That Time of the Month: Exploring the Relationship Between the Menstrual Cycle and ADHD Symptoms

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Abstract

Attention-Deficit/Hyperactivity Disorder (ADHD) is a common neurodevelopmental condition more commonly diagnosed in males than females. Increased awareness of sex differences in ADHD presentation has seen a recent increase of female prevalence rates, yet female-specific ADHD research remains scarce. Preliminary research suggests a possible link between hormonal fluctuations within the menstrual cycle and changes in ADHD symptoms and medication effectiveness. Emerging theories like Multiple Hormone Sensitivity Theory (MHST) postulate that these changes could be due to females with ADHD being especially sensitive to hormonal fluctuations. A cross-sectional online survey was conducted for females with ADHD (*n*=357) and without ADHD (*n*=37) to investigate self-reported changes in ADHD symptoms in the luteal phase of the menstrual cycle compared to the follicular phase. This study also investigated changes in medication effectiveness and duration for medicated ADHD participants. Results indicated that ADHD and non-ADHD participants both experienced worse ADHD symptoms during the luteal phase compared to the follicular phase. This effect was greater for ADHD participants. Self-reported medication effectiveness and duration were significantly worse during the luteal phase. Medicated and unmedicated participants displayed no significant differences in ADHD symptoms during the luteal phase. These findings, consistent with similar research, provide preliminary supportive evidence to MHST. Impacts of the menstrual cycle on ADHD symptoms should therefore be considered during the diagnostic and treatment planning process.

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterised by an ongoing pattern of inattention and/or hyperactivity-impulsivity that often persists into adulthood (American Psychiatric Association, 2022). It has three subtypes: predominately inattentive (ADHD-I); hyperactive/impulsive (ADHD-HI); or combined (ADHD-C). Most commonly diagnosed in children, ADHD has an estimated global prevalence rate of 5.3 per cent in children and 2.5 per cent in adults (Posner et al., 2020). Diagnosis rates for women and girls have risen in recent years (Davidovitch et al., 2017; Meehan, 2022) with increased awareness of gender differences and diagnostic complexities in female ADHD presentations (Arnold 1996; Abdelnour et al., 2022; Quinn & Madhoo, 2014). The increase in prevalence rates has prompted the need for further research exploring gender and sex differences in ADHD presentation, especially with newer research highlighting the potential interplay between hormonal fluctuations and ADHD symptoms, including the impact that hormonal events such as menstruation have on women and girls' experience of their ADHD symptoms (Quinn, 2005, Quinn & Madhoo, 2014; Haimov-Kochman & Berger, 2014; Camara et al., 2021; Jong et al., 2023; Eng et al., 2024).

Gender and Sex Terminology

Psychology research has struggled to adequately distinguish between sex and gender, often categorising participants as women, girl or female without clear consideration on how participants choose to identify (Coen & Banister, 2012; Heidari et al., 2016). Sex is associated with one's biological make up; chromosomal, gonadal and anatomical characteristics (Australian Bureau of Statistics, 2021). Gender is a social and cultural construct that refers to one's personal identity, expression and experience that may or may not align with the sex recorded at their birth (Australian Bureau of Statistics, 2021).

It is important to make the distinction between the two related yet independent determinants of health and wellbeing as a lack of understanding of the underlying sex and/or gender differences can lead to a "gender gap" that has disproportionately affected females and has resulted in adverse health outcomes (Heidari et al., 2016). Consistent with Eng et al (2024), the current study uses the term "women" and "girls" when referring to public health implications or when referencing past studies, respectively. "Female" will be used when discussing biological influences such as hormonal phases of the menstrual cycle.

Gender and Sex Differences in ADHD

Historically regarded as a condition significantly more prevalent in males than females, ADHD research has mostly relied on the use of male participants (Gross-Tsur et al., 2006; Skolgi et al., 2013). ADHD in females has relatively recently become a focus of clinical attention (Haimov-Kochman & Berger, 2014; Hinshaw et al., 2018). For decades, ADHD prevalence rates for males vastly outnumbered rates for women and girls (Gaub & Carlson, 1997; Nussbaum, 2012; Quinn, 2008; Sciutto & Eisenberg, 2007). Recent increases in diagnosis for women have seen a balance in adult prevalence rates; however, the

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diagnostic rates for girls remain lower than for boys (Cortese et al., 2016; da Silva et al., 2020). Despite increased awareness of ADHD in females, women and girls still remain underdiagnosed and untreated for ADHD (Hinshaw et al., 2018 Jong et al., 2023).

Despite experiencing equivalent impairment to their male counterparts (Sciutto et al., 2004), females may be consistently underdiagnosed and unrecognised due to not meeting the stereotypical male symptoms captured in ADHD assessment measures (Skolgi et al., 2013; Quinn, 2005). Furthermore, female symptom severity is often not adequately captured in diagnostic criteria and assessments (Nussbaum, 2012; Quinn & Madhoo, 2014), with well-regarded diagnostic manuals such as the DSM-5-TR being criticised for lacking gender-neutrality in their ADHD diagnostic criteria (Lynch & Davison, 2022).

Many of the symptoms experienced in female ADHD presentations overlap with other comorbid mood conditions, increasing the risk of incorrect differential diagnosis (Robison et al., 2008) or misdiagnosis with mood disorders such as depression, anxiety and bipolar disorder (Quinn & Madhoo, 2014; Rucklidge, 2010, Grevet et al., 2006; Piñeiro-Dieguez et al., 2016; Waite, 2007). Misdiagnosis can result in women and girls receiving inadequate or incorrect treatment (Quinn, 2005; Kok et al., 2020). This further emphasises the need for the medical community to build awareness of sex differences in ADHD presentations.

Hormonal Fluctuations

While awareness of sex differences in ADHD has increased as female prevalence rates rise, the physiological underpinnings of these differences are not yet well established (Haimov-Kochman & Berger, 2014; Roberts et al., 2018; Camara et al., 2021). Emerging research has highlighted a potential link between hormonal fluctuations and ADHD symptoms, including the impact that hormonal events such as the menstrual cycle have on women's experiences of their ADHD symptoms (Quinn, 2005; Roberts et al., 2018; Jong et al., 2023; Eng et al., 2024). The menstrual cycle has a typical duration between 24-35 days (Lenton et al., 1984) and consists of two main phases: the follicular phase and the luteal phase. Both phases are regulated by the hormonal fluctuations of the hypothalamus-pituitary-gonadal axis. The follicular phase, which involves the production of the follicle stimulating hormone, begins on day 1 of menses and concludes with ovulation (Le et al., 2020). The sex hormones estrogen and progesterone levels are usually low during the early follicular phase but experience a sharp increase in the second week of the phase in the lead up to ovulation. A surge in the luteinising hormone occurs just prior to ovulation, marking the start of the luteal phase. During the luteal phase, progesterone levels gradually rise until they peak in the middle of the phase and then begin to steadily decline towards the end of the phase. The luteal phase also sees Estradiol (E2) levels fall sharply then temporarily rise again before steadily declining in preparation for menses.

The influence of these sex hormones on cognition, emotions, behaviour and brain structure is well documented. Hormonal fluctuations that occur throughout regular hormonal phases (e.g. the menstrual cycle) can affect key neural processes associated with emotional regulation and cognitive functioning (Le et al., 2020; Sacher et al., 2013; Barth et al., 2015). For example, E2 is the most common type of estrogen present during females' reproductive years and it influences a range of functions including mood, learning, memory, and pain perception (Luine, 2014; Boulware & Mermelstein, 2005). However, the link between progesterone on cognition and mood has yielded mixed evidence (Barros et al., 2015; Henderson, 2018; Sofuoglu et al., 2011; Standeven et al., 2020).

The Menstrual Cycle and Mental Health Symptoms

Women and girls with ADHD often experience comorbid conditions such as depression and anxiety (Bolea-Alamañac et al., 2014) as well as an increased risk of suicide and self-harm compared to males with ADHD (Hinshaw, 2018; Beauchaine et al., 2019; Garas & Balazs, 2020; Kakuszi et al., 2018). Furthermore, women and girls with ADHD experience worse life outcomes such as adverse health (Nigg, 2013), social connection and peer issues (Kok et al., 2020; Robison et al., 2008) and academic struggles (Zalecki & Hinshaw, 2004).

Research has found that the symptoms of some mental health conditions such as depression and binge eating disorder (Martel et al., 2008, 2017; Klump et al., 2013) can increase in severity during the late luteal phase, because of hormonal surges (Schmidt et al., 2017) or perimenstrual steroid withdrawals (Eisenlohr-Moul et al., 2022). Mood conditions such as Premenstrual Syndrome (PMS) and Premenstrual Dysphoric Disorder (PMDD) involve symptoms that become more severe in the luteal phase, including cognitive functioning disruptions and mild to extreme emotional dysregulation including increased risk of suicide and non-suicidal self-injury (Green et al., 2016; Gehlert et al., 2008; Halbreich et al., 2003; Hantsoo & Epperson, 2015; Rapkin & Akopians, 2012; Le et al., 2020). The underlying relationship between hormonal fluctuations and symptom presentation for conditions like PMS and PMDD is relatively newly-recognised (Le et al., 2020). This relationship highlights the importance of understanding the impact that the menstrual cycle can have on mood, cognition, and emotions in order to develop comprehensive, gender-inclusive diagnostic procedures and treatments.

ADHD and Hormonal Fluctuations

Many women with ADHD have described changes in their ADHD symptoms throughout their menstrual cycle, particularly in the luteal phase, when symptoms are reported as becoming more severe (McCarthy, 2019; Rodgers, 2023; Rodgers & Kalyn, 2023; Rodgers & Kalyn, 2024). However, due to longstanding gender-bias in ADHD research (Clayton & Tannenbuam, 2016) there has been a lack of clinical interest, leaving the relationship between hormonal fluctuations and ADHD symptoms mostly unexamined (Nassbuam, 2012; Eng et al., 2024).

Research exploring the interplay between menstrual hormonal fluctuations and cognition and emotions for healthy women is limited and mixed (Haimov-Kochman & Berger, 2014; Garcia et al., 2018; Klump et al., 2013; Sandstrom & Williams, 2001; Schiller et al., 2016). Some evidence suggests that menstrual hormonal fluctuations can impact the functioning and structural neuroplasticity (Catenaccio et al., 2016) of key brain regions associated with processing and regulating emotional information (Sacher et al., 2013; Dubol et al., 2022). Systematic reviews exploring this interplay for females with ADHD are even more limited (Kok et al., 2020; Camara et al., 2021); however, foundational research has provided some evidence to suggest a link between worsening ADHD symptoms in the luteal phase. Quinn's (2005) single case study of a female patient with ADHD described a repeated pattern of worsening ADHD symptoms (e.g. moodiness and increased inattentiveness) the week prior to menstruation; these symptoms lessened in the weeks after her period. Roberts et al (2018) examined the impact of hormonal fluctuations on daily ADHD symptoms for 32 women. It was found that hormonal fluctuations typical of the luteal phase (low E2 levels in the presence of higher-than-average progesterone or testosterone), predicted next day increases in ADHD symptoms such as inattentiveness. However, this study measured ADHD

symptoms in naturally cycling women rather than specifically examining females with ADHD.

Impact of Menstrual Cycle on ADHD and Effective Pharmacotherapy

Pharmacotherapy, primarily psychostimulants, is often the first-line treatment for ADHD symptom management (Kok et al., 2020). However, despite females being at increased risk of clinically relevant drug reactions (Franconi & Campesi, 2014; Stolarz & Rusch, 2015), sex differences in the effects of ADHD medication treatment have only recently gained clinical attention. For healthy females, decreased estrogen levels and increased progesterone levels (typical of the luteal phase) result in weakened sensitivity to amphetamines and thus reduced effectiveness (Justice & de Whit, 1999; Terner & de Whit, 2006; Vansickel et al., 2010; Franconi et al., 2007).

Emerging research has also suggested that menstrual hormonal fluctuations may impact pharmacotherapy treatments for females with ADHD (Quinn, 2005; Quinn & Madhoo, 2014; Kok et al., 2020; Jong et al., 2023). Quinn's (2005) case study reported a reduction of ADHD symptom severity during the luteal phase after adjusting for additional psychostimulants in the week before menstruation. Jong et al (2023) found similar results for nine patients who reported worsening ADHD symptoms and decreased responsiveness to psychostimulants during the luteal phase compared to the follicular phase. When psychostimulant dosage was increased during the premenstrual week, all 9 women reported positive changes in their premenstrual mood and ADHD symptoms, despite between-subject variations (e.g. age, type of psychostimulant or co-occurring conditions) (Jong et al., 2023).

Additionally, evidence suggests that lower estrogen levels can negatively impact dopamine neurotransmission which is an essential regulator of cognition-emotion integration and processing (Eng et al., 2024). Disrupted or hypofunctioning (del Campo et al., 2011) dopaminergic systems have been implicated in the aetiology and expression of ADHD symptoms (Swanson et al., 2007; Volkow et al., 2009; Quinn & Madhoo, 2014; Şahin et al., 2022). Researchers have theorised that the drop in estrogen levels typical of the luteal phase may exacerbate the already compromised dopamine transmission in females with ADHD, resulting in worse ADHD symptoms and reducing the perceived effectiveness of previously established psychostimulant dosage (Quinn & Madhoo, 2014; Jong et al., 2023). Consequently, researchers and medical practitioners have suggested adjusting dosage patterns to account for menstrual phases as a critical step in developing comprehensive treatments (Quinn, 2005; Nassbuam, 2012; Kok et al., 2020; Jong et al., 2023). Effective treatment planning and collaboration may also prevent women from making adjustments to psychostimulant dosages independently, without proper monitoring (Jong et al., 2023).

Hormone Sensitivity and ADHD

While research on the interplay between ADHD and the menstrual cycle is still relatively new, mixed evidence suggests that individual differences in neurobiological sensitivity to normal hormonal events like the menstrual cycle may play a critical role in symptom severity for several psychopathologies (Garcia et al., 2018; Klump et al., 2013; Schiller et al., 2016, Eng et al., 2024). Eng et al's (2024) Multiple Hormone Sensitivity Theory (MHST) suggests the link between ADHD and the menstrual cycle could be a result of a neurobiological sensitivity to normal hormonal fluctuations, like decreases in estrogen. During the luteal phase, these fluctuations may lead to decreased executive cognitive functioning, producing symptoms like inattentiveness, emotional dysregulation, lower mood and negative affect (Eng et al., 2024; Peters et al, 2025). MHST postulates that estrogen withdrawal sensitivity (EWS) also impacts dopaminergic responses during the luteal phase when E2 is low, resulting in temporary impairments with executive functioning and emotion/behaviour regulation due to altered dopamine functioning in the prefrontal cortex as well as increases in anhedonia and reward responsivity due to reduced dopamine functioning in mesolimbic regions (Peters et al., 2025).

Current Theoretical and Clinical Limitations

While this emerging research is promising, more needs to be done to explore the relationship between ADHD and the menstrual cycle, especially as prevalence rates continue to rise. Updated clinical knowledge can be used to improve psychological tools and interventions to ensure they become more inclusive of sex and gender differences. Further research will also help clinicians to consider patients' symptom changes throughout their menstrual cycle and develop effective, person-centred treatments, including personalised dosage and timing adjustments to psychostimulant medication (Quinn, 2005; Jong et al., 2023). Understanding this connection is also important for duty of care as clinicians need to be aware of the elevated risk of poor mental health symptoms already associated with specific hormonal events for females with ADHD such as puberty or menopause (Chronis-Tuscano et al., 2010; Flory et al., 2006; Molina et al., 2007; Molina & Pelham, 2003; Eng et al., 2023; Hua et al., 2020; Meinzer et al., 2017). These gaps in current literature highlight the need for research that explores the connection between the menstrual cycle and ADHD to improve overall life outcomes for women and girls with ADHD.

Current Study

This study aimed to examine the relationship between ADHD symptoms and the menstrual cycle. Specifically, we aimed to explore the possible interplay between the luteal phase of the menstrual cycle, the subjective experience of ADHD symptom severity and the perceived effectiveness of ADHD medication in females with ADHD. The study addressed two key research questions:

1. During the luteal phase, do females with ADHD experience a significant change in their ADHD symptoms compared to females without ADHD when measured using the same symptom scale?
2. Do females with ADHD who do not take ADHD medication to manage their symptoms experience worse ADHD symptoms in the luteal phase compared to those who do take ADHD medication to manage their symptoms?

Based on Roberts et al's (2018) study of ADHD symptoms in healthy female participants, it was hypothesised that females in both the ADHD and non-ADHD groups would experience more severe ADHD symptoms in the luteal phase compared to the follicular phase. However, it was hypothesised that females with ADHD would report more significant changes in their ADHD symptoms during the luteal phase compared to females without ADHD during the luteal phase. Finally, as pharmacotherapy is often regarded as the first line of symptom management for ADHD (Kok et al., 2020), it was hypothesised that females with ADHD who do not take ADHD medication would report more significant changes in their ADHD symptoms during the luteal phase compared to females with ADHD who do take ADHD medication.

Method

Design

This study involved an online cross-sectional survey design. The study was part of a larger survey on the relationship between the menstrual cycle and ADHD symptoms. For the purposes of the current paper, the primary predictor variables included ADHD group (two levels: ADHD and non-ADHD) and medication use group (two levels: medicated and unmedicated). Source of Diagnosis (two levels: clinician-diagnosed and self-diagnosed) was also included as a predictor variable to examine within-subject differences for ADHD participants. The primary outcome variables included self-reported ADHD symptoms during the luteal phase and follicular phase of menstruation using two measures: WURS-25 total score (a measure of ADHD symptoms) and ASRS total score (a measure of ADHD symptoms). The total scores for WURS-25 and ASRS for ADHD symptoms during the luteal and follicular phases of the menstrual cycle, respectively, were combined to create a total score for the luteal phase and follicular phase. Additional outcome variables included changes in medication effectiveness and duration which were measured using two separate self-report scales.

Participants

Participants consisted of members of the general Australian public who were assigned female at birth, were adults aged 18 or over, and who identified as either having ADHD or not having ADHD. The study's target demographic was biological females within the reproductive hormonal phase of life (approximately 18-35 years) who were not experiencing other significant hormonal events. Participants who indicated they were pregnant, breastfeeding, less than 6 months postpartum, perimenopausal, post-menopausal, previously diagnosed with PMDD or undergoing hormone therapy were excluded from participating. Participants who answered "Male" for their assigned sex at birth were excluded from the study.

Of the 399 who completed the survey, 5 participants were removed using listwise deletion due to completing less than 50 per cent of the survey datapoints. Proration substitution was used to impute missing data deemed Missing at Random for adequately sampled participants and variables (approximately 0.25 per cent of total items). After data cleaning, 394 participants were retained. Ethical clearance was obtained through the Human Research Ethics Committee (Approval Number: H-2024-0130).

Materials

The survey collected primarily quantitative data including demographic information, standardised measures for self-reported ADHD symptoms as well as measures for changes in medication effectiveness and duration.

Demographics

Demographic variables included age, gender identity and sex, as well as items assessing for the exclusion criteria. Demographic items also included menstrual regularity and forms of contraception currently being used.

ADHD Diagnosis. ADHD diagnosis was measured using the item "Have you been diagnosed with ADHD?". Participants who answered "Yes, diagnosed by a clinician" and "Yes, self-diagnosed based on my knowledge of the condition" were categorised into the ADHD group, while those who answered "No" were categorised into the non-ADHD group. Participants in the ADHD group were divided into the "Medicated" or "Unmedicated" group based on a yes or no response to the question: "Do you take ADHD medication on a regular basis to manage your ADHD symptoms?"

Standardised Measures for ADHD Symptoms

Wender Utah Rating Scale (WURS-25). The WURS-25 is a 25-item self-report instrument designed to retrospectively screen for the presence and severity of childhood ADHD symptoms among adults (Ward et al., 1993). It uses a 5-point Likert scale to evaluate ADHD symptoms with item scores ranging from *not at all or very slightly* (0), to *very much* (4). The WURS-25 was used to screen all participants for childhood ADHD symptoms. This assessed the baseline presence of ADHD symptoms within the ADHD and non-ADHD groups as well as any differences between clinician-diagnosed participants and self-diagnosed participants. The WURS-25 was also used to assess the presence and severity of ADHD symptoms within the context of the menstrual cycle. Participants were asked to answer a series of 25 questions, and using a side-by-side matrix design completed the WURS-25 within the context of their menstrual cycle. The original WURS-25 prompt was altered to allow the assessment to be relevant to the luteal phase ("In the week leading up to the start of your period") and the follicular phase ("In the week after your period has ended"). Due to this section of the study focusing on present day ADHD symptoms within the context of menstruation, the wording of items 6, 10, 20, 22 and 23 were modified to allow for more adult-centric language (e.g. "work" replacing "school").

The WURS-25 has excellent internal consistency (α = 0.94) (Kouros et al., 2018), good concurrent validity with other measures of attention performance (Mackin & Horner, 2005) and has been identified as an important aid for diagnosing ADHD in adults given the diagnostic requirement for childhood onset of this condition (American Psychiatric Association, 2013). Additionally, the WURS-25 has been found to have high sensitivity and specificity (96 per cent; Ward et al., 1993).

Adult ADHD Self-Report Scale (ASRS). The ASRS (Kessler et al., 2005) is an 18-item self-report questionnaire designed to assess ADHD symptoms in adults. It uses a 5-point Likert scale to measure ADHD symptoms' presence and severity, with item ratings including *never, rarely, sometimes, often* and *very often.* Responses are scored as 0 or 1 depending on the item. The ASRS total score represents a measure of ADHD severity.

The ASRS was presented using a side-by-side matrix and the same prompts for the luteal and follicular phases, respectively. The ASRS has high internal consistency (α = 0.88) and concurrent validity (r = 0.84) with other measures of ADHD (Adler et al., 2006). The ASRS has been found to have high sensitivity (1.0) and moderate specificity (0.71) (Hines et al., 2012), making it a useful measurement tool for assessing the presence or lack thereof of ADHD symptoms.

Procedure

The current study was advertised using pay-per-click Facebook advertising, targeted at Australian females aged between 18 and 35 years. The advertisement included a brief description of the study, the inclusion criteria and the incentive for participating in the study (the chance of winning one of two $50 online gift cards). Potential participants clicked the "Learn more" button which redirected them to the study's Question Pro link. This presented the study's Information Statement. Participants provided implied consent by clicking "Continue to the survey". Participants then completed the demographic questions followed by the WURS-25 screener for baseline ADHD symptoms. Based on their responses to previous items, participants were not required to complete items not relevant to them based on their ADHD, Source of Diagnosis or Medication grouping.

Participants completed the ASRS and the adapted WURS-25 to measure their ADHD symptoms throughout the luteal and follicular phases of menstruation. Participants in the medicated ADHD group were presented with quantitative items for medication effectiveness and medication duration. On completion of the study, participants were directed to the exit page which included information on relevant support services, researcher contact information and a link to an additional survey to indicate whether they would like an update of the study's results as well as the chance to enter the random draw to win a $50 gift card. Participation was voluntary and took approximately 15 – 20 minutes to complete online using a mobile phone, tablet, or computer device.

Data Analysis

The demographic variables were analysed using descriptive statistics. A repeated measure, two-way mixed ANOVA was used to analyse the main effect and interaction effect of the predictor variable (ADHD group) on the outcome variable (ADHD symptoms in the luteal phase and follicular phase, respectively). An independent samples t-test was used to explore the difference of the predictor variable (medication effectiveness and duration) between medicated and unmedicated participants. All analyses were conducted using JASP software version 0.19.1 (JASP, 2024).

Results

Participant Characteristics

Participants described themselves as either having ADHD (*n* = 357) or not having ADHD (*n* = 37) (see Table 1). This uneven split was expected given the study's recruitment advertisements targeting people with ADHD as the primary population of interest. The mean age for both groups fell within the standard age range for the reproductive hormonal phase (Holland, 2018; Bellieni, 2016). Most participants identified as women/female; however, the ADHD group also included gender diverse participants. Over 80 per cent of participants in both groups reported regular menstruation. Over 60 per cent of participants in both groups reported not using any of the listed forms of contraception.

Within the ADHD group, there was an uneven split between clinician-diagnosed (*n* = 291) and self-diagnosed *(n* = 66) participants. Almost 80 per cent of clinician-diagnosed participants reported using ADHD medication to manage their symptoms.

Table 1.
Demographic Information Categorised by ADHD Group

	ADHD Group	
	ADHD[a] *M (SD)*	Non-ADHD[b] *M (SD)*
Age	29.80 (6.16)	28.00 (0.67)
	Count (%)	Count (%)
Gender Identity		
Women/female	330 (92.44)	37 (100)
Non-binary	18 (5.04)	0 (0)
Gender-fluid	4 (1.12)	0 (0)
Other	4 (1.12)	0 (0)
Not specified	1 (0.28)	0 (0)
Menstrual Regularity		
Regular	311 (87.12)	32 (86.49)
Irregular	46 (12.89)	5 (13.51)
Forms of Contraception		
Oral contraceptive pills	53 (14.85)	8 (21.62)
Contraceptive patches	0 (0)	0 (0)
Contraceptive implant or injection in your arm	18 (5.04)	0 (0)
Contraceptive vaginal ring	1 (0.28)	0 (0)
Intrauterine device (IUD)	46 (12.86)	4 (10.81)
I don't use any of these forms of contraception	239 (66.95)	25 (67.568)

Note. [a]*n* = 357 for ADHD. [b]*n* = 37 for non-ADHD.

Group Differences in the WURS-25 ADHD Screening Assessment

ADHD group. To check the validity of the ADHD and non-ADHD group allocations, an independent samples t-test was conducted to analyse if total scores for the WURS-25 screening assessment was significantly lower for the non-ADHD group compared to the ADHD group. No significant outliers were identified in either group. All test assumptions were met. However, due to expected deviation from normal distribution, a parametric Student test and non-parametric Mann-Whitney test were both conducted (Kim, 2013; Mishra et al., 2019). Both tests showed non-ADHD participants had significantly lower baseline ADHD symptoms (*M* = 22.11, *SD* = 12.71) compared to ADHD participants (*M* = 47.60, *SD* = 11.77) on the WURS-25 screening: *t*(392)= -12.44, *p*< .001 (one-tailed). Cohen's *d* (-2.19) confirmed a large effect size (Cohen, 1988).

Source of Diagnosis. To assess the validity of the decision to include self-diagnosed ADHD participants in the ADHD group, an independent samples t-test was conducted to assess differences in WURS-25 screening scores between clinician-diagnosed and self-diagnosed participants. No outliers were identified and all test assumptions were met. There was no significant difference in ADHD symptom scores between clinician-diagnosed (*M* = 47.80, *SD* = 11.88) and self-diagnosed participants (*M* = 46.71, *SD* = 11.34): *t*(355)= -0.68, *p*=0.50 (two-tailed). These results met threshold for clinical sensitivity, with scores 36 and above suggesting retrospectively rated childhood ADHD symptoms that are consistent with adults who have an ADHD diagnosis (Brevik et al., 2020). This result confirmed similar ADHD symptom severity in participants with clinician-diagnosed and self-diagnosed ADHD.

Group Differences in ADHD Symptoms Throughout the Menstrual Cycle

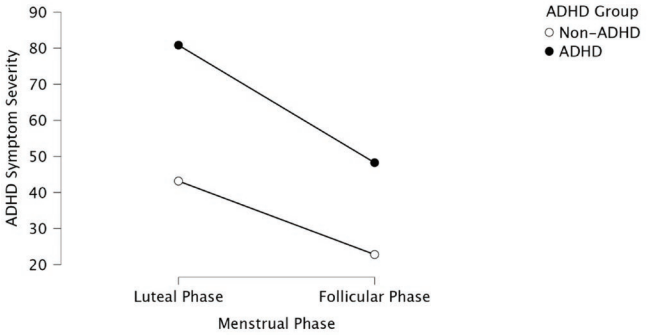
A repeated measures 2x2 mixed ANOVA was conducted to investigate the within-subjects main effect of ADHD symptoms. This test also investigated the between-subjects interaction effect of ADHD group on ADHD symptoms, to test the hypothesis that ADHD participants experience worse ADHD symptoms in the luteal phase compared to non-ADHD participants. Age was also included as a covariate. One outlier was removed for exceeding the 3.29 z-score cutoff (Tabachnick & Fidell, 2019). Pairwise deletion was used to exclude cases per dependent variable due to missing data (*n* = 1). All test assumptions were met.

Menstrual Phase. As predicted, a significant main effect was found for both groups $F(1, 389) = 14.21$, $p < .001$, $\eta^2_p =$

0.04, showing more severe ADHD symptoms in the luteal phase compared to the follicular phase. This represented a small to moderate effect size (Cohen, 1988). Age was not a statistically significant covariate for either ADHD symptoms (p=0.08) or ADHD group (p=0.14).

ADHD group. There was a significant between subjects main effect for ADHD group F(1, 389) =139.30, p<.001, η^2_p = 0.26, yielding a large effect size. These results indicate that ADHD participants experienced more severe ADHD symptoms than non-ADHD participants, regardless of menstrual phase (see Figure 1). Furthermore, there was an interaction between ADHD group and ADHD symptoms F(1, 389) =12.11, p<.001, η^2_p = 0.03, supporting the hypothesis that while all participants would experience more severe ADHD symptoms in the luteal phase, this effect would be more pronounced for those with ADHD than those without ADHD. This represented a small to moderate effect size.

Figure 1.
Comparison of ADHD Symptom Severity During the Luteal and Follicular Phases for ADHD and non-ADHD Groups



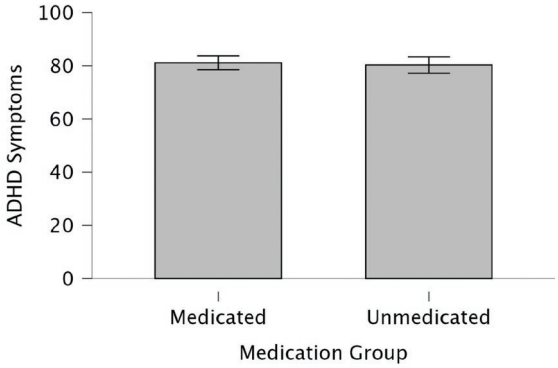
Post-hoc analyses were conducted using the Bonferroni correction. For the main effect of ADHD symptoms, ADHD symptoms were more severe in the luteal phase compared to the follicular phase (M = 26.66, SE = 1.68, p<.001) and that between the groups, ADHD participants reported more severe ADHD symptoms than non-ADHD participants (M = 31.89, SE = 2.70, p<.001). For the interaction effect, Bonferroni corrected post hoc tests showed significant between group differences for each level of ADHD symptoms (all p<.001) with the exception of non-ADHD participants' luteal symptoms compared to ADHD participants' follicular symptoms (M = -5.22, SE = 3.38, p=0.74).

A supplementary analysis to investigate group differences between self-diagnosed and clinician-diagnosed ADHD participants showed no significant main effect or interaction effect, suggesting both groups have similar experiences of ADHD symptoms throughout both menstrual phases.

Differences in ADHD Symptoms During the Luteal Phase Between the Medication Use Groups

To test the hypothesis that unmedicated participants would have worse ADHD symptoms during the luteal phase compared to medicated participants, an independent samples t-test was conducted. Assumption checks revealed violations of normality and equal variance. Therefore, a non-parametric Mann-Whitney test was conducted alongside a parametric Student test. Both tests revealed no statistically significant differences in luteal symptoms between medicated (Mdn = 84.0)[1] and unmedicated participants (Mdn = 82.0), W=15041.50, p=0.20 (one tailed). The hypothesis was therefore not supported.

Figure 5.
Comparison of ADHD Symptoms in the Luteal Phase Between Medicated and Unmedicated Participants



Discussion

The present study aimed to investigate the relationship between self-reported ADHD symptoms and the menstrual cycle. The results largely supported the hypotheses and were consistent with previous research. All groups experienced worse ADHD symptoms in the luteal phase compared to the follicular phase, although this effect was more pronounced for ADHD participants. Contrary to our hypothesis, unmedicated participants with ADHD did not report worse ADHD symptoms in the luteal phase compared to medicated participants with ADHD.

ADHD Group Differences for ADHD Symptoms

As hypothesised, both ADHD and non-ADHD groups experienced worse ADHD symptoms in the luteal phase compared to the follicular phase. These results are consistent with past research which found worse ADHD symptoms in the luteal phase for females with ADHD (Quinn, 2005; Jong et al., 2023) and without ADHD (Roberts et al., 2018). These results align with the growing literature that has linked hormonal fluctuations in the luteal phase with detrimental impacts on mood and cognitive functioning (Haimov-Kochman & Berger, 2014; Le et al., 2020; Sacher et al., 2013; Barth et al., 2015). This provides a plausible explanation for both groups experiencing worse ADHD symptoms during the luteal phase. However, the present study relied on subjective, self-reported data for symptom changes throughout the menstrual cycle, rather than using precise biological measures of hormonal fluctuations such as saliva samples (Roberts et al., 2018). Therefore, our findings are unable to provide insight into the impact of specific hormonal fluctuations (e.g. estrogen and progesterone levels) on ADHD symptoms, although they do contribute to the literature which speaks more generally to the impact of the luteal phase on ADHD symptoms, mood and cognition.

The interaction effect of ADHD group and ADHD symptoms highlighted that negative change in ADHD symptoms during the luteal phase was significantly more pronounced for ADHD participants. These results are partially consistent with previous research which has found that females with ADHD experience worse ADHD symptoms during the luteal phase compared to the follicular phase (Quinn, 2005; Jong et al., 2023), although these studies did not have a non-ADHD comparison

[1]When conducting a non-parametric Mann Whitney test the median value is reported instead of the mean (Ziegel & Wadsworth, 1999; Gibbons & Chakraborti, 2020).

group. To our knowledge, no other study has directly compared ADHD and non-ADHD groups on ADHD symptoms during the luteal phase. These novel findings provide preliminary support for MHST (Eng et al., 2024), suggesting that females with ADHD might be more neurobiologically sensitive to menstrual hormonal fluctuations compared to females without ADHD.

The estrogen withdrawal sensitivity concept may provide further explanation for our findings; ADHD participants may be more sensitive to the decline in E2 typical of the luteal phase due to their baseline difficulties in executive functioning and dopaminergic functioning (Eng et al., 2024; Peters et al., 2025). This underlying sensitivity may therefore exacerbate ADHD symptoms like executive functioning and emotional dysregulation more so than those without ADHD. Due to design limitations, the present study was limited with what conclusions could be drawn about the impact of specific hormonal fluctuations. However, using EWS as a framework for these results, it is plausible to infer that the luteal hormonal fluctuations such as the decline of E2 levels may play a key role in the premenstrual exacerbation of ADHD symptoms. These findings may also offer new insights for the research investigating the link between ADHD and prevalence rates of PMS and PMDD (Dorani et al., 2021; Jong et al., 2023).

Medication Use Group Differences for ADHD Symptoms

The results did not support our hypothesis that medicated participants would experience less severe changes in their ADHD symptoms in the luteal phase compared to non-medicated participants. To our knowledge, no pre-existing study has examined the impact of the menstrual cycle on ADHD symptoms between medicated and unmedicated participants. These novel results are surprising given that pharmacotherapy is considered the first line of ADHD symptom management (Kok et al., 2020). It would be reasonable to assume that medication would provide at least some protection against the impacts of the luteal phase on ADHD symptoms compared to those without such first line defences, however our results suggest this is not the case. This effect may be partially explained by the research regarding the reduced effectiveness of previously established psychostimulant dosages for females with ADHD during the luteal phase (Quinn & Madhoo, 2014; Jong et al., 2023). However, it does not explain why the effectiveness is reduced to the point of being on par with unmedicated participants' luteal phase symptoms.

Considering preliminary studies have found that adjusting dosage patterns to account for the luteal phase has positive and protective effect on ADHD symptoms (Quinn, 2005; Nussbaum, 2012, Kok et al., 2020; Jong et al., 2023), it can be inferred that medication is not rendered completely ineffective during the luteal phase. Perhaps the nuance of perceived medication effectiveness lies in the idea of one's previously established psychostimulant dosage. It could be theorised that with an established dosage comes a tolerance for baseline ADHD symptoms. Tolerance is the phenomenon where the effect of a drug decreases from repeated administration, thereby requiring an increased dosage to maintain the intended effect (Bespalov et al., 2016). Therefore, during the luteal phase, without additional dosages, the perceived changes in baseline ADHD symptoms exceeds one's medication tolerance levels so much so that it amounts to the same relative experience as an unmedicated person's perceived changes in baseline ADHD symptoms. However, the effect of tolerance in psychostimulant medication treatment for ADHD is limited and mixed (Handelman & Sumiya, 2022; Barnard-Brak et al., 2023). Our findings provide new insights into the interplay between the menstrual cycle, ADHD symptoms and pharmacotherapy and should be considered for future studies that compare symptom differences between medicated and unmedicated participants.

Strengths and Limitations

The current study design allowed for multiple group comparisons within the context of the luteal phase, many of which had not previously been compared (e.g. medicated and unmedicated participants with ADHD). These comparisons yielded novel findings that contribute new insights to the emerging research such as the MHST, particularly the EWS concept (Eng et al., 2024). Even partially-novel results like the findings that ADHD medication effectiveness and duration is reduced in the luteal phase, contribute supporting evidence to the limited literature base that currently exists on the relationship between pharmacotherapy, ADHD and the menstrual cycle (Quinn, 2005; Quinn & Madhoo, 2014; Kok et al., 2020; Jong et al., 2023).

A methodological strength of the present study included the large community sample of females with ADHD. As women and girls with ADHD have been historically underrepresented in clinical research, such a large sample focusing on women's experiences provides an important contribution to the literature. It also allowed within-group comparison for ADHD participants (e.g. medicated and unmedicated), providing novel contributions to comparisons not yet explored in the literature.

A methodological limitation of this study included the cross-sectional survey design which was reliant on the subjective, self-reported data of participants' perception and experiences as opposed to previous research that used objective, biological measures for hormonal fluctuations (Roberts et al., 2018). Consequently, the present study was unable to assess the specific hormonal fluctuations (e.g. E2 or progesterone levels) that may have been underlying the luteal changes in ADHD symptoms. This ultimately reduced the strength of our study's supporting evidence for MHST (Eng et al., 2024). However, our findings still contributed more broader supporting evidence for MHST, particularly the possible heightened sensitivity of ADHD participants in the luteal phase.

The study's cross-sectional design also meant that participants retrospectively reported changes in ADHD symptoms and medication effectiveness, unlike previous studies which measured daily ADHD symptoms (Quinn, 2005; Roberts et al., 2018; Jong et al., 2023). Research suggests that using retrospective self-report measures to assess premenstrual symptoms carries a significant bias of false positive reports compared to using daily-rating measures (Eisenlohr-Moul et al., 2015; Rubinow et al., 1984). This limitation should be taken into consideration when assessing the strength of our findings, due to the possibility of false positive reports of changes in ADHD symptoms during the luteal phase.

Clinical Implications and Future Research

As women experience menstruation for a significant portion of their life, it is vital that clinicians consider the ongoing impact of the menstrual cycle on their patients, especially during the luteal phase. Not doing so may result in sub-optimal treatment and worse health outcomes for women and girls. Clinicians should work collaboratively with patients to include the menstrual cycle in the diagnostic and treatment planning process, especially for patients experiencing significant hormonal transitions that are associated with negative impacts on mental health, such as puberty or menopause (Eng et al., 2024). Using daily measures of ADHD symptoms over the course of consecutive menstrual cycles may also be helpful in mapping patient's symptom changes throughout their cycle (Quinn, 2005; Quinn & Madhoo, 2014; Jong et al., 2023). This allows clinicians to develop a comprehensive understanding of their patients' unique ADHD symptom presentation throughout their menstrual cycle, including identifying at-risk periods for their patient's mental health. Ultimately this can aid the development of well-

informed treatment plans tailored to their patient's cycle.

Psychoeducation should be prioritised, as some patients may lack insight into the structure of the menstrual cycle and would benefit from learning about the associated hormonal fluctuations and the potential impacts on symptom presentation and medication effectiveness (Quinn, 2005; Jong et al., 2023). Without psychoeducation, patients may lack the awareness and sense of timing necessary to report the impact of cycle phases on their ADHD symptoms (Jong et al., 2023). Furthermore, the combination of insufficient psychoeducation and lack of patient-clinician collaboration may result in patients adjusting their own dosage to compensate for changes to their ADHD symptoms without the supervision or guidance of their clinician (Kok et al., 2020; Quinn & Madhoo, 2014; Jong et al., 2023). Therefore, clinicians should ensure that ADHD medication is titrated throughout the menstrual cycle, with dosage and timing adjusted accordingly, ensuring optimal symptom management.

Future studies involving females with ADHD should consider the menstrual cycle and hormonal fluctuations, particularly the impacts of the menstrual cycle on the effectiveness of psychostimulants. Considering the limited literature base (e.g. small sample case studies), future research should incorporate study designs that strive for higher quality of evidence such as large sample sizes, randomised and double-blind clinical trials with placebo/control arms. Longitudinal study designs should be prioritised, measuring at minimum two consecutive menstrual cycles to facilitate more consistent mapping of the participants' cycle phases and hormonal fluctuations (Schmalenberger et al., 2021; Jong et al., 2023).

In line with best practice guidelines for menstrual cycle studies, future research should measure changes in ADHD symptoms on a daily basis, rather than retrospectively or prospectively to avoid false positive bias (Schmalenberger et al., 2021). Finally, prioritising objective, biological measures for hormonal fluctuations would allow for new, more precise insights into the hormonal fluctuations within specific phases of the menstrual cycle.

Conclusions

The results from this study support existing research exploring the relationship between ADHD symptoms and the menstrual cycle, while also offering novel findings that offer new contributions to the literature base. Overall, these results substantiate the need for researchers and clinicians to consider the impact of the menstrual cycle, particularly the luteal phase when working with women and girls with ADHD. Future research should prioritise appropriate study designs in order to further explore this connection. Doing so may help establish better informed recommendations for effective and personalised treatment plans, which will ultimately improve health outcomes for women and girls with ADHD.

Statement of Contribution

The research question and study design were developed collaboratively by me and my supervisor, A/Prof Sean Halpin. I was responsible for developing and formatting all materials used in the study, including both the qualitative and quantitative aspects of the survey. I managed the data collection process, which involved recruiting participants, monitoring the progress of the study and ensuring accurate recording and storage of data. I conducted the data analyses and interpretation of results, under the guidance and supervision of A/Prof Sean Halpin. A/Prof Sean Halpin provided feedback on the Introduction, Method and Results sections of this thesis. All remaining written work, including the Abstract and Discussion sections and overall thesis editing, was completed independently by me.

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