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Recent trends in incidence, geographical distribution, and survival of papillary thyroid cancer in France

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ABSTRACT

Background: Over the past few decades, the incidence of thyroid cancer has dramatically increased in many countries. This increase was mainly seen in papillary cancer. The role of diagnostic practices and the effects of other risk factors were suggested to explain this increase. We provide a descriptive analysis in terms of changes in incidence, geographical distribution, and survival to check the relevance of assumptions about the increase.
Methods: A detailed analysis of changes in incidence recorded in French cancer registries between 1982 and 2010 was performed taking into account age, period, and birth cohort. The geographical distribution of the incidence in the 2006–2010 period was estimated from the standardized incidence ratios. The net survival was estimated to evaluate the effects of sex, age, and period of diagnosis in patients diagnosed between 1989 and 2004 and followed-up until 2013.
Results: The incidence of papillary cancer has increased sharply over the 1982–2010 period; the average annual rate of increase was 7.8% in men and 7.2% in women. The increase has slowed in the recent period in people aged less than 50 at the time of diagnosis. It has also slowed in the cohorts born 1945 and after. There was a strong geographic disparity in incidence between areas covered by cancer registries. Finally, the net survival was very high; the 10-year net survival was 96% and improved progressively from 82% in patients diagnosed between 1989 and 1993 to 95% in those diagnosed between 1999 and 2004.
Conclusion: The increased incidence results most probably from the effect of medical practice, although other risk factors seem also involved, but to a lesser extent. The increase seems to have slowed down in the recent years, especially in the youngest age groups. This observation suggests a recent trend towards saturation of the effects of medical practices in post-1945 cohorts associated with an effect of the gradual dissemination of the recommendations relative to the management of thyroid nodules.

1. Introduction

In most countries, the incidence of thyroid cancer has been increasing for many decades [1]. The largest increase was seen in papillary cancer which represents the major histological type [2–11]. In France, the incidence of thyroid cancer was particularly high in certain Départements. Two French cancer registries (covering Départements Isère and Vendée) were among the 10% registries with the highest incidence worldwide [12]. In France, the incidence of thyroid cancer ranks currently 4th among solid tumours (vs. 15th in 1980) [13]. Various hypotheses have been advanced to explain the progression of papillary cancer worldwide.

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Whereas the role of diagnostic procedures and medical practices was widely evoked, the role of other risk factors was also suggested [14,15].

In this article, we describe the changes in the incidence of papillary thyroid cancer in France from 1982 to 2010 and its geographic variations in period 2006–2010. We also provide estimates of net survival at 5 and 10 years in patients diagnosed 1989–2004.

2. Materials and methods

This study of incidence trends covered period 1982–2010 and took into account all cases of papillary cancer recorded in registries that covered the entire period. The topography and morphology of the cancers were recorded according to the International Classification of Diseases for Oncology, Third edition (ICD-O-3). The present study considered ICD-O-3 morphology codes 82603, 82903, 83403–83443, and 83503. Eight French Départements were involved: Ardennes, Bas-Rhin, Calvados, Doubs, Isère, Marne, Somme, and Tarn where 7983 cases of papillary cancer were observed between 1982 and 2010. The analysis of geographic variation examined period 2006–2010 and integrated data from five additional Départements: Hérault, Haut-Rhin, Loire-Atlantique, Manche, and Vendée. In these 13 Départements, from 2006 to 2010, 4640 incident cases were reported. Finally, the survival analysis concerned patients diagnosed 1989–2004 in nine Départements (Ardennes, Bas-Rhin, Calvados, Doubs, Haut-Rhin, Isère, Marne, Somme, and Tarn). The cut-off date for the survival analysis was June 30, 2013. The follow-up concerned 4647 patients.

Population data were obtained from the Institut National de la Statistique et des Etudes Economiques (INSEE) for each Département, with sex and age for each year from 1982 to 2011.

To describe the trends in incidence, the incidence rates were modelled separately for men and women using an age–period–cohort (APC) model. More precisely, the annual number of incident cases was analysed by a Poisson regression model that included a flexible continuous terms for age (annual), year of birth, and year of incidence [16]:

$$\log(\lambda_{a,c,(y)}) = s_1(a) + s_2(c) + s_3(y)$$

where $\lambda_{a,c}$ corresponds to the incidence rate for age a and birth cohort c; thus for the year of diagnosis $y = a + c$. In $s_i()$, $i = 1, 2,$ or 3 and corresponds to a smoothing spline. The degree of freedom for the spline functions was determined sequentially for age, cohort, and period terms, on the basis of minimising the Akaike Information Criterion (AIC) [17]. More precisely, the degree for s_1(age) was first determined in a model that included only this effect. The degree for s_2(cohort) was then determined in the model $\log(\lambda_{a,c}) = \alpha + s_1(a) + s_2(c)$, using the degree previously fixed for $s_1(a)$. Finally, the degree for s_3(year of diagnosis) was determined in the full model $\log(\lambda_{a,c}) = \alpha + s_1(a) + s_2(c) + s_3(y)$, using the degrees previously fixed for $s_1(a)$ and $s_2(c)$. The annual rate of change was estimated from the coefficient for the year of diagnosis (y) of model $\log(\lambda_{a,c,(y)}) = s_1(a) + y$. We used Splus software.

The trends in age-standardized world incidence rates that derived from the above APC model were first described graphically according to the year of diagnosis and sex. Then, for a detailed presentation of the change in incidence, the incidence rates derived from the APC were presented graphically through four figures for each sex: (i) by age for various year of diagnosis, (ii) by year of diagnosis for various ages, (iii) by age for various birth cohorts, and (iv) by birth cohort for various ages, as recommended by Carstensen [18].

Geographic variation in incidence was described on the basis of the standardized incidence ratios (SIR) using as references the incidence rates in whole areas covered by registries. The heterogeneity of the SIRs was examined with the Potthoff–Whittinghill test [19]. This test measures the departure from the null hypothesis of a common age-specific incidence rate in the various spatial units studied, assuming a Poisson distribution for the observed number of cases.

The net survival was obtained with the new Pohar–Perme estimator of the net cumulative rate [20]. The net survival is the survival that would be observed if thyroid cancer was the only cause of death [21]. The expected mortality rates (necessary for this estimator) were available by age, sex, year of diagnosis, and Département of residence; they were previously smoothed. Age-adjusted net survival estimates at 5 and 10 years were calculated using the International Cancer Survival Standard weights [22] for three periods of incidence: 1989–1993, 1994–1998, and 1999–2004.

3. Results

3.1. Trends in the incidence (eight Départements, 1982–2010)

The incidence of papillary cancer was 3.4–4.3 times higher in women than in men depending on the period considered between 1982 and 2010 (Table 1). The age-standardized incidence (world standard population) increased six-fold between period 1982–1985 and period 2006–2010. This increase corresponded to an annual percent of change of 7.2% [95% confidence interval, CI: 6.8; 7.6] in women and 7.8% [7.1; 8.5] in men over 29 years. This increase was continuous throughout the period analysed (Fig. 1a) but slowed in both sexes since the early 2000s (Fig. 1b).

Fig. 2a and b shows the specific incidence rates per age (from the modelling) for different years of diagnosis within period 1985–2010 (transversal incidence curves by year). The rates are given per 100 000 person-years on a logarithmic scale. The incidence curves show inverse U-shapes for all years of diagnosis with a shift of the peak from age nearly 40 in 1985 to age nearly 65 in 2010 for both sexes. Fig. 3a and b shows the incidence rates for different ages and years of diagnosis. The incidence increases for all age groups and

Table 1
Number of cases, age-adjusted incidence rates on world population and sex ratio by sex and period between 1982 and 2010; data eight "départements".

	1982–1985	1986–1990	1991–1995	1996–2000	2001–2005	2006–2010
Male						
Cases (%)	59	110	164	286	487	612
Rate* (CI)	0.6 [0.4;0.8]	0.8 [0.7;1.0]	1.1 [1.0;1.3]	1.9 [1.7;2.1]	3.0 [2.8;3.3]	3.5 [3.2;3.8]
Female						
Cases (%)	217	438	727	1 204	1 761	2 194
Rate* (CI)	2 [1.7;2.3]	3.2 [2.9;3.5]	4.9 [4.6;5.3]	7.8 [7.6;8.3]	10.6 [10.1;11.2]	12.6 [12.1;13.2]
Sex ratio**	3.4	4.0	4.3	4.1	3.5	3.6

* World age-adjusted incidence rate.
** Rate (female)/Rate (male).