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# Prevalence of thyroid dysfunction in pregnancy and its association with feto-maternal outcomes: A prospective observational study from a tertiary care institute in Northern India

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ABSTRACT

*Background:* Thyroid dysfunction in pregnancy is one of the most prominent endocrinological disorders. Physiological changes in thyroid status and non-adaptation to these changes during pregnancy lead to thyroid dysfunction resulting in feto-maternal complications. In this context, we undertook this study to estimate the prevalence of thyroid disorders in pregnant women and their association with feto-maternal outcomes.

*Methods:* This prospective observational study was carried out in a tertiary care institute in Punjab, North India. We recruited 347 pregnant women who visited the OPD (Out Patient Department) through consecutive sampling, out of which 300 were included in our final analysis. A detailed history and clinical examination were made. Apart from routine ante-natal investigations, we estimated the TSH levels. In case of abnormal TSH values, free T4 and T3 levels were assessed. Study participants were followed till 12 weeks post-delivery to observe their obstetrical and perinatal outcomes.

*Results:* Overall prevalence of thyroid disorders in pregnancy was 33.9%, with hypothyroidism (31.6%) being more common than hyperthyroidism (2.3%). A significant association was found between thyroid disorders and feto-maternal complications (p value $< 0.001$). Adverse maternal effects observed in the hypothyroid group as compared to the euthyroid group were preeclampsia (14.7% vs. 5.6%), anemia (7.4% vs. 6.1%), abortion (7.4% vs. 0.5%) and meconium-stained liquor (5.3% vs. 2.5%). Abortion (71.4%) was the main complication in the hyperthyroid group. Adverse neonatal outcomes were low and very low birth weight, low Apgar scores, respiratory distress syndrome, and meconium aspiration syndrome.

*Conclusion:* We observed a high prevalence of thyroid disorders and their relative adverse effects. Universal screening of all women in the pre-conception period or as early as pregnancy is diagnosed, is recommended to reduce subsequent feto-maternal morbidity and mortality.

## 1. Background

Thyroid dysfunction is the most common endocrinological disorder in pregnancy, only second to diabetes. In recent times, it is also the most sought-after area of research in clinical endocrinology.[1] Assessment of thyroid function is pertinent during pregnancy because of its proven influence on feto-maternal outcomes. As soon as pregnancy is established, thyroid physiology starts altering, which continues throughout the gestation, but is reversible postpartum.[2] The factors responsible include increased thyroxine-binding globulin (TBG), increased renal loss of iodine, altered peripheral metabolism of peripheral thyroid hormones, and change in iodine transfer to the placenta.[3] These changes help prepare the maternal thyroid gland to mitigate the increased physiological demands.

There is a wide geographical variation in the prevalence of thyroid disorders and their feto-maternal complications in pregnant women.[4] In India, as per existing literature, the prevalence of overt and subclinical hypothyroidism in pregnancy is reported between 3 to 4.58% and 6.47–9%, respectively.[5,6] Overt and subclinical hyperthyroidism complicates around 0.4–1.7% and 0.4–0.7% of pregnancies, respectively.[7]

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Several studies have reported that thyroid dysfunction -both overt and subclinical-has been associated with increased risk of abortions, anemia, preeclampsia, placental abruption, placental abnormalities, intrauterine growth restriction (IUGR), stillbirths, preterm delivery, postpartum hemorrhage, and even myopathy, congestive heart failure are reported among the affected pregnant mothers.[8] Reduced intellectual function in the offspring, congenital anomalies, and cretinism are most commonly seen in the babies of women, where iodine deficiency is the cause of hypothyroidism.[9] Thus, thyroid disorders during pregnancy predispose to increased feto-maternal and neonatal morbidity and mortality. This makes it imperative to identify women at risk by early screening and initiation of timely treatment. In this context, with relatively insufficient data regarding the prevalence of thyroid disorders and their effects on feto-maternal outcomes in Low and Middle-income countries like India,[5] we undertook this study to determine the prevalence of thyroid disorders in pregnancy in a tertiary care facility in Punjab, North India. The secondary objectives of the study were to compare the socio-demographic characteristics of euthyroid, hypothyroid, and hyperthyroid pregnant women and to observe the effect of thyroid status on feto-maternal outcomes.

## 2. Methods

**Study period:** The study was conducted for one and half years, i.e., January 1st 2019 to June 30th 2020. It included two phases; the recruitment phase of six months and a follow-up phase till June 2020.

**Study design:** Prospective observational study.

**Study settings:** This was carried out in Obstetrics and Gynaecology at a tertiary care hospital in the Malwa region of Punjab, North India.

### 2.1. Study population and sample size

We recruited pregnant women who attended the antenatal clinic for routine check-ups and agreed to follow up. We included all thyroid-treatment naïve pregnant females with singleton pregnancies irrespective of socio-demographic characteristics. Pregnant women with multiple pregnancies, gestational trophoblastic disease, bad obstetric history (BOH), medical illness (DM, HTN), with previous thyroid surgery, on treatment for thyroid disorders, those on drugs which affect the thyroid function like iodine, amiodarone, and those not willing to participate, were excluded from the study.

A sample size of 283 was calculated using the single population proportion formula after considering the overall prevalence of thyroid dysfunction in pregnancy to be around 10%,[10] with a 95% confidence interval and a margin of error to be 3.5%. However, we recruited 347 participants who visited our center in the antenatal period, irrespective of their gestational age. Among them, 300 were delivered in our hospital and were finally included in our analysis.

### 2.2. Data collection tool

A structured proforma was used to collect information from the patients on their first visit when they were recruited in our study. It consisted of three components. Part A collected information about the socio-demographic and clinical characteristics of the participants. Detailed history included age, residence, education, religion, parity, booking status, and clinical and obstetrical examination. We then noted the readings of all the routine and specific investigations. Part B recorded the values of the biochemical parameters like the TSH, T3, and T4. We recorded thyroid disorder, its various types, the time of detecting thyroid disorder in pregnant women, and mean TSH values. Part C recorded the course of pregnancy and the feto-maternal outcomes. Gestational age at the delivery time, mode of delivery (vaginal, instrumental, and lower segment cesarean section), antepartum, and intrapartum complications were recorded in pregnant women. Women were followed up at two, six, and twelve weeks after delivery, and pregnancy outcomes were studied.

For the biochemical parameters, 5–10 ml of the venous blood was initially collected in the fasting state and analyzed for TSH levels. If the serum TSH levels were in the abnormal range, we checked for free T3 and T4 levels. The reference ranges of the test values were evaluated as per the American Thyroid Association Guidelines 2011, with a first-trimester reference range of TSH 0.1–2.5 mIU/L, 0.2–3.0 m IU/L in the second trimester, and 0.3–3.0 m IU/L in the third trimester.[11] Depending on the hormonal values, patients were classified into Subclinical hypothyroidism – defined as elevated TSH levels with a normal serum free T3 and T4 levels; Overt hypothyroidism – abnormally high TSH levels accompanied by low levels of free T3 and T4; Subclinical hyperthyroidism – abnormally low serum TSH levels with normal T4 levels; and Overt hyperthyroidism – abnormally low serum TSH levels and high T4 levels. After diagnosis, the patient was adequately treated with thyroxine for hypothyroidism and anti-thyroid drugs for hyperthyroidism.

### 2.3. Statistical analysis

The data was compiled and coded on a Microsoft Excel spreadsheet (version- 2010). Data analysis was performed using Statistical Package for social sciences (SPSS) for Windows version 17.0 (SPSS Inc., Chicago, IL). Descriptive analysis was performed using frequency and proportions for categorical variables. Bivariate analysis was conducted to look for associations between the socio-demographic characteristics and type of thyroid disorders using the chi-square test, and $p < 0.05$ was considered significant.

### 2.4. Consent and ethical approval

Ethical Clearance was obtained from Adesh Institute of Medical Sciences and Research, Bathinda (Punjab), India (AIMSR/MC/Estt/10/2K18/2103). Written informed consent was obtained from all study participants before the interview. The consent form had two parts: information for the participant and the actual consent form, which the participant signed in the presence of a witness. We also took prior permission to take blood samples to estimate the thyroid profile. Confidentiality was assured to the participants during all phases of the study. Participants were also informed that enrolment in the study would not alter the treatment protocols to be followed for managing thyroid disorders (if diagnosed) during pregnancy. Also, they were assured that there was no added risk to the mother and baby because of the treatment, and they were free to withdraw from the study anytime. Interviews were conducted in a separate room adjacent to the clinic, maintaining adequate privacy.

## 3. Results

We recruited 347 pregnant women in the antenatal period, out of which 47 (13.5%) dropped out. The rest of the 300 participants were included in the final analysis, of which 51 (17%), 24 (7.3%), and 225 (75.7%) were recruited in the 1st, 2nd, and 3rd trimesters, respectively. Out of these, the overall prevalence of thyroid dysfunction was 34% (n = 102), of which 32% (n = 95) and 2.3% (n = 7) had hypo and hyperthyroidism, respectively. Of the total hypothyroid women, 6.3% (n = 19) had overt hypothyroidism, while 25.3%(n = 76) had sub-clinical hypothyroidism. All the hyperthyroid cases were overt, and no woman had subclinical hyperthyroidism in our study. The mean TSH levels in the euthyroid women, overt hypothyroid, subclinical hypothyroid, and overt hyperthyroid, were 1.88 ± 0.66, 9.06 ± 3.12, 3.99 ± 0.92, and 0.04 ± 0.02 mIU/ml, respectively (Table 1).

We compared the socio-demographic characteristics of the women with euthyroid, hypo, and hyperthyroid status. We observed that the most affected women were between 26 and 30 years of age, followed equally by the 21–25 and > 30 years age group (Table 2). But this

**Table 1**
Type of thyroid disorders and their prevalence among pregnant women.

| Type of thyroid disorder | | Frequency (Percentage) N = 300 | Mean TSH(±SD) (mIU/ml) |
|---|---|---|---|
| Eu-thyroidism | Total | 198(66.0) | 1.88 ± 0.66 |
| Hypo-thyroidism | Total | 95 (31.6) | |
| | Overt | 19(6.3) | 9.06 ± 3.12 |
| | Subclinical | 76(25.3) | 3.99 ± 0.92 |
| Hyper-thyroidism | Total | 7 (2.3) | |
| | Overt | 7 (2.3) | 0.04 ± 0.02 |
| | Subclinical | 0 | – |

**Table 2**
Distribution of the pregnant women according to their socio-demographic characteristics with or without thyroid disorders.

| | Eu-thyroidism | Hypo-thyroidism | Hyper-thyroidism | Total | Chi-square (p-value) |
|---|---|---|---|---|---|
| | N(%) | N(%) | N(%) | N(%) | |
| Total | 198(100) | 95(100) | 7(100) | 300 (100) | |
| **Age (in years)** | | | | | |
| ≤ 20 | 5(2.5) | 2(2.1) | 0 | 7(2.3) | 3.9 (0.687) |
| 21–25 | 55(27.8) | 20(21.1) | 1(14.3) | 76 (25.3) | |
| 26–30 | 92(46.5) | 45(47.4) | 5(71.4) | 142 (47.3) | |
| >30 | 46(23.2) | 28(29.5) | 1(14.3) | 75 (25) | |
| **Residence** | | | | | 2.45 (0.293) |
| Rural | 144(72.7) | 77(81.1) | 5(71.4) | 226 (75.3) | |
| Urban | 54(27.3) | 18(18.9) | 2(28.6) | 74 (24.7) | |
| **Socio economic status** | | | | | 37.92 (0.000)[a] |
| Upper middle | 41(20.7) | 7(7.4) | 0 | 48 (16) | |
| Middle | 86(43.4) | 33(34.7) | 1(14.3) | 120 (40) | |
| Lower middle | 66(33.3) | 36(37.9) | 4(57.1) | 106 (35.3) | |
| Lower | 5(2.5) | 19(20) | 2(28.6) | 26 (8.7) | |
| **Education** | | | | | 90.05 (0.000)[a] |
| Illiterate | 4(2) | 38(40) | 1(14.3) | 43 (14.3) | |
| Primary | 84(42.4) | 32(33.7) | 4(57.1) | 120 (40) | |
| Secondary | 95(48) | 13(13.7) | 1(14.3) | 109 (36.3) | |
| Tertiary | 15(7.6) | 12(12.6) | 1(14.3) | 28 (9.3) | |
| **Religion** | | | | | 2.63 (0.621) |
| Sikh | 123(62.1) | 51(53.7) | 5(71.4) | 179 (59.7) | |
| Hindu | 72(36.4) | 43(45.3) | 2(28.6) | 117 (39) | |
| Muslim | 3(1.5) | 1(1.1) | 0 | 4(1.3) | |

[a] denotes statistically significant associations.

association with age was not statistically significant on chi-square test (p-value>0.05). However, statistically, significant differences were observed for the patients' socioeconomic status and educational qualification. There was a significantly higher prevalence of hypothyroidism in the primigravida (53.7%; n = 51), while hyperthyroidism was seen exclusively in the multi-para women (100%; n = 7) (Table 3). Another important finding was a significantly higher incidence of emergency

**Table 3**
Analysis of obstetrical parameters of the pregnant women with or without thyroid disorders.

| | Eu thyroidism | Hypo thyroidism | Hyper thyroidism | Total | Chi-square (p-value) |
|---|---|---|---|---|---|
| | N(%) | N(%) | N(%) | N(%) | |
| Total | 198(100) | 95(100) | 7(100) | 300 (100) | |
| **Booking status** | | | | | 5.18 (0.075) |
| Booked | 146(73.7) | 81(85.3) | 6(85.7) | 233 (77.7) | |
| Unbooked | 52(26.3) | 14(14.7) | 1(14.3) | 67 (22.3) | |
| **Parity** | | | | | 11.7 (0.003)* |
| Primigravida | 75(37.9) | 51(53.7) | 0 | 126 (42) | |
| Multigravida | 123(62.1) | 44(46.3) | 7(100) | 174 (58) | |
| **Time of 1st estimation of thyroid levels** | | | | | 6.51 (0.368) |
| 1st trimester | 31(15.7) | 18(18.9) | 2(28.6) | 51 (17) | |
| 2nd trimester | 16(8.1) | 5(5.3) | 3(14.3) | 24(8) | |
| 3rd trimester | 151(76.3) | 72(75.8) | 2(28.6) | 225 (75) | |
| **Mode of delivery** | | | | | 102.6 (0.000) SSSSS |
| Elective LSCS | 19(9.6) | 13(13.7) | 0 | 32 (10.7) | |
| Emergency LSCS | 64(32.3) | 46(48.4) | 0 | 110 (36.7) | |
| Vaginal delivery | 105(53) | 29(30.5) | 2(28.6) | 136 (45.3) | |
| Instrumental delivery | 9(4.5) | 0 | 0 | 9(3.0) | |
| Suction and evacuation | 1(0.5) | 7(7.4) | 5(71.4) | 13 (4.3) | |
| **Gestational age at delivery** | | | | | 83.02 (0.000)[a] |
| < 28 weeks[b] | 2(1.0) | 7(7.4) | 5(71.4) | 14 (4.7) | |
| 28–$31^{+6}$ (early preterm) | 6(3) | 5(5.3) | 1(14.3) | 12(4) | |
| 32–$36^{+6}$ (late preterm) | 61(30.8) | 30(31.6) | 1(14.3) | 92 (30.7) | |
| 37–40 (term) | 128(64.6) | 53(55.8) | 0 | 181 (60.3) | |
| >40 weeks | 1(0.5) | 0 | 0 | 1(0.3) | |

[a] denotes statistically significant associations.
[b] Including women who had undergone Suction and evacuation procedure.

lower segment cesarean section (LSCS) in hypothyroid women (48.4%; n = 46) as compared to euthyroid women (32.3%; n = 64). On the other hand, most hyperthyroid women (71.4%; n = 5) ended in abortion and underwent suction and evacuation.

Table 4 compares the maternal complications amongst the hypo and hyperthyroid women with the euthyroid ones. About 52% (n = 103) of euthyroid women delivered uneventfully, compared to just 35.8% (n = 34) of hypothyroid and 14.3% (n = 1) of hyperthyroid women. Women with hypo (36.8%; n = 35) and hyperthyroidism (28.5%; n = 2) depicted a higher incidence of preterm labor compared to euthyroid women (33.8%; n = 67) (Table 4). Hypothyroid women had a higher incidence of preeclampsia (14.7%; n = 14 vs. 5.6%; n = 11), anemia (7.4%; n = 7 vs. 6.1%; n = 12), abortion (7.4%; n = 7 vs. 0.5%; n = 1), meconium-stained liquor (5.3%; n = 5 vs. 2.5%; n = 5), and other less common complications are depicted along in Table 4. On the other hand, abortions (71.4%; n = 5 vs. 0.5%; n = 1) and intrauterine death (14.3%; n =

**Table 4**
Comparison of the maternal complications among pregnant women with or without thyroid disorders.

| | Eu thyroidism | Hypo thyroidism | Hyper thyroidism | Total |
|---|---|---|---|---|
| Total | 198(100) | 95(100) | 7(100) | 300 (100) |
| No complications | 103(52) | 34(35.8) | 1(14.3) | 138 (46) |
| **Preterm labor** | 67(33.8) | 35(36.8) | 2(28.5) | 104 (34.6) |
| Preeclampsia | 11(5.6) | 14(14.7) | 0 | 25 (8.3) |
| Anemia | 12(6.1) | 7(7.4) | 0 | 19 (6.3) |
| Intrauterine death | 11(5.6) | 4(4.2) | 1(14.3) | 16 (5.3) |
| Abortion | 1(0.5) | 7(7.4) | 5(71.4) | 13 (4.3) |
| Meconium-stained liquor | 5(2.5) | 5(5.3) | 0 | 10 (3.3) |
| Intrahepatic cholestasis of Pregnancy | 7(3.5) | 3(3.2) | 0 | 10 (3.3) |
| Oligohydramnios | 7(3.5) | 1(1.1) | 0 | 8(2.7) |
| Premature rupture of membranes | 3(1.5) | 4(4.2) | 0 | 7(2.3) |
| Postpartum Fever | 5(2.5) | 1(1.1) | 0 | 6(2.0) |
| Oligohydramnios + IUGR | 3(1.5) | 2(2.1) | 0 | 5(1.7) |
| Postpartum hemorrhage | 4(2) | 1(1.1) | 0 | 5(1.7) |
| Urinary tract infection | 4(2) | 1(1.1) | 0 | 5(1.7) |
| Thrombocytopenia | 2(1) | 1(1.1) | 0 | 3(1.0) |
| Acute Hepatitis | 2(1) | 0 | 0 | 2(0.7) |
| Antepartum hemorrhage | 1(0.5) | 0 | 0 | 1(0.3) |
| Wound Infection | 1(0.5) | 0 | 0 | 1(0.3) |

1 vs. 5.6%; n = 11) were the most common complications in women with hyperthyroid disorders. There were no maternal deaths in any of the groups. No complications of thyroid storm were seen in our study. We observed a total of 13 abortions and zeroed neonatal mortality. Of the 13 abortions, most were reported in hyperthyroid (71.4%; n = 5), followed by hypo (7.4%; n = 4) and euthyroid women (0.5%; n = 1).

The proportion of low birth weight and very low birth weight neonates in women in hypothyroid group were (33%, n = 29), and (12.5%; n = 11) respectively, which was higher than the euthyroid group (27.9%; n = 55, 6.1%; n = 12). Whereas in the hyperthyroid group 5,0% (n = 1) were meager birth weight (Table 5). Similarly, infants with low APGAR scores of <7 at 5 min were significantly more in hypo (11.4%; n = 10) and hyperthyroid mothers (50%; n = 1) as compared to euthyroid women (7.6%; n = 15) (p-value<0.05). The incidence of other neonatal morbidities with their percentages is mentioned in Table 5.

**Table 5**
Analysis of perinatal outcomes and fetal complications in women with or without thyroid disorders.

| | Eu thyroidism | Hypo thyroidism | Hyper Thyroidism | Total | Chi-square (p-value) |
|---|---|---|---|---|---|
| **Total** | **198(100)** | **95(100)** | **7(100)** | **300 (100)** | |
| **Fetal Outcome** | | | | | 2.7 (0.352) |
| Live | 197(99.4) | 88(92.6) | 2(28.6) | 287 (95.7) | |
| Aborted | 1(0.5) | 7(7.4) | 5(71.4) | 13 (4.3) | |
| **Fetal complications Total** | **197(100)** | **88(100)** | **2(100)** | **287 (100)** | |
| **Birth weight** | | | | | 49.1 (0.000) |
| Very Low Birth Weight (<1.5 kg) | 12(6.1) | 11(12.5) | 1(50) | 24 (8.4) | |
| Low Birth Weight (<2.5 Kg) | 55(27.9) | 29(33) | 0 | 84 (29.3) | |
| Normal (2.5–4.0 kg) | 129(65.5) | 47(53.4) | 1(50) | 177 (61.7) | |
| Macrosomia (>4 kgs) | 1(0.5) | 1(1.1) | 0 | 2(0.7) | |
| **Apgar score (5 min)** | | | | | 38.8 (0.000) |
| <7 | 15(7.6) | 10(11.4) | 1(50) | 26 (9.1) | |
| ≥7 | 182(92.4) | 78(88.6) | 1(50) | 261 (90.9) | |
| **Neonatal morbidities** | | | | | 13.9 (0.83) |
| Nil | 118(59.9) | 51(58) | 1(50) | 170 (59.2) | |
| Neonatal jaundic | 11(5.6) | 4(4.5) | 0 | 15 (5.2) | |
| Respiratory distress syndrome | 12(6.1) | 10(11.4) | 0 | 22 (7.7) | |
| Sepsis | 7(3.6) | 4(4.5) | 0 | 11 (3.8) | |
| Birth Asphyxia | 5(2.5) | 0 | 0 | 5(1.7) | |
| Meconium aspiration syndrome | 3(1.5) | 4(4.5) | 0 | 7(2.4) | |

*denotes statistically significant associations.

## 4. Discussion

A healthy thyroid gland is instrumental in coping with the increased physiological demands during pregnancy and maintains adequate thyroid functioning. Any alteration in the maternal thyroid hormone levels consequently affects the feto-maternal outcomes. The prevalence of hypothyroidism was high (31.6%) in our study (6.3% of overt and 25.3% SCH), and the prevalence of overt hyperthyroidism was 2.3%. This is higher than the reported prevalence in other studies from India and abroad. Dhanwal et al. observed a prevalence of hypothyroidism to be around 14.3%, and the majority of those women had SCH, while Gayathri et al. reported a 2.8% prevalence of SCH.[12,13] A recent review and meta-analysis found that prevalence rates for overt hypothyroidism, subclinical hypothyroidism, and isolated hypothyroxinaemia were 0.50, 3.47, and 2.05%, respectively.[14] A study in China by Wang et al. reported a similarly high prevalence of hypothyroidism in pregnancy.[15] Besides altered physiology, high prevalence in Asian countries can be attributed to decreased iodine intake, presence of goitrogens in diet, and worsening of micronutrient deficiency such as selenium and iron deficiency during pregnancy.[2,16,17] Another reason for differences in prevalence can be using different cut-off values to label hypothyroidism.

We observed that most women with thyroid disorders were in the age group of 26–30 years. Other studies have reported higher prevalence in lower age groups. The differences may be because of demographic changes like late marriages and consequent late conceptions with increased spacing between children.[5] However, it is pertinent to know the status of pre-existing thyroid disorders and highlight the need for universal screening of thyroid disorders in the pre-pregnancy period. Urban-rural differences were higher for hypothyroidism, but this association was statistically non-significant. Most of the pregnant women with thyroid disorders were with low education levels. This might contribute to ignorance and neglect of early symptoms and inappropriate health-seeking behavior, resulting in complications during pregnancy. However, we did not observe any specific differences in the prevalence pattern based on religion. Other studies have also highlighted the influence of education, socioeconomic status, race, and faith

on diagnosing and treating thyroid disorders.[18,19] thyroid tests are not routinely done in most government health centers. They are deemed unnecessary by many families, and hence the advice to get tested for thyroid disorders is frequently ignored. This may be due to higher costs of thyroid profile in the private sector and lack of access to laboratories performing them, which seem to be more concentrated in urban areas. This reiterates the need for universal screening for thyroid disorders in the government health system.

We observed that all our hyperthyroid women (100%) were multiparous. Due to the subsequent depletion of micronutrients and other reserve elements with multiple pregnancies, most multigravida women have thyroid dysfunction, which coincides with previous studies.[1,20] Also, we observed that a higher number of hypothyroid women underwent LSCS (emergency or elective), 62.1%. Other authors have reported rates of cesarean delivery of 22.9% in women with hypothyroidism.[21,22] The rates are higher than the routine cesarean delivery rate in India, which is estimated to be around 17%.[23]

Previous studies have also observed that women with hypothyroidism have decreased odds of presenting in the spontaneous labor.[24–26] The increased risk of cesarean delivery may be due to the associated pregnancy complications, such as hypertensive disorders, gestational diabetes, and preterm birth. However, further studies are required to assess the association between thyroid disorders and the increased risk of cesarean section.

In the present study, we observed many complications in women with thyroid disorders that varied in severity and presentation, with preeclampsia being the most common in hypothyroid women, followed by anemia, abortions, meconium-stained liquor, preterm delivery, and premature rupture of membranes. At the same time, abortions were the most frequent complication in the hyperthyroid group. The results of the present study were comparable to other studies.[6,22]

In this study, LBW was observed in 42.1% of women with hypothyroidism which is higher than the national average of 16.4% as per the National Family Health Survey round 4 (2015–16). Another study from central India also reported a similarly high prevalence of LBW (31.6%) among hypothyroid women.[22] LBW is associated with hypothyroidism due to its association with preeclampsia. Reduced fetal thyroxine may disrupt the development of the pituitary-thyroid axis of the newborn, fetal pituitary growth hormone secretion, vascular responsiveness and maturation, and cardiovascular homeostasis in utero. These factors are causative for the reduced birth weight of offspring born to mothers with inadequately controlled hypothyroidism at the initial presentation or third trimester. We also observed other complications in neonates born to women with thyroid disorders like preterm birth, respiratory distress syndrome, jaundice, meconium aspiration syndrome, neonatal sepsis, and birth asphyxia, similar to previous studies from India.[17,27]

Our study did not report any neonatal mortality. The national level data from National Family Health Survey reports the neonatal mortality rate to be around 30 per 1000 live births. Previous studies report mixed opinions about neonatal mortality because it depends on factors like health system preparedness, appropriate management of newborns like aseptic surroundings, skilled neonatologists, and effective neonatal intensive care.[22,28]

The major strength of our study was the recruitment of a large number of antenatal women and following them up to delivery to make appropriate conclusions about the effect of thyroid dysfunction on feto-maternal outcomes. However, being a hospital-based study limits its generalizability to the community setup. Nevertheless, community-based studies need to be carried out on the prevalence of thyroid disorders to know the exact burden. The role of thyroid autoimmunity in hypothyroid pregnant mothers also needs to be considered, which we could not evaluate in our study. Since the women were enrolled after becoming pregnant, we could not establish the temporal trends in causality. Also, we cannot comment on the future status of thyroid disease in the postnatal period. Prospective cohort studies with adequate follow-up can answer these research questions.

Based on our results, we recommend universal screening for thyroid disorders in all the women, ideally in the pre-pregnancy period or at their first antenatal visit. Furthermore, we reinforce the need to include thyroid function tests as an essential laboratory investigation at all health system levels. Timely diagnosis of overt and subclinical thyroid disorders will minimize maternal and fetal complications. This will help to limit morbidity, mortality, and burden on the family in terms of out-of-pocket expenditure and the health system because of intensive care admissions.

## 5. Conclusions

We observed a high prevalence of thyroid disorders in our study. The presence of maternal thyroid disorders significantly impacts the maternal and fetal outcomes if adequate treatment is not initiated in the early gestational period. Therefore, serum TSH should be included in the battery of routine investigations for early diagnosis and management of thyroid disorders. This will immensely help us in our commitment to realizing our target of reducing maternal and neonatal morbidity and mortality, in track with the third Sustainable Development Goal-3.

## Ethics approval and consent to participate

The Institutional Ethics Committee approved the study of Adesh Institute of Medical Sciences and Research, Bathinda (Punjab), India (AIMSR/MC/Estt/10/2K18/2103). The duly signed consent forms were taken from the respondents with an option to withdraw from the study at any point in time.

## Consent for publication

Not applicable.

## Availability of data and materials

The data used in the article is available from the corresponding author on reasonable request to protect the anonymity of the participants.

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## Authors' contributions

**RK, RB, and PG** were equally involved in designing the study and manuscript writing results analysis, review, approval, and submission of the final manuscript.

**HKS and PG r**eviewed the final version of the paper and approved it for publication.

All authors have read and approved the manuscript

## Declaration of competing interest

None Declared.

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Not applicable.

## List of abbreviations

| | |
|---|---|
| SCH | subclinical hypothyroidism |
| OPD | Outpatient department |
| TSH | thyroid-stimulating hormone |
| TBG | thyroxine-binding globulin |

| | |
|---|---|
| IUGR | intrauterine growth restriction |
| BOH | bad obstetric history |
| HTN | hypertension |
| DM | diabetes mellitus |
| IUD | intrauterine death |
| PROM | premature rupture of membranes |
| SPSS | Statistical package for social sciences |
| NICU | neonatal intensive care unit |
| LSCS | lower segment cesarean section |

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