Disturbance in Biological Rhythms During Hormonal Imbalance Causes Polycystic Ovarian Syndrome (PCOS)

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Abstract:

To operate well the reproductive system relies on a stable hormonal equilibrium. When the hypothalamus emits Gonadotropin-releasing hormone (GnRH) it initiates the pituitary gland in making luteinizing hormone (LH) alongside follicle stimulating hormone (FSH). These hormones play a crucial role in controlling the menstrual cycle and ovulation. Oddities in this control can cause irregular cycles along with other gynaecological complications. Changes in hormone levels disrupt rhythm patterns in the body and result in polycystic ovarian syndrome. Women often deal with Polycystic Ovarian Syndrome (PCOS), typically unaware of how much it affects them. Irregular menstrual periods and higher levels of male hormones define the disorder. Hormonal imbalances result in disruptions of biologically regulated rhythms that lead to PCOS. This article examines the influence of these imbalances on PCOS and female health. Cognizing the natural rhythms of the body and hormonal equilibrium is important. In this article we try to compile maximum factor i.e. their dietary habits, their life style, that affect women health and causes PCOS.

Keywords:

Biological Rhythms, Hormonal imbalance, Gynaecological, Sleep cycle.

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Introduction

A natural process called circadian rhythm governs several body functions in our bodies. See it as your body's timekeeping system governed by the hypothalamus of the brain. The cycles require hormones to regulate effectively and guarantee that sleep and reproductive cycles proceed without issues. Female patients with PCOS can experience a number of detrimental impacts from disturbances in their biological rhythms. The menstrual cycle is highly affected by this. Chaos in sleeping patterns and stress can cause periods to fluctuate unpredictably, leading women to struggle with pregnancy planning. Such fluctuations can lead to major emotional turmoil and impact how they live.

Consequences of Unstable Biological Patterns on PCOS

Disturbed rhythms can result in weight gain and obesity seen often in women with PCOS. Increased stress and poor slumber may promote larger meals and an interest in junk food which causes weight to increase. Eating too much and gaining weight may enhance insulin resistance and hormone imbalances causing greater problems for PCOS. The effect of altered biological rhythms on psychological well-being should remain unrecognised. Typically women suffering from PCOS will face feelings of anxiety and depression along with mood shifts. managing unusual menstrual cycles along with weight increases and additional issues may harm their mental well-being. Handling the changes in biological rhythms might ease specific psychological effects and promote better well-being.

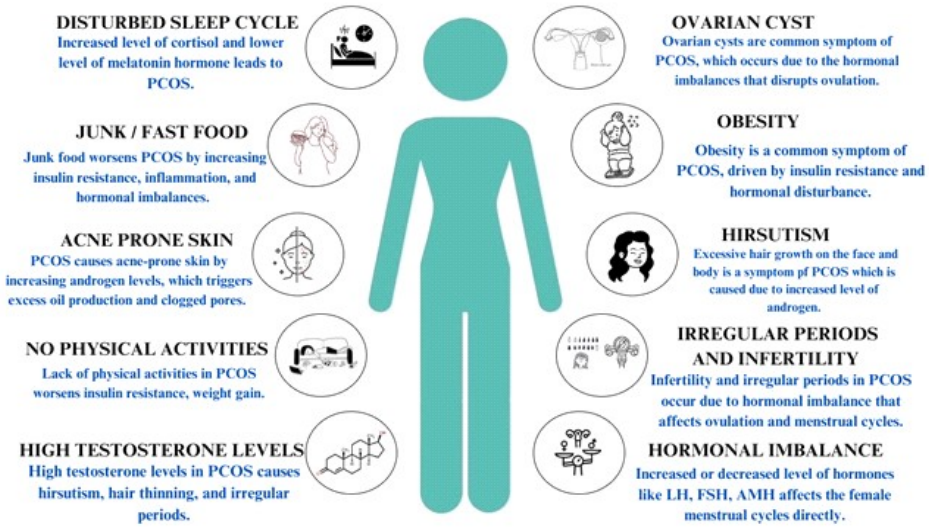


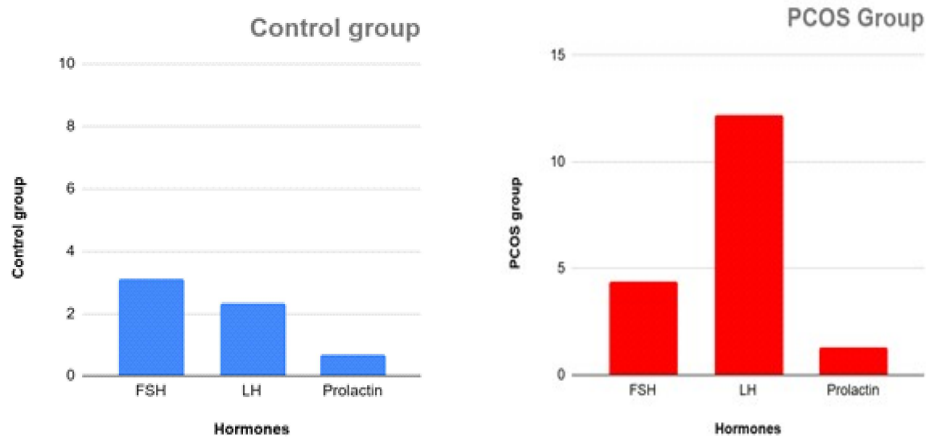
Image I- Showing Causes (Left) and symptoms (Right) in PCOS.

To control PCOS effectively requires the return of normal biological rhythms. Restoring affected biological rhythms is critical for people with PCOS and requires the adoption of strategies to handle their condition effectively Creating a routine sleep pattern ranks among the key measures. Adopting a rhythm for sleep and waking provides a basis for better internal timing and superior quality of rest. Including mindfulness, meditation, and yoga in stress management can also bring positive results. These techniques promote lower stress and enhance hormonal equilibrium. Conducting consistent workouts is essential in handling PCOS. Participating in exercise can maintain insulin levels and promote weight loss and a better mood. Making dietary modifications can be important for controlling PCOS. Eating a diet filled with entire foods like vegetables and lean proteins helps manage blood sugar and lowers insulin resistance. Reducing intake of processed foods and sugary treats can stop weight gain and boost health. On some occasions medical treatment may be vital for managing PCOS. Birth control pills act to manage menstrual cycles and lower androgen levels. In cases of diabetes treatment with metformin can also support insulin sensitivity and decrease PCOS signs.

Image 2- Comparing hormonal profiles: healthy women Vs women with PCOS

Women with PCOS Image 1- Showing significantly higher levels of FSH (4.38) and LH (12.22) compared to the control group (FSH: 3.10; LH: 2.35). (Ali, et.al 2023)

Additionally, prolactin levels were significantly elevated in women with PCOS (1.30) compared to the control group (0.66) (Ali et al., 2023). These findings are presented in table 2 and figure 2.



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Hormonal Imbalance and PCOS

Women suffering from PCOS experience a major disturbance in their hormone levels. This frequently leads to increased amounts of androgens termed as hyperandrogenism and insulin resistance. Exceeding levels of male hormones disrupts the growth of ovarian follicles causing cysts. When insulin resistance increases. the body produces more androgens exacerbating the hormonal imbalance. Challenges in biological cycles may intensify this condition. Individuals with PCOS usually show unreliable sleep patterns and abnormal circadian fluctuations. The release of hormones such as melatonin and cortisol gets impacted by this disruption. With great stress and inadequate rest today can make PCOS worse. In PCOS, up to 60% of androgens are produced by the ovaries, while the remaining 40% is contributed by the adrenals. It is well-established that androgens derived from both the ovaries and the adrenal glands are the primary sources of hyperandrogenemia in women with PCOS. When ovarian androgen synthesis is inhibited by GnRH agonists, women with PCOS have been found to exhibit higher androgen levels compared to normal women, indicating a possible overproduction of androgens by the adrenal glands. [9-14]

History

Increased levels of melatonin metabolites in women with PCOS have been demonstrated by a number of small studies.[1] In one small study, it was observed that melatonin levels were increased at night in women with PCOS who had significantly reduced sleep quality compared to control women.[2] A more recent study has been demonstrated to show later melatonin offset after wake time, later melatonin offset relative to sleep timing, and longer duration of melatonin secretion in obese adolescent girls with PCOS compared to obese control adolescent girls. In this study, hyperandrogenism and insulin resistance were associated with these abnormalities.[3]

In one study, melatonin levels were reduced in PCOS by oral contraceptives.[4] In a more recent study, sleep quality and measures of depression were improved by melatonin supplementation for 12 weeks, and a lowering of insulin levels and upregulation of gene expression of peroxisome proliferator-activated receptor gamma and low-density lipoprotein receptor were associated with this treatment.[5] The role of melatonin in the pathogenesis of PCOS and sleep disorders needs to be further investigated for its significance. Adverse changes in sleep architecture are associated with mood disorders such as depression and anxiety, and it appears that the associations are bidirectional.[6] Higher rates of depression, anxiety, and sleep disorders are found in women with PCOS.[7] The reasons behind the higher incidence of mood disorders in PCOS are not well established; however, the presence of comorbid psychiatric disorders is viewed as an additional risk factor that increases the likelihood of Obstructive sleep apnea (OSA) in this population.

Correlation Between AMH And FSH/LH Ratio: Normal Women Vs Women With PCOS

AMH stands for Anti-Müllerian Hormone, a hormone produced by the ovarian follicles (the fluid-filled sacs that contain eggs). AMH is often used as a marker of ovarian reserve, or the quantity and quality of a woman's remaining eggs. In simple terms, it gives an estimate of a woman's fertility potential. AMH levels help doctors assess a woman's ovarian reserve, which can provide insight into her fertility. Higher AMH levels generally indicate a higher number of eggs, while lower AMH levels suggest fewer eggs.

AMH levels naturally decline with age. Younger women typically have higher AMH levels, which gradually decrease as they get older, especially after the age of 35. A lower AMH level in older women may indicate a reduced fertility potential.

AMH is often measured in women undergoing fertility treatments, such as IVF (In Vitro Fertilisation), to predict their response to ovarian stimulation (the process used to produce multiple eggs for fertilisation). Women with higher AMH levels generally respond better to stimulation.

As women approach menopause, AMH levels continue to decline and eventually become undetectable. However, AMH does not necessarily predict the exact timing of menopause.

In normal females the production of Anti-Müllerian Hormone (AMH) begins with the activation of the hypothalamic-pituitary-gonadal (HPG) axis, which plays a crucial role in regulating reproductive function. The hypothalamus releases Gonadotropin-Releasing Hormone (GnRH), which acts on the anterior pituitary gland, stimulating it to release Follicle-Stimulating Hormone (FSH). FSH then travels through the bloodstream to the ovaries, where it binds to specific receptors on the granulosa cells of ovarian follicles.

Granulosa cells, found in early antral and preantral follicles, are essential for follicular growth and maturation. Upon FSH stimulation, these cells become activated, and AMH production begins. The granulosa cells produce AMH to help regulate follicle recruitment by inhibiting the sensitivity of follicles to FSH and preventing the excessive recruitment of primordial follicles. This regulation ensures that only a select few follicles progress to full maturity, maintaining ovarian health and efficiency.

AMH, once produced, is released into the bloodstream, where it can be measured clinically to assess ovarian reserve. Higher AMH levels generally indicate a greater reserve of functional ovarian follicles, whereas lower levels may suggest diminished ovarian reserve. This measurement is particularly useful for evaluating fertility and guiding decisions in reproductive medicine. The presence of AMH and its regulatory effects on follicular development make it a key hormone in reproductive

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biology, and its production by granulosa cells reflects the functional status of the ovarian reserve. [14,15,16,17]

In women with PCOS, AMH production is increased by ovarian granulosa cells compared to controls. Decreased aromatase enzyme expression is caused by excessive AMH activity in granulosa cells, leading to inhibition of folliculogenesis and ovulation, and resulting in follicular arrest. As the number of arrested follicles increases, further increases in AMH levels are observed. Receptors in GnRH neurons are believed to be acted upon by AMH, leading to an increase in the LH/FSH ratio.[18]

Discussion

Polycystic Ovarian Syndrome (PCOS) is a condition with multifaceted etiology driven by endocrine imbalance and disturbances in physiological rhythms. The involvement of the hypothalamic-pituitary-gonadal (HPG) axis in modulating major reproductive hormones like LH and FSH accentuates the central role played by hormonal balance to ensure peak reproductive health. A departure from such balance, as in the case of PCOS, leads to abnormal menstrual cycles, hyperandrogenism, and metabolic alterations, including insulin resistance and obesity.

The interaction between PCOS and biological rhythms has attracted much interest. Circadian disturbances, resulting from inadequate sleep and stress, intensify the presentation of PCOS, including weight gain and mood changes. The literature reviewed here highlights the involvement of melatonin. Whereas increased nocturnal melatonin levels have been linked with compromised sleep quality among PCOS women, supplementation has emerged as a possible way of enhancing both metabolic and psychologic outcomes. This highlights the two-way relationship between PCOS and sleep disorders, which calls for more research into therapeutic options focused on circadian regulation.

In addition, the dysregulated hormonal levels in PCOS—characterized by increased AMH, LH, and androgens—represent a multifaceted dysregulation of ovarian function. Hypersecretion of AMH by granulosa cells further leads to follicular stasis and worsens the hormonal derangements characteristic of PCOS. These observations highlight the diagnostic utility of markers like AMH and FSH/LH ratios in individualising care strategies.

The psychological burden of PCOS, such as increased rates of depression and anxiety, adds to its complexity. Their management through modifications in lifestyle, stress management therapy, and treatment can greatly enhance the quality of life in the affected women.

Conclusion

Polycystic Ovarian Syndrome is no longer just a reproductive disease but a systemic condition with complex hormonal and circadian dynamics. Dysfunction of the HPG axis in conjunction with metabolic and psychological impairment necessitates management with an integral approach. Reproduction of normal

hormonal balance and biological rhythms is essential, for which interventions range from lifestyle adjustment, dietary intake, stress moderation, and therapeutic medication. Future studies must continue to investigate the potential of circadian rhythm regulation and novel interventions, including melatonin supplementation, in reducing the varied symptoms of PCOS. Educating women about PCOS and its mechanisms will lead to better management and overall health.

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