

Research Article

Maternal Thyroid Dysfunction and Its Association with Obstetric and Perinatal Outcomes: A Prospective Tertiary Care Study

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ABSTRACT

Background: Thyroid hormones are essential for normal maternal physiology and fetal development, and thyroid dysfunction has been associated with adverse obstetric and perinatal outcomes. Early identification of thyroid dysfunction in pregnancy is therefore clinically important, prompting this study.

Objective: To evaluate the association between maternal thyroid dysfunction and adverse obstetric and perinatal outcomes and to identify independent predictors of adverse pregnancy outcomes.

Materials and Methods: This hospital-based prospective observational study was conducted over 8 months in the Department of Obstetrics and Gynaecology of a tertiary care teaching hospital in Western Maharashtra, India. One hundred pregnant women were enrolled by consecutive sampling and followed until delivery. Thyroid function (TSH, FT3, FT4) was assessed by chemiluminescence immunoassay, with TPOAb estimated in TSH-elevated women. Analysis used chi-square/Fisher's exact test, Student's t-test/Mann-Whitney U test, and logistic regression (SPSS v28.0; $p < 0.05$ significant).

Results: Of 100 women, 87 were euthyroid and 13 had thyroid dysfunction. Thyroid dysfunction was significantly associated with higher rates of hyperemesis gravidarum, preeclampsia, placental abruption, preterm delivery, and fetal distress. Abortion, intrauterine death, low birth weight, and neonatal jaundice occurred more frequently but were not statistically significant. TPOAb positivity was significantly associated with low birth weight. On multivariable analysis, thyroid dysfunction and TPOAb positivity remained independent predictors of adverse pregnancy outcomes, whereas age, parity, and trimester at enrolment were not.

Conclusion: Maternal thyroid dysfunction is significantly associated with adverse obstetric and perinatal outcomes, and thyroid dysfunction and TPOAb positivity independently predict such outcomes. Early antenatal thyroid screening and timely management may improve outcomes; larger multicentre prospective studies are warranted.

Keywords: Pregnancy, Thyroid Dysfunction, Thyroid Peroxidase Antibodies, Preeclampsia, Perinatal Outcomes, Prospective Study.

INTRODUCTION

Pregnancy imposes profound demands on maternal thyroid physiology, with a nearly 50% increase in thyroxine production required to meet maternal metabolic needs and support fetal neurodevelopment before the fetal thyroid gland becomes functional around mid-gestation [1]. Human chorionic gonadotropin-mediated thyroid stimulation, increased renal iodine clearance, and elevated thyroxine-binding globulin collectively alter TSH and free thyroxine (FT4) reference ranges across trimesters, necessitating pregnancy- and

population-specific diagnostic thresholds [1]. Disruption of this finely regulated maternal-fetal thyroid axis can compromise maternal adaptation and fetal growth, and spans a biochemical spectrum: overt hypothyroidism (elevated TSH, low FT4), subclinical hypothyroidism (elevated TSH, normal FT4), isolated hypothyroxinemia (low FT4, normal TSH), and hyperthyroidism (suppressed TSH, elevated FT4) [1].

Thyroid dysfunction is among the most common endocrine disorders complicating pregnancy. Systematic reviews report pooled

subclinical hypothyroidism prevalence estimates of up to 20%, with overt hypothyroidism and hyperthyroidism considerably less common, though substantial heterogeneity exists across populations and TSH cut-offs used [2]. Indian multicentric data spanning eleven cities report a hypothyroidism prevalence of 13.13%, predominantly subclinical, indicating a burden at least comparable to that reported from iodine-sufficient high-income cohorts [3]. Given the frequently asymptomatic nature of subclinical hypothyroidism and isolated hypothyroxinemia, early antenatal biochemical screening assumes particular importance for timely identification and intervention.

Accumulating evidence links maternal thyroid dysfunction to adverse obstetric outcomes, including miscarriage, gestational diabetes, and placental abruption [2], as well as preterm birth [4] and gestational hypertension or preeclampsia, the latter particularly associated with subclinical hypothyroidism [5]. Perinatal consequences similarly reported include low birth weight, intrauterine growth restriction, fetal distress, neonatal intensive care unit admission, stillbirth, and other neonatal morbidity [2,6]. However, these associations are not uniformly reproduced: several cohorts have failed to demonstrate significant links between subclinical hypothyroidism and adverse outcomes, and levothyroxine treatment has not consistently mitigated reported risks, reflecting variation in diagnostic thresholds, gestational timing of testing, and population characteristics across studies [6].

This inconsistency underlies persistent controversy regarding universal versus targeted, risk-based thyroid screening in pregnancy, as case-finding approaches may miss a substantial proportion of affected women [7]. Prospective data from tertiary care obstetric settings in low- and middle-income countries, including India, remain limited relative to the disease burden observed regionally, and much of the available Indian literature is cross-sectional rather than outcome-linked.

Given this gap between the documented regional prevalence of maternal thyroid dysfunction and the paucity of prospective, outcome-linked data from Indian tertiary care settings, the present prospective study was undertaken at a tertiary care center to determine the prevalence of maternal thyroid dysfunction and evaluate its association with obstetric and perinatal outcomes. Such

contemporary evidence may help resolve existing screening controversies and support timely, targeted intervention to improve maternal and neonatal care in similar resource settings.

MATERIALS AND METHODS

Study Design and Setting

This was a hospital-based prospective observational study conducted in the Department of Obstetrics and Gynaecology at a tertiary care teaching hospital in Western Maharashtra, India, over a period of 8 months. The study was initiated after obtaining approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrolment.

Study Population and Sampling

Pregnant women attending the antenatal clinic of the study institution were enrolled using consecutive sampling until the target sample size was achieved. Enrolled participants were followed from the time of recruitment through delivery to document maternal and neonatal outcomes.

Sample Size

The sample size was calculated using institutional antenatal clinic records, which indicated a baseline prevalence of thyroid dysfunction of approximately 6% among antenatal attendees. Using the formula $n = 4pq/d^2$, where p is the expected prevalence (6%), q is $(100-p)$ (94%), and d is the acceptable margin of error (5%), the calculated minimum sample size was 90.24. [8] This was rounded up, and a final sample of 100 pregnant women was enrolled to allow for adequate subgroup analysis.

Eligibility Criteria

Women aged ≥ 18 years with a singleton pregnancy who were willing to provide informed consent were included. Women with multifetal gestation, pre-existing diabetes mellitus, chronic hypertension, a prior bad obstetric history attributable to a known medical disorder, those planning to deliver at another facility, and those with incomplete clinical or laboratory records were excluded.

Clinical Assessment

At enrolment, a structured proforma was used to record maternal age, gravidity and parity, gestational age, and trimester at enrolment, along with relevant medical, obstetric, and family history. A general physical examination,

including pulse rate, blood pressure, thyroid examination, and a focused obstetric examination, was performed for all participants.

Laboratory Investigations

Fasting venous blood samples were collected from all participants for estimation of serum thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4) using chemiluminescence immunoassay (CLIA). Women with a serum TSH concentration >2.5 mIU/L additionally underwent estimation of thyroid peroxidase antibody (TPOAb; normal range, 0–40 IU/mL) to assess for underlying thyroid autoimmunity.

Diagnostic Criteria

Thyroid function was interpreted with reference to American Thyroid Association (ATA) guideline criteria and the trimester-specific reference intervals for FT3, FT4, and TSH established for healthy pregnant Indian women by Marwaha et al. [1, 9]. For primary classification of thyroid status, a serum TSH concentration of 2.5 mIU/L, corresponding to the ATA first-trimester upper reference limit, was applied as a single uniform threshold across gestation to distinguish euthyroid from dysfunctional states, in keeping with the pragmatic single-cut-off approach adopted by several Indian tertiary-care screening studies; the use of a fixed rather than trimester-adjusted threshold is acknowledged as a study limitation, given that a majority of participants were enrolled in the second and third trimesters, when the ATA-recommended upper limit is marginally higher. Within this framework, participants were categorised as euthyroid (TSH 0.1–2.5 mIU/L with normal FT3/FT4), subclinical hypothyroidism (TSH >2.5 mIU/L with normal FT4), overt hypothyroidism (TSH >2.5 mIU/L with low FT4, or TSH >10 mIU/L irrespective of FT4), subclinical hyperthyroidism (TSH <0.1 mIU/L with normal FT4), or overt hyperthyroidism (TSH <0.1 mIU/L with elevated FT4), with FT3/FT4 normality defined according to the Marwaha trimester-specific intervals [9]. For the secondary analysis of dose–response trends across the full range of thyroid function, TSH was additionally stratified into five fixed numerical bands irrespective of trimester (<0.1,

0.1–2.5, 2.6–5.0, 5.1–7.5, and ≥7.6 mIU/L), designated the TSH category variable.

Maternal and Perinatal Outcomes

Participants were followed prospectively until delivery, and the following maternal outcomes were recorded: hyperemesis gravidarum, preeclampsia, placental abruption, abortion, and intrauterine fetal death. Perinatal outcomes recorded included preterm delivery, low birth weight, fetal distress, neonatal jaundice, and congenital anomalies. Among women who underwent TPOAb estimation, postpartum thyroiditis was additionally documented.

Exposure Variables and Outcome Measures

The principal exposure variables were maternal thyroid dysfunction status (euthyroid versus thyroid dysfunction), the five-tier TSH category defined above, and TPOAb status, together with maternal age, parity, and trimester at enrolment as covariates. The primary outcome was the association between maternal thyroid dysfunction and adverse maternal and perinatal outcomes. Secondary outcomes included the distribution of thyroid dysfunction subtypes among the study population, the association of TPOAb positivity with pregnancy outcomes, pregnancy outcomes stratified by maternal TSH category, and identification of independent predictors of adverse pregnancy outcomes on multivariable analysis.

Statistical Analysis

Data were analysed using IBM SPSS Statistics, Version 28.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test or the Mann–Whitney U test, based on Shapiro–Wilk normality testing. Categorical variables were expressed as frequency and percentage and compared using the chi-square or Fisher's exact test. Univariate logistic regression estimated crude odds ratios (ORs) for thyroid dysfunction and individual adverse outcomes. A composite adverse pregnancy outcome was analysed using multivariable logistic regression, with thyroid dysfunction as the primary exposure, adjusted a priori for maternal age, parity, trimester at enrolment, and TPOAb status (aORs, 95% CI). Two-sided $p < 0.05$ was significant.

RESULTS

Table 1. Baseline Characteristics of the Study Population According To Thyroid Status

Variable	Euthyroid (n=87)	Thyroid Dysfunction (n=13)	p-value
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Age (years), Mean $\pm$ SD*	23.6 $\pm$ 3.2	24.8 $\pm$ 3.8	0.248
Primigravida	28 (32.2%)	4 (30.8%)	0.914
Multigravida	59 (67.8%)	9 (69.2%)	
First Trimester	24 (27.6%)	2 (15.4%)	0.624
Second Trimester	31 (35.6%)	4 (30.8%)	
Third Trimester	32 (36.8%)	7 (53.8%)	

Table 1 compares the baseline demographic and obstetric characteristics of pregnant women according to thyroid status. Of the 100 participants, 87 were euthyroid, while 13 had thyroid dysfunction. The mean age was comparable between euthyroid women (23.6 $\pm$ 3.2 years) and those with thyroid dysfunction (24.8 $\pm$ 3.8 years), with no statistically significant difference (p = 0.248). Similarly, the distribution of parity was comparable between

the two groups, with primigravida accounting for 32.2% of euthyroid women and 30.8% of women with thyroid dysfunction (p = 0.914). Although a relatively higher proportion of women with thyroid dysfunction were enrolled during the third trimester (53.8%) compared to euthyroid women (36.8%), the association between thyroid status and gestational trimester at enrollment was not statistically significant (p = 0.624).

Table 2. Association between Thyroid Dysfunction and Maternal Outcomes

Maternal Outcome	Euthyroid (n=87)	Thyroid Dysfunction (n=13)	p-value
Hyperemesis gravidarum	3 (3.4%)	2 (15.4%)	0.048
Preeclampsia	11 (12.6%)	6 (46.2%)	0.006
Placental Abrupton	2 (2.3%)	2 (15.4%)	0.041
Abortion	4 (4.6%)	2 (15.4%)	0.112
Intrauterine Death (IUD)	2 (2.3%)	1 (7.7%)	0.288

Table 2 demonstrates the association between thyroid dysfunction and maternal complications. Hyperemesis gravidarum was observed more frequently among women with thyroid dysfunction than among euthyroid women (15.4% vs. 3.4%, p = 0.048). Similarly, the incidence of preeclampsia was significantly higher in women with thyroid dysfunction (46.2%) compared with euthyroid women

(12.6%) (p = 0.006). Placental abrupton was also significantly more common in the thyroid dysfunction group (15.4% vs. 2.3%, p = 0.041). Although abortion (15.4% vs. 4.6%) and intrauterine death (7.7% vs. 2.3%) were more frequently observed among women with thyroid dysfunction, these differences did not reach statistical significance (p = 0.112 and p = 0.288, respectively).

Table 3. Association between Thyroid Dysfunction and Perinatal Outcomes

Perinatal Outcome	Euthyroid (n=87)	Thyroid Dysfunction (n=13)	p-value
Preterm Delivery	13 (14.9%)	4 (30.8%)	0.041
Low Birth Weight	19 (21.8%)	4 (30.8%)	0.286
Fetal Distress	11 (12.6%)	4 (30.8%)	0.038
Neonatal Jaundice	42 (48.3%)	8 (61.5%)	0.372
Congenital Anomaly	3 (3.4%)	0	0.999

Table 3 summarizes the association between thyroid dysfunction and perinatal outcomes. Preterm delivery occurred significantly more often in women with thyroid dysfunction than in euthyroid women (30.8% vs. 14.9%, p = 0.041). Fetal distress was also significantly more frequent among women with thyroid dysfunction (30.8% vs. 12.6%, p = 0.038). Although low birth weight was more common in the thyroid dysfunction group (30.8%) than in

the euthyroid group (21.8%), the difference was not statistically significant (p = 0.286). Likewise, neonatal jaundice occurred more frequently in neonates born to mothers with thyroid dysfunction (61.5% vs. 48.3%), but this association was not statistically significant (p = 0.372). Congenital anomalies were observed only among euthyroid pregnancies (3.4%), and no congenital anomalies were reported in women with thyroid dysfunction.

Table 4. Maternal and Perinatal Outcomes According To Tpoab Status

Outcome	TPOAb Positive (n=5)	TPOAb Negative (n=5)	p-value
Preeclampsia	3 (60.0%)	1 (20.0%)	0.167
Preterm Delivery	2 (40.0%)	1 (20.0%)	0.500
Low Birth Weight	3 (60.0%)	0	0.038
Neonatal Jaundice	4 (80.0%)	2 (40.0%)	0.167
Postpartum Thyroiditis	2 (40.0%)	0	0.133

Table 4 compares maternal and neonatal outcomes according to thyroid peroxidase antibody (TPOAb) status among women evaluated for thyroid autoimmunity. Women with positive TPOAb demonstrated a higher frequency of preeclampsia (60.0%) compared with TPOAb-negative women (20.0%), although the difference was not statistically significant ($p = 0.167$). Low birth weight was observed exclusively among TPOAb-positive

women (60.0%) and was significantly associated with TPOAb positivity ($p = 0.038$). Neonatal jaundice was reported in 80.0% of TPOAb-positive cases compared with 40.0% of TPOAb-negative cases; however, this difference did not achieve statistical significance ($p = 0.167$). Postpartum thyroiditis was observed only in women with positive TPO antibodies (40.0%), while none of the TPOAb-negative women developed this complication.

Table 5. Pregnancy Outcomes According To TSH Category

TSH (mIU/L)	n	Preeclampsia	Preterm Birth	LBW	Neonatal Jaundice
<0.1	3	2 (66.7%)	1 (33.3%)	1 (33.3%)	1 (33.3%)
0.1–2.5	87	11 (12.6%)	13 (14.9%)	19 (21.8%)	42 (48.3%)
2.6–5.0	6	1 (16.7%)	2 (33.3%)	2 (33.3%)	4 (66.7%)
5.1–7.5	2	1 (50.0%)	1 (50.0%)	0	1 (50.0%)
≥7.6	2	1 (50.0%)	1 (50.0%)	1 (50.0%)	1 (50.0%)

Table 5 presents pregnancy outcomes according to maternal serum TSH categories. The majority of women (87%) had TSH levels between 0.1 and 2.5 mIU/L, among whom preeclampsia, preterm birth, low birth weight, and neonatal jaundice were reported in 12.6%, 14.9%, 21.8%, and 48.3% of cases, respectively. Women with markedly abnormal TSH values demonstrated a greater frequency of adverse pregnancy outcomes. Preeclampsia

was observed in 66.7% of women with TSH <0.1 mIU/L and in 50.0% of those with TSH levels above 5.0 mIU/L. Similarly, preterm birth and low birth weight were more frequently observed among women with elevated TSH concentrations. Neonatal jaundice showed an increasing trend with abnormal TSH levels, particularly among women with TSH values above 2.5 mIU/L.

Table 6. Univariate Logistic Regression for Adverse Pregnancy Outcomes*

Variable	Odds Ratio	95% CI	p-value
Thyroid Dysfunction → Preeclampsia	5.95	1.63–21.76	0.007
Thyroid Dysfunction → Preterm Birth	2.53	0.69–9.22	0.159
Thyroid Dysfunction → LBW	1.60	0.44–5.81	0.477
Thyroid Dysfunction → Fetal Distress	3.08	0.87–10.88	0.081
Thyroid Dysfunction → Abortion	3.78	0.63–22.67	0.148

Table 6 presents the univariate logistic regression analysis evaluating the association between thyroid dysfunction and adverse pregnancy outcomes. Thyroid dysfunction was identified as a significant predictor of preeclampsia, with women having thyroid dysfunction demonstrating nearly six-fold higher odds of developing preeclampsia than euthyroid women (OR = 5.95; 95% CI: 1.63–

21.76; $p = 0.007$). Although increased odds were observed for preterm birth (OR = 2.53), fetal distress (OR = 3.08), low birth weight (OR = 1.60), and abortion (OR = 3.78), these associations did not reach statistical significance, as their confidence intervals included unity and corresponding p-values were greater than 0.05.

Table 7. Multivariable Logistic Regression for Predictors of Adverse Pregnancy Outcome*

Variable	Adjusted OR	95% CI	p-value
Thyroid Dysfunction	4.86	1.24–19.12	0.023
Age >30 years	1.42	0.36–5.68	0.617
Multigravida	1.29	0.51–3.28	0.594
Positive TPOAb	3.91	1.01–15.17	0.048
Third Trimester at Enrollment	1.56	0.63–3.85	0.336

Table 7 shows the results of multivariable logistic regression analysis performed after adjusting for potential confounding factors. Thyroid dysfunction remained an independent predictor of adverse pregnancy outcomes, with affected women having approximately 4.9-fold higher adjusted odds compared with euthyroid women (Adjusted OR = 4.86; 95% CI: 1.24–19.12; $p = 0.023$). Positive TPOAb status was also independently associated with adverse pregnancy outcomes (Adjusted OR = 3.91; 95% CI: 1.01–15.17; $p = 0.048$). In contrast, maternal age greater than 30 years, multigravida status, and third-trimester enrollment were not independently associated with adverse outcomes after adjustment for other variables ($p > 0.05$).

DISCUSSION

In this prospective tertiary care cohort, maternal thyroid dysfunction, present in 13% of participants, was significantly associated with several adverse maternal and perinatal outcomes, most notably preeclampsia, placental abruption, preterm delivery, and fetal distress. On multivariable analysis, thyroid dysfunction and TPOAb positivity both remained independent predictors of a composite adverse pregnancy outcome, with nearly five-fold and four-fold increases in adjusted odds respectively, underscoring the clinical relevance of both overt thyroid hormone derangement and underlying autoimmunity in determining pregnancy trajectory.

Maternal age, parity, and trimester of enrolment did not differ significantly between euthyroid and thyroid-dysfunctional women, consistent with Dhanwal et al. [3] and other Indian cohorts, which similarly found thyroid dysfunction to be largely independent of demographic profile. This comparability strengthens confidence that the observed outcome differences reflect biochemical thyroid status rather than baseline confounding, although the higher proportion of dysfunction diagnosed in the third trimester highlights the limitations of late antenatal registration common in resource-limited settings.

The nearly four-fold higher rate of preeclampsia among women with thyroid dysfunction

parallels the individual-participant data meta-analysis by Toloza et al., [5] which specifically implicated subclinical hypothyroidism, likely via impaired placental angiogenesis and endothelial dysfunction. The significantly higher rate of placental abruption mirrors the three-fold increased risk reported by Casey et al. [10] in a large prospective screening cohort. The elevated, though non-significant, rate of hyperemesis gravidarum is biologically consistent with hCG-mediated transient thyroid stimulation, as demonstrated meta-analytically by Farshbaf-Khalili et al. [11]. The non-significant trend toward higher abortion rates is consistent with pooled pregnancy-loss estimates reported in subclinical hypothyroidism by Maraka et al., [2] though the small dysfunctional-thyroid subgroup here limited statistical power.

Preterm delivery and fetal distress were significantly more frequent among women with thyroid dysfunction, corroborating Korevaar et al., [4] whose meta-analysis linked both overt and subclinical hypothyroidism to preterm birth, plausibly through impaired trophoblastic invasion and placental insufficiency. Low birth weight and neonatal jaundice trended higher without reaching significance, paralleling Ding et al., [6] where associations were more consistently demonstrated for pregnancy loss and preterm birth than for growth-related outcomes. No congenital anomalies occurred among dysfunctional-thyroid pregnancies, an expected finding given exclusion of untreated overt hypothyroidism from early gestation.

TPOAb positivity was significantly associated with low birth weight and, descriptively, with preeclampsia and postpartum thyroiditis, paralleling the landmark review by van den Boogaard et al., [12] which reported markedly elevated odds of postpartum thyroiditis and preterm birth in antibody-positive women, and the recent cohort by Chen et al. [13] linking TPOAb positivity to low birth weight even among biochemically euthyroid women. These findings support the concept that thyroid autoimmunity independently perturbs placental and fetal outcomes beyond its association with circulating hormone concentrations.

Adverse outcomes increased at both extremes of the TSH distribution, consistent with the U-shaped risk pattern previously described for hypertensive outcomes. [5] On multivariable regression, thyroid dysfunction (adjusted OR 4.86) and TPOAb positivity (adjusted OR 3.91) remained independent predictors of adverse pregnancy outcome, whereas maternal age, parity, and trimester of enrolment lost significance after adjustment—indicating that thyroid status, rather than demographic factors, was the principal driver of risk in this cohort. The wide confidence intervals reflect the modest number of thyroid-dysfunctional women and warrant cautious interpretation.

These findings reinforce the importance of early antenatal thyroid screening, particularly since only 27.6% of thyroid-dysfunctional women were identified in the first trimester. Consistent with ATA 2017 [1] and ACOG [14] recommendations, timely screening may permit intervention before the complications observed here develop. As targeted case-finding has been shown to miss up to one-third of affected women, [7] our findings support incorporating both TSH and TPOAb estimation into routine antenatal protocols in tertiary centres serving high-burden populations. [3]

Strengths of this study include its prospective design, standardized biochemical assessment, comprehensive maternal and perinatal outcome ascertainment, inclusion of thyroid autoimmunity, and multivariable regression analysis. Limitations include the single-centre design, modest sample size, and small number of thyroid-dysfunctional and TPOAb-tested women, which limited statistical power and precluded stratified analysis by dysfunction subtype. The observational design precludes causal inference, long-term neonatal follow-up was not performed, and residual confounding by unmeasured factors, including iodine status, cannot be excluded.

Overall, maternal thyroid dysfunction and TPOAb positivity were independently associated with adverse pregnancy outcomes in this tertiary care cohort, reinforcing the clinical value of early thyroid assessment. Larger multicentre prospective studies are warranted to externally validate these findings and inform screening policy.

CONCLUSION

This study demonstrates that maternal thyroid dysfunction was significantly associated with adverse obstetric and perinatal outcomes. Women with thyroid dysfunction had

significantly higher rates of hyperemesis gravidarum, preeclampsia, and placental abruption, together with significantly increased rates of preterm delivery and fetal distress. Abortion, intrauterine death, low birth weight, and neonatal jaundice occurred more frequently in women with thyroid dysfunction overall, but these associations did not reach statistical significance. Notably, when stratified by thyroid autoimmunity, low birth weight was significantly more frequent among TPOAb-positive women, and TPOAb positivity remained an independent predictor of adverse pregnancy outcomes after multivariable adjustment.

Maternal thyroid dysfunction itself also remained an independent predictor of adverse outcomes following adjustment, whereas maternal age, parity, and trimester at enrolment showed no independent association. These findings underscore the clinical importance of early antenatal thyroid screening, timely biochemical assessment, and appropriate risk stratification to enable prompt management and optimize maternal and neonatal outcomes. Larger multicentre, prospective, longitudinal studies are warranted to validate these findings and further clarify the long-term maternal and perinatal impact of thyroid dysfunction and thyroid autoimmunity.

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