**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]. More recently, major efforts towards universal health coverage have been implemented in most countries of the region [2]. Evidence suggest positive results in providing legal guarantees and increasing financial protection schemes related to health care for the population [2, 3]. Although most countries in the region still face major challenges in achieving universal health care, Brazil, Mexico and Colombia show the top levels of performance [3].

In Brazil, for example, universal health coverage was embedded as a mandate in 1988 [4]. As a result, there have been advances in primary care and a substantial decentralization process, social participation, and public awareness of a right to health care over the last two decades [5, 6]. Moreover, the implementation of the Family Health Program since 1994 has led to substantial benefits, such as a decrease in chronic disease hospitalizations and reductions in amenable mortality rates, including infant mortality and cardiovascular conditions [7-10]. This progress is also reflected in the continuous rise of national life expectancy over the last five decades for both females and males [11].

These improvements, however, are being jeopardized by a marked increase in homicide mortality in the new century in Latin America [12]. Violence and homicides have become a major public health concern in the region [13]. Mexico In Brazil, external causes of death are the third leading cause of death for the total population and the main cause of death for young adults in 2015. Brazil , had more than twice as high (23 per 100,000 population) the global injury rate (8.8 per 100,000) in 2000 [13] and risk of homicide in recent years is 10 times than more developed economies [].

Although important and informative, national figures mask large disparities at the subnational level, and between females and males. For instance, homicide rates are more than 10 times higher among males than females in countries with high levels of violence in Brazil [13, 15]. Even though homicides rates at the national level have not changed significantly in the last three decades in Brazil [12], at the state level major changes occurred between 2007 and 2011: some regions decreased homicides (e.g. Brasilia), while others (e.g. Bahia) suffered an increase of more than 40.0% [12]. From 1980 to 2000, it was observed a decline in life expectancy at birth across regions in Brazil for both males and females. However, in the most recent decades the gap between the Southeast and Northeast regions of the countries increased from 0.6 to 4.1 years []. 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% [7]. Disparities are also shown in life expectancy levels, which ranged from 63.2 years in Alagoas, to 71.3 years in Santa Catarina in 2000 [16].

Here, we analyze the effect of amenable mortality and homicides on changes in life expectancy for each one of the 27 states in Brazil in the period 2000-15. Given the large decentralization process and the variation in homicides rates between states, we hypothesize large heterogeneity in changes in life expectancy between states and sexes. We expect, medically amenable causes to contribute to the rise in life expectancy, albeit with variation between states. In states with large increases in homicide mortality, we expect and offsetting effect of amenable causes and injuries. Since homicides occurred mainly among the male population, some states could have experienced reversals in male life expectancy. Understanding state-specific trajectories in an important step toward reducing disparities in life expectancy, and for public health planning to reduce the burden of violence in Brazil.

**Data & Methods [800 including limitations]**

The paper uses data from the System of Mortality Information from Ministry of Health in Brazil ([www.datasus.gov.br](http://www.datasus.gov.br)). The database provides information on mortality at the municipal level by age, sex and causes of death. From 1996 on, causes of are collected according to the Xth version of the International Classification of Diseases (ICD). One main issue when studying mortality in Brazil and other Latin American countries is the quality of death counts coverage[}. Several studies show the evolution and variation of the quality in completeness of death counts coverage using traditional demographic methods in Brazil []. Completeness of death counts improved steadly for the country from 1980 to 2010, going from around 85% in 1980-1991 to 95% in 2000-2010. At the state level, it was observed that all states in the South and Southeast region have complete coverage of the mortality registration and also significant improvements in the less developed areas[]. This study uses estimates produced by Queiroz et al (2017) to adjust mortality levels for states with incomplete death registration systems. Population data, by age and sex, is available from the National Statistics Office (IBGE). The paper uses IBGE population projections by states from 2000 to 2015.

**Cause-of-death classification** The concept of *amenable/avoidable mortality* refers to those deaths that should not occur in presence of timely and high quality health care [17, 18]. This concept has successfully been used to link the progress of primary care expansion and reductions in amenable mortality in Brazil [7]. More recently the concept has also included causes amenable to public health interventions trough health behaviors, such as lung cancer, cirrhosis and homicides [19, 20].

We classified deaths with a classification previously used to capture the effect of homicides and progress in public health interventions [21]. Causes of death were grouped into eight categories (for details on codes from the International Classification of Diseases [ICD], see Appendix table 1 [22]) 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, (6) suicide and self-inflicted injuries.

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, and to the high prevalence of homicides, 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 [10, 23] and the number of deaths caused by suicides places Brazil among the ten countries with highest number of suicides [24].

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 [25, 26]. In addition, the concept of avoidable/amenable mortality often truncates causes of death at age 75 [19], and most homicides occur below this age [14].

**Methods**

The effect of mortality change in the evolution of life expectancy across states in Brazil is performed using the method proposed by Sánchez and colleagues []. There are a large number of decomposition techniques aiming to identify which changes led to a variation in mortality (or life expectancy). The most basic decomposition methods is derived from standardization techniques that aim to eliminate compositional (age structure and rates) effects of mortality change, in general using the crude mortality rate. Decomposition of life expectancy proposes to identify how changes in exposures and years lived in each age contribute to changes in life expectancy.

The method used in this paper combines decomposition methods to identify the contribuition of changes in causes of death to variation in life expectancy to cause-deleted life tables, which simulates changes in life expectancy whether one cause of death is eliminated. The authors show that changes in the number of years lost depends on the changes in survival due to a specific cause weighted by the probability of surviving from that cause.

**Limitations**

The analysis has several limitations. The first, and most important one, is the quality of causes of death registration in the country and how is evolves overtime and varies across Brazilian states. The paper focus on data from 2000 that uses ICD-10 classification that reduces inaccuracies. Also, there are strong evidence that quality of causes of death data in Brazil has improved steadily over the last years.

Second, since there is still a variation in completeness of death counts coverage across states in Brazil, it is necessary to adjusted the number of deaths observed. The current methods and estimates provide only one adjustment factor, one for male and one for females, that is used to correct the observed number of deaths by age and cause. It is possible that different causes of deaths have different quality in registration, but it is assumed that all have the same level of completeness.

The estimates of the impacts 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]**

***References***

1. Organization, W.H., *The world health report 2000: health systems: improving performance*. 2000: World Health Organization.

2. Organization, W.H., *The world health report 2013: research for universal health coverage*. 2014: World Health Organization.

3. Wagstaff, A., et al., *Assessing Latin America’s progress toward achieving universal health coverage.* Health Affairs, 2015. **34**(10): p. 1704-1712.

4. Medici, A.C., *Financiamento e contenção de custos nas políticas de saúde: tendências atuais e perspectivas futuras.* Planejamento e Políticas Públicas, 1990. **4**: p. 83-98.

5. Paim, J., et al., *The Brazilian health system: history, advances, and challenges.* The Lancet, 2011. **377**(9779): p. 1778-1797.

6. Guanais, F.C. and J. Macinko, *The health effects of decentralizing primary care in Brazil.* Health Affairs, 2009. **28**(4): p. 1127-1135.

7. Hone, T., et al., *Large reductions in amenable mortality associated with Brazil’s primary care expansion and strong health governance.* Health Affairs, 2017. **36**(1): p. 149-158.

8. Macinko, J., et al., *Major expansion of primary care in Brazil linked to decline in unnecessary hospitalization.* Health Affairs, 2010. **29**(12): p. 2149-2160.

9. Macinko, J., et al., *Going to scale with community-based primary care: an analysis of the family health program and infant mortality in Brazil, 1999–2004.* Social science & medicine, 2007. **65**(10): p. 2070-2080.

10. Rasella, D., et al., *Impact of primary health care on mortality from heart and cerebrovascular diseases in Brazil: a nationwide analysis of longitudinal data.* Bmj, 2014. **349**: p. g4014.

11. Nations, U., *World population prospects: the 2017 revision.* Population division of the department of economic and social affairs of the United Nations Secretariat, New York, 2017.

12. Drugs, U.N.O.o. and Crime, *Global study on homicide 2013: trends, contexts, data*. 2013: UNODC.

13. Briceño-León, R., A. Villaveces, and A. Concha-Eastman, *Understanding the uneven distribution of the incidence of homicide in Latin America.* International Journal of Epidemiology, 2008. **37**(4): p. 751-757.

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

15. Gamlin, J., *Violence and homicide in Mexico: a global health issue.* The Lancet, 2015. **385**(9968): p. 605-606.

16. Messias, E., *Income inequality, illiteracy rate, and life expectancy in Brazil.* American Journal of Public Health, 2003. **93**(8): p. 1294-1296.

17. Nolte, E. and C.M. McKee, *Measuring the health of nations: updating an earlier analysis.* Health affairs, 2008. **27**(1): p. 58-71.

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

19. Beltrán-Sánchez, H., *Avoidable mortality*, in *International handbook of adult mortality*. 2011, Springer. p. 491-508.

20. Elo, I.T., H. Beltrán-Sánchez, and J. Macinko, *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): p. 97-126.

21. Aburto, J.M., et al., *Homicides in Mexico reversed life expectancy gains for men and slowed them for women, 2000–10.* Health Affairs, 2016. **35**(1): p. 88-95.

22. Appendix, *Supplemental material for the paper on homicide and life expectancy in Brazil.* 2018.

23. de Almeida-Pititto, B., et al., *Type 2 diabetes in Brazil: epidemiology and management.* Diabetes, metabolic syndrome and obesity: targets and therapy, 2015. **8**: p. 17.

24. Botega, N.J. and L.d.S.L. Garcia, *Brazil: the need for violence (including suicide) prevention.* World psychiatry, 2004. **3**(3): p. 157.

25. Rosenberg, H.M., *Cause of death as a contemporary problem.* Journal of the history of medicine and allied sciences, 1999. **54**(2): p. 133-153.

26. Guralnick, L., *Some problems in the use of multiple causes of death.* Journal of Chronic Diseases, 1966. **19**(9): p. 979-990.