SOCIOECONOMIC INEQUALITY AND CANCER MORTALITY: AN ECOLOGICAL STUDY IN BRAZIL

Desigualdades socioeconômicas e mortalidade por câncer: um estudo ecológico no Brasil

Desigualdades socioeconómicas y mortalidad por cáncer: un estudio ecológico en Brasil

Original Article

Isabelle Ribeiro Barbosa[1]
Íris do Céu Clara Costa[1]
María Milagros Bernal Pérez[2]
Dyego Leandro Bezerra de Souza[1]

ABSTRACT

Objective: To analyze the socioeconomic inequalities and cancer mortality in Brazil. **Methods:** The study analyzed the deaths for cancer occurred from 2010 to 2012, obtained in the Mortality Information System. A total of 268 Brazilian municipalities presenting population over 80,000 inhabitants and better quality of information were selected. Socioeconomic indicators for the year 2000 were taken from the Atlas Brazil 2013. Pearson correlation and simple linear regression were applied to investigate the correlation between socioeconomic indicators and cancer mortality. **Results:** There was a negative correlation with illiteracy (r=-0.509) and the Gini coefficient (r=-0.197); the correlation was positive with the income indicator (r=0.414) and life expectancy (r=0.537); simple linear regression showed that there is a weak association between cancer mortality and the socioeconomic variables assessed. **Conclusion:** The cancer mortality analysis in Brazilian municipalities showed that the highest mortality rates were recorded in the municipalities with the best socioeconomic conditions, expressed by indicators of income and life expectancy.

Descriptors: Neoplasms; Mortality; Socioeconomic Factors; Health Inequalities.

RESUMO

Objetivo*: Analisar as desigualdades socioeconômicas e a mortalidade por câncer no Brasil.* **Métodos***: Foram analisados os óbitos por câncer ocorridos entre 2010 e 2012, obtidos no Sistema de Informação sobre Mortalidade. Foram selecionados 268 municípios brasileiros que apresentaram população acima de 80 mil habitantes e melhor qualidade de informação. Os indicadores socioeconômicos referentes ao ano 2000 foram extraídos do Atlas Brasil 2013. Para analisar a correlação entre indicadores socioeconômicos e a mortalidade por câncer foi utilizada a Correlação de Pearson e a regressão linear simples.* **Resultados***: Verificou-se correlação negativa com o analfabetismo (r=-0,509) e com o Gini (r=-0,197); a correlação foi positiva com o indicador de renda (r=0,414) e esperança de vida (r=0,537); a regressão linear simples mostrou que há uma associação fraca entre a mortalidade por câncer e as variáveis socioeconômicas pesquisadas.* **Conclusão***: A análise da mortalidade por câncer nos municípios brasileiros mostrou que as maiores taxas de mortalidade foram registradas nos municípios com as melhores condições socioeconômicas, expressadas pelos indicadores de renda e esperança de vida.*

Descritores: *Neoplasias; Mortalidade; Fatores Socioeconômicos; Desigualdades em Saúde.*

1) Federal University of Rio Grande do Norte (*Universidade Federal do Rio Grande do Norte - UFRN*) - Natal - Brazil

2) University of Zaragoza (*Universidad de Zaragoza - UNIZAR*) - Zaragoza - Spain

Received on: *02/15/2016*
Revised on: *04/06/2016*
Accepted on: *05/13/2016*

RESUMEN

Objetivo*: Analizar las desigualdades socioeconómicas y la mortalidad por cáncer en Brasil.* **Métodos***: Fueron analizados los óbitos por cáncer entre 2010 y 2012 identificados en el Sistema de Información sobre Mortalidad. Fueron elegidos 268 municipios brasileños que presentaron población mayor que 80 mil habitantes y mejor calidad de información. Los indicadores socioeconómicos referentes al año 2000 fueron retirados del Atlas Brasil 2013. Se utilizó la Correlación de Pearson y la regresión linear simple para analizar la correlación entre los indicadores socioeconómicos y la mortalidad por cáncer.* **Resultados***: Se verificó una correlación negativa con el analfabetismo (r=-0,509) y con el Gini (r=-0,197); la correlación fue positiva para el indicador de renta (r=0,414) y esperanza de vida (r=0,537); la regresión linear simple mostró una asociación débil entre la mortalidad por cáncer y las variables socioeconómicas investigadas.* **Conclusión***: El análisis de la mortalidad por cáncer en los municipios brasileños mostró que las mayores tasas de mortalidad se registraron en los municipios con mejores condiciones socioeconómicas expresadas por los indicadores de renta y esperanza de vida.*

Descriptores: *Neoplasias; Mortalidad; Factores Socioeconómicos; Desigualdades en Salud.*

INTRODUCTION

Cancer is the leading cause of death in developed countries and, within a few decades, will become the leading cause of morbidity and mortality in the world's poorest regions[1]. It is estimated that, by the year 2030, there will be 22.2 million cases of cancer and 12.7 million deaths worldwide. Two-thirds of these deaths will occur in poor and in developing countries[2].

The aging of the population, the adoption of lifestyles associated with the development of cancer, the disruption of health services, as well as the factors related to social inequities give rise to the incoherent fact that both incidence and mortality due to malignant neoplasms continue to increase in developing countries, despite the advances in cancer diagnosis and treatment in recent years[3].

Inequalities in the burden of cancer can be observed between countries, as well as within the same country[4]. Conceptual models related to socioeconomic factors and to the structuring of health services, including aspects related to different levels of exposure to risk factors and access to diagnosis, treatment and prevention, explain the iniquities in cancer mortality among socioeconomic, ethnic and gender groups[5].

The estimate for Brazil, for the biennium 2016-2017, indicates the onset of about 600 thousand new cases of cancer. Except for non-melanoma skin cancer (approximately 180,000 new cases), there will be 420,000 new cases of cancer, featuring prostate (28.6%), lung (8.1%) and intestine (7.8%) cancers as the most frequent types of cancer in men and, among women, breast (28.1%), intestine (8.6%) and cervical (7.9%) cancers[6].

Demographic and epidemiological transitions have contributed to a shift in the risk profile for chronic diseases such as cancer. Tobacco consumption levels, dietary patterns, and reproductive characteristics, in addition to the prevalence of cancer-related infections, are patterns that have changed rapidly. As a result of this process, cancer stands out as the second cause of death after heart and cerebrovascular diseases in Brazil[7].

The consequence of high incidences, especially of infection-related cancers, in association with the disruption of cancer patient care systems, where interventions for early detection and effective treatments remain inaccessible to most people, result in high mortality rates in poor or in developing countries such as Brazil[8].

Brazil is ranked among the countries with the greatest social and economic inequalities in the world and, despite the substantial economic and social development seen in the last decades, the deep social inequalities combined with the lack of comprehensive planning of the health system have led to the exacerbation of inequities in access to health care[9]. The conjunction of these problems is crucial in determining the levels of cancer mortality, as fatal cases are influenced by early diagnosis and the availability of treatments and patient care[5].

Evidence shows that groups of lower socioeconomic levels have shown high cancer mortality in general because of the greater proportion of late diagnosis of neoplasms susceptible to detection in the early stages through screening; greater difficulty in accessing the diagnosis and adequate treatment; worse prognosis and shorter survival after cancer diagnosis; higher risk of death from cancer in general and potentially curable types of cancer[8]. Thus, in the line of cancer care, primary health care is of great importance as regards to promotion, prevention, early detection and palliative care.

The production of ecological studies that analyze social and economic patterns allows us to quantify the disparities in cancer mortality related to groups in social advantage or disadvantage, and to identify areas or population groups that are at the highest risk of cancer mortality, serving as information for the monitoring of the populations' health status, the identification of risk groups, and for the planning, definition and implementation of public policies aimed at the most vulnerable areas.

Based on the importance of the burden of cancer in the health of the Brazilian population, given the intense social

inequalities registered in the country, the objective of this study was to analyze the socioeconomic inequalities and cancer mortality in Brazil.

METHODS

This is an ecological study of multiple groups whose units of analysis were Brazilian municipalities selected based on demographic criteria and on the quality of mortality records.

The criterion for selection of municipalities considered the problem of variability in mortality rates (which relates to the annual fluctuation of mortality rates due to small populations) and the quality of information (due to underreporting of deaths and deficiencies in the certification of causes of death in Brazil).

To minimize the problem of variability in mortality rates, 357 municipalities with a population equal to or greater than 80,000 inhabitants were initially selected in 2010.

Seeking to ensure a better quality of the registry of causes of death, a maximum proportion of 10% of ill-defined causes, on average, was admitted for the years from 2010 to 2012. This process resulted in the selection of 268 municipalities, represented by 118 municipalities of the Southeastern region, 56 municipalities of the Northeast region, 52 municipalities of the South, 25 of the Midwes,t and 17 of the North.

The dependent variable was cancer mortality, expressed by the Standardized Mortality Rate (SMR). The socioeconomic indicators represented by the Gini coefficient, per capita income, life expectancy at birth, and the illiteracy rate of people above 25 years, were considered as independent variables.

In order to calculate the cancer mortality rates, the study used the deaths from the total number of malignancies occurred in Brazil between 2010 and 2012. The deaths were obtained in a secondary way, collected from the Mortality Information System (*Sistema de Informação sobre Mortalidade - SIM*) available on the website of the Ministry of Health of Brazil.

Population data by municipality was obtained from information gathered in the 2010 Census and intercensity projections, on the website of the Brazilian Institute of Geography and Statistics[10]. Socioeconomic indicators for year 2000 were collected from the Atlas of Human Development in Brazil 2013, also called *Atlas Brasil 2013*, of the United Nations Development Program (UNDP)[11].

Gross rates were standardized through the direct method, considering the standard world population and expressed per 100,000 inhabitants per year[12].

A descriptive analysis of the variables used in the study was carried out. To evaluate the correlation between the selected socioeconomic indicators and cancer mortality in Brazil, Pearson's correlation tests and simple linear regression were applied. For the processing and statistical analysis, the IBM SPSS Statistics 22.0 program was used.

This research used secondary data available on official websites of the Brazilian Ministry of Health, being exempted from evaluation by a research ethics committee, in compliance with Resolution 466/12 of the National Health Council.

RESULTS

Table I presents the description of the socioeconomic variables assessed and the average cancer mortality rates in the 268 selected municipalities, grouped by Brazilian regions. It is observed that the worst social and economic conditions are concentrated in the North and Northeast regions of Brazil, the latter presenting the worst per capita income (R$ 364.84) and the highest percentage of illiterate people (24.12%). In the Northern and Northeastern regions, the selected municipalities have an average life expectancy of less than 70 years, more than 15% of the population over 25 years of age illiterate, and with a Gini index of around 0.6.

Table I - Mean values of socioeconomic variables and cancer mortality in 268 Brazilian municipalities by region of the country. Brazil, 2015.

Variables	North	Northeast	Midwest	Southeast	South
Standardized cancer mortality rate[1]	82,64	81,45	89,85	94,65	116,04
Per capita income[2]	428,31	364,84	580,92	730,54	725,82
Life expectancy[3]	68,92	67,88	71,47	72,10	73,70
Illiteracy[4]	15,68	24,12	13,26	9,40	7,68
Gini	0,60	0,58	0,56	0,54	0,53

[1]Standardized cancer mortality rate, expressed in number of deaths per 100 thousand inhabitants; [2] per capita income expressed in reais (R$); [3]Life expectancy expressed in years; [4]Illiteracy of people over 25 years old, expressed as a percentage of illiterate people in relation to the total population.

Table II - Relationship between socioeconomic variables and standardized cancer mortality in the 268 selected Brazilian municipalities. Brazil, 2015.

Variables	SMR	Income	Life expectancy	Illiteracy	Gini
SMR	1				
Income	0,414**	1			
Life expectancy	0,537**	0,622**	1		
Illiteracy	-0,595**	-0,687**	-0,745**	1	
Gini	-0,197**	0,163**	-0,254**	0,202**	1

Source: Demographic Census, 2000/IBGE; SIM/Datasus/Ministry of Health; *p<0.05, **p<0.01; SMR: Standardized mortality rate.

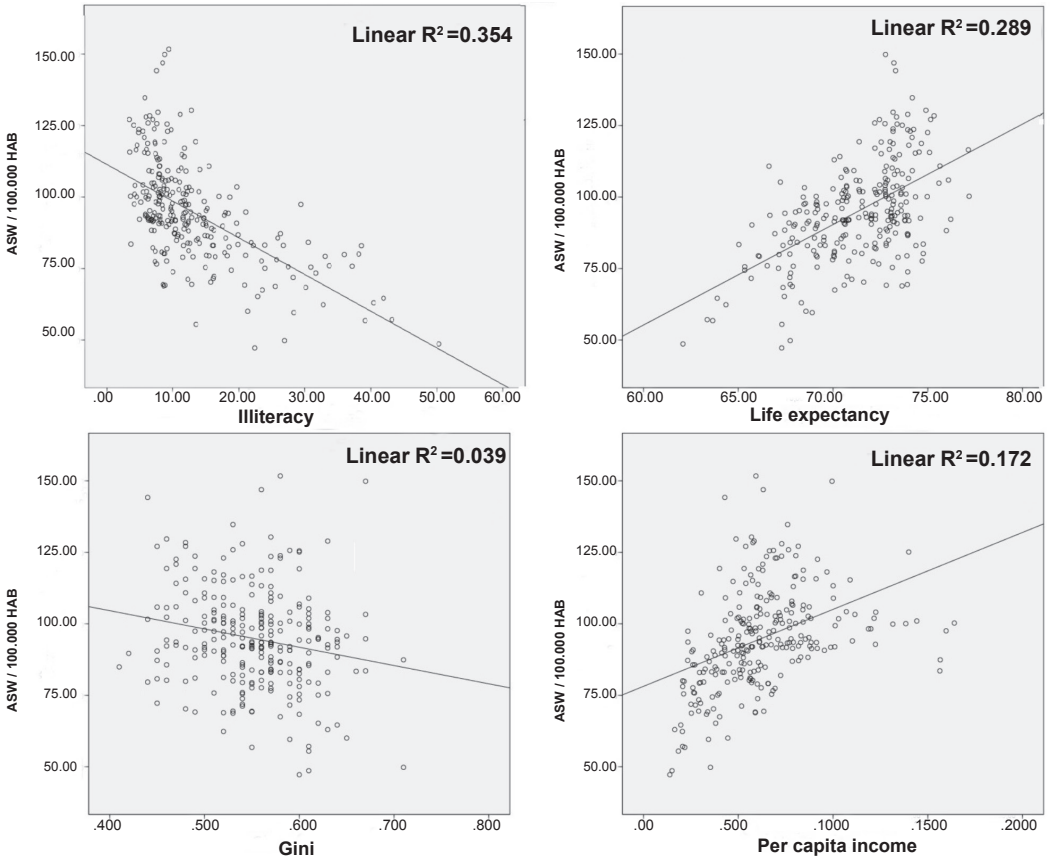

Figure 1 - Simple linear regression between the standardized cancer mortality rate and the socioeconomic indicators of the 268 Brazilian municipalities selected. Brazil, 2015.

The most developed regions of the country, South and Southeast, present great differences in relation to the poorest. These regions had a per capita income of around R$ 720.00 and an illiteracy rate of less than 10%.

On the other hand, the highest rates of cancer mortality were recorded in the municipalities of the South and Southeast of the country, which recorded an average of 94.65 deaths/100 thousand inhabitants in the Southeast, and 116 deaths/100 thousand inhabitants in the Southern region of Brazil.

The correlation between independent and dependent variables showed a strong and inversely proportional

correlation with illiteracy (r=-0.595). The correlation was positive with the income indicators (r=0.414) and life expectancy (r=0.537) (Table II).

Simple regression analysis showed that the better socioeconomic status is associated with higher cancer mortality risks. The indicator of illiteracy was the only one that showed association with the dependent variable, although this association was considered weak (r^2=0.354) (Figure 1).

DISCUSSION

As in the current study, other studies have also evidenced a positive correlation between cancer mortality and better socioeconomic conditions[13-15]. The study that evaluated colon and rectum cancer mortality in Brazil observed a direct correlation with gross income indicators[13]. In Iran, a positive correlation was observed between breast and ovarian cancer mortality and the provinces' social rank index[14]. High cancer mortality rates were recorded in populations with the highest levels of education, in countries such as Spain, Finland, Denmark, Norway, Belgium, France, Switzerland and Austria[15].

More recently, the global cancer transition has been described according to the stratification of the Human Development Index (HDI). This transition suggests that there will be a reduction in infection-related cancers (for instance, to the HPV-Human Papilloma Virus infection), while there will be an increase in cases of cancer associated with risk factors common to chronic noncommunicable diseases. Breast, lung, rectal colon and prostate cancers are related to the countries with the highest HDI, whereas cervical cancer is related to the least developed countries[1]. This hypothesis could explain the results of Brazilian studies that indicated an inverse correlation between socioeconomic conditions and mortality due to some types of cancer related to low socioeconomic conditions, such as mouth[16], head and neck cancer[17].

This idea is reinforced by the findings presented in the review of ecological studies that relate cancer incidence and mortality and socioeconomic inequalities: the incidence of prostate and breast cancer and the mortality from colon cancer are positively correlated with the socioeconomic level of the housing area. On the other hand, a consistent and negative correlation was found for incidence and mortality due to cancers of the esophagus, stomach and cervix[18].

It is possible that the problem of differential underreporting of deaths and the quality of information on causes of death interfere with the results of mortality analyses in ecological studies in Brazil. In the present study, the use of criteria that ensure the selection of municipalities with better quality of information resulted in findings compatible with those of international studies, in which the quality of information is guaranteed[15,19].

With the finding that there is a direct correlation between cancer mortality and better living conditions in Brazil, the dilemma of the Brazilian paradox is brought to the fore, underlined in the epidemiological patterns of cancer mortality and in the social and economic conditions of the different populations in the country. Regarded as one of the largest emerging economies on the planet, and despite the economic, social and political advances the country has undergone over the last decade, inequalities in income distribution throughout history have produced marked social abyss[20], reproduced, for instance, in social indicators such as the HDI of Brazilian municipalities. The exacerbation of internal inequalities is so relevant that one can find in Brazil areas with HDI of developed countries such as Denmark and Ireland (HDI>0.8), as well as areas with HDI of African countries such as Ethiopia and Congo (HDI<0.4)[21].

The Brazilian paradox is also expressed in the epidemiological patterns of cancer mortality. In addition to the overlap between the stages of the epidemiological transition, which combines high rates of morbidity and mortality from chronic-degenerative diseases with high incidences of infectious and parasitic diseases, the epidemiological polarization is reproduced through the persistence of differentiated levels of transition between distinct social groups[22], represented by differences in cancer mortality rates among Brazilian regions, as observed in this study.

In Brazil, the cancers that are most frequent and major causes of death in the population are those related to high levels of living conditions, such as lung, prostate and breast cancers, as opposed to cervical and stomach cancers, characteristic of areas with less privileged socioeconomic conditions[23]. From this profile, the Brazilian paradox can be described by the picture of an underdeveloped country with characteristics of cancer mortality of a developed country, which may explain the correlation between better living conditions and higher cancer mortality.

The indicators selected for this study reflect in a general way the socioeconomic status of a population and can be regarded the cause and consequence of poverty, determining the ways of birth, living and dying of a population[9]. The model used to understand the Social Determinants of Health in this study is the model that includes the natural and social conditions that affect health and the mechanisms through which these conditions produce such effects, including, beyond the more general social and economic conditions, the unemployment, housing conditions, level of education, and access to health services as more proximal variables[24].

Three main causes may be related to differences in cancer mortality rates in a defined population: the prevalence and distribution of cancer risk factors[17], the conformation of the health services network[20], and the demographic structure of the country[22]. Social and economic determinants influence these three key points that are related to cancer mortality patterns.

Smoking, alcoholism, reproductive and sexual characteristics, prevalence of cancer-related infections, use of hormonal therapies, eating patterns, physical activity, and behaviors related to Westernized and high-income lifestyle are described as risk factors for the development of cancer, and these behaviors, in turn, are intimately determined by the level of social and economic status of the individuals[7,8,16,18].

The structuring of screening services, prophylactic immunization actions and control of risk factors, the availability and access to diagnostic and treatment methods for cancer affect the survival rates and cancer mortality in a population[19]. In Brazil, as in other Latin American countries, there is a marked inequity between regions, and between major urban centers and the country area, with regard to the access to cancer diagnosis and treatment services[25]. In the present study, the association of cancer mortality in more privileged populations with greater access to diagnostic and therapeutic resources may be a result, also, of the better structuring of cancer epidemiological surveillance services in these areas, which leads to better quality in death records.

In this sense, it seems urgent to implement public health policies aimed at the most affected populations, associated with the reduction of social inequities and the access to primary prevention, early diagnosis and treatment, in order to reduce disparities in cancer mortality in Brazil.

It is highlighted as a limitation of this study the use of secondary data on mortality, which is subject to underreporting, even although, in recent years, it has been recognized that the Mortality Information System in Brazil has achieved a significant quality gain.

CONCLUSION

The results indicate that there is inequality in the distribution of cancer mortality in Brazil, influenced by social and economic factors. The Southern and Southeastern regions of the country recorded the highest mortality rates and the best socioeconomic indicators, showing that, in Brazil, mortality correlates directly with better living conditions, expressed by income and life expectancy indicators.

FUNDING

Doctoral "Sandwich" Program Abroad (*Programa de Doutorado Sanduíche no Exterior - PDSE*) (file No. 99999.002059/2014-02) of the Coordination for the Improvement of Higher Education Personnel (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES*) and Universal Announcement of the National Council for Scientific and Technological Development (CNPq) (file No. 481805/2013-3).

REFERENCES

1. Bray F, Jemal A, Grey N, Ferlay J, Forman D. Global cancer transitions according to the Human Development Index (2008–2030): a population-based study. Lancet Oncol. 2012;13(8):790-801
2. Farmer P, Frenk J, Knaul FM, Shulman LN. Expansion of cancer care and control in countries of low and middle income: a call to action. Lancet. 2010; 376(9747):1186-93.
3. Parkin DM. The role of cancer registries in cancer control. Int J Clin Oncol. 2008;13(2):102-11.
4. Barbosa IR, Souza DLB, Costa ICC, Pérez MB. Cancer mortality in Brazil. Medicine (Baltimore). 2015;94(16):e746.
5. Puigpinós R, Borrell C, Antunes JLF, Azlor E, Pasarín MI, Serral G, et al. Trends in socioeconomic inequalities in cancer mortality in Barcelona: 1992–2003. BMC Public Health. 2009;9:35.
6. Instituto Nacional de Câncer José Alencar Gomes da Silva. Estimativa 2016: incidência de câncer no Brasil. Rio de Janeiro: INCA; 2015.
7. Barbosa IR, Costa ICC, Bernal MM, Souza DLB. Tendência das taxas de mortalidade pelas dez principais causas de óbitos por câncer no Brasil, 1996-2012. Rev Ciência Plural. 2016;2(1):3-16.
8. Barbosa IR, Costa ICC, Bernal MM, Souza DLB. As iniquidades sociais e as disparidades na mortalidade por câncer relativo ao gênero. Rev Ciência Plural. 2015; 1(2): 79-86.
9. Pisani P. The cancer burden and cancer control in developing countries. Environ Health. 2011;10(Suppl1):S2.
10. Instituto Brasileiro de Geografia e Estatística - IBGE. Estimativas da população [acessed on 2014 July

20]. Available from: http://www.ibge.gov.br/home/estatistica/populacao/estimativa2015/default.shtm

11. Programa das Nações Unidas para o Desenvolvimento. Atlas do Desenvolvimento Humano do Brasil: consulta [acessed on 2014 July 20]. Available from: http://www.atlasbrasil.org.br/2013/pt/consulta/

12. Doll R, Payne P, Waterhouse JA, editors. Cancer Incidence in Five Continents. Berlin: Springer; 1966.

13. Guimarães RM, Rocha PGM, Muzi CD, Ramos RS. Incremento de renda e mortalidade por câncer colorretal no Brasil, 2001-2009. Arq Gastroenterol. 2013;50(1):64-9.

14. Kiadaliri AA. Social disparity in breast and ovarian cancer incidence in Iran, 2003-2009: a time trend province-level study. J Breast Cancer. 2013;16(4):372-77.

15. Strand BH, Kunst A, Huisman M, Menvielle G, Glickman M, Bopp M, et al. The reversed social gradient: higher breast cancer mortality in the higher educated compared to lower educated. A comparison of 11 European populations during the 1990s. Eur J Cancer. 2007;43(7):1200-7.

16. Ferreira MAF, Gomes MN, Michels FAS, Dantas AA, Latorre MRDO. Desigualdade social no adoecimento e morte por câncer de boca e orofaríngeo no Município de São Paulo, Brasil: 1997 a 2008. Cad Saúde Pública. 2012;28(9):1663-73.

17. Antunes JLF, Toporcov TN, Biazevic MGH, Boing AF, Bastos JL. Gender and racial inequalities in trends of oral cancer mortality in Sao Paulo, Brazil. Rev Saúde Pública. 2013;47(3):470-8.

18. Ribeiro AA, Nardocci AC. Desigualdades socioeconômicas na incidência e mortalidade por câncer: revisão de estudos ecológicos, 1998-2008. Saúde Soc. 2013;22(3):878-91.

19. Sharpe KH, McMahon AD, Raab GM, Brewster DH, Conway DI. Association between Socioeconomic Factors and Cancer Risk: A Population Cohort Study in Scotland (1991-2006). PLoS ONE. 2014;9(2):e89513.

20. Barros MBA, Franscisco PMSB, Zanchetta LM, César CLG. Tendências das desigualdades sociais e demográficas na prevalência de doenças crônicas no Brasil, PNAD: 2003- 2008. Ciênc Saúde Coletiva. 2011;16(9):3755-68.

21. United Nations Developments Program - UNDP. Human development reports [acessed on 2014 June 30]. Available from: www.hdr.org/in/data

22. Schramm JMA, Oliveira AF, Leite IC, Valente JG, Gadelha AMJ, Portela MC, et al. Transição epidemiológica e o estudo de carga de doença no Brasil. Ciênc Saúde Coletiva. 2004;9(4):897-908.

23. Ferlay J, Steliarova-Foucher E, Lortet-Tieulent J, Rosso S, Coebergh JW, et al. Cancer incidence and mortality patterns in Europe: estimates for 40 countries in 2012. Eur J Cancer. 2013;49(6):1374-403.

24. Graham H. Health Inequalities, social determinants and public health policy. Policy Polit. 2009;37(4):463-79.

25. Goss PE, Lee BL, Badovinac-Crnjevic T, Strasser-Weippl K, Chavarri-Guerra Y, St Louis J, et al. Planning cancer control in latin america and the caribbean. Lancet Oncol. 2013;14(5):391-436.

Mailing address:
Isabelle Ribeiro Barbosa
Universidade Federal do Rio Grande do Norte - UFRN
Rua Princesa Leopoldina, 3466
Bairro: Candelária
CEP: 59065-100 - Natal - RN - Brasil
E-mail: isabelleribeiro@oi.com.br