.) is/... = yes - affected negatively*

Q40 What particular parts of your training are/were affected negatively by your contraception (select all that apply)?

- [ ] I feel I'm not as strong/can't lift as much weight (1)
- [ ] I feel less coordinated or more clumsy (2)
- [ ] I feel like I fatigue more easily/my endurance is less (3)
- [ ] I feel vague or I am less able to concentrate on the coaches' instructions or tactics during a game (4)
- [ ] I feel my vision is affected and things seem closer/further away (5)
- [ ] I do not feel as fast in speed activities (6)
- [ ] My energy levels are different (7)
- [ ] I'm concerned that I might bleed through my clothes/uniform (8)
- [ ] other (please specify) (9)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

*And Do you think your exercise training (such as running, going to the gym, sports practice etc.) is/... = yes - affected negatively*

Q41 When during your cycle are these negative effects occurring (please select all that apply)?

- ☐ When I'm on my period (1)
- ☐ Just before my period (2)
- ☐ Just after my period (3)
- ☐ In the middle of my cycle around ovulation (4)
- ☐ Any other time (5)
- ☐ Never considered it (6)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

*And Do you think your exercise training (such as running, going to the gym, sports practice etc.) is/... = yes - affected positively*

Q42 What particular parts of your training are affected positively by your contraception (select all that apply)?

- ☐ I feel stronger or can lift more weight (1)
- ☐ I feel like my coordination improves (2)
- ☐ I feel like my endurance is better (3)
- ☐ I feel like my concentration is better or I'm able to concentrate better on tactics or coaches instructions (4)
- ☐ I feel like I'm faster in speed activities (5)
- ☐ I don't have to worry about getting my period (6)
- ☐ I don't have to worry about getting negative menstrual cycle symptoms (7)
- ☐ other (please specify) (8)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

*And Do you think your exercise training (such as running, going to the gym, sports practice etc.) is/... = yes - affected positively*

Q43 When during your cycle are these positive effects occurring (please select all that apply)?

- [ ] When I'm on my period (1)
- [ ] Just before my period (2)
- [ ] Just after my period (3)
- [ ] In the middle of my cycle around ovulation (4)
- [ ] Any other time (5)
- [ ] Never considered it (6)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q44 Do/did you ever miss or change your exercise training as a result of symptoms from your menstrual cycle or hormonal contraceptive?

- ○ Yes, frequently (every cycle) (1)
- ○ Yes, sometimes (every few cycles) (2)
- ○ Yes, rarely (3)
- ○ No, never (4)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q45 Do you think your performance on ‘game day’ or competition day is affected by your contraception?

- ○ Yes, affected negatively (1)
- ○ Yes, affected positively (2)
- ○ No, I don't notice any difference (3)
- ○ Not applicable I don't have a competition day (4)

*Skip To: Q51 If Do you think your performance on ‘game day’ or competition day is affected by your contraception? = Not applicable I don't have a competition day*

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

*And Do you think your performance on ‘game day’ or competition day is affected by your contraception? = Yes, affected negatively*

Q46 What particular parts of your performance on competition day are affected negatively by your contraception (select all that apply)?

- [ ] I feel I'm not as strong/can't lift as much weight (1)
- [ ] I feel less coordinated or more clumsy (2)
- [ ] I feel like I fatigue more easily/my endurance is less (3)
- [ ] I feel vague or I am less able to concentrate on the coaches' instructions or tactics during a game (4)
- [ ] I feel my vision is affected and things seem closer/further away (5)
- [ ] I do not feel as fast in speed activities (6)
- [ ] My energy levels are different (7)
- [ ] I'm concerned that I might bleed through my clothes/uniform (8)
- [ ] other (please specify) (9)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

*And Do you think your performance on 'game day' or competition day is affected by your contraception? = Yes, affected negatively*

Q47 When during your cycle are these negative effects occurring (please select all that apply)?

- ☐ When I'm on my period (1)
- ☐ Just before my period (2)
- ☐ Just after my period (3)
- ☐ In the middle of my cycle around ovulation (4)
- ☐ Any other time (5)
- ☐ Never considered it (6)

---

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

*And Do you think your performance on 'game day' or competition day is affected by your contraception? = Yes, affected positively*

Q48 What particular parts of your performance on competition day are affected positively by your contraception (select all that apply)?

- ☐ I feel stronger or can lift more weight (1)
- ☐ I feel like my coordination improves (2)
- ☐ I feel like my endurance is better (3)
- ☐ I feel like my concentration is better or I'm able to concentrate better on tactics or coaches instructions (4)
- ☐ I feel like I'm faster in speed activities (5)
- ☐ I don't have to worry about getting my period (6)
- ☐ I don't have to worry about getting negative menstrual cycle symptoms (7)
- ☐ other (please specify) (8)

_____

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

*And Do you think your performance on 'game day' or competition day is affected by your contraception? = Yes, affected positively*

Q49 When during your cycle are these positive effects occurring (please select all that apply)?

- [ ] When I'm on my period (1)
- [ ] Just before my period (2)
- [ ] Just after my period (3)
- [ ] In the middle of my cycle around ovulation (4)
- [ ] Any other time (5)
- [ ] Never considered it (6)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q50 Do/did you ever miss or change your exercise competition as a result of symptoms from your menstrual cycle or hormonal contraceptive?

- ○ Yes, frequently (every cycle) (1)
- ○ Yes, sometimes (every few cycles) (2)
- ○ Yes, rarely (3)
- ○ No, never (4)

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q51 Have you had any side effects or adverse events you think are related to being on hormonal contraceptives?

- ○ Yes (1)
- ○ No (2)

*Skip To: End of Block If Have you had any side effects or adverse events you think are related to being on hormonal contra... = No*

*Display This Question:*

*If Are you currently using any of the following forms of contraception? != None*

*And Are you currently using any of the following forms of contraception? != Non-hormonal copper coil (IUD)*

Q52 Can you briefly describe these adverse events or side effects?

_____

**End of Block: Hormonal Contraception**

**Start of Block: Contraceptive history**

Q53 The following questions will ask about your previous contraceptive use.

PLEASE NOTE: You will only be able to progress forward through the questionnaire. Please take the time to read each question carefully as you cannot go back to change previous answers.

Q54 Have you previously used any of the following forms of contraception? (This does not include any form of contraception you are currently using).

- ☐ Implant (1)
- ☐ Injection (2)
- ☐ Hormonal intrauterine device (IUD) e.g., Marina coil (3)
- ☐ Non-hormonal copper coil (IUD) (4)
- ☐ Vaginal ring (5)
- ☐ Oral contraceptive pill (OCP) (6)
- ☐ oestrogen patch (7)
- ☐ No (8)
- ☐ Other (please specify) (9) _____

*Skip To: End of Block If Have you previously used any of the following forms of contraception? (This does not include any... = No*

Q55 What was your reason for discontinuing this type of contraception

_____

Q56 Did you have any side effects or adverse events you think were related to being on hormonal contraceptives?

- ○ Yes (1)
- ○ No (2)

*Skip To: End of Block If Did you have any side effects or adverse events you think were related to being on hormonal contr... = No*

Q57 Can you briefly describe these adverse events or side effects?

_____

**End of Block: Contraceptive history**

**Start of Block: Physical activity**

Introduction The last series of questions will ask about your physical activity level and the types of sport/exercise that you participate in.

PLEASE NOTE: You will only be able to progress forward through the questionnaire. Please take the time to read each question carefully as you cannot go back to change previous answers.

Q58 During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____

Q59 How much time did you usually spend doing vigorous physical activities on one of those days?

_____

Q60 Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? DO NOT include walking.

_____

Q61 How much time did you usually spend doing moderate physical activities on one of those days?

_____

Q62 Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____

Q63 How much time did you usually spend walking on one of those days?

_____

Q64 This question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

During the last 7 days, how much time did you spend sitting on a week day?

_____

Q65 Which sports/types of exercise do you do regularly i.e. at least once a week?

- [ ] Running (1)
- [ ] Swimming (2)
- [ ] Cycling (3)
- [ ] Team sports e.g. (hockey, netball) (4)
- [ ] Gym-based class (e.g., spinning, circuit, yoga) (5)
- [ ] Cross-trainer or similar cardio-based exercise machine (6)
- [ ] Racket sports (7)
- [ ] Dance class/dance-based fitness class (8)
- [ ] Other prolonged exercise (e.g. walking, skiing, golf, rowing) (9)
- [ ] Martial arts (e.g. judo, karate) (10)
- [ ] Weight training (11)
- [ ] Other (please specify) (12)

_____

Q66 Do you compete in a sport or exercise?

- ○ Yes (1)
- ○ No (2)

*Skip To: Q71 If Do you compete in a sport or exercise? = No*

Q67 What is the primary sport/exercise which you compete in?

_____

Q68 In your primary sport, are you a team or an individual athlete?

- [ ] Team Sport (1)
- [ ] Individual (2)

Q69 What level do you compete at in your primary sport/exercise?

- ○ Recreational e.g. CrossFit against others in my gym, marathon running (1)
- ○ Club (please specify division or grade) (2)

_____

- ○ State/provincial (3)
- ○ National (4)
- ○ International (5)

Q70 How many hours of training do you do each week?

- ○ 1-3 hours (1)
- ○ 4-7 hours (2)
- ○ 8-12 hours (3)
- ○ 12-20 hours (4)
- ○ 20+ hours (5)

Q71 What is your ethnicity?

_____

Q72 What is your height in cm?

_____

Q73 What is your weight in kgs?

_____

Q74 Would you like to receive information about the presentation of the results after this research has been completed? If yes, please provide an email address so that we may contact you and send you the presentation details

- ○ Yes (1) _____
- ○ Maybe (2) _____
- ○ No (3)

**End of Block: Physical activity**

# Appendix B: Ethics Approval

HoU Review Group:

ReviewerGroup:

Dr Claire Badenhorst

Researcher: Hannah Wilton
Project Title: Prevalence and frequency of menstrual cycle symptoms in exercising females using hormonal contraception and perceived effect on sport and exercise performance.

Dear Hannah,

Thank you for the above application that was considered by the Massey University Human Ethics Human Ethics Northern Committee at their meeting held on 14/10/2022.

On behalf of the Committee I am pleased to advise you that ethical approval has been granted for your research.

Approval is valid for three years. If this project has not been completed within three years from the date of this letter, an amendment to extend the approval must be requested by contacting the Research Ethics Office at humanethics@massey.ac.nz.

If the nature, content, location, procedures or personnel of your approved application change, please contact the Research Ethics Office at humanethics@massey.ac.nz to request an amendment form.

If you wish to print an official copy of this letter:

1. Please login to the RIMS system (https://rme.massey.ac.nz).
2. In the Ethics menu, select Ethics Applications.
3. Using the Advanced option, select Ethics Applications (Area), Application ID (Search On), enter the ethics notification number in the Value area and select Find on the toolbar.
4. With the application the Results Tab, tick the empty box on the far left of the application and select Reports from the toolbar.
5. Select the "Human Ethics - Low Risk Notification Letter" link, this will open the report viewer.
6. Select the application code from the Report Parameters dropdown and submit. You can then select an export option from the top toolbar (Print, Save).

Yours sincerely
Professor Craig Johnson
Chair, Human Ethics Chairs' Committee and
Director (Research Ethics)