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## Variability in the Phases of the Menstrual Cycle

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## **Abstract:**

**Objective:** *To determine variability in the phases of the menstrual cycle among healthy, regularly cycling women.*

**Design:** *A prospective descriptive study of a new data set with biological markers to estimate parameters of the menstrual cycles.*

**Participants:** *One hundred forty one healthy women (mean age 29 years) who monitored 3 to 13 menstrual cycles with an electronic fertility monitor and produced 1,060 usable cycles of data.*

**Measures and Outcomes:** *Variability in the length of the menstrual cycle and of the follicular, fertile, and luteal phases, and menses. The estimated day of ovulation and end of the fertile phase was the peak fertility reading on the monitor (i.e., the urinary luteinizing hormone surge).*

**Results:** *Mean total length was 28.9 days (SD = 3.4) with 95% of the cycles between 22 and 36 days. Intacycle variability of greater than 7 days was observed in 42.5% of the women. Ninety-five percent of the cycles had all 6 days of fertile phase between days 4 and 23, but only 25% of participants had all days of the fertile phase between days 10 and 17.*

**Conclusions:** *Among regularly cycling women, there is considerable normal variability in the phases of the menstrual cycle. The follicular phase contributes most to this variability.*

Knowledge of menstrual cycle variability is critical for women who use fertility awareness-based methods to avoid or achieve pregnancy. Knowledge of the variability of the fertile phase of the menstrual cycle is of particular import for couples having difficulty achieving pregnancy. Furthermore, it is important to know normal variations of the menstrual cycle, since the menstrual cycle is used as a sign of women's health. However, little is known about the variability of the fertile and other phases of the menstrual cycle. There are few large data sets that include accurate measures of menstrual cycle parameters. This article reviews evidence on menstrual cycle variability and provides new information based on a data set generated by women using an electronic hormonal fertility monitor.

Classical longitudinal studies on menstrual cycle variability by Treloar, Boynton, Behn, and Brown (1967) and Vollman (1977) and a large cross-sectional study by Chiazze, Brayer,

Macisco, Parker, and Duffy (1968) demonstrated that based on length, the greatest variability of the menstrual cycle occurs at the two ends of the life span of fertility, that is, the 1st few years after menarche and the 2 to 3 years leading up to menopause. They also demonstrated that mean cycle lengths decrease as women age. Treloar et al. (1967) and Chiazze et al. (1968) did not provide information on the variability of the phases of the menstrual cycle. Vollman used the basal body temperature (BBT) shift as a marker of ovulation and determined that the follicular phase ranged from approximately 11 to 27 days and the luteal phase from 7 to 15 days. The use of the BBT shift as an estimate of ovulation, however, is rather imprecise (Barron & Fehring, 2005).

Researchers also have shown that there is greater variability in menstrual cycle length in the 1st few cycles after ovulation returns postchildbirth and breastfeeding (Zinaman & Stevenson, 1991), after discontinuation of hormonal contraception (Gnoth, Frank-Hermann, Schmoll, Godehardt, & Freundl, 2002), during times of stress (Barsom, Mansfield, Koch, Gierach, & West, 2004; Fenster et al., 1999), and with lifestyle factors such as excess exercise, obesity, smoking, and diet (Rowland et al., 2002; Solomon et al., 2001). Although some of these studies used various biological markers for estimating the phases of the menstrual cycle (e.g., serum level of luteinizing hormone [LH]), for the most part, variability was examined as a result of special circumstances and not as normal variations with regular cycle data.

Recent studies have contributed to our knowledge of normal variability of the length of the menstrual cycle (Creinin, Keverline, & Meyn, 2004; Munster, Schmidt, & Helm, 1992) and of the luteal phase (Lenton, Landgren, & Sexton, 1984). Munster et al. (1992) demonstrated that among a cohort of 3,743 Danish women aged 15 to 44, menstrual cycle variation of greater than 14 days was present in 29.3% of all women. More recently, Creinin et al. (2004) found that among 130 healthy U.S. women (who generated 786 cycles of data), 46% had cycle length ranges of 7 days or more, and 20% had cycle length ranges of 14 days or more. The studies of Munster et al. and the Creinin et al. did not have data to examine the variability of the fertile and luteal phases among the participants. Lenton et al. (1984) found that with a small data set of 327 menstrual cycles, the normal range of the luteal phase (based on urinary LH testing) was between 12 and 17 days. This study did not examine within-woman luteal phase variability.

Wilcox, Dunson, and Baird (2000) provided evidence for the variability of the 6-day fertile phase of the menstrual cycle, stated there is some probability that days of the fertile phase can occur on almost any day of the menstrual cycle, and concluded that only 30% of women have all of the days of their fertile phase between days 10 and 17 of the menstrual cycle. Wilcox,

Weinberg, and Baird (1995), Dunson, Baird, Wilcox, and Weinberg (1999), and Wilcox et al. (2000) previously demonstrated that the fertile phase of the menstrual cycle is approximately 6 days: the day of ovulation and the 5 days before. These three studies were based on a data set of 696 ovulatory menstrual cycles from 221 healthy women who documented their fertility by use of urinary estrogen and progesterone ratios. There is a need to document these findings with other data sets.

There are many causes of menstrual cycle variability: causes that essentially disrupt or suppress the rhythms of the hypothalamic-pituitary-ovarian axis. Most of the variability in the follicular phase is thought to be due to defects in the process of ovulation (Speroff & Fritz, 2005). Variability in the luteal phase could be a result of defects in the ovulatory process but also of defects in the corpus luteum and inadequate production of estrogen and progesterone. The variability of the luteal phase is thought to be less than that of the follicular phase. How the variability of each phase differs or relate to one another is unknown. Understanding normal variability of the menstrual cycle is important since the menstrual cycle can be a sign of health and disease for women.

A new data set of menstrual cycles has been developed with biological markers (e.g., threshold levels of urinary estrogen and LH) that provide a good estimate of the day of ovulation, and of the follicular, fertile, and luteal phases of the menstrual cycle. The purpose of this study was to determine inter(women) and intra(woman) variability of the phases of the menstrual cycle with a new data set of menstrual cycles generated by healthy, regularly cycling women. The specific research questions were as follows:

- 1 What is the variability in the length of the menstrual cycle?
- 2 What is the variability in the phases (i.e., follicular, fertile, luteal, and menses) of the menstrual cycle?
- 3 How do phases of the menstrual cycle relate and differ from one another?

## **Methods**

### **Design**

This was a descriptive analysis of the phases of the menstrual cycle by use of a new menstrual cycle data set. The data set was generated by 165 women who participated in an effectiveness study of an electronic fertility monitor for family planning purposes.

### **Sample**

All 165 women volunteers sought to learn how to monitor their fertility for the purpose of

avoiding pregnancy by use of an electronic fertility monitor called the Clear-blue (also called Clearplan) Easy Fertility Monitor (Unipath Diagnostics, Inc., Waltham, MA) at five clinical sites in four cities (Atlanta, Madison, Milwaukee, and Saint Louis). To participate in the study, the volunteers had to be between the age of 21 and 44; have menstrual cycles between 21 and 42 days; had not used depot medroxyprogesterone acetate over the past 12 months; had not used oral or subdermal contraceptives for the past 3 months, if breastfeeding had experienced at least three menstrual cycles past weaning; and had no known fertility problems. This study received Institutional Review Board approval from the Marquette University Office of Research Compliance.

### **Procedure**

The 165 participants were taught how to monitor their fertility by use of the Clearblue monitor and to record readings from the monitor and the days of their menses on a daily fertility chart. All participants received an initial 60-minute in-person information session by a health professional on reproductive anatomy and physiology, the menstrual cycle, how to use the monitor, and how to chart the biological indicators of fertility. In addition, they were provided in-person follow-up sessions at 1, 2, and 6 months, and a final follow-up at 12 months, at which time the data charts were reviewed with the participant. When there was a question about the accuracy of the charting and use of the monitor, data from the monitor was downloaded into a computer and reviewed by the health professional. The fertility charts were collected by a designated coordinator at each of the five clinical sites and sent to Marquette University Institute for Natural Family Planning. Information from each chart was entered into a data set. At the time of this analysis, 165 participants produced 1,335 menstrual cycle charts of which 1,181 (88%) had usable and complete data. For the current study, participants (of the original 165) were included only if they produced three or more menstrual cycles of data. Reduced production of data charts was a result of a number of factors, including pregnancy, discontinuation, noncompliance in charting, and early participation in the efficacy study.

### **Measurement**

The Clearblue Easy Fertility Monitor is a hand-held electronic device designed to read wick-type test strips imbedded with antibodies for estrogen and LH. The user sets the monitor by pressing a small button on the monitor, called the " M " button, on the 1st morning of her menses. The monitor provides a 6-hour testing window ( $\pm 3$  hours of when the button was pressed). The user then turns the monitor on every morning to read her level of fertility and to see if a test is required. This information is provided on a small display screen. When a test is

asked for, the user places the test strip under the urine stream for 3 seconds and then clips the test strip into the monitor where it is read by an infrared light. The monitor gives a daily reading of low, high, or peak fertility. A low reading is indicated by one bar, high with two bars, and peak with three bars (Figure 1). The high reading indicates a threshold level of urinary estrone-3-gluconuride (E3G) and the peak reading, a threshold level of urinary LH indicating the LH surge.

The Clearblue monitor automatically records 2 days of peak readings followed by 1 day of high readings when the urinary threshold of LH is reached. A recent study that used serial follicular ultrasound to determine the day of ovulation showed that ovulation occurred >91% of the time during the 2 peak days of the Clearblue monitor (Behre et al., 2000). According to product testing, the Clearblue monitor detected the LH surge in 169 of 171 cycles from 88 women, in agreement with a quantitative radioimmunoassay of LH for an accuracy of 98.8% (Unipath Diagnostics, 2001). In addition, on average the monitor will provide the user with 5 days of high and peak fertility readings. For the current study, the estimated day of ovulation was the 2nd peak day on the Clearblue monitor (Figure 1).

### **Definitions**

*Length of Cycle.* Length of cycle was determined by counting all the days of the menstrual cycle from the 1st day of recorded menses on the fertility chart through the last day before the next menses.

*The Fertile Phase.* The fertile phase was estimated to be the 6-day interval that ends with the 2nd peak day reading determined by the Clearblue monitor and the 5 preceding days, that is, the estimated day of ovulation and the 5 days before.

*The Follicular Phase.* The follicular phase was defined as the length from the 1st day of menses up to and including the estimated day of ovulation, that is, from the 1st day of the cycle up to and including the 2nd peak day recorded by the monitor.

*The Luteal Phase.* The luteal phase was defined as the length from the 1st day after the estimated day of ovulation up to and including the day before the next menstrual cycle.

*The Menses Phase.* The length of menses was determined by the 1st day of bleeding as observed by the woman up to and through the last day of bleeding. Bleeding was recorded as light, medium, and heavy.

### **Data Analysis**

The 13th version of the Statistical Package for Social Scientists (SPSS Inc., Chicago, IL) was utilized to determine means, medians, standard deviations, ranges, frequencies, and percents of the above-listed parameters of the menstrual cycle. Parametric paired *t* tests and

non-parametric Friedman Rank tests were used to compare differences in mean intracycle lengths of the various phases of the menstrual cycle. Pearson  $r$  correlation tests were used to determine relationships and contribution to overall intracycle length variability.

## Results

### Menstrual Cycle Data Sets

Of the 1,181 usable cycles, 24 of the participants only produced 1 to 2 cycles. These participants and their menstrual cycles were eliminated to reduce the data set to 1,142 cycles or 96.6% of the original 1,181. The data set was then reduced further to include only those cycles that had a Clearblue identified peak, that is, an estimated day of ovulation. This reduced the total to 1,060 cycles or 92.8% of the 1,142.

### Demographics

The average age of the remaining 141 participants (84.2% of the total) that generated the final 1,060 menstrual cycles of data was 29.0 years ( $SD = 5.6$ ; range 19-44). They had an average of 1.3 children,  $SD = 1.7$  (range 0-8), and each generated 3 to 13 cycles of data, with the mean being 5.2 cycles,  $SD = 3.2$ .

### Questions Answered

#### 1. What is the variability in the length of the menstrual cycle?

The mean length of the menstrual cycles was 28.9 ( $SD = 3.3$ ) and the median 29.0 days (mode 28) with 95% of the cycles falling between 22 and 36 days (95% confidence interval = 21.8-36.2). The mean cycle length for women participants older than 35 years was on average a little more than 1 day shorter (29.2 vs. 27.2). Only 2 (0.2%) cycles were less than 21 days in length, and 39 cycles (3.6%) were longer than 35 days. As seen in Table 1, 42.5% of the 140 women participants experienced cycle length differences greater than 7 days and 2.2% greater than 14 days.

#### 2. What is the variability in the phases of the menstrual cycle?

Mean length of the *follicular phase* was 16.5 days ( $SD = 3.4$ ), median = 16 days, mode = 15 days, and 95% of the menstrual cycles had follicular phase lengths between 10 and 22 days (See Table 2). A third of the participants (33.6%) experienced follicular phase length differences greater than 7 days.

Mean length of the *luteal phase* was 12.4 days ( $SD = 2.0$ ), median = 13 days, mode = 13 days, and 95% of the luteal phase lengths fell between 9 and 16 days. Only 9% of participants experienced luteal phase variability greater than 7 days.

Mean length of *menses* was 5.8 days ( $SD = 2.9$ ), median = 6 days, mode = 5 days, and 95% of the menstrual cycles had length of menses between 3 and 8 days. Only 3% of the cycles had interwomen menses cycle length differences greater than 5 days.

The days of the *fertile phase* of the menstrual cycle for all cycles was from cycle day 3 through cycle day 29. Approximately 66% of the cycles had all days of the 6-day fertile phase within days 13 to 20 of the menstrual cycle. The 6-day fertile phase varied by more than 7 days among 33.6% of the participants and by 14 days by only two (0.7%) of the participants. The mean beginning of the 6-day fertile phase was day 13, and the mean day of the 1st high (E3G threshold reading) indicating the beginning of fertility by the electronic monitor was day 12 ( $SD = 3.4$ ), range 5 to 26 days. The mean end of the 6-day fertile phase was the same as the estimated day of ovulation, that is, day 16.5 ( $SD = 3.4$ ).

### 3. How do phases of the menstrual cycle relate and differ from one another?

The strongest significant relationship among the phases of the menstrual cycle was between length of cycles and follicular phase length ( $r = .829, p = .01$ ). There was a mild but significant positive correlation between the length of the luteal phase and the length of the menstrual cycle ( $r = .255, p = 0.01$ ) and a mild significant negative correlation between the length of the luteal phase and the follicular phase ( $r = -.323, p = .01$ ). There was a very mild significant positive correlation between the length of menses and the length of the menstrual cycles ( $r = .172, p = .01$ ).

There was a significant ( $p < .001$ ) difference by paired  $t$  tests between the mean intrawoman cycle length difference of the luteal phase (3.6 days,  $SD = 2.5$ ), with the mean intracycle length difference of the follicular phase (5.8 days,  $SD = 2.6$ ), and with the mean intratotal cycle length difference (6.7 days,  $SD = 3.5$ ). The intracycle luteal phase difference showed the least mean difference, and the overall intracycle length difference showed the greatest. This was confirmed by a nonparametric Friedman Test mean rank as follows: intracycle length difference = 2.41, intrafollicular length difference = 2.21, and luteal phase rank difference = 1.39, with a significance of .001 or less.

## Discussion

### Variability in Menstrual Cycle Length

The findings, from a new data set of menstrual cycle parameters, confirm and extend information about norms of menstrual cycle variability. The mean length of 28.9 days (mode of 28 days) and the 95% range difference of 22 to 36 days compares with other studies that



analyzed a cross-section of menstrual cycles (Table 1). Furthermore, like previous studies on menstrual cycle length this study demonstrated a decrease in mean cycle length and cycle length variability from a high of 29.2 ( $SD = 3.5$ ) from women younger than 25 years to a mean of 27.9 ( $SD = 2.6$ ) among women older than 35 years. For example, the mean lengths of the menstrual cycles from women older than 35 years compared with women younger than 25 in the studies of Munster et al. (1992), the Treloar et al. (1967), and the Volman (1977) were 28.8/27.5, 30.4/27.7, and 30.1/28.1, respectively. The usual textbook range of normal menstrual cycle length is 21 to 35 days but does vary from a short cycle of 21 days to a long of 37 days (see textbook ranges in Table 3). The 21- to 35-day range is the most common cited and fits well with the 22- to 36-day 95% range of cycle length from the current study and the 22- to 35-day mean range of cycle lengths from the five cross-sectional studies listed in Table 1.

The within-woman (intracycle) length variability among the studies listed in Table 1 is not as consistent as other menstrual cycle parameters. However, the intracycle length variability of greater than 7 days from the current study (42.5%), the World Health Organization (WHO) Task Force (1983) study (40%), and the recent Creinin et al. (2004) study (46%) are similar. This might be because the participants from these studies were screened for cycle length prior to entry into the respective studies. However, the menstrual cycle length criteria for the current study was generous (between 21 and 42 day in length). The study of Chiazze et al. (1968) included women with any cycle length, which might explain the greater variability found with that study. The five studies listed in Table 1 seem to indicate that a within-women cycle length difference of greater than 7 days but less than 14 days is not too infrequent, that is, at least 40% of all participants experienced that variation, in all the studies.

### **Variability of Follicular and Luteal Phases**

The variability of the follicular phase and the luteal phase of the cycles in the current data set compares well with the WHO Task Force (1983) data set. However, the mean follicular phase length is about 1 day longer and the luteal phase length about 1 day shorter (Table 2). This is probably due to the differences in the biological marker used in each study to estimate the day of ovulation. In the WHO study, the peak in cervical mucus was used. This biological marker has a tendency to precede the urinary LH surge on average about 1 day (Fehring, 2002). Furthermore, by choosing the 2nd peak of the monitor to represent the estimated day of ovulation shortens the luteal phase with the data used for this study. In fact, Behre et al. (2000) observed that the 1st peak on the Clearblue monitor had slightly more than 50% of the actual days of ovulation as determined by serial ultrasound. Lenton et al. (1984) found the mean luteal

phase length of 14.13 days. This longer mean length might be due to the use of serum LH testing to estimate the day of ovulation. Serum LH tends to occur before the urinary LH peak.

Lenton et al. (1984) indicated that the normative luteal phase length range is 11 to 17 days. This is somewhat shorter than the 8- to 17-day (95%) range of the current study and the 7- to 20-day range of the WHO Task Force data. These differences could again be explained by the imperfection (accuracy) and differences of estimating the day of ovulation, that is, serum LH, urinary LH, and cervical mucus peak, and by the differences in the population of women that generated the data. The accumulative mean length of the luteal phase among all three studies was 13.3 and the range 9 to 18 days. The 9- to 18-day range is a more liberal range of length than all the luteal phase ranges that are listed in the published textbooks found in Table 3.

### **Variability of Fertile Window**

The variability of the beginning and end of the fertile window is of particular concern, since couples who are either achieving or avoiding pregnancy need to target those days. The current study indicated that days of the 6-day fertile window will range from day 4 to 23 for about 95% of all menstrual cycles. This is similar to the range found with the WHO Task force (1983) study. In the current study, 66% of all the menstrual cycles had the entire 6-day fertile phase fall between days 13 and 20. However, the study of Wilcox et al. (2000) determined that about 30% of women will have all of their days of the fertile window between cycle days 10 and 17. The current study found that approximately 25% will have all 6 days of the fertile window within that range. The intracycle fertile phase difference is less than that of the overall cycle length variability, but at least 33% had fertile phase beginning and end differences greater than 7 days.

The mean intrawoman cycle difference is the least with the luteal phase, most with overall menstrual cycle length difference, and in between (but considerable) with the follicular phase differences. These findings make sense in that the follicular and ovulatory process is what contributes most to the overall cycle length difference. These data also emphasize that the luteal phase is the most stable phase among the phases of the menstrual cycle but does contribute some (about 25%) to the overall intracycle length differences. The intrawomen menstrual cycle length differences are reinforced by the correlations among the phases of the menstrual cycle in that the follicular phase length and the length of cycle have the strongest positive correlation. In addition, the luteal phase length and the follicular phase length had a mild significant negative correlation, which was also found in the WHO Task Force (1983) study. This indicates that there is a mild tendency to have a shorter luteal phase after a long follicular phase and vice versa.

## **Variability in Menses**

The menstrual flow or menses (also called the period) is the external sign that the lining of the womb (or endometrium) is sloughing. The beginning of menses is considered the 1st day of the menstrual cycle. Textbooks indicate that menses lasts on average 3 to 5 days, but flows as short as 1 day and as long as 8 days are considered normal (see variability in lengths in Table 3 ). The loss of blood during menses is from scant to up to 80 mL. Usually, the greatest flow of blood is on the 1st and 2nd day. In the WHO (1983) 5-country study of the ovulation method, the mean length of bleeding was 5.0 ( $SD = 1.3$ ) days but varied from 4.3 for women in Manila to 5.9 days for women in Dublin. The mean length in the current study falls with the mean ranges of the WHO study. The Textbook parameter gives an average length of menses of 5 to 6 days with a normal range of 2 to 9 days, which is accurate (See Table 3). Of interest is that Creinin et al. (2004) and the current study found a slight significant positive correlation between length of menses and overall length of the menstrual cycle.

## **Limitations**

A limitation of this study is the utilization of imperfect biological markers for the estimated day of ovulation and the 6-day fertile phase. Using a more accurate marker for ovulation such as following follicular development and collapse through serial ultrasound would provide more accurate data and hence parameters of the menstrual cycle. However, serial ultrasound is expensive and time consuming for the woman participant and the investigator. The expense of time and money tend to prohibit a large data set as compared to the ease of self-measurement with an electronic fertility monitor. Another limitation is that there might be some variability of when the user presses the M button on the fertility monitor to indicate the beginning of her menstrual cycle. If her menses starts in the late morning, afternoon, or evening she is asked to wait until the next morning before pressing the button. This might have caused some variability in the total length of the menstrual cycle and the follicular phase. However, the 1st day of menses was also recorded on the data charts, and the charts were used as the source for determining total length of the given menstrual cycle.

A final limitation is that the participants were self-selected, provided only 3 to 13 cycles of data over a 1-year time period, and were cross-sectional rather than by age cohorts. As stated before, it is well known that there is greater variability with menstrual cycle length in the beginning and ends of a woman's reproductive life. The data set generated for this study was from women between the ages of 19 and 44 but with most (66%) between the ages of 25 and

35 when menstrual cycles are rather stable.

### **Implications of Findings**

The findings of this study essentially indicate that there is a lot of variability in the parameters of the menstrual cycle even among regularly cycling women in good health. This variability has implications for clinicians working in women's health and for couples seeking to achieve or avoid pregnancy. Variability in the length of the menstrual cycle can be a particular problem for couples who use calendar-based formulas for family planning (Brayer, Chiazze, & Duffy, 1969). Calendar-based methods that use total cycle lengths in their formulas are not recommended for women who have menstrual cycle lengths that vary more than 7 days (Kambic & Lamprecht, (1996). This a concern for almost half of the women in the United States who rely on calendar-based methods (Mosher, Martinez, Chandra, Abma, & Willson, 2004). Obviously, at least 40% of these women will have difficulty with the formulas and excessive abstinence.

Variability of the length of the menstrual cycle for blanket or fixed day methods of family planning that overestimate the days of fertility within a fixed range of menstrual cycles is also a concern but less so (days 8-19 of the menstrual cycle) (Arévalo, Jennings, & Sinai, 2002; Arévalo, Sinai, & Jennings, 2000). These methods are based on the variability of the day of ovulation and the fertile phase rather than the length of the cycle (Lamprecht & Grummer-Strawn, 1996). However, since only about 25% to 30% women with regular cycles will have all of the days of the fertile phase within days 11 to 17, these blanket calendar-based systems also need to manage this variability. The Standard Days Method developed at Georgetown University does this by screening for appropriate cycle length, intending the method for a narrow cycle length (26-32 days), overestimates the 6-day fertile phase (days 8-19), and by recommending use of another method when two cycles are out of the prescribed range within a 12-month time period (Sinai, Jennings, & Arévalo, 2004).

Variability of the menstrual cycle is not as great of concern for those women and couples who use natural methods of birth control that use prospective indicators of fertility. Prospective indicators of fertility such as self-observed estrogen-stimulated cervical mucus and urinary E3G and LH levels with the Clearblue fertility monitor will enable the woman user to track the variability of the 6-day fertile phase, even with irregular cycles (Stanford, White, & Hatasaka, 2002). Furthermore, these prospective indicators enable the user and her clinician to time hormonally sensitive clinical tests and treatments in relation to phases of the menstrual cycle. A recent example is the use of the Clearblue monitor to predict menses and to time medication for

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menstrual migraine headaches (MacGregor, Frith, Ellis, & Aspinall, 2005).

For clinicians working with women (between the ages of 20 and 44) who accurately record menstrual cycle length and other parameters of the menstrual cycle (e.g., peak in cervical mucus), they can be confident that if the usual cycle length is less than 21 days or more than 35 the menstrual cycles are abnormal. So too, if the running cycle length differences exceed 14 days, if their luteal phase is less than 9 or greater than 18 or luteal phase length differ by more than 7 days. The experience of menses that is greater than 8 days is not normative. Clinicians should be alert for women who have greater than normal variability in their menstrual cycle parameters, this can be a sign of future risk of type 2 diabetes mellitus, heart disease, infertility, poly cystic ovarian disease, and other health problems (Solomon et al., 2001, 2002).

## Conclusions

In conclusion, variability of the menstrual cycle is normal. There are, however, norms that if exceeded might indicate health problems. At a minimum, monitoring menstrual cycle length with a simple calendar is recommended. The addition of a biological marker for estimating the day of ovulation and the beginning of the fertile phase is essential for those seeking to avoid and achieve pregnancy and for assessing menstrual cycle health.

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## References

- Arévalo, M., Jennings, V., & Sinai, I. (2002). Efficacy of a new method of family planning: The standard days method. *Contraception*, *65*, 333-338.
- Arévalo, M., Sinai, I., & Jennings, V. (2000). A fixed formula to define the fertile window of the menstrual cycle as the basis of a simple method of natural family planning. *Contraception*, *60*, 357-360.
- Barron, M. L., & Fehring, R. J. (2005). Basal body temperature assessment: Is it useful to couples seeking pregnancy? *American Journal of Maternal Child Nursing*, *30*, 290-296.
- Barsom, S. H., Mansfield, P. K., Koch, P. B., Gierach, G., & West, S. G. (2004). Association between psychological stress and menstrual cycle characteristics in perimenopausal women. *Women's Health Issues*, *14*, 235-241.

- Behre, H. M., Kuhlage, J., Gassner, C., Sonntag, B., Schem, C., Schneider, H. P., et al. (2000). Prediction of ovulation by urinary hormone measurements with the home use Clear-plan Fertility Monitor: Comparison with transvaginal ultrasound scans and serum hormone measurements. *Human Reproduction*, *15*, 2478-2482.
- Brayer, F. T., Chiazze, L., & Duffy, B. J. (1969). Calendar rhythm and menstrual cycle range. *Fertility and Sterility*, *20*, 279-288.
- Carr, B. R. (1998). The normal menstrual cycle. In B. R. Carr & R. E. Blackwell (Eds.), *Textbook of reproductive medicine*. Stamford, CT: Appleton & Lange .
- Chiazze, L., Brayer, F. T., Macisco, J. J., Parker, M. P., & Duffy, B. J. (1968). The length and variability of the human menstrual cycle. *Journal of the American Medical Association*, *203*, 89-92.
- Creinin, M. D., Keverline, S., & Meyn, L. A. (2004). How regular is regular? An analysis of menstrual cycle regularity. *Contraception*, *70*, 289-292.
- Dunson, D., Baird, D. D., Wilcox, A. J., & Weinberg, C. R. (1999). Day-specific probabilities of clinical pregnancy based on two studies with imperfect measures of ovulation. *Human Reproduction*, *14*, 1835-1839.
- Fehring, R. (2002). Accuracy of the peak day of cervical mucus as a biological marker of fertility. *Contraception*, *66*, 231-235.
- Fenster, L., Waller, K., Chen, J., Hubbard, A. E., Windham, G. C., Elkin, E., et al. (1999). Psychological stress in the workplace and menstrual function. *American Journal of Epidemiology*, *149*, 127-134.
- France, J. T., Graham, F. M., Gosling, L., Hair, P., & Knox, B. S. (1992). Characteristics of natural conceptual cycles occurring in a prospective study of sex preselection: Fertility awareness symptoms, hormone levels, sperm survival, and pregnancy outcomes. *International Journal of Fertility*, *37*, 244-255.
- Gnoth, C., Frank-Hermann, P., Schmoll, A., Godehardt, E., & Freundl, G. (2002). Cycle characteristics after discontinuation of oral contraceptives. *Gynecological Endocrinology*, *16*, 307-317.
- Hilgers, T. W. (2002). *Reproductive Anatomy & Physiology*. Omaha, NE: Pope Paul VI Institute Press.
- Kambic, R.T., & Lamprecht, V. (1996). Calendar rhythm efficacy: a review. *Advances in Contraception*, *12*, 123-128.

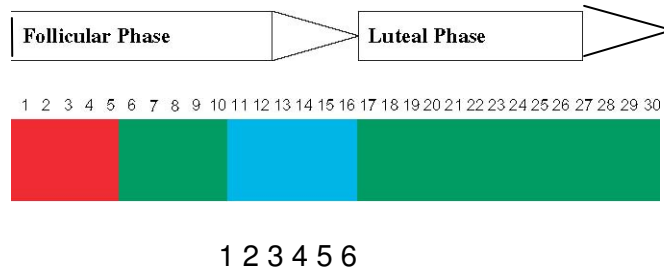
- Lamprecht, V. M., & Grummer-Strawn, L. (1996). Development of new formulas to identify the fertile time of the menstrual cycle. *Contraception, 54*, 339-343.
- Lenton, E. A., Landgren, B. M., & Sexton, L. (1984). Normal variation in the length of the luteal phase of the menstrual cycle: Identification of the short luteal phase. *British Journal of Obstetrics and Gynecology, 91*, 685-689.
- MacGregor, E. A., Frith, A., Ellis, J., & Aspinall, L. (2005). Predicting menstrual migraine with a home-use fertility monitor. *Neurology, 64*, 561-563.
- Mosher, W. D., Martinez, G. M., Chandra, A., Abma, J., & Willson, S. J. (2004, December 10). *Use of contraception and use of family planning services in the United States: 1982-2002* (Advance Data from Vital and Health Statistics CDC No. 350). Hyattsville, MD: Centers for Disease Control and Prevention, National Center for Health Statistics.
- Munster, K., Schmidt, L., & Helm, P. (1992). Length and variation in the menstrual cycle—A cross-sectional study from a Danish county. *British Journal of Obstetrics and Gynecology, 99*, 422-429.
- Olds, S. B., London, M. L., Ladewig, P. W., & Davidson, M. R. (2004). *Maternal-Newborn Nursing & Women's Health Care*. Upper Saddle River, NJ: Pearson, Prentice Hall.
- Ostrzenski, A. (2002). *Gynecology, Integration Conventional, Complementary, and Natural Alternative Therapy*. Philadelphia: Lippincott Williams & Wilkins.
- Palter, S., & Olive, D. (2002). Reproductive physiology. In S.J. Berek (Ed.), *Novak's Gynecology* (pp. 149-172). Philadelphia: Lippincott Williams & Wilkins.
- Rowland, A. S., Baird, D. D., Long, S., Wegeinka, G., Harlow, S. D., Alavanja, M., et al. (2002). Influence of medical of medical conditions and lifestyle factors on the menstrual cycle. *Epidemiology, 13*, 668-674.
- Sinai, I., Jennings, V., & Arévalo, M. (2004). The importance of screening and monitoring: The standard days method and cycle regularity. *Contraception, 69*, 201-206.
- Solomon, C. G., Hu, F. B., Dunaif, A., Rich-Edwards, J. E., Stampfer, M. J., Willett, W. C., et al. (2002). Menstrual cycle irregularity and risk for future cardiovascular disease. *Journal of clinical Endocrinology and Metabolism, 87*, 2013-2017.
- Solomon, C. G., Hu, F. B., Dunaif, A., Rich-Edwards, J., Willet, W. C., Hunter, D. J., et al. (2001). Long or highly irregular menstrual cycles as a marker for risk of type 2 diabetes mellitus. *Journal of the American Medical Association, 286*, 2421-2426.
- Speroff, L., & Fritz, M. A. (2005). *Clinical Gynecology Endocrinology and Infertility*. Philadelphia: Lippincott Williams & Wilkins.

- Stanford, J. B., White, G. L., & Hatasaka, H. (2002). Timing intercourse to achieve pregnancy: Current evidence. *Obstetrics & Gynecology*, *100*, 1333-1341.
- Treloar, A. E., Boynton, R., Behn, B., & Brown, B. (1967). Variation of the human menstrual cycle through reproductive life. *International Journal of Fertility*, *12*, 77- 26.
- Unipath Diagnostics. (2001). *Professional information: Clear plan easy fertility monitor*. Princeton, NJ: Unipath Diagnostics Company.
- Vollman, R. (1977). *The Menstrual Cycle*. Philadelphia: W.B. Saunders.
- Wilcox, A. J., Dunson, D., & Baird, D. D. (2000). The timing of the "fertile window" in the menstrual cycle: Day specific estimates from a prospective study. *British medical Journal*, *321*, 1259-1262.
- Wilcox, A. J., Weinberg, C. R., & Baird, D. D. (1995). Timing of sexual intercourse in relation to ovulation. *New England Journal of Medicine*, *333*, 1517-1521.
- World Health Organization Task Force. (1983). A prospective multicentre trial of the ovulation method of natural family planning. III. Characteristics of the menstrual cycle and of the fertile phase. *Fertility and Sterility*, *40*, 773-778.
- Zdanuk, J. L. (2000). Assessment of women. In D. E. Lowerdermilk, S. E. Perry, & I. M. Bobak (Eds.), *Maternity & Women's Health Care*, 88-114. St. Louis, MO: Mosby.
- Zinaman, M., & Stevenson, W. (1991). Efficacy of the symptothermal method of natural family planning in lactating women after the return of menses. *American Journal of Obstetrics and Gynecology*, *165*(Suppl. 2), 2037-2039. No., Part 2



**Appendix  
Figure 1**

**Phases of the menstrual cycle**



**ClearBlue Easy Fertility Monitor Recordings:**



Chart Interpretation

Red = Menses

Blue = Estimated 6-day fertile phase

1 dark box = Low fertility

2 dark boxes = High fertility = Estrogen rise

4 dark boxes = Peak fertility = LH surge

5 Second Peak fertility = Estimated day of ovulation

*.Note.* Chart interpretation: red = menses; blue = estimated 6 day fertile phase; 1 dark box = low fertility; 2 dark boxes = high fertility = estrogen rise; 3 dark boxes = peak fertility = luteinizing hormone surge; 2nd peak fertility = estimated day of ovulation

**Table 1****Variability of Menstrual Cycle Length Among Women With Reported Regularity**

<b>Study</b>	<b>No. of Subjects/Cycles</b>	<b>M (SD)</b>	<b>95% CI Range</b>	<b>Intrawoman Cycle variability</b>	
				<b>% 7 days</b>	<b>% &gt;14 days</b>
Current Study	141/1060	28.9 (3.4)	22-36	42.5	2.2
<25 yr	35/256	29.2 (3.5)			
25 to 35 yr	82/604	29.2 (3.4)			
>35 yr	24/200	27.9 (2.6)			
Chiazze et al. (1968)	2316/29238	28.1 (4.0)	20-36	70	50
Creinin et al. (2004)	130/786	29.1 (3.5)	22-36	46	20
Munster et al. (1992)	1128/1128	28.2 (2.6)	23-34	>35.9	14
WHO Task Force (1983)	725/6472	28.5 (3.2)	22-35	40	<5
<b>M</b>		<b>28.5 (3.3)</b>	<b>22-35</b>	<b>47.5</b>	<b>18.9</b>

Note. CI = confidence interval.

**Table 2****Variability of Follicular, Luteal, and Menses Phases of the Menstrual Cycle**

<b>Study</b>	<b>Menses</b>		<b>Follicular Phase</b>		<b>Luteal Phase</b>	
	<b>M (SD)</b>	<b>95% CI Range</b>	<b>M (SD)</b>	<b>95% CI Range</b>	<b>M (SD)</b>	<b>95% CI Range</b>
Current Study	5.8 (2.9)	0-12	16.5 (3.4)	9-23	12.4 (2.0)	8-17
France et al. (1992) <sup>a</sup>	5.0 (1.1)	2-8	15.5 (3.1)	9-22	12.6 (1.8)	9-17
WHO Task Force (1983) <sup>b</sup>	5.0 (1.3)	2-8	15.0 (2.6)	9-21	13.5 (2.8)	7-20
Lenton et al. (1984) <sup>c</sup>	NA		NA		14.1 (1.4)	11-17
<b>M</b>	<b>5.4 (2.1)</b>	<b>1-10</b>	<b>15.7 (3.0)</b>	<b>10-22</b>	<b>13.3 (2.1)</b>	<b>9-18</b>

Note. CI=Confidence interval.

<sup>a</sup> Number of subjects = 139; number of menstrual cycles 1,060.

<sup>b</sup> Number of subjects = 82; number of cycles of data 80.

<sup>c</sup> Number of subjects = 725; number of menstrual cycles 6,472.

**Table 3**  
**Normal Menstrual Cycle Parameters in Medical and Nursing Textbooks**

<b>Book Author</b>	<b>Length of Cycle (days)</b>	<b>Length of Luteal Phase (days)</b>	<b>Menses (days)</b>
Carr (1998)	25-30	13-14	NA*
Hilgers (2002)	25-37	9-17	NA
Ostrzenski (2002)	21-35	11-17	2-8
Olds et al. (2004)	23-33	NA	2-8
Palter and Olive (2002)	21-35	NA	2-6
Speroff and Fritz (2005)	24-35	NA	4-6
Zdanuk (2000)	NA	13-15	3-6

NA=Not Available