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How regular is regular? An analysis of menstrual cycle regularity

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Abstract

We performed a retrospective analysis to ascertain how accurately women who believe that they have regular menstrual cycles estimate the length of their actual cycles. Data were extracted from a chart review of subjects from three different studies of barrier contraceptives. Subjects were between 18 and 40 years of age and reported "regular" prestudy menstrual cycles with a consistent cycle length between 21 and 35 days. Participants prospectively recorded their menses for the up to 30 weeks. Each subject's estimated cycle length was compared to the average of her actual cycle lengths and the range and variability in each individual's cycle length was calculated. A total of 786 cycles from 130 women who recorded 4 or more cycles were analyzed. The averages of the participants' estimated cycle lengths was similar to the prospective averages of their actual cycle lengths (29.0 ± 2.7 days vs. 29.1 ± 3.5 days, respectively, $p = 0.8$). Forty-six percent of all subjects had a cycle range of 7 days or more, and 20% had a cycle range of 14 days or more. The average length of menses was 5.2 ± 1.0 days. When evaluating only women with cycle lengths from 21 to 35 days, the average length of menses was positively associated with the average actual cycle length ($p = 0.04$). Although the average of a woman's menstrual cycles compares favorably to her impression of her cycle length, the variability in menstrual cycle lengths is significant. This variation may have clinical impact on contraceptive practice, contraceptive research studies and pregnancy-related care.

Keywords: Menstrual cycle; Menses; Menstrual flow; Menstrual bleeding

1. Introduction

Accurate assessment of a woman's last menstrual period and menstrual cycle pattern is basic to the practice of women's reproductive health care. We rely on a woman's accuracy regarding her last menstrual period (LMP), length of her menstrual cycles, presence of menstrual cycle variability and length of her menstrual flow as the basis of her menstrual history.

However, we have little reliable data to demonstrate the accuracy of a woman's description of her own menstrual cycle characteristics. Clinically, this information is necessary to initiate appropriate evaluations for cycle irregularity and calculate gestational age in pregnancy. Additionally, many research trials involving contraception, infertility and other women's health areas rely on women to accurately represent if they have "regular" cycles and their usual cycle length. Few published reports describe normal menstrual cycle characteristics. More importantly, we are aware of only one study that attempts to compare women's conceived characteristics and actual characteristics, but this study only examined overall cycle length [1].

Thus, we reviewed information from menstrual diaries of women enrolled in barrier method research studies to ascertain how accurately subjects who believe that they have regular menstrual cycles estimate the length of their actual cycles. We were also interested in learning if the duration of a subject's period was influenced by menstrual cycle length.

2. Materials and methods

After obtaining approval from the Magee-Womens Hospital Institutional Review Board, we extracted data from menstrual diaries from subjects who participated in three different studies of barrier contraceptives at our institution between January 1994 and January 2001. The clinical results of these trials have been published [2–4]. To be eligible for these contraceptive studies, subjects had to be between 18 and 40 years of age and report having "regular"

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prestudy menstrual cycles with a consistent cycle length between 21 and 35 days. Exclusion criteria included pregnancy and the use of exogenous hormones. Subjects were required to keep menstrual diaries and prospectively record their menstrual flow for the next 8–30 weeks. All subjects enrolled in the three contraceptive studies were eligible for this nested analysis if they had recorded at least five consecutive menses in their diaries. This would ensure that there were at least four menstrual cycles available for review and comparison. Data collection began with the first day of the first recorded menses and ended with the last day of the last recorded menses.

In addition to the menstrual diaries, information extracted from this data set included each subject's age, education level, gravidity, parity, height, weight, marital status and the subject's estimated cycle length. Using the subject's recorded menstrual periods, it was possible to calculate her actual cycle length for 4–8 cycles and to calculate the duration of menstrual flow.

To address the question of how accurately the subjects estimated the length of their actual cycles, each subject's estimated cycle length was compared to the average of her actual cycle lengths over 4–8 cycles. The difference between each subject's estimated cycle length and actual cycle length was also compared for all cycles. The variability in an individual's cycle length was quantified as the range of menstrual cycle lengths. The range was calculated by subtracting the shortest cycle length from the longest cycle length.

All statistical analyses were performed using SPSS statistical software version 10.1.4 (SPSS Inc., Chicago, IL, USA) and evaluated at the 0.05 level of significance (two-tailed). Means were compared using the Student's t test or analysis of variance. Differences between participants' estimated cycle lengths and their prospective average of their actual cycle lengths were evaluated using a paired Student's t test. Differences between participants' estimated cycle lengths and the individual actual cycle lengths were compared using a paired Student's t test and evaluated at a Bonferroni-adjusted significance level [5]. Linear regression was used to evaluate factors associated with the accuracy of participants' cycle-length estimations. Accuracy was defined as the absolute value of the difference (in days) between estimated cycle length and the average actual cycle length.

3. Results

There were 276 subjects in the contraceptive data set, of which 130 subjects had information available for four or more cycles and were eligible for analysis. Mean estimated cycle length for eligible subjects (n = 130) and ineligible subjects (n = 146) did not differ significantly (29.0 ± 2.7 days vs. 28.9 ± 2.7 days, respectively, p = 0.9). A total of 786 menstrual cycles were eligible for analysis, including 9 subjects for 4 cycles, 28 subjects for 5 cycles, 46 subjects for 6 cycles, 42 subjects for 7 cycles and 5 subjects for 8 cycles.

Table 1
Clinical characteristics of eligible participants

Age (y), mean ± SD	29.3 ± 5.6
Gravidity (%)	
≥4	28 (22)
3	26 (20)
2	24 (18)
1	27 (21)
0	25 (19)
Parity (%)	
≥3	23 (18)
2	38 (29)
1	31 (24)
0	38 (29)
Education level (y), mean ± SD	15.1 ± 2.1
Body mass index, mean ± SD	26.8 ± 6.3
Estimated cycle length (days), mean ± SD	29.0 ± 2.7
Average actual cycle length (days), mean ± SD	29.1 ± 3.5
Average menstrual cycle flow (days), mean ± SD	5.2 ± 1.0

Demographic and clinical features of the study population are listed in Table 1. The average of the participants' estimated cycle lengths was not statistically different than the prospective average of her actual cycle lengths (29.0 ± 2.7 days vs. 29.1 ± 3.5 days, respectively, p = 0.8) or for any individual cycle length ($p > 0.5$). The relative similarity between the estimated cycle length and average actual cycle length are demonstrated in Table 2. The average cycle length was more than 3 days different than the estimated cycle length in 21% of subjects. Although subject's entered the study reporting an average cycle length between 21 and 35 days, 4 (3.1%) actually had average cycle lengths outside of this range.

The average cycle range was 10.2 days, the median cycle range was 7 days and the maximum cycle range was 39 days. Forty-six percent of all subjects had a cycle range ≥7 days, and 20% of all subjects had a cycle range ≥14 days. Linear regression analysis showed that cycle range and age were the only independent predictors of how well a subject estimated her cycle length. Cycle range was inversely re-

Table 2
Subject accuracy in estimating average actual cycle length

Difference (days) between average actual cycle length and estimated cycle length	% of study population
0	2
1	33
2	62
3	79
4	86
5	92
6	95
7	97

lated with how well a subject estimated her cycle length ($p < 0.001$), while age was positively associated ($p = 0.03$). Other factors such as education level, body mass index, marital status, gravidity and parity were not found to be predictive of how well a subject estimated her cycle length.

The average length of menstrual flow was 5.2 ± 1.0 days. The average length of menstrual flow for each subject was not significantly associated with her average actual cycle length ($p = 0.2$). However, if the four subjects with an average actual cycle length <21 or >35 days were excluded, the average length of menstrual flow was positively associated with the average actual cycle length ($p = 0.04$). Similarly, if only the first recorded cycle for each subject was considered, the length of menstrual flow was not significantly associated with the actual cycle length ($p = 0.1$). However, when the seven subjects with a first cycle <21 or >35 days were excluded, the length of menstrual flow was positively associated with the actual cycle length ($p = 0.002$).

4. Discussion

We found a good correlation between a woman's estimation of her cycle length and the average of her actual cycle lengths (29.0 vs. 29.1 days). This result is similar to Steiner et al. [1], who described a subset of 195 women in a female condom study with a mean retrospective estimate of 28.4 days and an average of actual cycle lengths in the prospective study of 30.8 days.

In our current study, however, when comparing the estimated cycle length to each individual cycle, the correlation was not as strong. This is most likely due to the wide range of cycle lengths. For example, a subject may have had an average actual cycle length of 29 days but a cycle range of 14 days. Although her average actual cycle length may be similar to her estimated cycle length, each individual cycle could be 1 week before or after the anticipated onset of her menstrual flow. This scenario was encountered in 20% of the study population. Therefore, one out of every five subjects who reported that they had regular cycles were experiencing periods that occurred 1 week away from the expected date.

The data described on cycle range from this study is similar to data reported by Belsey and Pinol [6]. Based upon a cohort of 1000 women who kept menstrual diaries for up to 40 years, they found a cycle range of 7 days or more in 50% of the subjects and a cycle range of 13 days or more in 25% of the subjects.

Cycle range and age were the only variables that correlated with how well a subject could predict her cycle length. The greater the cycle range, the poorer a subject's ability to predict her actual cycle length. Conversely, the older the subject, the better she was at predicting her actual cycle length. Although menstrual cycle lengths change with advancing age [6], this fact does not appear to impair a woman's ability to understand her actual cycle length. Based on this information, it may be worthwhile to incorporate questions about cycle range when taking a menstrual history. Given the results of our study, asking about menstrual cycle variability of 1 week or greater within the last year may be a useful way to initiate such a discussion.

An association between menstrual cycle length and length of menstrual flow has not previously been described in the literature. This study found that the length of menstrual flow was positively correlated with cycle length when subjects with average cycles <21 or >35 days were excluded. It is difficult to draw conclusions as to why this relationship breaks down at the extremes of cycle length due to the small number of subjects in which this occurred ($n = 4$).

There are several limitations to this retrospective study. Factors such as tobacco use, alcohol use and exercise level were not available for comparison. In addition, subjects were reimbursed for their participation and monetary gain may have been a motivating factor for some subjects to state that they had regular cycles, when in fact they did not. Lastly, the ages of women in this study ranged from 18 to 40 and menstrual cycle length varies with age. Belsey and Pinol [6] describe that the range of menstrual cycle lengths decreases from ages 19–38 and then begins to increase. As such, menstrual cycle length will be variable within such a wide age range as that of the women in this analysis. We feel the size of our dataset was inadequate to perform meaningful analyses within smaller subgroups based on age.

The fact that menstrual cycle length varies tremendously from cycle to cycle, even in women who report that their cycles are regular, potentially has important clinical relevance. In the earliest part of pregnancy, several studies from the medical abortion literature demonstrate that, based on ultrasound examination, 40–60% of women are more than 4 days off from their predicted gestational age based on LMP [7–9]. In actuality, the findings from this evaluation of menstrual cycle variation provide the rationale as to why such differences are prevalent. Moreover, the fact that 20% of cycles are 7 days longer or shorter than the expected length demonstrates that significant variance in ovulation must occur, explaining these differences.

The variance in ovulation is demonstrated by Wilcox et al. [10] who, using high sensitivity urine pregnancy tests, demonstrated that 10% of pregnancies had not implanted by the first day of the "missed" period. If every woman always had "regular" periods, then implantation would have occurred by approximately 7 days prior to the "missed" period. This variance may have clinical impact on other obstetric outcomes including multiple marker screening and the percentage of women going "post-dates" during pregnancy. Given the variation in menstrual cycle lengths demonstrated in this report, even in women who state they have "regular" cycles, prospective trials would be valuable to establish if early ultrasound examination, when the varia-

tion in gestational dating is 3 days or less, would have clinically significant impact on obstetric outcomes.

This study establishes that "regular" menstrual cycles are quite variable from cycle to cycle. The inherent variability in menstrual cycle length, which is likely a function of when ovulation occurs, must be studied prospectively to understand its full impact on contraceptive research trials and pregnancy-related care.

References

[1] Steiner MJ, Hertz-Picciotto I, Taylor D, Schoenbach V, Wheeless A. Retrospective vs. prospective coital frequency and menstrual cycle length in a contraceptive effectiveness trial. Ann Epidemiol 2001;11: 428–33.

[2] Mauck C, Callahan M, Weiner DH, Dominik R, FemCap™ Investigators Group. A comparative study of the safety and efficacy of FemCap™, a new vaginal barrier contraceptive, and the Ortho All-Flex®diaphragm. Contraception 1999;60:71–80.

[3] Steiner MJ, Dominik R, Rountree RW, Nanda K, Dorflinger LJ. Contraceptive effectiveness of a polyurethane condom and a latex condom: a randomized controlled trial. Obstet Gynecol 2003;101: 539–47.

[4] Raymond EG, Chen PL, Luoto J, the Spermicide Trial Group. Contraceptive effectiveness and safety of five Nonoxynol-9 spermicides: a randomized trial. Obstet Gynecol 2004;103:430–9.

[5] Rosner B. Fundamentals of biostatistics, 4th ed. Belmont (CA): Wadsorth Publishing Company, 1995.

[6] Belsey EM, Pinol AP. Menstrual bleeding patterns in untreated women. Contraception 1997;55:57–65.

[7] Creinin MD, Jerald H. Success rates and estimation of gestational age for medical abortion vary with transvaginal ultrasound criteria. Am J Obstet Gynecol 1999;180:35–41.

[8] Creinin MD, Spitz IM. Use of various ultrasound criteria to evaluate the efficacy of mifepristone and misoprostol for medical abortion. Am J Obstet Gynecol 1999;181:1419–24.

[9] Ellertson C, Elul B, Ambardekar S, Wood L, Carroll J, Coyaji K. Accuracy of assessment of pregnancy duration by women seeking early abortions. Lancet 2000;355:877–81.

[10] Wilcox AJ, Baird DD, Dunson D, McChesney R, Weinberg CR. Natural limits of pregnancy testing in relation to the expected menstrual period. JAMA 2001;286:1759–61.