Research Article

Thyroid Autoimmune Disorders Among Reproductive-Age Women In An Iodine-Sufficient Region Of North-East India

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Abstract

Background: Autoimmune thyroid disorders are common among women and may adversely affect health during the reproductive years. Although iodine deficiency remains an important cause of thyroid dysfunction, thyroid autoimmunity can persist in populations with adequate iodine intake. Thyroid peroxidase (anti-TPO) and thyroglobulin (anti-Tg) antibodies are established biomarkers of autoimmune thyroid disease. North-East India has historically experienced endemic goitre, and persistent thyroid dysfunction following universal salt iodization may partly reflect underlying thyroid autoimmunity.

Objective: To estimate the prevalence of thyroid autoantibody positivity and examine its association with thyroid biochemical function among women of reproductive age in an iodine-sufficient region of North-East India.

Methods: A community-based cross-sectional study was conducted among women of reproductive age in Imphal East district, Manipur. The analysis included 242 women with available measurements of thyroid-stimulating hormone (TSH), free thyroxine (FT4), free triiodothyronine (FT3), anti-TPO and anti-Tg antibodies. Participants were categorized according to antibody status. Continuous variables were summarized using mean ± standard deviation or median with interquartile range, as appropriate. Associations between antibody status and thyroid function were assessed using the Mann–Whitney U and chi-square tests. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated, with $p<0.05$ considered statistically significant.

Results: Among the 242 participants, 110 (45.5%) were anti-TPO positive and 102 (42.1%) were anti-Tg positive. Overall, 119 women (49.2%; 95% CI: 42.7–55.7%) had at least one positive thyroid autoantibody, while 93 (38.4%) were positive for both antibodies. The median concentrations of TSH, FT4 and FT3 were 1.83, 1.36 and 2.46, respectively. Women with at least one positive antibody had significantly higher median TSH than antibody-negative women (3.11 vs. 1.56; $p=0.0046$). At an exploratory TSH threshold of >4.0, elevated TSH was observed in 42.9% of antibody-positive women compared with 14.6% of antibody-negative women (OR=4.38; 95% CI: 2.36–8.12; $p<0.001$).

Conclusion: Thyroid autoantibody positivity was highly prevalent, affecting approximately half of the women studied. Antibody-positive women had significantly higher TSH levels and a markedly greater likelihood of elevated TSH, indicating a potential role of thyroid autoimmunity in thyroid dysfunction despite adequate iodine nutrition. Further large-scale community studies incorporating urinary iodine assessment, dietary factors, thyroid ultrasonography and reproductive characteristics are needed to identify determinants and establish the clinical significance of this substantial burden of thyroid autoimmunity.

Keywords: Thyroid autoimmunity, anti-TPO, anti-thyroglobulin, TSH, women of reproductive age.

Introduction

Thyroid disorders are among the most prevalent endocrine conditions affecting women, with particular relevance during the reproductive years because thyroid hormones influence menstrual function, ovulation, fertility, conception, pregnancy and fetal development. Autoimmune thyroid diseases, especially Hashimoto thyroiditis and Graves' disease, occur predominantly in women and may adversely affect reproductive and maternal–fetal health. Vanderpump (2011) emphasized the substantial burden of thyroid disease among women and its important public-health implications, while Ragusa et al. (2019) identified Hashimoto thyroiditis as a major autoimmune cause of thyroid dysfunction, particularly hypothyroidism, in iodine-sufficient populations. Thyroid autoimmunity is commonly assessed using antibodies against thyroid peroxidase (anti-TPO) and thyroglobulin (anti-Tg), with anti-TPO considered a particularly useful marker of autoimmune thyroid disease. Caturegli et al. (2014) noted that thyroid autoantibodies may provide important diagnostic evidence of Hashimoto thyroiditis and can be detectable before overt thyroid dysfunction becomes clinically apparent. Historically, iodine deficiency has been a major determinant of goitre and thyroid dysfunction in India and other regions worldwide. Although universal salt iodization has substantially improved iodine nutrition, thyroid disorders may persist even after iodine deficiency has been corrected.

Zimmermann and Boelaert (2015) highlighted the complex relationship between iodine nutrition and thyroid disorders, noting that both iodine deficiency and excessive or changing iodine exposure can influence thyroid health. Similarly, Jaiswal et al. (2014) reported a high prevalence of maternal hypothyroidism among Indian pregnant women despite adequate iodine status, indicating that factors beyond iodine deficiency may contribute to thyroid dysfunction.

North-East India represents an important epidemiological setting for investigating this issue because endemic goitre and thyroid dysfunction have historically been reported in the region despite improvements in iodine nutrition. In a community-based study in Manipur, Singh et al. (2021) reported a median urinary iodine concentration of 166 µg/L and adequate household salt iodization, yet goitre persisted among women and children; notably, thyroid autoantibodies were detected in 41.62% of individuals with grade-2 goitre. These findings suggest that persistent thyroid abnormalities in iodine-sufficient communities may involve autoimmune mechanisms and other environmental or dietary factors. WHO (2013) recommends urinary iodine concentration as a key population-level indicator of iodine nutrition, with a median concentration of 100–199 µg/L indicating adequate iodine status among school-age populations and 150–249 µg/L considered adequate during pregnancy. The coexistence of adequate iodine nutrition and thyroid autoimmunity therefore warrants closer investigation, particularly among women of reproductive age who may be especially vulnerable to the reproductive consequences of thyroid dysfunction. Against this background, the present study examines thyroid autoimmunity among women of reproductive age in an iodine-sufficient setting of North-East India, with particular emphasis on the prevalence of anti-TPO and anti-Tg antibodies and their association with biochemical thyroid function. The findings are expected to contribute to a better understanding of the role of autoimmune mechanisms in persistent thyroid dysfunction in a population where iodine deficiency may no longer be the predominant explanatory factor.

Literature Review

The previous findings indicate that thyroid disorders constitute an important health concern among women, particularly during the reproductive years. Vanderpump (2011) highlighted the considerable epidemiological burden of thyroid disease and its disproportionate occurrence among women. More specifically, Ragusa et al. (2019) described Hashimoto thyroiditis as one of the most important autoimmune causes of hypothyroidism, with genetic susceptibility, environmental exposures and immune dysregulation contributing to its development. Caturegli et al. (2014) emphasized that anti-thyroid peroxidase (anti-TPO) and anti-thyroglobulin (anti-Tg) antibodies are valuable indicators of thyroid autoimmunity and may be detectable before clinically overt thyroid dysfunction. The reproductive implications of autoimmune thyroid disease have also received increasing attention. Carafone et al. (2024) reported a complex association between autoimmune thyroid disease and female fertility, noting that thyroid dysfunction and autoimmunity may influence menstrual regularity, ovulation, conception and pregnancy outcomes. The relationship between iodine nutrition and thyroid disease is similarly complex. Zimmermann (2009) and Zimmermann and Andersson (2012) demonstrated substantial global improvements in iodine nutrition following salt iodization, while Pearce et al. (2013) emphasized the continuing need to monitor iodine status because both deficiency and excessive iodine exposure may affect thyroid function. Zimmermann and Boelaert (2015) further noted that autoimmune thyroid disorders may remain important causes of thyroid dysfunction even in iodine-sufficient populations. Evidence from India supports this observation. Jaiswal et al. (2014) reported a high prevalence of hypothyroidism among Indian pregnant women despite adequate iodine status, suggesting that iodine deficiency alone cannot explain the continuing burden of thyroid dysfunction. These findings collectively indicate that thyroid autoimmunity deserves particular attention in women of reproductive age living in populations where iodine deficiency has been substantially controlled.

Evidence from North-East India provides additional support for investigating thyroid autoimmunity in iodine-sufficient settings. The region has historically been characterized by endemic goitre and thyroid disorders, and the persistence of these conditions despite improved iodine nutrition suggests the involvement of additional environmental, dietary and immunological factors. Singh et al. (2021), in a community-based study in rural Manipur, reported adequate iodine nutrition, with a median urinary iodine concentration of 166 µg/L and adequately iodized household salt, yet goitre continued to occur among women and children. Importantly, thyroid autoantibodies were detected in 41.62% of individuals with grade-2 goitre, indicating a possible contribution of autoimmune mechanisms to persistent thyroid disease. WHO (2013) recommends urinary iodine concentration as a principal indicator of population iodine status, while WHO/UNICEF/ICCIDD (2007) emphasizes continued monitoring of iodine nutrition even after successful implementation of salt iodization programmes. Selenium and other nutritional factors may also influence autoimmune thyroid disease; Kong et al. (2023) and Huwiler et al. (2024) reported evidence suggesting potential effects of selenium supplementation on thyroid autoimmunity and biochemical parameters in patients with Hashimoto thyroiditis, although the clinical benefits remain incompletely established. Despite these advances, relatively limited community-based evidence is available on the combined prevalence of anti-TPO and anti-Tg antibodies and their relationship with biochemical thyroid function among women of reproductive age in North-East India. The present study

therefore addresses an important regional research gap by examining thyroid autoantibody positivity and its association with TSH, FT4 and FT3 among women in an iodine-sufficient setting of Manipur. Such evidence may help clarify whether persistent thyroid dysfunction in the region is associated predominantly with autoimmune mechanisms rather than continuing iodine deficiency.

Objectives

The present study aimed to determine the prevalence of thyroid autoantibody positivity among women of reproductive age residing in an iodine-sufficient region of North-East India. Specifically, the study sought to estimate the prevalence of anti-thyroid peroxidase (anti-TPO) and anti-thyroglobulin (anti-Tg) antibody positivity, determine the proportion of women positive for both antibodies, and describe the distribution of thyroid-stimulating hormone (TSH), free thyroxine (FT4), and free triiodothyronine (FT3) concentrations. It further aimed to compare thyroid function parameters between antibody-positive and antibody-negative women and assess the association between thyroid autoantibody positivity and elevated or abnormal TSH concentrations.

Materials and Methods

Study Design and Setting: A community-based cross-sectional study was conducted among women of reproductive age residing in Imphal East district of Manipur, North-East India, an area with adequate iodine nutrition.

Study Population: The study population comprised eligible women of reproductive age enrolled according to the original study protocol. For the present analysis, 242 participants with complete biochemical data on thyroid-stimulating hormone (TSH), free thyroxine (FT4), free triiodothyronine (FT3), anti-thyroid peroxidase (anti-TPO), and anti-thyroglobulin (anti-Tg) antibodies were included.

Eligibility Criteria: Women belonging to the defined study population who provided informed consent and had complete thyroid biochemical and antibody measurements were eligible. Participants with incomplete or unavailable thyroid function or antibody results were excluded from the present analysis.

Data Collection and Laboratory Assessment: Community-based data were obtained from eligible participants in Imphal East district. Serum thyroid function was assessed by measuring TSH, FT4 and FT3, while thyroid autoimmunity was evaluated using anti-TPO and anti-Tg antibody measurements. Antibody status was classified according to the laboratory-recorded results. Participants were considered thyroid-autoantibody positive if either anti-TPO or anti-Tg was positive.

Assessment of Iodine Sufficiency: Iodine sufficiency was assessed using available community-level information on urinary iodine concentration and/or household salt iodine content, consistent with WHO recommendations for population iodine assessment.

Definition of Thyroid Autoimmunity: Anti-TPO positivity and anti-Tg positivity were defined according to laboratory-recorded positive results; positivity for either antibody indicated overall thyroid autoantibody seropositivity, whereas positivity for both indicated dual-antibody positivity. Antibody positivity was interpreted as evidence of thyroid autoimmunity rather than a definitive diagnosis of Hashimoto thyroiditis in the absence of clinical, ultrasonographic or cytological confirmation.

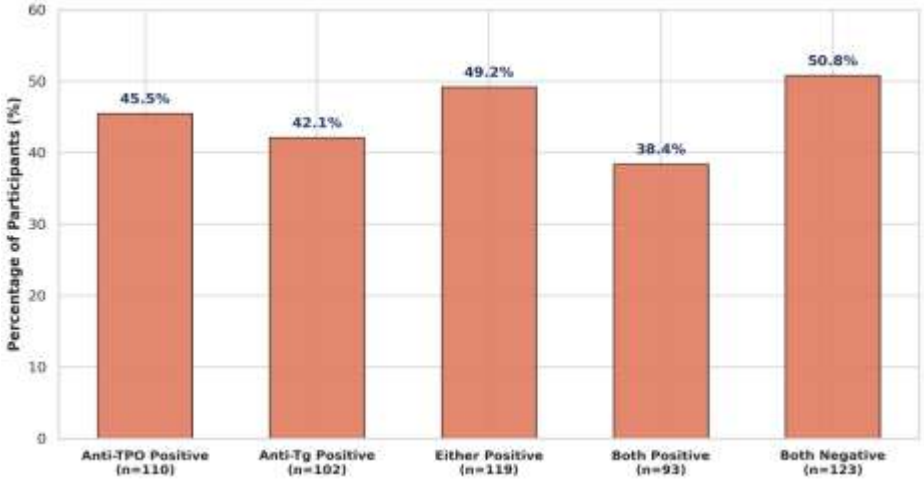
Analysis and Results

The analysis included 242 women of reproductive age with complete thyroid-function and thyroid-autoantibody measurements. Table 1 shows that thyroid autoantibody positivity was relatively high in the study population. Anti-TPO antibodies were positive in 110 women (45.5%), while anti-Tg antibodies were positive in 102 women (42.1%). Overall, 119 participants (49.2%) were positive for either anti-TPO or anti-Tg, whereas 123 (50.8%) were negative for both antibodies. Importantly, 93 women (38.4%) were positive for both anti-TPO and anti-Tg antibodies, indicating that a considerable proportion of antibody-positive participants had dual autoantibody positivity. The distribution presented in Figure 1 similarly demonstrates that almost one-half of the participants had evidence of thyroid autoimmunity. These findings indicate a substantial burden of thyroid autoantibody positivity among women in the study population, despite the setting being characterized by adequate iodine nutrition.

Table 1: Thyroid autoantibody status among study participants

Antibody status	Cases (n)	n (in %)
Anti-TPO positive	110	45.5
Anti-TPO negative	132	54.5
Anti-Tg positive	102	42.1
Anti-Tg negative	140	57.9
Either anti-TPO or anti-Tg positive	119	49.2
Both anti-TPO and anti-Tg positive	93	38.4
Both antibodies negative	123	50.8

Figure 1: Combine Thyroid Autoantibody Status Among Study Participants (N=242)

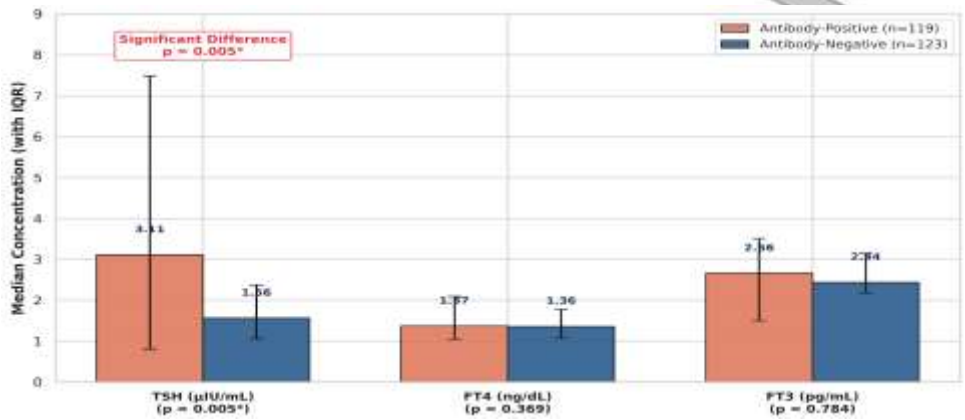


The comparison of biochemical thyroid-function parameters by autoantibody status is presented in Table 2 and illustrated in Figure 2. The median TSH concentration for the overall study population was 1.83 (IQR: 0.99–4.76), but it was considerably higher among antibody-positive women [3.11 (0.81–7.49)] than among antibody-negative women [1.56 (1.06–2.37)]. This difference was statistically significant (p=0.005), indicating a significant association between thyroid autoantibody positivity and higher TSH concentrations. In contrast, FT4 levels were highly comparable between antibody-positive [1.37 (1.05–2.09)] and antibody-negative [1.36 (1.07–1.78)] participants, with no statistically significant difference (p=0.369). Similarly, FT3 was slightly higher among antibody-positive women [2.66 (1.50–3.51)] than antibody-negative women [2.44 (2.18–3.15)], but the difference was not statistically significant (p=0.784). Thus, among the three biochemical indicators, TSH showed the clearest differentiation according to antibody status, whereas FT4 and FT3 remained broadly similar between the two groups.

Table 2: Thyroid function profile according to thyroid autoantibody status among study participants (N=242)

Thyroid function parameter	Overall population (N=242), Median (IQR)	Antibody-positive (n=119), Median (IQR)	Antibody-negative (n=123), Median (IQR)	P-value
TSH	1.83 (0.99-4.76)	3.11 (0.81-7.49)	1.56 (1.06-2.37)	0.005
FT4	1.36 (1.05-1.82)	1.37 (1.05-2.09)	1.36 (1.07-1.78)	0.369
FT3	2.46 (2.06-3.22)	2.66 (1.50-3.51)	2.44 (2.18-3.15)	0.784

Figure 2: Thyroid Function Profile According to Autoantibody Status (N=242)

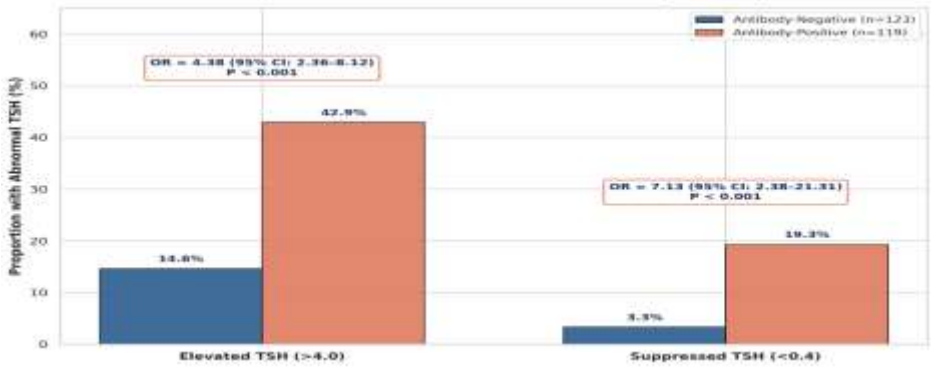


The association between thyroid autoantibody positivity and abnormal TSH concentrations is further demonstrated in Table 3 and Figure 3. Elevated TSH (>4.0) was observed in 51 (42.9%) of the 119 antibody-positive women, compared with only 18 (14.6%) of the 123 antibody-negative women. Consequently, antibody-positive women had significantly higher odds of having TSH >4.0, with an odds ratio (OR) of 4.38 (95% CI: 2.36–8.12; p<0.001). A similar and stronger pattern was observed for suppressed TSH (<0.4): 23 (19.3%) antibody-positive women had TSH below 0.4 compared with only 4 (3.3%) antibody-negative women. The corresponding odds ratio was 7.13 (95% CI: 2.38–21.31; p<0.001). Figure 3 graphically highlights both the higher prevalence of abnormal TSH and the markedly increased odds among antibody-positive participants. Taken together, Tables 1–3 and Figures 1–3 demonstrate that thyroid autoantibody positivity was common and was strongly associated with biochemical TSH abnormalities, although FT4 and FT3 did not differ significantly according to antibody status.

Table 3: Association between thyroid autoantibody positivity and abnormal TSH levels among study participants (N=242)

TSH Status	Category	Antibody -ve, n (%)	Antibody +ve, n (%)	Total n (%)	OR (95% CI)
TSH>4.0	No	105 (85.4)	68 (57.1)	173 (71.5)	Reference
	Yes	18 (14.6)	51 (42.9)	69 (28.5)	4.38 (2.36-8.12); P<0.001
TSH<0.4	No	119 (96.7)	96 (80.7)	215 (88.8)	Reference
	Yes	4 (3.3)	23 (19.3)	27 (11.2)	7.13 (2.38-21.31); P<0.001

Figure 3: Prevalence and Risk of TSH Abnormilities by Antibody Status



Discussion

The findings of the present study indicate that thyroid autoimmunity represents an important health concern among women of reproductive age in an iodine-sufficient setting of North-East India. Nearly half of the participants (49.2%) were positive for either anti-TPO or anti-Tg antibodies, while 38.4% were positive for both antibodies. This relatively high prevalence is noteworthy because the study population resides in a setting where iodine nutrition is considered adequate, suggesting that

iodine deficiency alone is unlikely to explain the observed burden of thyroid autoimmunity. The finding is consistent with the view of Zimmermann and Boelaert (2015) that autoimmune thyroid disorders can remain important causes of thyroid dysfunction even in iodine-sufficient populations. Similarly, Jaiswal et al. (2014) reported a substantial burden of hypothyroidism among Indian women despite adequate iodine status, reinforcing the possibility that factors other than iodine deficiency contribute to thyroid abnormalities. The present findings are also particularly relevant to the North-East Indian context. Singh et al. (2021) reported adequate iodine nutrition in rural Manipur, with a median urinary iodine concentration of 166 µg/L and adequately iodized household salt, but thyroid autoantibodies were detected in 41.62% of individuals with grade-2 goitre. The comparatively high antibody positivity observed in the present study therefore strengthens the possibility that autoimmune mechanisms contribute to the persistence of thyroid disorders in the region. From the authors' perspective, the substantial occurrence of both anti-TPO and anti-Tg antibodies suggests that thyroid autoimmunity should not be regarded as a marginal phenomenon in this population. However, antibody positivity should be interpreted as evidence of thyroid autoimmunity rather than definitive Hashimoto thyroiditis, because clinical, ultrasonographic and cytological confirmation was not available. The findings are nevertheless biologically plausible in view of Ragusa et al. (2019), who emphasized the roles of genetic susceptibility, environmental exposures and immune dysregulation in autoimmune thyroid disease, and Caturegli et al. (2014), who noted that thyroid antibodies may become detectable before clinically overt thyroid dysfunction.

A particularly important observation was the significantly higher TSH concentration among antibody-positive women compared with antibody-negative women, whereas FT4 and FT3 did not differ significantly between the groups. This pattern suggests that thyroid autoimmunity may be associated with altered thyroid regulatory function before substantial changes in circulating thyroid hormones become evident. The association was further strengthened by the markedly higher prevalence of abnormal TSH among antibody-positive women: elevated TSH (>4.0) occurred in 42.9% compared with 14.6% among antibody-negative women, corresponding to 4.38-fold higher odds, while suppressed TSH (<0.4) occurred in 19.3% versus 3.3%, with 7.13-fold higher odds. In the authors' view, these findings provide stronger evidence of a relationship between thyroid autoimmunity and biochemical thyroid dysfunction than antibody prevalence alone. The simultaneous association with both elevated and suppressed TSH should, however, be interpreted cautiously because the cross-sectional design does not establish temporal or causal relationships. The findings are consistent with Caturegli et al. (2014), who emphasized that thyroid autoantibodies may precede clinically apparent thyroid dysfunction, and with Carafone et al. (2024), who highlighted the potential reproductive implications of thyroid autoimmunity and thyroid dysfunction, including effects on menstrual function, ovulation, conception and pregnancy outcomes. Given that the participants were women of reproductive age, the observed association has potential clinical and public-health relevance. The authors therefore consider that screening based solely on overt thyroid dysfunction may overlook women with underlying autoimmune activity and abnormal TSH. At the same time, the results should not be interpreted as evidence that autoimmunity is the sole cause of thyroid abnormalities, since environmental, nutritional and genetic factors may also contribute. Kong et al. (2023) and Huwiler et al. (2024) have suggested that nutritional factors such as selenium may influence thyroid autoimmunity and biochemical parameters, although their clinical benefits remain uncertain. Overall, the present findings support greater attention to thyroid autoantibody assessment and thyroid-function monitoring among women of reproductive age in iodine-sufficient populations, particularly in North-East India, while prospective studies are needed to determine whether antibody-positive women subsequently develop persistent thyroid dysfunction and adverse reproductive outcomes.

Conclusion and Implications

The present study demonstrates a substantial burden of thyroid autoimmunity among women of reproductive age in an iodine-sufficient setting of North-East India. Nearly half of the participants (49.2%) were positive for either anti-TPO or anti-Tg antibodies, and 38.4% were positive for both antibodies, indicating that thyroid autoimmunity is an important health concern even where iodine nutrition is considered adequate. Autoantibody-positive women had significantly higher median TSH concentrations than antibody-negative women, while FT4 and FT3 did not differ significantly between the two groups. Furthermore, antibody-positive women had markedly greater odds of both elevated TSH (>4.0) and suppressed TSH (<0.4), demonstrating a strong association between thyroid autoimmunity and biochemical thyroid abnormalities. These findings suggest that the persistence of thyroid dysfunction in the study population cannot be attributed solely to iodine deficiency and that autoimmune mechanisms may have an important role. However, because the study was cross-sectional, the observed associations cannot establish causality or determine whether antibody positivity precedes thyroid dysfunction. Moreover, antibody positivity should be regarded as evidence of thyroid autoimmunity rather than a definitive diagnosis of Hashimoto thyroiditis in the absence of clinical, ultrasonographic or cytological confirmation.

The present findings have important clinical, public-health and research implications. Thyroid health programmes in iodine-sufficient regions should not focus exclusively on iodine deficiency but should also recognize thyroid autoimmunity as a

potential contributor to thyroid dysfunction. Particular attention may be warranted for women of reproductive age because abnormalities of thyroid function and autoimmunity may affect menstruation, ovulation, fertility, conception and pregnancy outcomes. Integrating appropriate thyroid-function assessment, particularly TSH measurement, into reproductive and maternal healthcare may facilitate earlier identification and management of women at increased risk. Where clinically appropriate, assessment of anti-TPO and anti-Tg antibodies may provide additional information for women with abnormal TSH or other indications of thyroid dysfunction. At the population level, continued monitoring of iodine nutrition remains important, while investigation of other potential determinants—including genetic, environmental and nutritional factors—should be strengthened. The present findings also highlight the need for greater community-based surveillance of thyroid autoimmunity in North-East India, where thyroid disorders have historically persisted despite improvements in iodine nutrition. Future research should employ larger, representative and longitudinal samples to establish temporal relationships between antibody positivity and thyroid dysfunction and to examine their implications for reproductive and pregnancy outcomes. Further studies incorporating clinical examination, thyroid ultrasonography and relevant nutritional and environmental factors would also help clarify the underlying mechanisms. Overall, the study supports a broader approach to thyroid health in iodine-sufficient populations in which iodine sufficiency should not be equated with freedom from thyroid disease or thyroid autoimmunity.

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