

# *Endocrine Abnormalities and Their Relationship with Menstrual Irregularities: A Meta-analysis*

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**Abstract:** The endocrine system is one of the important systems that maintain physiological balance in the human body, and its abnormalities are closely related to the occurrence of various diseases, especially irregular menstruation in women. Irregular menstruation not only affects women's quality of life, but also has a negative impact on fertility. Therefore, exploring the relationship between endocrine abnormalities and menstrual irregularities has important clinical significance. Although numerous studies have explored the relationship between endocrine abnormalities and menstrual irregularities, the conclusions are inconsistent. This article systematically evaluated the degree of association between endocrine disorders and menstrual irregularities through meta-analysis. Firstly, the background knowledge of endocrine disorders and menstrual irregularities is introduced, and then the progress and shortcomings of related research are reviewed. Next, the research method, experimental investigation results, and discussion of this article were introduced in detail. Through meta-analysis, this article found a significant correlation between endocrine abnormalities and menstrual irregularities.

## 1. Introduction

The endocrine system regulates the body's metabolism, growth and development, and reproductive functions by secreting hormones. Endocrine abnormalities refer to the overactive or decreased function of endocrine glands, resulting in excessive or insufficient hormone secretion, leading to a series of clinical symptoms. Irregular menstruation is one of the common endocrine problems in women, manifested as abnormalities in menstrual cycle, menstrual length, or menstrual volume.

This article firstly introduces the basic content of endocrine abnormalities and irregular menstruation, and then examines the progress and shortcomings of the research content of scholars in related fields. Then, the research principle of meta-analysis is described in detail. An experimental survey is designed and the results of the survey are discussed. Finally, according to the results of the survey data, there is a significant association between endocrine abnormalities and irregular menstruation.

Through meta-analysis, this article provides an in-depth study of the relationship between

endocrine abnormalities and irregular menstruation and provides an accurate assessment of the relationship between the two, which can provide an important reference for clinical diagnosis and treatment. The following are the contributions of this study: (1) by analyzing the results, the meta-analysis helps to identify common trends and patterns between endocrine abnormalities and irregular menstruation, which promotes understanding of the complexity of this relationship; (2) the meta-analysis improves the efficiency of doctors in choosing the best endocrine treatment in treating irregular menstruation.

## 2. Related Work

Although numerous studies have explored the relationship between endocrine abnormalities and menstrual irregularities, the conclusions are inconsistent. Some studies suggested that endocrine disorders are one of the main causes of menstrual irregularities, while others suggested that the correlation between the two is not significant. This inconsistency is caused by differences in research methods, sample size, study population, and other factors. Vannuccini S, et al. discussed hormone therapy methods for treating endometriosis and explored the endocrine background of these treatment methods [1]. Rytz C L, et al. analyzed the menstrual abnormalities and reproductive lifespan in female patients with chronic kidney disease (CKD) [2]. Tsukui Y, et al. investigated the role of AMH levels in the diagnosis of polycystic ovary syndrome in adolescents [3]. Uldbjerg C S, et al. investigated the effects of prenatal and postpartum exposure to endocrine disruptors on the onset of puberty in girls and boys through systematic evaluation and meta-analysis [4]. Cho I Y, et al. analyzed the relationship between long or irregular menstrual cycles and the prevalence and risk of non-alcoholic fatty liver disease (NAFLD) [5]. Forslund M, et al. analyzed and compared the effects of different types of oral contraceptives in the treatment of polycystic ovary syndrome [6]. Li Z, et al. analyzed and discussed the relationship between polycystic ovary syndrome and the risk of endometrial cancer, ovarian cancer and breast cancer [7]. Amiri M, et al. evaluated the prevalence of idiopathic hirsutism [8]. Ezeh U, et al. investigated the relationship between the severity of menstrual dysfunction and hyperinsulinemia and blood glucose abnormalities in polycystic ovary syndrome [9]. Sharma P, et al. analyzed the relationship between serum element concentrations and polycystic ovary syndrome [10]. This article is based on the research of the above scholars and uses meta-analysis to study the relationship between endocrine abnormalities and menstrual irregularities.

## 3. Methods

### 3.1 Correlation between Endocrine Abnormalities and Menstrual Irregularities

The endocrine system is closely related to the regulation of the menstrual cycle in women, involving complex interactions between multiple endocrine glands and hormones. When the hormone levels secreted by these glands are abnormal, it often leads to irregular menstruation [11-12]. The following is the relationship between endocrine abnormalities and menstrual irregularities:

(1) Hypothalamus-hypophysis dysfunction: The releasing hormone released by the hypothalamus regulates the gonadotropins (FSH and LH) released by the hypophysis. Hypothalamus-hypophysis dysfunction leads to abnormal secretion of FSH and LH, which in turn affects follicle development and ovulation, resulting in irregular menstruation. Hyperfunction or hypofunction of the hypothalamus, pituitary adenoma, and other factors can cause abnormal menstrual cycles.

(2) Ovarian dysfunction: The ovaries are the main reproductive organs of women, responsible for producing and secreting key hormones such as estrogen and progesterone. Ovarian dysfunction,

such as early-onset ovarian insufficiency and premenopausal ovarian dysfunction, can lead to a decrease in estrogen and progesterone levels, leading to irregular menstruation [13-14].

(3) Abnormal thyroid function: There is a complex interaction between thyroid hormones and sex hormones. When hypothyroidism occurs, insufficient synthesis of thyroid hormones leads to irregular menstruation by affecting the functions of the hypothalamus and hypophysis, which in turn affects the secretion of sex hormones.

(4) Hyperprolactinaemia: High prolactin level inhibits the hypophysis from releasing FSH and LH, affecting follicular development and maturation, leading to irregular menstruation.

(5) Abnormal sex hormone levels: Abnormal levels of sex hormones such as estrogen, progesterone and androgens can all directly affect the regulation of the menstrual cycle [15-16].

From the dysfunction of the hypothalamic-pituitary-ovarian axis, to abnormal thyroid function, hyperprolactinaemia, and abnormal sex hormone levels, all affect the regularity of the menstrual cycle. Therefore, when irregular menstruation occurs, the overall condition of the endocrine system needs to be considered for a comprehensive assessment and diagnosis.

### 3.2 Meta-analysis Methods

When analyzing endocrine abnormalities and their relationship with menstrual irregularities, this article adopts a meta-analysis method, which can integrate the results of multiple independent studies and provide a more comprehensive and accurate conclusion for this article. The following are the detailed details of each key step:

#### 1) Literature search and screening

(1) Determining retrieval strategy: This article first identifies keyword combinations such as "endocrine abnormalities", "irregular menstruation", "sex hormones", "hormone levels", etc., and conducts systematic searches in major databases.

(2) Preliminary screening: Based on the title and abstract, this article preliminarily screens studies related to endocrine disorders and menstrual irregularities.

(3) Full text screening: This article obtains the full text of the preliminary screened studies and conducts strict screening according to the preset inclusion and exclusion criteria.

#### 2) Data extraction

(1) Developing a data extraction table: This article develops a detailed data extraction table based on the characteristics of the research and the content that needs to be analyzed.

(2) Data extraction and verification: Data extraction and cross check are performed to ensure accuracy and consistency of the data.

#### 3) Data integration and preprocessing

(1) Data standardization: This article standardizes the data, merges and analyzes it, and converts hormone levels from different studies to the same units or ranges [17-18].

(2) Heterogeneity evaluation: This article uses statistical methods (Q-statistics,  $I^2$  statistics, etc.) to evaluate the degree of heterogeneity between different studies. Excessive heterogeneity can affect the accuracy and reliability of the results, so this article needs to choose appropriate merging methods based on the degree of heterogeneity.

#### 4) Meta-analysis

(1) Choosing the appropriate statistical method: Based on the characteristics of the study and the content to be analyzed, this article selects the appropriate statistical method for meta-analysis, and calculates the effect size for each study  $i$ .

(2) Merging effect sizes: This article uses the selected statistical method to merge the effect sizes of multiple studies to obtain a comprehensive estimate of the effect sizes and their confidence intervals. Based on the quality of the study and the sample size, a weight  $w_i$  is assigned to each

study. The weight is usually proportional to the quality and sample size of the study, and the weighted average is calculated as the combined effect size. The formula is as follows:

$$\text{Combined effectsize} = \frac{\sum_{i=1}^n w_i \times \text{effectsize}_i}{\sum_{i=1}^n w_i} \quad (1)$$

Among them,  $n$  is the number of studies included. In meta-analysis, heterogeneity refers to the degree of variation in the magnitude of effects between different studies. If the heterogeneity is high, it is not appropriate to directly combine the results of these studies. The Q-statistic is a commonly used heterogeneity testing method, and its calculation formula is as follows:

$$Q = \sum_{i=1}^n w_i \times (\text{effectsize}_i - \text{combinedeffectsize})^2 \quad (2)$$

The larger the Q-statistic, the higher the heterogeneity between studies. However, the size of the Q-statistic alone cannot directly determine whether heterogeneity is significant. In order to evaluate the significance of the Q-statistic, this article also needs to consider its degrees of freedom (usually by reducing the number of studies by 1) and the corresponding chi square distribution [19-20]. If the value of the Q-statistic is greater than the critical value of the chi square distribution at the corresponding degree of freedom, or if the p-value of the Q-statistic is less than the preset significance level (such as 0.05), it is considered to have significant heterogeneity.

(3) Explanation result: This article explains the relationship between endocrine abnormalities and menstrual irregularities based on the estimated values and confidence intervals of the combined effect size. If the estimated value of the combined effect size is greater than 0 and the confidence interval does not include 0, it indicates that the standard error (SE) of endocrine abnormalities and menstrual irregularities is used to measure the accuracy of the estimate, which can be calculated using the following formula:

$$SE = \sqrt{\frac{\sum_{i=1}^n w_i \times (\text{effectsize}_i - \text{combinedeffectsize})^2}{\sum_{i=1}^n w_i}} \quad (3)$$

Here,  $w_i$  is the weight of each study, usually determined based on factors such as the quality of the study and sample size.

## 4. Results and Discussion

### 4.1 Meta-analysis of Experimental Data

Table 1 presents the test data from a meta-analysis of endocrine abnormalities and their relationship with menstrual irregularities in this article. In this analysis, data from multiple studies are collected and organized to explore how abnormal levels of various hormones in the endocrine system affect the menstrual cycle, including levels of follicle stimulating hormone (FSH), luteinizing hormone (LH), estradiol (E2), progesterone (P), prolactin (PRL), and androgens. These hormones play a crucial role in the endocrine system, and their abnormal levels are related to menstrual irregularities.

Table 1: Test data values

Indicator name	Range of normal value
Follicle stimulating hormone (FSH)	5-40 U/L
Luteinizing Hormone (LH)	5-10 U/L
Estradiol (E2)	70-1835 pmol/L
Progesterone (P)	0-2.3 nmol/L
Prolactin (PRL)	0.64-4.14 pmol/L
Androgens	Normal female level is low

## 4.2 Results of Meta-analysis

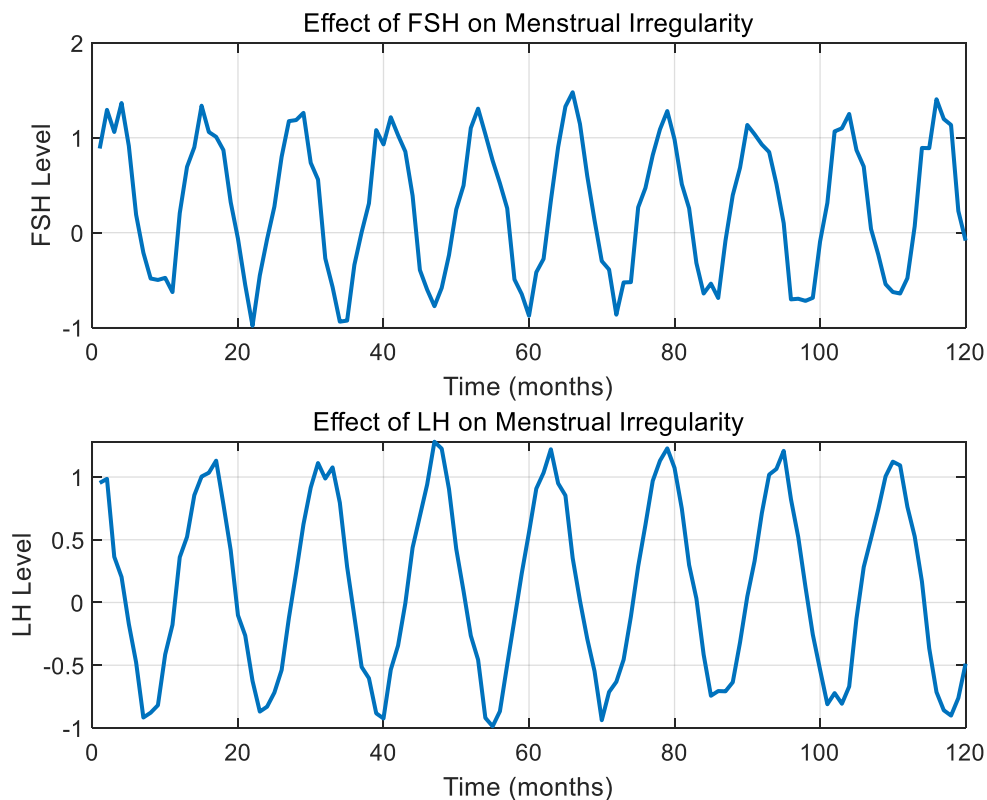


Figure 1: The effects of FSH and LH on menstrual irregularities

According to the data in Figure 1, the follicle stimulating hormone (FSH) data reflect the cyclical changes in FSH levels over 120 months; while the pattern of change in the luteinizing hormone method is different from that of FSH, indicating that LH may have a different mechanism of action in the regulation of the menstrual cycle. The smaller random noise indicates that the changes in LH

levels are relatively stable, although they are also affected by some external factors, implying a more stable role for LH in maintaining menstrual regularity. Cyclical fluctuations of both hormones and random noise work together to influence the regularity of menstruation; cyclical fluctuations of FSH may dominate the basic pattern of the menstrual cycle, whereas noise may lead to slight fluctuations or irregularities in the menstrual cycle. Cyclical fluctuations of LH play an important role in specific phases of the menstrual cycle, and its small random noise suggests a high degree of stability of the role played by LH in the maintenance of regularity of menstruation. The roles of these hormones in menstrual regulation are intertwined, and together they maintain the normal functioning of the female reproductive system.

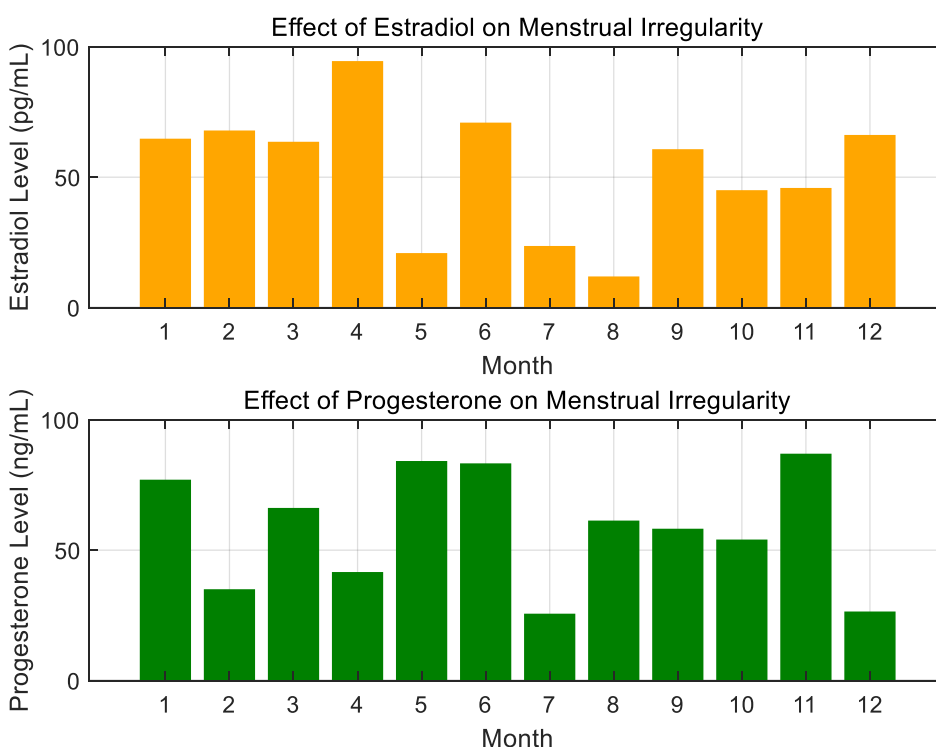


Figure 2: Comparison of the effects of estradiol and progesterone on menstrual irregularities

From the data in Figure 2, the data on estradiol levels shows erratic fluctuations over the 12 months and lacks a clear cyclical pattern. This instability reflects the fact that estradiol levels are affected by multiple lifestyle modalities during the menstrual cycle, and these factors contribute to the instability of estradiol levels, which in turn causes irregular menstruation. The data of progesterone levels also lacks a fixed periodicity. From the graphs above, this article can see that instability of estradiol and progesterone levels has a negative effect on menstrual regularity. This instability is the result of multiple external factors acting on the hormonal regulatory mechanisms in the body. In order to gain a deeper understanding of this relationship and to find effective interventions, this article requires a more detailed and systematic study to reveal the exact mechanism of action between estradiol and progesterone levels and menstrual irregularity.

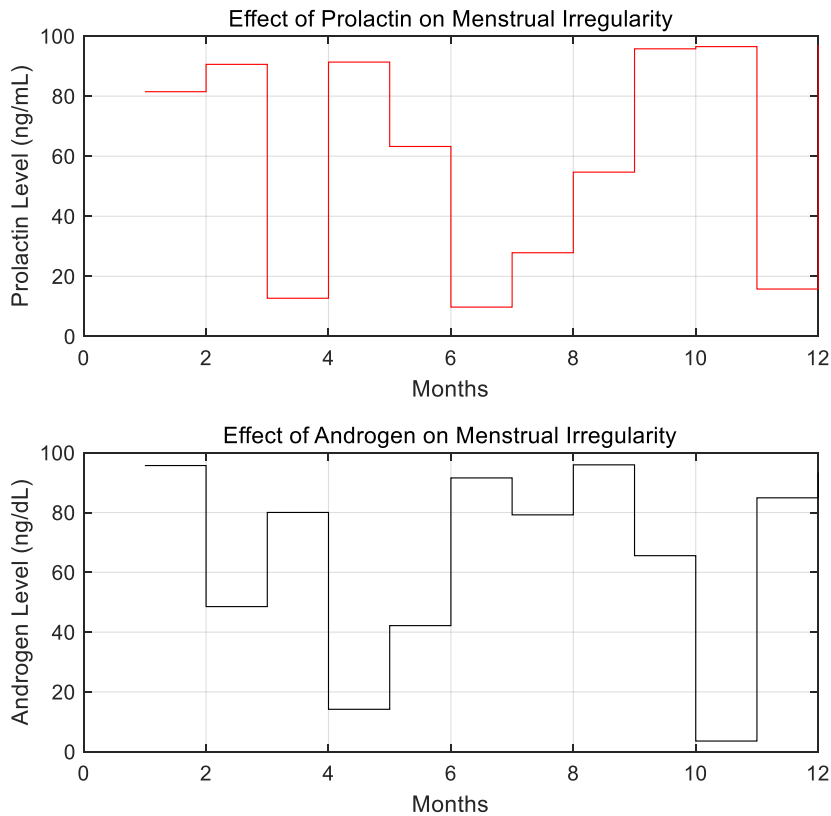


Figure 3: The effects of prolactin and androgen on menstrual irregularities

As can be seen from the data in Figure 3, the prolactin level data range from 10-98. Prolactin levels gradually decrease from 80ng/mL in January to 10ng/mL in June, and then gradually increase again to 98ng/mL in December. Prolactin regulates reproductive hormones, and when their menstruation is irregular, the level of prolactin increases. Whereas the rapid rise in androgen levels in June is associated with an increase in menstrual irregularity, its rapid decline later in the year reflects the body's efforts to restore hormonal balance before the menstrual cycle returns to normal. This synergistic action of the two hormones, fluctuating over time, together influence the regularity of the menstrual cycle. By monitoring and analyzing prolactin and androgen levels, it is possible to study the regulatory mechanisms of the menstrual cycle thoroughly and provide accurate data for the treatment of irregular menstruation.

## 5. Conclusions

Irregular menstruation is one of the common health problems in women, often hiding complex physiological mechanisms behind it. In recent years, endocrine disorders have received widespread attention as one of the important causes of menstrual irregularities. This article aims to provide a more comprehensive and in-depth perspective on the relationship between endocrine disorders and menstrual irregularities through a meta-analysis and synthesis of existing research results. The content structure of this article mainly includes the following aspects. Firstly, a systematic review was conducted on the definition, classification, and clinical manifestations of endocrine disorders and menstrual irregularities; secondly, the research progress on the relationship between endocrine abnormalities and menstrual irregularities in recent years was reviewed; once again, a comprehensive evaluation of existing research was conducted through meta-analysis, and key

information was extracted; finally, based on the analysis results, the relationship between endocrine abnormalities and menstrual irregularities was summarized and discussed.

During the experiment, this article strictly followed the standard process of meta-analysis. Firstly, relevant research literature was comprehensively collected through a literature search system; secondly, strict screening and evaluation of the literature were carried out to ensure the quality of the literature included in the analysis; once again, data extraction and organization were carried out on the included literature; finally, statistical methods were used to comprehensively analyze and interpret the data. Through meta-analysis, this article found a significant correlation between endocrine abnormalities and menstrual irregularities. Specifically, abnormal levels of various endocrine hormones, such as estrogen, progesterone, androgen, etc., all lead to irregular menstruation. In addition, there are differences in the impact of different types of endocrine abnormalities on menstrual regularity. For example, as a common endocrine disorder, patients with polycystic ovary syndrome (PCOS) often exhibit obvious menstrual irregularities.

Although this article has achieved certain results, there are still some shortcomings. Firstly, due to the large number of literature involved in the study, there are cases where some important literature has not been included in the analysis; secondly, methodological differences between different studies lead to certain biases in the results; finally, this article mainly focuses on the correlation between endocrine abnormalities and menstrual irregularities, but does not delve into the specific mechanisms behind them. In response to the above shortcomings, future research can improve in the following areas. Firstly, the scope of literature search can be further expanded to ensure that the literature included in the analysis has higher representativeness and comprehensiveness; secondly, stricter and more unified methodological standards can be adopted to reduce bias between different studies; finally, the specific mechanism by which endocrine abnormalities lead to menstrual irregularities can be thoroughly explored, providing more precise guidance for clinical treatment and prevention.

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