

# Knowledge, Attitude and Practice Regarding Thyroid Disorders in Pregnant Women: A Cross-Sectional Study in Guangdong, China

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**Background:** Thyroid disorders are diseases that can harm both the fetus and the pregnant woman. This study aimed to investigate the knowledge, attitudes, and practices (KAP) of pregnant women regarding thyroid disorders during pregnancy.

**Methods:** A cross-sectional study was conducted from May 20, 2024, to June 30, 2024, in the Obstetrics and Gynecology Department of Zhujiang Hospital, Southern Medical University to pregnant women. Online questionnaires were distributed to collect demographic data and KAP scores. The KAP questionnaire was developed based on the 2017 American Thyroid Association Guidelines and relevant literature. Content validity was reviewed by three experts, and a pilot test involving 30 participants was conducted. The questionnaire demonstrated excellent internal consistency with a Cronbach's alpha of 0.957.

**Results:** A total of 568 valid questionnaires were included in the study and the effective rate was 93.11%. Of the respondents, 272 (47.89%) had a normal Body Mass Index (BMI), and 263 (46.3%) were experiencing their first pregnancy. The mean  $\pm$  SD scores for knowledge, attitude, and practice were  $34.04 \pm 7.87$  (possible range: 10–50),  $28.82 \pm 4.39$  (possible range: 7–35), and  $26.43 \pm 5.59$  (possible range: 8–40), respectively. Multivariate logistic regression analysis indicated that practice score (OR = 1.212, 95% CI: [1.136–1.294],  $P < 0.001$ ) and age (OR = 1.069, 95% CI: [1.007–1.135],  $P = 0.029$ ) were protective factors directly associated with thyroid disease complicating pregnancy. The structural equation model (SEM) results showed a direct effect of knowledge on attitude ( $\beta = 0.434$ ,  $P = 0.021$ ) and of attitude on practice ( $\beta = 0.604$ ,  $P = 0.012$ ). Moreover, knowledge indirectly influenced practice through attitude ( $\beta = 0.262$ ,  $P = 0.009$ ).

**Conclusion:** Pregnant women demonstrated suboptimal knowledge, positive attitudes, and inactive practices regarding thyroid disorders during pregnancy. These findings underscore the need for targeted educational interventions to enhance knowledge and promote proactive practices among pregnant women, which may help mitigate the risk of thyroid-related complications during pregnancy.

**Keywords:** pregnant women, thyroid disorders, knowledge, attitudes, practices, cross-sectional

## Background

Thyroid disorders are relatively common among women of childbearing age.<sup>1</sup> Pregnancy significantly impacts thyroid function, leading to a nearly 50% increase in the production of thyroid hormones, thyroxine (T4) and triiodothyronine (T3), as well as a 50% increase in daily iodine requirements. The influence of thyroid disorders on women is profound, whether before, during, or after pregnancy.<sup>2</sup> The prevalence of thyroid dysfunction in pregnancy ranges from 0.5% to 3.5% for hypothyroidism and around 1% for hyperthyroidism in early trimesters.<sup>3</sup>

The fetal thyroid gland becomes functionally active between 10 and 12 weeks of gestation, but full maturation occurs around 18–20 weeks.<sup>3</sup> Consequently, during the critical early stages of development, the fetus relies on maternal thyroid hormones transferred via the placenta.<sup>4</sup> Abnormal thyroid function can increase the risk of complications such as miscarriage, preterm birth, low birth weight, gestational hypertension, and placental abruption. Additionally, thyroid

hormones are vital for fetal neurodevelopment, with hypothyroidism potentially impairing neonatal cognitive development.<sup>5</sup> Moreover, postpartum thyroiditis, a destructive thyroiditis occurring within 12 months postpartum, affects 5–8% of women. This condition is believed to result from a rebound in underlying thyroid autoimmunity following the cessation of pregnancy-induced immune tolerance.<sup>6</sup>

The knowledge, attitude, and practice (KAP) model suggest that individual behaviors are heavily influenced by one's knowledge and attitudes. In public health, the assessment of behavioral practices is often coupled with evaluations of knowledge and risk perception, frequently conducted through KAP surveys. This theory is crucial for understanding health-related behaviors and guiding interventions.<sup>7</sup>

Previous studies in China have revealed inadequate knowledge about iodine among pregnant women.<sup>8</sup> Another similar study found that only 9.7% of pregnant women were aware of the importance of increased iodine intake during pregnancy and the recommended daily intake.<sup>9</sup> Pregnant women lack sufficient knowledge about thyroid disorders and their potential impact on pregnancy, which can lead to the neglect of symptoms or failure to seek timely medical evaluation. Concerns about medication side effects, cultural factors, or economic constraints may also cause some pregnant women to avoid treatment or question medical advice.<sup>10</sup> Understanding the knowledge levels of pregnant women regarding thyroid disorders can inform the design of more effective educational interventions and enhance public health awareness.

Given the potential risks associated with thyroid disorders during pregnancy and the current deficiencies in knowledge and practice, this study aims to explore pregnant women's understanding, attitudes, and practices related to this issue. The data collected will support the development of more effective public health strategies. Through this research, we hope to identify key issues and provide valuable insights for policymakers, healthcare providers, and expectant mothers, ultimately improving the quality and effectiveness of prenatal health management. However, there is limited research on pregnant women's knowledge, attitudes, and practices regarding thyroid disorders in China, especially in Guangdong. Unlike previous KAP studies conducted in other provinces or national-level samples, this study focuses on pregnant women in Guangdong, providing region-specific insights that may guide local public health strategies.

## Methods

### Study Design and Participants

This cross-sectional study was conducted from May 20, 2024, to June 30, 2024, in the Obstetrics and Gynecology Department of Zhujiang Hospital, Southern Medical University. The participants were pregnant women who had registered for prenatal care at the hospital. This study used a convenience sampling method to recruit pregnant women who attended prenatal care at Zhujiang Hospital between May 20 and June 30, 2024, and met the inclusion criteria. Participants were approached through outpatient obstetric clinics with the assistance of healthcare providers. The study was approved by the Ethics Committee of Zhujiang Hospital, Southern Medical University (2024-ky-217-01), and informed consent was obtained from all participants.

The inclusion criteria included pregnant women who registered for prenatal care at the hospital between May 20, 2024, and June 30, 2024, were eligible to participate. The specific criteria included: 1) age between 18 and 45 years; 2) confirmation of intrauterine pregnancy with a visible fetal heartbeat and embryo by transvaginal ultrasound at 6–7 weeks; 3) ability to understand and independently complete the questionnaire; and 4) willingness to provide informed consent and participate voluntarily.

The exclusion criteria referred to individuals who were unwilling to participate and unable to complete the survey due to illness or other reasons.

### Questionnaire and Quality Control

The questionnaire was developed based on the 2017 Guidelines of the American Thyroid Association for the Diagnosis and Management of Thyroid Disease During Pregnancy and the Postpartum and<sup>2</sup> Management of hyperthyroidism during pregnancy in Asia.<sup>11</sup>

The questionnaire was completed and submitted to three experts for review and suggested changes to the questionnaire. The revised questionnaire was piloted with a small sample of 30 respondents, yielding a Cronbach's  $\alpha$  coefficient of 0.957, indicating excellent internal consistency.

The final questionnaire consisted of four sections: demographic data, knowledge, attitude, and practice dimensions. The knowledge dimension contained 11 questions, the last of which was not accounted for in the analysis as a trap question to control the quality of the questionnaire. Responses were rated as "very knowledgeable" (5 points), "fairly knowledgeable" (4 points), "somewhat knowledgeable" (3 points), "not knowledgeable" (2 points), and "not at all knowledgeable" (1 point), with total scores ranging from 10 to 50. The attitude dimension comprised 7 questions, rated on a five-point Likert scale from "strongly agree" (5 points) to "strongly disagree" (1 point), with total scores ranging from 7 to 35. The practice dimension included 8 questions, also rated on a five-point Likert scale from "always" (5 points) to "never" (1 point), with total scores ranging from 8 to 40. Scores above 70% of the maximum in each section were considered indicative of adequate knowledge, a positive attitude, and proactive practices.<sup>12</sup>

The Body Mass Index (BMI) threshold was based on the Chinese BMI classification where underweight ( $<18.5 \text{ kg/m}^2$ ), normal weight ( $18.5$  to  $23.9 \text{ kg/m}^2$ ), overweight ( $24$  to  $27.9 \text{ kg/m}^2$ ), and obesity ( $\geq 28 \text{ kg/m}^2$ ).

Questionnaires were distributed to pregnant women registered for obstetrics and gynecology at the Zhujiang Hospital Obstetrics and Gynecology Medical Center of Southern Medical University after informed counseling during outpatient visits. In order to address the difficulties encountered by individuals in completing the questionnaires, one-on-one assistance was provided by well-versed members of the study team. After all the questionnaires were collected, we conducted confirmatory factor analysis (CFA), which indicated that the questionnaire has good structural validity (CMIN/DF = 4.732, RMSEA = 0.079, IFI = 0.925, TLI = 0.913, CFI = 0.925) ([Tables S2](#) and [S3](#) and [Figure S1](#)).

## Statistical Analysis

Data analysis was conducted using SPSS 27.0 (IBM, Armonk, NY, USA) and AMOS 26.0. Continuous variables were presented as means and standard deviations (SD), while categorical data were expressed as counts (percentages). Normality of continuous variables was assessed using the Shapiro–Wilk test. The KAP scores did not follow a normal distribution; although median and interquartile range (IQR) are statistically preferred, we presented mean  $\pm$  SD for clarity of comparison. Non-parametric tests were used for between-group comparisons accordingly. Differences in knowledge (K) and attitude (A) scores across various demographic groups were assessed using the Mann–Whitney *U*-test or the Kruskal–Wallis *H*-test, depending on the number of groups. Spearman correlation analysis was performed to explore the relationships among knowledge, attitude, and practice scores. Univariate and multivariate regression analyses were used to evaluate whether demographic variables, knowledge, and attitude scores were risk factors for thyroid disorders during pregnancy. Structural equation modeling (SEM) was employed to investigate the relationships among KAP components. A two-sided *P*-value less than 0.05 was considered statistically significant.

## Results

### Demographic Characteristics and KAP Scores

Initially, a total of 610 questionnaires were collected. However, some were excluded based on the following criteria: 1) age under 18 years; 2) completion outliers; and 3) incorrect answers to trap questions. Ultimately, 568 valid questionnaires were included in the study, yielding an effective rate of 93.11%. The mean age of participants was  $31.09 \pm 4.67$  years. Among them, 272 (47.89%) had a normal BMI, 218 (38.38%) had a bachelor's degree, 263 (46.3%) were in their first pregnancy, 330 (58.1%) were in late pregnancy, 73 (12.85%) had thyroid disorders, and 63 (11.09%) had direct family members with a history of thyroid disorders. The mean  $\pm$  SD scores for knowledge, attitude, and practice were  $34.04 \pm 7.87$ ,  $28.82 \pm 4.39$ , and  $26.43 \pm 5.59$ , respectively. Analysis of demographic characteristics identified several factors influencing KAP scores. For variables with significant group differences in [Table 1](#), pairwise comparisons were conducted and Bonferroni-adjusted *P* values were reported (see [Table S1](#)). Participants with different BMI levels ( $P = 0.002$ ,  $P = 0.039$ ,  $P = 0.048$ ), residence ( $P < 0.001$ ,  $P < 0.001$ ,  $P < 0.001$ ), average monthly education ( $P < 0.001$ ,  $P < 0.001$ ,  $P < 0.001$ ), occupation ( $P = 0.003$ ,  $P < 0.001$ ,  $P < 0.001$ ), annual health check-ups ( $P < 0.001$ ,  $P < 0.001$ ,  $P < 0.001$ ), and current thyroid disorder status ( $P < 0.001$ ,  $P = 0.013$ ,  $P < 0.001$ ) were more likely to have

**Table 1** Baseline Characteristics and KAP Scores

Variables	N (%)	Knowledge, Mean ± SD	P	Attitude, Mean ± SD	P	Practice, Mean ± SD	P
<b>N=568</b>							
<b>Total score</b>		34.04±7.87		28.82±4.39		26.43±5.59	
<b>Age</b>	31.09±4.67						
<b>BMI</b>			0.002		0.039		0.048
Underweight	32 (5.63)	38.34±6.47		29.16±4.14		28.44±4.87	
Normal	272 (47.89)	34.35±8.22		29.02±4.48		26.68±5.30	
Overweight	168 (29.58)	33.21±7.29		28.92±4.73		26.17±6.20	
Obesity	96 (16.9)	33.15±7.80		28.00±3.48		25.49±5.32	
<b>Residence</b>			<0.001		<0.001		<0.001
Rural	77 (13.56)	30.56±5.45		25.82±4.16		23.75±4.91	
Urban	491 (86.44)	34.58±8.05		29.30±4.24		26.85±5.58	
<b>Education</b>			<0.001		<0.001		<0.001
Junior high school or below	57 (10.04)	30.98±8.38		26.56±5.50		23.91±6.22	
High school/Technical school	97 (17.08)	32.15±6.68		26.63±3.86		25.87±5.93	
College	157 (27.64)	32.78±7.93		29.16±3.86		25.61±5.62	
Bachelor's degree	218 (38.38)	35.74±7.54		29.73±4.22		27.50±5.04	
Master's degree and above	39 (6.87)	38.69±7.46		31.18±3.49		28.82±4.52	
<b>Occupation</b>			0.003		<0.001		<0.001
Employed	354 (62.32)	34.72±8.02		29.54±4.03		27.08±5.00	
Homemaker	47 (8.27)	34.53±7.80		29.11±3.89		27.62±6.47	
Freelancer	92 (16.2)	33.17±7.02		27.50±4.71		25.64±5.36	
Other	75 (13.2)	31.53±7.67		26.91±5.02		23.59±6.85	
<b>Number of Pregnancies</b>			0.842		0.453		0.218
First pregnancy	263 (46.3)	34.05±7.54		29.00±4.04		26.92±5.20	
Second pregnancy	194 (34.15)	33.77±7.87		28.91±4.50		26.05±5.90	
Third or more pregnancies	111 (19.54)	34.47±8.63		28.26±4.98		25.92±5.87	
<b>Pregnancy Trimester</b>			0.485		0.001		0.006
Early pregnancy (6–13+6 weeks)	102 (17.96)	32.98±8.42		27.25±3.79		25.46±5.34	
Mid-pregnancy (14–27+6 weeks)	136 (23.94)	34.76±8.65		29.32±4.16		27.73±5.03	
Late pregnancy (28 weeks to delivery)	330 (58.1)	34.06±7.32		29.10±4.56		26.19±5.80	
<b>Annual Health Check-ups</b>			<0.001		<0.001		<0.001
Yes	332 (58.45)	36.17±7.83		29.84±4.27		28.01±5.05	
No	236 (41.55)	31.03±6.88		27.39±4.17		24.21±5.57	
<b>Current Thyroid Disorder Status</b>			<0.001		0.013		<0.001
Yes	73 (12.85)	37.66±7.86		30.26±4.30		30.95±6.38	
No	495 (87.15)	33.50±7.73		28.61±4.37		25.76±5.15	
<b>Family History of Thyroid Disorders</b>			0.085		0.276		0.696
Yes	63 (11.09)	35.37±7.37		28.65±3.52		26.86±4.99	
No	505 (88.91)	33.87±7.92		28.85±4.49		26.37±5.66	

**Notes:** The Mann–Whitney U-test was used for comparison of the two independent groups, and the Kruskal–Wallis rank-sum test was used for comparison of multiple independent groups. The significance level is set at two-tailed 0.05.

differing knowledge, attitude, and practice scores. Additionally, pregnant women in different trimesters ( $P = 0.001$  and  $P = 0.006$ ) were more likely to have differing attitude and practice scores (Table 1).

## The Distribution of Knowledge, Attitude and Practice Scores

The distribution of responses in the knowledge dimension revealed that the three questions with the highest percentage of participants selecting “Not knowledgeable” were: “Thyroid hormones play a crucial role in fetal brain development; thyroid dysfunction may lead to cognitive development issues in children” (K3) with 34.33%, “Postpartum thyroid function may take time to return to normal, especially for mothers with hypothyroidism” (K9) with 33.1%, and “Untreated or inadequately treated hyperthyroidism (or hypothyroidism) during pregnancy can trigger hyperthyroid

**Table 2** Responses to Knowledge Questions

	N (%)				
	Very Knowledgeable	Fairly Knowledgeable	Somewhat Knowledgeable	Not Knowledgeable	Not Knowledgeable at All
1. Thyroid dysfunction includes hyperthyroidism and hypothyroidism, which may affect fetal neurodevelopment and pregnancy outcomes.	28 (4.93)	118 (20.77)	240 (42.25)	170 (29.93)	12 (2.11)
2. Hyperthyroidism may increase the risk of pregnancy-induced hypertension in mothers.	26 (4.58)	106 (18.66)	243 (42.78)	184 (32.39)	9 (1.58)
3. Thyroid hormones play a crucial role in fetal brain development; thyroid dysfunction may lead to cognitive development issues in children.	31 (5.46)	140 (24.65)	193 (33.98)	195 (34.33)	9 (1.58)
4. Thyroid function tests during pregnancy can timely detect and manage thyroid dysfunction, reducing adverse effects on the fetus.	53 (9.33)	198 (34.86)	178 (31.34)	129 (22.71)	10 (1.76)
5. Autoimmune thyroid diseases such as thyroiditis may increase the risk of pregnancy complications.	33 (5.81)	140 (24.65)	234 (41.2)	150 (26.41)	11 (1.94)
6. Untreated or inadequately treated hyperthyroidism (or hypothyroidism) during pregnancy can trigger hyperthyroid crises during delivery, surgery, infection, or improper discontinuation of medication, jeopardizing maternal and fetal safety.	28 (4.93)	116 (20.42)	216 (38.03)	184 (32.39)	24 (4.23)
7. Severe, uncontrolled thyroid dysfunction in pregnant women can lead to adverse outcomes such as miscarriage, preterm birth, fetal growth restriction, and fetal thyroid dysfunction or goiter.	25 (4.4)	138 (24.3)	205 (36.09)	183 (32.22)	17 (2.99)
8. During pregnancy, due to increased fetal demand for thyroid hormones, the maternal need for thyroid hormones also increases.	30 (5.28)	126 (22.18)	233 (41.02)	172 (30.28)	7 (1.23)
9. Postpartum thyroid function may take time to return to normal, especially for mothers with hypothyroidism.	25 (4.4)	120 (21.13)	228 (40.14)	188 (33.1)	7 (1.23)
10. Thyroid dysfunction may affect maternal emotional states, increasing the risk of anxiety and depression.	44 (7.75)	115 (20.25)	240 (42.25)	162 (28.52)	7 (1.23)

crises during delivery, surgery, infection, or improper discontinuation of medication, jeopardizing maternal and fetal safety (K6)” with 32.39% (Table 2).

Responses in the attitude dimension showed that the vast majority of participants had a positive attitude. However, regarding the question of whether thyroid dysfunction during pregnancy affected their postnatal emotional state (A5) and ability to breastfeed (A6), 23.94% and 29.4% were neutral, respectively. Additionally, 2.46% did not believe that a reasonable increase in iodine-rich food intake would be beneficial for them and their fetus (A7) (Table 3).

In terms of related practices, 70.95% of participants never took thyroid hormone medication regularly during pregnancy (P2), 20.77% never underwent thyroid function tests during pregnancy (P1), and 18.13% never proactively consulted their doctors about abnormal thyroid function during pregnancy for knowledge and information (P3) (Table 4). A survey of dietary habits revealed that 238 participants had inadequate calcium intake, and 143 consumed high-fat foods over an extended period (Figure 1).

## Correlation Between Knowledge, Attitude and Practice

Further correlation analysis revealed positive correlations between knowledge and attitude scores ( $r = 0.400$ ,  $P < 0.001$ ), as well as between knowledge and practice scores ( $r = 0.432$ ,  $P < 0.001$ ). Additionally, attitude scores were positively correlated with practice scores ( $r = 0.518$ ,  $P < 0.001$ ) (Table 5).

**Table 3** Responses to Attitude Questions

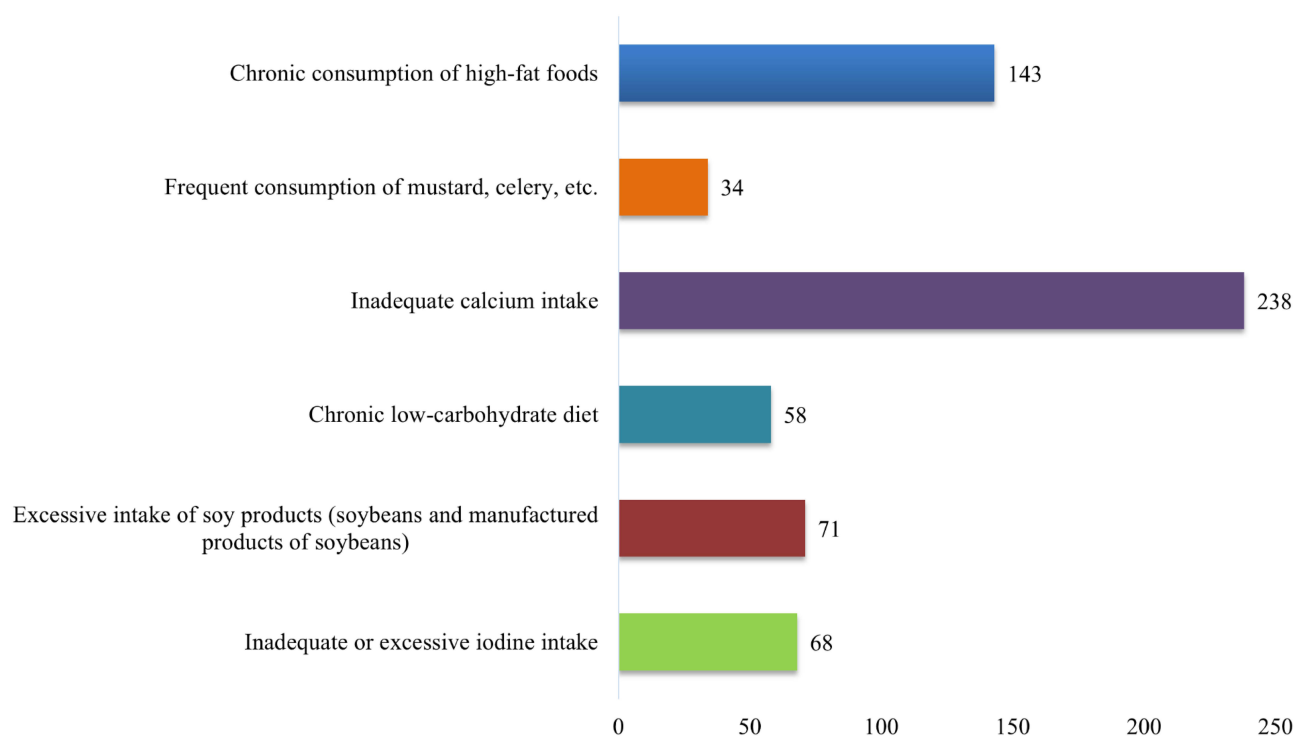
	N (%)				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I believe it is important to understand thyroid dysfunction during pregnancy.	221 (38.91)	274 (48.24)	69 (12.15)		4 (0.7)
2. I am willing to undergo regular thyroid function tests during pregnancy.	207 (36.44)	273 (48.06)	79 (13.91)	9 (1.58)	
3. I believe that thyroid dysfunction during pregnancy may impact fetal health.	196 (34.51)	295 (51.94)	76 (13.38)	1 (0.18)	
4. I am willing to actively cooperate with the doctor's treatment plan to manage thyroid dysfunction during pregnancy.	206 (36.27)	293 (51.58)	66 (11.62)	3 (0.53)	
5. I believe that thyroid dysfunction during pregnancy may affect my emotional state postpartum.	177 (31.16)	252 (44.37)	136 (23.94)	3 (0.53)	
6. I believe that thyroid dysfunction during pregnancy may affect my ability to breastfeed.	135 (23.77)	246 (43.31)	167 (29.4)	20 (3.52)	
7. I believe that increasing the intake of iodine-rich foods during pregnancy is beneficial for both me and my fetus.	141 (24.82)	303 (53.35)	110 (19.37)	14 (2.46)	

**Table 4** Responses to Practice Questions

	N (%)				
	Always	Often	Sometimes	Rarely	Never
1. I have thyroid function tests conducted during every pregnancy check-up.	61 (10.74)	70 (12.32)	147 (25.88)	172 (30.28)	118 (20.77)
2. I regularly take thyroid hormone medication during pregnancy.	48 (8.45)	24 (4.23)	26 (4.58)	67 (11.8)	403 (70.95)
3. I proactively consult my doctor about thyroid dysfunction during pregnancy to understand related knowledge and information.	40 (7.04)	57 (10.04)	168 (29.58)	200 (35.21)	103 (18.13)
4. I follow my doctor's recommendations for managing diet and lifestyle during pregnancy.	177 (31.16)	249 (43.84)	106 (18.66)	23 (4.05)	13 (2.29)
5. I regularly monitor my weight changes during pregnancy.	210 (36.97)	235 (41.37)	90 (15.85)	21 (3.7)	12 (2.11)
6. I actively participate in pregnancy exercises or activities recommended by my doctor.	156 (27.46)	180 (31.69)	184 (32.39)	39 (6.87)	9 (1.58)
7. I make efforts to reduce stress and anxiety during pregnancy.	158 (27.82)	230 (40.49)	146 (25.7)	25 (4.4)	9 (1.58)
8. I avoid overexertion and fatigue, maintaining a good daily routine.	143 (25.18)	266 (46.83)	125 (22.01)	31 (5.46)	3 (0.53)

## Exploration of Risk Factors for Thyroid Disease Complicating Pregnancy

Multivariate logistic regression analysis indicated that practice score (OR = 1.212, 95% CI: [1.136–1.294],  $P < 0.001$ ) and age (OR = 1.069, 95% CI: [1.007–1.135],  $P = 0.029$ ) were protective factors directly associated with thyroid disease complicating pregnancy (Table 6). It should be noted that statistical significance ( $P$  values) indicates the likelihood of an observed association under the null hypothesis but does not necessarily reflect clinical or practical importance.



**Figure 1** Dietary habits of the surveyed population.

## Structural Equation Model of Knowledge, Attitude and Practice

The fitting indices of the structural model (CMIN/DF = 5.530, IFI = 0.907, TLI = 0.895, CFI = 0.907, RFI = 0.875) surpassed the respective threshold values, indicating that the data fit the model satisfactorily (Table 7). The results

**Table 5** Correlation Analysis of Knowledge, Attitude, and Practice

	Knowledge	Attitude	Practice
Knowledge	1		
Attitude	0.400 (P<0.001)	1	
Practice	0.432 (P<0.001)	0.518 (P<0.001)	1

**Notes:** Spearman rank correlation was used for correlation analysis. The significance level is set at two-tailed 0.05.

**Table 6** Exploration of Risk Factors for Thyroid Disease Complicating Pregnancy

	Univariate Logistic Regression		Multivariate Logistic Regression	
	OR (95% CI)	P	OR (95% CI)	P
<b>Knowledge score</b>	1.068 (1.035–1.102)	<0.001	1.031 (0.992–1.071)	0.120
<b>Attitude score</b>	1.092 (1.030–1.158)	0.003	0.931 (0.856–1.013)	0.095
<b>Practice score</b>	1.211 (1.148–1.278)	<0.001	1.212 (1.136–1.294)	<0.001
<b>Age</b>	1.072 (1.022–1.124)	0.004	1.069 (1.007–1.135)	0.029

(Continued)

**Table 6** (Continued).

	Univariate Logistic Regression		Multivariate Logistic Regression	
	OR (95% CI)	P	OR (95% CI)	P
<b>BMI</b>				
Underweight	1.494 (0.535–4.171)	0.444		
Normal	ref			
Overweight	1.545 (0.882–2.704)	0.128		
Obesity	1.044 (0.501–2.174)	0.909		
<b>Residence</b>				
Rural	ref		ref	
Urban	2.984 (1.057–8.427)	0.039	1.439 (0.436–4.746)	0.550
<b>Education</b>				
Junior high school or below	ref		ref	
High school/Technical school	9.446 (1.208–73.880)	0.032	6.319 (0.761–52.503)	0.088
College	5.915 (0.763–45.847)	0.089	5.295 (0.657–42.657)	0.117
Bachelor's degree	11.448 (1.536–85.330)	0.017	7.254 (0.916–57.456)	0.061
Master's degree and above	10.182 (1.174–88.311)	0.035	4.986 (0.527–47.206)	0.161
<b>Occupation</b>				
Employed	ref			
Homemaker	1.409 (0.619–3.206)	0.414		
Freelancer	0.933 (0.462–1.884)	0.846		
Other	0.936 (0.436–2.009)	0.866		
<b>Number of Pregnancies</b>				
First pregnancy	ref			
Second pregnancy	0.951 (0.544–1.663)	0.860		
Third or more pregnancies	1.052 (0.548–2.021)	0.878		
<b>Pregnancy Trimester</b>				
Early pregnancy (6–13+6 weeks)	ref			
Mid-pregnancy (14–27+6 weeks)	1.393 (0.668–2.905)	0.376		
Late pregnancy (28 weeks to delivery)	0.865 (0.440–1.698)	0.673		
<b>Annual Health Check-ups</b>				
Yes	2.218 (1.277–3.853)	0.005	0.907 (0.463–1.779)	0.777
No	ref		ref	
<b>Current Thyroid Disorder Status</b>				
Yes	1.511 (0.749–3.052)	0.249		
No	ref			

**Note:** The significance level is set at two-tailed 0.05.

**Table 7** Fit of the SEM Model

Model Fit Index	Ref.	Measured results
<b>CMIN/DF</b>	1-3 excellent, 3–5 good	5.530
<b>IFI</b>	>0.8 good	0.907
<b>TLI</b>	>0.8 good	0.895
<b>CFI</b>	>0.8 good	0.907
<b>RFI</b>	>0.8 good	0.875

**Table 8** Direct and Indirect Effects of the Model

Model Paths	Standardized Total Effects		Standardized Direct Effects		Standardized Indirect Effects	
	$\beta$ (95% CI)	P	$\beta$ (95% CI)	P	$\beta$ (95% CI)	P
Knowledge→Attitude	0.434 (0.350–0.490)	0.021	0.434 (0.350–0.490)	0.021		
Knowledge→Practice	0.332 (0.237–0.419)	0.006	0.069 (–0.017–0.163)	0.104		
Attitude→Practice	0.604 (0.505–0.670)	0.012	0.604 (0.505–0.670)	0.012		
Knowledge→Practice					0.262 (0.201–0.323)	0.009

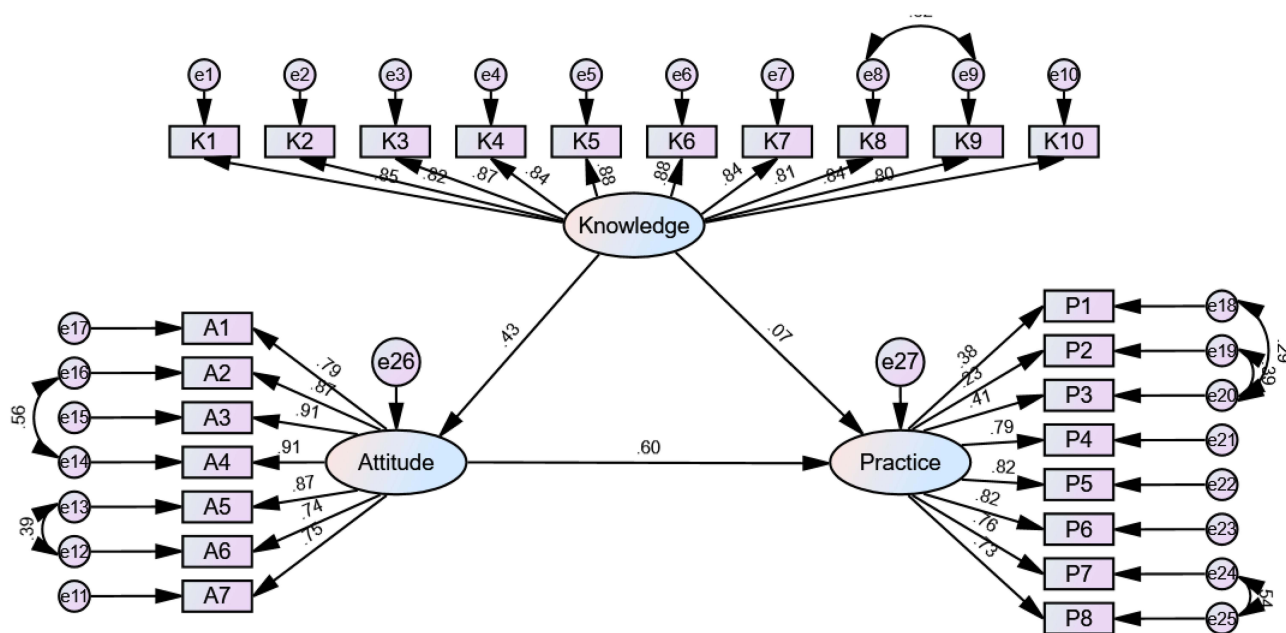
**Note:** The significance level is set at two-tailed 0.05.

showed a direct effect of knowledge on attitude ( $\beta = 0.434, P = 0.021$ ) and of attitude on practice ( $\beta = 0.604, P = 0.012$ ). Moreover, knowledge indirectly influenced practice through attitude ( $\beta = 0.262, P = 0.009$ ) (Table 8 and Figure 2).

## Discussion

The results indicate limited awareness, generally favorable perceptions, but low engagement in thyroid-related health behaviors among pregnant women. These findings suggest a possible association between KAP levels and the need for targeted educational strategies to support thyroid health management during pregnancy. This study reveals that pregnant women exhibited suboptimal knowledge, positive attitudes, and inactive practices concerning thyroid disorders during pregnancy. The overall low knowledge scores, alongside relatively inactive practices, align with findings from similar study that reported inadequate management of thyroid disorders among pregnant women, potentially contributing to the persistence of poor maternal and fetal outcomes.<sup>13,14</sup> The positive attitude observed in this study, while promising, has not translated into corresponding health practices, highlighting a significant gap between knowledge, attitudes, and behavior. This gap underscores the need for targeted interventions to enhance both awareness and practical management of thyroid disorders in this population.

The correlation analyses, multivariate logistic regression, and SEM collectively indicate a strong interrelationship between knowledge, attitude, and practice. Specifically, higher knowledge scores were associated with better attitudes ( $r = 0.400, P < 0.001$ ) and improved practices ( $r = 0.432, P < 0.001$ ), which is consistent with the theoretical underpinnings of the KAP model. Additionally, attitude scores positively correlated with practice scores ( $r = 0.518, P < 0.001$ ), further reinforcing the critical role of



**Figure 2** SEM Model Path Diagram.

positive attitudes in translating knowledge into action. The SEM analysis further elucidates that knowledge indirectly influences practice through attitudes ( $\beta = 0.262$ ,  $P = 0.009$ ), suggesting that while knowledge is a prerequisite, attitudes serve as a crucial mediator in adopting healthy practices. These findings are supported by previous research emphasizing the role of attitudes as a bridge between knowledge and practice in health behavior.<sup>15,16</sup>

Significant differences in KAP scores were observed across various demographic variables, including BMI, residence, education level, occupation, annual health check-ups, and current thyroid disorder status. For instance, urban residents, participants with higher education levels, and those undergoing regular health check-ups demonstrated better knowledge, attitudes, and practices, as reflected in both the correlation and multivariate logistic regression analyses ( $P < 0.001$  for all variables). These results, also supported by the logistic regression, suggest that higher educational attainment and better access to healthcare resources significantly enhance the KAP concerning thyroid disorders<sup>8,9,17–20</sup>. Conversely, the lower KAP scores among rural residents and those with lower education levels may be attributed to reduced access to information and healthcare services, as previously documented in the literature.<sup>17,18</sup> Additionally, the association between current thyroid disorder status and higher KAP scores could be due to increased awareness and vigilance among affected individuals, as suggested by the positive correlation and logistic regression results ( $P < 0.001$ ).<sup>21,22</sup>

The findings from the knowledge dimension indicate that many pregnant women possess limited knowledge regarding thyroid disorders, particularly in areas concerning the impact of thyroid dysfunction on fetal brain development, postpartum thyroid recovery, and the risks associated with untreated hyperthyroidism or hypothyroidism. For example, a significant proportion of respondents were not knowledgeable about the role of thyroid hormones in fetal cognitive development, and many were unaware of the potential dangers of inadequate thyroid management during pregnancy. These results are consistent with previous studies that also reported low levels of thyroid-related knowledge among pregnant women.<sup>10,23</sup> The insufficient knowledge observed in this study suggests the need for more comprehensive educational programs specifically tailored to pregnant women. These programs should focus on the critical aspects of thyroid health, including the implications of thyroid disorders for both maternal and fetal health, and emphasize the importance of timely screening and management. To reach those with lower educational levels or from rural areas—groups identified as having particularly low knowledge scores—healthcare providers could employ multimedia resources, such as educational videos or mobile apps, that deliver information in an accessible and engaging manner. Moreover, integrating thyroid health education into routine prenatal care, with consistent messaging from healthcare providers, could reinforce the importance of this issue.<sup>24,25</sup>

In the attitude dimension, while the majority of participants held positive attitudes toward the importance of understanding and managing thyroid dysfunction during pregnancy, there were notable gaps. A considerable number of respondents were neutral or uncertain about the impact of thyroid dysfunction on their postpartum emotional state and breastfeeding ability. This ambivalence may stem from a lack of concrete knowledge or firsthand experience, which suggests that merely having a positive attitude is insufficient without accompanying education and awareness. Comparisons with other studies reveal similar trends, where positive attitudes did not always translate into proactive health behaviors.<sup>26,27</sup> To address this, targeted communication strategies are necessary to clarify the connection between thyroid health and postpartum outcomes. For instance, counseling sessions could be designed to specifically address common concerns and misconceptions related to postpartum thyroid issues, thereby fostering a more proactive stance among pregnant women. Additionally, healthcare policies could mandate regular workshops or support groups where women can share experiences and receive guidance on managing thyroid health during and after pregnancy. These interventions would help in bridging the gap between attitudes and behaviors, ultimately promoting better health outcomes.<sup>28,29</sup>

The practice results indicate a significant disconnect between the positive attitudes and the actual health behaviors of pregnant women concerning thyroid health. For instance, the majority of women rarely or never took thyroid hormone medication regularly during pregnancy, and a large portion did not consistently consult with their doctors about thyroid dysfunction. To improve these practices, it is essential to implement more structured follow-up protocols within prenatal care systems. For example, routine reminders and follow-ups via text messages or phone calls could encourage pregnant women to adhere to thyroid-related healthcare practices. Furthermore, establishing a more robust healthcare provider-patient communication channel, where providers actively monitor and discuss thyroid health, could help reinforce the

importance of these practices. Healthcare providers should also be trained to identify and address barriers to adherence, such as misconceptions about medication safety during pregnancy or concerns about the cost of tests and treatments. Additionally, for women from demographic groups with poorer practice outcomes, such as those in lower educational brackets or rural areas, offering personalized counseling sessions or home visits could provide the support necessary to improve adherence to recommended practices. Implementing these strategies could lead to significant improvements in the management of thyroid disorders during pregnancy, thereby reducing associated risks for both mother and child.<sup>30,31</sup>

This study has several limitations. First, the use of an online questionnaire may have introduced selection bias, as it likely excluded women without internet access or those less inclined to participate in online surveys. Second, the cross-sectional design of the study limits the ability to establish causal relationships between knowledge, attitudes, and practices regarding thyroid disorders. Third, the study was conducted in a single hospital, which may limit the generalizability of the findings to other populations or regions. Additionally, unmeasured confounding factors such as participants' baseline health literacy or previous experience with thyroid conditions may have influenced their responses. The lack of qualitative data also limits our understanding of why knowledge does not consistently translate into practice. Future studies should consider longitudinal or interventional designs to evaluate the impact of educational strategies on behavior change over time.

## Conclusions

In conclusion, pregnant women demonstrated suboptimal knowledge, positive attitudes, and inactive practices regarding thyroid disorders during pregnancy. These findings suggest the need for targeted educational strategies such as routine prenatal counseling, multimedia education tools, and rural community outreach to enhance pregnant women's awareness and engagement. Such interventions may contribute to improved maternal-fetal outcomes by promoting timely recognition and management of thyroid disorders during pregnancy.

## Abbreviations

KAP, Knowledge, attitudes, and practices; SEM, Structural equation model; SD, Standard deviations.

## Data Sharing Statement

All data generated or analysed during this study are included in this published article.

## Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Zhujiang Hospital, Southern Medical University (2024-ky-217-01), and written informed consent was obtained from all participants. I confirm that all methods were performed in accordance with the relevant guidelines. All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare that they have no competing interests in this work.

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