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RESEARCH ARTICLE
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EXAMINING THE EFFECTS OF MENSTRUAL CYCLE AND HORMONAL CONTRACEPTIVES ON SATIETY HORMONES AND EATING PATTERNS

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ABSTRACT

Background: Appetite regulation in women is influenced by fluctuations in reproductive hormones throughout the menstrual cycle, as well as by the use of hormonal contraceptives. These hormonal changes may impact the levels of appetite-related peptides such as ghrelin, leptin, GLP-1, and PYY, which in turn influence food intake and satiety.'To evaluate the association between menstrual cycle phases and hormonal contraceptive use with levels of satiety hormones and patterns of food intake in women of reproductive age'

Methods: This observational study was conducted at the Department of Obstetrics and Gynaecology, Khairpur Medical College, Khairpur Mir's Sindh, Pakistan,from January 2021 to January 2022. A total of 75 women aged 18 to 35 years were included. Participants were grouped based on menstrual phase (follicular, ovulatory, luteal) and contraceptive status (users vs. non-users). Data on food intake were collected using a 24-hour dietary recall and food diary. Using ELISA, fasting blood samples were analyzed for ghrelin, leptin, GLP-1, and PYY levels. Statistical analysis was performed using SPSS version 25, with p-values less than 0.05 considered significant.

Results: Ghrelin levels were highest in the follicular phase and declined significantly in the luteal phase ($p=0.032$), while leptin levels showed an increasing trend ($p=0.041$). Hormonal contraceptive users had lower ghrelin and higher leptin and GLP-1 levels compared to non-users ($p<0.05$). Despite elevated satiety hormone levels, food intake, particularly total calories and carbohydrate consumption, was significantly higher in the luteal phase ($p=0.012$ and $p=0.045$, respectively).

Conclusion: Hormonal fluctuations across the menstrual cycle and the use of hormonal contraceptives significantly affect appetite-regulating hormones and food intake in women. These

findings highlight the importance of considering hormonal status when addressing dietary behavior and nutritional counseling in women's health.

Keywords: 'Menstrual cycle, hormonal contraception, ghrelin, leptin, satiety hormones, appetite, food intake, reproductive health'

INTRODUCTION

Women's appetite control is affected by several intertwining systolic and behavioral elements (1, 2). During a woman's menstrual cycle, estrogen and progesterone impact reproductive mood oscillations along with energy metabolism and eating patterns. Changes in these hormones may modify the secretion and action of the satiety hormones ghrelin, leptin, peptide YY (PYY), and glucagon-like peptide-1 (GLP-1), which are critical in the communication of fullness and hunger to the brain (3, 4).

Production of Ghrelin, pancreatic GLP-1 and PYY precursor, and leptin secretion from adipose tissues is modulated by the central nervous system based on the hungry state. Leptin, secreted by fat tissues, is known to signal satiety while ghrelin secreted from the stomach is known to increase appetite (5, 6). These gut and peripheral derived hormones cross the blood-brain barrier and activate central nervous system pathways. 'They are responsive to changes in the transitioning phases of the menstrual cycle. Such sensitivity has been observed in many studies'(7, 8).

Alongside the physiological fluctuations of hormones, the appetite controlling systems can be impacted by the use of hormonal contraceptives as well (9, 10)Estrogen and progestin contraceptives change the woman's internal hormonal clock and may either enhance or dampen appetite reflexes. Nonetheless, what is known about these impacts is mostly sparse, especially considering biochemical parameters, dietary consumption, and sophisticated analyses of eating behaviour (11).

Earlier research has noted 'alterations in energy balance and eating behavior at different phases of the menstrual cycle, identifying increased appetite and higher caloric consumption in the luteal phase'(12). However, there is a relative gap in research examining the underlying satiety hormone profiles during these cycles, particularly in women with hormonal birth control.

In light of the context provided, the objective of this research was to explore the relationships between the phases of the menstrual cycle, the use of hormonal contraceptives, and the levels of the main satiety hormones: ghrelin, leptin, PYY, and GLP-1. Furthermore, the study evaluated how these hormonal changes relate to the actual eating behaviors regarding the total energy intake, the amount of consumed macronutrients, and their proportions. The integration of both biochemical and behavioral metrics aims to comprehensively elucidate appetite control in women across different hormonal states.

METHODOLOGY

The research was designed as an observational comparative study to assess the relationship between different cycles of the menstrual period and food consumption patterns in women with and without the hormonal contraceptive, as well as the fluctuation of satiety hormones. The study of the research was conducted in one year, starting from January 2021 to January 2022,in the Department of Obstetrics and Gynaecology, Khairpur Medical College, Khairpur Mir's Sindh, Pakistan.

The study followed a cross-sectional comparative approach. Participants were selected from both outpatient departments and clinical units within the Department of Obstetrics and Gynaecology, Khairpur Medical College, Khairpur Mir's Sindh, Pakistan. The setting was chosen due to its large and diverse patient base and its accessibility to laboratory facilities required for hormone analysis.

A total of 75 women aged between 18 and 35 years were enrolled. The sample size was determined using an online calculator, taking into account a 95% confidence level, 80% power, and expected variations in ghrelin and leptin levels between hormonal and non-hormonal groups based on previous literature. Participants were selected through purposive sampling, ensuring equal representation from users of hormonal contraceptives and those with natural menstrual cycles.

Women who had regular menstrual cycles or were using hormonal contraceptives (oral, injectable, or implant-based) for at least three months were eligible. Those with known endocrine disorders (e.g., PCOS, thyroid dysfunction), eating disorders, metabolic diseases (e.g., diabetes), pregnancy, or lactation were excluded to avoid hormonal and metabolic confounders.

After obtaining written informed consent, participants underwent structured interviews and physical assessments. Demographic data including age, BMI, education, occupation, and lifestyle details (sleep, physical activity) were recorded. Menstrual history, including regularity, cycle length, and contraceptive use, was documented.

To classify menstrual phases, participants not on hormonal contraception were evaluated based on self-reported last menstrual period. Hormonal users were grouped based on the type and duration of contraceptive use.

Each participant completed a '24-hour dietary recall and a 3-day food diary under the supervision of a trained nutritionist'. Data on total calorie intake, meal frequency, and macronutrient distribution (carbohydrates, proteins, fats) were analyzed using a validated nutritional software.

Venous blood samples were collected in the morning after an overnight fast. Samples were centrifuged and stored at −20°C until batch analysis. Hormone assays included serum ghrelin, leptin, peptide YY (PYY), and glucagon-like peptide-1 (GLP-1), measured using commercially available ELISA kits following the manufacturer's protocols. All samples were run in duplicates to ensure assay reliability.

All hormone measurements were performed using standardized protocols to ensure validity, and dietary records were cross-checked for consistency. A pilot test was conducted on 10 participants to refine the data collection tools. Internal reliability of the hormone assays was confirmed by using the intra-assay coefficient of variation (CV) within acceptable limits (<10%).

'The study was approved by the Institutional Review Board of the Department of Obstetrics and Gynaecology, Khairpur Medical College, Khairpur Mir's Sindh, Pakistan. Participation was voluntary, and confidentiality was maintained throughout the study. Participants had the right to withdraw at any stage without affecting their clinical care.

'Data were analyzed using SPSS version 25'. Descriptive statistics were used for demographic variables. Independent t-tests and ANOVA were applied to compare hormone levels and food intake across menstrual phases and contraceptive use. A p-value less than 0.05 was considered statistically significant.

RESULT

The study involved 75 women aged between 18 and 35 years. The average age was around 25 years, and most participants fell within a normal BMI range. A significant portion of the participants were married and had completed higher education. Around 41% of them were working, and a good proportion engaged in moderate-to-high physical activity. Most participants reported getting 6–7 hours of sleep daily. These variables help ensure a representative baseline and reduce potential bias due to extreme socio-demographic or lifestyle variations.

Table 1: 'Demographic and Baseline Characteristics of Participants (n = 75)'

Variable	Mean ± SD / n (%)
Age (years)	24.8 ± 3.6
BMI (kg/m²)	22.7 ± 2.9
Marital status (Married)	42 (56%)
Education (Graduate+)	49 (65.3%)
Employment (Employed)	31 (41.3%)
Physical activity (Moderate to High)	28 (37.3%)
Sleep duration (hours/night)	6.4 ± 1.2

Most participants had regular menstrual cycles, and sampling was evenly distributed across the three key phases—follicular, ovulatory, and luteal. Nearly half the sample was using some form of

hormonal contraception, predominantly combined oral contraceptives. This mix of natural and hormonal cycles allowed a meaningful comparison of hormone profiles and behavioral differences across menstrual states.

Table 2: Menstrual and Contraceptive Variables

Variable	Frequency (%)
Regular menstrual cycle	53 (70.7%)
Cycle phase at sampling	
– Follicular	21 (28%)
– Ovulatory	24 (32%)
– Luteal	30 (40%)
Hormonal contraceptive use	35 (46.7%)
Type of contraception	
– Combined oral pills	24 (68.6%)
– Progestin-only	7 (20%)
– Injectable	4 (11.4%)

Among women not using hormonal contraception, notable variations were observed in hunger and satiety hormones across the menstrual cycle. Ghrelin, which stimulates appetite, was higher in the follicular phase and dropped during the luteal phase. In contrast, leptin increased in the luteal phase, signaling more satiety. Although PYY and GLP-1 showed numerical increases, their differences across phases weren't statistically significant.

Table 3: Satiety Hormone Levels by Menstrual Phase

Hormone	Follicular (n=21)	Ovulatory (n=24)	Luteal (n=30)	p-value
Ghrelin (pg/mL)	91.2 ± 15.3	84.6 ± 13.1	79.8 ± 12.5	0.032*
Leptin (ng/mL)	12.4 ± 4.2	13.6 ± 4.6	15.9 ± 5.1	0.041*
PYY (pg/mL)	72.3 ± 9.1	74.8 ± 8.7	76.5 ± 9.4	0.247
GLP-1 (pmol/L)	8.3 ± 1.4	8.6 ± 1.2	9.0 ± 1.6	0.186

Women using hormonal contraceptives exhibited a different hormonal pattern compared to those with natural cycles. They had significantly lower levels of ghrelin and higher levels of leptin and GLP-1, suggesting greater suppression of appetite. The rise in leptin and GLP-1 waconsistent with hormonal modulation through exogenous estrogen and progesterone. These findings reinforce the idea that contraceptives may affect hunger regulation biochemically.

Table 4: Satiety Hormone Levels by Hormonal Contraceptive Use

Hormone	Contraceptive Users (n=35)	Non-Users (n=40)	p-value
Ghrelin (pg/mL)	78.5 ± 11.8	86.9 ± 14.9	0.009*
Leptin (ng/mL)	16.2 ± 5.3	12.8 ± 4.4	0.004*
PYY (pg/mL)	75.1 ± 8.6	73.5 ± 9.3	0.412
GLP-1 (pmol/L)	9.2 ± 1.4	8.5 ± 1.3	0.028*

There were significant differences in dietary behavior across the menstrual cycle. Total caloric intake and carbohydrate consumption peaked during the luteal phase, corresponding with higher leptin and reduced ghrelin. This suggests that although biochemical satiety signals are stronger in the luteal phase, actual food intake also increases—possibly due to emotional or metabolic changes. Increased snacking further supports the idea of behavioral changes influenced by hormonal shifts.

Table 5: Food Intake across Menstrual Phases

Variable	Follicular	Ovulatory	Luteal	p-value
Total energy intake (kcal/day)	1985 ± 211	2024 ± 230	2251 ± 240	0.012*
Carbohydrates (%)	52.3 ± 4.2	50.9 ± 4.8	54.8 ± 5.1	0.045*
Proteins (%)	16.9 ± 3.1	17.2 ± 2.9	15.7 ± 2.8	0.081
Fats (%)	30.8 ± 3.6	31.9 ± 4.0	29.5 ± 3.5	0.107
Snacking frequency	1.1 ± 0.6	1.2 ± 0.7	1.7 ± 0.9	0.019*

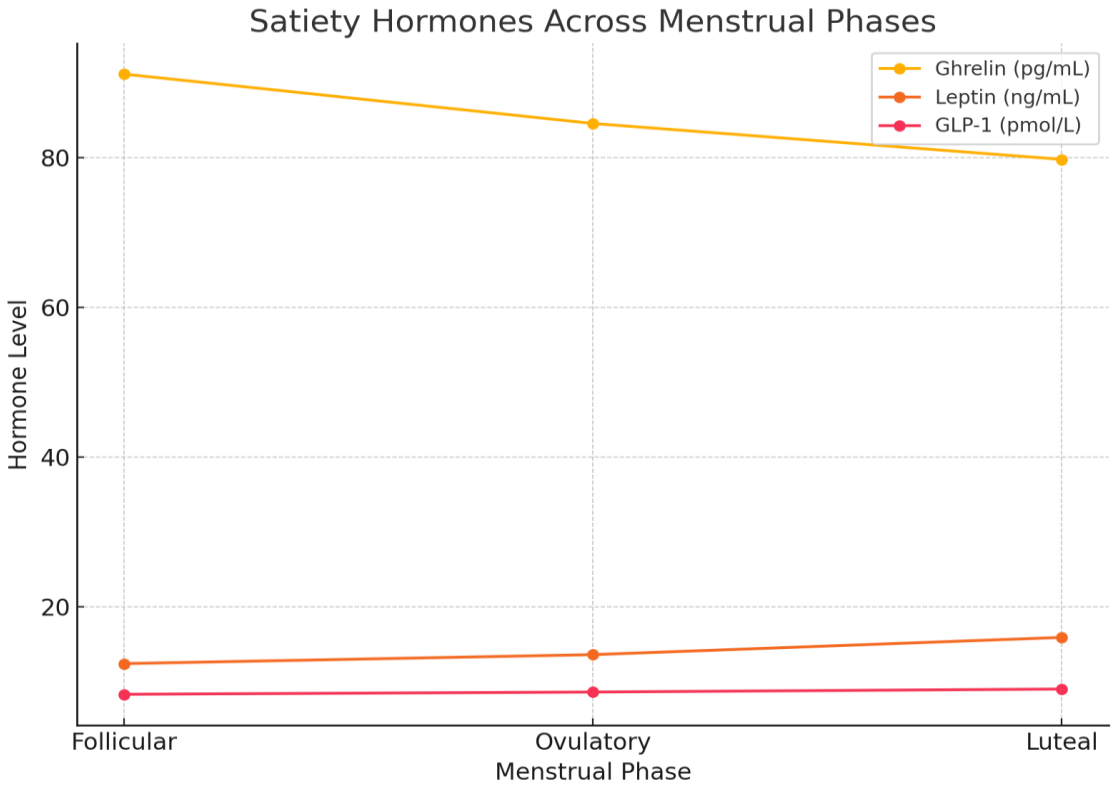

Figure 1

The graph shows that ghrelin levels, which stimulate hunger, are highest during the follicular phase and gradually decrease toward the luteal phase. In contrast, leptin and GLP-1, both associated with satiety, rise as the cycle progresses. This suggests that women may experience stronger hunger earlier in the cycle and feel fuller in the later phases. These hormonal shifts may help explain changes in appetite and food intake across different menstrual phases.

DISCUSSION

'This study analyzed the impact of menstrual cycle phases and the use of hormonal birth control on women's satiety-regulating hormones and their consumption patterns'. The study findings underscored important changes in hormonal levels throughout the menstrual cycle and significant changes in appetite related hormones in contraceptive users and non-users which adds to understanding the dynamics of nutrition in women vis-a-vis their hormonal levels (13-15).

A key finding was the opposite correlation between the levels of ghrelin and leptin throughout the menstrual cycle. As previously mentioned, ghrelin, the hunger hormone, was highest in the follicular phase and decreased toward the luteal phase. This supports evidence from earlier research which indicated that appetite stimulating hormones are more active in the earlier part of the cycle (16, 17). On the other hand, leptin was found to significantly rise during the luteal phase, supporting other studies that show an increase in appetite control signals near the time of menstruation (18). The disparity in ghrelin and leptin trends strengthens the theory of appetite regulation being constantly modulated by internal hormonal changes.

Furthermore, GLP-1, which is an incretin hormone that supports the feeling of fullness, showed a slight increase during the luteal phase which supports earlier observations indicating that estrogen-dominant phases may increase responsiveness of GLP-1. Even though the increase in GLP-1 and PYY was not statistically significant, the trend indicates the potential involvement of these hormones in appetite control related to the menstrual cycle (19).

There was a particular profile in users of hormonal contraceptives that had significantly lower ghrelin and higher leptin and GLP-1 compared to non-users. These differences could stem from the influences of estrogen and progesterone on appetite-suppressing mechanisms. This aligns with other studies (20), which showed that contraceptive pills can alter appetite control by diminishing ghrelin and increasing leptin, which alters the suppression mechanism. Moreover, some studies indicated that women using hormonal contraceptives tend to demonstrate more controlled eating behavior, possibly due to less fluctuating hormonal levels (21).

Based on the actual food eaten, total calories and the amount of snacking done, was highest in the luteal phase indicative of increased appetite even when levels of satiety hormones are high. These outcomes resonate with results from other studies that suggest some emotions along with metabolic drives, for example, progesterone dominance in the luteal phase is likely to fuel food cravings and increase consumption, particularly of carbohydrates (22).

Similar to previous literature, the results reveal a biological system for appetite control corresponding to the phases of the menstrual cycle and is modified by the use of hormonal contraceptives. This could be useful for counseling patients regarding diet, controlling weight, or even formulating treatment strategies for clinical obesity or eating disorders in which endocrine changes are significant.

CONCLUSION

This study demonstrated that hormonal changes across the menstrual cycle significantly impact appetite-regulating hormones and food intake in women. Ghrelin levels were highest in the follicular phase and decreased in the luteal phase, while leptin and GLP-1 levels rose closer to menstruation. Hormonal contraceptive use was associated with reduced hunger signals and enhanced satiety. Despite higher satiety hormone levels, food intake, particularly caloric and carbohydrate consumption, increased in the luteal phase. These findings suggest that both natural and artificial hormonal states modulate appetite and eating behavior, offering implications for personalized dietary strategies in women's health.

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