Research Square

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Are Pregnant Women Iodine Sufficient in Sri Lanka? An Assessment Using Urinary Iodine Concentration

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Abstract

Background: Adequate maternal iodine intake is essential for optimal foetal brain development, and even mild deficiency can impair cognitive outcomes. Sri Lanka introduced Universal Salt Iodisation (USI) in 1995, yet emerging evidence indicates possible gaps in iodine ststus among pregnant women. This study aimed to assess urinary iodine concentration (UIC) among first-trimester pregnant women to evaluate iodine sufficiency.

Methods: Across-sectional study was conducted in three selected districts representing different geographic and demographic settings. Antenatal clinics were sampled using a stratified approach to capture sectoral variation. Spot urine samples were collected from 337 first-trimester pregnant women during routine clinic visits. Median urinary iodine concentration (mUIC) was used as the primary indicator of iodine status, following WHO criteria.

Result: The overall mUIC was 135.9 µg/L, below the WHO-recommended range of 150–249 µg/L for pregnancy. District level variation was notable, with the highest mUIC in Colombo and the lowest in Kandy (168.1 vs 106.4 µg/L; $p<0.01$). Urban-rural differences were not statistically significant ($p>0.05$). More than half of participants (52.8%) were iodine deficient (mUIC <150µg/L), while only 22.6% were within the adequate range. Conversely, 20.8% exhibited UIC levels “above requirements” and 3.9% had “excessive” levels (≥500 µg/L), with both categories higher in Colombo (26.0% and 8.0% respectively).

Conclusion; Nearly three decades after the implementation of USI, iodine insufficiency persists among pregnant women in Sri Lanka, with wide district disparities and emerging pockets of excess intake. These findings highlight the need for strengthened monitoring of iodine nutrition during pregnancy and periodic evaluation of the salt iodisation programme to prevent mild iodine deficiency during pregnancy to ensure optimal foetal development.

Introduction

Iodine is an essential micronutrient required for thyroid hormones synthesis, which is critical for metabolic regulation and normal foetal brain development. During pregnancy, iodine requirements increase substantially to support maternal thyroid hormone production, placental transfer, and foetal neurodevelopment. Even mild moderate iodine deficiency has been linked to miscarriage, stillbirth, congenital anomalies, and measurable cognitive impairment in offspring (1–6).

Although Universal Salt Iodisation (USI) has significantly reduced iodine deficiency disorders (IDDs) worldwide (7–9), pregnant women remain at increased risk. Variations in soil iodine content, environmental leaching, and dietary patterns influence iodine availability, In Sri Lanka, despite natural iodine sources in some regions, high rainfall and soil erosion- particularly in coastal and wet zones- contribute to geographic variability in iodine intake. Iodised salt is the primary dietary source, yet iodine content can fluctuate depending on salt quality, storage practices, and household consumption behaviours (10–14).

International evidence highlights this vulnerability. The Avon Longitudinal Study of Parents and Children (ALSPAC) in the United Kingdom reported iodine insufficiency among pregnant women, with levels below the WHO-recommended adequate range, and mild deficiency associated with lower verbal IQ and reduced reading comprehension in their children (15, 16). Comparable findings have been reported in Italy, Kuwait, Thailand, and Armenia (17–19).

Historically, iodine deficiency was a major public health concern in Sri Lanka, particularly in the wet zones where endemic goitre was prevalent. The national USI program launched in 1995 resulted in marked reduction in goitre and improved iodine status among school-aged children (20). By 2005, Sri Lanka was classified as iodine sufficient at the population level, and iodisation standards were adjusted to prevent excess intake (21,22).

However, pregnancy-specific data reveal persistent gaps. The 2012-2013 national survey reported a mUIC of 113.7 µg/L among pregnant women, with more than 60% below the recommended sufficiency threshold and declining values with advancing gestation (23). A subsequent survey in 2015 showed only modest improvement, with nearly half of pregnant women remaining iodine insufficient (21,24).

These findings indicate a disparity between population-level iodine sufficiency and maternal iodine adequacy. Given the heightened physiological demand in pregnancy and the consequences for foetal neurodevelopment, updated evidence is essential. This study therefore aimed to assess urinary iodine concentration as an indicator of iodine status among pregnant women attending antenatal clinics in Sri Lanka.

Materials and Methods

A cross-sectional study was conducted among pregnant women attending antenatal clinics (ANCs) in Sri Lanka. Three districts were purposively selected to represent distinct ecological zones and provincial diversity: Colombo (wet zone, Western Province), Kandy (intermediate zone/hill country, Central Province), and Anuradhapura (dry zone, North Central Province).

The calculated sample size was 390, based on a 95% confidence interval, 5% margin of error, and an assumed 50% prevalence of iodine sufficiency. Within each district, ANCs were randomly selected, and participants were recruited from clinic registers after obtaining the informed consent from each individual. An equal number of urban and rural participants were targeted, with 65 pregnant women from each setting per district.

Spot urine samples were obtained from consenting first-trimester pregnant women using sterile, leak-proof containers. Samples were collected by trained clinic staff as a routine clinic procedure, transported to the International Institute of Health Sciences (IIHS) laboratory in cool boxes at 4 ^{0}C, and stored at -20 ^{0}C until analysis.

Urinary iodine concentration (UIC) was determined using the ammonium persulphate-modified microplate method. Quality Control (QC) procedures included both internal and external validation. Internal QC was maintained using urine samples with known iodine concentrations analysed alongside study samples. External QC was ensured through participation in the US Centres for Disease Control and Prevention (CDC), Atlanta, ensuring the Quality of Urinary Iodine Procedures (EQUIP) programme.

Of the 390 samples collected, 337 (86.4%) met QC requirements and were included in the final analysis. Statistical analysis were performed using IBM SPSS ver.26 and Microsoft EXCEL. UIC values were categorized according to World Health Organisation (WHO) criteria for pregnant women: <150 µg/L (insufficient), 150–249 µg/L (adequate); 250–499 µg/L (above requirements); ≥500 µg/L (excessive). Differences in UIC between districts were assessed using the Kruskal–Wallis test, with statistically significance set at $p < 0.05$.

Results

The overall mUIC of the study population was 135.9 µg/L (range: 10.2 -1148.6 µg/L), indicating insufficient iodine status among pregnant women (Table 01). Figure 01 illustrates, the distribution of UIC values, which was positively skewed (skewness = 2.60), reflecting a substantial proportion of participants with low iodine levels.

Table 01
– Demographic data distribution among the pregnant women.

Variable	**Total (n = 337)**	**Dry Zone (n = 118)**	**Intermediate Zone (n = 119)**	**Wet Zone (n = 100)**
Age (years) Mean ± SD	29.06 ± 5.04	28.69 ± 4.64	28.92 ± 5.31	29.71 ± 5.14
Urinary Iodine (µg/L) Median (IQR)	135.9 (74.4-243.8)	131.9 (76.0-226.5)	106.4 (63.4-224.6)	168.1 (82.0-287.3)

Only 22.6% of the total sample achieved the WHO-defined adequate iodine range (150–249 µg/L), while 52.8% were iodine sufficient (150 µg/L). Post-hoc pairwise comparisons with Bonferroni correction indicated that Colombo had significantly higher UIC values than Kandy ($p = 0.003$). Differences between Colombo and Anuradhapura ($p = 0.075$) and between Kandy and Anuradhapura ($p = 0.842$) were not statistically significant after adjustment.

In contrast to the high proportion of deficiency, 20.8% of women had UIC in the “above requirement” range (250–449 µg/L), and 3.9% had “excessive” iodine levels (≥ 500 µg/L). Colombo recorded the highest prevalence in both categories, with 26.0% above requirements and 8.0% excessive.

Overall, the findings highlight marked regional disparities in iodine intake, with the greatest gap observed between Colombo and Kandy, and demonstrate a coexistence of insufficient and excessive iodine levels among pregnant women (Fig. 02).

Figure 2 *illustrates iodine status across the three ecological zones represented by the selected districts. The district from the wet zone (Colombo) demonstrated overall iodine sufficiency, while both the dry zone (Anuradhapura) and the hill country/intermediate zone (Kandy) exhibited insufficient iodine levels. Among the three, the hill zone (Kandy) showed the lowest median urinary iodine concentration, indicating the most severe iodine deficiency within the study population.*

Discussion

This study provides an updated assessment of iodine status among first-trimester pregnant women in three sentinel districts of Sri Lanka-Colombo, Kandy, and Anuradhapura. The findings highlight important geographic and sectoral disparities and underscore ongoing vulnerability to iodine insufficiency during pregnancy despite longstanding national iodisation efforts.

The overall mUIc of 135.9 µg/L falls below the WHO-recommended range of 150–249 µg/L for pregnant women (11), indicating mild iodine deficiency in the study population. A considerable proportion of pregnant women had suboptimal iodine levels, including a small subset with moderate to severe deficiency. These results are consistent with national surveys conducted between 2012 and 2016, which documented persistent maternal iodine insufficiency despite population-level; improvements following the USI programme.

District-level analysis revealed notable variations. Colombo recorded the highest mUIC (168.1 µg/L), while Kandy demonstrated the lowest (106.4 µg/L), a difference remained statistically significant after post-hoc testing. Urban-rural disparities were also evident, with urban women showed higher iodine levels. These variations likely reflect differences in food intake. The pattern observed in Anuradapura district- where rural women had higher UIC than their urban counterparts-warrants further exploration of district-specific dietary habits and salt procurement practices (14, 23).

Although iodised salt is the primary source of dietary iodine in Sri Lanka, this study did not explore the relationship between the iodine content of household salt and urinary iodine concentration. However, improper iodisation, iodine losses during storage and cooking, varying consumption of processed foods, and use of prenatal supplements may all contribute to the observed heterogeneity (26). Notably, 20.8% of women exhibited UIC values above requirements and 3.9% had excessive levels, most prominently in urban Colombo. Excess iodine intake, though less common, carries potential risks such as thyroid autoimmunity and warrants continued monitoring (1).

The sentinel site surveillance approach was instrumental in detecting localised disparities that may be obscured in national averages. The findings reaffirm that population iodine sufficiency does not guarantee adequacy in physiologically vulnerable groups such as pregnant women, who have increased

requirements driven by maternal thyroid hormone production, renal iodine clearance, and foetal needs (27).

The limitations of this study are spot urine samples were used to assess iodine intake, although it is recommended for population-based assessment, it is subject to day-to-day variability. Additionally, the absence of detailed data on dietary intake, supplement use, and contributory factors on thyroid functions. Despite these limitations, the use of standardised laboratory methods and participation in external quality assurance strengthens confidence in the results.

Conclusion

While Sri Lanka's USI programme has substantially reduced iodine deficiency at the population level, gaps remain among pregnant women, particularly in certain districts. Strengthening routine monitoring, ensuring availability of adequately iodise salts at household level, improving regulatory enforcement, and promoting appropriate prenatal iodine supplementation are essential steps to safe guard maternal thyroid health to optimise foetal neurodevelopment. Continued targeted interventions will be critical to sustaining Sri Lanka's progress toward eliminating iodine deficiency disorders.

Declarations

Acknowledgement

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Ethical Consideration

Conflict of interest

The authors declare that they have no conflict of interest

Ethics approval

This study was reviewed by the Ethics Review Committee of the International Institute of Health Sciences, Walisara, Sri Lanka (Application No.: BI_ERC_2026_019) and an ethical clearance waiver was granted. Informed consent was obtained from all the participants before recruitment and the study was

conducted in accordance with national public health guidelines and the principles of the Declaration of Helsinki.

Data availability

The raw quantitative datasets used to support the findings of this study are deidentified participant data and are available from the corresponding authors upon reasonable request. Please contact Dr. Renuka Jayatissa or Ms. PK Weerawickrama.

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Author Contribution

RJ conceptualized and supervised the study. PK, SR, DH, and DM designed the study, and performed sample analysis, with quality control and validation. GA and HJ coordinated sample collection, logistics and overall project. The main manuscript was drafted by PK, DH, DM, GA and GG with contributions to writing and critical revisions from KJ AND RJ. Tables and figures were prepared by PK and reviewed by RJ. All authors reviewed and approved the final manuscript.

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Table 2

Table 2 is available in the Supplementary Files section.

Figures

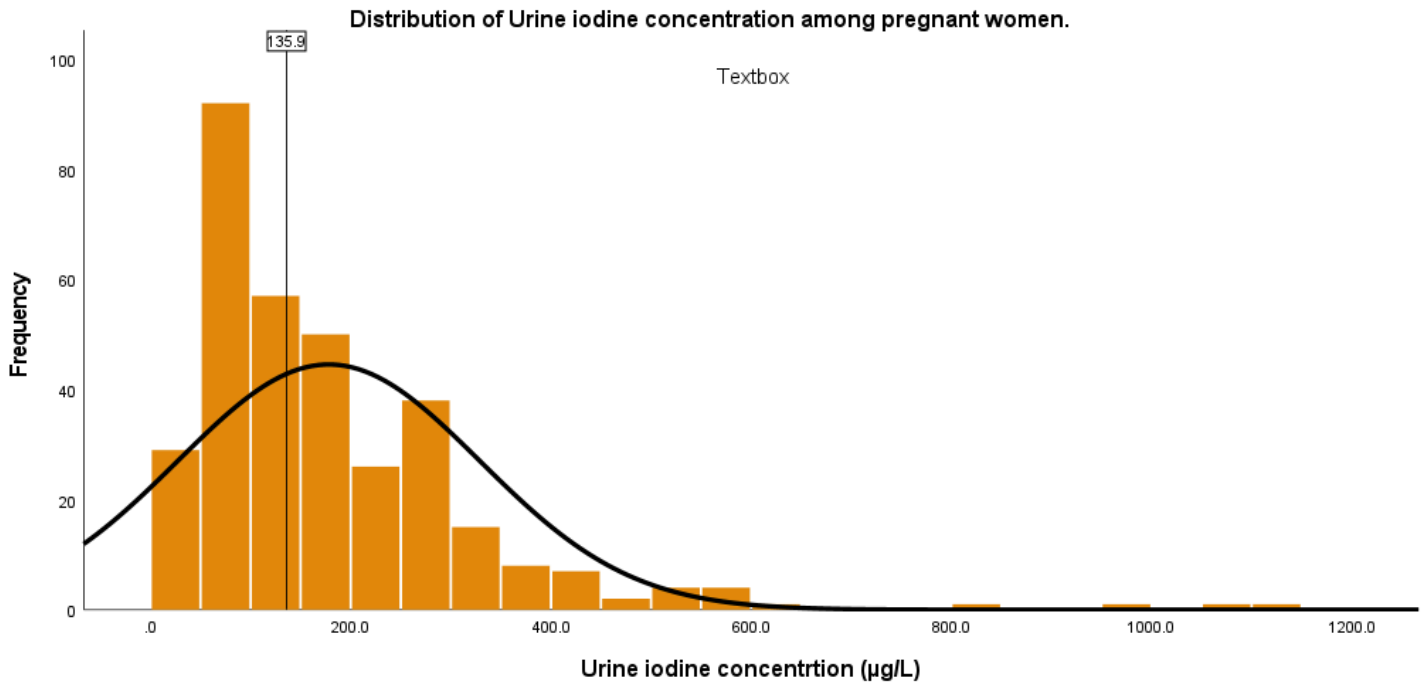


Figure 1

Distribution of urine iodine concentration among the pregnantwomen

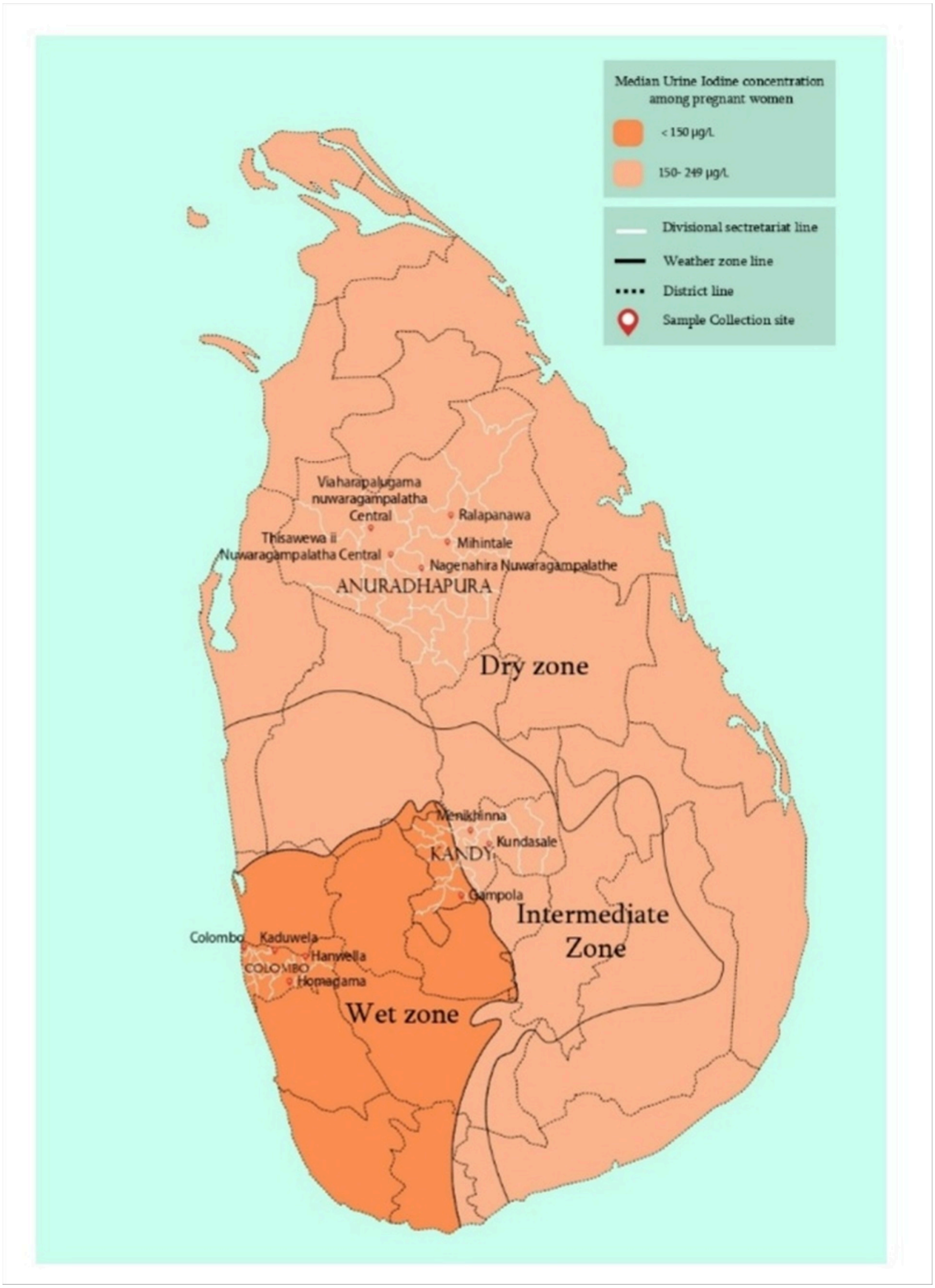


Figure 2

Geographic Distribution of Median Urinary Iodine Concentration Among Pregnant Women.

illustrates iodine status across the three ecological zones represented by the selected districts. The district from the wet zone (Colombo) demonstrated overall iodine sufficiency, while both the dry zone (Anuradhapura) and the hill country/intermediate zone (Kandy) exhibited insufficient iodine levels. Among

the three, the hill zone (Kandy) showed the lowest median urinary iodine concentration, indicating the most severe iodine deficiency within the study population.

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- Table02.docx