Global prevalence and epidemiological trends of Hashimoto’s thyroiditis in adults: A systematic review and meta-analysis

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Objective: Although Hashimoto’s thyroiditis is associated with cardiovascular disease and malignancy, the global status of Hashimoto’s thyroiditis is not well characterized across regions. Our objective was to evaluate the prevalence and trends of Hashimoto’s thyroiditis in adults in regions with different economic income levels around the world.

Methods: For this systematic review and meta-analysis, we searched PubMed, Embase, MEDLINE, Scopus, and Web of Science databases, and 48 random-effects representative studies from the inception to June 2022 were included without language restrictions to obtain the overall prevalence of Hashimoto’s thyroiditis in adults worldwide. In addition, we stratified by time of publication, geographic region, economic level of the region of residence, gender, diagnostic method, etc.

Results: A total of 11,399 studies were retrieved, of which 48 met the research criteria: 20 from Europe, 16 from Asia, five from South America, three from North America, and three from Africa. Furthermore, there are two projects involving 19 countries and 22,680,155 participants. The prevalence of Hashimoto’s thyroiditis was 7.5 (95% CI 5.7–9.6%), while in the low-middle-income group the prevalence was 11.4 (95% CI 2.5–25.2%). Similarly, the prevalence was 5.6 (95% CI 3.9–7.4%) in the upper-middle-income group, and in the high-income group, the prevalence was 8.4 (95% CI 5.6–11.8). The prevalence of Hashimoto’s varied by geographic region: Africa (14.2 [95% CI 2.5–32.9%]), Oceania (11.0% [95% CI 7.8–14.7%]), South America and Europe 8.0, 7.8% (95% CI 0.0–29.5%) in North America, and 5.8 (95% CI 2.8–9.9%) in Asia. Although our investigator heterogeneity was high (I²), our results using a sensitivity analysis showed robustness and reliability of the findings. People living in low-middle-income areas are more likely to develop Hashimoto’s thyroiditis, while the group in high-income areas are more likely to develop Hashimoto’s thyroiditis than people in upper-middle-income areas, and women’s risk is about four times higher than men’s.
Conclusions: Global Hashimoto’s thyroiditis patients are about four times as many as males, and there are discrepancies in the regions with different economic levels. In low-middle-income areas with a higher prevalence of Hashimoto’s thyroiditis, especially countries in Africa, therefore local health departments should take strategic measures to prevent, detect, and treat Hashimoto’s thyroiditis. At the same time, the hidden medical burden other diseases caused by Hashimoto’s thyroiditis should also be done well.

Systematic review registration: https://www.crd.york.ac.uk/prospero/, identifier: CRD 42022339839.

**KEYWORDS**
Hashimoto’s thyroiditis, global prevalence, epidemiological trends, systematic review, meta-analysis

**Introduction**

Hashimoto’s thyroiditis (HT), also known as autoimmune thyroiditis (AIT) or chronic lymphocytic thyroiditis, is an autoimmune disease of the thyroid gland, often characterized by an enlarged thyroid gland, lymphocytic infiltration, and elevated serum autoimmune antibody levels. HT is a common cause of hypothyroidism in iodine-replete settings and increases the risk of malignancy (1–3).

The prevalence of HT varies by region and socioeconomic level, ranging from 4.8–25.8% in women and 0.9–7.9% in men (4). As we all known, the prevalence of HT varies significantly depending on geographic location. Although several previous studies have systematically described the prevalence of HT, none of them reviewed global HT prevalence and trends. Current researches have shown that the global prevalence of various autoimmune diseases was increasing (5), it is worth being exploring whether the global prevalence of HT has also increased. This study aimed to quantify the possible healthcare burden and plan for the future by assessing the global prevalence and trends of HT by analyzing the prevalence of HT in different regions.

**Methods**

**Registration**

Meta-based analysis was applied in this study. Compared with traditional literature review or the emerging bibliometric analysis, systematic review and meta-analysis had a relatively broad horizon of the current hotspots and can quantitatively reflect the research status in the field (1–3). This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols guidelines (4) and is registered with the International Prospective Register of Systematic Reviews (CRD42022339839).

![Figure 1](imageurl)

**Search strategy and selection criteria**

Five database including PubMed, Embase, MEDLINE, Scopus, and Web of Science databases were searched from inception until June 2022, with no language restrictions. The retrieval strategies included three core panels, associated with using AND connectors: (1) Hashimoto’s thyroiditis, (2) Prevalence, and (3) Observational studies. The three core
| Source       | Year | Nation     | Income group | Continent | Case | Type of study design | Sample type          | Test method                          | Time period | Sample source                        |
|--------------|------|------------|--------------|-----------|------|----------------------|----------------------|--------------------------------------|-------------|---------------------------------------|
| Okayasu I    | 1991 | Japan      | High income  | Asia      | 328  | Cross-sectional study | Thyroid tissue       | Pathological section                | 1990        | Clinic-based study                    |
| Okayasu I    | 1994 | USA        | High income  | North America | 457  | Cross-sectional study | Thyroid tissue       | Pathological section                | 1975-1992   | Clinic-based study                    |
| Morinaka S   | 1995 | Japan      | High income  | Asia      | 61   | Cross-sectional study | Serum                | Antibodies, ultrasound, fine needle aspiration | 1990-1994 | Clinic-based study                    |
| Tomimori E   | 1995 | Brazil     | Upper middle income | South America | 72   | Cross-sectional study | -                    | Ultrasound                           | 1990-1995 | Population-based study                |
| Nagata K     | 1998 | Japan      | High income  | Asia      | 142  | Cross-sectional study | Serum Antibodies, ultrasound, fine needle aspiration | 1998 | Population-based study                |
| Aghini-Lombardi F | 1999 | Italy      | High income  | Europe    | 50   | Cross-sectional study | Serum                | Antibody                            | 1998 | Population-based study                |
| Pedersen IB  | 2003 | Denmark    | High income  | Europe    | 787  | Array research        | Serum                | Antibody                            | 1997-1998 | Population-based study                |
| Velioke H    | 2003 | Germany    | High income  | Europe    | 47   | Cross-sectional study | Serum                | Antibody                            | 1997-2001 | Population-based study                |
| Teng W       | 2006 | China      | Upper middle income | Asia | 32 | Cross-sectional study | Serum                | Antibody                            | 1999 | Population-based study                |
| Camargo RY   | 2006 | Brazil     | Upper middle income | South America | 82  | Cross-sectional study | Serum Antibodies, ultrasound | 1998-2005 | Population-based study                |
| Okosieme OE  | 2007 | Nigeria    | Lower middle income | Africa | 7   | Cross-sectional study | Serum                | Antibody                            | 2006 | Clinic-based study                    |
| Kurata S     | 2007 | Japan      | High income  | Asia      | 25   | Cross-sectional study | Serum,thyroid tissue Antibodies, ultrasound, fine needle aspiration | 2002-2007 | Clinic-based study                    |
| Teng X       | 2008 | China      | Upper middle income | Asia | 67 | Array research       | Serum                | Antibodies, ultrasound | 2005 | Population-based study                |
| Camargo RY   | 2008 | Brazil     | Upper middle income | South America | 183 | Cross-sectional study | Serum                | Antibody                            | 2004 | Population-based study                |
| Dobert N     | 2008 | Germany    | High income  | Europe    | 98   | Cross-sectional study | Serum                | Antibodies, ultrasound              | 2006 | Population-based study                |
| Benvenega S  | 2008 | Italy      | High income  | Europe    | 4064 | Array research       | Serum,thyroid tissue Antibodies, ultrasound, fine needle aspiration | 1975-2005 | Clinic-based study                    |
| Teng XC      | 2011 | China      | Upper middle income | Asia | 363 | Cross-sectional study | Serum                | Antibodies, ultrasound | 2007 | Population-based study                |
| Deshpande P  | 2016 | Australia  | High income  | Oceania   | 17   | Cross-sectional study | Serum                | Antibody                            | 1994 | Population-based study                |
| Fernando RF  | 2012 | Sri Lanka  | Lower middle income | Asia | 353 | Cross-sectional study | Serum                | Antibody                            | 2007-2008 | Population-based study                |
| Sardu C      | 2012 | Italy      | High income  | Europe    | 678  | Cross-sectional study | NR                  | NR                                   | 2009        | Population-based study                |
| Source                  | Year | Nation          | Income group | Continent     | Case | Total   | Type of study design | Sample type | Test method               | Time period | Sample source  |
|------------------------|------|-----------------|--------------|---------------|------|---------|----------------------|-------------|---------------------------|-------------|----------------|
| Aghini Lombardi F       | 2013 | Italy           | High income  | Europe        | 224  | 1,065   | Cross-sectional study | Thyroid tissue | Antibodies, ultrasound     | 2010        | Population-based study  |
| Vecchiatti SM           | 2015 | Brazil          | Upper middle income | South America | 106  | 4,613   | Cross-sectional study | Thyroid tissue | Pathological section       | 2003-2007   | Clinic-based study       |
| Wu Q                   | 2015 | China           | Upper middle income | Asia     | 172  | 6,152   | Cross-sectional study | Serum         | Antibody                  | 2013        | Population-based study   |
| Flores-Rebollar A       | 2015 | Mexico          | Upper middle income | North America | 36   | 427     | Cross-sectional study | Serum         | Antibodies, ultrasound     | 2010-2015   | Population-based study   |
| Li Y                   | 2016 | China           | Upper middle income | Asia     | 187  | 2,856   | Array research       | Serum         | Antibody                  | 2013        | Population-based study   |
| Caturegli G            | 2016 | USA             | High income  | North America | 4    | 1,075   | Cross-sectional study | NR           | NR                        | 2015        | Population-based study   |
| Tammaro A              | 2016 | Italy           | High income  | Europe        | 2828 | 7,976   | Array research       | Serum         | Antibody                  | 2003-2010   | Population-based study   |
| Tolentino Júnior DS    | 2019 | Brazil          | Upper middle income | South America | 85   | 60,413  | Cross-sectional study | NR           | NR                        | 2016        | Population-based study   |
| Pilli T                | 2019 | Italy           | High income  | Europe        | 9    | 142     | Cross-sectional study | Serum         | Antibody                  | 2014-2019   | Clinic-based study       |
| Troshina EA            | 2021 | Russia          | Upper middle income | Europe     | 428  | 100,000 | Cross-sectional study | Serum         | Antibody                  | 2018        | Population-based study   |
| Chen Y                 | 2021 | China           | Upper middle income | Asia     | 298  | 2,946   | Cross-sectional study | Serum         | Antibodies, ultrasound     | 2016-2021   | Population-based study   |
| Kim HJ                 | 2021 | South Korea     | High income  | Asia          | 29429 | 217,05883 | Array research      | NR           | NR                        | 2002-2017   | Population-based study   |
| Yu ZW                  | 2021 | China           | Upper middle income | Asia     | 148  | 1,159   | Cross-sectional study | Thyroid tissue | Pathological section       | 2016-2020   | Population-based study   |
| Józkow P               | 2017 | Poland          | High income  | Europe        | 29375 | 586,703 | Cross-sectional study | Serum         | Antibody                  | 2006-2013   | Clinic-based study       |
| Izcic B                | 2021 | Bosnia and Herzegovina | Upper middle income | Europe | 358  | 82,000  | Array research       | Serum         | Antibody                  | 2015-2020   | Population-based study   |
| Gu F                   | 2016 | China           | Upper middle income | Asia     | 17   | 5,293   | Cross-sectional study | Serum         | Antibodies, ultrasound     | 2011        | Population-based study   |
| Bjøro T                | 1984 | Norway          | High income  | Europe        | 56   | 1,640   | Cross-sectional study | Serum         | Antibody                  | 1979        | Population-based study   |
| Chabchoub G            | 2006 | Tunisia         | Lower middle income | Africa   | 246  | 1,079   | Array research       | Serum         | Antibody                  | 1990-2003   | Clinic-based study       |
| Dingle PR              | 1966 | England         | High income  | Europe        | 52   | 469     | Cross-sectional study | Serum         | Antibody                  | 1962        | Population-based study   |
| Jacobs A               | 1969 | England         | High income  | Europe        | 99   | 989     | Cross-sectional study | Serum         | Antibody                  | 1969        | Population-based study   |
| Tunbridge WM           | 1977 | England         | High income  | Europe        | 56   | 2779    | Cross-sectional study | Serum         | Antibody                  | 1972-1974   | Population-based study   |
| Source       | Year | Nation    | Continent | Income group | Total Type of study | Case group | Sample size | Type of study design | Sample type | Test method | Time period | Sample source |
|-------------|------|-----------|-----------|--------------|--------------------|------------|-------------|--------------------|-------------|-------------|------------|----------------|
| Prentice LM  | 1990 | England  | Europe    | High income  | Cross-sectional study | Serum      | 124         | Antibody           | 1985-1990   | Population-based study |
| Aho K       | 1971 | Finland  | Europe    | High income  | Cross-sectional study | Serum      | 89          | Antibody           | 1970        | Clinic-based study   |
| Gordin A    | 1972 | Finland  | Europe    | High income  | Cross-sectional study | Serum      | 282         | Antibody           | 1970-1972   | Population-based study |
| Bryhni B    | 1996 | Norway   | Europe    | High income  | Cross-sectional study | Serum      | 176         | Antibody           | 1979-1980   | Population-based study |
| Konno N     | 1993 | Japan    | Asia      | High income  | Cross-sectional study | Serum      | 457         | Antibody           | 1990-1991   | Population-based study |
| O’Leary PC  | 2005 | Australia| Asia      | High income  | Cross-sectional study | Serum      | 262         | Antibody           | 1990-1991   | Population-based study |
| Li YS       | 2008 | China    | Asia      | Upper middle  | Cross-sectional study | Serum      | 353         | Antibodies, ultrasound | 2004        | Population-based study |

The articles we included were all observational studies which reported the prevalence of HT with no interventions. We excluded articles for which full-text or original data were not available, and studies with a sample size fewer than 100 participants. Two authors (XH and YiS) independently screened eligible research records in accordance with title and abstract, respectively. And two additional authors (RT and YuS) retrieved the full text of potentially eligible articles to determine final inclusion. Inconsistent choices are resolved through discussion or third-party author participation.

### Data extraction and quality assessment

Data were extracted by one author using a standardized template, cross-checked by another author, and ambiguities resolved by discussion. Extracted data included the year of publication, first author, country of publication, geographic location, study type, sample size, diagnostic method, duration, sample source, and prevalence. We used an existing checklist modified by Hoy D to assess the quality of included studies (6). The list contained a total of nine questions, each question could be answered “yes” or “no,” and answering “yes” earns one point. The final score for each study was between zero and nine. Zero to three was low quality, four to six was medium quality, and seven to nine was high quality.

### Statistical analyses

We performed a meta-analysis of the extracted data and carried out statistical analysis using R software (version 4.0.3). The *meta* package in R software (version 4.0.3, Auckland University, USA) was mainly used for data analysis and the main outcome was assessed via single-arm analysis. For the prevalence or proportion, firstly, the normality test was conducted. If the data did not conform to the normality, it would be transformed by logarithm, logit, or double anti-sinusoidal transformation, and then, the inverse variance weighting method was used to combine.

The Cochrane *Q*-test and *I*² value were used to test whether there was significant heterogeneity among all studies (7). According to the Meta-analysis of Observational Studies in Epidemiology guideline (8), if *P* > 0.10 and *I*² ≤ 50%, it indicated that there was no statistical heterogeneity among the research results, and the fixed effect model was applied to analyze the results; If *P* ≤ 0.1 and *I*² > 50%, the random effect model was used for meta-analysis. Publication bias was evaluated using Egger’s test combined with a funnel plot. If there was obvious publication bias, we would use the trim-and-fill method to adjust
| Scale | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | Overall |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | + | X | + | + | + | + | + | + | + | + |
| 2 | + | X | + | + | + | + | + | + | + | + |
| 3 | + | X | + | + | + | + | + | + | + | + |
| 4 | + | X | + | + | + | + | + | + | + | + |
| 5 | + | X | + | + | + | + | + | + | + | + |
| 6 | + | X | + | + | + | + | + | + | + | + |
| 7 | + | X | + | + | + | + | + | + | + | + |
| 8 | + | X | + | + | + | + | + | + | + | + |
| 9 | + | X | + | + | + | + | + | + | + | + |
| 10 | + | X | + | + | + | + | + | + | + | + |

**FIGURE 2**
Literature quality assessment.

1. The targeted population was a true representation of the studied population.
2. The sampling frame was a true or close representation of the target population.
3. The subjects were not excluded after randomization.
4. The case definition was acceptable.
5. The data collection methods used were reliable and valid.
6. The method used to collect the data was the same for all subjects.
7. The study was a sufficient period of time or equal to the time to account for seasonal variations of the parameter of study interest.
8. The data were largely recorded directly from the participants.

**Judgment**
- Low
- Under
- High
for prospective plot asymmetry. And provided that necessary, sensitivity analysis was performed by grouping or omitting each study. Given that it was infeasible to make a quantitative synthesis and conduct a meta-analysis, a narrative approach and descriptive statistics were used. In addition, we performed subgroup analyses by income, geographic region, study type, diagnostic method, time of the study, and source of participants.

**Result**

**Study characteristics**

A total of 11,399 records were retrieved and identified across five databases. After removing duplicate literature, 7,989 articles were screened out. Hundred and fifty four studies were reviewed.
FIGURE 4
Global prevalence of Hashimoto’s thyroiditis, by time of study implementation.
for full text, and a total of 48 studies were finally included (9–56) (Figure 1). All studies were observational (40 cross-sectional, eight cohort studies) involving 22,680,155 participants (Table 1). Thirty-seven of the 48 studies were population-based and 11 were clinical-based. Thirty-seven of the 48 studies were population-based and 11 were clinical-based. Twenty-seven studies confirmed HT was due to serum autoantibody levels, nine studies that used serum autoantibodies combined with ultrasonography to confirm the diagnosis, three studies that used serum autoantibodies to combine ultrasonography and fine needle aspiration, four studies on biopsy, only one study on ultrasonography alone, and four items not reported. Participants spanned from 1962 to 2021 and included studies published from 1966 to 2021 (Table 1). Twenty-one studies were published before 2000 and 27 studies were published after 2000. Of the 48 studies, 20 were from Europe, 16 from Asia, five from South America, three from North America, two from Africa, and two from Oceania, involving 19 countries. The quality scores of 48 articles are all six points or above, and the detailed quality assessment results are shown in Figure 2.

**Meta-analysis results**

We extracted data points from 48 studies that met the inclusion criteria to form the initial data. The initial data was tested by Shapiro-Wilk (SW), \( P = 0.002047 < 0.05 \), which did not conform to the normal distribution, so we adopted Freeman-Tukey double arcsine transformation. After the transformation, the data showed a normal distribution. We executed a data pooled meta-analysis and estimated the global prevalence of HT in adults to be 7.5% (Figure 3). The prevalence of HT in adults has declined over the past 60 years, from 9% before 2000 to 6.5% after 2000 (Figure 4). HT prevalence of female adults was 3.86 adult males times (17.5 vs. 6.0%) (Figure 5). The prevalence of HT in clinical studies was 8.6% higher than in population-based studies (8.6 vs. 7.5%) (Figure 6). The prevalence of HT in adults from different continents was diverse, with the highest prevalence of HT in African adults (14.2%), followed by Oceania (11.0%), 8.0% in both South American and European adults, and 7.8% in North America. The lowest prevalence of HT in Asian adults was 5.8% (Figure 7). According to the latest income classification of the World Bank (https://datatopics.worldbank.org/world-developmentindicators/the-world-by-incomeand-region.htm), we conducted a subgroup analysis according to low-income, lower-middle-income, upper-middle-income, and high-income groups. The results showed that the prevalence of HT adults in the low-middle-income group was 11.4%, in the upper-middle-income group, the prevalence was 5.6%, and in the high-income group, the prevalence was 8.4% (Figure 8).

**Quality assessment**

We conducted a subgroup analysis according to different diagnostic methods. The results of analysis indicated that the prevalence of HT diagnosed by serum autoantibodies was 7.8 (95% CI 5.4–10.5%), and the prevalence of HT diagnosed by ultrasonography was 13.2 (95% CI 5.7–9.6%). Similarly, the prevalence of HT was diagnosed by pathological examination was 12.5 (95% CI 3.3–26.5%) (Figure 9). The prevalence rate of HT diagnosed by serum autoantibody level combined with color Doppler ultrasound was 10.4 (95% CI 5.1–17.1%), while the prevalence rate of HT diagnosed by serum autoantibody level, color Doppler ultrasonography, and fine
FIGURE 6
Global prevalence of Hashimoto’s thyroiditis, by study source.
FIGURE 7

Global prevalence of Hashimoto’s thyroiditis, by geographic location.
FIGURE 8

Global prevalence of Hashimoto’s thyroiditis, by income.
FIGURE 9
Subgroup analysis of diagnostic methods.
FIGURE 9
Prevalence of Hashimoto's thyroiditis by country.

| Region       | Count | Prevalence (95% CI) |
|--------------|-------|---------------------|
| Europe       |       |                     |
| Asia         |       |                     |
| South America|       |                     |
| North America|       |                     |
| Africa       |       |                     |
| Oceania      |       |                     |

The prevalence of HT in adults varies significantly across countries, ranging as high as 22.8% (95% Cl 20.3–25.4%) in Tunisia and 18.8% (95% Cl 17.6–20.0%) in Denmark, while the prevalence in South Korea is as low as 0.1%, and in adults in Russia and Bosnia and Herzegovina, The prevalence of HT was 0.4% (Figure 10).

Among the 48 observational studies, 42 studies were low risk (good quality), and 6 studies were rated as medium risk, making a risk of bears evaluation chart (Figure 11). Funnel plots and Egger's test linear regression were used to test for publication bias. There was a publication bias in each study (P < 0.05). The results are shown in the Appendix 1 (Figure 12). We used the trim-and-fill method to correct for publication bias. Sensitivity analysis showed that the literature included in this study had little impact on the results of the study analysis, and removing any one of the studies would have a small impact (Figure 13).

Discussion

This systematic review and meta-analysis provides a comprehensive assessment of the prevalence of HT in adults worldwide, which is associated with the occurrence of various malignant tumors (2, 57, 58). In total, this study pooled 48 studies involving more than 20 million adult patients with HT and performed subgroup analyses by type of study, diagnostic method, the timing of study conduct, patient source, gender, geographic location, and economic level. We found that the prevalence of HT in adults varies widely across continents. African adults have the highest prevalence of HT, more than double the prevalence in Asia. We also found that the prevalence of HT in adults decreased as time went by. Unlike previous studies (59–61), the prevalence of Hashimoto's thyroiditis in adults decreased over time.

In our study, the overall prevalence of HT in adults was 7.5%, with a prevalence of 17.5% in women and 6.0% in men. The risk of developing HT in adult women is approximately 4 times that of adult men. Tunbridge et al. reported that in the United States, 10% of the population had thyroid antibodies, a prevalence of 14% in whites and about 5% in blacks (49). In the report, the prevalence of female HT was higher, and the ratio of female HT patients to male HT patients was 8–9:1 (60). In contrast, the prevalence of HT in the study by Gu et al. was much lower (3.2%) (24).

Our study involved 19 countries and 6 continents (Europe, Asia, South America, North America, Africa, and Oceania), and needle aspiration (FNA) was 4.7% (95% 0.0–21.0%) (Figure 9).

We performed a subgroup analysis of samples diagnosed with HT. The prevalence of HT confirmed by serum was 7.8% (95% Cl 5.8–10.1%), the prevalence of HT confirmed by serum or pathological tissue was 7.6% (95% Cl 0.0–30.2%), and the prevalence of HT confirmed by thyroid tissue alone was 14.1% (95% Cl 5.2–26.5%).
The prevalence data of HT adults in various regions of the world were aggregated to estimate the prevalence of HT in adults and development trend as far as possible. From 1960 to the present, we pooled data on adults with HT every 20 years to assess trends in the prevalence of HT in adults. We were surprised to find that the prevalence of HT in adults decreased regardless of whether we divided the study by time before and after 2000 or every 20 years. This is inconsistent with most studies. This may be related to different regions and periods, socioeconomic development, availability, and availability of medical resources. The progress of the social economy will promote people to pay more attention to physical health, increase the records of hospital visits, and also increase the chances of HT being detected and recorded. Therefore, studies in different periods in the same region have shown an increase in the prevalence of HT. Whether this is due to an increase in the prevalence of HT due to an increase in the number of people with HT or an increase in the probability of being detected is unclear. In our study, which pooled population-based and clinical-based studies separately, the prevalence of HT in adults was lower in
FIGURE 13
Sensitivity analysis chart of included studies.
population-based studies than in clinical studies (7.2 vs. 8.6%). This provides persuasive evidence for our hypothesis. Another reason may be that in the studies we included, the proportion of studies in different regions and different periods was different. The lowest prevalence of HT in adults (6.7%) was observed in 2000–2021, with a higher proportion of studies in Asia and Europe during this period, and a relatively high proportion of HT studies in North and South America between 1960–1981.

When we performed a subgroup analysis according to the latest income classification of the World Bank, we found an interesting phenomenon. A higher prevalence of HT among adults in low- and middle-income countries is conceivable. However, the higher prevalence of HT in adults in high-income countries than in upper-middle-income countries is indeed an interesting finding. This may be related to the pathogenesis of HT. People living in economically developed countries have increased pressure from various aspects (62), and mental health status is also an important cause of HT (61).

In our systematic review, Africa had the highest prevalence (14.2%) while Asia had the lowest prevalence (5.8%). The prevalence varies widely, which may be related to lifestyle and dietary habits. The pathogenesis of Hashimoto’s thyroiditis is still unclear, and some studies have pointed out that the lack of micronutrients may be related to the pathogenesis of thyroiditis, such as vitamin D deficiency (4, 63). In Africa, some people still live a traditional way of life (gathering, hunting, nomadic animals) (64). The lack of diversification of nutrient intake due to geographic location, environmental factors, and economic level may explain the high prevalence of HT in African adults. It may also be related to the number of studies included, with 16 studies included in Asia and only two studies from Africa. We cannot rule out differences due to differences in the number of included cases. HT is a chronic inflammatory disease, and chronic inflammation increases the risk of a variety of malignancies (65–67). The studies we included were all observational studies, most of which were cross-sectional studies, only to assess the prevalence of HT, with no follow-up for later cancer risk and treatment in HT patients. Therefore, our pooled estimates of the adult prevalence of HT may underestimate the actual burden on health care.

Our study systematically evaluated the global adult prevalence of HT for the first time and includes the largest number of studies on the prevalence of HT in adults. However, our study also involves certain limitations. The period of the studies we included was large. From 1962 to 2021, there may exist differences in the diagnostic criteria and detection methods of HT in different periods. In many cases, we were unable to obtain specific information on the diagnostic criteria for HT in the studies. Although we were unable to unify the diagnostic criteria for HT, we analyzed the prevalence of HT in adults by detection method. There was considerable heterogeneity among studies, and we performed subgroup analyses where possible, but this did not reduce heterogeneity between studies. This may be related to the regional economy, dietary habits, lifestyle, and diagnostic criteria of HT in different periods of the included studies. Sensitivity analysis showed that each study included in the study had little effect on the results and had good stability. The studies we included may have some selection bias, but the information in the studies was insufficient to assess these errors. We hope that the diagnostic criteria for HT will be unified as much as possible in future research so that the research results will be more convincing.

Conclusions

In conclusion, we found that the prevalence of Hashimoto’s thyroiditis in adult females is approximately four times that of male patients, and the prevalence of HT is relatively high in adults worldwide, especially in Africa. There are differences in the prevalence of HT among adults at different economic levels. The prevalence of HT in low- and middle-income countries is the highest, and the prevalence in high-income countries is higher than that in upper-middle-income countries. Therefore, we suggest that public health departments in low- and middle-income countries should take strategic measures to prevent, detect, and treat HT as early as possible, while high-income countries should also pay attention to the prevalence of HT and the burden of medical services.

Data availability statement

The original contributions presented in the study are included in the article-supplementary material, further inquiries can be directed to the corresponding author/s.

Author contributions

XH and YShen conceptualized, involved, and conducted this study. XH wrote the first draft under the guidance of HQ. YC, YShen, YSheng, and RT reviewed drafts and provided input for all versions. XH and YC accessed, verified, analyzed, and interpreted the data. All authors contributed to the article and approved the submitted version.

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Appendix

Literature search strategies.

**PubMed:** (((((epidemiology[Title/Abstract])) OR (incidence[Title/Abstract])) OR (prevalence[Title/Abstract])) AND (("Hashimoto Disease"[Mesh])) OR ((((((((((((((((((((((((((((((((((((Disease, Hashimoto[Title/Abstract])) OR (Hashimoto Struma[Title/Abstract])) OR (Hashimoto Thyroiditis[Title/Abstract])) OR (Hashimoto Thyroiditides[Title/Abstract])) OR (Hashimoto’s Syndrome[Title/Abstract])) OR (Hashimoto Syndrome[Title/Abstract])) OR (Hashimoto’s Syndromes[Title/Abstract])) OR (Hashimotos Syndrome[Title/Abstract])) OR (Syndrome, Hashimoto’s[Title/Abstract])) OR (Syndromes, Hashimoto’s[Title/Abstract])) OR (Hashimoto’s Struma[Title/Abstract])) OR (Chronic Lymphocytic Thyroiditis[Title/Abstract])) OR (Chronic Lymphocytic Thyroiditides[Title/Abstract])) OR (Lymphocytic Thyroiditides, Chronic[Title/Abstract])) OR (Lymphocytic Thyroiditis, Chronic[Title/Abstract])) OR (Thyroiditides, Chronic Lymphocytic[Title/Abstract])) OR (Thyroiditis, Chronic Lymphocytic[Title/Abstract])) OR (Disease, Hashimoto’s[Title/Abstract])) OR (Hashimotos Disease[Title/Abstract])) OR (Autoimmune thyroiditis[Title/Abstract]))).