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Raphael Mendonça Guimarães, Marcelo Rasga Moreira, Nilson do Rosário Costa

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THE SILENT CRISIS: RISING TRENDS IN ADOLESCENT SUICIDE IN BRAZIL

Raphael Mendonça Guimarães[1]

Marcelo Rasga Moreira[2]

Nilson do Rosário Costa[3]

1. MSc and Dsc in Public Health; MA and PhD in Demography. Senior Research Scientist and Full Professor. Social Sciences Department, National School of Public Health, Oswaldo Cruz Foundation, Brazil. ORCID: https://**orcid**.org/0000-0003-1225-6719
2. MSc and Dsc in Public Health. Senior Research Scientist and Full Professor. Social Sciences Department, National School of Public Health, Oswaldo Cruz Foundation, Brazil. ORCID: http://**orcid**.org/0000-0003-3356-7153
3. MSc and Dsc in Public Health. Senior Research Scientist and Full Professor. Social Sciences Department, National School of Public Health, Oswaldo Cruz Foundation, Brazil. ORCID: http://**orcid**.org/0000-0002-8360-4832.

Corresponding Author
Raphael Mendonça Guimarães
Senior Research Scientist | Full Professor
Rua Leopoldo Bulhões, 1480 – ENSP, Suite #916
Rio de Janeiro, RJ, Brazil
raphael.guimaraes@fiocruz.br
+55 21 995 859 959

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ABSTRACT

Purpose

This study aims to analyze trends in youth suicide rates and the odds of suicide comparing different age groups from 2000 to 2022 in Brazil.

Methods

We conducted a temporal trend study on suicide mortality in Brazil from 2000 to 2022, using data from the Mortality Information System and population projections from the Brazilian Institute of Geography and Statistics (IBGE). We calculates mortality rates for the following age groups: adolescents (10-19 years), young adults (20-29 years), youth (10-29 years), adults including youth (20 years and older), and adults excluding youth (30 years and older). We applied Joinpoint regression to identify changes in trends and calculated the Mortality Odds Ratio (MOR) to compare suicide mortality between youth and adults.

Results

Between 2000 and 2022, suicide mortality significantly increased among adolescents, with a higher average annual percentage change compared to young adults. The Mortality Odds Ratio (MOR) for youth was 5.05 in 2000, rising to 8.56 in 2022. For adolescents, the MOR increased from 3.27 to 8.86 over the same period, indicating that in 2022, the suicide risk was 21% higher among adolescents than young adults, highlighting a significant reversal in the context of the Covid-19 pandemic.

Discussion

These findings underscore the urgent need for national mental health policies targeted at adolescents, particularly those in high vulnerability. The results of this study provide an evidence base for policymakers and public health officials to develop and implement interventions aimed at curbing the rising trend of youth suicide in Brazil.

KEYWORDS: Suicide, Adolescents, Health Policy, Time Series Analysis.

INTRODUCTION

The behavior of suicide rates in a given society and within the various classes and segments that comprise its population is a historical concern of different fields of social, human, and biomedical sciences, dating back at least to the turn of the 19th to the 20th century [1,2]. In contemporary times, this concern has gained global attention through the 2030 Agenda via SDG 3.4, which aims to reduce premature mortality from non-communicable diseases by one-third. Crucially, this goal emphasizes actions that would make it possible: "prevention, treatment, and promotion of mental health and well-being," all directly linked to the need for public health and intersectoral policies [3]. As a signatory and promoter of this Agenda, Brazil defined the suicide mortality rate in the population over five years of age as an indicator for target 3.4, maintaining the proposal of reducing it by one-third.

Over the past 20 years, the scenario of suicide has been marked by growing concerns and significant efforts to understand and address this complex issue [4]. For this reason, suicide has been recognized as an essential public health problem, responsible for millions of deaths annually [5]. In Brazil, although suicide rates have historically been lower than in some other countries, they have gradually increased over the past decades [6]. Regarding adolescents, suicide is one of the leading causes of death among young people, with rates varying in different regions of the world [7]. According to data from the World Health Organization (WHO), approximately 800,000 people take their own lives each year, and among adolescents, the rates have increased in many countries [8].

In Brazil, suicide rates among adolescents have generally been lower than in other age groups. However, there has been a concerning increase in recent years. The studies by Fernandes et al. [9] and Cocogna et al. [10] offer a comprehensive view of suicide trends among young people in Brazil during specific periods. Fernandes et al. [9] analyzed suicide data among adolescents and young adults between 2010 and 2019. There was an increase in suicide rates in this age group, especially among young adult males. There was a total of 14,852 deaths between 1997 and 2016, with a male predominance (67.59%) and an annual increase trend of 1.35%. Cocogna et al. [10] examined suicide trends among young people from 2000 to 2015, identifying an increase in rates, particularly among males and in urban areas. They identified a total of 11,947 deaths between 2000 and 2015, with a male-to-female ratio of 2.06:1. There was a statistically significant increase in suicide mortality among

adolescents, rising from 1.71 per 100,000 inhabitants in 2000 to 2.51 in 2015, an increase of 47%.

METHODS

We conducted a temporal trend study on suicide mortality in Brazil between 2000 and 2022. We used data from Brazil for the analysis. We extracted mortality data from the Brazilian Mortality Information System (SIM/SUS). We calculated age-specific mortality rates for young age groups, stratified as follows: adolescents (10 to 19 years); young adults (20 to 29 years); youth (10 to 29 years); adults including youth (20 years and older); and adults excluding youth (30 years and older). Additionally, we calculated the age-standardized overall rate, considering the standard world population. We based our calculations on the population projections of the Brazilian Institute of Geography and Statistics (IBGE).

The study followed three methodological steps. First, we conducted an exploratory data analysis to examine the proportion of suicide among deaths in each age group. Next, we applied the segmented regression method (Joinpoint Regression). This technique allows us to identify significant changes in trends over time. This model assumes a linear trend between inflection points (joinpoints) to achieve this. We defined the joinpoint model for observations (x_1,y_1), …, (x_n,y_n), where $x_1 \leq \cdots \leq x_n$ without loss of generality, as:

$$\mathrm{E}[y|x] = \beta_0 + \beta_1 x + \delta_1 (x - \tau_1)^+ + \cdots + \delta_k (x - \tau_k)^+$$

where $\tau_k's$ are unknown joinpoints, and $a^+ = a$ for $a > 0$ and 0 otherwise.

We used Poisson distribution parameters with robust variance to ensure homoscedasticity assumption. To estimate the APC, we used the following model:

$$\log(Y_x) = \beta_0 + \beta_1 x$$

Where $\log(Y_x)$ is the natural logarithm of the rate in year x, then the APC from year x to year x+1 is:

$$\mathrm{APC} = \frac{e^{\beta_0+\beta_1(x+1)} - e^{\beta_0+\beta_1 x}}{e^{\beta_0+\beta_1 x}} x100 = \left(e^{\beta_1} - 1\right) x100$$

We estimated a 95% confidence interval considering:

$$\mathrm{APC_L} = \left(e^{\log(\mathrm{APC}+1)-1{,}96\sqrt{w_x^2\sigma_x^2)}} - 1\right) \mathrm{x100};\ \mathrm{APC_U} = \left(e^{\log(\mathrm{APC}+1)+1{,}96\sqrt{w_x^2\sigma_x^2)}} - 1\right) \mathrm{x100}$$

Where σ^2_x is the variance estimate of ßx obtained from fitting the joinpoint model, once the number k of joinpoints was defined, we compared the different models with k joinpoints by estimating their Bayesian Information Criterion (BIC) [11].

To capture differences in the level and trend of suicide mortality between adolescents, youth, and the general population, we calculated mortality rate ratios for the groups, year by year. By visually inspecting the time series of these rate ratios, we obtained a direct measure of the difference in mortality between groups. Finally, to verify the discrepancy in the odds of suicide between youth and adults, we estimated the Mortality Odds Ratio (MOR). This association measure allows us to verify the odds of suicide death versus deaths excluding suicide in the groups. We estimated the odds of suicide in each age group and then calculated the MOR using the following formula:

$$\mathrm{MOR} = \frac{\frac{D_x^s}{D_x^{ns}}}{\frac{D_{1-x}^s}{D_{1-x}^{ns}}}$$

whereD_x^s = suicide deaths in age group x; D_x^{ns} = deaths excluding suicide in age group x; D_{1-x}^s = suicide deaths in the population excluding age group x; D_{1-x}^{ns} = deaths excluding suicide in the population excluding age group x.

We calculated the confidence intervals for the MOR using the following formula:

$$95\%\ \mathrm{CI}\ (\mathrm{OR}) = \exp\left(\ln(\mathrm{OR})\right) \pm 1.96 * \mathrm{SE}(\ln(\mathrm{OR}))$$

where SE = Standard Error; OR = Odds Ratio.

We conducted the analyses using public data from the Mortality Information System, with no form of individual identification. In accordance with the Declaration of Helsinki and Brazilian legislation on research ethics involving human subjects (Resolutions 466/2012 and 510/2016), the study is exempt from ethical committee review.

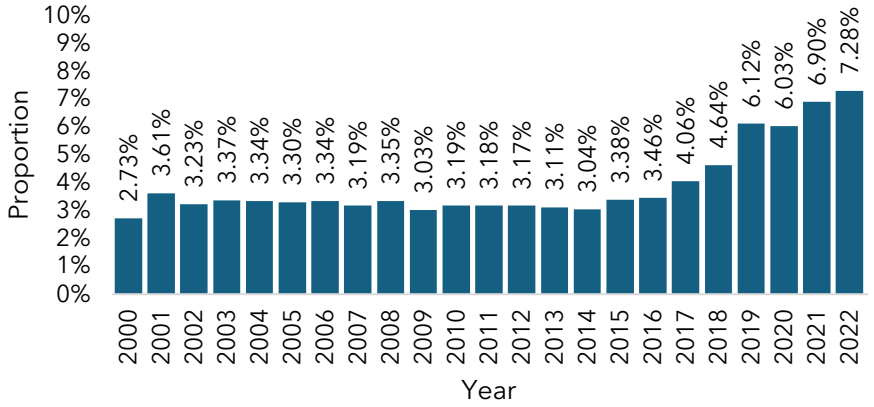
RESULTS

The proportional distribution of suicides across age groups is quite heterogeneous (Figure 1). Between 2000 and 2022, suicide accounted for an average of 4.02% (SD ± 0.97%) of deaths among individuals aged 10 to 29 years. The contribution was substantially lower for

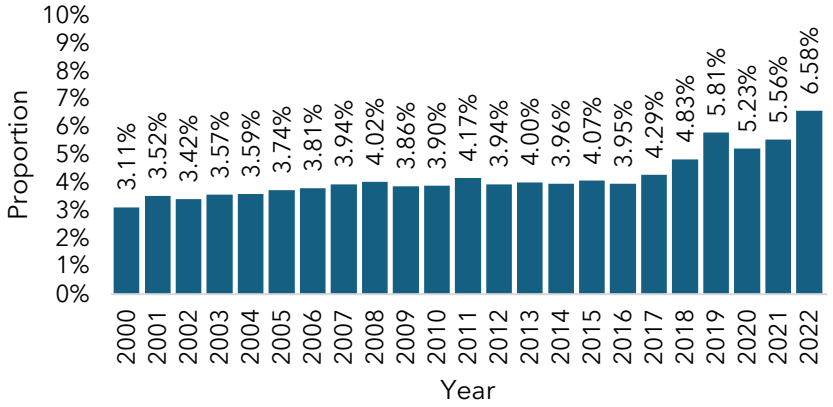
the group aged 30 and older, at 0.68% (SD ± 0.06%). The youth group is also internally heterogeneous. Although to a lesser extent, the youth group is also internally heterogeneous: among adolescents (10 to 19 years), suicide corresponds to 3.63% (SD ± 1.31%) of deaths, versus 4.21% (SD ± 0.84%) among young adults (20 to 29 years). This difference is statistically significant (p=0.042). Across all age groups, the trend in the contribution of suicide is upward. However, the increase between 2000 and 2022 is more significant among youth (131.39%) than adults aged 30 and older (41.61%). Again, there is a significant intra-group difference, with a variation of 185.27% among adolescents versus 111.78% among young adults. It is important to note that, although historically the contribution of suicides among adolescents has been lower than among young adults, this discrepancy has diminished over time as the rate of increase among adolescents is higher.

Regarding the suicide mortality rate, the combined rate for the 10 to 29-year age group shows a pattern that reflects the trends observed in the groups of adolescents (10 to 19 years) and young adults (20 to 29 years): an average of 4.68 deaths per 100,000 people (SD=1.03/100,000). The age-adjusted rate for the general population also shows variations but is generally higher than among youth (μ=5.30/100,000; SD=0.75/100,000). In terms of magnitude, the suicide rate in the 10 to 19-year age group shows some fluctuations but tends to be relatively lower compared to other age groups (μ=2.61/100,000; SD=0.78/100,000). On the other hand, suicide rates are higher in the 20 to 29-year age group (μ=6.73/100,000; SD=1.16/100,000) compared to the 10 to 14-year age group.

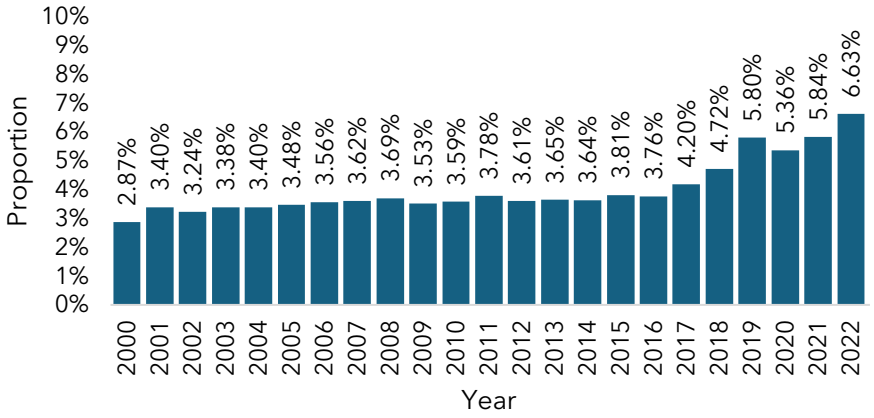
The joinpoint analysis allowed for the exploration of the historical series. Figure 2 presents the visual inspection of this analysis. We observe that for all age groups, there is a single inflection point in the trend over the 23 years of observation. Although the year of inflection varies according to the group, it is notable that the inflection marks the transition from a phase of slow growth or stationarity to a period of consistent growth. Table 1 presents the quantitative analysis of the temporal trend for different youth age groups and the age-adjusted general population. Regarding the pattern, the 10 to 29-year age group is like the general population: an inflection in 2016 marking a phase of slow growth, followed by a second phase, between 2016 and 2022, of more significant annual increase. It is essential to highlight that the groups are distinct in terms of magnitude.



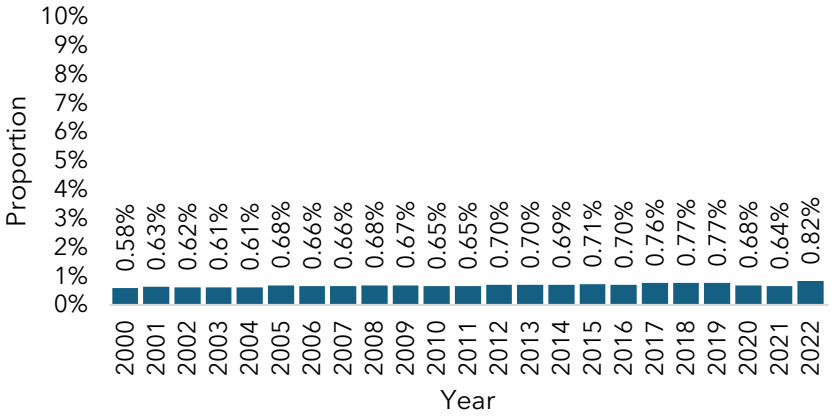
Adolescentes (10 a 19 anos)



Adultos jovens (20 a 29 anos)



População Jovem (10 a 29 anos)



População geral não jovem (30 anos e mais)

Figure 1: Proportion of deaths by suicide according to age groups. Brazil, 2000-2022.

Source: Mortality Information System (SIM/SUS) | Brazilian National Bureau for Statistics (IBGE)

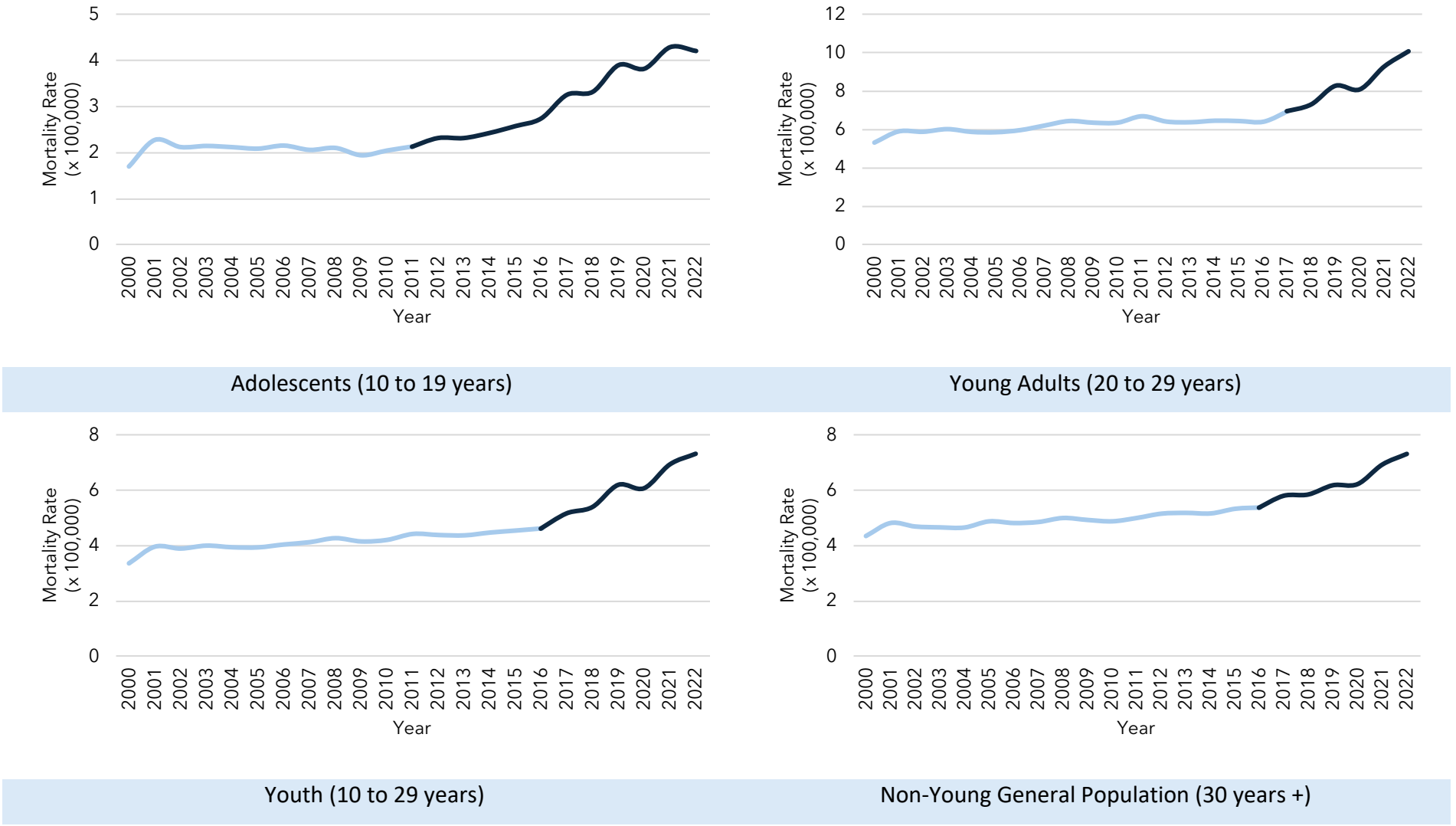


Figure 2: Time series of suicide mortality rates by age groups. Brazil, 2000-2022.

Source: Mortality Information System (SIM/SUS) | Brazilian National Bureau for Statistics (IBGE)

The average annual percentage change for the 10 to 29-year age group was 50.94% higher than that of the general population. Consistently, the youth group shows a higher yearly percentage change than the general population, regardless of the period: between 2000 and 2016, the 10 to 29-year age group had an APC 43.13% higher. For the period between 2016 and 2022, the difference is even more remarkable: 56.86%. There is a difference between adolescents and young adults within the youth group. First, the inflection point for adolescents (2011) is earlier than that for young adults (2017). Additionally, for adolescents, there is a non-significant trend between 2000 and 2011, with a significant increase from 2011 to 2022. Conversely, in the young adult group, the increase was already substantial since 2000, albeit at different rates of growth

Despite the higher annual percentage changes among young adults, there is an essential element to recognize. The accelerated increase among them is more recent, and this possibly determines a greater magnitude. However, this increase occurs more often among adolescents, reflected in the average annual percentage change, which, paradoxically, is higher among adolescents than among adults (a difference of 37.98%). This evidence suggests that although the magnitude among adolescents is still lower, there is potential for an inversion in this relationship in the medium term.

We can assume that the first period of the time series, before the inflection point, serves as a counterfactual to evaluate the change in the rate of increase in the rates in each age group. In this analysis, we found that the general population has a growth rate equivalent to 4 times the rate of the initial period of the historical series. When comparing the 10 to 29-year age groups, we found a similar relative difference, around 4.47 times. However, when stratifying this group, we found a difference of 6.83 times for the 20 to 29-year age group and impressively 53.6 times for the 10 to 19-year age group.

Finally, we attempted to quantify the association between population groups and mortality to confirm which groups are more vulnerable to suicide. To do this, we calculated the Mortality Odds Ratio, which provides a precise measure of the strength of the association. We composed three distinct scenarios: we initially compared the youth group (10-29 years) with the adult group, excluding youth (30 years and older). Then, in a second scenario, we specifically compared the adolescent population (10-19 years) with adults (20 years and older). Finally, to verify intra-group differences, we compared adolescents (10-19 years) and young adults (20-29 years). We present the statistics in Table 2.

Age group	Period	APC (95% CI)	p value
10 to 19 yrs	2000-2011	0.13 (-1.20 a 1.49)	0.863
	2011-2022	7.10 (5.68 a 8.55)	<0.001
	AAPC	3.56 (2.65 a 4.48)	<0.001
20 to 29 yrs	2000-2017	1.03 (0.68 a 1.38)	<0.001
	2017-2022	8.07 (5.70 a 10.49)	<0.001
	AAPC	2.58 (2.04 a 3.13)	<0.001
10 to 29 yrs	2000-2016	1.46 (1.06 a 1.86)	<0.001
	2016-2022	8.00 (6.15 a 9.88)	<0.001
	AAPC	3.20 (2.67 a 3.73)	<0.001
General Population	2000-2016	1.02 (0.75 a 1.30)	<0.001
	2016-2022	5.10 (3.84 a 6.37)	<0.001
	AAPC	2.12 (1.75 a 2.49)	<0.001

Table 1: Time-trend analysis of suicide mortality rates by age groups. Brazil, 2000-2022.

Source: Mortality Information System (SIM/SUS) | Brazilian National Bureau for Statistics (IBGE)

Year	Scenario #1 (10-19 yrs vs. 20-29 yrs)		Scenario #2 (10-19 yrs vs. 20 yrs +)		Scenario #3 (10-29 yrs vs. 30 yrs +)	
	MOR	95% CI	MOR	95% CI	MOR	95% CI
2000	0.76	(0.69 - 0.84)	3.27	(3.01 - 3.56)	5.05	(4.79 - 5.31)
2001	0.89	(0.82 - 0.97)	4.00	(3.72 - 4.31)	5.54	(5.28 - 5.81)
2002	0.84	(0.77 - 0.91)	3.71	(3.44 – 4.00)	5.39	(5.14 - 5.66)
2003	0.83	(0.76 - 0.90)	3.87	(3.58 - 4.17)	5.73	(5.47 - 6.01)
2004	0.82	(0.75 - 0.89)	3.88	(3.60 - 4.19)	5.75	(5.49 - 6.03)
2005	0.78	(0.72 - 0.85)	3.52	(3.26 - 3.80)	5.30	(5.06 - 5.55)
2006	0.79	(0.72 - 0.86)	3.70	(3.43 – 4.00)	5.59	(5.34 - 5.86)
2007	0.73	(0.67 - 0.80)	3.53	(3.26 - 3.81)	5.65	(5.40 - 5.91)
2008	0.73	(0.67 - 0.79)	3.49	(3.23 - 3.77)	5.63	(5.39 - 5.89)
2009	0.70	(0.64 - 0.77)	3.30	(3.05 - 3.57)	5.42	(5.19 - 5.67)
2010	0.73	(0.67 - 0.79)	3.54	(3.28 - 3.83)	5.69	(5.44 - 5.95)
2011	0.69	(0.63 - 0.75)	3.56	(3.30 - 3.84)	5.97	(5.72 - 6.24)
2012	0.74	(0.68 - 0.80)	3.48	(3.23 - 3.74)	5.35	(5.12 - 5.58)
2013	0.72	(0.66 - 0.78)	3.47	(3.22 - 3.74)	5.38	(5.16 - 5.62)
2014	0.74	(0.68 - 0.80)	3.55	(3.30 - 3.81)	5.40	(5.17 - 5.63)
2015	0.79	(0.73 - 0.86)	3.85	(3.58 - 4.13)	5.51	(5.28 - 5.75)
2016	0.85	(0.78 - 0.92)	4.06	(3.78 - 4.35)	5.51	(5.28 - 5.75)
2017	0.93	(0.87 – 1.00)	4.49	(4.21 - 4.79)	5.70	(5.47 - 5.93)
2018	0.92	(0.86 - 0.99)	4.96	(4.65 - 5.29)	6.42	(6.17 - 6.68)
2019	1.00	(0.93 - 1.07)	6.35	(5.97 - 6.74)	7.98	(7.68 - 8.28)
2020	1.09	(1.02 - 1.17)	7.08	(6.66 - 7.53)	8.21	(7.91 - 8.53)
2021	1.21	(1.14 - 1.30)	8.86	(8.36 - 9.40)	9.60	(9.26 - 9.94)
2022	1.03	(0.97 - 1.11)	7.03	(6.63 - 7.46)	8.56	(8.27 - 8.86)

Table 2: Mortality Odds Ratios (MOR) for suicide among young people and adolescents by scenarios. Brazil, 2000-2022

Source: Mortality Information System (SIM/SUS) | Brazilian National Bureau for Statistics (IBGE)

Consistently, throughout all the years of the historical series, the likelihood of dying by suicide was higher among youth than among non-youth adults. However, it is essential to note that the odds gradually increased, rising from 5.05 (95% CI 4.79 – 5.31) in 2000 to 8.56 (95% CI 8.27 – 8.86) in 2022. The comparison between the specifically adolescent group and adults is even more impressive. The variation was even more remarkable, from 3.27 (95% CI 3.01 – 3.56) to 8.86 (95% CI 8.36 – 9.40) in 2022. It is worth noting that for the last year of the series, the MOR for the scenario comparing only adolescents exceeded the measure of the scenario that included all youth, highlighting the contribution of adolescents to this magnitude. Finally, when comparing adolescents (10-19 years) and young adults (20-29 years), considering only the set defined for youth (10-29 years), we recognize that historically the likelihood of suicides among young adults was higher than among adolescents. However, this likelihood gradually became similar over the years, and from 2019 it equalized. It then became more unfavorable for adolescents. In the last year of the series, there was a significant reversal in the likelihood, and the chance of suicide among adolescents was 21% higher than among young adults (MOR = 1.21, 95% CI 1.14 – 1.30). It is important to note that this reversal occurred during the Covid-19 pandemic.

DISCUSSION

Suicide is a complex issue and addressing it in the same way as other causes of death might not capture all its depth and nuances. While suicide is sometimes linked to mental health problems, social factors play a significant role in it [12]. These aspects require a broader analysis considering the interaction between the individual and the social and cultural environment. Suicide arises from the idea of an individual's disconnection from their life context, leading to the interruption of their own life [13]. This extreme act does not have a natural history of diseases like heart failure or tuberculosis. In this sense, addressing suicide allows for the development of specific and effective prevention and intervention strategies [14]. It involves understanding warning signs, providing appropriate support to at-risk individuals, and promoting mental health at individual and community levels.

The analysis of temporal trends helps us better understand how circumstances surrounding suicide have changed over time for different age groups and for the population. On one hand, suicide itself is an emerging public health issue [15]. Suicide among young people is particularly concerning. Firstly, because of the potential of unrealized life due to the

premature interruption of life before becoming an adult [16]. Secondly, because of the impact that a young person's self-inflicted death can have on family and community [17]. Furthermore, a young person's suicide highlights an inability to cope with an environment that is often hostile to them [18]. In this sense, suicide is a marker of social adversity, resulting from ruptures in social contracts, family conflict situations, and community disconnections that generate a lack of hope for the future.

Recent evidence on the impact of the pandemic on youth suicide is controversial in Brazil [19-22], with some discrepancies compared to international evidence [23]. On the one hand, Brazilian population data are imprecise since the population projections are possibly overestimated. This diagnosis is recent, following the publication of the preliminary results of the 2022 Brazilian Demographic Census [24]. During this census, the government realized that previous population estimates were overestimated compared to the collected data.

Population estimates are usually calculated using statistical methods and projections based on previous data, such as the last demographic census and administrative records like birth and death registers. However, these estimates can become inaccurate over time due to various factors, such as migration, underreporting of births and deaths, and changes in fertility and mortality rates [25]. It implies two central issues: first, that recent studies may be using rates that underestimate the magnitude of youth suicide, thereby masking changes in recent trends. The second issue is that demographic events influence projections, and the pandemic may have acted against expected population growth, primarily due to excess deaths, whether directly or indirectly related to COVID-19, and reduced fertility due to delayed intentions of pregnancy caused by uncertainty about the future.

Regarding theCOVID-199 pandemic in Brazil, there is speculation that social measures related to COVID-19 protect against suicide [26]. However, this analysis overlooks the temporality of events. In the immediate term, there may be fewer suicides than expected due to parental vigilance and the apparent plasticity of young people in the virtual environment. Moreover, some analysts suggest that the pandemic did not change the previous trend of suicide among adolescents [27]. From a technical standpoint, we must recognize that a definitive analysis of the pandemic's impact will require a more extended observation period after the end of the public health emergency of international concern [28]. Current analyses, with varying degrees of limitation, refer to the pandemic period, whose scenario is entirely different from the one currently observed and will likely have medium- and long-term

consequences. Therefore, the pandemic's influence on suicides may manifest years after the pandemic's end because it may have affected social, emotional, and economic relationships. It includes everything from depersonalization due to physical distancing to despair over instability caused by the pandemic's economic fragility.

Suicide is a public health problem that should be a priority on the political agenda for the youth population. Regarding the contribution of this group to the demographic composition, Guimarães, Moreira, and Costa [29] discussed demographic changes in Brazil and their implications for health policies. They observed an average reduction of 1.93% per decade in the youth population over the past 50 years. Since 2000, the adolescent group has been more prominent than the children group, and this has required efforts from the Ministry of Health to ensure health policies, especially within the Unified Health System (SUS), strengthening nutritional education and mental health programs for young people and adolescents, reflecting in more effective public policies. For this reason, we reaffirm that suicide cannot be analyzed as a disease but as a social problem [30]. In this aspect, our analysis aims to be a call for action, emphasizing that the timing for formulating and implementing public policies in this direction is now, with prevention in mind.

Our analyses have limitations. Regarding the population estimates used as denominators for the rates, there was a drop in the expected population in the estimates used by IBGE, and possibly the mortality rates are underestimated. However, we assume that population projections in the intercensal years between 2010 and 2022 are inflated due to the projection method. Thus, we believe this inaccuracy has altered the magnitude; however, it has created a modest effect on the overall trend since it was inflated in all years of the historical series.

Finally, we recommend considering the 2020-2022 triennium as a period to perform analysis due to the possible effect of instabilities created by the pandemic. It is likely that measures such as social isolation and uncertainty about science's capacity to understand the pattern of suicide, especially among adolescents and young adults. Although segmented regression analysis can capture the percentage variation in this short period, the fact that there are few points in time increases variability and, therefore, creates uncertainties about comparisons with the previous period (2000-2019). Other analytical methods are more accurate in testing this hypothesis of the pandemic period effect.

IMPLICATIONS AND CONTRIBUTION SUMMARY:

This study highlights the growing crisis of youth suicide in Brazil, revealing significant upward trends through robust Joinpoint analysis. The findings emphasize the urgent need for national mental health policies tailored to adolescents, especially those in high-risk demographics. By providing a detailed examination of suicide trends, this research contributes to the global understanding of adolescent mental health crises and underscores the importance of timely, data-driven public health interventions.

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