Modeling Fertile Window Differences Across the Reproductive Lifespan with Quantitative Urine Hormone Monitoring of the Menstrual Cycle

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Abstract

Background

Reproductive hormones of the fertile window are often referenced to women in regular cycles, but this may not be representative of the hormonal profiles of women in different circumstances like polycystic ovarian syndrome, the postpartum period, and the perimenopause transition. This observational cohort study sought to identify the variability in the hormones of the fertile window in various reproductive categories and to establish potential thresholds for each category based on hormone measurements with the Mira urinary hormone monitor.

Results

A total of 57 women (ages 22–51) in various circumstances (regular cycles, polycystic ovarian syndrome, postpartum and perimenopause) tracked Mira urine hormone measurements (estrone-3-glucuronide, luteinizing hormone, pregnanediol glucuronide), contributing 444 cycles of data. Using additive mixed models, hormone values were stratified by the four different reproductive categories. The perimenopause and polycystic ovararian syndrome groups demonstrated relative hypoestrogenic states, while the perimenopause group showed low luteal pregnanediol glucuronide and the polycystic ovarian syndrome group showed high luteal pregnanediol glucuronide. The perimenopause group had higher luteinizing hormone values throughout the whole cycle.

Conclusion

The fertile window hormone thresholds vary depending on a woman's specific reproductive category. Women in different circumstances should not necessarily use the same hormonal thresholds for the fertile window and ovulation. A larger dataset with ultrasound correlation to ovulation is required to delineate the fertile window with more precision. Hormone differences across the menstrual cycle could be used for targeted treatments in polycystic ovarian syndrome and perimenopause women.

Background

In a recent clinical opinion article [1], Cromack and Walter described the rapidly expanding Femtech industry with a focus on wearables and personal devices to identify the fertile window. Marketing and use of these devices for menstrual cycle monitoring is outpacing evidence-based validation studies [1]. Of historic interest, the same climate of change was present over three decades ago at a conference sponsored by the World Health Organization [2]. Multiple studies presented the use of at-home tests to track the fertile window [3–6], including a new urine fertility monitor to avoid pregnancy[7]. By that time, ultrasound studies had already been published outlining criteria for the detection of ovulation [8], and at this conference Flynn[9] described ovulation on ultrasound in breastfeeding women. The current study

recapitulates this early work defining the fertile window and ovulation in various reproductive circumstances with an emphasis on the menstrual cycle as a vital sign for women's health [10–12]. However, a vital sign requires having validation, for example, valid tools to track bleeding [13], ovulation [1], and confirmation of whether ovulation has occurred [14,15]. This vital sign needs to take into account variability in cycle length[16] and phases of the menstrual cycle in various reproductive circumstances, not just regularly cycling women [17,18]. Monitoring the menstrual cycle parameters in postpartum and perimenopause women as well as those with polycystic ovarian syndrome (PCOS) using the new Mira fertility monitor was the aim of the present study, to understand the variability in hormones across the continuum of the menstrual cycle [19].

The Mira monitor measures the urinary metabolites of follicle-stimulating hormone (FSH), of estradiol in the form of estrone-3-glucuronide ($E_1$3G), of luteinizing hormone (LH), and of progesterone in the form of pregnanediol glucuronide (PDG) previously described in detail [20]. Urine hormone monitoring provides a non-invasive means of assessing underlying ovulatory function and menstrual cycle physiology[21] and Mira $E_1$3G has been compared to serum estradiol in a recent study [22]. In the follicular phase of the menstrual cycle, rising levels of estrogen from the dominant follicle trigger a surge of luteinizing hormone from the anterior pituitary gland. This LH surge typically occurs 24–48 hours before ovulation, leading to the release of a mature egg [23]. Following ovulation, the luteinized follicle (corpus luteum) produces progesterone, which is essential for preparing the endometrium for potential implantation [24]. Urine and serum reproductive hormone measurements demonstrate strong agreement [25], but unlike serum testing, which provides a measure of reproductive hormone levels at a single time point, daily first morning urine hormone testing enables a real-time analysis of hormone levels across the entire menstrual cycle. This could refine our understanding of menstrual cycle parameters, including follicular and luteal phase length, the fertile window, and timing of ovulation [20,26–28]. The Mira monitor was chosen for the current study based on pilot data demonstrating good acceptability and ease of use by participants [20].

Tracking the fertile window is challenging in women with polycystic ovarian syndrome (PCOS). The diagnosis of PCOS is based on meeting two of the following three consensus-based Rotterdarm criteria [29]: irregular cycles, clinical and/or biochemical signs of hyperandrogenism, and polycystic ovaries on ultrasound. With the cycle irregularities of PCOS, related to estradiol dysregulation [30] and abnormal gonadotropin LH secretion [31], the Mira monitor has the potential to provide clarity to women with PCOS regarding their hormone patterns by identifying whether an LH rise is appropriately followed by a progesterone rise suggesting corpus luteum formation. It may also provide a way to track pre- and post-treatment interventions for PCOS.

Another challenging time to navigate the menstrual cycle is during postpartum amenorrhea and the first few transition cycles that are longer than usual [32]. The ClearBlue Fertility Monitor (CBFM) has been used in combination with the Marquette Method of family planning to track the return of fertility postpartum [33,34], but does not provide quantitative hormone data so may incorrectly identify the day of ovulation [35]. Using the Mira monitor to track $E_1$3G, LH and PDG can help to identify which rises in

$E_1$3G and LH may potentially be ovulatory, with rising PDG to confirm the first ovulation postpartum. This would inform the postpartum return of fertility [36].

Finally, the perimenopause transition also presents difficulties related to irregular cycles, variable hormonal patterns and disturbing vasomotor symptoms due to these hormonal changes [37]. This transition has been categorized in detail based on the Stages of Reproductive Aging Workshop (STRAW) in 2012 [38]. Instead of using a woman's age as a marker for infertility, this system takes into account cycle length variability to describe reproductive stage and fertility. However, rather than just identifying cycle length variability, the Mira monitor may help to better delineate the hormonal transition as proposed in a recent case series [39].

In the current study, quantitative urine hormones ($E_1$3G, LH and PDG; due to insufficient FSH data, FSH was not included), referenced to the LH surge day (the estimated day of ovulation) and confirmed by a rise in PDG, were compared between four reproductive categories to outline group differences in hormones during the fertile window and phases of the menstrual cycle.

Methods

Aim, Design and Setting

This was an observational cohort study with prospective data collection using the Mira Monitor in various circumstances, with ethical approval by the Marquette University research ethics board (HR 4276, April 4, 2023) in accordance with the Declaration of Helsinki. Inclusion criteria were: (1) English-speaking women between the ages of 18 and 52, (2) using their own Mira monitor and test wands, in (3) the four reproductive categories (regular cycles, PCOS, postpartum and perimenopause). Women were excluded if they: (1) were on hormonal medications that would impact ovulation, (2) had a previous hysterectomy or oophorectomy. All participants provided informed consent to participate.

Recruitment was initiated via email to Marquette Method health care providers who teach women how to monitor their menstrual cycles. Eligible participants were asked to email the principal investigator (MS), who sent them a description of the study and links to complete: a consent form, a demographics form, and a chart data form. Participants consented to share their hormone data from an online Mira portal for health care providers. Forms and chart data were uploaded to a secure, private Marquette University OneDrive folder. Data was collected over 1 year, after which access to the portal was discontinued.

Definitions of reproductive categories

The definition of regular cycles was based on previously established criteria,[40] with consistent cycles (≤ 7 days variation between cycles) that were 24–38 days in length. Postpartum women were defined as being within delivery of a child in the last year and within the first 6 transition cycles postpartum after the initial postpartum amenorrhea, they self-reported their breastfeeding status. The diagnosis of PCOS was

self-reported but they had to confirm diagnosis by a clinician. Perimenopause participants were diagnosed based on the Stages of Reproductive Aging Workshop (STRAW) criteria [38] and were classified as early (> 7 day differences between cycle lengths), or late (there are > 60 days of amenorrhea).

Menstrual cycle monitoring with urinary hormones

Participants tracked their menses, cycle length and used the Mira Monitor to test hormones in their first morning urine. Participants could use a Mira test wand that measures three hormone metabolites ($E_1$3G, LH and PDG on the “Max” wand), or two test wands measuring the hormones separately ($E_1$3G, LH on the “Plus” wand, and PDG on the “Confirm” wand). The wands are lateral flow assays using double antibody fluorescent labelling detected by the optical receiver in the monitor. The $E_1$3G and PDG use a competition antibody assay, and the LH uses a sandwich assay (Fig. 2), previously described in detail [41].

Definition of the estimated day of ovulation (EDO)

Preliminary results and pilot studies [20] have suggested that the Mira LH surge happens the day before or the day of ovulation. Based on calculations in comparison to the ClearBlue Fertility Monitor LH surge [20], which has been validated by ultrasound, the probability of ovulation occurring on the day of or day after the Mira LH surge is close to 80%. Thus the estimated day of ovulation (EDO = Day 0) used in this study was the day of the Mira LH surge.

Statistical analysis

Demographic, clinical and hormonal characteristics were analyzed using R software (R version 4.3.2, The R Foundation for Statistical Computing). Continuous variables (age, BMI, cycle length, follicular/luteal phase length) were described with means and standard deviations, with differences between groups calculated with ANOVA and post-hoc pairwise comparisons ($p < 0.05$, with post-hoc Bonferroni corrections). Discrete variables (gravida, parity) were described with median and interquartile intervals and categorical variables (ethnicity, education) were described as percentages; group differences were calculated with non-parametric Mann-Whitney U test. Missing data was excluded.

The theoretical fertile window used for the statistical modeling was based on previously established criteria being 6 days up to and including the day of ovulation (EDO) [42]. Hormonal data were analyzed using additive mixed models, establishing a best fit based on smoothing splines for the hormones and random effects of individual women and individual cycles.

With our sample size, we were powered to detect an effect-size of 0.5 in hormonal differences with 90% power, with alpha of 0.05, calculated with G*Power 3.1.

Results

Participants and Demographics

An initial group of 141 women consented to be contacted for the study (Fig. 1). There were 65 participants who contributed sufficient data to be included in the study. Three of these participants withdrew their consent during the study and 5 participants were part of a chemotherapy menstrual cycle tracking group that was analyzed separately. This left a total of 57 participants contributing a total of 444 cycles of data, with an average of 11.6 days of Mira testing per cycle, summarized in Fig. 1 and Table 1. After 6 transition cycles postpartum, there were 10 women who overlapped with other groups: 9 women had regular cycles after the postpartum transition, and 1 woman was in early perimenopause after the postpartum transition. Some of the postpartum participants (20 of the 24 in this study) were previously analyzed in more detail.[36] Breastfeeding status was available for 20 of 24 postpartum participants, 5 were partial breastfeeding and 15 were fully breastfeeding at entry in the study, but transition from full to partial breastfeeding was not tracked in detail. Of the perimenopause participants, 9 were in early perimenopause and 5 were in late perimenopause (based on STRAW criteria cycle variability, FSH was not measured).

The population in this study was homogeneous (Table 1) - predominantly white, university educated women - not unlike previous studies of women who use hormone fertility monitors [43]. The perimenopause women were significantly older than the other 3 groups ($p < 0.001$). Perimenopause women had higher parity than the other 3 groups (Mann-Whitney U test p-values were all < 0.005). Women with PCOS had the lowest number of pregnancies and parity compared to all 3 groups (Table 1).

TABLE 1

Demographic and clinical characteristics

Characteristics	Regular Cycles (n=10+8)	Postpartum (n=24)	Perimenopause (n=13+1)	PCOS (n=10)
Age	32.3±4.2	32.9±5.1	46.2±2.9	30.2±5.0
Gravida	2.5 (1.25-5)	3.5 (2-5)	5.5 (4.25-9.5)	1 (0-3.25)
Parity	2 (1-3)	2 (2-4)	4 (3-6.25)	1 (0-1.0)
BMI	24.5±3.7	25.8±6.6	27.6±7.9	29.0±6.3
Race				
White	17 (94.4%)	20 (83.3%)	14 (100%)	9 (90%)
Black		2 (8.3%)		
Hispanic	1 (5.6%)	2 (8.3%)		
Other				1 (10%)
Highest Education				
High School	2 (11.1%)	2 (8.3%)	3 (21.4%)	2 (20%)
Undergraduate	9 (50%)	11 (45.8%)	7 (50%)	3 (30%)
Graduate	5 (27.8%)	7 (29.2%)	2 (14.3%)	4 (40%)
Unknown	2 (11.1%)	4 (16.7%)	2 (14.3%)	1 (10%)
Perimenopause				
Early			8 (71.4%)	
Late			4 (28.6%)	

Data are mean +/- standard deviation for continuous variables (age, BMI), median (interquartile range) for discrete variables (gravida, parity), and n (%) for categorical variables (Race, Education, STRAW perimenopause criteria). *BMI* = body mass index. Samples for each group include overlapping numbers + n for those cycles after 6 transition cycles postpartum, e.g. 8 participants with regular cycles after 6 transition cycles postpartum.

Cycle Characteristics

Cycle length was significantly longer for the postpartum transition cycles than for regular cycles ($p = 0.01$), but the other 3 groups did not significantly differ in cycle length (Table 2). Follicular phase length was longer (i.e. later peak day) in postpartum transition cycles, as previously described [36], than regular cycles ($p < 0.001$) and perimenopause women ($p = 0.001$), but not significantly different from PCOS women. Luteal phase length was shorter in postpartum women than all the other groups ($p < 0.001$).

Table 2
Cycle Parameters

Characteristics	Regular Cycles (n = 10 + 8)	Postpartum* (n = 24)	Perimenopause (n = 13 + 1)	PCOS (n = 10 + 3)
Cycle length	28.7 ± 3.3[a]	33.1 ± 22.9[a]	29.5 ± 7.3	30.5 ± 5.7
Follicular phase length	15.3 ± 3.1[b]	22.4 ± 22.8[b,c]	16.6 ± 6.8[c]	17.8 ± 6.1
Luteal phase length	13.4 ± 1.6[d]	10.6 ± 2.7[d,e,f]	12.9 ± 2.8[e]	12.8 ± 2.1[f]

Data are mean +/- standard deviation. *LH*, luteinizing hormone. *Postpartum cycle parameters exclude postpartum amenorrhea. Significant paired-samples differences are shown by superscript letters: [a]p=0.01, [b]p<0.001, [c]p=0.001, [d,e,f]p<0.001.

Hormone Profile Modeling

Hormone profiles ($E_1$3G, LH and PDG) were modelled for each group with additive effects for each reproductive category and random effects per woman and per cycle (Figs. 3–6). Raw data with threshold values for each hormone on days − 5, 0 and + 5 are shown in Table 3. In Figs. 3–5, non-overlapping standard error bands indicate a significant difference between the groups.

There is a significant difference in $E_1$3G levels among all reproductive categories, with women in regular cycles having higher levels overall, especially in the fertile window and the luteal phase. The perimenopause group reflected an overall hypoestrogenic state, with less of a decline in estrogen through the luteal phase than the other groups. The PCOS group also had a relatively hypoestrogenic state compared to the postpartum and regular cycles group in the follicular phase and fertile window (Fig. 3).

The perimenopause group had higher LH values throughout the whole cycle, as shown in the model (Fig. 4) which made the LH surge in the model higher than the other groups, even though the raw data shows that the Postpartum group clearly has higher LH values (Table 3). The LH surge is concentrated in all groups around the EDO (day 0).

Urinary progesterone metabolites (PDG) clearly showed the luteal phase shift. The PCOS group had the highest PDG levels, overlapping with the regular cycles group, significantly higher than both postpartum and perimenopause. The postpartum group had the lowest PDG in the model (Fig. 5) but the perimenopause group had the lowest PDG in the raw data (Table 3).

A summary of all three hormone profiles stratified by group is shown in Fig. 6, showing the group differences described above, demonstrating the hypoestrogenic state of the PCOS and perimenopause

groups and the hypoprogestogenic state of perimenopause and postpartum groups.

Discussion

Principal findings and results

The fertile window delineated by urine hormone metabolites using the Mira monitor varies depending on a woman's reproductive category. Women are already using these technologies on their own and will likely seek to integrate this with advice from their clinicians. With more validating studies on FemTech devices, clinicians may consider turning to evaluating personalized daily urinary hormone patterns rather than infrequent serum hormone checks that are difficult to extrapolate into the bigger picture of each menstrual cycle.

In PCOS, fertile window hormonal variability is not surprising, given that there is known estradiol[30] and LH[31] abnormalities to explain the cycle irregularities. In postpartum and perimenopause transitions [35], hormone changes are present as fertility returns postpartum or wanes towards menopause. The present study demonstrated differences in the fertile window in women with perimenopause, relative to the other three groups. Our data clearly show hypoestrogenism in perimenopause, which has been well described [44], but of interest, the luteal $E_1$3G plateau (Fig. 3) that we observed in perimenopause may reflect previous findings of loop-out-of-phase follicular development in the perimenopause transition [45]. Levels of LH were high across the cycle in this group (Fig. 4), with previous data showing multiple LH rises occur in this group [35]. Low luteal PDG (Fig. 5) in the perimenopause may reflect underlying abnormal luteinization processes [46].

In the postpartum group, which has been previously analyzed [35,36], higher raw LH values (Table 3) are likely due to a decreased sensitivity of the ovary to LH (higher values are required to trigger ovulation). In the model (Fig. 4), this was reflected in the earlier LH rise in the fertile window compared to the regular cycles and PCOS group. The postpartum group had relatively similar $E_1$3G values compared to the regularly cycling group, which were higher than the PCOS and perimenopause groups for most of the cycle, reflecting their similarities in follicular $E_1$3G to women in regular cycles.

The PCOS group had lower overall $E_1$3G and a higher luteal PDG levels, with minimal differences in LH secretion. If follicular development in women with PCOS were stimulated with medications, and it would be possible to track and individualize response to fertility treatments in PCOS using urinary hormones.

The typical "textbook" menstrual cycle is the result of taking average hormone results and plotting them on a curve. An alternative to this would be individualizing assessment of the menstrual cycle by tracking urinary hormones to identify the group and individual hormonal variability [24,47–49]. Presently, applying a personalized fertile window has been left to smartphone Apps that are often inaccurate [50], or industry-developed tools that have yet to establish validity [1] or have proprietary algorithms that are not open-source. Clinicians should be aware of which tools available to patients are validated to help their

patients track their menstrual cycle hormones accurately. The results of this study were not compared to the proprietary Mira algorithm used in the device's App, but a comparison to their algorithm could be considered in the future.

In the current study, we have demonstrated the importance of factoring a woman's reproductive category (e.g. regular cycles, postpartum, PCOS, perimenopause; of course many other categories could be added to this) in delineating the fertile window, since thresholds of $E_1$3G, LH and PDG were different in these four different groups (Figs. 3–6, Table 3). In the future, a woman's individual hormone pattern can help to identify her own personalized fertile window that becomes more precise as more cycles are added to the predictive model. This predictive modeling is not only an educational opportunity to increase menstrual and ovulation health literacy in using these tools [51], but also a collaborative opportunity for clinicians and their patients to identify abnormalities that could help track response to treatment (e.g. for PCOS or hormone therapy in perimenopause).

With a larger sample size of women with PCOS, it may have been possible to see significant differences in cycle length, later peak days and shorter luteal phases compared to women with regular cycles. Similar non-significant signals were found in perimenopause, and it is possible that perimenopause and PCOS may follow similar patterns. It should also be noted that most of our perimenopause participants were in early perimenopause, which may skew the cycle parameters which a larger sample size with more women in late perimenopause would clarify. In the future, with the use of a Mira FSH test, these hormone results may help in predicting menopause. The developers of the ClearBlue Fertility Monitor have also proposed a new FSH test for predicting menopause [52].

Strengths and limitations

Our study was adequately powered to detect differences in the fertile window between the four reproductive categories, but future studies with larger sample sizes could help identify more subtle differences between the groups. The main limitation was the lack of ultrasound-confirmed ovulation, but the confirmation with a rise in urinary progesterone metabolites (PDG) effectively confirms that ovulation has occurred within the fertile window that we have defined. The sample was relatively homogenous, so future studies should focus on recruiting women with more diverse backgrounds to evaluate the role of ethnic, socioeconomic or other sources of diversity that may lead to greater personalization of the fertile window. The cost of the monitor and test wands are barriers for using these tools, but the economic benefits of urine metabolite testing at-home could lead to system-wide reduction in health care costs (e.g. with associated reduction serum hormone testing) that may lead health policy makers to consider advocating for insurance plans to cover these new testing tools just as diabetic supplies are now ubiquitously covered.

Conclusions

Personalization of the fertile window is not a new concept [53], but the integration of tools like urine fertility monitors with smartphone Apps[1,43] require evidence-based validation for clinicians to be

confident in recommending them to patients. Validating new technology for at-home menstrual cycle monitoring should be a high priority for clinicians and health authorities to contribute to increasing menstrual health literacy and improved integration with women's fertility goals [51].

Abbreviations

CBFM: ClearBlue Fertility Monitor

$E_1$3G: estrone-3-glucuronide

EDO: estimated day of ovulation

LH: luteinizing hormone

PCOS: polycystic ovarian syndrome

PDG: pregnanediol glucuronide

STRAW: Stages of Reproductive Aging Workshop

Declarations

Clinical Trial Number: Not applicable

Author's contributions (CReditT Authorship Contribution Statement)

TPB (Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, review & editing)

RJF (Conceptualization, Formal analysis, Methodology, Supervision, Validation, Writing – original draft, review & editing)

MM (Methodology, Supervision, Validation, Writing – original draft, review & editing)

TS (Methodology, Validation, Writing – original draft, review & editing)

LB (Data curation, Methodology, Validation, Writing – original draft, review & editing)

AS (Data curation, Methodology, Validation, Writing – original draft, review & editing)

KS (Data curation, Methodology, Validation, Writing – original draft, review & editing)

BS (Formal analysis, Investigation, Methodology, Software, Supervision, Validation, Visualization, Writing – review & editing)

MS (Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Writing – original draft, review & editing)

Availability of data and materials

Individual participant data that underlie results after deidentification could be provided to researchers to achieve aims in a methodologically sound proposal approved by an independent review committee up to 36 months after article publication.

Competing interests

TPB's PhD studies are sponsored by a University of Calgary Mitacs grant co-sponsored by Quanovate Tech, developers of the Mira urine hormone fertility monitor. The remaining authors report no competing interests.

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Table 3

Table 3 is available in the Supplementary Files section.

Figures

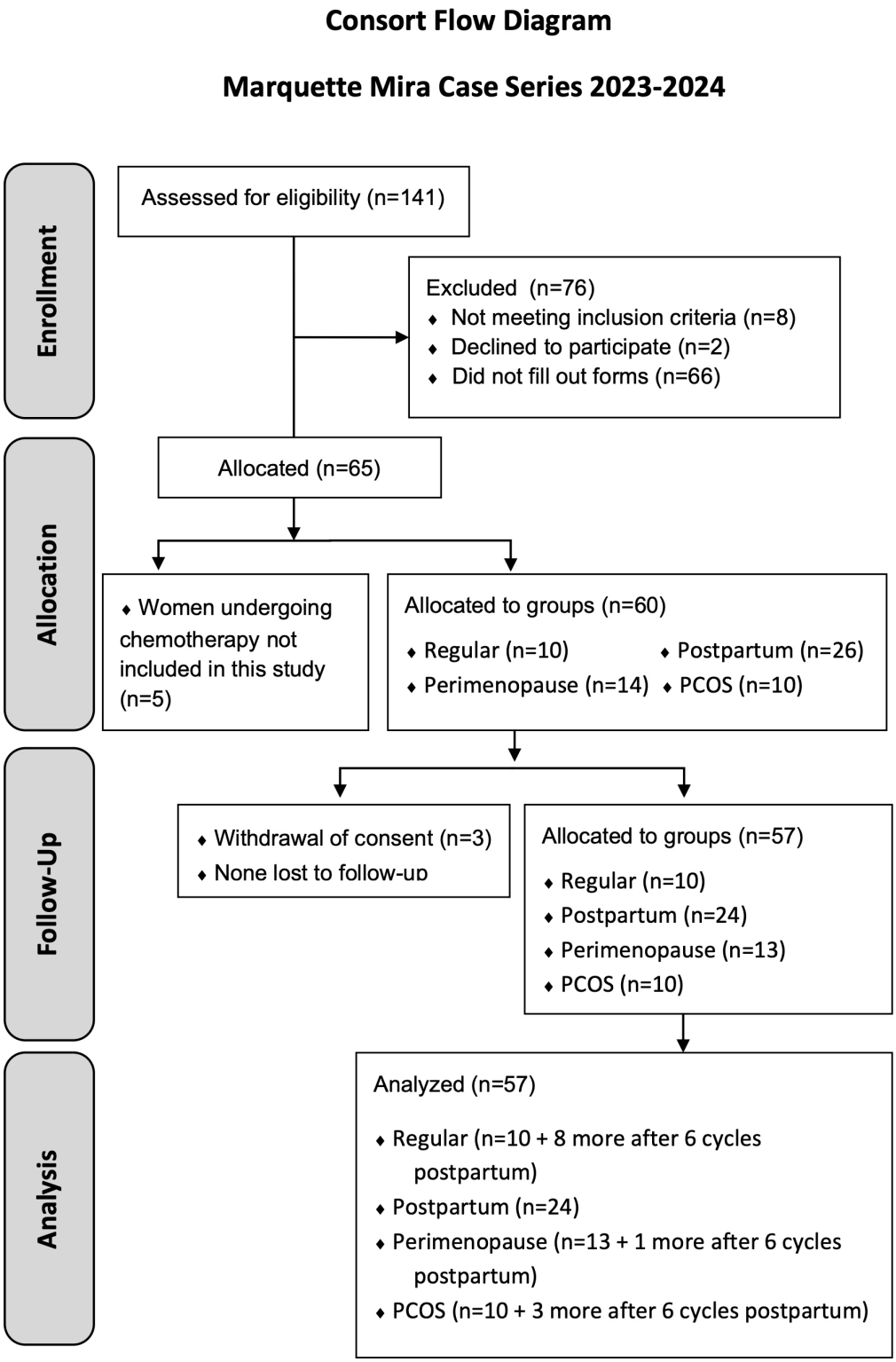

Figure 1

Consort Flow Diagram. Consort describing outlining initial enrollment, allocation to four groups, attrition (follow-up) and final analysis (n=57) with the breakdown of different groups. For women beyond 6 cycles postpartum, they were allocated into regular cycles (n=8), perimenopause (n=1) and PCOS (n=3).

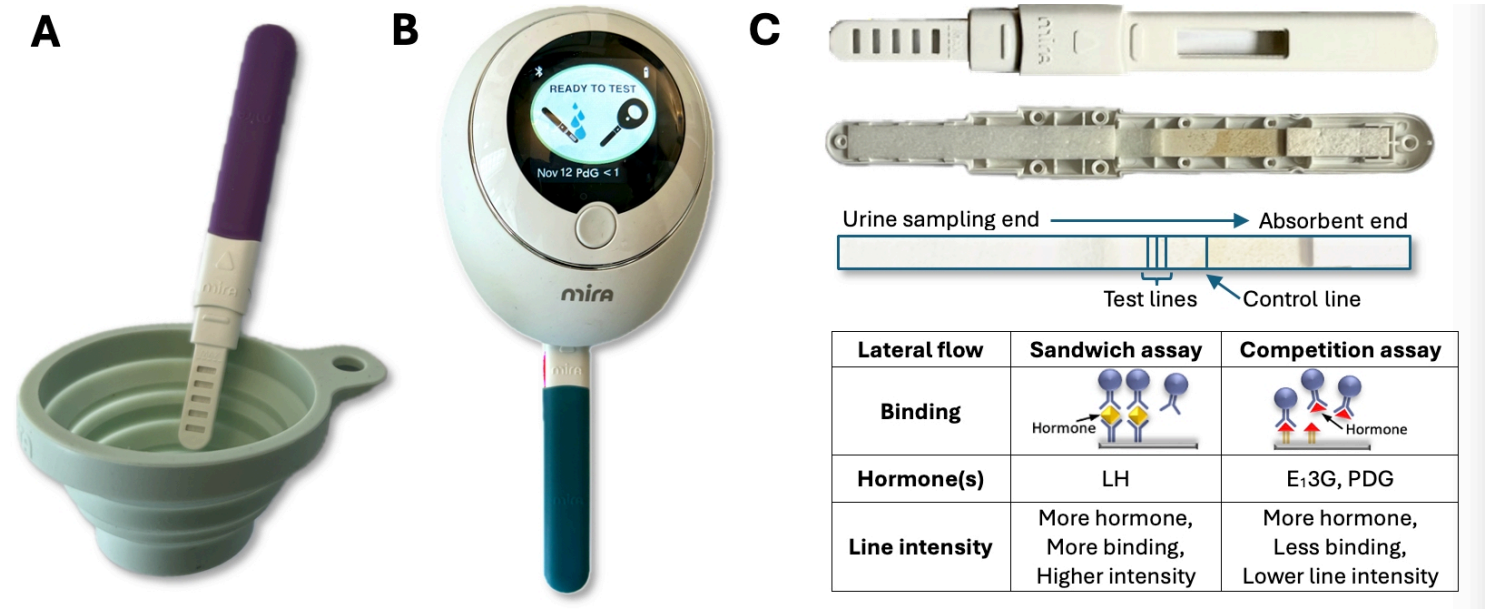

Figure 2

Mira Monitor testing and lateral flow assay. (A) Mira test stick dipped into first morning urine cup. (B) Insertion of test stick into the Mira monitor with optical analyzer. (C) Lateral flow assay view inside test stick with absorbent end on right and urine sampling end on left. The lateral flow assay is described based on hormone binding for sandwich and competition assays and how these affect line intensity.

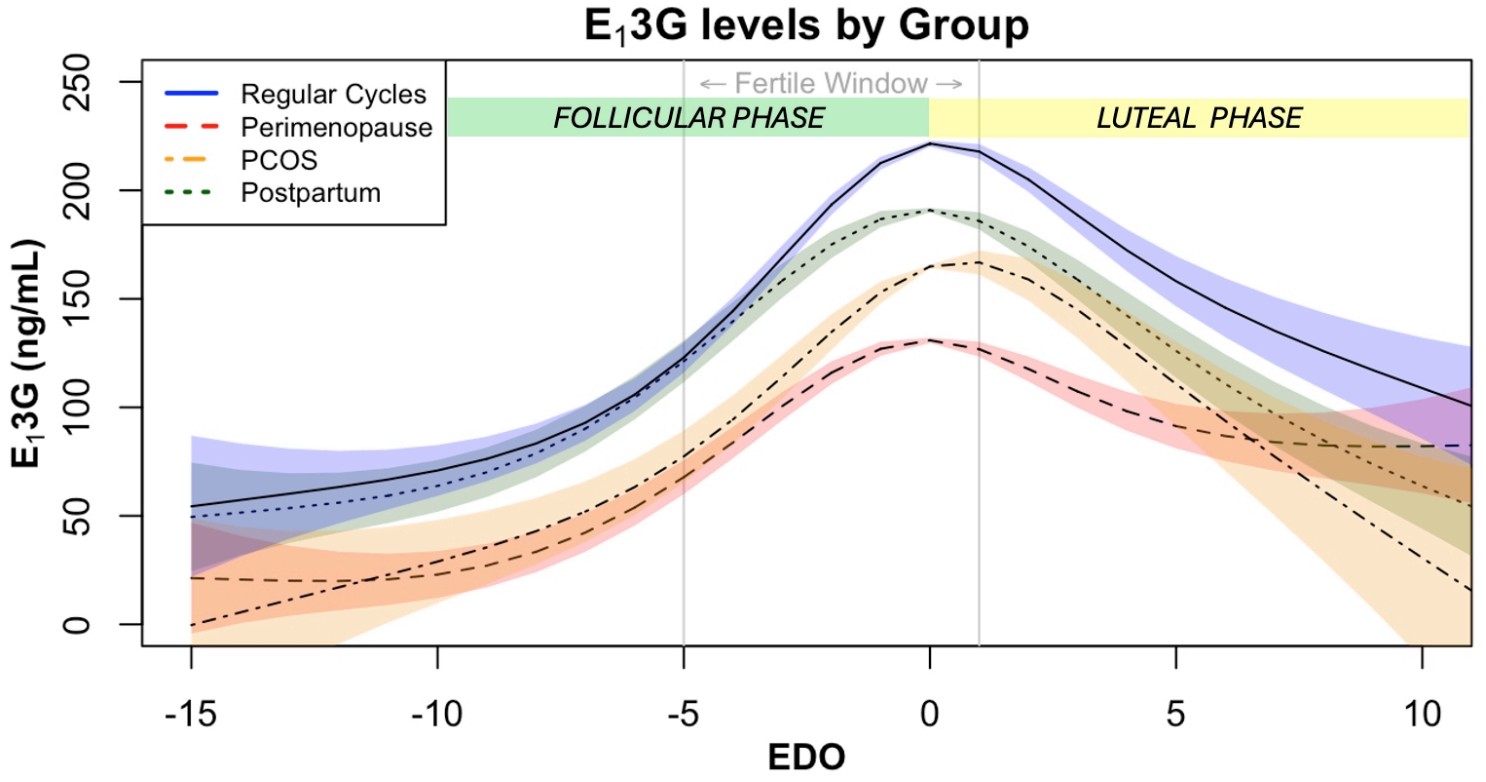

Figure 3

$E_1$3G hormone levels stratified by reproductive category. Estrone-3-glucuronide ($E_1$3G) hormone values (ng/mL) plotted against the estimated day of ovulation (EDO, EDO=0 is the day of the Mira LH surge), with four curves based on the four groups shown in the legend (regular cycles, perimenopause, PCOS, postpartum). The fertile window is delineated by the two grey bars from days -5 to +1 relative to the EDO. The follicular and luteal phases are marked in bands (negative days are the follicular phase and positive days are the luteal phase).

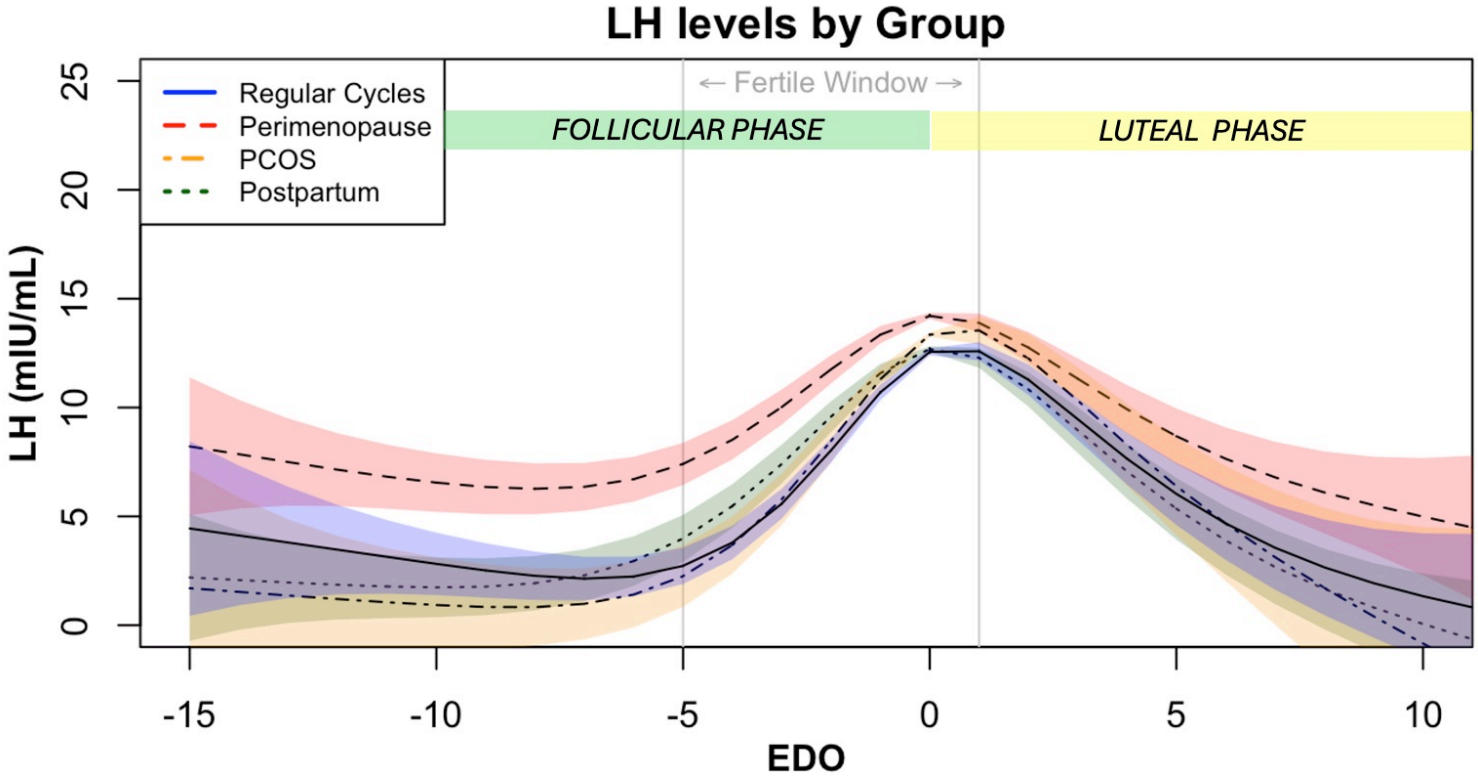

Figure 4

LH hormone levels stratified by reproductive category. Luteinizing hormone (LH) hormone values (mIU/mL) plotted against the estimated day of ovulation (EDO, EDO=0 is the day of the Mira LH surge), with four curves based on the four groups shown in the legend (regular cycles, perimenopause, PCOS, postpartum). The fertile window is delineated by the two grey bars from days -5 to +1 relative to the EDO. The follicular and luteal phases are marked in bands (negative days are the follicular phase and positive days are the luteal phase).

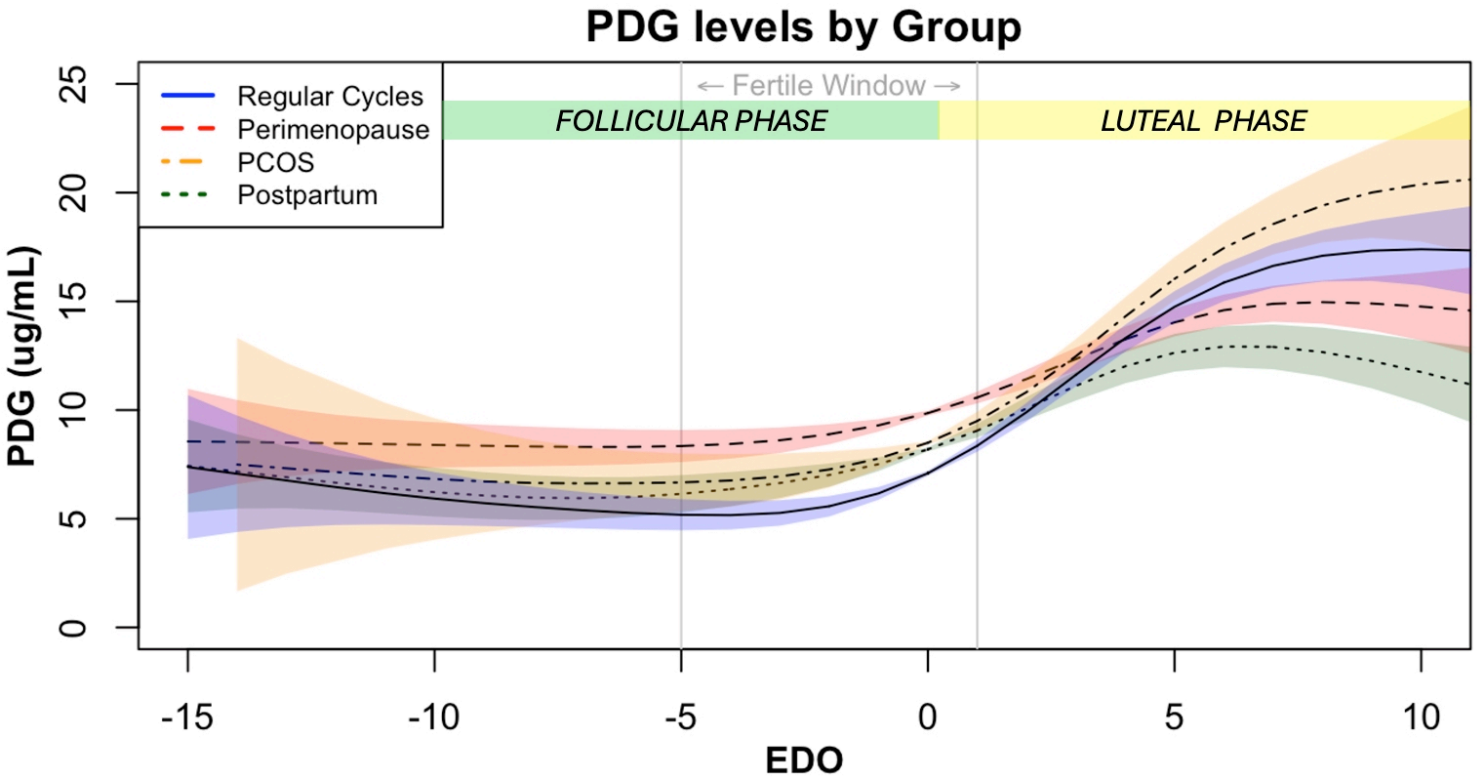

Figure 5

PDG hormone levels stratified by reproductive category. Pregnanediol glucuronide (PDG) hormone values (ug/mL) plotted against the estimated day of ovulation (EDO, EDO=0 is the day of the Mira LH surge), with four curves based on the four groups shown in the legend (regular cycles, perimenopause, PCOS, postpartum). The fertile window is delineated by the two grey bars from days -5 to +1 relative to the EDO. The follicular and luteal phases are marked in bands (negative days are the follicular phase and positive days are the luteal phase).

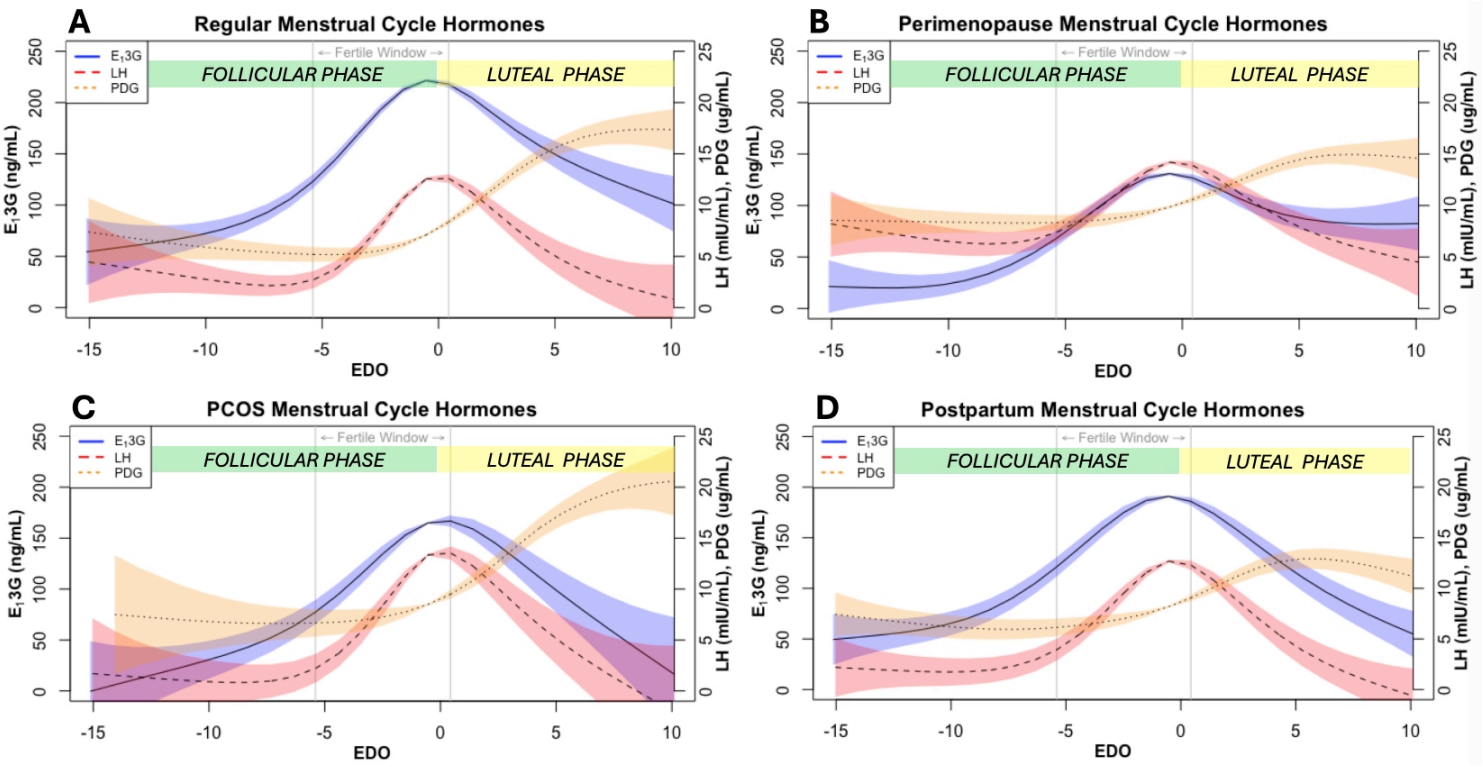

Figure 6

Hormone profiles by reproductive category. All three hormones ($E_1$3G, LH and PDG) are plotted against the estimated day of ovulation (EDO, EDO=0 is the day of the Mira LH surge), separated for each of the four groups (A) regular cycles, (B) perimenopause, (C) PCOS, (D) postpartum. The fertile window is delineated by the two grey bars from days -5 to +1 relative to the EDO. The follicular and luteal phases are marked in bands (negative days are the follicular phase and positive days are the luteal phase).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- TABLE3.docx