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ORIGINAL RESEARCH

Global, Regional, and National Burden of Iodine Deficiency in Reproductive Women From 1990 to 2019, and Projections to 2035: A Systematic Analysis for the Global Burden of Disease Study in 2019

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Background: Iodine deficiency threatens women of reproductive-age (15–49 years) worldwide, increasing risks of thyroid dysfunction and developmental abnormalities. Accurate trend prediction is essential for targeted prevention strategies.

Purpose: To investigates the global, regional, and national disease burden of iodine deficiency among reproductive-age women from 1990 to 2019, as well as projected trends through 2035.

Patients and methods: Using Global Burden of Disease 2019 data, we assessed prevalence, mortality, years lived with disability (YLDs), and disability-adjusted life years (DALYs) across 204 countries/territories (1990–2019). Age-period-cohort Bayesian model was used to predict trends from 2020 to 2035.

Results: In 2019, 81.4 million women of reproductive age globally had iodine deficiency (age-standardized prevalence: 2871.7/100,000), reflecting a 13.3% reduction since 1990. The condition caused 1.1 million YLDs (age-standardized rate: 38.4/100,000), marking a 27.4% decrease from 1990. Projections suggest sustained declines through 2035. Notably, a strong inverse correlation emerged between Socio-demographic Index (SDI) and disease burden, with a correlation coefficient of −0.58 (95% CI: −0.63 to −0.53, $p<0.001$). Geographically, the highest burden clustered in Central Sub-Saharan Africa, South Asia, and Eastern Sub-Saharan Africa, with Somalia, the Democratic Republic of the Congo, and Congo having the highest national prevalence.

Conclusion: The global burden of iodine deficiency among women of reproductive age has decreased substantially since 1990. Nonetheless, considerable challenges persist in lower SDI regions, especially affecting women within the reproductive age. Addressing these inequities in global iodine nutrition and alleviate the iodine deficiency-related burden, targeted implementation strategies and continuous monitoring measures are urgently needed.

Keywords: iodine deficiency, women of reproductive age, prevalence, years lived with disability

Introduction

Iodine deficiency remains a major challenge to global public health, particularly among women of childbearing age (15–49 years), a group vulnerable due to their heightened physiological demands.[1–3] As an essential micronutrient, iodine plays a fundamental role in thyroid hormone synthesis, with these hormones critically regulating metabolic processes, neurological development, and reproductive health.[4–6] Inadequate iodine intake can result in various health issues, including thyroid disorders, intellectual impairment, and reproductive disorders.[7–10] Although universal iodized salt programs have achieved remarkable success in reducing global iodine deficiency prevalence, persistent challenges remain. Recent epidemiological estimates highlight that 53% of populations in low- and middle-income countries remain at risk of iodine deficiency, especially for pregnant women in these regions with prevalence rates soaring to 83%.[11] This

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underscores the urgent need to address the enduring burden of iodine insufficiency, particularly among populations constrained by socioeconomic barriers to accessing diversified, iodine-rich diets.

Geographically, the burden of iodine deficiency exhibits stark regional disparities, disproportionately impacting low- and middle-income countries (LMICs) and regions with lower SDI, such as sub-Saharan Africa and South Asia.[2,12,13] Global Burden of Disease (GBD) analyses indicate that while age-standardized prevalence and years lived with disability (YLDs) related to iodine deficiency have declined globally from 1990 to 2019, high SDI regions, including the United States, now face a resurgence of deficiency among pregnant women, posing risks of developmental delays and thyroid dysfunction in children.[14,15] Despite advancements in iodine fortification initiatives, regional disparities in iodine intake persist, particularly in socioeconomically disadvantaged regions.[16] These gaps in surveillance data underscore the imperative for sustained global monitoring of population iodine status and the implementation of context-specific interventions to address inequities in dietary access and healthcare infrastructure.

The GBD study is pivotal in quantifying the worldwide and regional influence of iodine deficiency by estimating the prevalence and disability adjusted life year (DALY), thereby unveiling the extensive health issues linked to iodine deficiency. The main objective of this study is to comprehensively evaluate Global, Regional, and National burden of iodine deficiency in women of childbearing age from 1990 to 2019 and to project the global prevalence of iodine deficiency in childbearing-age women to 2035. This will provide invaluable guidance for public health policy responses.

Materials and Methods

Patient and Public Involvement

Because the study used publicly available integrated data, patients and the public were not involved in the setting of the research questions or outcome measures, nor in the process of designing or implementing the study.

Definitions and Data Source

The Global Burden of Disease 2019 study has estimated the prevalence of 369 diseases and injuries across 204 nations and territories, as well as 23 regions, for the years between 1990 and 2019.[17] Relevant descriptions of statistical methods have been documented,[18,19] with both fatal and nonfatal outcomes have been reported (https://vizhub.healthdata.org/gbd-compare/ and https:// ghdx.healthdata.org/gbd-results-tool.

In this study, iodine deficiency disorders (IDD) were identified using the International Classification of Diseases, 10th Revision (ICD-10) codes E00-E02. These codes were specifically assigned to cases of IDD associated with visible goiter (grade 2) and related complications, including thyroid dysfunction, heart failure, and intellectual disability. Notably, the study excluded the subclinical iodine deficiency or non-visible goiter (grade 1) to the estimated prevalence of IDD.[17] An extensive analysis was conducted to extract information on data related to the prevalence of iodine deficiency disorders and years lived with disability (YLDs). The analysis covered a global perspective and further analyzed data from 1990 to 2019 by region, income group and age. Our estimates are presented as raw values and age-standardized ratios. YLDs is a crucial component of Disability-Adjusted Life Years (DALYs), quantifies disease burden through two key parameters: disability weight (measuring health state severity on a 0–1 scale) and duration of disability. This metric allows standardized comparison of non-fatal health loss across diverse populations and pathologies.[20,21] To integrate these data, we utilized the GBD study, which integrates clinical data from a variety of global information sources, including healthcare provider records, outpatient care (eg GP visits) and health insurance claims information. For each GBD condition, we calculated the ratio of non-primary diagnosis rates to primary diagnosis rates and the ratio of outpatient to inpatient care across multiple regions. In our modelling process, we used DisMod-MR,[20] a Bayesian hierarchical regression model, to synthesize epidemiological data and quantify uncertainty in disease parameter estimation. The model addresses heterogeneity across regions and time. The strategy allowed us to generate precise estimates for each metric of interest (including prevalence and YLDs), considering variables such as age, gender, location, and year of analysis.

Socio-Economic Status

The Social Demographic Index (SDI), a composite metric reflecting regional socioeconomic development status, integrates three core dimensions: average educational attainment, per capita income level, and total fertility rate. This standardized measure enables cross-regional comparisons of development disparities and their health outcome associations. The SDI is categorized into five levels representing the socio-economic development of the societies under study: low (< 0.46), low-moderate (0.46–0.61), medium-high (0.61–0.69), medium-high (0.69–0.80), and high (> 0.80).[22] Uncertainty intervals were defined as the 2.5th and 97.5th values of the ordered draws.

Projections to 2035

We applied a Bayesian age-period-cohort (BAPC) model to assess and predict the prevalence of iodine deficiency disorders and the rate of YLDs by 2035.[23] The BAPC model relies on an integrated nested Laplace approximation to estimate the marginal posterior distributions, which helps to avoid some of the mixing and convergence problems associated with traditional Bayesian approaches to Markov chain Monte Carlo sampling.[24] The BAPC model was built using the BAPC and INLA packages in R Statistical Software (version 4.3.3).

Statistical Analysis

The relationship between the YLDs and the SDI for the 21 regions and 204 countries and territories was analyzed using Smoothing Splines models. All statistical analyses and visualizations were conducted using R statistical software (version 4.3.3). Statistical significance was determined using a p value of <0.05.

Results

Global Level

In 2019, 81.4 million prevalent cases of iodine deficiency among women of reproductive age were reported globally, with an age-standardized point prevalence of 2871.7 per 100 000, marking a 13.3% decrease since 1990. The number of YLDs for iodine deficiency in women of reproductive age was 1.1 million in 2019, with an age-standardized rate of 38.4 YLDs per 100,000, showcasing a 27.4% decline since 1990 (Table 1).

Regional Level

In 2019, the regions with the highest age-standardized point prevalences of iodine deficiency among women of reproductive age (per 100,000) were high-income Central Sub-Saharan Africa (17,701), South Asia (6,611.4), and Eastern Sub-Saharan Africa (5,219.7). Conversely, Latin America (84.4), Tropical Latin America (119.2), and Eastern Southern Latin America (151.2) recorded the lowest prevalences (Table 1). Additionally, in 2019, the highest age-standardized YLDs rates (per 100,000) were observed in Central Sub-Saharan Africa (202.2), South Asia (90.4), and Eastern Sub-Saharan Africa (65.8), while the lowest rates were found in High Andean Latin America (1.1), Tropical Latin America (1.3), and Southern Latin America (1.6) (Table 1).

The largest increases in the age-standardized point prevalence of iodine deficiency among women of reproductive age, from 1990 to 2019, were observed in East Asia (26.6%) and Eastern Europe (5.5%), while the greatest decreases were found in Southeast Asia (−51.6%), North Africa and the Middle East (−40.9%), and Central Asia (−39.4%) (Table 1). During the same period, the age-standardized YLDs rates decreased in all regions from 1990 to 2019, with the largest declines seen in Southeast Asia (−63.8%), Oceania (−46.8%), Southern Sub-Saharan Africa (−44.3%), and North Africa and the Middle East (−42.1%) (Table 1).

National Level

In 2019, the national age-standardized point prevalence of iodine deficiency among women of reproductive age varied significantly, ranging from 49.2 to 23,758.1 cases per 100,000. Somalia (23,758.1), the Democratic Republic of the Congo (21,481.5), and Congo (15,758.5) reported the highest age-standardized point prevalences, while Samoa (49.2), American Samoa (51.8), and Guam (54.3) had the lowest estimates (Figure 1 and Table S1).

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Table 1 Prevalent Cases and Years Lived with Disability (YLDs) for Iodine Deficiency Among Women of Reproductive Age in 2019 to and Percentage Change in Age-Standardized Rate (ASR) per 100,000 to by Global Burden of Disease Region to From 1990 to 2019

Regional	Number of Prevalence			Number of YLDs		
	Number in Millions (95% UI)	ASRs per 100,000 (95% UI)	Percentage Change in ASR from 1990 to 2019	Number in Thousands (95% UI)	ASR per 100,000 (95% UI)	Percentage Change in ASR from 1990 to 2019
Global	81.4 (65.2 to 102.7)	2871.7 (2346.8 to 3546.3)	−13.3 (−18.6 to −8.2)	1068.5 (586.7 to 1929.7)	38.4 (21.4 to 67.9)	−27.4 (−36.4 to −20)
High-income Asia Pacific	0.1 (0.1 to 0.2)	287.4 (221.3 to 362.7)	−16 (−18.9 to −13.1)	1.6 (0.7 to 3.1)	3.1 (1.4 to 5.9)	−15.8 (−19.6 to −11.9)
High-income North America	0.3 (0.2 to 0.4)	264.8 (202.1 to 337.2)	−0.5 (−2.5 to 1.2)	3 (1.3 to 5.9)	2.8 (1.3 to 5.3)	−0.7 (−3.6 to 2)
Western Europe	1.9 (1.5 to 2.5)	1433.4 (1133.2 to 1814.8)	−21.1 (−23.3 to −19)	20.6 (9.4 to 41.1)	15.2 (7.1 to 30.2)	−21.1 (−23.4 to −18.8)
Australasia	0 (0 to 0)	236 (179.1 to 300.4)	−5.9 (−11.9 to 0.8)	0.2 (0.1 to 0.4)	2.5 (1.1 to 4.8)	−5.9 (−14.9 to 4.6)
Andean Latin America	0 (0 to 0)	84.4 (62.7 to 112)	−14.8 (−20.4 to −9.3)	0.2 (0.1 to 0.4)	1.1 (0.6 to 2)	−25.7 (−41.6 to −11.8)
Tropical Latin America	0.1 (0.1 to 0.1)	119.2 (89.6 to 156.4)	−6.9 (−9.6 to −4.4)	1 (0.4 to 2)	1.3 (0.6 to 2.4)	−19.2 (−31.1 to −10.8)
Central Latin America	0.9 (0.7 to 1.1)	962.6 (752 to 1209.7)	0.2 (−2.2 to 2.9)	11.6 (6.1 to 20.6)	13.1 (7.1 to 22.9)	−6.2 (−14.8 to 0.4)
Southern Latin America	0 (0 to 0)	151.2 (111.1 to 195.8)	−22.8 (−30.4 to −16.3)	0.4 (0.2 to 0.7)	1.6 (0.7 to 3.1)	−23 (−32.5 to −13.2)
Caribbean	0.1 (0.1 to 0.1)	639.4 (481.8 to 811.3)	−24.4 (−31.2 to −16.2)	2 (1.1 to 3.2)	12.1 (6.6 to 19.7)	−22.1 (−31.1 to −11.2)
Central Europe	0.1 (0.1 to 0.1)	247.3 (185.8 to 316.8)	−32.2 (−37.2 to −27.9)	0.9 (0.4 to 1.8)	2.6 (1.2 to 5.1)	−40.4 (−49.4 to −33.6)
Eastern Europe	0.2 (0.2 to 0.3)	381.9 (293.7 to 482.1)	5.5 (0 to 12)	5 (2.7 to 8.1)	7.9 (4.5 to 12.7)	5.2 (−4.1 to 15.6)
Central Asia	0.3 (0.2 to 0.4)	827.8 (639.6 to 1056.1)	−39.4 (−44.2 to −34.8)	4.4 (2.4 to 7.6)	13.4 (7.7 to 23.3)	−41.9 (−52.6 to −33.8)
North Africa and Middle East	2.4 (1.8 to 3)	1223 (972.1 to 1497.7)	−40.9 (−44.9 to −37.2)	51.5 (30.5 to 81.5)	26.6 (16 to 41.2)	−42.1 (−48 to −36.8)
South Asia	44 (34.6 to 55.8)	6611.4 (5317.6 to 8188.3)	−34.4 (−40.9 to −28.3)	596.2 (336.3 to 1055.6)	90.4 (51.5 to 157.4)	−45.4 (−52.7 to −39.1)
Southeast Asia	2.7 (2 to 3.4)	1003 (787.3 to 1265.4)	−51.6 (−55.1 to −48.5)	40.7 (22.6 to 70.3)	15.4 (8.8 to 26.2)	−63.8 (−70.4 to −58)
East Asia	11.1 (8.5 to 14)	2000.1 (1576.5 to 2513.8)	26.6 (11.4 to 43.2)	120.1 (54.7 to 238.3)	21.5 (9.8 to 42)	−5.5 (−32.6 to 18.2)
Oceania	0 (0 to 0)	93.1 (69.1 to 123.8)	−37.7 (−43.1 to −32.6)	0.1 (0.1 to 0.2)	2.6 (1.5 to 4.1)	−46.8 (−57.4 to −35.1)
Western Sub-Saharan Africa	2.6 (2 to 3.5)	1872.4 (1483.1 to 2395.1)	−38.2 (−41.4 to −35.1)	35.3 (18.9 to 63.5)	24.6 (13.4 to 43.9)	−41.9 (−46.9 to −37.8)
Eastern Sub-Saharan Africa	7 (5.6 to 8.7)	5219.7 (4249.3 to 6382.1)	−30.8 (−33.5 to −28)	87.9 (47.2 to 160.1)	65.8 (35.8 to 118.9)	−35.9 (−41.4 to −31.9)
Central Sub-Saharan Africa	7.2 (5.9 to 8.7)	17,701 (14,452.9 to 21351.6)	−30.1 (−39.9 to −19)	81.9 (40.6 to 155.9)	202.2 (103.8 to 381.7)	−29.1 (−38.5 to −18.4)
Southern Sub-Saharan Africa	0.4 (0.3 to 0.5)	1252.4 (986.9 to 1582.4)	−39.8 (−48.6 to −30.5)	3.9 (1.8 to 7.6)	13.6 (6.5 to 26.2)	−44.3 (−53.6 to −34.9)

Abbreviations: 95% UI, 95% uncertainty intervals; ASR, Age-standardized rate; YLDs, Years lived with disability.

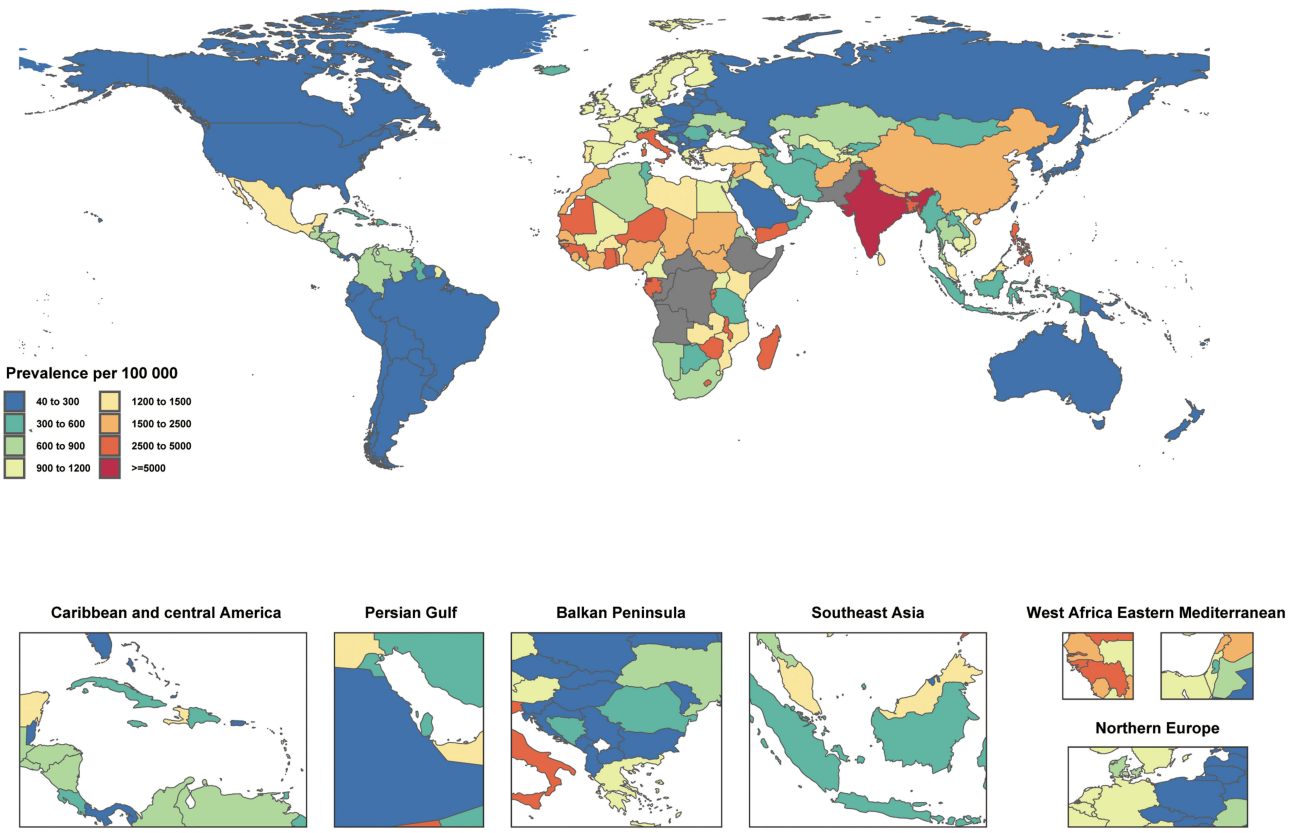

Figure 1 Global age-standardized point prevalence of iodine deficiency among women of reproductive age per 100,000 population in 2019.

Additionally, in 2019, the national age-standardized YLDs rate for iodine deficiency among women of reproductive age ranged from 0.5 to 300.2 cases per 100,000. The highest rates were recorded in Somalia (300.2), the Democratic Republic of the Congo (245.5), and Djibouti (174.6), whereas the lowest rates were found in American Samoa (0.5), Samoa (0.5), and Guam (0.6) (Table S2).

The percentage change in age-standardized point prevalence from 1990 to 2019 varied significantly between countries, with the Philippines (53.3%), Libya (30%), and China (26.7%) experiencing the largest increases. In contrast, Malaysia (−84%), Equatorial Guinea (−83.2%), and Cambodia (−79.7%) saw the most substantial decreases (Table S1). During the same period, Libya (30.9%), Ukraine (16.8%), and Pakistan (7.5%) recorded the highest increases in the age-standardized YLDs rate for iodine deficiency among women of reproductive age. On the other hand, the most notable decreases were observed in Equatorial Guinea (−83.1%), Indonesia (−82%), and Malaysia (−79.8%) (Figure 2 and Table S2).

Age Patterns

In 2019, the global prevalence of iodine deficiency among women of reproductive age was higher, reaching its peak within the 30–34 age group. Likewise, the number of prevalent cases was highest in the 30–34 age group, decreasing as age increased (Figure 3A and B). Overall, global YLDs rates for iodine deficiency in females remained high during the reproductive years, before declining with age, and peaking in the 25–29 age group. Similarly, the number of YLDs cases was highest in the 25–29 age group, but decreased with age (Figures 3C and D).

Association with the SDI

At the regional level, a significant inverse correlation was observed between the SDI and age-standardized YLDs rate of iodine deficiency among women of reproductive age from 1990 to 2019, with a correlation coefficient of −0.58 (95% CI:

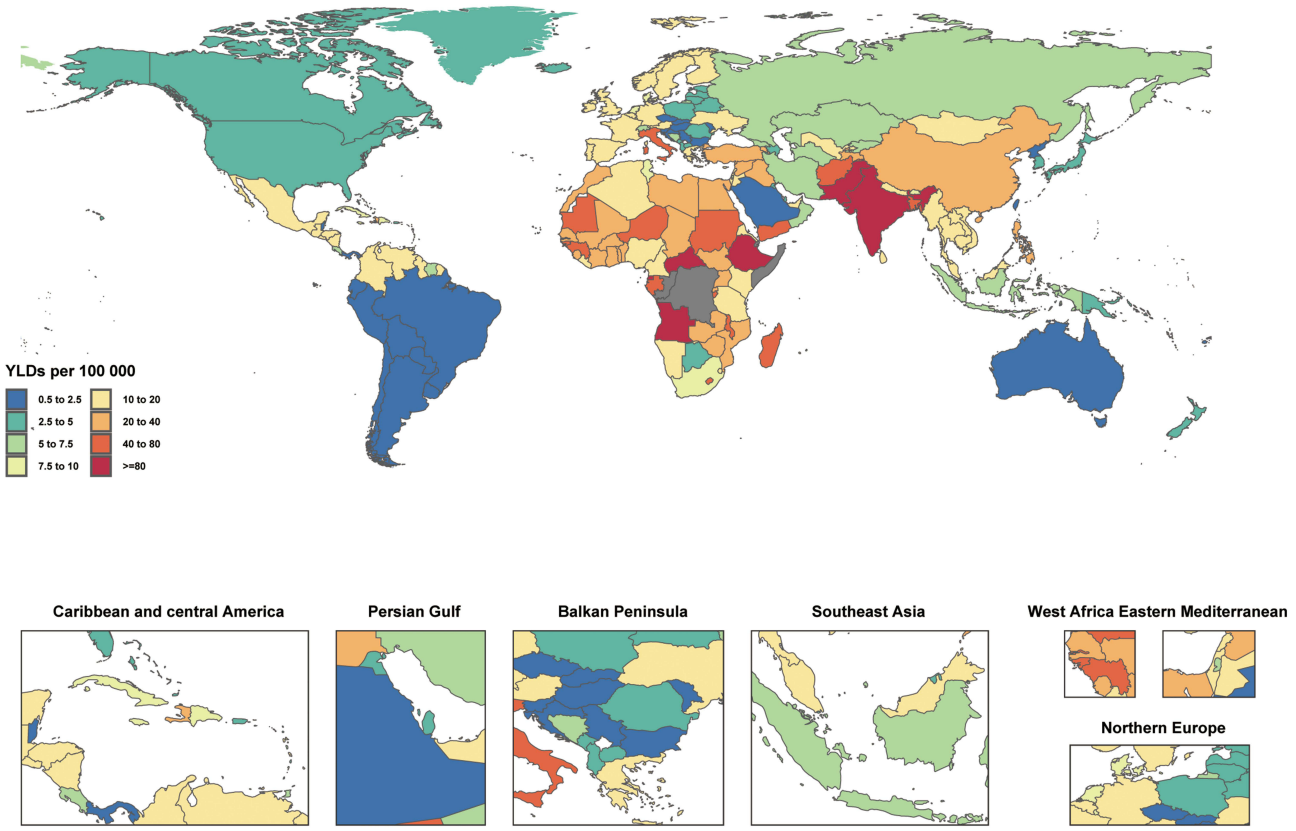

Figure 2 Global age-standardized point YLDs rates of iodine deficiency among women of reproductive age per 100,000 population in 2019.

−0.63 to −0.53, p<0.001). Central Sub-Saharan Africa, South Asia, and Western Europe exhibited higher-than-expected YLDs rates based on their sociodemographic index during this period. In contrast, Eastern Sub-Saharan Africa, Western Sub-Saharan Africa, Oceania, Tropical Latin America, Southern Latin America, Central Latin America, and Andean Latin America experienced lower-than-expected burdens from 1990 to 2019 (Figure 4).

At the country level in 2019, the burden of iodine deficiency among women of reproductive age showed a significant decrease with increasing socioeconomic development up to a sociodemographic index of about −0.50 (−0.60, −0.39) (Figure S1). Countries and territories such as Somalia, the Democratic Republic of the Congo, India, Djibouti, Ethiopia, and Pakistan had much higher-than-expected burdens, while Niger, Burundi, Burkina Faso, Papua New Guinea, and Mozambique had much lower-than-expected burdens (Figure S1).

Trends Projections to 2035

The prevalence rates and the number of YLDs cases among women of childbearing age are projected to remain essentially unchanged from 2020 to 2035 (Figure 5A and B). However, after adjusting for age-standardized rates, the projections indicate that the age-standardized prevalence and YLDs rates will range from 1.49 to 1.34 and from 0.019 to 0.016, respectively, over the same period (Figure 5C and D).

Discussion

The present study highlights significant progress in reducing the global burden of iodine deficiency among women of reproductive age from 1990 to 2019, marked by an overall decline in both prevalence and YLDs. However, notable disparities persist, particularly in low-SDI regions such as Central Sub-Saharan Africa and South Asia, where iodine deficiency prevalence remains alarmingly high. Age-specific analysis revealed that iodine deficiency peaked in the 30–34

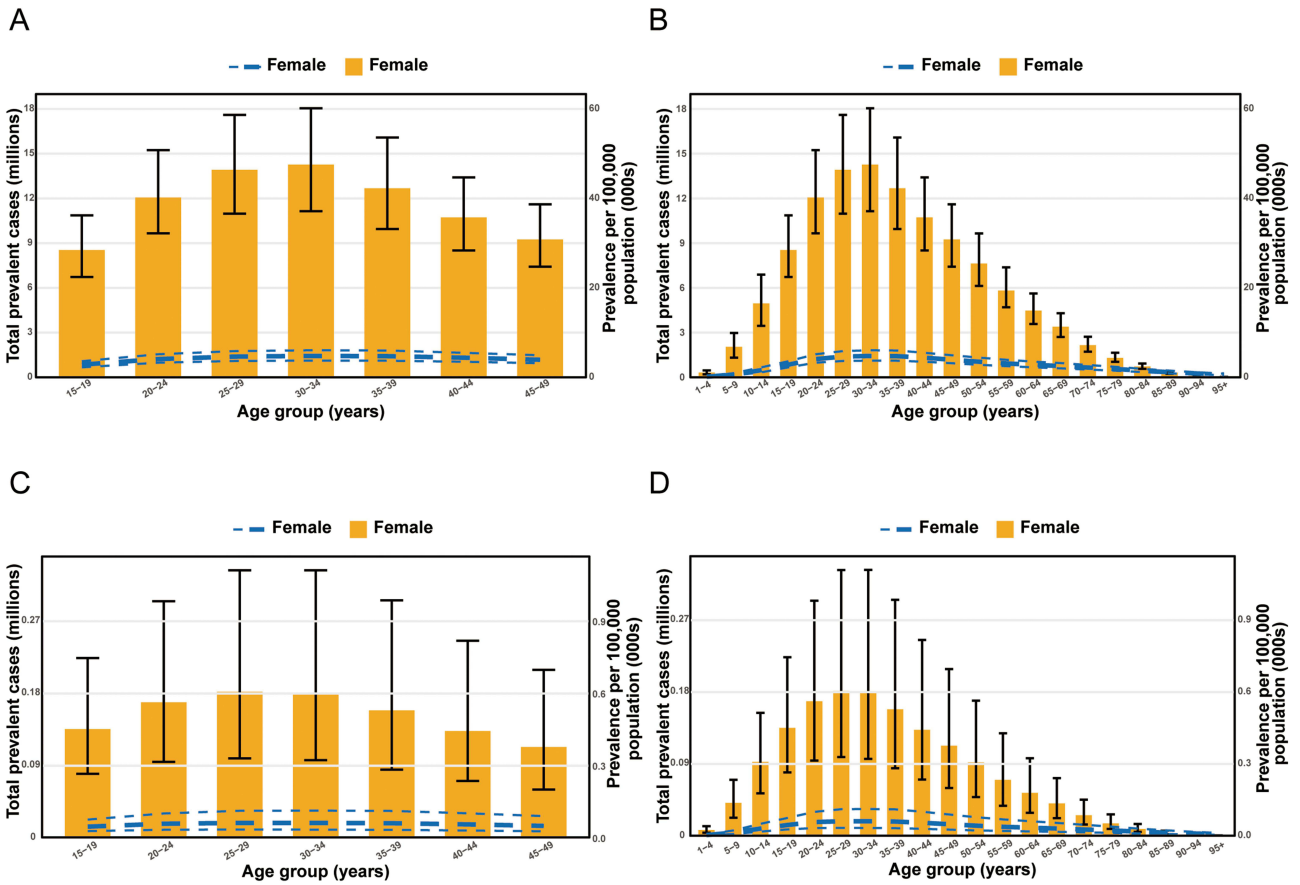

Figure 3 Global number of cases and rates of iodine deficiency among female per 100,000 population in 2019. Lines indicate prevalent case with 95% uncertainty intervals for female. (**A**) Global number of prevalent cases and prevalence of reproductive age. (**B**) Global number of prevalent cases and prevalence of all age groups. (**C**) Global number of YLDs cases and YLDs rate of reproductive age. (**D**) Global number of YLDs cases and YLDs rate of all age groups.

age group, while YLDs rates were highest among women aged 25–29. At the national level, Somalia, the Democratic Republic of the Congo, and Congo exhibited the highest prevalence and YLDs rates, underscoring the continued vulnerability of these regions. Projections through 2035 indicate potential further reductions in iodine deficiency rates.

Iodine deficiency poses significant health risks for women of childbearing age, particularly in relation to thyroid hormone, reproductive health, and child mental development.[25–29] Previous research has underscored the essential role of iodine in fetal neurodevelopment; deficiencies can lead to heightened risks of developmental delays and intellectual disabilities.[30,31] Additionally, iodine deficiency is associated with an increased likelihood of pregnancy loss, preterm birth, and low birth weight.[32–34] Furthermore, the importance of iodine in cardiovascular health, particularly its connection to hypertension during pregnancy, is increasingly acknowledged.[35,36] In 1994, the WHO recommended eliminating IDDs by iodizing all salt for human consumption.[37] Globally, the proportion of people consuming iodized salt increased from <20% in 1990 to ~70% by the year 2000, which contributed to a considerable reduction in the prevalence of iodine deficiency worldwide.[38] However, substantial health risks persist across various regions, especially in vulnerable areas characterized by low SDI and among different age groups, as demonstrated by our study.

Our investigation revealed considerable regional disparities in iodine deficiency among women of reproductive age. The highest prevalence was observed in Central Sub-Saharan Africa, South Asia, and Eastern Sub-Saharan Africa. These findings are consistent with previous studies that have consistently identified these regions as bearing the greatest burden of iodine deficiency due to socio-economic challenges, limited access to iodine-fortified foods, and inadequate healthcare infrastructure.[1,39,40] However, notable differences emerge when comparing specific regional trends. For instance, our results indicate a more pronounced decline in iodine deficiency rates within Southeast Asia compared to earlier studies; this may reflect successful implementation of salt iodization programs in countries such as Thailand and Cambodia,

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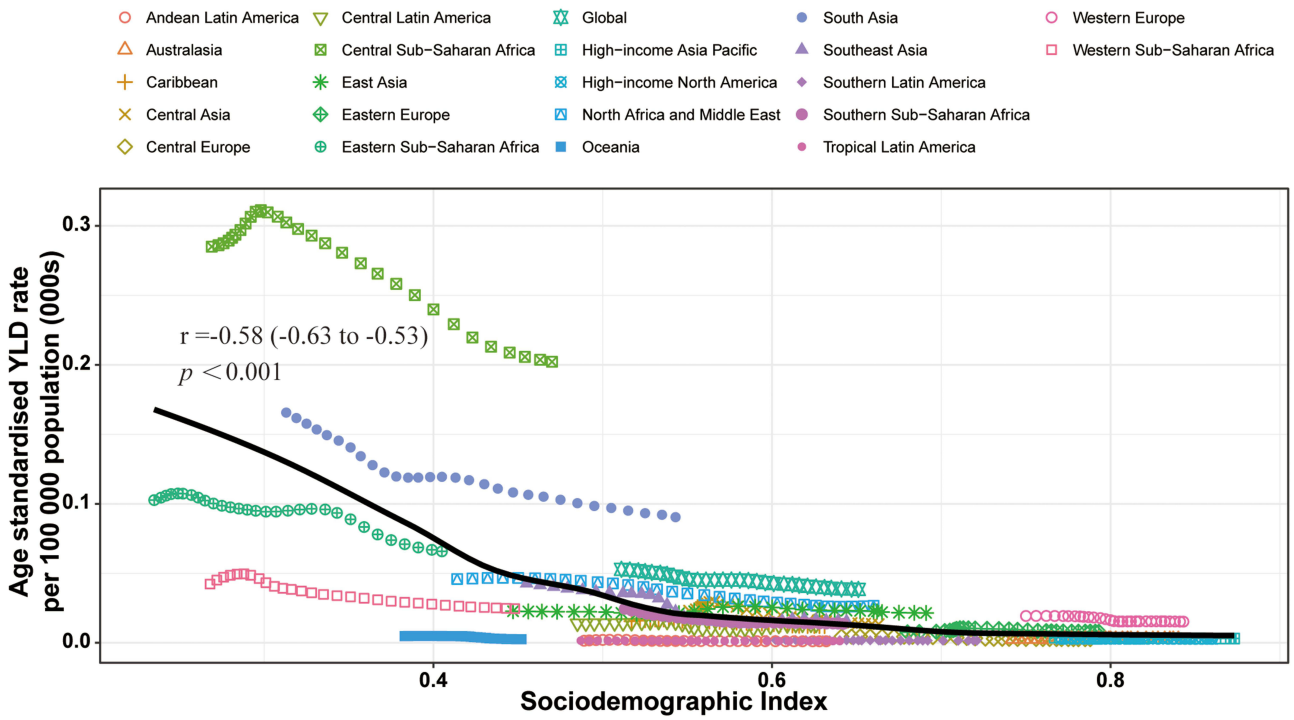

Figure 4 Age-standardized YLDs rates of iodine deficiency among women of reproductive age for the 21 Global Burden of Disease regions by sociodemographic index, 1990–2019. Thirty points are plotted for each region and show the observed age standardized YLDs rates from 1990 to 2019 for that region. Expected values, based on sociodemographic index and disease rates in all locations, are shown as a solid line. Regions above the solid line represent a higher-than-expected burden and regions below the line show a lower-than-expected burden.

studies showed that in Thailand, household coverage of adequately iodized salt was found to be between 78.9% and 79.9% in, 2015−2016[41] household iodized salt coverage in Cambodia increased from 13% to 83% between 2000 and 2017.[42] Conversely, regions like Eastern Europe and East Asia have experienced a slight increase in rates of iodine deficiency over recent years—a trend that contrasts with prior studies reporting declines. The fragmentation of the post-Soviet health systems, along with ongoing conflicts such as the situation in Ukraine, have significantly weakened public health capacity.[43,44] North Korea's limited food imports, due to prolonged UN sanctions, combined with an underdeveloped healthcare infrastructure, present substantial challenges.[45] These factors collectively hinder effective national efforts to prevent iodine deficiency disorders (IDD). This discrepancy is likely attributable to variations among populations studied since our analysis encompassed all ages and genders.

Our study underscores a pronounced negative correlation between the SDI and iodine deficiency, with regions characterized by lower SDI exhibiting significantly higher burdens of iodine deficiency. This observation is consistent with prior research, which consistently indicates that areas with diminished SDI, such as Sub-Saharan Africa and South Asia, experience elevated prevalence rates of iodine deficiency.[46,47] Contributing factors include limited access to iodine-rich foods, inadequate healthcare infrastructure, and insufficient implementation of public health initiatives like salt iodization.[48,49] However, our findings indicate that even in regions classified as having middle SDI, such as certain parts of Eastern Europe and East Asia, a resurgence of iodine deficiency has been observed in recent years. This deviation from earlier trends, which reported a steady decline in iodine deficiency within these areas, may be attributed to changing dietary patterns, urbanization processes, and decreased governmental emphasis on programs for iodine fortification.[50,51] In contrast, high-SDI regions such as North America and Western Europe continue to report low rates of iodine deficiency. This phenomenon can likely be explained by superior healthcare systems, sustained public health interventions, and elevated socio-economic standards that ensure a reliable supply of iodine-rich foods.[52,53] These findings

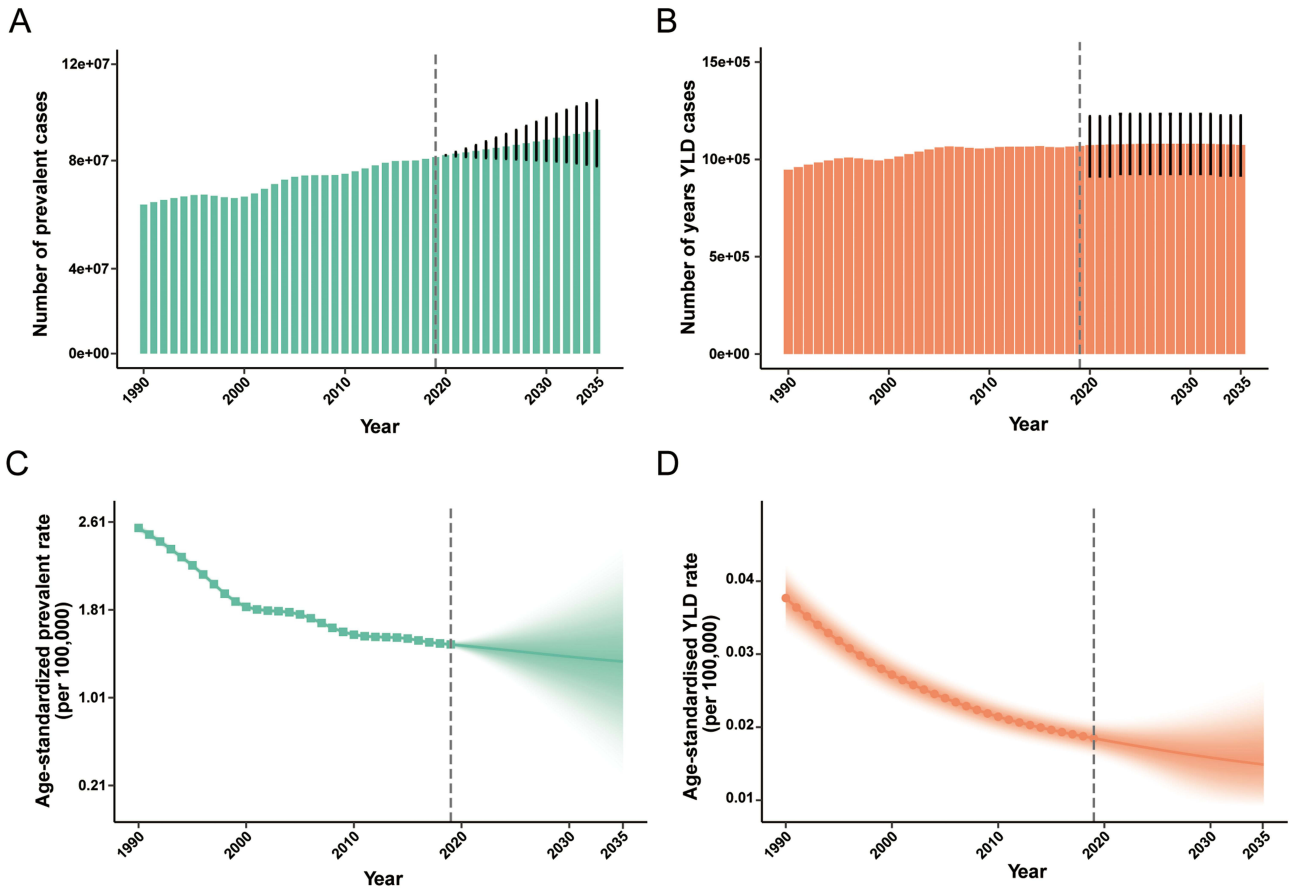

Figure 5 Trends in global iodine deficiency among women of reproductive age burden from 1990 to 2035. (**A**) Number of prevalent cases. (**B**) Number of YLDs cases. (**C**) Age-standardized prevalent rate. (**D**) Age-standardized YLDs rate.

highlight the critical influence of socio-economic factors on the prevalence of iodine deficiency and emphasize the necessity for tailored interventions that consider regional socio-economic conditions.

Our study reveals significant age-related patterns in iodine deficiency, with the highest prevalence observed among women aged 30–34, while peak YLDs rates occurring in the 25–29 age group. This subtle paradox, characterized by late-age prevalence but early-age YLDs rates, suggests that while iodine deficiency remains a health concern for women throughout their reproductive years, its impact on disability may diminish as women age. This decline could be attributed to changes in physiological iodine requirements or increased attention to public health interventions targeting younger demographics. Women aged 30–34 may be in the later stages of their reproductive years or have a history of multiple pregnancies, demonstrate heightened physiological iodine requirements due to cumulative gestational demands.[54] Meanwhile, women aged 25–29 may be in the early stages of pregnancy, with health issues such as thyroid disorders beginning to emerge, which can affect their quality of life and contribute to an increase in YLDs. The present study predicts a significant downward trend in iodine deficiency among women of childbearing age by 2035, a finding that has not been previously addressed in existing literature.

Our findings diverge from earlier research conducted in regions with higher SDI scores, such as North America and Western Europe, where iodine deficiency is reported to be more prevalent in older populations.[55] This discrepancy may be explained by variations in dietary patterns, access to iodine-rich foods, and the use of supplements during pregnancy within these regions.[56,57] Furthermore, Wei noted that age-related differences in iodine deficiency rates might also arise from regional disparities in public health policies; some countries have implemented more effective iodine supplementation programs specifically for younger women.[2] Eduardo and Gallego emphasized the importance of prenatal care programs aimed at younger women, which may alleviate the burden of iodine deficiency within this demographic.[58,59]

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Collectively, these findings underscore the necessity for targeted interventions across different age groups—particularly for younger women residing in low-SDI regions—where the burden remains high despite global advancements toward reducing iodine deficiency.

This study presents the first comprehensive overview and exploration of the burden of iodine deficiency among women of reproductive age. We assessed the burden of iodine deficiency in this demographic across various regional and national contexts, different levels of SDI, and distinct age groups globally from 1990 to 2019. The findings will aid in identifying gaps related to iodine deficiency among women of reproductive age and facilitate the formulation of targeted regional or national responses. Notably, macro-political security and socio-cultural capital are critical measures for addressing iodine deficiency in this population, surpassing economic capital in importance. Implementing essential public health strategies remains crucial to addressing iodine deficiency disorders. Strengthening salt iodization requires prioritizing strict monitoring in high-risk areas such as sub-Saharan Africa, supported by tax incentives for compliant producers and penalties for non-compliant industries to bridge implementation gaps. Concurrently, targeted monitoring for reproductive-aged women should integrate iodine screening into prenatal programs, complemented by community-based nutrition education to enhance pregnancy adherence. Furthermore, robust surveillance systems must establish regional networks tracking urinary iodine concentrations, thereby enabling responsive policy adjustments.

This study has several important limitations that warrant consideration. First, being a secondary analysis of GBD data, the validity of our estimates is inherently constrained by the completeness and accuracy of input data within the GBD framework. The absence of independent validation studies precluded external verification of our findings. Second, our prevalence estimation focused exclusively on grade 2 goiter, potentially underestimating total burden by excluding subclinical iodine deficiency and non-visible goiter cases. Third, potential underreporting in low-SDI countries may introduce geographical bias, particularly in estimating deficiency rates among women of childbearing age. Fourth, the attribution of YLDs to iodine deficiency may be confounded by concurrent micronutrient deficiencies (eg, iron-deficiency anemia), with the GBD's fixed disability weights potentially failing to account for compounded disability effects in multimorbidity contexts. The GBD's use of fixed disability weights could further underestimate burden when comorbidities amplify disability severity. Finally, while our analysis identified a significant inverse association between SDI and YLDs (Pearson's $r = -0.58$, $p < 0.001$), the inability to adjust for confounding factors such as dietary heterogeneity and healthcare accessibility limits causal interpretation. Notwithstanding these limitations, our study represents the most comprehensive utilization of currently available global evidence. Future research should prioritize longitudinal individual-level studies incorporating (1) biochemical iodine status assessments, (2) covariate-adjusted analyses of socioeconomic determinants, and (3) comorbidity-sensitive disability weight calculations to advance understanding of this complex public health issue.

Conclusion

The global burden of iodine deficiency among women of childbearing age is anticipated to decrease from 2020 to 2035, influenced by economic development, political safeguards, and heightened societal awareness. Nevertheless, significant disparities remain across various regions and age groups, particularly in South Asia and sub-Saharan Africa. Future research should aim to bridge these gaps by enhancing data accuracy from low- and middle-income countries while investigating the genetic and environmental factors that influence iodine metabolism. Comprehensive evaluations of public health interventions are essential for understanding and addressing the evolving burden of iodine deficiency, especially considering changing dietary habits and urbanization. A sustained focus on targeted interventions for women of childbearing age is crucial to mitigate the long-term health impacts on both mothers and their children.

Abbreviations

BAPC, Bayesian age-period-cohort; DALY, disability adjusted life year; GBD, Global Burden of Disease; SDI, Socio-Demographic Index; YLDs, years lived with disability.

Data Sharing Statement

The data used for these analyses are all publicly available at online GBD repository (http://ghdx.healthdata.org/gbd-results-tool).

Ethics Approval and Consent to Participate

The requirement for ethical review was waived by the Ethics Committee of Xiangya Hospital, Central South University, because it used publicly available and deidentified data from GBD database.

Consent for Publication

All authors gave consent for the publication of this study.

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Author Contributions

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

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Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Zimmermann MB. Iodine deficiency. *Endocr Rev*. 2009;30(4):376–408. doi:10.1210/er.2009-0011
2. Wei R, Wang Z, Zhang X, Wang X, Xu Y, Li Q. Burden and trends of iodine deficiency in Asia from 1990 to 2019. *Public Health*. 2023;222:75–84. doi:10.1016/j.puhe.2023.06.034
3. Andersson M, de Benoist B, Rogers L. Epidemiology of iodine deficiency: salt iodisation and iodine status. *Best Pract Res Clin Endocrinol Metab*. 2010;24(1):1–11. doi:10.1016/j.beem.2009.08.005
4. Roche J, Michel R. Thyroid hormones and iodine metabolism. *Annu Rev Biochem*. 1954;23:481–500. doi:10.1146/annurev.bi.23.070154.002405
5. Laurberg P. Thyroid function: thyroid hormones, iodine and the brain-an important concern. *Nat Rev Endocrinol*. 2009;5(9):475–476. doi:10.1038/nrendo.2009.155
6. Mullur R, Liu YY, Brent GA. Thyroid hormone regulation of metabolism. *Physiol Rev*. 2014;94(2):355–382. doi:10.1152/physrev.00030.2013
7. Zimmermann MB, Jooste PL, Pandav CS. Iodine-deficiency disorders. *Lancet*. 2008;372(9645):1251–1262. doi:10.1016/S0140-6736(08)61005-3
8. Zimmermann MB, Boelaert K. Iodine deficiency and thyroid disorders. *Lancet Diabetes Endocrinol*. 2015;3(4):286–295. doi:10.1016/S2213-8587(14)70225-6
9. Glinoer D. Pregnancy and iodine. *Thyroid*. 2001;11(5):471–481. doi:10.1089/105072501300176426
10. Boyages SC, Collins JK, Maberly GF, Jupp JJ, Morris J, Eastman CJ. Iodine deficiency impairs intellectual and neuromotor development in apparently-normal persons. A study of rural inhabitants of north-central China. *Med J Aust*. 1989;150(12):676–682. doi:10.5694/j.1326-5377.1989.tb136760.x
11. Patriota ESO, Lima ICC, Nilson EAF, Franceschini SCC, Goncalves VSS, Pizato N. Prevalence of insufficient iodine intake in pregnancy worldwide: a systematic review and meta-analysis. *Eur J Clin Nutr*. 2022;76(5):703–715. doi:10.1038/s41430-021-01006-0
12. Li M, Eastman CJ. The changing epidemiology of iodine deficiency. *Nat Rev Endocrinol*. 2012;8(7):434–440. doi:10.1038/nrendo.2012.43
13. Saha S, Abu BAZ, Jamshidi-Naeini Y, et al. Is iodine deficiency still a problem in sub-Saharan Africa?: a review. *Proc Nutr Soc*. 2019;78(4):554–566. doi:10.1017/S0029665118002859
14. Daniel KS, Mangano KM. Resurgence of iodine deficiency in the United States during pregnancy: potential implications for cognitive development in children. *Nutr Rev*. 2025. doi:10.1093/nutrit/nuaf025
15. Kiely ME, McCarthy EK, Á H. Iron, iodine and vitamin D deficiencies during pregnancy: epidemiology, risk factors and developmental impacts. *Proc Nutr Soc*. 2021;80(3):290–302. doi:10.1017/s0029665121001944

16. Assefa DT, Berbada DA, Merkina MM, et al. Association between nutritional status and physical activity among reproductive age women in Arba Minch health and demographic surveillance site, Southern Ethiopia. *Int J Public Health*. 2025;70:1608161. doi:10.3389/ijph.2025.1608161
17. Diseases GBD, Injuries C. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10258):1204–1222. doi:10.1016/S0140-6736(20)30925-9
18. Collaborators GBDD. Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950-2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10258):1160–1203. doi:10.1016/S0140-6736(20)30977-6.
19. Collaborators GBDRF. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10258):1223–1249. doi:10.1016/S0140-6736(20)30752-2.
20. DALYs GBD, Collaborators H. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2017: a systematic analysis for the global burden of disease study 2017. *Lancet*. 2018;392(10159):1859–1922. doi:10.1016/S0140-6736(18)32335-3.
21. Disease GBD, Injury I, Prevalence C. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392 (10159):1789–1858. doi:10.1016/S0140-6736(18)32279-7.
22. Wang H, Zhao S, Wang S, et al. Global magnitude of encephalitis burden and its evolving pattern over the past 30 years. *J Infect*. 2022;84 (6):777–787. doi:10.1016/j.jinf.2022.04.026
23. Liu Y, Yang X, He Z, et al. Spinal cord injury: global burden from 1990 to 2019 and projections up to 2030 using Bayesian age-period-cohort analysis. *Front Neurol*. 2023;14:1304153. doi:10.3389/fneur.2023.1304153
24. Huang J, Yan H, Li H, Li FX, Tang M, Lu DL. The comparative burden of brain and central nervous system cancers from 1990 to 2019 between China and the United States and predicting the future burden. *Front Public Health*. 2022;10:1018836. doi:10.3389/fpubh.2022.1018836
25. Bath SC, Rayman MP. Iodine deficiency in the U.K.: an overlooked cause of impaired neurodevelopment? *Proc Nutr Soc*. 2013;72(2):226–235. doi:10.1017/S0029665113001006
26. Niwattisaiwong S, Burman KD, Li-Ng M. Iodine deficiency: clinical implications. *Cleve Clin J Med*. 2017;84(3):236–244. doi:10.3949/ccjm.84a.15053
27. Sorrenti S, Baldini E, Pironi D, et al. Iodine: its role in thyroid hormone biosynthesis and beyond. *Nutrients*. 2021;13(12):4469. doi:10.3390/nu13124469
28. Redmond GP. Thyroid dysfunction and women's reproductive health. *Thyroid*. 2004;14 Suppl 1:S5–15. doi:10.1089/105072504323024543
29. Bougma K, Aboud FE, Harding KB, Marquis GS. Iodine and mental development of children 5 years old and under: a systematic review and meta-analysis. *Nutrients*. 2013;5(4):1384–1416. doi:10.3390/nu5041384
30. Redman K, Ruffman T, Fitzgerald P, Skeaff S. Iodine deficiency and the brain: effects and mechanisms. *Crit Rev Food Sci Nutr*. 2016;56 (16):2695–2713. doi:10.1080/10408398.2014.922042
31. Melse-Boonstra A, Jaiswal N. Iodine deficiency in pregnancy, infancy and childhood and its consequences for brain development. *Best Pract Res Clin Endocrinol Metab*. 2010;24(1):29–38. doi:10.1016/j.beem.2009.09.002
32. Mills JL, Ali M, Buck Louis GM, et al. Pregnancy loss and iodine status: the LIFE prospective cohort study. *Nutrients*. 2019;11(3):534. doi:10.3390/nu11030534
33. Snart CJP, Threapleton DE, Keeble C, et al. Maternal iodine status, intrauterine growth, birth outcomes and congenital anomalies in a UK birth cohort. *BMC Med*. 2020;18(1):132. doi:10.1186/s12916-020-01602-0
34. Greenwood DC, Webster J, Keeble C, Taylor E, Hardie LJ. Maternal iodine status and birth outcomes: a systematic literature review and meta-analysis. *Nutrients*. 2023;15(2):387. doi:10.3390/nu15020387
35. Businge CB, Longo-Mbenza B, Kengne AP. Mildly elevated thyroid-stimulating hormone is associated with endothelial dysfunction and severe preeclampsia among pregnant women with insufficient iodine intake in Eastern Cape province, South Africa. *Ann Med*. 2021;53(1):1083–1089. doi:10.1080/07853890.2021.1947520
36. Businge CB, Longo-Mbenza B, Kengne AP. Iodine deficiency in pregnancy along a concentration gradient is associated with increased severity of preeclampsia in rural Eastern Cape, South Africa. *BMC Pregnancy Childbirth*. 2022;22(1):98. doi:10.1186/s12884-021-04356-6
37. World Health Organization. *Nutrition U. Iodine and Health: Eliminating Iodine Deficiency Disorders Safely Through Salt Iodization, a Statement by the World Health Organization*. Geneva: World Health Organization; 1994.
38. Delange F, Burgi H, Chen ZP, Dunn JT. World status of monitoring iodine deficiency disorders control programs. *Thyroid*. 2002;12(10):915–924. doi:10.1089/105072502761016557
39. Jiang S, Liu J, Qi X, et al. Global, regional, and national estimates of nutritional deficiency burden among reproductive women from 2010 to 2019. *Nutrients*. 2022;14(4):832. doi:10.3390/nu14040832
40. Ji S, Zhou Y, Zhao Q, Chen R, Su Z. Trends in three malnutrition factors in the global burden of disease: iodine deficiency, vitamin A deficiency, and protein-energy malnutrition (1990-2019). *Front Nutr*. 2024;11:1426790. doi:10.3389/fnut.2024.1426790
41. Chotivichien S, Chongchaithet N, Aksornchu P, et al. Assessment of the contribution of industrially processed foods to salt and iodine intake in Thailand. *PLoS One*. 2021;16(7):e0253590. doi:10.1371/journal.pone.0253590
42. Codling K, Laillou A, Rudert C, Borath M, Gorstein J. Universal Salt Iodisation: lessons learned from Cambodia for ensuring programme sustainability. *Matern Child Nutr*. 2020;16 Suppl 2(Suppl 2):e12827. doi:10.1111/mcn.12827
43. Claborn DM. A narrative review of the role of economic crisis on health and healthcare infrastructure in three disparate national environments. *Int J Environ Res Public Health*. 2020;17(4):1252. doi:10.3390/ijerph17041252
44. Kardas P, Mogilevkina I, Aksoy N, et al. Barriers to healthcare access and continuity of care among Ukrainian war refugees in Europe: findings from the RefuHealthAccess study. *Front Public Health*. 2025;13:1516161. doi:10.3389/fpubh.2025.1516161
45. Shin SS, Choi RY, Novotny TE. Economic sanctions towards North Korea. *BMJ*. 2009;339:b4069. doi:10.1136/bmj.b4069
46. Wu Z, Liu Y, Wang W. The burden of iodine deficiency. *Arch Med Sci*. 2024;20(5):1484–1494. doi:10.5114/aoms/178012
47. Gong B, Wang C, Yang W, Shan Z. Changing trends in the global, regional, and national burden of iodine deficiency among adolescents and young adults: population-based study. *Eur J Pediatr*. 2024;183(7):2855–2863. doi:10.1007/s00431-024-05545-z

48. Díaz JR, de Las Cagigas A, Rodríguez R. Micronutrient deficiencies in developing and affluent countries. *Eur J Clin Nutr*. 2003;57 Suppl 1:S70–2. doi:10.1038/sj.ejcn.1601820
49. Müller O, Krawinkel M. Malnutrition and health in developing countries. *Cmaj*. 2005;173(3):279–286. doi:10.1503/cmaj.050342
50. Ning P, Ren Q, Teng D, et al. Current iodine nutrition status and prevalence of thyroid disorders in Tibetan adults in an oxygen-deficient plateau, Tibet, china: a population-based study. *Thyroid*. 2020;30(5):759–766. doi:10.1089/thy.2019.0669
51. Chakravarty I, Sinha RK. Prevalence of micronutrient deficiency based on results obtained from the national pilot program on control of micronutrient malnutrition. *Nutr Rev*. 2002;60(5 Pt 2):S53–8. doi:10.1301/00296640260130740
52. Pretell EA, Pearce EN, Moreno SA, et al. Elimination of iodine deficiency disorders from the Americas: a public health triumph. *Lancet Diabetes Endocrinol*. 2017;5(6):412–414. doi:10.1016/s2213-8587(17)30034-7
53. Zimmermann MB, Gizak M, Abbott K, Andersson M, Lazarus JH. Iodine deficiency in pregnant women in Europe. *Lancet Diabetes Endocrinol*. 2015;3(9):672–674. doi:10.1016/s2213-8587(15)00263-6
54. Mallawa Kankanamalage O, Zhou Q, Li X. Understanding the pathogenesis of gestational hypothyroidism. *Front Endocrinol*. 2021;12:653407. doi:10.3389/fendo.2021.653407
55. Als C, Keller A, Minder C, Haldimann M, Gerber H. Age- and gender-dependent urinary iodine concentrations in an area-covering population sample from the Bernese region in Switzerland. *Eur J Endocrinol*. 2000;143(5):629–637. doi:10.1530/eje.0.1430629
56. Bath SC. Thyroid function and iodine intake: global recommendations and relevant dietary trends. *Nat Rev Endocrinol*. 2024;20(8):474–486. doi:10.1038/s41574-024-00983-z
57. Zimmermann MB. Iodine deficiency in industrialized countries. *Clin Endocrinol*. 2011;75(3):287–288. doi:10.1111/j.1365-2265.2011.04168.x
58. Rodriguez-Diaz E, Pearce EN. Iodine status and supplementation before, during, and after pregnancy. *Best Pract Res Clin Endocrinol Metab*. 2020;34(4):101430. doi:10.1016/j.beem.2020.101430
59. Gallego G, Goodall S, Eastman CJ. Iodine deficiency in Australia: is iodine supplementation for pregnant and lactating women warranted? *Med J Aust*. 2010;192(8):461–463. doi:10.5694/j.1326-5377.2010.tb03586.x