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Development of New Formulas to Identify the Fertile Time of the Menstrual Cycle

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The calendar method is perceived to be less effective than other methods of family planning. A large existing data set was used to determine how well the fertile time is identified using the traditional calendar method formula and to determine if better formulas could be developed to identify the fertile time more accurately and require less abstinence. We compared the traditional formula with three alternatives, two of which were developed for this analysis. All three alternative formulas performed better than the traditional formula in identifying the presumed fertile time. The result of our analysis is a summary table which can be used to select the best rules for testing the effectiveness of the calendar method. © 1996 Elsevier Science Inc. All rights reserved. CONTRACEPTION 1996;54:339–343

KEY WORDS: calendar method, fertile phase, natural family planning, periodic abstinence

Introduction

According to the Demographic and Health Surveys (DHS), a substantial number of couples worldwide abstain on certain days of the menstrual cycle to avoid pregnancy.[1] Many of these couples do not know when during the menstrual cycle the fertile time occurs. The introduction of a simple means to identify the fertile time could help some couples to time intercourse to avoid pregnancy. This may be especially important for couples who cannot afford to buy contraceptives or do not have access to them.

The calendar method was developed in the 1930s and uses a formula to identify the fertile time of the menstrual cycle. The method is based on the assumption that the oocyte (egg) lives about 1 day, sperm survive for 3–4 days, and that ovulation occurs about 14 days prior to the beginning of menses.[2] The fertile time is identified by subtracting a certain number of days from the longest and shortest cycle lengths recorded in the past 6–12 cycles. The true fertile days are presumed to exist within the bounds set by the numbers plugged into the formula.

The calendar method is often perceived to be less effective than most other methods of family planning. The purpose of our analysis was to determine how well the fertile time is identified using the formula traditionally used with the calendar method, and to determine if better formulas could be developed to identify the fertile time more accurately and require less abstinence.

Very few well-designed clinical studies have been conducted to estimate the effectiveness of the calendar method. One study reports a 24-month Pearl pregnancy rate of 5.2.[3] Earlier studies, conducted between 1937 and 1968, report pregnancy rates ranging from 14 to 47 per 100 woman-years.[4] A recent literature review estimates the failure rate of the calendar method to be about 13%, when only well-designed clinical studies are considered.[5]

It is difficult to assess the effectiveness of the calendar method based upon published reports. First, different studies report the use of different rules to identify the fertile time, and roughly half of the studies do not even report the rule used.[5] This makes it difficult to compare studies, or to test a rule in another setting. Second, some of these studies are surveys, and the results are not comparable to clinical trials. Third, the reports often combine user failure and method failure rates together, so that it is not possible to assess the effectiveness of the calendar method when the method is used correctly. Fourth, none of the clinical trials provide the requisite information to compute method failure rates correctly.[6] To do this, it is necessary to collect data on intercourse during the presumed fertile and non-fertile phases of the cycle, as defined by the particular rule used.

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Materials and Methods

To help us identify a formula(s) that identifies the fertile time accurately and minimizes the number of days of abstinence required, we analyzed a large existing data set taken from the World Health Organization's trial of the Ovulation Method of Natural Family Planning.[7] Women admitted into the study were between 20 and 39 years old, had at least one child, and had regular menstrual cycles (between 23 and 35 days in length). (Actual cycle lengths reported in the study ranged from 14 to 78 days.) Following a teaching phase lasting 3–5 cycles, women entered the effectiveness phase of trial and were followed for up to 13 cycles. A total of 7,514 cycles were used in this analysis.

To identify potentially fertile days, women observed cervical mucus patterns daily. Women were asked to identify the peak day in each cycle. The peak day is defined as the last day the woman observes stretchy, clear, slippery mucus, or feels a wet or a lubricative sensation at the vulva, and is associated with highest fertility.[8]

Our analysis considers all cycles in which a peak day was identified among the 725 women who entered the effectiveness phase of the trial. We used cycle length and peak day data to develop and compare formulas to identify the fertile time.

We compared the traditional calendar method formula with three alternatives, two of which we developed for our analysis. The four formulas are described here with a example for each.

I. Traditional

This formula is most commonly used with the calendar method. Various numbers (s and l) are plugged into the formula and are subtracted from the number of days in the shortest (S) and longest (L) cycles in the past 6 cycles:

$S - s, L - l$

For example, consider the rule, S – 17, L – 12. If a woman recorded cycles ranging from 27 to 30 days in the past 6 cycles, she and her partner would abstain from Day 10 to Day 18 (inclusive). (27 – 17 = 10; and 30 – 12 = 18.)

II. Blanket

All couples would begin abstaining on the same day of the cycle (indicated by s) and stop abstaining on the same day of the cycle (indicated by l). We decided to include this formula in our analysis because it is reported that some couples use variations of this formula in regions throughout the world:

$s \rightarrow l$

For example, consider the rule 9 → 19. A couple would abstain from Day 9 to Day 19 of the woman's cycle (inclusive).

Two new formulas were developed for our analysis.

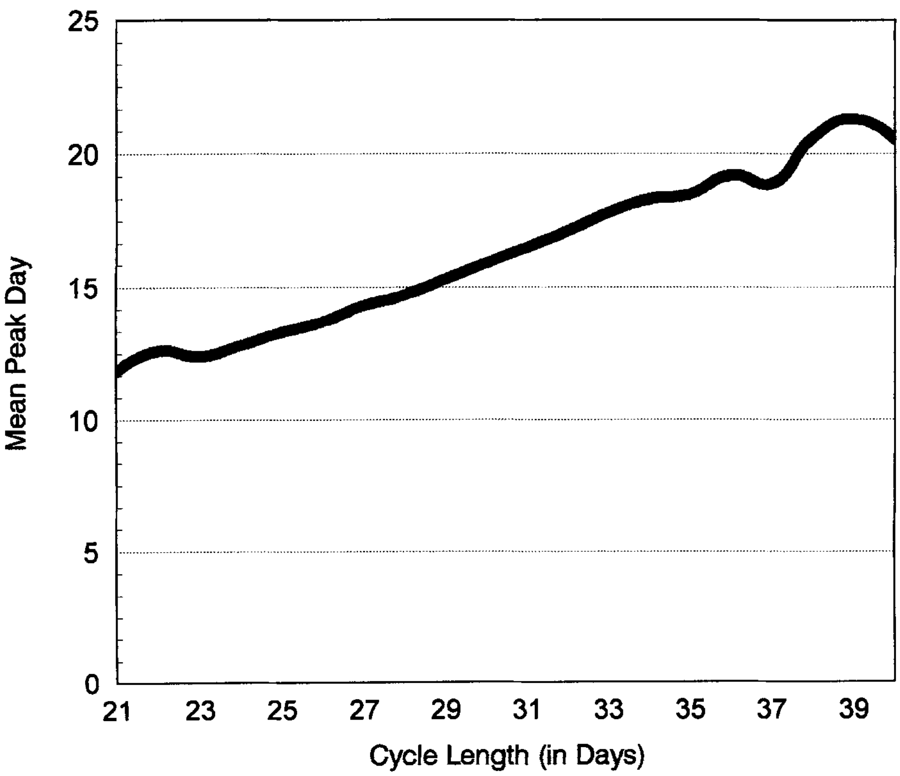

Figure 1. Mean peak day by cycle length.

Since we know that peak mucus day is associated with ovulation, we used peak day as our basis for developing new formulas. The WHO data show that peak day roughly corresponds to one-half cycle length (Figure 1). Thus, our two new formulas are based on taking one-half cycle length.

III. Midcycle
Half of the length of longest and shortest cycle in the past 6 cycles is determined. Then, various numbers (s) are subtracted from half of the shortest cycle (S), and various numbers (l) are added to half of the longest cycle (L):

½ S − s, ½ L + l

For example, if a couple uses the rule, ½ S − 3, ½ L + 3, and the woman's cycles vary between 26 and 30 days in the past 6 cycles, the couple would abstain from Day 10 to Day 18 (inclusive): (½ 26 = 13; ½ 30 = 15. 13 − 3 = 10 and 15 + 3 = 18).

Note: If the couple chooses to use the Midcycle formula and ½ S and/or ½ L is not an integer, the answer is always rounded down (e.g., if ½ S is 12.5 and ½ L is 14.5, the answers would be rounded to 12 and 14, respectively).

IV. Average Midcycle
Half of the length of the average of the past 6 cycle lengths (A) is determined, and various numbers (s) are subtracted from, and added to (l), to the interval:

½ A − s, ½ A + l

For example, if a couple uses the rule, ½ A − 6, ½ A + 6 and the woman's cycle lengths in the past 6 cycles were 28, 27, 26, 29, 30, and 28 days, the couple would abstain from Day 8 to Day 20, inclusive [(½ 28) − 6 = 14 − 6 = 8; and (½ 28) + 6 = 14 + 6 = 20)].

Note: If the couple chooses to use the Average Midcycle formula and ½ A is not an integer, the answer is rounded down to the nearest whole integer (e.g., if one-half of the average cycle length is 13.3 days, the answer rounded down to 13.)

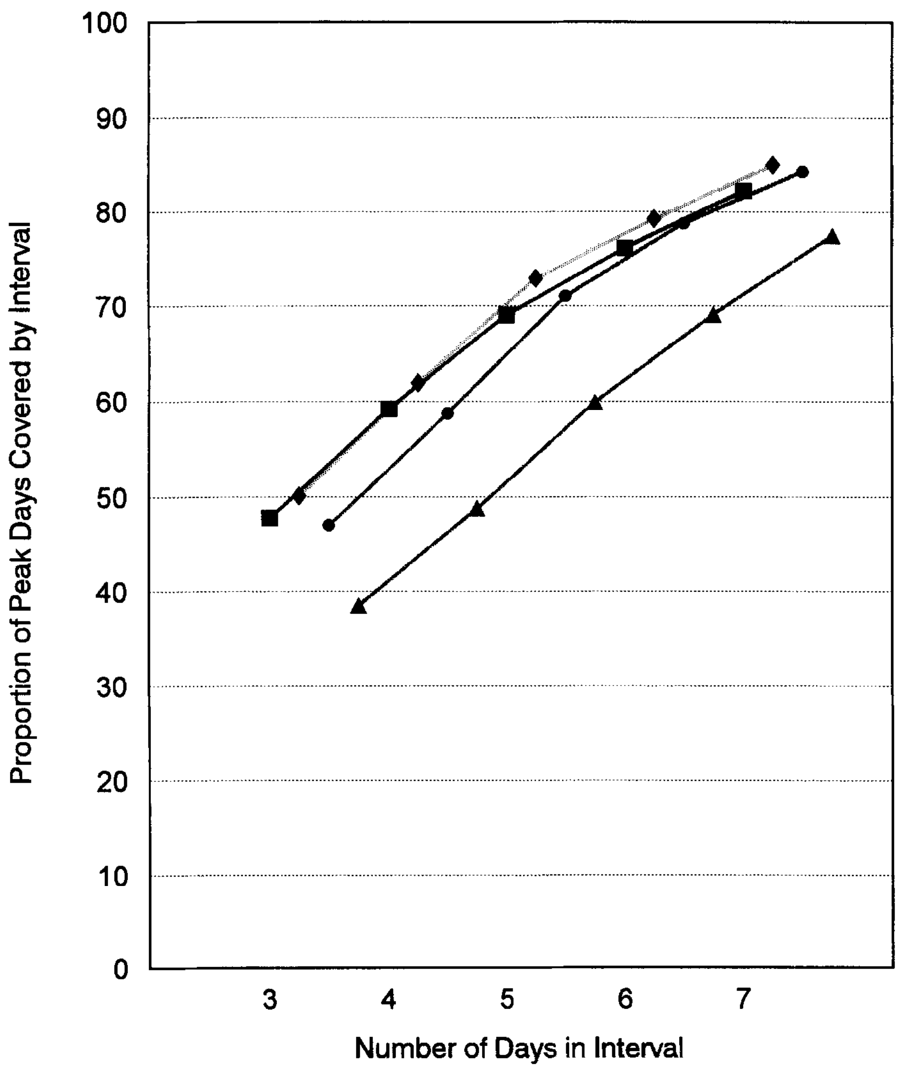

Figure 2. Comparison of four formulas used to identify the peak mucus day. For a given interval length (in days) permutations yielding the highest proportion of peak days identified are plotted. These permutations form the basis for the "best rules" for each formula. Four days were added to the beginning of the interval and 2 days were added to the end of the intervals to allow for the lifespan of the gametes. The formulas plotted are Traditional (▲), Blanket (■), Midcycle (●), and Average Midcycle (♦).

Contraception 1996;54:339–343

We first used each formula to identify the peak mucus day. For each formula, we plugged in various combinations of numbers, s and l (permutations), which resulted in an interval of days between 4 and 7 days in length. We then selected the permutations which identified the largest proportion of peak days covered for a given interval length. Finally, we "padded" these intervals with additional days on either end to allow for the lifespan of the gametes. The results are the best rules to identify the fertile time.

We decided to pad the intervals by adding 4 days to the beginning, and 2 days to the end of the interval. In padding the intervals in this way, we assume that ovulation is most likely to occur within 1–2 days of peak mucus day,[9] the oocycte lives less than 1 day,[10] conception is most likely to occur as a result of intercourse 1–2 days before ovulation,[10] and the likelihood of fertilization is greatly diminished if ejaculation occurs more than 4 days prior to peak day.[10,11]

Results

Table 1 shows, for each formula, the length of the interval used to identify the peak day, the proportion of peak days covered in these intervals prior to "padding," the "best rules" to define the fertile time, and the average number of days of abstinence required by these rules. The number of days of abstinence required by each of the rules listed is exactly 6 days more than the number of days in the interval used to predict the peak day.

Figure 2 shows how the four formulas compare in their coverage of the peak day for a given interval length. We see that the Average Midcycle and the Blanket formulas predict the fertile phase most accurately. The Midcycle formula performs similarly, but is less accurate when the unpadded interval is less than 5 days. The Traditional formula, most widely used with the calendar method, performs the least favorably.

Discussion

It is interesting to note that the formula that performs the least favorably is the Traditional formula. We conclude that one reason for this is that the formula assumes that ovulation always occurs about 14 days

Table 1. Summary table

Length of Interval to Identify Peak Day	Proportion of Peak Days Identified Prior to Padding	"Best Rules" to Identify Fertile Time	Average Number of Days of Abstinence Required
		I. Traditional	
4.6	48.8	S - 17, L - 12	10.6
5.6	59.9	S - 17, L - 11	11.6
6.6	69.1	S - 17, L - 10	12.6
7.6	77.4	S - 18, L - 10	13.6
		II. Blanket	
4	59.2	9 - 18	10
5	69.0	9 - 19	11
6	76.1	8 - 19	12
7	82.2	8 - 20	13
		III. Midcycle	
4.3	59.7	$\frac{1}{2}S - 3, \frac{1}{2}L + 3$	10.3
5.3	71.0	$\frac{1}{2}S - 4, \frac{1}{2}L + 3$	11.3
6.3	78.7	$\frac{1}{2}S - 4, \frac{1}{2}L + 4$	12.3
7.3	84.3	$\frac{1}{2}S - 5, \frac{1}{2}L + 4$	13.3
		IV. Average Midcycle	
4	61.9	$\frac{1}{2}A - 5, \frac{1}{2}A + 4$	10
5	72.9	$\frac{1}{2}A - 5, \frac{1}{2}A + 5$	11
6	79.2	$\frac{1}{2}A - 5, \frac{1}{2}A + 6$	12
7	85.0	$\frac{1}{2}A - 6, \frac{1}{2}A + 6$	13

For all rules: abstinence is required starting on the first day identified by the rule up until and including the last day (and night).
Midcycle rule: If $\frac{1}{2}$ S and/or $\frac{1}{2}$ L, is not an integer, the answer is always rounded down (e.g., if $\frac{1}{2}$ S is 12.5 and $\frac{1}{2}$ L is 14.5, the answers are rounded to 12 and 14, respectively).
Average Midcycle rule: If $\frac{1}{2}$ A is not an integer, the answer is rounded down to the nearest whole integer (e.g., if $\frac{1}{2}$ A is 13.3 days, the answer is rounded down to 13).

prior to next menses. Our data show that the day of the cycle on which peak day occurs does not increase one-to-one as cycle length increases. For every one day increase in cycle length, the mean peak day increases by about one-half day. In our data set, it appears that halving the cycle length gives a better prediction of the mean peak day compared to subtracting 14 days from the number of days in the cycle (Figure 1). A second possible reason for the poor performance of the Traditional formula is that using shortest and longest cycles in the past 6 cycles does not give a good prediction of future cycle length, because the range is too large.

Table 1 provides a decision matrix to choose the best rules to identify the fertile time. Selection among the rules can be made depending upon (1) the proportion of peak days covered, (2) the length of abstinence required, and (3) how easy it is to use a rule. It is not possible to determine pregnancy probabilities from these data, although our analyses suggest how the rules might perform. Determining the effectiveness of the calendar method using any of the rules requires actual clinical testing. We decided not to list rules requiring more than 13 days of abstinence because prolonged abstinence may be difficult for many couples.

Among the best rule choices, we selected two rules which we believe are promising ones to test in a clinical trial. For about 11 days of abstinence per cycle, the Average Midcycle rule, ½ A – 5, ½ A + 5, provides 72.9% of peak days covered (prior to padding), and the Blanket rule, 9 – 19, provides 69% of peak days covered (prior to padding) for the same number of days. Both of these rules provide better coverage compared to the Traditional rule used most often with the calendar method (S – 18, L – 11), which requires about 13 days of abstinence and provides 67.8% coverage of peak days.

We recommend that any introduction of a calendar-based method be accompanied by basic education about how the method works. According to Laing, one of the major shortcomings of past research on calendar-based methods is that there is not sufficient information to assess the couple's estimation of which days are "safe" to have intercourse.[12] It is not known if couples use the calendar method more effectively if they know the woman is most likely to become pregnant. It seems likely, however, that if a couple understands when the fertile time is likely to occur, they may be more likely to abstain during those days.

There is always a trade-off between the amount of abstinence required and coverage of the fertile days of the cycle. Ultimately, the decision about which rule to use for field testing may depend upon which rule is easiest to use and teach in a given setting, and what are the acceptable limits for the length of abstinence required in a given population.

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References

1. Weinberger, M. Recent trends in contraceptive behavior. In: Demographic and Health Surveys World Conference: Proceedings, vol 1. Columbia, Maryland: IRD/Macro International, 1991:555–73.
2. Dunn H. The safe period. Lancet 1956; Sept 1:441–2.
3. Dicker D, Wachsman Y, Feldberg D, Ashkenazi J, Yeshaya A, Goldman J. The vaginal contraceptive diaphragm and the condom: A re-evaluation and comparison of two barrier methods with the rhythm method. Contraception 1989;40:497–503.
4. Liskin L. Periodic abstinence: How well do new approaches work? Popul Rep 1981;1:1–38.
5. Kambic R, Lamprecht V. Calendar rhythm efficacy: A review. Adv Contraception 1996;12:123–128.
6. Trussell J, Grummer-Strawn L. Contraceptive failure of the Ovulation Method of periodic abstinence. Fam Plann Persp 1990;22:63–75.
7. World Health Organization (WHO): Task Force on Methods for the Determination of the Fertile Period. Special Program of Research, Development and Research Training in Human Reproduction. A prospective multicentre trial of the Ovulation Method of natural planning. II. The effectiveness phase. Fert Steril 1981; 36:591–8.
8. World Health Organization (WHO): Task Force on Methods for the Determination of the Fertile Period. Special Program of Research, Development and Research Training in Human Reproduction. A prospective multicentre trial of the Ovulation Method of natural planning. III. Characteristics of the menstrual cycle and of the fertile phase. Fert Steril 1983;40:773–8.
9. Hilgers T, Abraham G, Cavanagh D. Natural family planning: I. The peak symptom and estimated time of ovulation. Obstet Gynecol 1978;52:575–80.
10. Wilcox A, Weinberg C, Baird D. Timing of sexual intercourse in relation to ovulation: Effects on the probability of conception, survival of the pregnancy, and sex of the baby. NEJM 1995;333:517–21.
11. Gould J, Overstreet J, Hanson F. Assessment of human sperm function after recovery from the female reproductive tract. Biol Reprod 1989;31:888–94.
12. Laing J. Periodic abstinence in the Philippines: New findings from a national survey. Stud Fam Plann 1987; 18:32–41.