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Mortality from oral and oropharyngeal cancer in Brazil, between 2000 and 2013: trends by sociodemographic strata

Amanda Ramos da Cunha (https://orcid.org/0000-0002-6358-5582) [1]
Taiane Schaedler Prass (https://orcid.org/0000-0003-3136-909X) [2]
Fernando Neves Hugo (https://orcid.org/0000-0003-2222-7719) [1]

Abstract *Generalized observations of temporal trends in mortality could mask consistent specific patterns. This study aims to analyze the trend of oral and oropharyngeal cancer mortality rates in Brazil, from 2000 to 2013, considering the differences by gender, anatomical site, age group and ethnicity. Data on oral and oropharyngeal cancer mortality were retrieved from the Mortality Information System. The trend of historical series mortality rates by stratum was estimated through a generalized linear regression by the Prais -Winsten method. In total, 61,190 deaths from oral and oropharyngeal cancer were recorded in the 2000-2013 period (mean of coefficients: 3.50 deaths/100 thousand inhabitants/year). The trend of mortality rates was stable for males and increasing for females (1.31%/year). A growing pattern was identified for men aged 20-29 years (2.92%/year) and brown men (20.36%/year). The increasing pattern was also identified for white women (2.70%/year) and brown women (8.24%/year). We can conclude that surveillance of this condition should consider the sociodemographic differences of the population for equitable planning of care strategies because they reflected in different trends of oral and oropharyngeal cancer mortality rates in Brazil.*

Key words *Mouth neoplasms, Oropharyngeal neoplasms, Mortality, Ethnicity and Health*

[1] Faculdade de Odontologia, Universidade Federal do Rio Grande do Sul (UFRGS). R. Ramiro Barcelos 2492, Santa Cecília. 90035-003 Porto Alegre RS Brasil. amandaracunha@yahoo.com.br
[2] Instituto de Matemática e Estatística, UFRGS. Porto Alegre RS Brasil.

Introduction

Oral and oropharyngeal cancer is a widely studied topic and its relevance is corroborated by recent epidemiological data. The International Agency for Research on Cancer (IARC) estimated approximately 370,000 new cases of oral cancer, 97,000 cases of oropharyngeal cancer and 240,000 deaths from these neoplasms worldwide for 2020[1]. Concerning the male population, oral cancer has the 11th and 12th rate of incidence and mortality, respectively, among all types of cancer, and these estimates do not account for tonsil and oropharyngeal neoplasms[2,3].

In Brazil, 15,000 new cases of oropharyngeal cancer have been estimated for 2018, which is approximately 3.5% of all new cancer cases in the country this year. This number is distributed at an estimated risk of 10.86 new cases per 100,000 men and 3.28 per 100,000 women. Regarding males, it is the fifth most common cancer in Brazil and ranks 4th in the Southeast region[4]. Concerning mortality, 5,900 deaths from this pathology were recorded in 2015, which resulted in an age-adjusted mortality rate of 3.05 deaths per 100,000 people[5].

Tobacco and alcohol consumption is the main etiological factor for the development of oral cancer[6-8], while Human Papillomavirus (HPV) has recently been considered the main etiologic factor for oropharyngeal cancer[9-11]. It is understood that the temporal trend of incidence and mortality rates by this disease, among other aspects, has reflected changes in the exposure of populations to risk factors. Some developed countries, such as Japan, Australia, Canada, and the United States have recorded a decreasing or stable pattern in the incidence of oral cavity neoplasms – which are most strongly related to tobacco exposure[12]. In contrast, the incidence of neoplasms at anatomical sites associated with the presence of HPV virus has been increasing in these same regions, especially in younger men. The association of this pattern with aspects related to the sexual behavior of the populations is speculated[3,12,13].

The magnitude and trend of oral and oropharyngeal cancer mortality rates reflect exposure to risk factors and are also influenced by sociodemographic and socioeconomic aspects and by the availability, efficacy and quality of treatment provided to the patients[14-16]. Poorer socioeconomic conditions, reflected by both individual-level variables, such as schooling and occupation, and contextual-level variables, such as HDI and Gross Domestic Product (GDP), are associated with worse outcomes, including death[16]. The availability of timely access to health services is also an essential aspect for mortality due to this disease, as it is related to the opportunity for early diagnosis. It is even more relevant because the delayed diagnosis is an overly familiar situation for this type of cancer (more than 50% of cases) and is related to the detection of tumors in advanced stages[17-19].

Given these aspects, it is understood that the monitoring of mortality rates in populations, especially if analyzed by strata, can help in the planning and formulation of more equitable health strategies and programs, both in the area of prevention and early diagnosis, as well as in the treatment and rehabilitation[20]. Recently, the trend of oral and pharyngeal cancer mortality rates in Brazil for the 2002-2013 period was analyzed by gender, anatomical site and national macro-regions[21]. This is a particularly interesting period since it covers the initial years of the restructuring of public oral healthcare in Brazil. This study aims to analyze the trend of oral and oropharyngeal cancer mortality rates in Brazil in a similar time series (from 2000 to 2013), however, considering the different strata: besides the "anatomical site", this study shows the analysis by age group and by ethnicity/skin color and the intergender variation in these strata.

Methods

This is an ecological study of time series. Data on oral and oropharyngeal cancer mortality between 2000 and 2013 were retrieved from the Mortality Information System (SIM), managed by the Brazilian Ministry of Health and made available through the Portal of the Department of Information Technology of the SUS (DATASUS). Deaths of individuals aged 15 years and older caused by malignant neoplasms of the oral cavity and oropharynx were included [C00-C10 categories of the International Classification of Diseases – 10th revision (ICD-10)][22]. Data concerning the Brazilian population were obtained through the Department of Information Technology of SUS (DATASUS), which gathers information from the Demographic Censuses and Inter-Census Projections of the country conducted by the Brazilian Institute of Geography and Statistics (IBGE).

In this study, all mortality rates (number of deaths due to oral and oropharyngeal cancer per 100,000 inhabitants) analyzed and presented

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were previously standardized by gender and age group (15-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79 years and 80 years and over) by the direct method[23], using the 2010 Brazilian population as standard. The standardization aimed to consider and remove the effects of factors related to the distribution of population that interfere with the risk of death from oral and oropharyngeal cancer. The mean annual rates are the arithmetic mean of the annual standardized mortality rates for the 2000-2013 period.

The databases used for the standardization had some limitations, which were circumvented as follows: 1- In the historical series analyzed, data by ethnicity/skin color of the Brazilian population in the census years (2000 and 2010) are not available; the geometric progression method was employed – for each ethnic group/skin color to fill these gap, for the year 2000, we assumed $q=P2002/P2001$, where *P2002* is the population (of each ethnic group/skin color) in 2002, and *P2001* is the population (of each ethnic group/skin color) in 2001. For 2010, in the same perspective, we assumed $q=P2009/P2008$[24]. 2- For some age groups, the number of the indigenous population is not available for a few years of the historical series. However, the population of the other ethnic groups/skin colors and the total population are shown. In this case, the difference between the total and the sum of the populations of the other ethnic groups/skin colors was defined as the number of the indigenous population. 3- For some age groups, the indigenous population and also the yellow population are unknown for a few years of the historical series. In this case, the geometric progression method was used to obtain an estimate for these two populations – in each missing year, we assumed q as the population ratio (indigenous or yellow) of the two contiguous years of the series, closest to the gap, in the age group in question[24]. 4- Concerning the age groups of 70-79 years and 80 years and over, for both genders, there were many missing data for the indigenous and yellow ethnic groups/skin colors (for the age group "80 years and over", the indigenous population is unknown for all the years of the series, for example). Due to the impossibility of applying geometric progression to correct these gaps, we decided to calculate the rates and analyze the trend for these ethnic groups/skin colors, for both genders, excluding these two age groups.

A generalized linear regression by the Prais-Winsten method[25,26] was employed to estimate the mortality trend of the historical series – by gender, anatomical site, age group and ethnicity/skin color –, which allows the correction of the first order autocorrelation in the analysis of series of values organized time-wise. This procedure facilitated the classification of the mortality rates into ascending ($p<0.05$ and positive regression coefficient), declining ($p < 0.05$ and negative regression coefficient) or stable ($p > 0.05$), and the measurement of the mean annual increase or decline of coefficients, according to Antunes and Cardoso's method[26]. Residuals were verified by graphical analysis in conjunction with the R^2 analysis. Statistical analysis was performed using software "R" version 3.2.4.

Results

In total, 61,190 deaths from oral and oropharyngeal cancer were recorded in Brazil from 2000 to 2013. The mean annual mortality rates in the historical series were 3.50 deaths per 100,000 inhabitants for both genders, 7.25/100,000 inhabitants for males and 1.84/100,000 inhabitants for females – 3.94 times higher in males than females. The intergender gap decreased when comparing the initial and final years of the series: in 2000, the mortality rate among men was 4.41 times higher than among women (5.34 deaths/100,000 men vs. 1.21 deaths/100,000 women); in 2013, it was 3.76 times higher among men than among women (5.57 deaths/100,000 men vs. 1.48 deaths/100,000 women).

The five anatomical sites responsible for the highest concentration of analyzed deaths were "oropharynx" (31.72%), "other parts and unspecified parts of the mouth" (21.55%), "other parts and unspecified parts of the tongue" (18.95%), "base of the tongue" (8.18%) and "palate" (4.83%). The sites "parotid gland", "floor of the mouth" and "tonsil" concentrated, respectively, 4.51%, 3.66% and 3.18% of the deaths. Finally, "other major and unspecified salivary glands", "lip" and "gum" accounted for 1.45%, 1.07% and 0.89% of the analyzed deaths, respectively.

Table 1 shows the mean annual rates of the historical series (per 100,000 inhabitants), by anatomical site, age group and ethnicity/skin color, considering both genders and each gender separately. Also, it indicates the intergender ratio of these rates. The anatomical site with the highest mortality rate was "oropharynx", with 1.11 deaths per 100,000 inhabitants/year, followed by "other parts of the mouth" (0.76/100,000 inhabitants/year). Concerning the intergender ratio, the

"base of the tongue" showed the most significant discrepancy, with 6.07 deaths for men at for each woman's death.

The descriptive analysis by age group showed that the highest concentration of deaths, considering both genders, occurred in the group of 50-59 years – that showed a mean annual rate of 1.02 deaths per 100,000 inhabitants. – followed by the group of 60-69 years (0.87/100.000 inhabitants/year). Regarding the analysis by ethnicity/skin color, the highest mortality rate, considering both genders, was identified in blacks, with 3.39 deaths per 100,000 inhabitants. Next are whites (3.36/100.000 inhabitants/year). These data are detailed in Table 1.

In the trend analysis of the rates in the period studied by gender, it was identified that the male mortality rate went from 5.34 per 100,000 inhabitants in 2000 to 5.57 per 100,000 inhabitants in 2013. Considering the full time series, this gap was not statistically significant: the trend of mortality rates for males was stable. For females, the mortality rate per 100,000 inhabitants ranged from 1.21 in 2000 to 1.48 in 2013. Statistical analysis for this gender indicated a statistically significant growing trend, with a mean annual increase of 1.31% ($p = 0.03$). Graph 1 shows the overall and gender-wise pattern of mortality rates in the period studied. These results are detailed in Table 2.

Trends per anatomical site are shown in Graph 2, and results are detailed in Table 2. They revealed an increased trend of mortality rates due to malignant neoplasms of the base of the tongue and malignant neoplasms of the floor of the mouth, with a mean annual increase of 1.5% and 2.6%, respectively. The anatomical site "tonsil" was the only one with a declining tendency, with a mean annual drop of about 2%.

Table 1. Mean of adjusted mortality rates due to oral cancer and oropharyngeal cancer (per 100,000 inhabitants) by gender, anatomical site, age group and ethnicity/skin color and ratio between rates (M/W). Brazil, 2000-2013.

Variable	Overall	Men (M)	Woman (W)	M/W Ratio
Anatomical Site				
Lip	0.038	0.058	0.019	3.05
Base of the tongue	0.283	0.498	0.082	6.07
Other parts of the tongue	0.662	1.080	0.270	4.00
Gum	0.031	0.041	0.022	1.86
Floor of the mouth	0.126	0.213	0.046	4.63
Palate	0.169	0.248	0.095	2.61
Other parts of the mouth	0.760	1.146	0.399	2.87
Parotid gland	0.159	0.208	0.113	1.84
Other major salivary glands	0.051	0.060	0.042	1.43
Tonsil	0.112	0.195	0.034	5.74
Oropharynx	1.108	1.947	0.322	6.05
Age Group				
15 - 19	0.003	0.003	0.002	1.37
20 - 29	0.014	0.018	0.011	1.60
30 - 39	0.076	0.122	0.033	3.70
40 - 49	0.493	0.889	0.121	7.35
50 - 59	1.021	1.845	0.250	7.38
60 - 69	0.874	1.493	0.295	5.06
70 - 79	0.596	0.873	0.337	2.59
80 and +	0.423	0.451	0.396	1.14
Ethnicity/Skin Color				
White	3.355	5.632	1.221	4.61
Black	3.385	5.441	1.459	3.73
Brown	2.275	3.565	1.067	3.34
Yellow*	1.402	2.341	0.522	4.48
Indigenous*	0.883	1.355	0.442	3.07

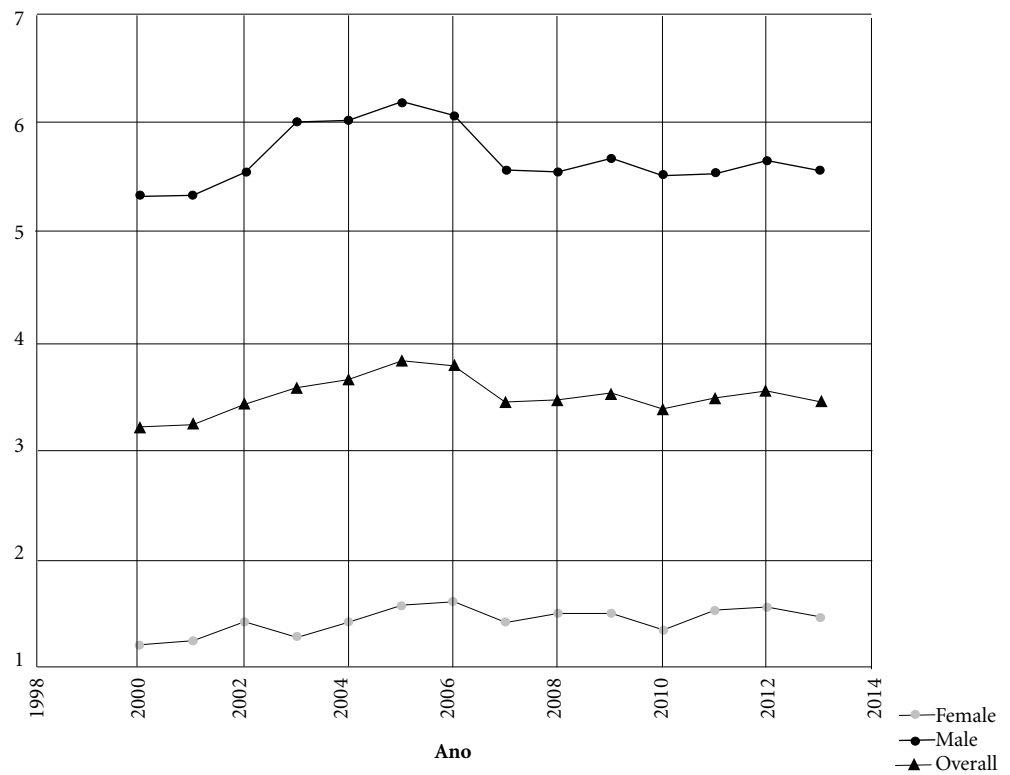
Source: Prepared by the authors.
*Excluding age groups of 70-79 years and 80 years and over.

The analysis of mortality rate trends that considered age groups separately identified an upward trend for women aged 30-39 years and 80 years and over, an increasing trend for men aged 20-29 years and a declining trend for men aged 30-39 years and 40-49 years. Finally, analysis by ethnicity/skin color showed an upward trend in mortality rates for white and brown women, and a declining trend for black women. Considering males, an increasing trend was also identified for browns and a declining trend for yellows (Table 3).

Discussion

The behavioral trend of oral and oropharyngeal cancer mortality rates in Brazil in the period 2000-2013 was quite varied among the strata studied, evidencing the relevance of more detailed monitoring of this condition.

The trend of the overall rates was stable for both genders and males and increased for females. This trend may be reflecting the variations experienced by the country in the pattern of tobacco consumption. Brazilian tobacco use indicators have been monitored since 1989. From 1989 to 2003, their prevalence has fallen from 34.8% to 22.4% (a decrease of approximately 35%). This decline was observed in both genders; however, it was more pronounced among men than among women (37% and 32%, respectively)[27]. A similar pattern was identified in the most recent temporal selection analysis: an overall reduced prevalence of tobacco use was observed in Brazil (about 0.6% per year) in the 2006-2014 period; however, this decline was less marked, slower and later for women compared to men[28]. It is worth noting that the inquiry on the impact of smoking cessation on the mortality of a population should include the long latency period of the outcome, so the reflection of current tobacco



Graph 1. Trend of adjusted mortality rates due to oral and oropharyngeal cancer (per 100,000 inhabitants), for each gender and both genders. Brazil, 2000-2013.

Source: Prepared by the authors.

Table 2. Trend of adjusted oral and oropharyngeal cancer mortality rates, by anatomical site and gender and annual percent change (APC) of the rates. Brazil, 2000-2013.

Variable	APC (%)	95% CI		P-value	Trend	R^2
		Lowest	Highest			
Anatomical Site						
Lip	0.942	-1.405	3.345	0.402	Stable	0.997
Base of the tongue	1.507	0.398	2.629	0.012	Increasing	0.997
Other parts of the tongue	0.667	-0.447	1.794	0.217	Stable	0.960
Gum	-1.020	-2.811	0.804	0.245	Stable	0.999
Floor of the mouth	2.613	0.973	4.279	0.005	Increasing	0.997
Palate	0.958	-0.092	2.018	0.070	Stable	0.999
Other parts of the mouth	-0.244	-1.597	1.128	0.704	Stable	0.888
Parotid gland	0.797	-1.599	3.251	0.486	Stable	0.992
Other major salivary glands	-0.624	-2.690	1.487	0.529	Stable	0.998
Tonsil	-1.982	-3.327	-0.618	0.008	Decreasing	0.998
Oropharynx	0.188	-1.048	1.440	0.747	Stable	0.551
Gender						
Women	1.307	0.121	2.507	0.033	Increasing	0.957
Men	0.175	-0.968	1.331	0.746	Stable	0.997
Overall	0.413	-0.722	1.561	0.445	Stable	0.995

Source: Prepared by the authors.

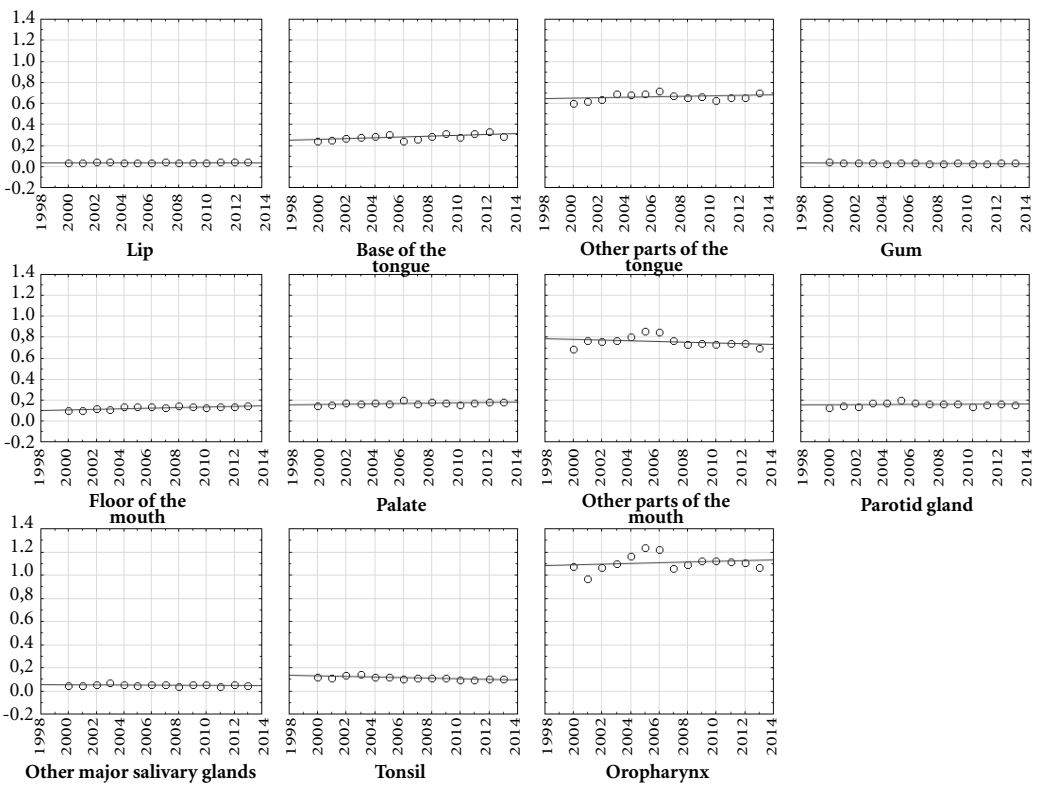


Chart 2. Trend of adjusted mortality rates due to oral and oropharyngeal cancer (per 100,000 inhabitants), per anatomical site. Brazil, 2000-2013.

Source: Prepared by the authors.

Table 3. Trend of adjusted oral and oropharyngeal cancer mortality rates, by age group and ethnicity/skin color and annual percent change (APC) of the rates for each gender. Brazil, 2000-2013.

Variable	APC (%)	95%CI		P-value	Trend	R^2
		Lowest	Highest			
Age Group						
Women						
15 - 19	3.733	-6.456	15.031	0.455	Stable	0.985
20 - 29	1.298	-1.867	4.565	0.394	Stable	0.998
30 - 39	1.961	0.145	3.810	0.036	Increasing	0.999
40 - 49	0.640	-1.349	2.669	0.500	Stable	0.997
50 - 59	0.493	-0.549	1.546	0.324	Stable	0.998
60 - 69	0.312	-0.616	1.249	0.480	Stable	0.998
70 - 79	1.390	-0.045	2.846	0.057	Stable	0.993
80 and +	2.821	0.467	5.230	0.023	Increasing	0.971
Men						
15 - 19	1.805	-3.419	7.301	0.474	Stable	0.997
20 - 29	2.915	0.597	5.286	0.018	Increasing	0.999
30 - 39	-2.598	-4.047	-1.128	0.002	Decreasing	0.998
40 - 49	-1.807	-3.318	-0.272	0.025	Decreasing	0.651
50 - 59	0.428	-0.640	1.508	0.401	Stable	0.985
60 - 69	0.299	-0.734	1.342	0.542	Stable	0.968
70 - 79	0.462	-0.595	1.530	0.361	Stable	0.785
80 and +	1.517	-0.131	3.191	0.068	Stable	0.980
Ethnicity/Skin Color						
Women						
Yellow*	-3.649	-10.197	3.377	0.272	Stable	0.884
White	2.701	1.397	4.023	0.001	Increasing	0.999
Indigenous*	-4.339	-19.211	13.272	0.579	Stable	0.563
Brown	8.242	3.481	13.221	0.002	Increasing	0.986
Black	-5.789	-10.431	-0.907	0.024	Decreasing	0.992
Men						
Yellow*	-40.386	-59.298	-12.688	0.012	Decreasing	0.846
White	-6.925	-17.223	4.655	0.207	Stable	0.996
Indigenous*	-43.994	-71.635	10.582	0.088	Stable	0.457
Brown	20.335	9.782	31.902	0.001	Increasing	0.993
Black	-13.903	-28.943	4.322	0.115	Stable	0.988

*Excluding age groups of 70-79 years and 80 years and over.
Source: Prepared by the authors.

use trends in Brazil should be monitored for the next decades.

Regarding the analysis by anatomical site, the stable trend shown at the "oropharynx" site is highlighted, a result compatible with a similar time series study[21]. However, in the 1979-2002 period, the same site had a growing trend of mortality rates in Brazil[29], as well as in the city of São Paulo, in the 1980-2002 period[30]. The association of HPV as an etiologic factor of neoplasms in this location is proven in the literature[13,31,32] and it is known that the cases associated with this virus have a more favorable prognosis[9,10,33], with patients evidencing a lower risk of death and recurrence than in cases not related to HPV[34,35]. This prognostic gap in oropharyngeal cancer is so relevant that the 8th edition of the Cancer Staging Manual of the American Joint Committee on Cancer (2018) considered the risk of the tumor as being associated with HPV (identified by immunohistochemistry analysis) in its categorization[36,37].

Affirming that this is the justification for the stability of mortality at this site in Brazil is hasty since the role of HPV has been consistently identified in economically developed countries only[12]. However,

given the limited evidence that elucidates the role of HPV in the behavior of oral neoplasms in Brazil, this association cannot be ruled out. Following this perspective, a Brazilian cohort study identified that patients with oropharyngeal cancer who had a positive result for HPV16 E6/E7 antibodies had a higher overall survival[38]. It is noteworthy that, unlike what is shown for oropharynx, the association of HPV virus with oral cancer is still not well established[39].

The results of the analysis of the trends by age group for males (decreasing or stable for all age groups, except for 20-29 years) may be partly understood by the Brazilian tobacco use dynamics. The prevalence of "heavy smoking" in the country, that is, referring to individuals smoking 20 cigarettes or more a day, has been decreasing in recent years. This downward trend is more significant among men and between the age groups of 18-24 years and 35-54 years[28,40].

There are at least two interpretative realms for the growing age group: the first, briefly explored in a previous paragraph (which here retains its speculative nature), concerns the role of the HPV virus in the etiology of the disease, since this seems to be more significant in men and younger individuals[32,41], which could be associated with the sexual behavior of this population. A recent systematic review of the literature with a meta-analysis indicated a relationship between aspects of sexual behavior with the risk of developing head and neck cancer, with a statistically significant association between the number of sexual partners and an increase in this risk[42]. The second possible interpretation builds on a statistical limitation: the small number of cases in this age group can result in instability in the statistical analysis.

It should be pointed out that, regarding females, the 30-39 years' age group, which showed an increasing trend, is also the approximate age stratum that has a higher prevalence of frequent consumption of alcoholic beverages among women in Brazil[43,44]. Alcohol is a significant risk factor for mouth, throat and esophagus tumors, especially if associated with tobacco use because it potentiates the carcinogenic effect of nicotine. Considering head and neck, colorectal, breast, liver and bile duct neoplasms, it was estimated that, for Brazilian women, in 2012, 2.6% of the cases were attributed to alcohol consumption[45]. It should be noted that the available data on the prevalence of alcohol intake are contemporary to the historical series studied, and an association with the outcome can only be considered if they reflect the pattern of the last decades.

It is imperative to note that mortality from this pathology is not only related to exposure to its risk factors. Survival rates are associated with socioeconomic factors, opportunities for access to health services for early diagnosis and treatment, as well as the quality of treatment provided[14-16]. In the historical series studied, Brazil experienced the most significant restructuring of public oral health services in its history, with the implementation of the National Oral Health Policy (PNSB). This policy reorganized oral health care, with an emphasis on expanding access through the expansion of Primary Health Care (PHC) and ensuring continuity of care at the specialized level[46]. International studies indicate that strategies to curb the delayed diagnosis of oral cancer should include the streamlining of oral health primary care services[47,48].

The PNSB specifies that oral cancer-related actions are a priority. The initial individual approach to this disease is attributed to the PHC oral health teams. The relevance of the development of preventive actions, early detection of injuries and specialized care to those at higher risk are encouraged[49]. In the study period, the coverage by Oral Health Teams of the Family Health Strategy in Brazil – the teams responsible for oral health care in PHC – went from zero to around 40%. Faced with the suspicion of a malignant lesion, the PHC team refers the patient to the secondary level of care, represented by the Dentistry Specialty Centers (DSC), services responsible for diagnosis and referral for hospital treatment. In the period from 2000 to 2013, the number of DSCs in Brazil rose from zero to approximately 1,000[50].

However, little is known about the impact of the implementation of the PNSB and the restructuring of the oral health care network on the outcome studied. Considering the time elapsed, still insufficient for prevention-related results, the increased access to health services – for a historically unassisted population – would be mainly responsible for the effect on mortality. This hypothesis is still speculative and is strengthened by a characteristic of the disease itself: oral and oropharyngeal cancer is located in a topography that is easily identified by the visual inspection of a trained professional, such as the dental surgeon, and does not require technological devices to identify a suspect case[51]. In this scenario, the expanded access to PHC could be even more powerful, since it would facilitate early diagnosis.

It is known that the provision of public oral health services in Brazil considers social inequal-

ities, favoring the neediest areas[52]. With the restructuring of oral health within the SUS, unequal access to and use of dental services among individuals with higher and lower income[53] was reduced. In this study, the analysis of the results of the ethnicity/skin color stratum is the one that most presents the potential for reflections in this field, since the socioeconomic inequalities in Brazil are deeply marked by the ethnic-racial component[54]. The "nonwhite" population is disadvantaged in all socioeconomic indicators evaluated in Brazil, including years of schooling, income, unemployment, access to health services, housing and sanitation, and so forth[55]. A suggested, still speculative hypothesis is that the pro-equity nature of the aforementioned public policy may be associated with the outcomes found for blacks (decreasing for women and stable for men), mainly due to the expanded access to health services.

Concerning the Brazilian population, there is a shortage of publications that associate mortality from oral cancer with ethnicity/skin color, hindering comparisons. A study that evaluated the trends of these rates in the city of São Paulo (from 2003 to 2009) found an increasing trend of mortality rates for blacks and stable rates for whites[20]. However, this work addresses a specific region and grouped black and brown individuals in a single category, overly hampering comparability.

Recent international studies related to oral and oropharyngeal cancer mortality that consider ethnicity/skin color are mainly North American and have indicated a more favorable pattern for the white population. However, justifications are directed to the fact that this population evidences percentages of HPV-related head and neck neoplasms much higher than those identified in non-white populations and this etiological factor is related to a longer survival[56,57].

The ethnic-racial distribution of the Brazilian population in the national territory is also an aspect that should be considered in the ethnicity/skin color trend analysis. This distribution is not uniform in Brazil; in the South and Southeast, whites predominate (78 and 55% of the population, respectively), while browns prevail in the North and Northeast regions (67% and 59% of the population, respectively)[58]. The trend of rates for a given ethnicity/skin color could, in part, be reflecting the trend of the Brazilian regions in which it is predominant. A recent study showed that, in the 2002-2013 period, the only macro-region in the country that showed a growth pattern in oral cancer mortality rates was the Northeast[21]. The comparison of this outcome with that of this study – which shows an upward trend in the brown population rates – could suggest some relationship, which must be investigated with the analysis of the rates by ethnicity/skin color in each macro-region.

It is necessary to consider that mortality in a historical series reflects, in part, the therapeutic conducts in force in the period and the preceding periods. It is mentioned that the 1990s concentrated essential advances in the treatment of this disease. A study that evaluated 3,267 patients treated at a Brazilian institution of reference identified that surgical treatment in this decade became much more representative for stage I and II tumors than in previous decades[59]. It is noteworthy that, even in the face of the finding of global stable trends, the beneficial effects of technological advances may be significant, with increased survival, an aspect not measured in this study. Also, conclusions of this nature must also be evaluated in light of the incidence of the disease.

This work has limitations; firstly, related to its design. Ecological studies have the potential to raise hypotheses and are unable to assess causality. Another aspect to be discussed refers to the fact that secondary data are analyzed, which makes study validity dependent on the reliability of the sources. However, it is considered that, while they show a percentage of underreporting, the Brazilian data on deaths by cause are as reliable as those from any other countries with a long tradition in the elaboration of such statistics, such as the United States and other European countries[60]. A similar finding is obtained when only oral cancer mortality is brought into focus[61].

SIM coverage in Brazil in 2011 was 96.1%. It was close to 100% in almost all states in the Southeast, South and Midwest regions, but lower in the North and Northeast regions. In the Northern region, three states had coverage lower than 80%[62]. These discrepancies were not considered in the data analysis, which may have influenced the trends in mortality rates, mainly in the indigenous population, which is very concentrated in this region. Also, it is emphasized that ethnicity/skin color analyses for indigenous and yellows did not include the 70-79 years and 80 years and over age groups.

The main conclusions of this study are that the trend of the oral and oropharyngeal cancer mortality rates in Brazil varies significantly when analyzed by strata. The identification and monitoring of these aspects in a disaggregated way

may allow a more accurate understanding of the dynamics of the disease studied. Surveillance of health conditions in a country with such disparate characteristics cannot be generalized, that is, it must be characterized by subgroup characteristics to ensure the epidemiological basis for pro-equity planning; this need applies to the monitoring of oral and oropharyngeal cancer in Brazil.

Also, we can conclude that associations of the variation of the studied trends with the expanded provision of oral health services in Brazil should be explored. This study suggests the need for exploratory studies regarding the role of HPV in the etiology of oral and oropharyngeal cancer in Brazil, based on the results of "anatomical site" and "age range" strata.

Collaborations

AR Cunha worked on the design of the project, the search, analysis and interpretation of data, the writing of the article and the approval of the final version to be published. TS Prass and FN Hugo collaborated in the design of the project, in the analysis and interpretation of the data, in the relevant critical review of the intellectual content and in the approval of the final version to be published.

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