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Global, regional, and national burden of thyroid cancer in young people aged 10–24 years from 1990 to 2021: an analysis based on the Global Burden of Disease Study 2021

Kaiyuan Huang[1†], Ningxin Wang[1†], Xuanwei Huang[1], Shuoying Qian[1], Yuan Cai[1], Fan Wu[2*] and Dingcun Luo[1,2,3*]

Abstract

Background The burden of thyroid cancer (TC) among young people aged 10–24 years has not been systematically studied to date. This study aims to analyze the burden of TC among young people aged 10–24 years globally, regionally, and nationally from 1990 to 2021.

Methods We collected data on the incidence, mortality, and disability-adjusted life years (DALYs) rates for TC among young people aged 10–24 years from 1990 to 2021 using the Global Burden of Disease (GBD) 2021. Joinpoint regression analysis, frontier analysis, and health inequality analysis were employed to examine the variations and changes in TC burden among young people aged 10–24 years across different countries and regions.

Results From 1990 to 2021, the global burden of TC among young people has increased from 2.726 per 100,000 people [95% Uncertainty Interval (UI) 2.38–3.181] to 2.956 per 100,000 people (95% UI: 2.339–3.922), with an Average Annual Percent Change (AAPC) of 0.258 (95% Confidence Interval (CI): 0.138—0.378). The highest incidence rates were observed in Saudi Arabia, Taiwan (China), and Vietnam, while the highest mortality rates were in India, China, and Bangladesh. Frontier analysis revealed that the largest disparities in effective differences were found in the Netherlands, Germany, Canada, the United States of America, and Guinea-Bissau. The Slope Index of Inequality (SII) for DALYs increased slightly from -0.15 in 1990 to -1.3 in 2021.

Conclusions Over the past three decades, the burden of TC has increased globally among young people, particularly in poorer countries and regions. This study highlights the importance of formulating public health policies tailored to the specific circumstances of different countries and regions aimed at reducing the TC burden among young people.

Keywords Thyroid cancer, Global disease burden 2021, Health inequality, DALYs

†Kaiyuan Huang and Ningxin Wang joint first authorship.

*Correspondence:
Fan Wu
docwf58@163.com
Dingcun Luo
ldc65@zju.edu.cn
Full list of author information is available at the end of the article

Introduction

Thyroid cancer is among the most common malignant endocrine tumors worldwide [1] and is a prevalent cancer among young people [2]. In recent years, the extensive discussion around the overdiagnosis and overscreening of TC suggests a significant potential increase in its incidence, particularly in high-income countries with well-established medical practices and robust healthcare services [3, 4]. Evidence from South Korea, Japan, and the United States indicates a correlation between overdiagnosis and increased TC risk [5–7]. Advancements in screening and diagnostic technologies have improved early detection but have also contributed to increased false positives [8]. In contrast, low- and middle-income countries, especially among young populations, have limited access to TC screening and diagnosis. These countries are often in a demographic transition phase with a higher proportion of young people compared to high-income countries [2]. Additionally, the incidence of TC among young people is on the rise [9]. It is worth noting that there is a negative correlation between patient age and disease aggressiveness, with younger patients often exhibiting higher recurrence rates, more lymph node metastases, and extraglandular invasion [10]. Their transition from students to workers increases their exposure to radiation. Additionally, hormonal changes during puberty contribute to an elevated risk of TC [11]. Quantifying the incidence and mortality rates of young people's TC across various countries, regions, and income levels provides valuable insights into the ecological correlation between the burden of young people's TC and socio-economic inequalities. Despite extensive research into the incidence and burden of TC in adults [12, 13], the burden of TC in the young people aged 10—24 years based on the GBD database still lacks systematic studies.

This study aims to systematically assess the global burden of TC among adolescents and young adults aged 10–24 years. We sought to analyze the spatiotemporal trends in TC incidence and mortality rates, while investigating geographic disparities in disease burden across different regions and providing specific and feasible solutions.

Methods

Data source

This study utilizes the latest GBD 2021, which documents the incidence, prevalence, mortality, and disability-adjusted life years (DALYs) rate for over 300 diseases and injuries across 204 countries and regions [14]. It includes data from censuses, household surveys, civil registration and vital statistics, disease registries, health service utilization, air pollution monitoring, satellite imaging, disease notifications, and other sources [15]. Disease estimates were generated using Disease Modelling Meta-Regression, version 2.1 (DisMod-MR 2.1). The TC diagnostic codes included in this study are C73-C73.9, D09.3, D09.8, D34-D34.9, D44.0 from ICD-10, and 193–193.9, 226–226.9 from ICD-9. We extracted data on incidence, mortality, DALY rate, and numbers for TC among young people aged 10–24 years from 1990 to 2021, along with their 95% Uncertainty Interval (UI). UI were produced for every metric using the 25th and 975th ordered 1000 draw values of the posterior distribution. from the GBD database. As the data was sourced from this public database, no specific ethical approval was required for this study [16].

Statistical and data analysis

We employed Joinpoint software to calculate the average annual percent change (AAPC) and its corresponding 95% confidence intervals for DALYs among 10–24 year-olds across various countries and regions from 1990 to 2021, assessing trends in disease burden. The model is capable of flexibly identifying multiple trend change points in the data, segmenting the time series into different trend segments, and adapting to various data distribution types. An AAPC's 95% Confidence Interval (CI) greater than zero indicates an increasing trend, less than zero a decreasing trend, and equal to zero a stable trend [17]. The Locally Estimated Scatterplot Smoothing (Loess) method was applied to model the non-linear relationships between the SDI and age-standardized incidence/mortality rates across geographic regions, revealing disease burden trends associated with SDI variations.

To explore the relationship between the TC burden and socio-demographic development, we employed data envelopment analysis (DEA) to plot a nonlinear frontier. Using data from the GBD database, we calculated the average DALYs rate for each Sociodemographic Index (SDI) through 1000 bootstrap replications. We then applied Loess with a polynomial degree of 1 and a span of 0.2 to generate a smooth frontier, excluding super-efficient countries to avoid the influence of outliers. This frontier represents the lowest feasible burden under varying development conditions, offering insights into potential improvements in each country or region's TC burden [18].

Following the World Health Organization's guidelines, we applied the Slope Index of Inequality (SII) and the Concentration Index (CI) to assess absolute and relative income-related inequalities between countries [19]. We ranked populations by socioeconomic status from lowest to highest across each country and region. We then performed linear regression analysis on the DALYs for TC among young people aged 10–24 years, using the SDI ranking as the independent variable and DALYs as the dependent variable. The slope of this regression model represents the SII, which indicates the health changes per unit of socioeconomic status. Additionally, we calculated the cumulative proportions of the population and DALYs across different countries and regions. Lorenz curves were plotted with the cumulative population proportion on the x-axis and cumulative DALYs proportion on the y-axis [20]. The CI is twice the area between the Lorenz curve and the diagonal line.

The DALYs is a comprehensive health metric commonly used to assess the total health loss in a population due to diseases, injuries, and premature death. It is one of the most widely used measures of health loss in the GBD study, providing crucial insights for policymakers to understand the impact of various diseases, health conditions, or interventions on overall population health.

The SDI is a composite indicator that measures the level of social and demographic development in a country or region. It enables comparisons between different countries and regions in terms of the relationship between socio-economic development and health burden. SDI is represented on a scale from 0 to 1, where 0 indicates the lowest per capita income, the lowest educational attainment, and the highest total fertility rate among all GBD regions, while 1 represents the highest per capita income, the highest educational attainment, and the lowest total fertility rate.

Statistical analyses and visualizations were conducted using R statistical software (version 4.3.2) and Joinpoint software (version 5.1.0.0). A p-value less than 0.05 was considered statistically significant.

Results

Global and temporal trends in thyroid cancer burden among young people aged 10–24 years

In 21 GBD regions, DALYs for TC among young people aged 10–24 years generally declined, with the most significant reductions observed in Central Europe (AAPC = −3.079, 95% CI: −3.762—−2.391) and Western Europe (AAPC = −3.023, 95% CI: −3.366—−2.679). The DALYs rate in Central Asia has also improved significantly (AAPC = −2.162, 95% CI: −3.555—−0.749). (Table 1). However, the overall global trend in TC DALYs has risen, primarily due to increases in North Africa and Middle East, South Asia, Oceania, and Southern Sub-Saharan Africa, with South Asia being the major contributor. In 2021, the highest incidence rates at the national and regional levels were recorded in Saudi Arabia (1.521, 95% UI: 0.855–2.679 per 100,000 people), followed by Taiwan (China) (1.248, 95% UI: 0.932–1.704 per 100,000 people), and Vietnam (1.240, 95% UI: 0.485–2.167 per 100,000 people), with the lowest incidence in Kiribati (0.011, 95% UI: 0.006–0.021 per 100,000 people) (Fig. 1A). The top three mortality rates were observed in Ethiopia, Pakistan, and Uganda with rates of 0.161 (95% UI: 0.100–0.254) per 100,000 people, 0.145 (95% UI: 0.096–0.224) per 100,000 people, and 0.133 (95% UI: 0.081–0.210) per 100,000 people, respectively, with the lowest mortality in Yemen (0.012, 95% UI: 0.008–0.017 per 100,000 people) (Fig. 1B). The countries with the highest numbers of cases were India (2387 cases, 95% UI: 1769–3499), China (1039, 95% UI: 828–1331 cases), and Bangladesh (386, 95% UI: 202–859 cases), which were also the top three countries in terms of mortality numbers (India: 220, 95% UI: 169–308 cases; China: 40, 95% UI: 32–51 cases; Bangladesh: 31, 95% UI: 17–65 cases) (Fig. 1C, D). According to the data recorded in the GBD database, the disease burden of TC among young people rose from the 9th position in 1990 to the 8th position (Table 2). In addition, although the age-standardized DALYs rate (ASDR) of TC decreased from 1990 to 2021, the DALYs rate among young people aged 10–24 increased, showing a different trend (Table 3).

Thyroid cancer burden across different SDI levels

From 1990 to 2021, the incidence rates of TC among young people aged 10–24 years generally showed a declining trend in regions such as Australasia, Central Asia, Central Europe, Eastern Europe, and Western Europe, while other regions experienced an upward trend. Globally, along with Oceania, South Asia, and Southern Sub-Saharan Africa, mortality rates exhibited an increasing trend, whereas other regions showed a decrease over time. Additionally, in 2021, the incidence rates of TC increased with rising SDI levels (Fig. 2A), whereas mortality rates decreased as SDI levels rose (Fig. 2B). At the national level, incidence rates generally increased with higher SDI, with some fluctuations(Fig. 3A); mortality rates initially increased and then decreased as SDI levels rose (Fig. 3B).

Frontier analysis

The black line represents the minimum disease burden corresponding to the SDI of the leading countries or regions. The effective difference, which is the gap between the actual observed disease burden and the potentially achievable minimum burden, is indicated by the distance from the black line. This gap has the potential to be reduced or eliminated through social and demographic adjustments specific to each country or region. The analysis reveals that as SDI increases, the effective differences generally widen, suggesting that countries or regions with higher SDIs have greater potential for reducing the burden of TC [21].

For 2021, we estimated the effective differences between each country and region and the black line using

Table 1 Global and regional disability-adjusted life years (DALYs) rate and case numbers for the population aged 10–24 years in 1990 and 2021 across the 21 GBD regions, including the corresponding AAPC

Location	1990		2021		1990-2021AAPC
	DALYs	DALYs rate per 100,000 people	DALYs	DALYs rate per 100,000 people	
	n(95% UI)	n(95% UI)	n(95% UI)	n(95% UI)	n(95% CI)
Global	42173 (36830–49222)	2.726 (2.380–3.181)	55812 (44161–74032)	2.956 (2.339–3.922)	0.258 (0.138–0.378)
High-income Asia Pacific	681 (578–819)	1.616 (1.373–1.945)	287 (239–366)	1.099 (0.916–1.401)	−1.064 (−1.536– −0.590)
High-income North America	670 (621–728)	1.095 (1.015–1.190)	724 (658–800)	1.015 (0.924–1.122)	−0.275 (−0.948–0.402)
Western Europe	1549 (1439–1680)	1.885 (1.751–2.044)	559 (497–637)	0.776 (0.689–0.884)	−3.023 (−3.366– −2.679)
Australasia	75 (62–91)	1.552 (1.292–1.884)	50 (40–62)	0.878 (0.702–1.085)	−1.733 (−3.306– −0.133)
Andean Latin America	357 (294–440)	2.901 (2.389–3.574)	453 (356–574)	2.623 (2.059–3.325)	−0.341 (−1.155–0.480)
Tropical Latin America	849 (799–908)	1.773 (1.669–1.896)	864 (808–927)	1.707 (1.598–1.833)	−0.083 (−0.335–0.170)
Central Latin America	1121 (1066–1190)	2.067 (1.965–2.194)	1242 (1125–1389)	1.91 (1.730–2.136)	−0.126 (−0.565–0.314)
Southern Latin America	254 (219–294)	1.919 (1.657–2.220)	238 (197–280)	1.55 (1.286–1.828)	−0.752 (−1.773–0.280)
Caribbean	216 (172–258)	2.025 (1.609–2.415)	226 (160–295)	1.994 (1.409–2.603)	−0.119 (−0.584–0.348)
Central Europe	580 (546–618)	1.987 (1.871–2.116)	138 (123–155)	0.762 (0.676–0.855)	−3.079 (−3.762– −2.391)
Eastern Europe	892 (828–955)	1.888 (1.752–2.023)	376 (340–424)	1.141 (1.030–1.286)	−1.755 (−2.907– −0.589)
Central Asia	363 (339–389)	1.828 (1.711–1.961)	207 (178–240)	0.935 (0.807–1.084)	−2.162 (−3.555– −0.749)
North Africa and Middle East	1885 (1521–2754)	1.731 (1.396–2.529)	2797 (2260–3472)	1.723 (1.393–2.139)	0.012 (−0.241–0.2670)
South Asia	14899 (12322–19403)	4.455 (3.684–5.801)	27338 (20226–39202)	5.199 (3.846–7.455)	0.414 (0.020–0.810)
Southeast Asia	3835 (2807–4501)	2.585 (1.892–3.034)	3833 (3019–4603)	2.241 (1.765–2.691)	−0.475 (−0.563– −0.386)
East Asia	7936 (6330–9658)	2.132 (1.701–2.595)	3612 (2868–4516)	1.486 (1.180–1.858)	−1.117 (−1.435– −0.798)
Oceania	53 (35–72)	2.547 (1.664–3.458)	109 (65–152)	2.708 (1.609–3.777)	0.250 (−0.053–0.555)
Western Sub-Saharan Africa	387 (257–527)	0.646 (0.429–0.881)	876 (626–1245)	0.543 (0.388–0.771)	−0.570 (−0.713– −0.426)
Eastern Sub-Saharan Africa	5017 (3867–6313)	8.088 (6.234–10.176)	10809 (7507–16476)	7.432 (5.162–11.328)	−0.269 (−0.397– −0.141)
Central Sub-Saharan Africa	198 (140–294)	1.142 (0.811–1.698)	447 (303–727)	0.995 (0.674–1.617)	−0.451 (−0.616– −0.287)
Southern Sub-Saharan Africa	356 (283–435)	2.081 (1.655–2.545)	627 (453–825)	2.872 (2.076–3.780)	1 .000 (0.578–1.424)

the DALYs rate and SDI (Fig. 4). The five countries or regions with the largest effective differences include the Ethiopia, Pakistan, Uganda, Zambia, and Tokelau. Conversely, the countries or regions with the smallest effective differences are Tajikistan, Niger, Chad, Nigeria, and Ghana.

Health inequality analysis

The SII is an absolute measure of health inequality, reflecting the linear relationship between health indicators and socio-economic status (such as income, education level, etc.). SII represents the health gap between the most disadvantaged and the most advantaged groups. The CI, on the other hand, is a relative measure of health inequality. It reflects the distribution of health indicators across socio-economic status. The CI ranges from −1 to 1, with values closer to 0 indicating smaller inequality; positive values suggest better health outcomes among wealthier groups, while negative values indicate better health outcomes among poorer groups [22].

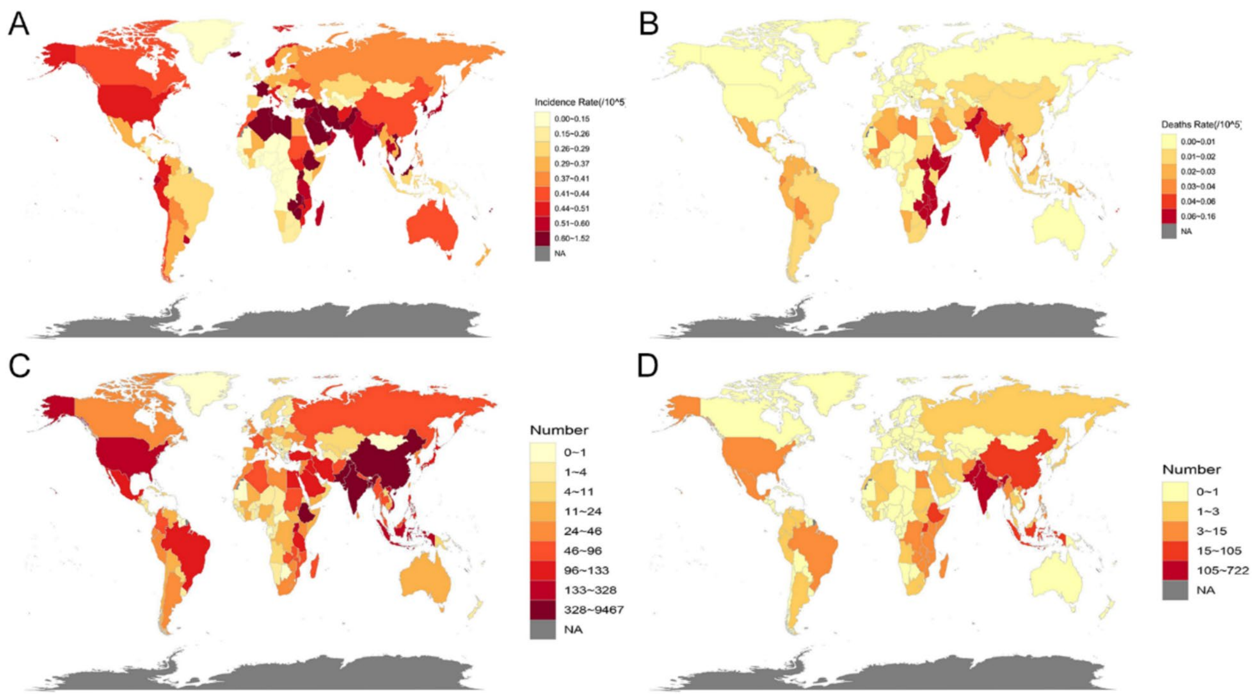

Fig. 1 The global burden of thyroid cancer among young people aged 10–24 years across 204 countries and regions in the 2021. **A** Incidence Rate, **B** Mortality Rate, **C** Number of Incidence Cases, and **D** Number of Mortality Cases

Table 2 Global DALYs rate and case number of main cancers among young people aged 10–24 years in 1990 and 2021

Cancer	1990		2021	
	DALYs	DALYs rate per 100,000 people	DALYs	DALYs rate per 100,000 people
	n(95% UI)	n(95% UI)	n(95% UI)	n(95% UI)
Colon and rectum cancer	248466 (210799–276661)	16.059 (13.624–17.881)	182608 (162128—205212)	9.673 (8.588–10.870)
Liver cancer	198037 (175466–228699)	12.799 (11.340–14.781)	163380 (144834—187190)	8.654 (7.672–9.915)
Breast cancer	84488 (76010–94403)	5.460 (4.912–6.101)	160007 (130815—194085)	8.476 (6.929–10.281)
Tracheal, bronchus, and lung cancer	187927 (170512–206786)	12.146 (11.020–13.365)	143696 (132394—155251)	7.611 (7.013–8.224)
Stomach cancer	249871 (215393–274243)	16.149 (13.921–17.725)	120759 (103252–131095)	6.396 (5.469–6.944)
Nasopharynx cancer	191256 (171321–211643)	12.361 (11.073–13.679)	120014 (102776–139432)	6.357 (5.444–7.386)
Lip and oral cavity cancer	65354 (60697–70931)	4.224 (3.923–4.584)	100095 (77151–122770)	5.302 (4.086–6.503)
thyroid cancer	**42173 (36830–49222)**	**2.726 (2.38–3.181)**	**55812 (49031–58891)**	**2.956 (2.339–3.922)**
Kidney cancer	53385 (50266–56804)	3.450 (3.248–3.671)	53972 (49031–58891)	2.859 (2.597–3.119)
Pancreatic cancer	29779 (26728–32655)	1.924 (1.727–2.110)	28087 (25,072–31988)	1.487 (1.328–1.694)
Esophageal cancer	39000 (33616–43392)	2.520 (2.172–2.804)	27950 (24764–33173)	1.480 (1.311–1.757)
Bladder cancer	17573 (13888–19441)	1.135 (0.897–1.256)	13906 (12,111–16213)	0.736 (0.641–0.858)
Larynx cancer	10670 (8288–11917)	0.689 (0.535–0.770)	9662 (8007–11811)	0.511 (0.424–0.625)
Gallbladder and biliary tract cancer	9427 (6633–10895)	0.609 (0.428–0.704)	8945 (6643–10975)	0.473 (0.351–0.581)
Uterine cancer	10843 (6158–13745)	0.700 (0.398–0.888)	8619 (6538–10405)	0.456 (0.346–0.551)
Prostate cancer	4078 (2902–4938)	0.263 (0.187–0.319)	4348 (3226–5154)	0.230 (0.170–0.273)

Table 3 Global DALYs rate and Incidence rate of thyroid cancer among young people aged 10–24 years in 1990 and 2021, age-standardized incidence rate and age-standardized DALYs rate and corresponding AAPC

Age	1990		2021	
	DALYs	DALYs rate per 100,000 people	DALYs	DALYs rate per 100,000 people
	n(95% UI)	n(95% UI)	n(95% UI)	n(95% UI)
10–24 years	42173 (36830–49222)	2.726 (2.38–3.181)	55812 (49031–58891)	2.956 (2.339–3.922)
Age-standardized	646741 (599119–17357)	15.206 (14.184–16.830)	1246485 (1094416–375853)	14.571 (12.783–16.115)

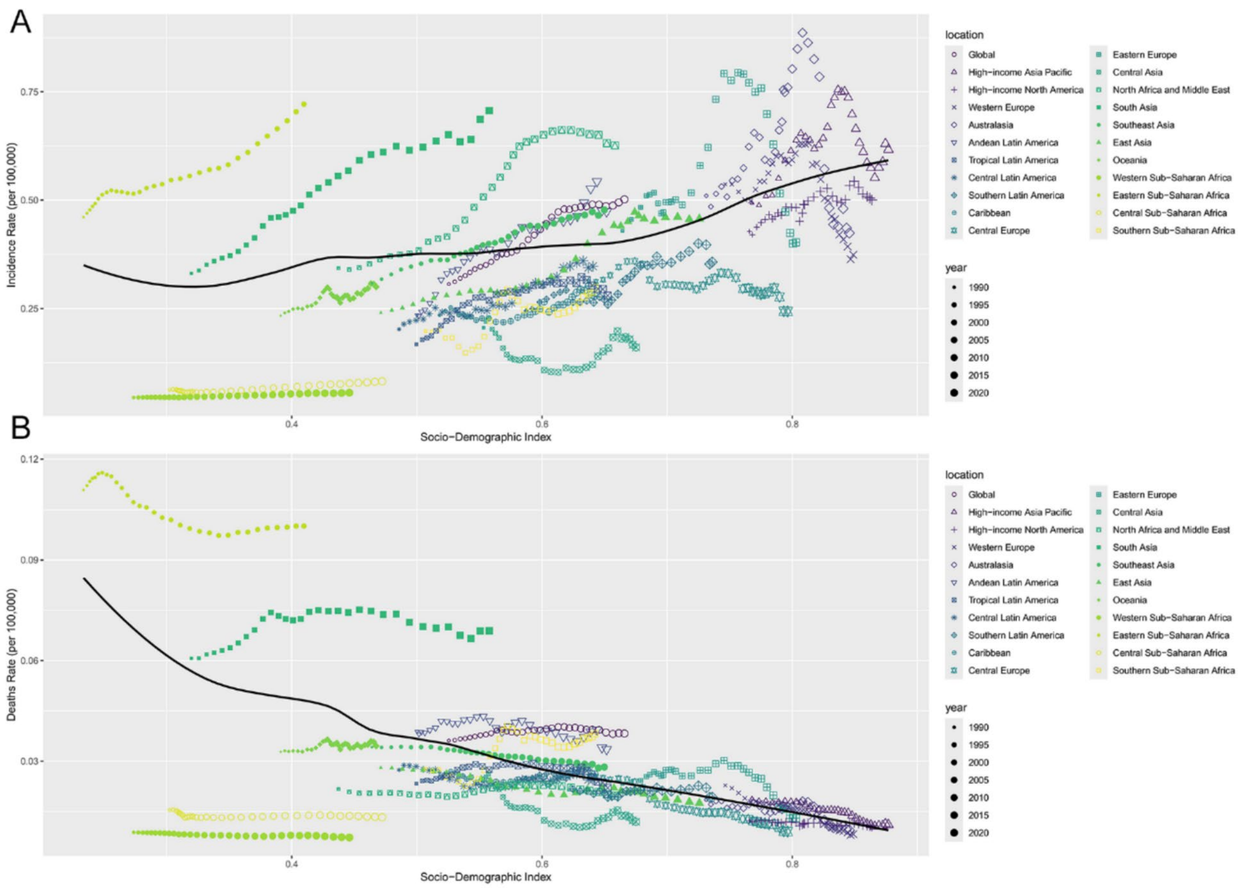

Fig. 2 Changes in incidence and deaths rate of thyroid cancer among young people aged 10–24 years globally and across different socio-demographic index (SDI) regions, 1990–2021. **A** incidence rate; **B** deaths rate. The black line represents an adaptive correlation based on all data points, fitted using adaptive Loess regression

In 1990 and 2021, the SII for DALYs was −0.147 (95% CI: −0.589–0.295) and −1.299 (95% CI: −1.724—−0.874), respectively, with a slight increase in 2021 compared to 1990. The CI for DALYs was 0.299 (95% CI −0.430—−0.093) in 1990 and 0.393 (95% CI −0.511—−0.245) in 2021. The health inequality analysis revealed that there is still a gap in the disease burden of TC among young people aged 10–24 years between poor and rich countries, although the gap is not large (Fig. 5).

Discussion

Several studies based on the GBD database have explored the burden of TC [23, 24], but GBD research specifically focusing on the burden of TC among young people has yet to be published. TC is one of the five most common malignancies in adolescents [25]. In low- and middle-income countries, medical resources are limited compared to high-income countries, yet young people constitute a larger proportion of the population. Understanding the TC burden among young people in different

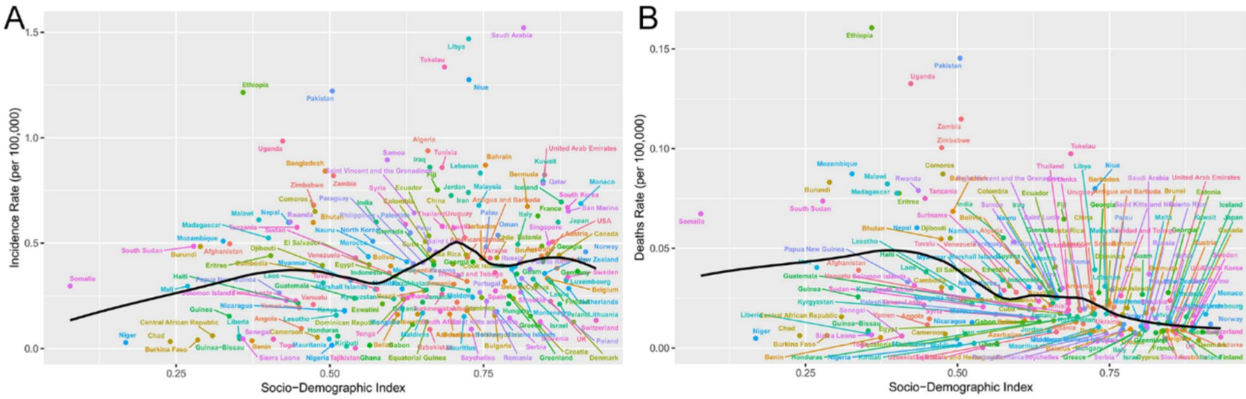

Fig. 3 Changes in incidence and deaths rate of thyroid cancer among young people aged 10–24 years across 204 countries and regions in 2021. **A** Incidence rate; **B** deaths rate. The black line represents an adaptive correlation based on all data points, fitted using adaptive Loess regression

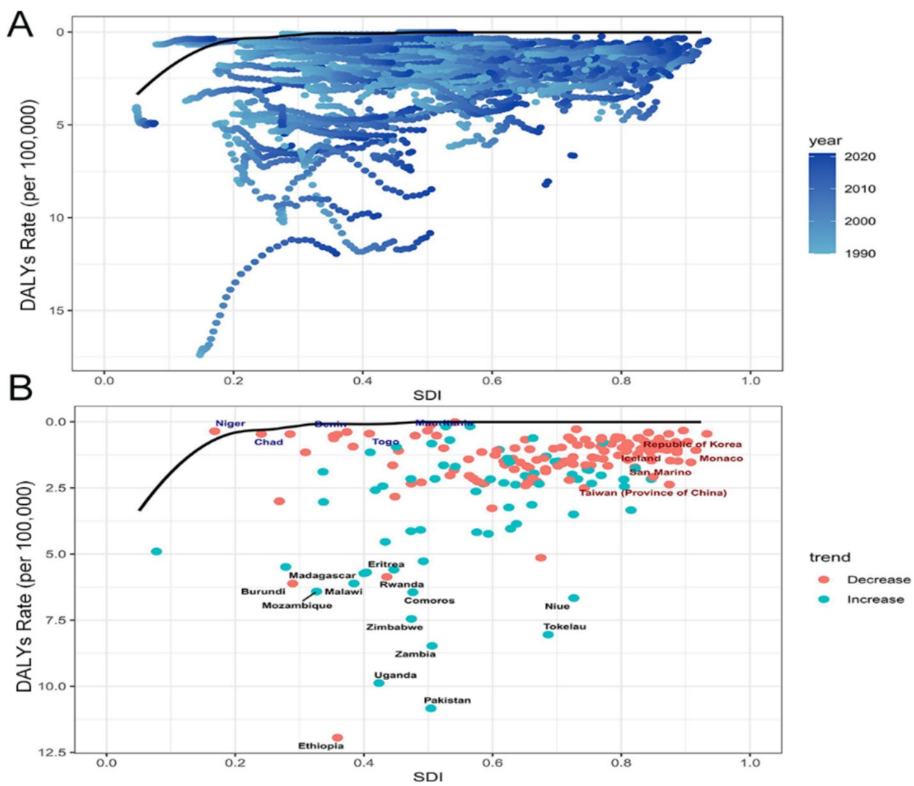

Fig. 4 **A** Frontier analysis based on SDI and thyroid cancer DALYs rate Among 10–24 years from 1990 to 2021. **B** Frontier analysis based on SDI and thyroid cancer DALYs rate among 10–24 years in 2021. Boundaries are indicated by black lines. Countries and regions are represented by dots. The top 15 countries or regions with the highest effective gaps are marked in black. The top 5 countries or regions with the highest effective gaps among those with high SDI are marked in red. The top 5 countries or regions with the lowest effective gaps among those with low SDI are marked in blue

countries can facilitate the development of more effective public health strategies.

This study utilized the GBD 2021 database to analyze the burden of TC among young people aged 10–24 years globally, examining its temporal trends and the impact of the SDI. The results show that from 1990 to 2021, the DALYs rate increased in several GBD regions, including North Africa and the Middle East, South Asia, Oceania, and Southern Sub-Saharan Africa—regions that are relatively underdeveloped. This highlights significant

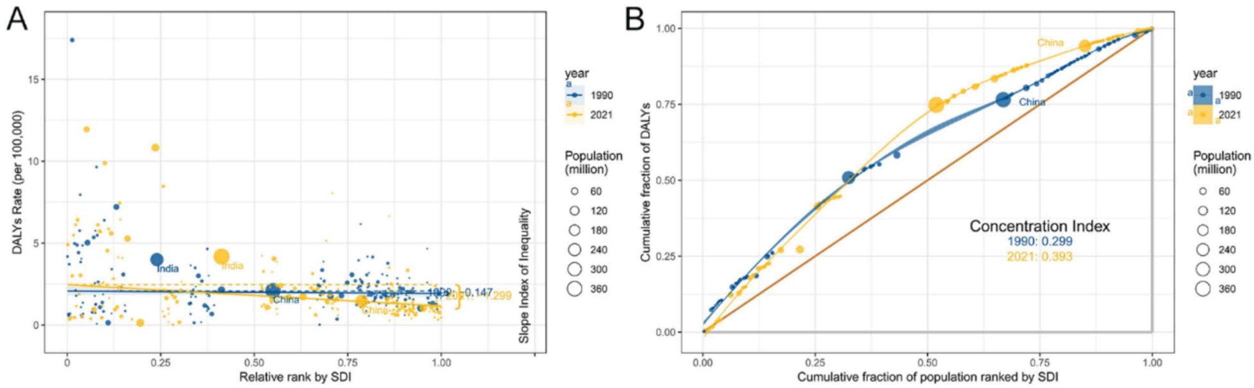

Fig. 5 **A** Slope Index of Inequality (SII), Absolute health inequality regression lines for thyroid cancer among young people aged 10–24 years in 1990 and 2021. **B** Concentration Index(CI), Relative health inequality concentration curves for thyroid cancer among young people aged 10–24 years in 1990 and 2021

disparities in the TC burden among young people aged 10–24 years between high-income and low-income regions. At the national and regional levels in 2021, the countries with the highest incidence rates were Saudi Arabia, Taiwan (China), and Vietnam, while the highest mortality rates were observed in Ethiopia, Pakistan, and Uganda. Notably, the countries with the highest incidence rates are concentrated in Asia, while those with the highest mortality rates are located in Africa. Besides genetic factors and molecular mechanisms [26, 27], TC incidence may also be influenced by diagnostic technology and health awareness [28]. Additionally, environmental radiation exposure, iodine intake and obesity might play significant roles [29–31]. As a developing region, Central Asia has experienced a decrease in the DALYs rate, which may be due to the widespread use of ultrasound examinations and the increased iodine intake in the diet. The high mortality rates in African countries are likely associated with relatively underdeveloped healthcare systems. Patients without insurance and those with lower socioeconomic status and educational levels are also less likely to receive total thyroidectomy, formal lymph node dissection, and adjuvant radioactive iodine treatment [32, 33]. The incidence of TC increases with higher SDI, while the mortality decreases with the increase of SDI. This may be due to economic development, with high-income countries incorporating thyroid ultrasound screening programs into health check-ups, which increased the detection rate of TC. At the same time, with the advancement of medical technology, the mortality rate also gradually decreased.

Although many high-SDI countries exhibit a lower disease burden, frontier analysis reveals significant potential for improvement even within these countries. For instance, the substantial effective differences in the Taiwan (China), Marino, Monaco, Republic of Korea, and Iceland suggest that optimizing resource allocation and enhancing disease management efficiency remain important even in well-resourced nations. Most countries are located in coastal areas, which may be related to their iodine intake. Interestingly, as early as 1999, the South Korean government implemented a nationwide cancer screening program, prompting hospitals to provide thyroid ultrasound examinations [7]. However, there is still significant room for improvement in the DALYs rate of TC among young people in Korea, which may be related to aggressive and early surgical interventions. Studies have shown that, in addition to the reasons mentioned above, other risk factors, such as obesity, smoking, hormonal influences, and genetic susceptibility, may also be associated with the incidence and mortality of TC [11, 34, 35]. Therefore, it is essential to develop personalized medical strategies for high-risk populations, rather than relying on a single standard of care, to effectively allocate medical resources and reduce the disease burden.

Moreover, our data reveal issues related to health inequality. The SII remained relatively stable between 1990 and 2021, but the CI has increased in the past 30 years, indicating that the gap in the disease burden of TC among young people aged 10–24 years between low-income and high—income countries still exists. This underscores the need for more policy interventions, particularly in low-SDI countries, to reduce health inequalities and improve the effectiveness of disease prevention and management. Discussing from the following three aspects may help improve the thyroid burden among young people.

Medical policy

Studies have shown that both excessive and insufficient iodine intake may increase the risk of TC [31]. For inland areas with relatively low iodine intake, the iodine content in salt can be appropriately adjusted. The American Thyroid Association (ATA) revised its guidelines, recommending a more conservative approach to the diagnosis and treatment of TC [36]. The U.S. Preventive Services Task Force (USPSTF) also issued a statement advising against screening asymptomatic individuals for TC [37]. However, this may only be applicable to economically developed countries with abundant medical resources and a low burden of TC. For regions with a high burden of TC, strengthening primary healthcare infrastructure is crucial. Incorporating TC screening into existing health programs and intensifying efforts to promote prevention and healthcare are essential. This includes improving access to specialized medical resources, strengthening the standardized implementation of clinical guidelines, deepening community participation in health management, facilitating seamless integration of medical services, and establishing a comprehensive economic support system to alleviate the financial burden on cancer patients.

Risk factors

Gene proteins (such as DIRC3), hyperthyroidism, and changes in hormone levels within the body may all increase the risk of TC [35, 38]. In high-income countries, it is possible to consider developing personalized screening strategies for young people. For populations with the above-mentioned susceptible risks, the frequency of thyroid ultrasound screening can be increased. Additionally, smoking, obesity, and radiation exposure can also increase the risk of TC. Therefore, improving lifestyle habits and reducing radiation exposure are cost-effective and efficient measures. It is worth noting that young patients often experience a range of health-related psychological issues after surgery [39]. Risk stratification is essential to avoid unnecessary interventions and reduce the risk of overtreatment [40].

Future directions

With the development of artificial intelligence, deep learning can be utilized to analyze ultrasound images and clinical data, optimize the diagnostic process, improve diagnostic accuracy, and reducing unnecessary fine—needle aspiration biopsies [41]. Meanwhile, the development of multimodal treatment approaches, combining active surveillance, surgery, thermal ablation, iodine-131 therapy, and targeted therapy, can help establish a "stepped" treatment plan. Data inaccuracies in low- and middle-income countries may lead to an underestimation of their TC burden, so it is necessary to improve data collection methods in these areas. The long—term impact of screening policies and the genetic determinants of TC in young people still require further research.

This study has several limitations: First, the accuracy and completeness of the GBD estimates may be constrained by the data reporting systems and collection methodologies of individual countries, particularly in low- and middle-income countries. Moreover, variations in diagnostic standards between countries may introduce biases in the analysis results. Second, due to data constraints, we were unable to reveal the epidemiological characteristics of different pathological types of TC, such as papillary, follicular, and medullary thyroid cancers [42]. Third, limited data collection in some low- and middle-income countries might lead to an underestimation of the true burden of TC among young people. Fourth, differences in diagnostic equipment and technology across countries and regions may introduce information bias.

Conclusion

The burden of TC among young people aged 10–24 years exhibits geographic heterogeneity across countries with different income levels, with a notable upward trend in low-income regions over the past 30 years. It is imperative to develop personalized medical strategies for different regions and high-risk populations to reduce health inequalities in the TC burden among young people.

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Disclosure of interest
The authors declare no competing interests.

Compliance with ethical standards
As the data was sourced from this public database, no specific ethical approval was required for this study.

Authors' contributions
Kaiyuan Huang： completed the entire manuscript, making Figs. 1, 2, 3, 4 and 5, Ningxin Wang： made Table 1 and data collation, Xuanwei Huang; Shuoying Qian; Yuan Cai： Collecting the literature Fan Wu; Dingcun Luo： Article guidance and revision.

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Data availability
The authors confirm that the datasets generated and/or analyzed during the current study are publicly available in the Global Health Data Exchange repository accessible from https://vizhub.healthdata.org/gbd-results/ and https://ghdx.healthdata.org/ihme_data . The diagnostic codes for thyroid cancer used in this study are C73-C73.9, D09.3, D09.8, D34-D34.9, and D44.0 in ICD-10, and 193–193.9 and 226–226.9 in ICD-9. In addition, the processed data can be found in the article and related files.

Declarations

Consent for publication
By submitting my article I agree to pay the APC in full if my article is accepted for publication (unless it is covered by an institutional agreement or journal partner, or a full waiver has been granted).

Competing interests
The authors declare no competing interests.

Author details
[1]The Fourth Clinical Medical College, Zhejiang Chinese Medical University, Hangzhou First People's Hospital, Zhejiang, Hangzhou 310053, China. [2]Department of Surgical Oncology,, Affiliated Hangzhou First People's Hospital, School of Medicine, Westlake University, Hangzhou, Zhejiang 310006, China. [3]College of Mathematical Medicine, Zhejiang Normal University, Jinhua, Zhejiang 321004, China.

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