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

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**Abstract [Max 150 words]:**

**\maintext[~ 4500 words]**

**Introduction [450 words]**

Most Latin American countries have experienced substantial improvements in health since the second half of the 20th century.1-3 More recently, major efforts towards universal health coverage have been implemented in most countries of the region.4 Improvements in providing legal guarantees and increasing financial protection related to health care have been documented.4 5 Although most countries in the region still face challenges in achieving universal health care, Brazil, Mexico, and Colombia show the top levels of performance.5 These improvements, however, are being jeopardized by a marked increase in homicides during the new century in Latin America.6

In Brazil, universal health coverage was embedded as a mandate in 1988.7 As a result, advances in primary care, a substantial decentralization process, social participation, and public awareness of the right to health care over the last two decades have taken place.8-10 Moreover, since 1994 the Family Health Program has led to substantial benefits,11 such as decreases in chronic disease hospitalizations and reduction in amenable mortality, including birth conditions and cardiovascular conditions.12-16 This progress is also reflected in the continuous rise of national life expectancy over the last five decades for both females and males.17

Violence and homicides have become a major public health concern in the region.18 In Brazil, homicides and accidents are the third leading cause of death for the total population and the main cause of death for young adults.19 20 Brazil had more than twice as high (23 per 100,000 people) the global injury rate (8.8 per 100,000 people) in 2000,18 and the risk of homicide is 10 times higher than in developed countries.20

Although important and informative, national figures mask large disparities at the subnational level, and between females and males in Brazil. For instance, homicide rates are more than 10 times higher among males than females.18 21 Even though homicides rates at the national level have not changed significantly in the last three decades,6 at the state level major changes occurred between 2007 and 2011: while some states decreased homicides (for example Brasilia), others (for example Bahia) suffered an increase larger than 40.0 percent.6 22 Thus, since homicides occurred mainly among the male population,23 some states could have experienced reversals in male life expectancy. Similarly, the largest reductions in amenable mortality in the period 2000-12 were achieved in regions with highest governance scores (11.0%), while those with lowest scores lagged with decreases of 4.3 percent.12 Therefore, medically amenable causes could have contributed to the rise in life expectancy, albeit with variation between states. Moreover, since life expectancy ranged from 63.2 years in Alagoas, to 71.3 years in Santa Catarina in 2000,24 and the gap in adult life expectancy between Southeast and Northeast regions has increased from 0.6 to 4.1 years in recent years,22 we expect large disparities between states in changes in life expectancy.

Given the high homicide rates in Brazil and the variation in public health interventions’ outcomes between states, understanding state-specific trajectories is an important step toward reducing disparities in life expectancy, and public health planning to reduce the burden of violence in Brazil.

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

We used data from the System of Mortality Information from Ministry of Health in Brazil to compute the proportions of deaths by cause, age, sex and state in a given year.25 These data provide information on mortality at the state level by age, sex and causes of death. Additionally, we used death estimates corrected for completeness, age misstatement, and migration available from Queiroz and colleagues,26 and population estimates available from the National Statistics Office (IBGE) from 2000 to 2015 at the state level.27

**Cause-of-death classification** We used the concept of amenable or avoidable mortality to classify deaths. This concept refers to those deaths that should not occur in presence of timely and high quality health care.28 29 This concept has successfully been used to link the progress of primary care expansion and reductions in amenable mortality in Brazil.12 More recently the concept has also included causes amenable to public health interventions trough health behaviors, such as lung cancer, cirrhosis and homicides.30

We use a recent cause-of-death classification system based on previous studies.31-33 Causes of death were grouped into eight categories (for details on codes from the *International Classification of Diseases* [ICD] 10th revision, see Appendix Table 1) 34 as follows: (1) amenable to medical service (includes those conditions that could be reduced by primary care, secondary intervention, and timely medical care), (2) homicides, (3) causes sensitive to public health policies and health behaviors (e.g. drunk driving, smoking), (4) diabetes, (5) ischemic heart diseases, (6) HIV/AIDS, (7) suicide and self-inflicted injuries, and all other causes labeled *residual causes*.

The first two categories are linked to the major health care interventions that have been implemented in the last decades in Brazil such as the Family Health Program,11-14 and to the high prevalence of homicides,6 respectively. The third category includes deaths caused by lung cancer, cirrhosis, and accidents. We analyze diabetes, ischemic heart diseases (IHD), HIV/AIDS and suicide separately because these conditions are amenable to both health behaviors and medical attention. In addition, diabetes and IHD represent public health challenges in Brazil 15 35 and the number of deaths caused by suicides places Brazil among the ten countries with highest number of suicides 36.

Our cause-of-death results refer to mortality below age 75. We do so in order to avoid miss-interpretations due to the high prevalence of comorbidities at older ages and because misclassification of causes of death is more frequent 37 38. In addition, the concept of avoidable or 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 looking at 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 first calculated age- and sex- specific death rates in five-year age groups with a last open-age interval at age 85 for the twenty-seven Brazilian states. We performed period life tables by sex following standard demographic methods for each year from 2000 to 2015.40 Then we calculated age- and cause- specific contributions to differences in life expectancy at birth for each following year by sex using a standard decomposition procedure.41 Finally, the effect for a specific period, for example *2000-07*, was calculated summing up the single-year decompositions:*2000-01* + *2001-02* + … + *2006-07.*

**Limitations** The analysis had several limitations. Firstly, one main issue when studying mortality in Brazil and other Latin American countries is the quality of death counts coverage.1 Completeness of death counts improved steadily for the country from 1980 to 2010, going from around 85% in 1980-1991 to 95% in 2000-2010. 26 At the state level, all states in the South and Southeast region have complete coverage of mortality registration and significant improvements in the less developed areas.26 To mitigate these limitations, we used estimates following a recent methodology to improve accuracy of completeness and age misstatement.26

Secondly, causes of death are treated as mutually exclusive, while they may not be (e.g., poor sight due to diabetes may lead to an accident); 2) medical doctors and even coroners have imperfect knowledge about causes of death; and 3) trends in awareness of certain diseases, and changing insights in disease processes affect classification. To reduce inaccuracies, we used broad cause-of-death categories before age 75 and focused on data from 2000 that uses *ICD*-10 classification.

Thirdly, the concept of avoidable mortality is a proxy to capture the effect of health care interventions on a set of causes of death. This concept represents an indicator of potential weaknesses in health care and not as evidence of differences on how health care interventions have been effective over time and between states.28 In addition, the estimates of homicides can be considered of good quality. 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]**

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