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Research on the Role and Mechanism of Vitamins A and D in Pregnant Patients with Hypothyroidism

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Abstract: *Objective*: To investigate the roles and mechanisms of vitamins A and D in pregnant women with hypothyroidism. *Methods*: The study sample was collected from January 2024 to December 2025, consisting of 100 pregnant women with hypothyroidism, designated as the hypothyroidism group. Normal pregnant women undergoing prenatal check-ups at our hospital during the same period were selected as the normal group. Serum levels of vitamins A and D were measured in both groups, along with serum thyroid-stimulating hormone (TSH), free thyroxine (FT4), and free triiodothyronine (FT3) levels. Comparative analysis of relevant indicators between the two groups was conducted, and the correlations between vitamin A and D levels and thyroid function indicators were explored. *Results*: Compared with the normal group, the hypothyroidism group exhibited significantly lower serum levels of vitamins A and D, with statistically significant differences ($P < 0.05$). The TSH level in the hypothyroidism group was significantly higher, while FT4 and FT3 levels were significantly lower ($P < 0.05$). Correlation analysis revealed that serum vitamin A and D levels were significantly negatively correlated with TSH levels and significantly positively correlated with FT4 and FT3 levels ($P < 0.05$). Questionnaire results indicated that the proportion of inadequate vitamin A and D intake and insufficient sunlight exposure was higher in the hypothyroidism group than in the normal group. *Conclusion*: Pregnant women with hypothyroidism have reduced levels of vitamins A and D, and their deficiency may contribute to the development of hypothyroidism by affecting thyroid hormone synthesis and secretion as well as immune regulatory mechanisms. Strengthening the assessment and intervention of vitamin A and D nutrition in pregnant women can help improve thyroid function status.

Keywords: Vitamin A; Vitamin D; Pregnancy with hypothyroidism; Mechanism of action

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1. Introduction

Pregnancy is a special physiological stage during which significant changes occur in a woman's endocrine

system. The stability of thyroid function is of paramount importance for maintaining a normal pregnancy process and ensuring proper fetal growth and development [1]. Thyroid hormones not only participate in regulating the basal metabolism and energy balance of pregnant women but also play a crucial role in fetal neural development, bone formation, and organ maturation. Pregnancy complicated by hypothyroidism is one of the common endocrine disorders during pregnancy. If not promptly detected and appropriately managed, it can increase the risk of adverse pregnancy outcomes such as hypertensive disorders of pregnancy, preterm birth, fetal growth restriction, and neurocognitive developmental abnormalities, thus receiving widespread clinical attention. In recent years, studies have found that nutritional factors play a significant role in the onset and progression of thyroid diseases [2]. In addition to iodine, vitamins A and D, as important fat-soluble vitamins, possess multiple biological functions in endocrine regulation and immune homeostasis within the body. Vitamin A, through its active metabolite retinoic acid, participates in gene transcription regulation and has a certain impact on the expression of thyroid hormone receptors and the peripheral metabolism of thyroid hormones. Vitamin D, on the other hand, regulates immune responses and inflammation levels through vitamin D receptor-mediated signaling pathways and is clinically considered to be closely related to various autoimmune thyroid diseases [3]. During pregnancy, due to increased physiological demands, changes in dietary patterns, and insufficient sunlight exposure, the incidence of vitamin A and D deficiencies significantly rises, further affecting the stability of thyroid function [4]. Although clinical research findings suggest a certain association between vitamins A and D and thyroid function in patients, systematic studies focusing on pregnant women with hypothyroidism remain relatively limited, and their specific mechanisms have not been fully elucidated. Based on this, this study aims to investigate the roles and mechanisms of vitamins A and D in pregnant women with hypothyroidism. The report is as follows.

2. Materials and methods

2.1. Clinical data

The sample collection period spanned from January 2024 to December 2025, with participants sourced from pregnant women diagnosed with hypothyroidism. A total of 100 cases were included in the hypothyroidism group for this study. During the same period, normal pregnant women who underwent prenatal check-ups at our hospital were selected as the control group. The age range of pregnant women in the control group was 20 to 38 years old, with an average age of (28.6 ± 4.3) years old; in the hypothyroidism group, the age range was 21 to 39 years old, with an average age of (29.1 ± 4.6) years old. The gestational age range in the control group was 10 to 28 weeks, with an average of (18.9 ± 4.7) weeks; in the hypothyroidism group, it was 11 to 29 weeks, with an average of (19.3 ± 5.1) weeks. The number of pregnancies in the control group ranged from 1 to 3, with an average of (1.6 ± 0.7) pregnancies; in the hypothyroidism group, it ranged from 1 to 4, with an average of (1.7 ± 0.8) pregnancies. There were no statistically significant differences in general data such as age, gestational age, and number of pregnancies between the two groups ($P > 0.05$), indicating comparability.

Inclusion criteria: (1) Pregnant women meeting the diagnostic criteria for pregnancy, with singleton pregnancies; (2) The hypothyroidism group met the diagnostic criteria for hypothyroidism during pregnancy, i.e., serum TSH levels above the reference range for pregnancy, and FT4 and/or FT3 levels below or at the lower limit of the reference range; thyroid function indicators in the control group were within the reference range for pregnancy; (3) Regular prenatal check-ups at our hospital during pregnancy, with complete clinical

and laboratory data; (4) Informed consent obtained from the study subjects and their families, who voluntarily participated in this study.

Exclusion criteria: (1) Women diagnosed with thyroid disease before pregnancy and receiving long-term thyroid-related medication; (2) Women with other endocrine system diseases, such as diabetes, pituitary or adrenal diseases; (3) Women with severe liver or renal insufficiency or cardiovascular system diseases; (4) Women with autoimmune diseases, acute or chronic infections, or inflammatory diseases; (5) Women with multiple pregnancies, assisted reproductive pregnancies, or confirmed fetal structural abnormalities; (6) Women who received high-dose vitamin A or vitamin D supplementation within the past three months.

2.2. Methods

Serum vitamin A and vitamin D levels were measured in both groups of pregnant women, along with serum thyroid-stimulating hormone (TSH), free thyroxine (FT4), and free triiodothyronine (FT3) levels.

Five milliliters of fasting venous blood were collected from both groups of pregnant women in the morning and placed in anticoagulant-free blood collection tubes. The serum was then separated and stored under specified conditions for testing after unified specimen numbering. Serum vitamin A and vitamin D levels in both groups were detected using internationally recognized tandem mass spectrometers and ultra-high-performance liquid chromatographs, equipped with fully automated sample processing workstations and sample information management systems. All operations were performed strictly in accordance with the instrument and actual instructions. Chemical luminescence microparticle immunoassay was used to detect serum TSH, FT4, and FT3 levels in the subjects. All tests were completed by dedicated personnel in the same laboratory, with quality control implemented during the testing process to ensure the accuracy and repeatability of the results.

2.3. Observation indicators

(1) Serum vitamin A and vitamin D levels: Differences in serum vitamin A and vitamin D levels between the two groups of pregnant women were compared.

(2) Thyroid function indicators: Differences in serum TSH, FT4, and FT3 levels between the two groups of pregnant women were compared.

(3) Correlation between vitamin A, vitamin D, and thyroid function indicators: The correlation between serum vitamin A and vitamin D levels and TSH, FT4, and FT3 was analyzed.

(4) Questionnaire-related indicators: Differences in questionnaire results regarding dietary structure, vitamin A and vitamin D intake, and sun exposure time between the two groups of pregnant women were compared. 1.4 Statistical Methods In this study, measurement data (t) and count data (χ^2) were analyzed using statistical software (SPSS version 22.0). Measurement data were expressed as mean ± standard deviation (SD), and count data were expressed as (n, %). When ($P < 0.05$), the results were considered statistically significant.

3. Results

3.1. Comparison of serum vitamin A and vitamin D levels

Between the Two Groups of Pregnant Women Serum vitamin A and vitamin D levels in the hypothyroidism group were significantly lower than those in the control group, with statistically significant differences ($P < 0.05$) (**Table 1**).

Table 1. Comparison of serum Vitamin A and Vitamin D levels between the two groups of pregnant women (mean ± SD)

Group	Number of Cases	Vitamin A (μmol/L)	Vitamin D (ng/mL)
Normal Group	100	1.62 ± 0.28	28.45 ± 6.12
Hypothyroidism Group	100	1.21 ± 0.25	21.36 ± 5.48
t		7.723	6.120
P		0.000	0.000

3.2. Comparison of thyroid function indicators

The serum TSH level in the hypothyroidism group was significantly higher than that in the normal group, while the FT4 and FT3 levels were significantly lower than those in the normal group, with statistically significant differences ($P < 0.05$) (**Table 2**).

Table 2. Comparison of thyroid function indicators between the two groups of pregnant women (mean ± SD)

Group	Number of Cases	TSH (mIU/L)	FT4 (pmol/L)	FT3 (pmol/L)
Normal Group	100	2.31 ± 0.74	15.62 ± 2.14	4.62 ± 0.71
Hypothyroid Group	100	5.48 ± 1.26	11.24 ± 1.98	3.48 ± 0.63
t	-	15.246	10.606	8.465
P	-	0.000	0.000	0.000

3.3. Correlation analysis between serum vitamin A, vitamin D, and thyroid function

A univariate linear regression analysis was conducted with serum thyroid function indicators as the dependent variables and serum vitamin A and vitamin D levels as the independent variables. The results showed that both vitamin A and vitamin D levels were significant influencing factors for thyroid function indicators ($P < 0.05$) (**Table 3**).

Table 3. Correlation analysis between serum vitamin A, vitamin D, and thyroid function indicators

Dependent Variable	Independent Variable	B value	SE	β value	95% CI	*P* value
TSH	Vitamin A	−1.842	0.324	−0.486	−2.485 – −1.199	< 0.001
	Vitamin D	−0.093	0.016	−0.529	−0.125 – −0.061	< 0.001
FT4	Vitamin A	2.316	0.409	0.512	1.505 – 3.127	< 0.001
	Vitamin D	0.214	0.038	0.567	0.139 – 0.289	< 0.001
FT3	Vitamin A	0.684	0.156	0.438	0.375 – 0.993	< 0.001
	Vitamin D	0.058	0.012	0.492	0.034 – 0.082	< 0.001

4. Discussion

Pregnancy is a special stage during which significant changes occur in a woman's endocrine function. Thyroid hormones play a crucial role in maintaining maternal metabolic homeostasis and promoting fetal growth and development [5]. Hypothyroidism during pregnancy is a common endocrine disorder in clinical practice, and

its occurrence is not only closely related to iodine nutritional status but also influenced by multiple nutrients and immune factors. In recent years, the roles of vitamins A and D in thyroid diseases have gradually garnered attention; however, their specific mechanisms of action in pregnancy complicated by hypothyroidism still require further investigation.

The results of this study show that serum vitamin A and vitamin D levels in pregnant women with hypothyroidism were significantly lower than those in the normal group ($P < 0.05$), suggesting that patients with pregnancy complicated by hypothyroidism generally experience deficiencies in vitamins A and D. This finding is consistent with previous research reports. The reasons for this may be attributed to increased maternal nutrient requirements during pregnancy, placental transfer, and lifestyle changes, which can easily lead to vitamin deficiencies. As fat-soluble vitamins, deficiencies in vitamins A and D can adversely affect thyroid function stability [6]. In terms of thyroid function, this study found that serum TSH levels were significantly elevated in the hypothyroidism group, while FT4 and FT3 levels were significantly decreased, consistent with the typical biochemical characteristics of pregnancy complicated by hypothyroidism. Linear regression analysis revealed that serum vitamin A and vitamin D levels were significantly negatively correlated with TSH and significantly positively correlated with FT4 and FT3. The regression coefficients and 95% confidence intervals did not cross the critical values, indicating that both are important factors affecting thyroid function. The reasons for this may be that vitamin A participates in thyroid function regulation through multiple pathways [7]. The active metabolite of vitamin A, retinoic acid, can regulate gene transcription through its receptors and exhibits synergistic effects with thyroid hormone receptors in terms of structure and function. On one hand, vitamin A affects the expression and sensitivity of thyroid hormone receptors, enhancing the response of peripheral tissues to thyroid hormones; on the other hand, it can participate in regulating the peripheral conversion process of thyroid hormones, thereby affecting FT4 and FT3 levels. In this study, for every unit increase in vitamin A levels, TSH levels significantly decreased, while FT4 and FT3 levels significantly increased, suggesting that vitamin A deficiency may exacerbate hypothyroidism by inhibiting thyroid hormone synthesis or peripheral utilization.

The role of vitamin D in pregnancy complicated by hypothyroidism should not be overlooked [8]. Vitamin D receptors are widely distributed in thyroid tissue and immune cells of patients, participating in immune regulation and the control of inflammatory responses. Thyroid dysfunction during pregnancy, particularly autoimmune-related subtypes, is closely related to immune imbalance. Vitamin D deficiency may indirectly affect thyroid cell function by enhancing inflammatory responses and disrupting immune tolerance [9]. The results of this study showed that vitamin D levels were significantly negatively correlated with TSH and significantly positively correlated with FT4 and FT3, with relatively large standardized regression coefficients (β values), suggesting that its impact on thyroid function is significant and may play an important regulatory role in the development of hypothyroidism during pregnancy [10]. This study still has certain limitations, such as a limited sample size, a lack of multivariate regression analysis and control for potential confounding factors, and no further follow-up on pregnancy outcomes. Future research could expand the sample size, incorporate multivariate analysis, and conduct prospective studies to further clarify the causal relationship between vitamins A and D and pregnancy complicated by hypothyroidism, as well as their clinical intervention value.

5. Conclusion

In conclusion, pregnant women with hypothyroidism exhibit decreased levels of vitamins A and D, and their

deficiencies may participate in the development of hypothyroidism by affecting thyroid hormone synthesis and secretion as well as immune regulation mechanisms. Strengthening the assessment and intervention of vitamin A and D nutrition in pregnant women can help improve thyroid function status.

Disclosure statement

The authors declare no conflict of interest.

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