DOI: 10.1590/1980-5497201700050014

ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Burden of disease by lower respiratory tract infections in Brazil, 1990 to 2015: estimates of the Global Burden of Disease 2015 study

Carga de doença por infecções do trato respiratório inferior no Brasil, 1990 a 2015: estimativas do estudo Global Burden of Disease 2015

Ricardo de Amorim Corrêa[I], Bruno Piassi de São José[I], Deborah Carvalho Malta[II], Valéria Maria de Azeredo Passos[III], Elisabeth Barboza França[IV], Renato Azeredo Teixeira[V], Paulo Augusto Moreira Camargos[VI]

ABSTRACT: ***Introduction:*** Lower respiratory tract infections (LRTIs) present significant incidence and mortality in the world. This article presents the impact of LRTIs in the burden of disease, according to the metrics used in the Global Burden of Disease study (GBD 2015) for Brazil in 1990 and 2015. ***Methods:*** Analysis of estimates from the GBD 2015: years of life lost due to premature death (YLLs), years lived with disability (YLDs), years of life lost due to death or disability (DALYs = YLLs + YLDs). ***Results:*** LRTIs were the third cause of mortality in Brazil in 1990 and 2015, with 63.5 and 47.0 deaths/100,000 people, respectively. Although the number of deaths increased 26.8%, there was a reduction of 25.5% in mortality rates standardized by age, with emphasis on children under 5 years of age. The disability indicators, as measured by the DALYs, demonstrate a progressive reduction of the disease burden by LRTIs. ***Discussion:*** Despite the reduction in mortality rates in the period, LRTIs were an important cause of disability and still the third cause of death in Brazil in 2015. The increase in the number of deaths occurred due to the increase in population and its aging. The reduction in mortality rates accompanied the improvement of socioeconomic conditions, broader access to health care, national availability of antibiotics, and vaccination policies adopted in the country. ***Conclusion:*** Despite the current socioeconomic difficulties, there has been a progressive reduction of the LRTIs load effect in Brazil, mostly in mortality and disability, and among children under 5 years of age.

Keywords: Health evaluation. Respiratory tract infections. Mortality. Pneumonia.

[I]Postgraduate Programs in Infectology and Tropical Medicine, and Applied Sciences for Adult Health, Department of Clinical Medicine, School of Medicine, *Universidade Federal de Minas Gerais* – Belo Horizonte (MG), Brazil.

[II]Department of Maternal and Child Nursing, School of Nursing, *Universidade Federal de Minas Gerais* – Belo Horizonte (MG), Brazil.

[III]*Universidade Federal de Minas Gerais* and *Faculdade Ciências Médicas de Minas Gerais* – Belo Horizonte (MG), Brazil.

[IV]Posgraduate Program in Public Health, School of Medicine, *Universidade Federal de Minas Gerais* – Belo Horizonte (MG), Brazil.

[V]Research Group on Epidemiology and Evaluation of Services of *Universidade Federal de Minas Gerais* – Belo Horizonte (MG), Brazil.

[VI]Department of Pediatrics, School of Medicine, *Universidade Federal de Minas Gerais* – Belo Horizonte (MG), Brazil.

Corresponding author: Ricardo de Amorim Corrêa. Universidade Federal de Minas Gerais. Faculdade de Medicina. Departamento de Clínica Médica. Programa de Pós-graduação em Infectologia e Medicina Tropical e Ciências Aplicadas à Saúde do Adulto. Avenida Professor Alfredo Balena, 190, sala 245, Santa Efigênia, CEP: 30130-100, Belo Horizonte, MG, Brasil. E-mail: racorrea9@gmail.com

Conflict of interests: nothing to declare – **Financial support:** Bill & Melinda Gates Foundation (GBD Global) and Ministry of Health (GBD 2015 Brazil-states), through the National Health Fund (Process No. 25000192049/2014-14).

RESUMO: ***Introdução:*** Infecções do trato respiratório inferior (ITRi) apresentam incidência e mortalidade significativas no mundo. Este artigo apresenta o impacto das ITRi na carga de doença, segundo as métricas utilizadas no estudo *Global Burden of Disease* 2015 (GBD 2015) para o Brasil, em 1990 e 2015. ***Métodos:*** Análise de estimativas do GBD 2015: anos de vida perdidos por morte prematura (YLLs), anos vividos com incapacidade (YLDs) e anos de vida perdidos por morte ou incapacidade (DALYs = YLLs + YLDs). ***Resultados:*** As ITRi foram a terceira causa de mortalidade no Brasil em 1990 e 2015, com 63,5 e 47,0 mortes/100 mil habitantes, respectivamente. Embora o número absoluto de óbitos tenha aumentado 26,8%, houve redução de 25,5% nas taxas de mortalidade padronizadas por idade, sendo a redução mais marcante em menores de 5 anos. Também houve redução progressiva da carga da doença, expressa em DALYs. ***Discussão:*** Apesar da redução da carga da doença no período, as ITRi foram importante causa de incapacidade e a terceira causa de mortes no Brasil em 2015. O aumento do número de óbitos ocorreu devido ao aumento e envelhecimento populacional. A redução das taxas de mortalidade acompanhou a melhora das condições socioeconômicas, do acesso mais amplo aos cuidados de saúde, da disponibilidade nacional de antibióticos e das políticas de vacinação adotadas no país. ***Conclusão:*** Apesar das dificuldades socioeconômicas vigentes, constatou-se uma redução progressiva da carga das ITRi, principalmente na mortalidade e na incapacidade, e entre os menores de cinco anos de idade.

Palavras-chave: Avaliação em saúde. Infecções respiratórias. Mortalidade. Pneumonia.

INTRODUCTION

Lower respiratory tract infections (LRTIs) include diseases of the lower airways, such as acute bronchitis, bronchiolitis, and infections in patients with bronchiectasis and infections that compromise air spaces such as pneumonia, among others. These conditions include community-acquired pneumonia (CAP) and pneumonia acquired in the hospital or in health facilities. CAPs are the main cause of death in the world, with pneumococcal etiology having the highest incidence[1-3].

According to the Global Burden of Disease (GBD) study in 2015, LRTIs, among all diseases, had the fourth highest incidence in the world, with more than 290 million cases, accounting for 4.9% of all deaths in the world. The analysis of age-standardized rates revealed that the mortality rate for LRTIs in 2015 was 41.6 per 100,000 inhabitants, with a confidence interval (95% CI) 38.0-43.5; 6.8% higher than the 2005 rate[4].

The impact of LRTIs on morbidity and mortality has been verified and can be measured in several ways. Age-adjusted mortality rates have been used because they enable geographic comparisons between countries and allow for temporal trend assessments, which are useful for planning interventions in terms of public health policies. With respect to morbidity, the impact of diseases on specific populations has been measured by metrics such as years of life lost by death or disability (disability-adjusted life-years – DALYs), which is a combined measure of years of life lost due to premature death (YLLs – years

of life lost) with the years lived with disability (YLDs). A DALY means a year of healthy life lost, and the sum of the DALYs in a given population means the difference between the current health status of that population and the ideal state in which everyone would grow old in perfect health[5].

The population structure in the world has undergone significant changes with an increase in life expectancy, a reduction in mortality due to infectious diseases, and an increase in deaths due to external causes – accidents and violence – and chronic non-communicable diseases[6]. Similarly to the rest of the world, in Brazil, although there has been a significant reduction in the proportion of deaths due to infectious diseases, LRTIs still remain high in the last decades, with an expressive impact on morbidity and mortality[7].

The objective of this article was to present the impact of LRTIs on mortality and morbidity rates in Brazil in 1990 and 2015.

METHODS

This study stems from the partnership between the Institute for Health Metrics and Evaluation (IHME), the Ministry of Health and the technical group of the GBD Brazil 2015 Study, using estimates from the GBD 2015 study[4].

The methodology of GBD is described in other publications, and updates on procedures and conceptual principles have been carried out since the first publication[8]. Estimates of the burden of disease used in this study were accessed on the IHME website[9]. The main source of mortality data used in Brazil was the death registry database of the Mortality Information System (acronym in Portuguese – SIM) of the Ministry of Health[10]. It was necessary to correct underreporting of deaths by the estimation of envelope mortality, and for deaths recorded in the SIM with basic cause classified as ill-defined causes (IDC) and other garbage codes – such as unspecified pneumonia – that have been redistributed to defined causes. For this analysis, the International Classification of Diseases codes, version 10, used in GBD 2015 were A48.1, A70, J09-J15.8, J16-J16.9, J20-J21.9, and P23.0-P23.4. Details of clustering of causes using CID9 and CID10 reviews have been previously described[11]. Next, statistical models and modeling were used to estimate data by age, sex, country, year, and cause[12,13].

In this study, mortality rates and DALYs, composite indicators integrating YLLs and damage caused by disease, sequelae or disability were considered as metrics, taking into account different levels of severity of one or more diseases at the same time (YLDs). This indicator considers a lost year of premature death equal to a year lost due to disability, which is weighted by the product of the disability weight due to the prevalence of each disease.

Comparisons were made between the absolute number of deaths and the age-standardized mortality rates of LRTIs deaths in Brazil and states in the period from 1990

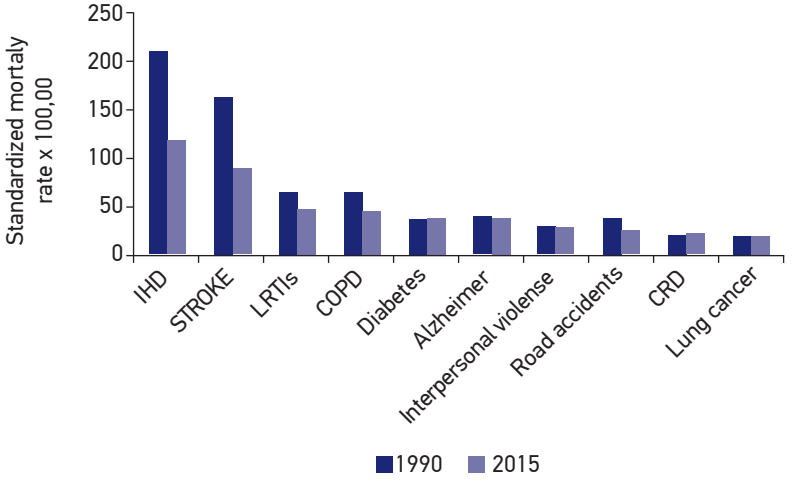
to 2015, and a descriptive analysis of the distribution of mortality rates and DALYs by age group.

In the GBD study, 95% (95% UI) uncertainty intervals are calculated, which provide information on the variability of estimates resulting from errors due to the sample process and also non-sample errors due to adjustments of the data sources and modeling[6].

RESULTS

In the study period, it was observed that the LRTIs were the third cause of mortality in both 1990 and 2015 in Brazil, corresponding to 63.5 and 47.0 deaths/100,000 inhabitants, respectively (Figure 1). In 1990, these infections corresponded to 6.5% of total deaths in the country, and 5.6% in 2015. The absolute number of deaths in this period increased by 26.8%, from 59,599 in 1990 to 75,602 in 2015 (Figure 2A). However, a 25.5% reduction in age-standardized mortality rates was observed over this same time frame (Figure 2B). There has been a progressive reduction in both sexes, although men have constantly presented higher mortality rates (data not shown).

The distribution of death rates by age group, in the years 1990 and 2015, occurs in the form of "U", that is, there is an increase in the extremes of age, with higher rates among children under 4 years – particularly among children under 1 year – and those over 60 – particularly among individuals over the age of 70 years. Comparing 2015 with 1990, there is a marked reduction in the number of deaths among children under four years of age.



IHD: ischemic heart disease; Stroke; LRTIs: lower respiratory tract infections; COPD: chronic obstructive pulmonary disease; CRD: chronic renal dysfunction.

Figure 1. Age-standardized mortality rates for the top ten causes of death in Brazil in 2015, compared to 1990, both sexes.

This reduction was lower among people aged 50–69 years, unlike those aged 70 years or older, who experienced a notable increase in 2015 (Figure 3A).

In relation to mortality rates standardized by age of LRTIs, there was reduction among those under 5 years of age, and increased risk of death among individuals older than 70 years (Figure 3B). In the period, there was a progressive reduction of the disease burden by LRTIs expressed in DALYs (Figure 4).

In relation to the Brazilian states, there was a reduction in age-standardized mortality rates in all of them, comparing the years 2015 and 1990. The overall reduction in

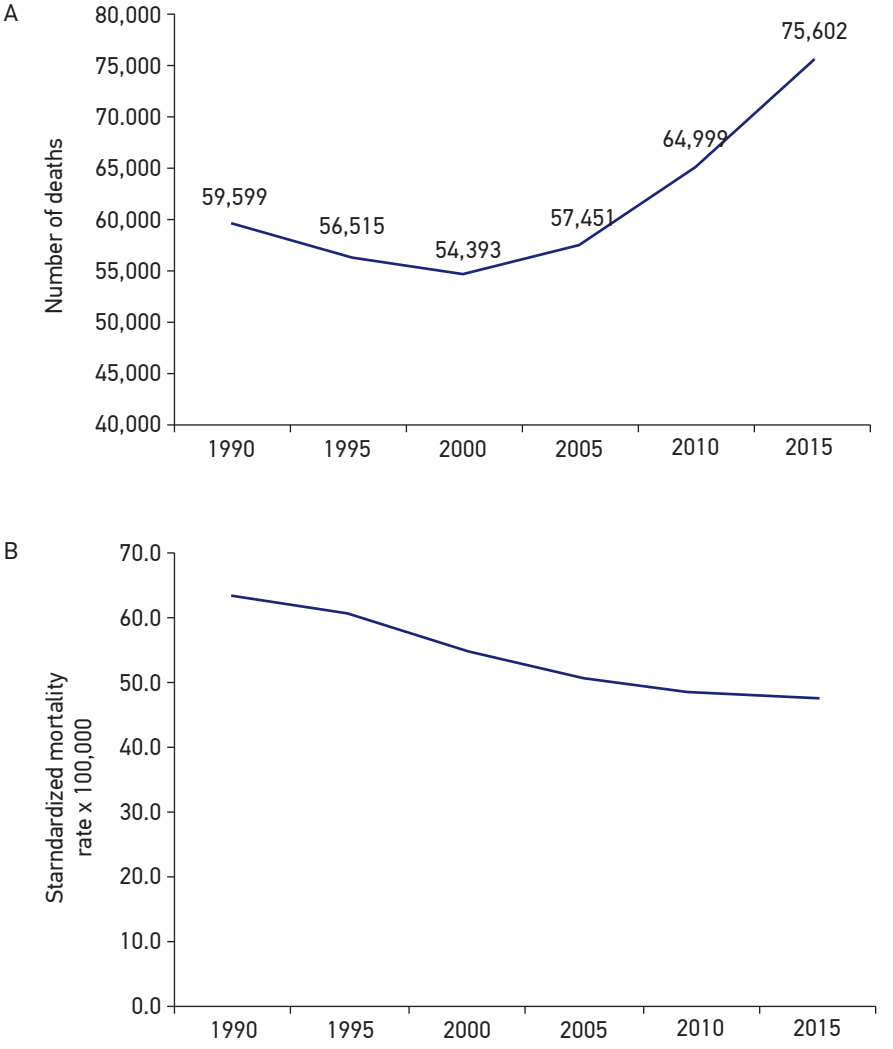


Figure 2. Absolute number of deaths (A) and mortality rate standardized by age per 100,000 inhabitants (B) for lower respiratory tract infections, both sexes. Brazil, 1990 to 2015.

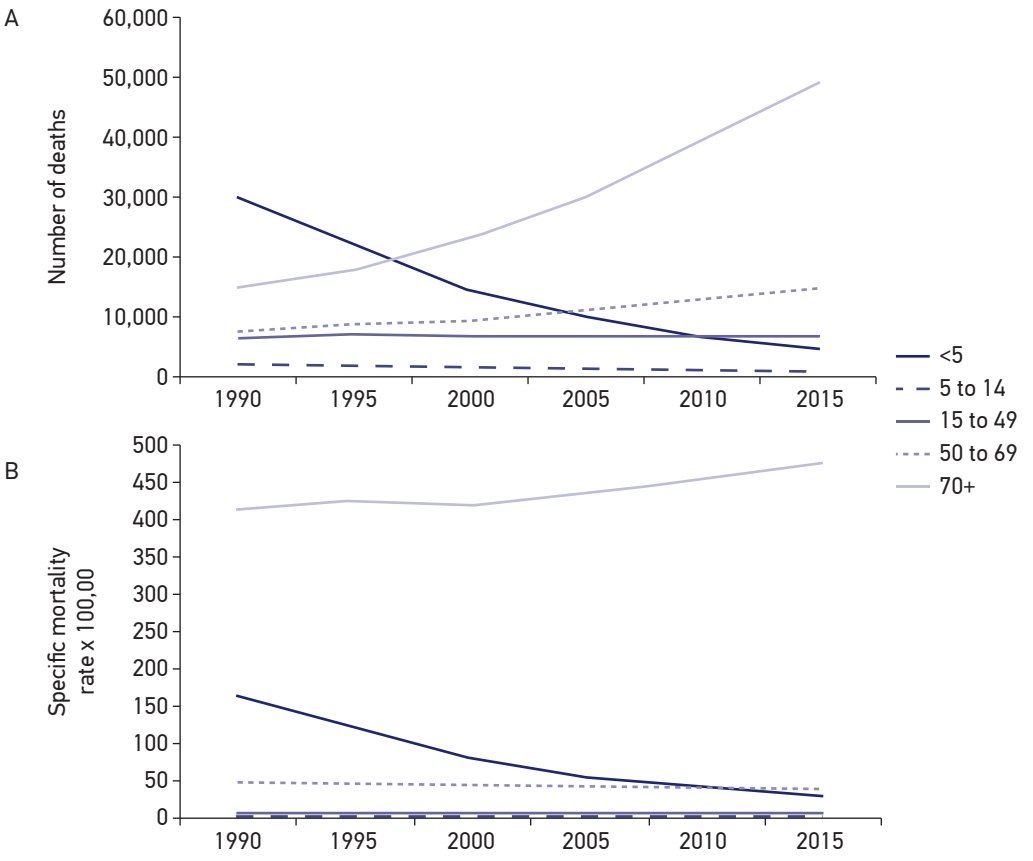
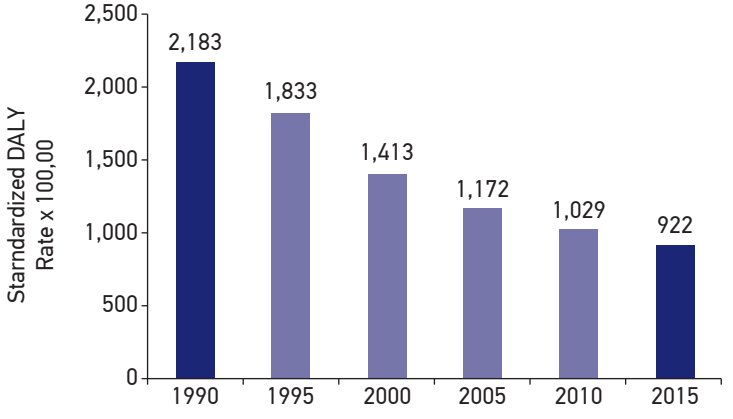


Figure 3. Absolute number of deaths (A) and specific mortality rate per 100,000 inhabitants (B) due to lower respiratory tract infections, according to age group, between 1990 and 2015.



DALYs: *disability-adjusted life years*.

Figure 4. Age-standardized rate, per 100,000 inhabitants, of years lost due to premature death and resulting from incapacity for lower respiratory tract infections, both sexes. Brazil, 1990 to 2015.

this rate for both sexes was 25.9, and the highest variation occurred in Alagoas (42.2%), followed by Pernambuco (41.8%), Rio Grande do Norte (34.4%), Maranhão (33.0%), and Rondônia (30,4%) (Table 1). This reduction occurred with both men and women (data not shown).

Table 1. Mortality rates standardized by age, per 100,000 inhabitants, of lower respiratory tract infections and percentage reduction. Brazil and the states, 1990 and 2015.

State	Rates by 100,000 habitants		Percentage change*
	1990	2015	
Acre	66.2	51.7	-22.0
Alagoas	74.9	43.3	-42.2
Amapá	56.2	54.4	-3.3
Amazonas	55.9	49.6	-11.3
Bahia	52.4	39.2	-25.2
Ceará	67.7	51.7	-23.6
Distrito Federal	49.0	34.3	-30.0
Espírito Santo	46.0	37.2	-19.2
Goiás	53.7	47.2	-12.1
Maranhão	66.5	44.6	-33.0
Mato Grosso	56.1	44.7	-20.2
Mato Grosso do Sul	60.9	47.2	-22.6
Minas Gerais	60.3	49.0	-18.8
Pará	57.9	52.1	-10.0
Paraíba	61.7	43.7	-29.2
Paraná	50.9	41.1	-19.2
Pernambuco	68.9	40.2	-41.8
Piauí	55.5	40.4	-27.2
Rio de Janeiro	68.9	54.1	-21.4
Rio Grande do Norte	68.7	45.1	-34.4
Rio Grande do Sul	52.5	37.6	-28.3
Rondônia	60.8	42.3	-30.4
Roraima	68.2	51.3	-24.8
Santa Catarina	52.6	38.5	-26.8
São Paulo	74.4	52.2	-29.8
Sergipe	56.3	39.5	-29.8
Tocantins	54.5	39.5	-27.6
Brasil	63.5	47.0	-25.9

Source: GHDx, 2015.
*Percentage change: (rate2015-rate1990)/rate1990 x 100.

DISCUSSION

The main results of this article show that in Brazil, despite the significant reduction on mortality rates between 1990 and 2015, the LRTIs are still the third cause of mortality among its population. As occurred in other countries, the number of deaths in Brazil increased due to the increase and aging of the population, despite the drop in mortality rates standardized by age of 25.5% in relation to 1990. The highest reduction in these rates occurred in the under-5 age group, probably due to improved socioeconomic conditions, broader access to health care, national availability of antibiotics and vaccination policies[14-16].

As pneumonia, particularly pneumococcal disease , is the major cause of death, the universal availability of influenza vaccines since 1999, the introduction of pneumococcal conjugate vaccine for children in the Unified Health System (SUS) in 2010, the well-known herd protection effect of a broad childhood vaccination, and the improvement of living conditions and access to health services in the period could be listed among the possible causes of reduction of cases and deaths by vaccine strains[17,18]. It is worth mentioning that some of the pneumonia deaths included among the LRTIs may have been due to other diseases of the lower respiratory tract, such as exacerbations of chronic obstructive pulmonary disease (COPD).

In Brazil, 10-valent pneumococcal conjugate vaccine (PCV 10) was incorporated in the National Immunization Program in 2010 for use in all children up to two years of age[19]. The impact of this vaccine was evaluated in Brazil according to the number of hospitalizations of children aged 2–35 months, with a diagnosis of CAP with clinical or radiological confirmation, in the 3 years following the start of vaccine application in 17 hospitals in the city of Goiânia. The authors found a relative rate of reduction of pneumonia with clinical confirmation and by chest X-ray of 13.1 and 25.4%, respectively, in children between 2 and 23 months of age. The most pronounced effect occurred in the group of 2–11 months of age, with a reduction of 853/100,000 inhabitants – from 6,788 to 5,935/100,000 inhabitants – and of 729/100,000 inhabitants – from 2,871 to 2,142/100,000 inhabitants – for pneumonia with clinical diagnosis and radiologically confirmed diagnosis[20]. These data confirm the outcomes observed in other countries with the 7-valent conjugate vaccine[21,22].

The increase in the number of deaths and mortality rates due to LRTI in the population aged 70 years or more contrasts with what has been observed in countries that have implanted pneumococcal conjugate vaccination in children prior to Brazil and that, more recently, have invested in the implantation also for the adults[23-25]. In these countries, although the number of deaths due to LRTIs among the elderly is higher than in other age groups, mortality rates have been decreasing, speculating that this is primarily due to the "herd" effect of childhood immunization, and also to the vaccination of the elderly themselves, which occurred in subsequent years[23,24].

As of the date of this article, conjugate anti-pneumococcal vaccination for the elderly in Brazil had not yet been included in the National Immunization Program, being available in private vaccination programs, and not accessible to the majority of the population.

LRTIs are among the main causes of disability in Brazil and worldwide. As it is possible to be observed, the world experiences a drop in the estimates that quantify the impact of the LRTIs on health – in terms of disability – as it happened with the DALYs in the last decades in Brazil. Despite the accelerated and somewhat disorganized context of urbanization that has shaped the Brazilian scenario in recent decades, the implementation of public health programs has been successful in some areas. Those aimed at controlling vaccine-preventable diseases such as diarrhea, respiratory infections and tuberculosis have provided universal and free access to vaccination, as well as to primary health care[26].

Smoking is an important cause of morbidity and mortality in Brazil and in the world. Data from the World Health Organization (WHO) show that, overall, smoking is directly related to 80% of the deaths caused by the 10 main diseases worldwide, with the first 5 being: ischemic heart disease, stroke, COPD, LRTIs, and lung cancer[27].

Regarding the CAP, the attributable risk of acquiring the disease due to smoking was evaluated in a case–control study involving 205 patients with the disease, aged between 15 and 74 years, and 475 paired community controls. The authors found that smoking of any type of tobacco resulted in an odds ratio of 2.0 for smokers in general (95% CI 1.2–3.2), 1.88 for current smokers (95% CI 1.1–3.2), and 2.1 for ex-smokers (95% CI 1.3–3.6). In this sample of patients, there was a 50% reduction of this risk in ex-smokers for more than 5 years. The attributable risk of CAP for smoking in this population was 32.4% (95% CI 14.8–50.1), and in the controls it was 23% (95% CI 3.3–42.7%)[28].

Thus, the impact of the implementation of public policies aiming reduction of the prevalence of smokers in Brazil, prevention and reduction of mortality due to LRTIs and other diseases should be considered. Some of these policies have included campaigns and approval of stricter anti-smoking laws that have shown significant results, such as the reduction in the number of smokers in the country: in 1989, 34.8% of the population over 18 years were smokers. In the last decade, according to data from the Protection and Risk Factors for Chronic Diseases by Telephone Inquiry (Vigitel)/2015, the prevalence found in Brazilian capitals was 10.5%[29]. These expressive results highlight the importance of the continuity and improvement of these policies in parallel with the adoption of other measures also necessary for the economic and social development of the country, such as urbanization planning involving the improvement of sanitary conditions in the surroundings of the big cities. In contrast, the heterogeneity of the demographic, economic, sanitary, and developmental conditions among the federated units must underlie the different rates of reduction of mortality observed among the Brazilian states.

This study presents some limitations that should be emphasized. Although there has been a significant improvement in the information on causes of death available in the SIM database in recent years, its coverage and quality of information on causes of death are still unequal in Brazilian states, and in temporal analyzes. These data therefore required

adjustments to allow adequate comparisons in the GBD study estimates, which required modeling with widely reported limitations[6,11,13,30]. In contrast, the GBD approach produces estimates and temporal comparisons between states and countries with standardized methodology and annual updates, allowing more adequate interventions for populations that are more vulnerable to priority health problems[30], as the results of this study indicate.

CONCLUSION

In the period analyzed, from 1990 to 2015, there is a significant impact of LRTIs in Brazil, which, despite the current socio-economic difficulties, has been reducing, especially in terms of mortality and disability among children under 5 years of age. The impact on the mortality rates of the elderly, not yet analyzed, should be verified in subsequent studies, with a longer period after the initiation of anti-pneumococcal vaccination among children and possibly adults.

REFERENCES

1. Welte T, Torres A, Nathwani D. Clinical and economic burden of community-acquired pneumonia among adults in Europe. Thorax 2012 Jan 1;67(1):71-9.
2. Rozenbaum MH, Pechlivanoglou P, van der Werf TS, Lo-Ten-Foe JR, Postma MJ, Hak E. The role of Streptococcus pneumoniae in community-acquired pneumonia among adults in Europe: a meta-analysis. Eur J Clin Microbiol & Infect Dis2013;32(3):305-16.
3. Donalisio M, Arca C, Madureira P. Clinical, epidemiological, and etiological profile of inpatients with community-acquired pneumonia at a general hospital in the Sumaré microregion of Brazil. J Bras Pneumol2011;37(2):200-8.
4. Vos T, Allen C, Arora M, Barber RM, Bhutta ZA, Brown A, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 2016;388(10053):1545-602.
5. Rushby JF. Calculating and presenting disability adjusted life years (DALYs) in cost-effectiveness analysis. Health Policy Plan 2001;16(3):326-31.
6. Wang H, Naghavi M, Allen C, Barber RM, Bhutta ZA, Carter A, et al. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 2016;388(10053):1459-544.
7. Monteiro C. Contribuição para o estudo do significado da evolução do coeficiente de mortalidade infantil no município de São Paulo, SP (Brasil) nas três últimas décadas (1950–1979). Rev Saúde Pública 1982;16:7-18.
8. Murray C, Lopez A. The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020. Cambridge: Harvard University Press; 1996.
9. Institute for Health Metrics and Evaluation (IHME). Data Visualization. 2016. Disponível em: http://www.healthdata.org/results/data-visualizations (Acessado em: 18 de outubro de 2016).
10. Brasil. Sistema de Informação sobre Mortalidade (SIM). Brasília: GIAE/Secretaria de Vigilância em Saúde. Disponível em: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sim/cnv/ext10br.def (Acessado em: 18 de outubro de 2016).
11. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012;380(9859):2095-128.
12. Forouzanfar MH, Afshin A, Alexander LT, Anderson HR, Bhutta ZA, Biryukov S, et al. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet2016;388(10053):1659-724.

13. Foreman KJ, Lozano R, Lopez AD, Murray CJL. Modeling causes of death: an integrated approach using CODEm. Popul Health Metr 2012;10(1):1.
14. Ferrari R, Bertolozzi M. Postnatal mortality in Brazilian territory: a literature review. Rev Esc Enferm USP 2012;46(5):1207-14.
15. United Nations Children's Fund/World Health Organization. Levels & Trends in Child Mortality. Report 2015: Estimatives developed by the UN inter-agency group for child mortality estimation. New York; 2015. Disponível em: http://www.childmortality.org/files_v20/download/IGME Report 2015_9_3 LR Web.pdf (Acessado em: 7 de janeiro de 2017).
16. Batista Filho M, Cruz R. A saúde das crianças no mundo e no Brasil. Rev Bras Saude Mater Infant 2015;15(4):451-4.
17. Waight PA, Andrews NJ, Ladhani SN, Sheppard CL, Slack MPE, Miller E. Effect of the 13-valent pneumococcal conjugate vaccine on invasive pneumococcal disease in England and Wales 4 years after its introduction: an observational cohort study. Lancet Infect Dis 2015;15(5):535-43.
18. Chalmers JD, Campling J, Dicker A, Woodhead M, Madhava H. A systematic review of the burden of vaccine preventable pneumococcal disease in UK adults. BMC Pulm Med 2016;16(1):77.
19. Brazilian Guidelines for Reference Centers to Special Immunobiologics. Secretariat of Health Surveillance, Department of Epi-demiological Surveillance. 2006. Disponível em: http://bvsms.saude.gov.br/bvs/publicacoes/manual centro referencia imunobiologicos.pdf (Acessado em: 7 de novembro de 2017).
20. Sgambatti S, Minamisava R, Bierrenbach AL, Toscano CM, Vieira MA, Policena G, et al. Early impact of 10-valent pneumococcal conjugate vaccine in childhood pneumonia hospitalizations using primary data from an active population-based surveillance. Vaccine 2016;34(5):663-70.
21. Grijalva CG, Nuorti JP, Arbogast PG, Martin SW, Edwards KM, Griffin MR. Decline in pneumonia admissions after routine childhood immunisation with pneumococcal conjugate vaccine in the USA: a time-series analysis. Lancet 2007;369(9568):1179-86.
22. Vogel A, Trenholme A, Stewart J, Best E, McBride C, Lennon D. Impact of pneumococcal vaccine on hospital admission with lower respiratory infection in children resident in South Auckland, New Zealand. N Z Med J 2013;126(1378):26-35.
23. Harboe ZB, Dalby T, Weinberger DM, Benfield T, Mølbak K, Slotved HC, et al. Impact of 13-valent pneumococcal conjugate vaccination in invasive pneumococcal disease incidence and mortality. Clin Infect Dis 2014;59(8):1066-73.
24. Lexau C, Lynfield R, Danila R, Al E. Changing epidemiology of invasive pneumococcal disease among older adults in the era of pediatric pneumococcal conjugate vaccine. JAMA 2005;294(16):2043-51.
25. Bonten MJM, Huijts SM, Bolkenbaas M, Webber C, Patterson S, Gault S, et al. Polysaccharide Conjugate Vaccine against Pneumococcal Pneumonia in Adults. N Engl J Med 2015;372(12):1114-25.
26. Barreto ML, Teixeira MG, Bastos FI, Ximenes RAA, Barata RB, Rodrigues LC. Successes and failures in the control of infectious diseases in Brazil: social and environmental context, policies, interventions, and research needs. Lancet 2011;377(9780):1877-89.
27. World Health Organization. The top 10 causes of death. 2014. Disponível em: http://www.who.int/mediacentre/factsheets/fs310/en/index.html (Acessado em: 7 de janeiro de 2017).
28. Almirall J, González CA, Balanzó X, Bolíbar I. Proportion of Community-Acquired Pneumonia Cases Attributable to Tobacco Smoking. Chest 1999;116(2):375-9.
29. Malta DC, Szwarcwald CL. Lifestyles and chronic non-transmissible diseases of the Brazilian population according to the National Health Survey: balance of the main results. São Paulo Med J 2015;133(4):286-9.
30. Wang H, Wolock TM, Carter A, Nguyen G, Kyu HH, Gakidou E, et al. Estimates of global, regional, and national incidence, prevalence, and mortality of HIV, 1980-2015: the Global Burden of Disease Study 2015. Lancet HIV2016;3(8):e361-87.

Received on: 02/15/2017
Final version presented on: 03/04/2017
Accepted on: 03/08/2017