Thyroid cancer incidence trends by histology in 25 countries: a population-based study

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Summary

Background The incidence of thyroid cancer has increased in different populations worldwide in the past 30 years. We present here an overview of international trends of thyroid cancer incidence by major histological subtypes.

Methods We did a population-based study with data for thyroid cancer incidence collected by the International Agency for Research on Cancer (IARC) for the period 1998–2012. Data were extracted from the Cancer Incidence in Five Continents *plus* compendium. We selected data for 25 countries that had a population of more than 2 million individuals covered by cancer registration (87 registries in total). Further criteria were that the selected registration areas had to have a proportion of unspecified thyroid cancer of less than 10% and analyses were restricted to individuals aged 20–84 years. We calculated age-specific incidence rates and age-standardised rates per 100 000 person-years for individuals aged 20 to 84 years, and assessed trends by country, sex, and major histological subtype (papillary, follicular, medullary, or anaplastic) based on absolute changes in age-standardised incidence rates between 1998–2002 and 2008–12.

Findings Papillary thyroid cancer was the main contributor to overall thyroid cancer in all the studied countries, and was the only histological subtype that increased systematically in all countries, although with large variability between countries. In women, the age-standardised incidence rate of papillary thyroid cancer during 2008–12 ranged from 4·3–5·3 cases per 100 000 person-years in the Netherlands, the UK, and Denmark, to 143·3 cases per 100 000 women in South Korea. For men during the same period, the age-standardised incidence rates of papillary thyroid cancer per 100 000 person-years ranged from 1·2 cases per 100 000 in Thailand to 30·7 cases per 100 000 in South Korea. In many countries in Asia, the increase in papillary thyroid cancer rates in women was particularly pronounced after the year 2000; rates stabilised since around 2009 in the USA, Austria, Croatia, Germany, Slovenia, Spain, Lithuania, and Bulgaria. Temporal trends for follicular and medullary thyroid cancer did not show consistent patterns across countries, but slight decreases were seen for anaplastic thyroid cancer in 21 of 25 countries between 1998–2002, and 2008–12. In 2008–12, age-standardised rates for the follicular subtype ranged between 0·5 and 2·5 cases per 100 000 women (and between 0·3 and 1·5 per 100 000 men), while those for the medullary subtype were always less than 1 case per 100 000 women or men, and for anaplastic thyroid cancer less than 0·2 cases per 100 000 women or men.

Interpretation In the period from 1998 to 2012, the rapid increases in thyroid cancer incidence were observed only for papillary thyroid cancer, the subtype more likely to be found in a subclinical form and therefore detected by intense scrutiny of the thyroid gland.

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Introduction

Thyroid cancer represents 3% of the global incidence of all cancers, with 586 000 new patients estimated in 2020.[1] The incidence of thyroid cancer has risen substantially in the past 30 years in several high-income and medium-income countries, although the rates of increase vary between and within populations.[2,3] By contrast with the increased incidence, mortality rates for thyroid cancer have decreased or remained stable, and are at low levels almost everywhere.[4]

There is wide heterogeneity in the frequency and clinical behaviour of the major histological subtypes of thyroid cancer, from common and mostly asymptomatic papillary tumours, to larger and more advanced papillary tumours,[5] and to rare but highly aggressive and rapidly lethal anaplastic malignancies.[6] National[5,7,8] and international[9] studies have reported observed increases in thyroid cancer incidence that were largely limited to papillary thyroid cancer; international comparisons of less common histological subtypes of thyroid cancer; ie, follicular, medullary, and anaplastic, have been less studied.

To provide evidence-based information on the time trends and the possible impact of diagnostic pressure, we present for the first time a global comparison of the geographical and temporal variations of thyroid cancer incidence by major histological subtype. The study includes several countries worldwide and used high-quality data collected by population-based cancer registries

Research in context

Evidence before this study

We used high-quality data collected by population-based cancer registries and compiled at the International Agency for Research on Cancer to explore the incidence and trends of papillary, follicular, medullary, and anaplastic thyroid cancers worldwide. We used the search terms "papillary", "follicular", "medullary", "thyroid cancer", "incidence", and "trend" on PubMed with no restriction for dates or language. We identified 41 studies; however, no study had been published on global comparisons of less common thyroid cancer subtypes, and only one study compared these trends in Europe.

Added value of this study

To our knowledge, ours is the first population-based study providing a global assessment of the epidemiology of less-common thyroid cancer types in a long observation period (1998–2012). We identified diverging trends by subtypes and different degrees of between-country variation. Notably, papillary thyroid cancer was the only subtype to show increases in incidence in all countries, whereas there were no systematic increases for other subtypes. We found that the incidence of the most severe thyroid cancer type (ie, anaplastic) showed smaller geographical variations compared with all other thyroid cancer subtypes, with declining trends almost everywhere, including in countries that showed large increases in papillary thyroid cancer incidence rates.

Implications of all the available evidence

Our population-based study clarifies the epidemiology of less common thyroid tumours in several populations. Our results confirmed that the increasing incidence of thyroid cancer is largely limited to papillary thyroid cancer—the subtype more likely to be found in a subclinical form and therefore detected by intense scrutiny of the thyroid gland.

and compiled at the International Agency for Research on Cancer (IARC).

Methods

Data sources and populations

We did a population-based study with data for the observed number of new patients with thyroid cancer by histological type and corresponding population-at-risk. These data were extracted from the Cancer Incidence in Five Continents (CI5) *plus*, a compendium of high-quality cancer incidence data based on submissions from population-based cancer registries at a national or subnational level.[10] Only registries that have passed a detailed assessment of compliance (adherence to international standards and guidelines), completeness (the degree to which cancers diagnosed in the catchment population are indeed registered), and validity checks (ascertaining that the recorded cases are accurate) are published in the CI5 series.[11] For this study, countries with at least 2 million inhabitants covered by cancer registration, regardless of whether it was through a national or regional registry, or a grouping of regional registries, were selected. 87 registries were thus included from 25 countries. Additionally, the selected registration areas had to have a proportion of unspecified thyroid cancer of lower than 10%. We examined time trends in the selected registries for the period 1998 to 2012, the most recent three available 5-year periods published by CI5, and restricted the analyses to individuals aged 20–84 years.

In the absence of national coverage, an existing sub-national registry or a pool of such registries represented the corresponding country. Registries included were: Australia (QLD, SA, VIC, WA, NT, TAS, NSW, and ACT), Austria (national), Bulgaria (national), Canada (national excluding NU, QC, and YT), China (Shanghai, Zhongshan, Harbin, and Jiashan), Colombia (Cali), Croatia (national), Denmark (national), France (Calvados, Somme, Martinique, Haut-Rhin, Doubs, Manche, Bas-Rhin, Herault, Isère, and Loire-Atlantique), Germany (Hamburg and Saarland), Ireland (national), Italy (Ragusa, Veneto, Modena, Biella, Naples, Parma, Romagna, and Ferrara), Japan (Miyagi, Nagasaki, Osaka, and Fukui), Lithuania (national), Netherlands (national), New Zealand (national), Norway (national), South Korea (Busan, Seoul, Ulsan, Gwangju, and Incheon), Slovenia (national), Spain (Cuenca, Tarragona, Albacete, Girona, Navarra, Basque country, Murcia, Canary Islands, and Granada), Switzerland (Geneva, Neuchatel, St Gall-Appenzell, Vaud, Valais, and Ticino), Thailand (Chiang Mai, Khon Kaen, Songkhla, and Lampang), Turkey (Antalya and Izmir), USA (USA Surveillance, Epidemiology, and End Results programme [nine registries]), and UK (Scotland, Northern Ireland, England northeast, England northwest, England Yorkshire-Humber, England east Midlands, England west Midlands, England east, England London, England southeast, and England southwest).

We used thyroid cancer morphology codes (International Statistical Classification of Diseases [ICD] and Related Health Problems ICD10 C73),[12] classified according to the ICD for Oncology (ICD-O-3) and grouped into major histological subtypes, corresponding to papillary thyroid cancer (8050, 8260, 8340–8344, 8350, 8450–8460), follicular thyroid cancer (8290, 8330–8335), medullary thyroid cancer (8345, 8510–8513), anaplastic thyroid cancer (8020–8035), unspecified carcinoma (8010–8015), sarcoma (8800–8811, 8830, 8840–8921, 8990–8991, 9040–9044, 9120–9133, 9150, 9540–9581), and other unspecified malignant neoplasm (8000–8005).

Statistical analysis

We calculated age-standardised rates using the world standard population. Age-specific incidence rates per

100 000 person-years were created for 5-year age groups ranging from age 20–24 years to 80–84 years, (except for Thailand, where the last age group with available data was age 75–79 years). Analyses were done at the levels of country, sex, and histological type. We plotted smoothed values (with locally weighted regression LOWESS) of age-standardised incidence rate as curves.[13] We used several different scales: the arithmetic scale was used to visualise absolute changes in trends; the semi-logarithmic scale (logarithmic on the y-axis and linear on the x-axis) was used to compare relative changes in trends across countries and histological subtypes with different background levels of incidence; and the log–log scale was used to visualise age-specific curves, since it has been shown that thyroid cancer incidence rates increased with age according to a power law (ie, linearity in log–log scale) before the widespread use of modern diagnostic techniques.[14]

Absolute changes in age-standardised incidence rates between the periods of 1998–2002 and 2008–12 were estimated by sex, country, and for the major histological subtypes. Detailed information about the methods to estimate differences in rates and an approximation of 95% CIs are published elsewhere.[15] All analyses were done with R software, version 3.5.2.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, writing of the report, or the decision to submit for publication.

Results

Age-standardised incidence rates for all thyroid cancer types in 2008–12 are shown by country for women in table 1 and for men in table 2. Papillary thyroid cancer was the main contributor to overall incidence of thyroid cancer in all studied countries. In women, the age-standardised incidence rates for papillary thyroid cancer ranged from 4·3 to 5·3 cases per 100 000 women in the Netherlands, the UK, and Denmark (representing approximately 70% of all cases of thyroid cancer) to 143·3 cases per 100 000 person-years in South Korea (representing 96% of all cases of thyroid cancer), corresponding to a ratio of greater than 30 times between the highest and lowest observed age-standardised rate. The geographical heterogeneity of age-standardised incidence rates was much lower for other histological subtypes in women. Rates for follicular thyroid cancer ranged from 0·53 cases per 100 000 women in Colombia to 2·52 cases per 100 000 women in Turkey. The age-standardised incidence rates for medullary thyroid cancer never exceeded 1 case per 100 000 women, with values for 18 of 25 countries in the range 0·2–0·6 cases per 100 000 women (the highest value was 0·8 cases per 100 000 women in Italy). For anaplastic thyroid cancer, the age-standardised incidence rate was 0·20 cases per 100 000 women in Colombia and was lower in all other countries. Anaplastic thyroid cancer represented less than 5% of all thyroid cancer cases in women in all countries and less than 2% in 20 (80%) of 25 countries. Most of the countries had a low proportion of cases of unspecified thyroid cancer, particularly countries from Europe, North America, and Oceania.

In men during 2008–12, the age-standardised rates for papillary thyroid cancer ranged from 1·21 cases per

	Total number of cases	Age-standardised incidence rates per 100 000 person-years					
		All thyroid cancer types combined	Papillary	Follicular	Medullary	Anaplastic	Other or unknown
Europe							
Northern							
Denmark	823	7·5	5·3	1·41	0·31	0·19	0·32
Ireland	774	9·1	7·1	1·34	0·13	0·18	0·35
Norway	974	10·3	8·6	1·08	0·36	0·11	0·19
UK	8684	7·4	5·3	1·45	0·17	0·10	0·41
Western							
Austria	3807	19·4	16·2	1·84	0·57	0·11	0·68
France	3393	21·8	19·6	1·44	0·44	0·13	0·14
Germany	595	9·9	7·6	1·16	0·37	0·07	0·71
Netherlands	1906	5·6	4·3	0·81	0·24	0·15	0·15
Switzerland	880	16·8	14·0	2·23	0·29	0·11	0·18
Southern							
Croatia	2068	22·3	18·6	1·56	0·56	0·08	1·52
Italy	4029	36·7	32·9	1·84	0·82	0·13	1·03
Slovenia	559	12·9	11·0	1·49	0·29	0·10	0·01
Spain	2597	16·2	13·8	1·77	0·37	0·12	0·16
Eastern							
Lithuania	1556	21·3	18·7	1·56	0·65	0·14	0·28
Bulgaria	1221	7·8	6·7	0·66	0·17	0·04	0·27
Americas							
North							
Canada	15 158	29·3	27·2	0·98	0·20	0·08	0·87
USA	15 535	28·2	25·6	1·87	0·29	0·11	0·29
South							
Colombia	844	21·2	18·8	0·53	0·29	0·20	1·41
Asia							
South eastern							
China	5806	28·7	25·8	0·77	0·19	0·02	1·91
Japan	4368	13·6	12·3	0·56	0·10	0·13	0·48
South Korea	59 499	148·5	143·3	2·10	0·50	0·14	2·46
Thailand*	775	6·9	5·1	1·12	0·05	0·17	0·46
Turkey	3406	32·4	28	2·52	0·49	0·17	1·24
Oceania							
Australia	8106	19·2	16·1	2·29	0·33	0·12	0·33
New Zealand	893	10·7	8·4	1·88	0·14	0·12	0·16

Data are the number of cases, and mean annual thyroid cancer age-standardised incidence rates (cases per 100 000 person-years), overall and by major histological subtype based on the total number of cases in 2008–12.
*For Thailand, ages 20–79 years.

Table 1: **Number of cases and age-standardised incidence rates of thyroid cancer in women aged 20–84 years*, 2008–12**

100 000 men in Thailand and fewer than 2 per 100 000 men in Denmark, Ireland, and the UK, to 11·4 per 100 000 men in Italy and 32·4 per 100 000 men in South Korea (table 2). The age-standardised rates for follicular thyroid cancer for most countries ranged between 0·3 and 1·0 cases per 100 000 men, reaching 1·12 per 100 000 men in Italy; the medullary thyroid cancer age-standardised rates ranged between 0·2 and 0·4 cases per 100 000 men in 18 of 25 countries with the highest value recorded in Austria of 0·62 per 100 000 men. For anaplastic thyroid cancer, the highest age-standardised rate was found in Austria and Switzerland (0·15 cases per 100 000 men).

See Online for appendix

	Total number of cases	Age-standardised incidence rates per 100 000 person-years					
		All thyroid cancer types combined	Papillary	Follicular	Medullary	Anaplastic	Other or unknown
Europe							
Northern							
Denmark	293	2·7	1·76	0·52	0·21	0·11	0·11
Ireland	232	2·9	1·82	0·55	0·22	0·08	0·23
Norway	351	3·5	2·80	0·37	0·22	0·05	0·06
UK	2984	2·6	1·74	0·50	0·16	0·06	0·14
Western							
Austria	1396	7·7	5·5	0·94	0·62	0·15	0·49
France	1039	6·8	5·48	0·71	0·35	0·11	0·14
Germany	192	3·4	2·15	0·59	0·29	0·07	0·30
Netherlands	790	2·3	1·59	0·36	0·20	0·09	0·05
Switzerland	251	4·9	3·62	0·85	0·16	0·15	0·12
Southern							
Croatia	494	6·2	4·75	0·52	0·31	0·04	0·58
Italy	1406	13·6	11·40	1·12	0·5	0·07	0·51
Slovenia	187	4·1	3·17	0·39	0·39	0·12	0·02
Spain	704	4·5	3·44	0·57	0·24	0·11	0·14
Eastern							
Lithuania	263	4·5	3·53	0·35	0·41	0·09	0·12
Bulgaria	263	1·9	1·29	0·23	0·10	0·06	0·22
Americas							
North							
Canada	4343	8·5	7·52	0·36	0·23	0·09	0·31
USA	4882	9·0	7·77	0·71	0·22	0·11	0·19
South							
Colombia	154	5·2	4·50	0·14	0·07	0·09	0·40
Asia							
South eastern							
China	1749	9·8	8·66	0·26	0·12	0·003	0·76
Japan	1340	4·7	3·97	0·17	0·10	0·11	0·34
South Korea	12 336	32·4	30·70	0·68	0·22	0·09	0·71
Thailand*	185	1·9	1·21	0·28	0·08	0·11	0·21
Turkey	813	8·3	6·59	0·78	0·41	0·10	0·41
Oceania							
Australia	2752	6·5	5·01	1·02	0·21	0·07	0·19
New Zealand	307	3·9	2·87	0·56	0·21	0·07	0·19

Data are the number of cases, and mean annual thyroid cancer age-standardised incidence rates (cases per 100 000 person-years) overall and by major histological subtype based on the total number of cases from 2008 to 2012. *For Thailand, ages 20–79 years.

Table 2: **Number of cases and age-standardised incidence rates of thyroid cancer in men aged 20–84 years*, 2008–12**

The incidence rate of papillary thyroid cancer increased in women (figure 1), and in men (appendix p 2) with large variability between countries and by sex. Conversely, trends were relatively stable and incidence rates low for other histological subtypes (in women, not exceeding 3 cases per 100 000). The increases in papillary thyroid cancer rates in women were rapid and reached high levels (>20 cases per 100 000 men) in France, Italy, Canada, the USA, Colombia, China, South Korea, and Turkey. Other countries where the incidence rate of papillary thyroid cancer increased substantially included Austria, Croatia, Slovenia, Spain, Lithuania, Japan, Australia, and Colombia. In Asia, rates in South Korea, China, Japan, and Turkey were low and stable until the 2000s, but rose markedly thereafter. In some countries—eg, the USA, Austria, Croatia, Germany, Slovenia, Spain, Lithuania, and Bulgaria, the increase in papillary thyroid cancer incidence was followed by a stabilisation of the trend since around 2009.

Other than the consistent increases for papillary thyroid cancer, increases were also observed for follicular thyroid cancer in some countries (figure 2), including the northern European countries, the USA, China, South Korea, and Turkey. However, the increase for follicular thyroid cancer rates was, with the possible exceptions of Denmark and Slovenia, lower than that for papillary thyroid cancer. Trends in the incidence of medullary and anaplastic thyroid cancers did not appear correlated with the corresponding trends of papillary thyroid cancer and follicular thyroid cancer incidence (figure 2). China, and to some extent Turkey, were the only countries showing consistent increases between 1998–2002 and 2008–12 for all thyroid cancer subtypes. In men (appendix p 3), similarly to women, the age-standardised rates increased in all countries for papillary thyroid cancer but less consistent patterns emerged for follicular thyroid cancer and medullary thyroid cancer, with decreasing anaplastic thyroid cancer rates in most countries.

The papillary thyroid cancer incidence rates increased in all countries in women, particularly in South Korea (an absolute change in age-standardised rates of +125·0 cases per 100 000 inhabitants between 1998–2002 and 2008–12; figure 3), China (+24·4 cases per 100 000 inhabitants), and Turkey (+22·4 cases per 100 000 inhabitants), with most countries showing an absolute change of 10–20 cases per 100 000 women. By contrast, declines in anaplastic thyroid cancer (although smaller in absolute value compared with papillary thyroid cancer) were seen in most countries (21 [84%] of 25). A less clear pattern was observed for follicular thyroid cancer and medullary thyroid cancer although in general,

absolute rates for these two subtypes increased in most countries. Results for men were similar to those for women (appendix p 4).

In women, the age-specific incidence rates showed a clear and consistent marked departure from linearity (on a log–log scale) towards an inverted U-shape only for papillary thyroid cancer in all the examined countries (figure 4). Conversely, the age-specific curves for anaplastic thyroid cancer were consistent with linearity in most countries. Less-clear patterns for age-specific rates were observed for follicular thyroid cancer and for medullary thyroid cancer. In men (appendix p 4), the evidence of departure from linearity of age-specific rates toward an inverted U-shape was clear only for papillary

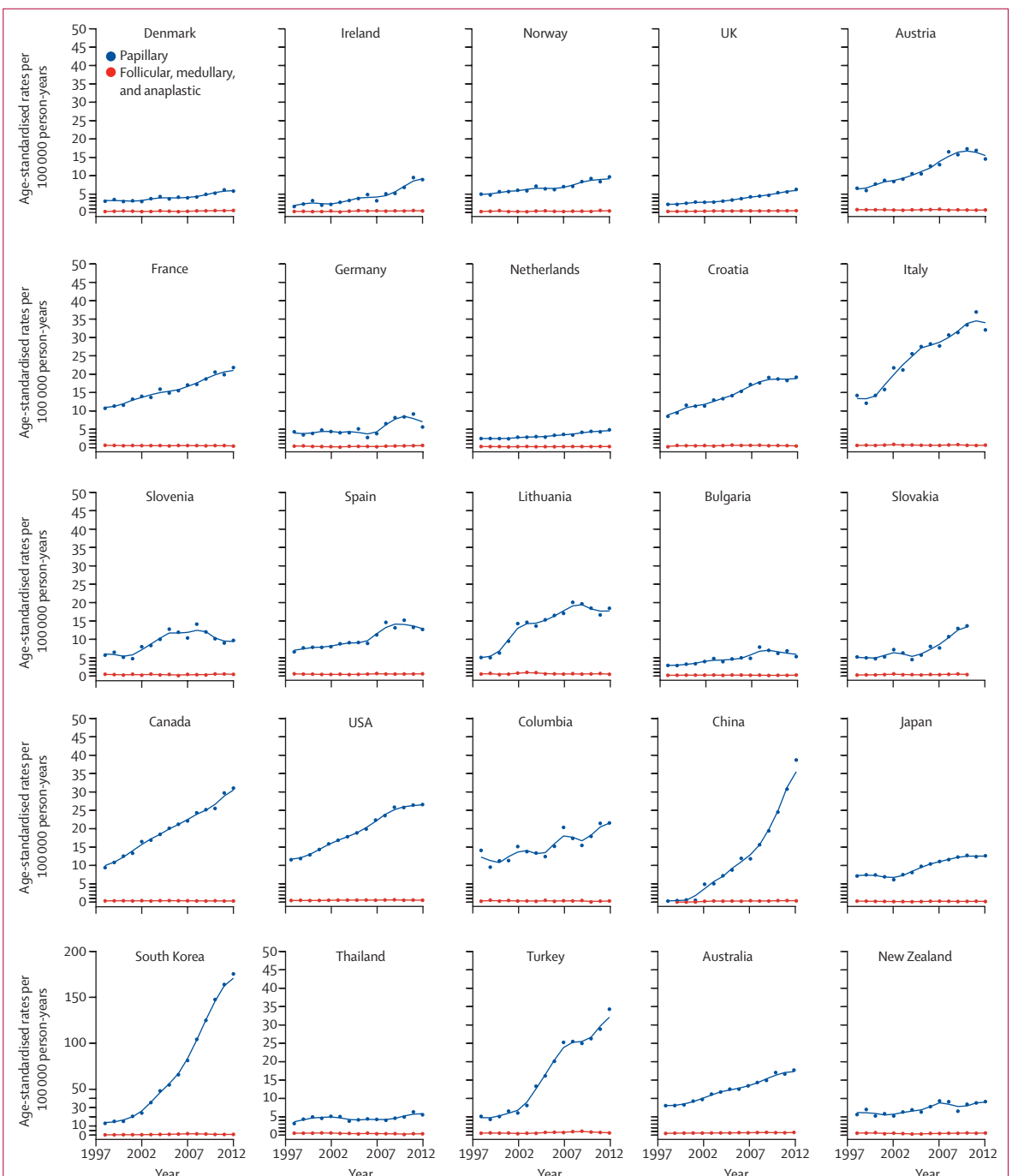


Figure 1: **Time trends in age-standardised incidence rates of thyroid cancer by histological subtype in women, from 1998 to 2012**
Data are age-standardised incidence rates per 100 000 person-years. Data for men are in the appendix (p 2).

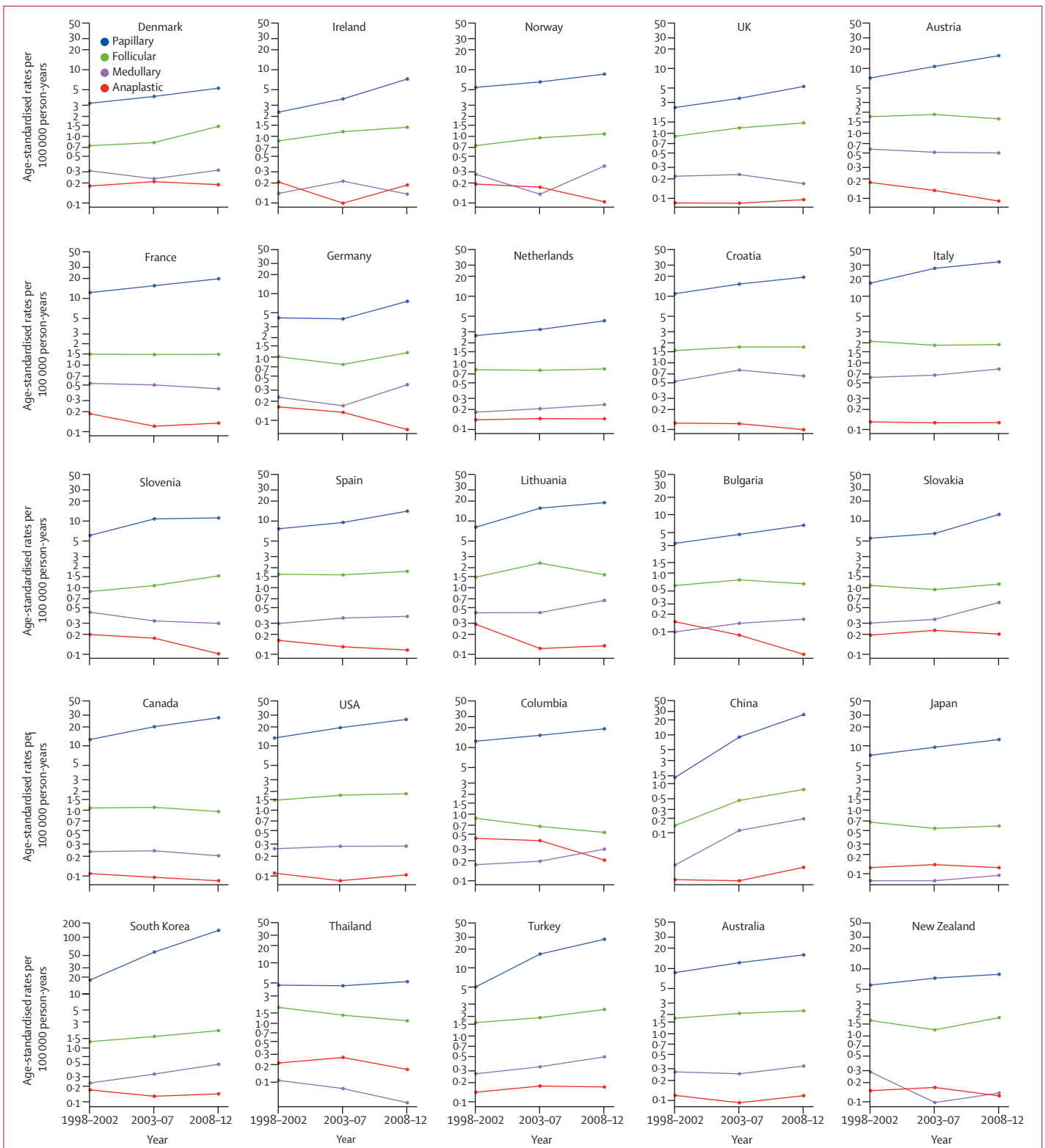


Figure 2: **Time trends in age-standardised incidence rates of thyroid cancer in individuals aged 20–84 years by histological subtype on a semi-logarithmic scale in women, from 1998 to 2012**
Data are age-standardised incidence rates per 100 000 person-years. Data for men are in the appendix (p 3).

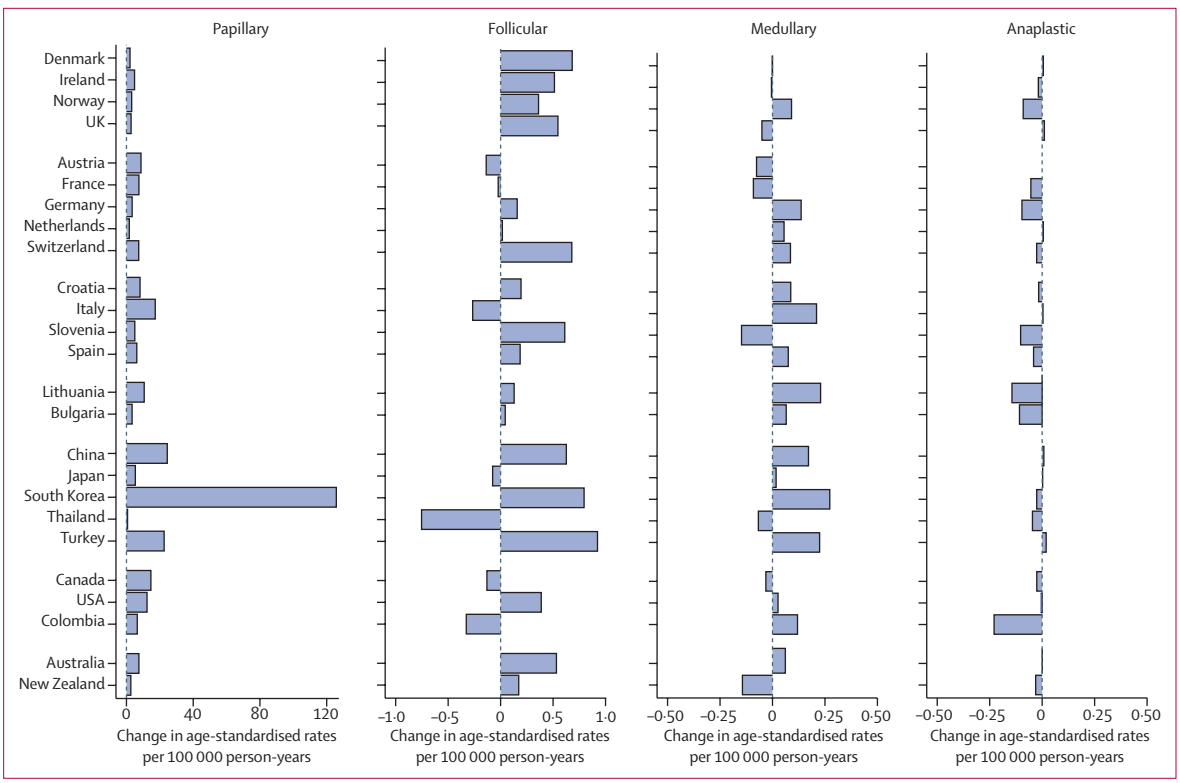


Figure 3: **Absolute change in age-standardised incidence rates of thyroid cancer by histological type in women from 1998–2002 and 2008–12**
Data are the absolute changes in age-standardised rates per 100 000 individuals. The scale differs for histological subtypes because of the different magnitudes of age-standardised rates. Data for men are in the appendix (p 4).

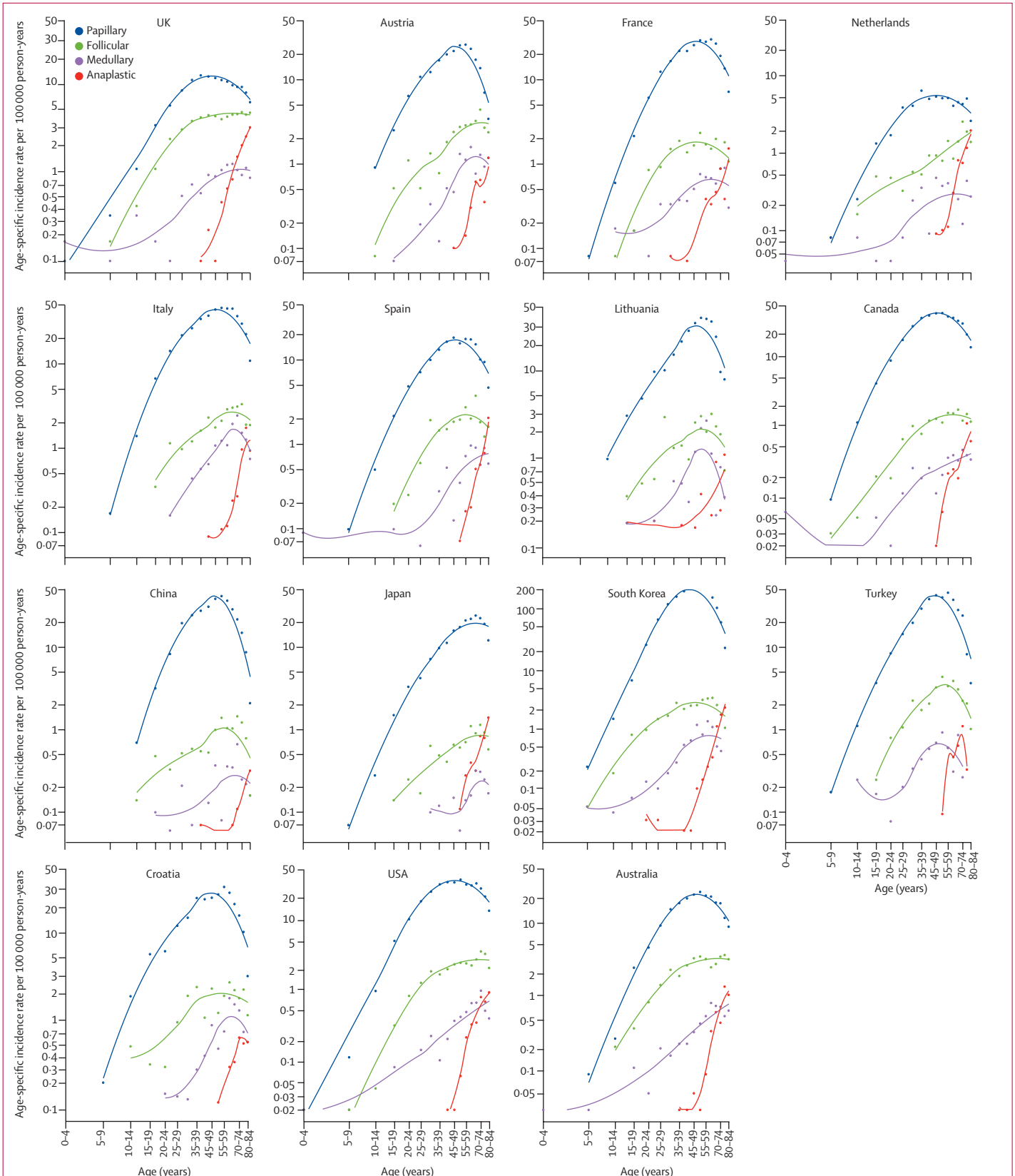
thyroid cancer, while for other subtypes the increasing rates with age were consistent in almost all countries (with peak rates after age 70 years).

Discussion

We provide here the first global assessment and comparison of incidence trends for the major thyroid cancer histological subtypes using data from high-quality population-based cancer registries. In the study period 1998–2012, rapid increases were observed only for papillary thyroid cancer whereas no consistently clear changes were noted for other histological subtypes. Papillary thyroid cancer also showed the largest geographical variation, with highest rates recorded in some high-income countries, such as the South Korea, Italy, France, Canada, and the USA, as well as in socioeconomically transitioning countries in Asia (eg, Turkey and China), and Latin America (eg, Colombia). Conversely, other subtypes did not show clear temporal changes, and were characterised by a much smaller country-level heterogeneity of the age-standardised rates. Anaplastic thyroid cancer incidence rates were much lower, and with less geographical variation, than all other thyroid cancer subtypes, with declining trends almost everywhere, including in countries that experienced large increases in overall thyroid cancer incidence rates and those for papillary thyroid cancer.

Another important epidemiological feature that differs substantially across thyroid cancer subtypes is the shape of the age-specific rate curves. Again, papillary thyroid cancer and anaplastic thyroid cancer showed opposing patterns: whereas the age-specific curve of anaplastic thyroid cancer incidence increased with a power law of age, in agreement with the historical behaviour of all thyroid cancer combined in periods before the widespread introduction of ultrasound and other diagnostic techniques,[16] the age-curve for papillary thyroid cancer progressively departed from this shape, displaying, in more recent periods, an inverse U-shape with a peak in incidence around middle age. The gradual changes of the age-specific curves for papillary thyroid cancer are likely to be due to the effect of intense scrutiny of the thyroid gland (by using sensitive imaging techniques, such as ultrasonography or CT scan) in middle-aged individuals.[17–20] Autopsy studies have shown that there was a large reservoir of subclinical asymptomatic tumours in the thyroid glands of 4–11% of individuals of all ages and that this fraction did not change over time.[21,22]

Changes in age-specific curves of incidence were previously used to assess the effect of overdiagnosis on overall thyroid cancer,[14] which was estimated to be responsible for more than 90% of all thyroid cancers diagnosed in women between 1998 and 2012 in South Korea and Belarus,[3] for 87% of all thyroid cancer cases in China,



and for more than 60% in several other countries. This and other evidence have led to recommendations that screening should be discouraged in asymptomatic individuals.[23]

In our study, there were hints of some stabilisation of thyroid cancer incidence rates after 2009 in some countries, which might possibly have resulted from the availability of newer, more conservative diagnostic guidelines.[24] Other possible explanations include the rising awareness of problems caused by overtreatment,[25] and the prospect that patients are more clearly advised of the benefits and harms in treating low-risk microtumours.[26]

The major strength of this study was the population-based, high-quality design including nationally representative thyroid cancer series from 25 countries across four continents for 15 years. Our findings might nevertheless have been affected by limitations in the cancer registry data—eg, the varying quality of histological information, and unfeasibility of centralised review of pathological reports. Consistency of histological classification and reporting is crucial in international comparisons. Local differences in the accuracy of the thyroid cancer diagnosis and in registry practices could have introduced a potential source of bias in this study. In particular, caution is needed when retrospectively evaluating follicular thyroid cancer in large nationwide databases because of possible misclassification with papillary thyroid cancer resulting from an increasing understanding of the pathogenesis, histology, and behaviour of thyroid cancer.[27] Discordance in the classification of histological subtypes might occur in some cases[28] although it is unclear the extent to which this problem could potentially affect incidence rates at the population level. Furthermore, it is possible that with the proposed changes in the classifications of thyroid cancer,[29] some follicular-patterned tumours might have been reclassified as papillary carcinoma.[27] Less likely to affect the results reported here are the changes over time in the classification of anaplastic thyroid cancer (undifferentiated) or medullary thyroid cancer, which arise from the neuroendocrine parafollicular C cells.[30]

A limitation of this study was the absence of data by tumour stage and size and the degree of surveillance of the thyroid gland in each country, as these data are not collected routinely in cancer registries. The availability of this information would have improved the understanding of the effect of overdiagnosis[17,18] and whether other factors might have partly contributed to the increase of thyroid cancer incidence trends.[31]

Other limitations of this study include the fact that we were not able to present data for the rarest variants of thyroid cancer (eg, Hurthle cell tumours or mixed medullary–papillary cancer) or aggressive variants of papillary thyroid cancer[32] or to disentangle sporadic from hereditary medullary thyroid cancer, which represents around a quarter of medullary thyroid cancer in some countries—eg, Denmark.[33] Finally, for some countries, incidence data were derived from subnational cancer registries that might not be completely representative of the entire country. Although variations in registry practices in collecting information on cases might create bias in international comparisons, registries included in CI5 have been considered of good quality by an appointed editorial board; a detail description on the criteria applied is published elsewhere.[11] Briefly, the editorial team evaluates three main domains of comparability, completeness, and accuracy. All registries included have been assessed to ensure the registry meets the high standards. For strength comparability, we applied two additional criteria, including those population-based cancer registries with a higher population coverage and a lower proportion of unspecified morphology for thyroid cancer. Additionally, we have further excluded registries with a fraction of unspecified thyroid cancer greater than 10% and, to ensure comparability across thyroid cancer subtypes, we have restricted the analyses to the more recent period (15 years) available using the same morphology codes for all registries.

This study examined incidence patterns and trends of major thyroid cancer histological types, revealing distinct epidemiological patterns for papillary thyroid cancer and other subtypes. Although the increases in the incidence of papillary thyroid cancer, the subtype most likely to be found in a subclinical form and therefore detected by intense scrutiny of the thyroid gland, are consistent in all countries, moderate but declining trends were observed for anaplastic thyroid cancer, whereas temporal changes for follicular thyroid cancer and medullary thyroid cancer did not show consistent patterns across populations.

Figure 4: **Age-specific incidence rates for thyroid cancer by histological subtype in women, from 2008 to 2012**
Data are incidence rates per 100 000 person-years shown on a log-log scale. Data for men are in the appendix (p 4).

Contributors

SV and LDM conceptualised the study, acquired the funding, and supervised the study. AM-F, JL-T, FB, and BC collected the data. SV, AM-F, and LDM contributed to the methodology. AM-F, SV, JL-T, and LDM did the formal analysis and investigation. AM-F, JL-T, and SV accessed and verified the data. AM-F, SV, and LDM wrote the report. All authors interpreted the data, and reviewed and approved the report. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication. Where authors are identified as personnel of the IARC or WHO, the authors alone are responsible for the views expressed in the article and they do not necessarily represent the decisions, policy, or views of IARC or WHO.

Declaration of interests

We declare no competing interests.

Data sharing

Data used in this study are fully available in ci5*plus*.

For more on **CI5*plus*** see https://ci5.iarc.fr/CI5plus/Pages/download.aspx

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