The effect of the menstrual cycle on patterns of food intake\textsuperscript{1-3}

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**ABSTRACT** The dietary intakes of eight human females were obtained by interview each day for 60 days to determine whether the menstrual cycle affected patterns of food intake. The study was double blind in the sense that the subjects did not know its purpose, while the interviewer did not know the timing of their cycles. Mean differences in calorie intake between 10 preovulation and 10 postovulation days were calculated. For cycle one the difference was 504 (SD = 219) cal/day and for cycle two, 496 (SD = 378) cal/day, with the postovulation intake being higher in calories. A dependent t test was performed and these differences were found to be significant at \( p < 0.0004 \) for cycle one and \( p < 0.0008 \) for cycle two. The evidence indicates that women eat more food per day during the 10 days after they ovulate than during the 10 days before.  


**KEY WORDS** Appetite, estrogen, food intake, hunger, menstrual cycle, ovulation, women

**Introduction**

The roles of ovarian hormones in mammals have been extensively studied over the last 40 yr for their effects on reproductive behavior, activity, bodyweight-regulating behaviors, and pattern of food intake (1). However, most research in human studies has centered on ovarian hormones as a factor in premenstrual tension and depression (2). A definite relationship in several mammals has been observed to exist between sex steroids and pattern of food intake (3-6): there is a depressed intake at ovulation when estrogen levels are at their peak (5), and it is logical to suspect that a similar pattern exists in human females. This research was undertaken to determine whether women change their food intake significantly during the menstrual cycle.

Most studies concerning the interactions between feeding and ovarian hormones have been conducted with the laboratory rat. A summary of the most important findings follows: 1) Estradiol appears to be the principal ovarian hormone for regulating body weight. 2) At proestrus, when estradiol is at its peak, food intake and body weight decrease. 3) During diestrus, when progesterone is high and estrogen is low, food intake and weight increase. 4) Female rats have a higher saccharin preference than females due to the stimulatory effect of ovarian hormones. 5) After ovariectomy, meal size increases, but treatment with estradiol causes a return to control levels. 6) In intact female rats, treatment with progesterone causes an increase in feeding and body weight. 7) There is no change in feeding following progesterone administration to ovariectomized rats (4, 8-10).

Female primates also show a cyclic pattern of food intake that is associated with ovarian changes throughout the menstrual cycle (3, 5, 7). Decreased food intake has been noted at midcycle, an interval characterized by a preovulatory surge of estrogen. When primates which have been ovariectomized are injected with estradiol, a similar depression of food consumption occurs (3). Food consumption is significantly higher during the luteal phase of the menstrual cycle than during the rest of the cycle, and this fact led Gilbert and Gillman (cited in Reference 3) to hypothesize that progesterone, which is increased during this phase, acts as an appetite stimulant. These investigators administered progesterone to intact baboons during the midcycle of their menstrual period and found that there was an increase in food intake.

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Other studies do not support the notion that progesterone acts as an appetite stimulant. Czaja (3) found that administration of progesterone to ovarietomized female monkeys did not influence their food intake. In addition, Hess and Resko (11) showed that raising progesterone levels during the periovular and follicular stages of the menstrual cycle had the effect of lowering the estradiol level and preventing its normal surge before ovulation; the observed increase in feeding was evidently secondary to the decreased level of estradiol.

The question has also been raised whether progesterone acts as an antagonist to estradiol. In a recent study by Czaja (7) no such antagonism was found. In monkeys pretreated with progesterone, estradiol successfully lowered food intake; progesterone did not interfere. Also, female monkeys chronically stimulated with estradiol showed no change in food intake when progesterone was administered. Ovarian hormones obviously affect food intake in primates, but it is not clear exactly how they do so.

There are similarities between the rat and primate studies, but the rat study results cannot be generalized to other mammalian species without certain qualifications. Rats have an estrous cycle; primates have a menstrual cycle (3, 7). The rat has a 4- to 5-day estrous cycle in which estrogen dominates except when progesterone shows a brief surge on the night of proestrus. The primate menstrual cycle averages 29 days, and differs primarily in that it has a prolonged spontaneous luteal phase after ovulation which is dominated by progesterone (12, 13).

The levels of serum estrogen, progesterone and luteinizing hormone (LH) in the rhesus monkey during the menstrual cycle resemble those of the human female except for two differences (7, 12, 15). The first difference is that serum estradiol and LH concentrations reach their peak simultaneously in the monkey while in the human female, the estradiol peak precedes the LH peak. Second, human females have a sustained luteal phase serum estrogen peak whereas this has been noted in only one rhesus monkey (12).

The demonstrated relationships between the menstrual cycle and feeding behavior have been little explored in humans (7). The earliest study in which mention is made of a varied food pattern or particular cravings associated with the menstrual cycle was done by Morton et al. (2). In this study, prison inmates were questioned to determine the incidence and severity of premenstrual symptoms. A craving for sweets was reported by 37%, and increased appetites by 23%. Sugar tolerance tests showed a hypoglycemic curve in the premenstrual period, indicating an alteration in carbohydrate metabolism to account for an increased sugar tolerance. Hypoglycemia is characterized by an increased appetite, craving for sweets, and depression.

Fortin (cited in Reference 14) studied premenstrual symptoms in 45 women and listed a craving for sweets as one of the most frequently reported phenomena.

These results were confirmed and extended by Smith and Sauder (14), who reported associations between 1) cravings for food or sweets and premenstrual tension, 2) the occurrence of fluid retention and a craving during a specific time such as during menstrual periods or depression, and 3) compulsive eating and a tendency to more frequent depression. The results indicated that there might be a physiological basis for the cravings and suggested the hypoglycemic phenomenon. However, no studies have been undertaken to test this hypothesis.

The studies with humans have thus all been based on subjects' qualitative impressions of their food intakes or cravings obtained via questionnaire. This study was undertaken to obtain food intake records in order to extract from them more quantitative information on the relationship between food intake and the menstrual cycle.

Methods

Subjects

To obtain subjects, an announcement was made in a college nutrition class which included 80 women that volunteers were needed for a research project, that the purpose of the study would not be revealed until the study was completed, and that whoever volunteered would be asked to report food intake to an interviewer each day for 60 days. Each subject would be given $25 at the end of the study. Students were asked not to volunteer if they anticipated any major changes in their lives such as moving, or if they expected to leave town for more than a weekend. Seventeen students volunteered and were given a short questionnaire which asked...
RESULTS

Self-reported food intakes for two menstrual cycles were obtained from each subject. Subjects were not weighed but were asked at the end of the study if their weight had changed. All but one said they had maintained their weight; one had been losing weight gradually by following the Weight Watchers diet. None reported cramps at any time.

As hypothesized, subjects showed an increase in food consumption during the 10 days postovulation. Figure 1 provides a comparison between the average total caloric variation in percent for the 10 days before and the 10 days after ovulation for the two combined cycles of the eight subjects.

Figure 2 shows the raw data for one subject for the 60 day duration of the study. The vertical lines indicate day 1 of each menstrual cycle. The graph indicates a cyclical pattern of food intake during the menstrual cycle. Greater peaks in caloric level are noted prior to day 1 of menstruation than after.

Table 1 presents the average caloric intake for each female for the 10 days before and the 10 days after ovulation for the two cycles. As one of the cycles for subject 8 began on day 1 of the study and one of her other cycles on day 60, the preperiod and postperiod data adjacent to these days were combined and treated as one cycle. In five cases, the study ended during the collection of the postperiod data and only 8 days were obtained. Averages for 8 days were used for the second menstrual cycle postperiod for subjects 1 to 5.

The means for the differences between the 10 preovulatory and 10 postovulatory days for cycle one and cycle two were 504 (SD = 219) and 496 (SD = 378) cal, respectively. A dependent t test was performed on the averaged differences for each cycle, yielding t's of 6.5 and 3.7, which are significant at p < 0.0004 and p < 0.008, respectively. A 95% confidence interval around the differences was constructed and found to be (321, 687) for cycle one, and (180, 812) for cycle two.
FIG. 1. Averaged caloric intakes for eight subjects for 10 days pre- and postmenstrual period. Each day's caloric intake for each subject was first converted to a percentage of that subject's average intake over the 60-day period. Each bar represents the average for all eight subjects on a given day of the cycle for both cycles, an average of 16 numbers.

![Caloric Intake Graph](https://academic.oup.com/ajcn/article-abstract/34/9/1811/4693552)

**TABLE 1**

Mean caloric intake for 10 days pre- and postmenstrual period

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<th>Postmenstrual</th>
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**Discussion**

Observation of the reported food intakes of eight cycling females shows systematic fluctuations in caloric intake during the menstrual cycle, with the intake being about 500...
cal/day higher during the 10 days before the onset of the menstrual period than during the 10 days after. There is no other research on the food intake patterns of the human female with which to compare these data, but the observed fluctuations correlate with changing ovarian conditions and may result from or be influenced by steroid levels. In particular: estrogen levels begin to fall after ovulation and begin to rise at menstruation. Estrogen may be an appetite-suppressing hormone, and the change in its concentration may account for the observed changes in food intake.

The pattern of food intake shown by these subjects may provide useful background information for future study of the factors affecting human food behavior. In addition, the findings may benefit women who have difficulty controlling their weight.

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References