Estimates of thyroid cancer incidence in Brazil: an approach using polynomial models

Estimativa da incidência do câncer de tireóide no Brasil: uma abordagem por meio de modelos polinomiais

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Abstract

This study aimed to estimate thyroid cancer incidence in Brazil in 2006 using polynomial models that take age and birth cohort effects into account in the estimation process. Estimates were based on new cases of thyroid cancer in nine Brazilian cities (Manaus, Palmas, Natal, Recife, Cuiabá, Belo Horizonte, São Paulo, Porto Alegre, and Curitiba) and the Federal District from 1997 to 2001. We estimated 6,066 new cases, of which 1,065 in men and 5,001 in women. The incidence rates were, respectively, 1.16 and 5.27 per 100,000 inhabitants. Rates increased with age in both genders, especially after 30 years. The size and profile of rates according to age and gender indicate that the method yields plausible estimates.

Incidence; Thyroid Neoplasms; Neoplasms

Introduction

The recent literature has shown an increase in differentiated thyroid cancer. The hypothesis has been raised that this increase results from the expanded use of diagnostic practices such as ultrasound and fine needle biopsy [1,2]. According to another hypothesis, the increase is actually determined by an association with a series of risk factors, including age, gender, ethnicity, and geographic location [1,3].

According to estimates by the GLOBOCAN project [4], in 2002 there were 141,013 new cases of thyroid cancer in the world, with 35,575 deaths. These figures correspond to estimated age-adjusted thyroid cancer incidence rates in females of 5.5/100,000 in developed regions and 2.6/100,000 in less developed regions. For men, the estimates were 2.1/100,000 and 1.0/100,000, respectively [5].

Access to information on cancer incidence is essential for defining the role of risk factors and setting priorities for prevention, planning, and health services administration. However, such information is rarely available at the national or regional level. Methods that allow obtaining an estimate of new cases based on information about incidence are highly useful and offer an overview of the cancer distribution pattern for the country and its regions. In Brazil, as in various other countries, the real number of new cases diagnosed by health services each year in not known, due to the lack of a nationwide cancer registry, so that annual incidence estimates are still highly useful [6].

The ratio between incidence and mortality [7] is one of the most widely used methods for obtaining estimates. Although the method is easy to implement, it is limited by the fact that it does not consider age and birth cohort effects. Application of the ratio between incidence and mortality, combined with polynomial models that consider age and cohort effects, represents an alternative for treating these effects when estimating incidence rates [8]. The objective of this study was to estimate thyroid cancer incidence in Brazil in the year 2006 by means of polynomial models that consider age and birth cohort effects.

Methods

An ecological study was conducted to estimate cancer incidence for Brazil in the year 2006.

The population data sources were the *National Population Censuses* (1980, 1991, and 2000), the *Population Count* (1996), and population estimates (Instituto Brasileiro de Geografia e Estatística – IBGE; http://www.ibge.gov.br). Mortality data for the years 1979 to 2004 were obtained from the Mortality Information System (SIM). Population data and mortality data from the SIM were downloaded from the website of the Health Informatics Department (Departamento de Informática do SUS – DATASUS; http://www.datasus.gov.br). New cases of thyroid cancer were downloaded from data in the Population-Based Cancer Registries (PBCR) for Manaus, Palmas, Natal, Recife, Distrito Federal, Cuiabá, Belo Horizonte, São Paulo, Porto Alegre, and Curitiba, available on the website of the Brazilian National Cancer Institute (Instituto Nacional de Câncer – INCA; http://www.inca.gov.br) according to gender and age bracket for the years 1997 to 2001, which includes most of the records.

New cases of thyroid cancer in Brazil by gender, calendar year (1979 to 2004), and age bracket were estimated based on thyroid cancer incidence rates obtained by multiplying the incidence/mortality ratio for Brazil by the mortality rates in the States according to gender, calendar year, and age bracket. In other words, the estimated number of new cases in Brazil from 1979 to 2004 was obtained by adding the new cases in the States, which were obtained by applying the estimated incidence rates in the States to the respective populations.

$$TI_L = TM_L \times \left(\frac{I_R}{M_O} \right)$$

Where: TI_L = estimated State incidence rate by gender, calendar year, and age bracket; TM_L = State mortality rate by gender, calendar year, and age bracket; I_R = number of new cases of thyroid cancer from 1997 to 2001, recorded among all the PBCR studied here; and M_0 = number of deaths recorded in the SIM with the same temporal and territorial coverage as in the number of new cases (I_R).

Poisson polynomial models were adjusted for the estimated incidence rates for the year 2006. These models considered age and birth cohort information during the incidence rate estimation process [8].

Age brackets were divided into five-year intervals ($\Delta x = 5$), while the last bracket was defined as 80 years and older. Mean points in the age brackets (x) were calculated and centered on 42 years (x_0), the midpoint between 40 and 44 years. The following formula was thus applied:

$$\text{age} = \frac{x - x_0}{\Delta x} \ .$$

Five-year cohorts were defined (Δu = 5). For example, the birth cohort for children 0 to 4 years of age from 1979 to 1983 corresponds to the cohort of children 5 to 9 years of age from 1984 to 1988. Birth cohort was defined as a function of age bracket and the period in which a new case occurred, both in five-year intervals. For analytical purposes, birth cohort (u) is equal to the midpoint in the period (p) minus the midpoint in age (u = p-x). The birth cohort (u) was centered on the year 1991 (u_0). The following formula was thus applied:

$$\text{cohort} = \frac{u - u_0}{\Delta u} \ .$$

Estimated incidence rates ($\lambda_{x,u}$) as a function of age and birth cohort were obtained for the year 2006 from Poisson polynomial models ("I" and "C"), orders " l" and "m", for age and birth cohort, respectively. These models are identified by I_lC_m:

$$Log\ \lambda_{x,u} = I\left(\frac{x - x_0}{\Delta x} \right) + C\left(\frac{u - u_0}{\Delta u} \right);$$

$$Log\ \lambda_{x,u} = \alpha\left(\frac{x - x_0}{\Delta x} \right) + \beta\left(\frac{u - u_0}{\Delta u} \right);$$

where: α and β are the model's coefficients.

The orders ("*l*" and "*m*") of the polynomials were defined by increasing the polynomial's degree until at least two consecutive coefficients were not significant. In other words, "*l*" is the integer for which α_0, α_1, ... α_l are different from zero, since α_{l+1} and α_{l+2} are not significant. After defining the order of the age polynomial, the order "m" of the cohort polynomial was defined by gradually increasing the order "m" of the cohort polynomial, with age already in the model, until at least two consecutive "β" coefficients were not significant.

The models used to estimate the incidence rate (λx,u) are identified as I_3C_6 for men and I_1C_4 for women:

Men (I_3C_6):

$$Log\ \lambda_{x,u} = \alpha_0 + \alpha_1\left(\frac{x-x_0}{\Delta x}\right)^1 + \alpha_2\left(\frac{x-x_0}{\Delta x}\right)^2 + \alpha_3\left(\frac{x-x_0}{\Delta x}\right)^3 + \beta_1\left(\frac{u-u_0}{\Delta u}\right)^1 + \beta_2\left(\frac{u-u_0}{\Delta u}\right)^2 + \beta_3\left(\frac{u-u_0}{\Delta u}\right)^3 + \beta_4\left(\frac{u-u_0}{\Delta u}\right)^4 + \beta_5\left(\frac{u-u_0}{\Delta u}\right)^5 + \beta_6\left(\frac{u-u_0}{\Delta u}\right)^6$$

Women (I_1C_4):

$$Log\ \lambda_{x,u} = \alpha_0 + \alpha_1\left(\frac{x-x_0}{\Delta x}\right)^1 + \beta_1\left(\frac{u-u_0}{\Delta u}\right)^1 + \beta_2\left(\frac{u-u_0}{\Delta u}\right)^2 + \beta_3\left(\frac{u-u_0}{\Delta u}\right)^3 + \beta_4\left(\frac{u-u_0}{\Delta u}\right)^4$$

The analyses were performed in Stata 8.0 (Stata Corp., College Station, USA). The study was approved by the Institutional Review Board of the Clementino Fraga Filho University Hospital, Rio de Janeiro Federal University (Hospital Universitário Clementino Fraga Filho, Universidade Federal do Rio de Janeiro) Brazil.

Results

The study estimated 6,066 new cases of thyroid cancer for the year 2006, including 1,065 cases in men and 5,001 cases in women. The respective incidence rates were 1.16 and 5.27 per 100,000 inhabitants. In both genders there was an increase in incidence rates with age, especially beginning at 30 years. The incidence rates were also higher in women (Table 1).

Table 1

Estimated number of new cases of thyroid cancer and incidence rates * according to adjusted polynomial models. Brazil, 2006.

Age bracket (years)	Men		Women	
	New cases	Incidence	New cases	Incidence
0-4	0.04	0.00	17.83	0.20
5-9	0.32	0.00	9.95	0.11
10-14	1.36	0.01	8.19	0.09
15-19	3.54	0.04	8.89	0.09
20-24	6.19	0.07	10.58	0.12
25-29	9.21	0.12	14.30	0.18
30-34	14.75	0.21	23.84	0.32
35-39	24.13	0.37	43.11	0.62
40-44	37.33	0.66	74.25	1.24
45-49	56.27	1.21	124.82	2.53
50-54	82.55	2.21	202.01	5.07
55-59	108.71	3.85	305.95	9.82
60-64	147.08	6.28	482.02	18.11
65-69	165.73	9.31	663.02	31.44
70-74	164.60	12.36	838.71	51.13
75-79	122.93	14.57	842.66	77.90
≥ 80	120.02	15.22	1,330.67	111.79
Total **	1,065	1.16	5,001	5.27

* Rates per 100,000;

** The total numbers of new cases were rounded to whole numbers.

Discussion

The approach presented here [8] is a refinement of the method based on the ratio between incidence and mortality [5], since it considers the effects of age and birth cohort on the incidence estimation process. Ignoring the effects of age and birth cohort (data not shown), we obtained estimates for thyroid cancer incidence rates of 1.34 for men and 6.3 for women (per 100,000 inhabitants), which were, respectively, 13% and 16% higher than those obtained when polynomial models were used. Approaches that consider age and birth cohort effects also proved relevant in estimating incidence rates for cancers of the breast and lung, among others [9,10].

The profile of estimated rates by gender and age is consistent with what is expected for thyroid cancer, with a predominance in women and increasing incidence with age, especially after 30 years [1,2,3]. As for the size of the rates, a recent study based on PBCR in the cities of Belém, Recife, Goiânia, São Paulo, and Porto Alegre from 1993 to 2001 showed a wide variation in the incidence rates [5], and the estimates obtained in the current study were consistent with what would be expected for a mean value for Brazil. According to Coeli et al. [5], the possible explanations for the geographic variations in incidence are probably related to the availability of medical care resources in the different regions and to the quality of data in the cancer registries. Thus, it would be interesting to conduct future studies aimed at evaluating the method's adequacy for obtaining estimates in smaller geographic areas such as regions and States of the country.

Resumo

Este estudo tem o objetivo de estimar a incidência do câncer de tireóide no Brasil no ano de 2006 por meio de modelos polinomiais que consideram os efeitos da idade e coorte de nascimento. As estimativas tomaram por base casos novos de câncer de tireóide incluídos em registros de câncer de base populacional de nove cidades brasileiras (Manaus, Palmas, Natal, Recife, Cuiabá, Belo Horizonte, São Paulo, Porto Alegre e Curitiba) e do Distrito Federal, entre 1997 e 2001. Foram estimados 6.066 casos novos, sendo 1.065 casos entre os homens e 5.001 casos entre as mulheres. As taxas de incidência foram respectivamente 1,16 e 5,27 por 100.000 habitantes. Em ambos os sexos houve crescimento das taxas segundo a idade, especialmente a partir dos 30 anos. A magnitude e o perfil das taxas segundo idade e sexo sugerem que o método empregado fornece estimativas plausíveis.

Incidência; Neoplasias da Glândula Tireóide; Neoplasias

Contributors

A. S. Brito and F. S. Barbosa contributed to planning the study, data processing and analysis, and writing of the paper. C. M. Coeli participated in the choice of the theme, planning the study, data analysis, and writing the paper. R. Caetano and M. O. Santos contributed to the interpretation of the results and revision and final editing of the text. M. Vaisman participated in the choice of the theme, interpretation of the results, and revision and final editing of the text.

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