# Clearblue®

## Can apps and calendar methods
# predict ovulation with accuracy?

## Background

The fertile window is the time in a woman's cycle where unprotected intercourse can lead to pregnancy, and typically lasts 6 days ending on the day of ovulation[1], so it is important that women wishing to become pregnant have intercourse in this window. Predicting the fertile window is difficult, due to considerable intra- and inter-individual variation in cycle length[2] and significant variation in the day of ovulation[3]. There are an increasing amount of freely-available fertility applications which claim to be able to predict either the day of ovulation, or the fertile window, but few apps disclose the algorithms used for these predictions. Most apps make predictions using user-inputted data such as date of last menstrual period and cycle length, or the assumption of a 28 day cycle, with ovulation on day 14.

## Objectives

This study explored the variability in the timing of ovulation, via measurement of the LH surge, during women's cycles and used this information to assess prediction accuracy of calendar apps and calendar-based methods for women seeking to become pregnant.

## Methods

Women over 18 years who were trying to conceive were recruited from the UK. Volunteers collected daily urine samples for an entire menstrual cycle, and completed a menstrual cycle diary. Urinary LH was measured using an AutoDELFIA™ (Perkin Elmer, Waltham, USA) assay for intact LH.

All cycle-tracking calendar apps (iOS and Android) found between 4th-13th October 2017 were downloaded. None of the apps published their method of calculation, so a simulated cycle was entered using idealised characteristics; 28 day cycle, regular, no hormonal contraception, period length 5 days (not all apps required all the information).

Published methods of fertile-phase calculation were also assessed. These included:

- Standard days method (predicts days 8-19 as fertile days)[4]
- Rhythm method[5] and alternative rhythm method[6] (predict fertile phase using formulae based on the longest and shortest of the last 6 cycles)
- Simple calendar method (subtracts 14 and 15 days from the last cycle length to give the peak fertility days).[7]

A probability table was created to record the likelihood of ovulation on any given day for the range of cycle lengths, based on the percentage of the population observed to have ovulated on any given day.

The accuracy of the tested calendar apps was determined by comparison of the prediction provided following input of standard data, with the probability of ovulation obtained from examination of real cycle data.

Accuracy of the calendar-based methods was determined retrospectively as a 'best-case scenario' using the volunteer cycle characteristics supplied.

## Results

Mean cycle length was 28 days (range 23–35). The most likely day of ovulation for a 28-day cycle was day 16 (21%), with day 14 being the fourth most likely day of ovulation (14%), after Day 15 (19%) and Day 17 (17%). For a 28 day cycle the ovulation day ranged from day 11 to day 20 (Table 1).

| Actual cycle length | Mean | SD | N | Probability of ovulating on this day | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 23 | 13.15 | 2.41 | 13 | 1% | 2% | 4% | 7% | 11% | 15% | 17% | 16% | 12% | 8% | 5% | 2% | 1% | 0% | 0% | 0% | 0% | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 24 | 13.16 | 1.99 | 37 | 0% | 1% | 2% | 6% | 11% | 17% | 20% | 18% | 13% | 7% | 3% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | n/a | n/a | n/a | n/a | n/a | n/a |
| 25 | 13.72 | 1.81 | 69 | 0% | 0% | 1% | 3% | 7% | 14% | 20% | 22% | 17% | 10% | 4% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | n/a | n/a | n/a | n/a | n/a |
| 26 | 14.22 | 1.51 | 83 | 0% | 0% | 0% | 1% | 3% | 9% | 19% | 26% | 23% | 13% | 5% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | n/a | n/a | n/a | n/a |
| 27 | 15.14 | 1.71 | 118 | 0% | 0% | 0% | 0% | 1% | 4% | 11% | 19% | 23% | 21% | 13% | 6% | 2% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | n/a | n/a | n/a |
| 28 | 15.76 | 1.91 | 119 | 0% | 0% | 0% | 0% | 1% | 3% | 7% | 14% | 19% | 21% | 17% | 10% | 5% | 2% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | n/a | n/a |
| 29 | 16.77 | 1.61 | 74 | 0% | 0% | 0% | 0% | 0% | 0% | 2% | 6% | 14% | 22% | 25% | 19% | 9% | 3% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | n/a |
| 30 | 17.56 | 1.75 | 73 | 0% | 0% | 0% | 0% | 0% | 0% | 1% | 3% | 8% | 15% | 22% | 22% | 16% | 9% | 3% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 31 | 18.87 | 2.26 | 61 | 0% | 0% | 0% | 0% | 0% | 0% | 1% | 2% | 4% | 8% | 13% | 16% | 18% | 16% | 11% | 7% | 3% | 1% | 0% | 0% | 0% | 0% | 0% | 0% |
| 32 | 19.23 | 1.50 | 31 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 1% | 3% | 9% | 19% | 26% | 23% | 13% | 5% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 33 | 20.55 | 2.02 | 38 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 2% | 4% | 9% | 15% | 19% | 19% | 15% | 9% | 5% | 2% | 1% | 0% | 0% | 0% | 0% | 0% | 0% |
| 34 | 21.60 | 1.63 | 35 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 2% | 7% | 15% | 23% | 24% | 17% | 8% | 3% | 1% | 0% | 0% | 0% | 0% | 0% | 0% |
| 35 | 21.82 | 2.51 | 17 | 0% | 0% | 0% | 0% | 0% | 0% | 1% | 2% | 5% | 8% | 12% | 15% | 16% | 14% | 11% | 7% | 4% | 2% | 1% | 0% | 0% | 0% | 0% | 0% |

*Figure 1 Probability of ovulation on any given day of the cycle according to cycle length. Ovulation day = day of LH surge + 1 day.*

Out of the 73 apps investigated, 18 (nearly 25%) did not state a predicted day of ovulation. The most frequent ovulation day predicted was day 15 (predicted by 32 apps (44% of apps investigated), but the probability of ovulation occurring on this day was only 19%. The accuracy of apps at predicting ovulation day was no better than 21% (Table 2).

**Table 2. Prediction of day of ovulation by apps**

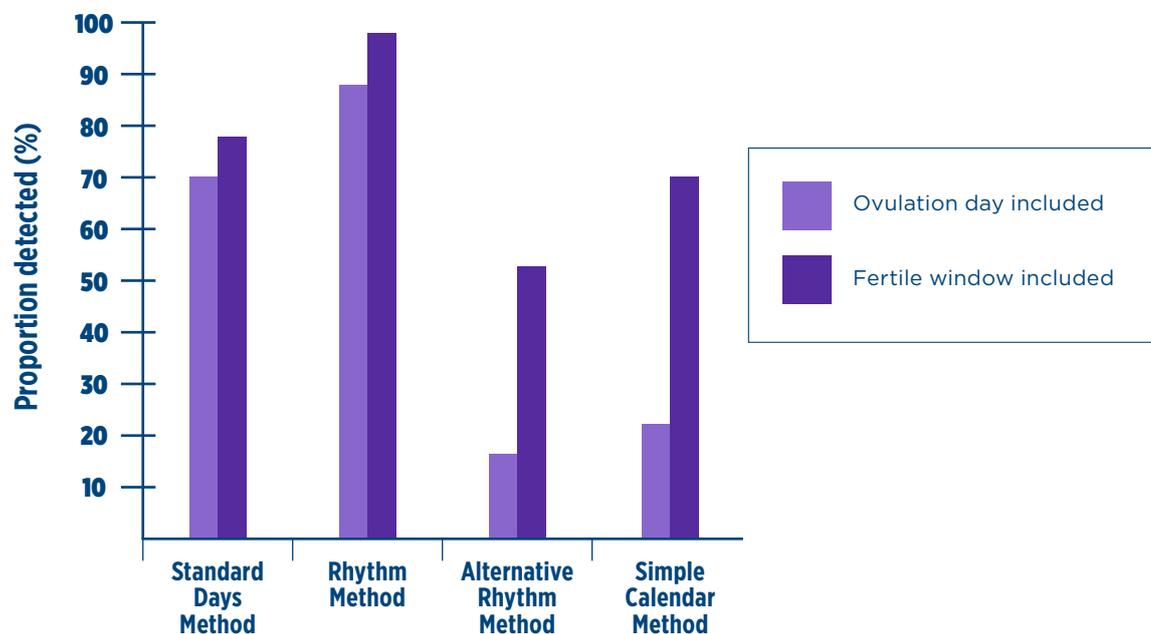| Ovulation days predicted by app | Number of apps providing that prediction | Number of ovulation days predicted by the apps | Probability of ovulation day occurring on day(s) predicted by apps (accuracy) |
|---|---|---|---|
| 12 | 1 | 1 | 3% |
| 14 | 11 | 1 | 14% |
| 15 | 32 | 1 | 19% |
| 16 | 4 | 1 | 21% |
| 17 | 1 | 1 | 17% |
| 11-13 | 1 | 3 | 11% |
| 12-15 | 2 | 4 | 43% |
| 13-14 | 1 | 2 | 21% |
| 13-15 | 1 | 3 | 40% |
| 14-15 | 1 | 2 | 33% |
| Did not state | 18 | NA | NA |



Figure 2 - proportion of published calendar methods that identify ovulation day or fertile window on any given day.

All four calendar methods had ovulation-day prediction accuracy lower than 90%. The standard days and rhythm methods were most likely to predict ovulation (70% and 89%, respectively), but the alternative rhythm method and simple calendar method had low accuracy. However, the more accurate methods rely on providing the user with a broad fertile window in which to target intercourse.

## Conclusions
- The true day of ovulation varies considerably for any given cycle length.
- Calendar/app methods are not able to provide women with an accurate prediction of the day of ovulation.
- Women should be advised not to rely on such methods to enable the optimal timing of sexual intercourse to achieve pregnancy.

References
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