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Comparison of Sexual Hormone Secretion, Executive Brain Functions, and Changes in General Health in Women with and without Premenstrual Syndrome

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A B S T R A C T

Objective: This study aimed to compare the secretion of sexual hormones, executive brain functions, and changes in general health in women with and without premenstrual syndrome (PMS).

Methods and Materials: The research design was a causal-comparative method. The statistical population included all women who visited the health center in Zanjan in 2023. The sample consisted of 200 women with and without PMS, selected using purposive convenience sampling. The instruments used in this research included blood tests, a PMS assessment questionnaire, the Wisconsin Card Sorting Test for assessing executive brain functions, and a general health questionnaire. Data analysis was performed using independent t-tests and multivariate analysis of variance (MANOVA).

Findings: The findings indicated that the normal group had higher executive brain functions compared to those with PMS. Additionally, the general health of women with PMS was lower than that of the normal group. However, both groups exhibited the same level of progesterone hormone secretion, with no difference in the amount of progesterone secretion.

Conclusion: The study found that women with premenstrual syndrome (PMS) exhibited lower executive brain functions and general health compared to women without PMS. No significant differences were observed in estrogen and progesterone secretion levels between the two groups. These findings suggest that PMS negatively impacts cognitive functions and general health, highlighting the need for targeted interventions to improve the quality of life for affected women.

Keywords: *Sexual hormone secretion, executive brain functions, general health, premenstrual syndrome.*

1. Introduction

Premenstrual syndrome (PMS) is a complex and multidimensional condition characterized by a collection of psychological and physical symptoms that appear during the luteal phase of the menstrual cycle and decrease or disappear with the onset of menstrual bleeding (King, 2020). These symptoms can significantly impact women's quality of life. PMS symptoms include depression, irritability, anxiety, fatigue, bloating, and physical pains that can affect women's daily activities, social, and occupational functioning (King, 2020).

Sex hormones such as estrogen and progesterone play a significant role in the manifestation of PMS symptoms (Triebner et al., 2022). These hormones considerably affect mood fluctuations and cognitive functions in women. Changes in the levels of these hormones can lead to mood swings and physical symptoms associated with PMS. Given the importance of these hormones, numerous studies have been conducted to examine their effects on PMS symptoms, but there is still a need for more comprehensive and detailed studies in this area (Lee et al., 2022).

Another component that seems to be associated with PMS is the executive functions of the brain (Miza, Pimenta, Vazquez, Balderas, & Toledo, 2021). Executive brain functions include a set of cognitive processes such as working memory, attention, impulse control, and cognitive flexibility, which are essential for daily activities (Aghaziarati et al., 2023; Bulut et al., 2024; Lin et al., 2022). Studies have shown that women with PMS may experience impairments in these functions. These impairments can negatively impact their academic and occupational performance (Lin et al., 2022; Meza-Moreno et al., 2021). However, few studies have systematically and comprehensively examined the differences in executive functions between women with PMS and normal women.

It appears that the general health of women is also affected by PMS. Hormonal and cognitive changes resulting from PMS can lead to sleep disturbances, increased risk of mental disorders such as depression and anxiety, and a decrease in quality of life (Hwang et al., 2023). A better understanding of these impacts can help develop effective therapeutic and intervention strategies to improve women's general health. Given the high prevalence of PMS and its extensive effects on women's quality of life, comprehensive and multifaceted research in this area is essential. The present study aims to compare the secretion of sexual hormones, executive brain functions, and general health changes between women with PMS and normal women. This research can provide new and precise data, helping to fill existing scientific gaps in this field and offering valuable information for developing therapeutic and intervention strategies.

2. Methods and Materials

2.1. Study design and Participant

This research is applied in nature and descriptive-survey in method. Since the present study compares the secretion levels of hormones, brain function, and mood changes in women with PMS, the researcher seeks to determine causal relationships between variables, employing a causal-comparative research method. The statistical population included all women who visited the health center in Zanjan in 2023. The sample consisted of 200 women with and without PMS, selected using convenience sampling (100 individuals in each group). After selecting the samples, the participants responded to the required questionnaires and underwent relevant tests.

Before starting the research, complete information about the study, including objectives, hypotheses, and methods, was provided to all participants. After coordinating with the relevant authorities, the Wisconsin Card Sorting Test was used to assess executive brain functions, blood tests were conducted to evaluate sexual hormones, and the GHQ was used to assess general health. Participants were assured of confidentiality, and it was emphasized that the study posed no risks or side effects. Ethical considerations included random selection of participants, anonymized questionnaires, and ensuring confidentiality of data.

2.2. Measures

2.2.1. Premenstrual Syndrome

This questionnaire contains 32 questions aimed at assessing PMS symptoms from various dimensions (psychological, behavioral, and physical symptoms). The scoring method is based on a four-point Likert scale ranging from 0 (no symptoms) to 3 (severe). The psychological and behavioral symptoms are covered by questions 1-16 and 22-24, while the physical symptoms are addressed by questions 17-21 and 25-32. The scores for each dimension are summed, and the total score is obtained by adding the scores of both dimensions. The validity and reliability of this questionnaire were tested in Delara et al.'s study (2011). The content validity ratio and index were 0.78 and 0.90,

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respectively, and the Cronbach's alpha coefficient for psychological and behavioral symptoms was 0.915 and for physical symptoms was 0.791, indicating good reliability (Maddineshat et al., 2016; Teimouri et al., 2017).

2.2.2. *Executive Brain Functions*

The Wisconsin Card Sorting Test (WCST) was used to assess executive brain functions. The initial version of this test was developed by Berg in 1948. The test involves giving the participant a set of 64 stimulus cards and asking them to match each card with one of four key cards arranged in a specific order. The stimulus cards contain shapes of different colors, numbers, and forms. The participant must match the cards based on one of three dimensions (color, shape, and number). The participant must maintain the concept or rule understood during consecutive trials and adapt to new rules when feedback indicates a change. Perseverative errors, where the participant continues to respond based on a previously successful principle despite feedback indicating a rule change, are used as the primary score. Lezak, Howieson, and Loring (2004) reported a reliability coefficient of 0.86 for this test, and the test-retest reliability in an Iranian sample was 0.85 (Bulut et al., 2024; Emami Khotbesara et al., 2024).

2.2.3. *General Health*

Developed by Goldberg in 1972, this questionnaire is widely used to assess mental health in various populations and contexts. It consists of 28 questions across four subscales: physical symptoms, anxiety and sleep disturbances, social functioning, and depressive symptoms. Each subscale contains seven questions, scored on a Likert scale. Higher scores indicate poorer general health. The validity and reliability of the Persian version of this questionnaire have been confirmed in various studies, with Cronbach's alpha coefficients ranging from 0.78 to 0.92 for the total score and subscales (Behroozi et al., 2018).

2.2.4. *Blood Test*

A blood test was conducted on all participants to estimate and analyze the levels of sexual hormones.

2.3. *Data Analysis*

Both descriptive and inferential statistics were used to analyze the collected data. Central tendency and dispersion indices, frequency tables, and charts were used to describe the data. Independent t-tests and multivariate analysis of variance (MANOVA) were employed to determine differences between variables in the target groups. Data analysis was conducted using SPSS-22 software.

3. Findings and Results

Among the 200 participants in this study, 100 were in the normal group, and 100 were in the group of women with premenstrual syndrome (PMS), evaluated using the research instruments. The mean age of the participants in the normal group was 28.05 years with a standard deviation of 6.14, while the mean age of the participants with PMS was 32.83 years with a standard deviation of 6.79, ranging from 21 to 40 years old.

Table 1

Means and Standard Deviations of Executive Functions, General Health, and Sexual Hormone Secretion in Two Groups

Variable	Group	Mean	Standard Deviation	Minimum Score	Maximum Score	N
Executive Functions	Normal	80.11	15.03	55	110	100
	PMS	65.23	20.02	40	60	100
General Health	Normal	45.77	10.55	30	65	100
	PMS	55.88	12.36	35	75	100
Estrogen (ng/mL)	Normal	23.08	7.78	15	40	100
	PMS	25.39	8.44	10	35	100
Progesterone (ng/mL)	Normal	18.19	6.23	10	30	100
	PMS	16.96	5.11	8	28	100

As seen in Table 1, the null hypothesis for the equality of variances between the scores of the two groups in the research variables is confirmed, indicating that the assumption of equal variances between the scores of the two groups is validated. The results of the Kolmogorov-Smirnov test for the normality assumption of score distribution in the population showed that the null hypothesis for the normal distribution of scores in the research variables is confirmed. Therefore, the assumption of normal score distribution in the pre-test and both groups is validated.

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Table 2

Results of Multivariate Analysis of Variance (MANOVA) on Mean Scores of Research Variables

Test Name	Value	Hypothesis DF	Error DF	F	p	Eta Squared
Pillai's Trace	.47	4	195	24.47	.001	.47
Wilks' Lambda	.52	4	195	24.47	.001	.47
Hotelling's Trace	.89	4	195	24.47	.001	.47
Roy's Largest Root	.89	4	195	24.47	.001	.47

As shown in Table 2, by controlling the pre-test levels, the significance levels of all tests indicate that there is a significant difference between the normal group and the group with PMS in at least one of the dependent variables ($F = 24.47$, $p < .001$). To determine which variable shows a significant difference between the two groups, four univariate analyses of covariance (ANCOVA) were conducted within the MANOVA, and the results are presented in Table 3. The effect size is .47, meaning that 47% of individual differences in executive functions, general health, and sexual hormone secretion scores are due to group membership.

Table 3

Results of Univariate Analysis of Variance (ANOVA) within MANOVA on Post-Test Mean Scores of Executive Functions, General Health, and Sexual Hormone Secretion in Normal and PMS Groups

Variable	Source	Sum of Squares	df	Mean Square	F	p	Eta Squared	Power
Executive Functions	Group	214.24	1	214.24	11.24	.001	.05	.91
	Error	3771.75	198	19.04				
General Health	Group	1378.12	1	1378.12	45.68	.0001	.18	1.00
	Error	5972.67	198	30.16				
Estrogen	Group	95.22	1	95.22	1.11	.176	.07	.12
	Error	4250.70	198	21.46				
Progesterone	Group	55.45	1	55.45	1.13	.139	.02	.10
	Error	4934.88	198	24.92				

As seen in Table 3, there is a significant difference between the normal group and the PMS group in terms of executive functions ($F = 11.24$, $p < .05$). Therefore, the first hypothesis is confirmed. In other words, based on the mean scores of executive functions, the normal group has higher executive brain functions compared to the PMS group. There is also a significant difference in general health between the normal group and the PMS group ($F = 45.68$, $p < .0001$). Therefore, the second hypothesis is confirmed. In other words, based on the mean scores of general health, women with PMS have lower general health compared to the normal group (higher scores indicate lower general health). The effect size is .18, meaning that 18% of individual differences in scores between the two groups are due to group membership. There is no significant difference in estrogen hormone secretion between the normal group and the PMS group. In other words, based on the mean scores of estrogen hormone secretion, the normal group and the PMS group have the same level of estrogen hormone secretion, with no difference in the amount of estrogen secretion. Similarly, there is no significant difference in progesterone hormone secretion between the normal group and the PMS group. In other words, based on the mean scores of progesterone hormone secretion, the normal group and the PMS group have the same level of progesterone hormone secretion, with no difference in the amount of progesterone secretion.

4. Discussion and Conclusion

The results indicate that the normal group has higher executive brain functions compared to the PMS group. Based on the mean scores of general health, women with PMS have lower general health compared to the normal group (higher scores indicate lower general health). Based on the mean scores of estrogen hormone secretion, the normal group and the PMS group have the same level of estrogen hormone secretion, with no difference in the amount of estrogen secretion. Based on the mean scores of progesterone hormone secretion, the normal group and the PMS group have the same level of progesterone hormone secretion, with no difference in the amount of progesterone

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secretion. These findings are consistent with the prior research (Chumpalova et al., 2020; King, 2020; Kulkarni et al., 2022; Montazeri et al., 2019; Triebner et al., 2022).

To explain these findings, it can be said that this study aimed to examine significant differences between women with PMS and normal women in terms of sexual hormone secretion, executive brain functions, and changes in general health. The findings showed significant differences between these two groups in some dependent variables.

The results of the analyses indicated significant differences in executive functions between the normal group and the PMS group. In other words, normal women had better executive brain functions compared to women with PMS. These findings are consistent with previous studies that show PMS can negatively affect cognitive and executive functions. For example, a study by Balor et al. (2020) showed that women with PMS perform worse in executive tasks such as planning, working memory, and sustained attention compared to women without PMS. This significant difference significantly affects executive tasks such as planning, working memory, and attention. One possible reason for this difference could be related to brain chemical changes during the premenstrual period. During this period, a decrease in serotonin levels, which plays an essential role in mood regulation and cognitive functioning, can lead to reduced executive functions.

Additionally, changes in GABA levels, which play a crucial role in regulating anxiety and stress, can affect executive functions. Studies have shown that decreased GABA levels during the premenstrual period can lead to increased anxiety and reduced concentration (Epperson et al., 2012). These factors may explain the reduced executive functions in women with PMS. On the other hand, hormonal changes, especially decreased progesterone and increased estrogen, can cause changes in different brain areas associated with executive functions. These hormonal changes can directly impact the prefrontal cortex, responsible for planning, decision-making, and impulse control (Endicott et al., 2006; Epperson et al., 2012; Hantsoo & Epperson, 2015).

The findings of this study also showed a significant difference in general health between the normal group and the PMS group. Women with PMS had lower general health compared to normal women. This result is also consistent with previous studies. Additionally, the negative impacts of PMS on social and family relationships can also lead to reduced general health. Studies have shown that women with PMS may experience difficulties in interpersonal and family relationships, which can increase stress and reduce general health (Hantsoo & Epperson, 2015). The negative impacts of PMS on general health can also lead to increased absenteeism from work and reduced occupational performance. Women with PMS may be unable to work effectively in their workplace due to severe physical and psychological symptoms, leading to reduced job satisfaction and increased stress (Endicott et al., 2006).

In this study, no significant difference was observed in estrogen and progesterone hormone secretion between the normal group and the PMS group. This finding indicates that although hormonal changes occur in PMS, the overall levels of these hormones do not differ between the two groups. This result aligns with some previous research, suggesting that changes in hormone sensitivity rather than changes in hormone levels may play a role in the manifestation of PMS symptoms (de Wit, 2021; Schmidt et al., 1998). The hormonal changes during the premenstrual period are more related to how the brain and body respond to these hormones than the hormone levels themselves. This may explain the lack of significant differences in sexual hormone secretion levels.

The results of this study showed that executive brain functions and general health are influenced by group membership in normal women and women with PMS. In other words, women with PMS not only had lower executive brain functions but also had poorer general health. These findings suggest that PMS can have multiple negative effects on women, manifesting at both cognitive and general health levels.

One possible reason for these differences could be related to neurotransmitter changes and the central nervous system during the premenstrual period. Studies have shown that changes in serotonin and GABA levels during the premenstrual period can lead to PMS symptoms (Ipperson et al., 2012). These changes may lead to impairments in executive brain functions and reduced general health.

Similar studies in this field have also reported similar results. For example, a study by Hantsoo et al. (2014) showed that women with PMS have poorer performance in executive tasks compared to women without PMS, which is related to hormonal changes (Hantsoo & Epperson, 2015). Additionally, a study by Endicott et al. (2008) showed that PMS can significantly reduce women's quality of life and general health (Endicott et al., 2006).

In summary, the results of this study showed significant differences between normal women and women with PMS in terms of executive brain functions and general health.

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These results suggest that PMS can have extensive effects on women's cognitive functions and general health. Therefore, addressing this issue in health and treatment programs can help improve the quality of life and reduce problems associated with PMS.

5. Limitations and Suggestions

Like any study, this study has limitations that should be considered: This study used convenience sampling, which may limit the results to a specific sample and may not be generalizable to a broader population. Measuring sexual hormone levels and executive brain functions was done using specific methods that may have measurement errors. This study was conducted over a specific time frame, and the results may be influenced by seasonal or environmental conditions. The results of this study may not be generalizable to populations with different cultures, as cultural differences can significantly impact PMS experiences and general health. Using self-report questionnaires may introduce reporting errors, as respondents may not be able or willing to provide accurate information. Individual differences in hormone responses and other physiological factors can influence the results, and this topic was not fully addressed in this study.

To expand knowledge in the field of sexual hormone secretion, executive brain functions, and changes in general health in women with PMS, the following suggestions may be useful: Conducting longitudinal studies to examine hormonal and psychological changes over time and their relationship with PMS symptoms can provide a better understanding of this disorder. Exploring the experiences of women with PMS in different cultures can help understand cultural differences and their impact on general health. Providing appropriate interventions such as psychological counseling, medication treatments (such as contraceptive pills and SSRIs), and hormonal treatments can help reduce PMS symptoms and improve women's general health. Establishing support networks and support groups for women with PMS can increase solidarity and reduce stress associated with this disorder.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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