**Title: The effect of homicides on life expectancy in Brazil (Aim: Health Affairs, AJPH,…)**

**Authors:** José Manuel Aburtoa, Bernardo L. Queirozb, Julia Calazansb, Shammi Luharc & Vladimir Canudas-Romod

**Author affiliations:**

a Unit of Biodemography, Institute of Public Health, University of Southern Denmark.

b CEDEPLAR, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil.

c London School of Hygiene and Tropical Medicine.

d Australian National University.

**Corresponding author:**

José Manuel Aburto

Email: jmaburto@health.sdu.dk

Tel. number: +45 65 50 94 16

Affiliation: Institute of Public Health, Unit of Biodemography, University of Southern Denmark.

Address: J.B. Winsløws Vej 9. DK-5000 Odense C, Denmark.

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**Abstract [Max 150 words]:**

**\maintext[~ 4500 words]**

**Introduction [450 words]**

Recent increases in homicide in Latin America may be jeopardizing population health gains,6, ADDIN EN.CITE <EndNote><Cite><DisplayText>1-3</DisplayText><record></record></Cite></EndNote>1-3 brought about by efforts towards universal health coverage4 and reductions in health-related financial insecurity in the past half a century.

Between 1960 and 2015, life expectancy in Brazil increased from 54.2 to 74.7 years, converging with many developed countries. Reductions in amenable mortality have contributed to these gains, in particular, infant and cardiovascular disease mortality, ADDIN EN.CITE <EndNote><Cite><DisplayText>12-16</DisplayText><record></record></Cite></EndNote>12-16 and has coincided with the introduction of a mandated universal healthcare system in the past three decades ADDIN EN.CITE <EndNote><Cite><DisplayText>8-10</DisplayText><record></record></Cite></EndNote>8-10, and the subsequent Unified Health System (Sistema Único de Saúde)11.

Violence and homicides, however, present a major public health concern in Latin America.18 In Brazil specifically, they are the third leading cause of death for the total population and the main cause of death among young adults. ADDIN EN.CITE <EndNote><Cite><DisplayText>19 20</DisplayText><record></record></Cite></EndNote>19 20 Between 2000 and 2007, the homicide rate was 23 per 100,000 people, a rate considerably higher than most neighbouring countries. Currently, the homicide risk is ten times higher than in most developed countries.20

Although informative for the purpose of cross country comparisons, national statistics for Brazil mask large disparities sub-nationally, and between females and males. For instance, life expectancy ranged from 63.2 years in Alagoas to 71.3 in Santa Catarina in 200024, and the rate of change in life expectancy in recent years has varied from 0.6 to 4.1 years between Southeast and Northeast regions22, respectively. A large contributory factor may be inequality in amenable mortality reductions, which varied between 11% and 4.3% in states with high and low governance scores, respectively12.

Further complicating our understanding of Brazil’s mortality experience is the variation in homicide rates between men and women18 21. High homicide rates have the potential to reverse life expectancy gains, as was recently reported in the context of Mexico31, and homicide rates among Brazilian men are ten times that of women. Although national statistics do not indicate any change in homicide rates in the last decade,6 this could be due to the neutralising effect of homicide rate increases in some states, and decreases in others. For instance, whilst the homicide rate has declined in Brasilia between 2007 and 2011, in the same period, homicides have increased by more than 40 per cent in Bahia6 22.

Despite the considerable inter-gender and subnational variation in mortality and homicides in Brazil, studies examining the contributing effect of homicide mortality to changes in life expectancy are scarce. This paper aims to examine the effect of homicide mortality on changes in state-level life expectancy between year1 and year2, in order to inform public health planning aiming to reduce the burden of violence in Brazil.

**Study Data and Methods [800 including limitations]**

We used state-level mortality data by age, sex and causes of death to compute proportions of deaths by cause, age, sex and state in a given year.25 We obtained the data from the Mortality Information System produced by the Brazilian Ministry of Health. We used population size estimates available from the National Statistics Office (IBGE) from 2000 to 2015 at the state-level.27

**Cause-of-death classification**

The concept of amenable mortality formed the basis of the cause of death classifications in our study, and refers to mortality that should be absent in the presence of timely, and quality, health care.28 29 This idea has been successfully used to link the progress of primary care expansion and reductions in amenable mortality in Brazil,12 and more recently it has also included causes amenable to public health interventions through health behaviors, such as lung cancer, and homicides.30

Using a cause of death classification system utilized in similar studies ADDIN EN.CITE <EndNote><Cite><DisplayText>31-33</DisplayText><record></record></Cite></EndNote>31-33, we grouped the causes into the following eight categories, based on the *International Classification of Diseases* [ICD] 10th revision (Appendix 1) 34: (1) amenable to medical service (including conditions that could be reduced by primary care, secondary intervention, and timely medical care, (2) homicides, (3) causes related to public health policies and health behaviors (e.g. drunk driving, smoking, etc), (4) diabetes, (5) ischemic heart diseases (IHD), (6) HIV/AIDS, (7) suicide and self-inflicted injuries, and all other causes (*residual causes)*.

The first category is linked to major health care interventions that have been implemented in the last decades in Brazil, including the Family Health Program, guaranteeing healthcare free at the point of use. ADDIN EN.CITE <EndNote><Cite><DisplayText>11-14</DisplayText><record></record></Cite></EndNote>11-14 The third category includes deaths caused by lung cancer, cirrhosis, and accidents. We analyzed diabetes, IHD, HIV/AIDS and suicide separately as they are amenable to both health behaviors and medical attention, and pose important public health challenges in Brazil. 15 35 For instance, Brazil was in the top ten countries ranked by number of suicide deaths in 200136.

In order to avoid cause of death mis-classification at older ages, due to a high prevalence of comorbidity, 37 38, we restricted our analysis to mortality below age 75. ~~Furthermore, the concept of amenable mortality often truncates causes of death at age 75,~~~~30~~ ~~and most homicides occur below this age.~~~~39~~

We analyzed changes in life expectancy during the first 15 years of the 20th century by comparing changes within two time periods: 2000-07 and 2007-15. These periods allowed us to capture the rise of homicides and major public health interventions in recent years. [need something more here, anything important that happened in this period?]

**Methods** We calculated age- and sex- specific death rates for five-year age-groups, with an open-age interval at 85, for the twenty-seven Brazilian states, and constructed sex-specific period life-tables for each year from 2000 to 201540. We then calculated age- and cause- specific contributions to differences in life expectancy at birth for each following year using a standard decomposition procedure.41 We summed up single-year decompositions in order to obtain the aggregate effect for the specified period.

**Limitations** This study is subject to a few limitations. Firstly, despite improvements in death counts coverage, particularly regarding certificate completeness and age reporting, at the turn of the century Brazilian mortality data was still considered ‘incomplete’ according to the Pan American Health Organization’s (PAHO) criteria. To overcome any resultant bias in our output, we used death estimates corrected for completeness, age misstatement, and migration. 26

Secondly, cause of death could have been misclassified for the following reasons: 1) We treat causes of death as mutually exclusive, whereas, they may actually be more ambiguous, for instance, poor eyesight, due to diabetes, may lead to an external cause of death; 2) medical doctors, or coroners may have imperfect knowledge about causes of death; and 3) developments in awareness of certain diseases in the past may lead to the same cause to be misclassified depending on when the individuals died. To overcome this limitation, we used broad cause-of-death categories before age 75, and used data from 2000 onwards, using only the *ICD*-10 classification.

Finally, although the concept of amenable mortality can be used to capture the effect of health care interventions on a set of causes of death, it is not able to allude to differences in the effectiveness of health care interventions over time and between states.28 Although more likely to be underreported in states with higher homicide rates, estimates of homicides as a cause of death are generally of good quality, especially due to the consistency of its definition, and as trained medical professionals or coroners may have little incentive to intentionally misreport it on a death certificate. Level of information and standardization of procedures to collect information of external causes of death in Brazil and states are homogeneous.

**Results [750]**

**Discussion [1200]**

**Conclusion [200]**

***References***

[1. Palloni A, Pinto-Aguirre G. Adult mortality in Latin America and the Caribbean. International Handbook of Adult Mortality: Springer 2011:101-32.](https://www.ibge.gov.br/estatisticas-novoportal/sociais/populacao/9103-estimativas-de-populacao.html2017)

.

28. Nolte E, McKee CM. Measuring the health of nations: updating an earlier analysis. *Health affairs* 2008;27(1):58-71.

29. Nolte E, McKee M. Does health care save lives? Avoidable mortality revisited: The Nuffield Trust 2004.

30. Beltrán-Sánchez H. Avoidable mortality. International handbook of adult mortality: Springer 2011:491-508.

31. Aburto JM, Beltrán-Sánchez H, García-Guerrero VM, et al. Homicides in Mexico reversed life expectancy gains for men and slowed them for women, 2000–10. *Health Affairs* 2016;35(1):88-95.

32. Elo IT, Beltrán-Sánchez H, Macinko J. The contribution of health care and other interventions to black–white disparities in life expectancy, 1980–2007. *Population research and policy review* 2014;33(1):97-126.

33. Malta DC, Sardinha L, Moura Ld, et al. Atualização da lista de causas de mortes evitáveis por intervenções do Sistema Único de Saúde do Brasil. *Epidemiologia e Serviços de Saúde* 2010;19(2):173-76.

34. Appendix. Supplemental material for the paper on homicide and life expectancy in Brazil.2018.

35. de Almeida-Pititto B, Dias ML, de Moraes ACF, et al. Type 2 diabetes in Brazil: epidemiology and management. *Diabetes, metabolic syndrome and obesity: targets and therapy* 2015;8:17.

36. Botega NJ, Garcia LdSL. Brazil: the need for violence (including suicide) prevention. *World psychiatry* 2004;3(3):157.

37. Rosenberg HM. Cause of death as a contemporary problem. *Journal of the history of medicine and allied sciences* 1999;54(2):133-53.

38. Guralnick L. Some problems in the use of multiple causes of death. *Journal of Chronic Diseases* 1966;19(9):979-90.

39. Canudas-Romo V, Aburto JM. The diversity in survival in Latin America and the Caribbean: The lost youth by homicides. World Bank (<https://wb-lac.shinyapps.io/lac_diversity/)2018>.

40. Preston S, Heuveline P, Guillot M. Demography: measuring and modeling population processes. 2000

41. Beltrán-Sánchez H, Preston SH, Canudas-Romo V. An integrated approach to cause-of-death analysis: cause-deleted life tables and decompositions of life expectancy. *Demographic research* 2008;19:1323.