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## Overdose death rates in Brazil: an ecological analysis by region

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Mortality due to drug and alcohol overdose is a significant and understudied public health concern in Brazil.<sup>1</sup> National mortality rates almost doubled between 2000 and 2014.<sup>2</sup> The highest drug-related hospitalization and death rates are in the Midwest and South. This study analyzed drug overdose mortality trends in Brazil from 2000 to 2018 using joinpoint regression models. We also report differences among the five national macroregions (the South, Southeast, Midwest, Northeast, and North) defined by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística [IBGE]).

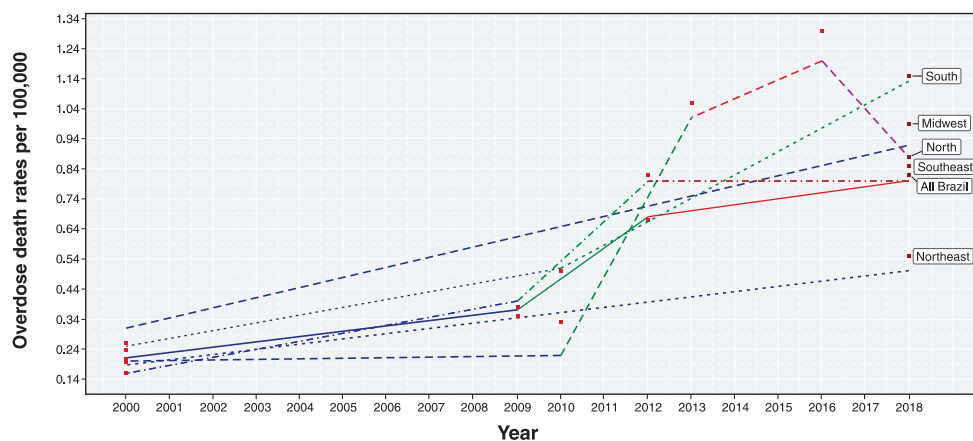
We collected data from public-use mortality files (SIM-DATASUS) containing city-level information on deaths between 2000-2018, analyzing unintentional (X40-X44), intentional (X60-64), undetermined (Y10-14), and alcohol-related (X45, X65, and Y15) overdose ICD-10 death

codes as underlying causes of death, following other studies on overdose mortality.<sup>3</sup> Total overdose deaths nationwide and in each macroregion per 100,000 inhabitants per year between 2000 and 2018 were calculated.

Potentially significant changes in death trends from overdose over time in the country/regions were identified through joinpoint regression analyses, in which the slopes were converted to annual percentage rates (APRs), i.e., estimated annual change in each identified slope. The joinpoint software<sup>4</sup> yields point estimates for APRs and their statistical significance. Figure 1 was produced using R statistical software 4.1.2. We report overdose rate trends nationwide and according to each macroregion.

The number of yearly overdose deaths in Brazil ranged from about 350 in 2000 to over 1700 in 2018. Overdose death rates in Brazil ranged from 0.20/100,000 in 2000 to 0.82/100,000 persons in 2018. Three different increasing trends in overdose death rates were found: 2000-2009 (APR: +0.02,  $p < 0.01$ ), 2009-2012 (APR: +0.10,  $p < 0.01$ ), and 2012-2018 (APR: +0.02,  $p < 0.01$ ). The most frequently involved substances were, in descending order: alcohol, cocaine, and benzodiazepines.

Overdose death rates in the North were 0.21/100,000 in 2000 and 0.88/100,000 in 2018, with rates significantly increasing between 2010 and 2013 (APR: +0.26,  $p < 0.01$ ) and decreasing between 2016 and 2018 (APR: -0.16,  $p = 0.04$ ). Overdose death rates in the Northeast were 0.26/100,000 in 2000 and 0.55/100,000 in 2018, whereas the rates in the Midwest were 0.24/100,000 in 2000 and 0.99/100,000 in 2018. Those two regions had a significant increasing trend over the study period (APR<sub>Northeast</sub>: +0.02,  $p < 0.01$ ; APR<sub>Midwest</sub>: +0.03,  $p < 0.01$ ). Overdose death rates in the Southeast were 0.16/100,000 in 2000 and 0.85/100,000 in 2018, with the rate increasing significantly between 2000 and 2009 (APR: +0.03,  $p < 0.01$ ). Finally, overdose death rates in the South were 0.20/100,000 in 2000 and 1.15/100,000 in 2018, including upward trends between 2000 and 2010 (APR: +0.03,  $p < 0.01$ ) and 2010-2018 (APR: +0.08,  $p < 0.01$ ) (Figure 1).



**Figure 1** Joinpoint regression analysis of the overdose death rate per 100,000 persons between 2000 and 2018 nationwide and in each macroregion (the North, Northeast, Midwest, Southeast, and South). Different colors indicate trend lines within the same curve.

Drug overdose deaths in Brazil have increased four-fold between 2000 and 2018, from 350 in 2000 to 1700 in 2018. This increase was much higher than the population growth between 2000 (170 million people according to the 2000 census) and 2018 (208 million people as estimated by the IBGE), a 22% increase.<sup>5,6</sup> Evidence-based treatment and harm reduction approaches are needed to address the increase in fatal overdoses in Brazil. These data involve limitations, since mortality data rely on the quality of death certificates, which may be subject to misclassification.

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### Disclosure

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