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Spatiotemporal Patterns and Determinants of Suicide in a Brazilian State: An Eleven-Year Ecological Study

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Spatiotemporal patterns and determinants of suicide in a Brazilian state: an eleven-year ecological study

Running title: Spatiotemporal Patterns and Suicide Determinants

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Abstract

Objective: Investigate spatial and temporal distribution of suicide mortality across the Regional Health Care Networks of São Paulo State, Brazil, from 2012 to 2022, evaluating associations with mental health service availability, psychiatric workforce density, and socioeconomic indicators.

Methods: Longitudinal retrospective ecological study using annual data from 19 Regional Health Care Networks. Suicide mortality (ICD-10 X60–X84) rates per 100,000 inhabitants were analyzed using descriptive epidemiology, exploratory spatial data analysis, and fixed-effects panel regression models with spatial error specifications and one-year lagged independent variables.

Results: Suicide rates increased from 4.8 to 6.3 per 100,000 (32%). Female aged 10–14 years experienced a 332% increase. Spatial clustering revealed persistent high-risk areas in inland regions. In panel regression models (within-$R^2 = 0.53$), psychiatrist density in the public health system demonstrated a protective association ($\beta = -0.20$, $p < 0.05$), as did psychiatric bed rates in lagged models ($\beta = -0.01$, $p < 0.05$). Psychosocial Care Centers coverage showed no significant association. GDP per capita was positively associated with suicide rates.

Conclusions: Psychiatric workforce availability and acute care capacity emerge as key modifiable factors. Increase among female adolescents and persistent geographic disparities warrant targeted prevention strategies. Findings provide actionable evidence for suicide prevention resource allocation in middle-income settings.

Keywords: Suicide; mental health services; social determinants of health; spatial analysis; Brazil

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Introduction

Suicide remains a major global public health challenge. Despite an overall declining trend worldwide, the Global Burden of Disease Study 2021 estimated 746,000 suicide deaths globally, representing the fourth leading cause of death among young adults.[1] The Americas stand out as the only World Health Organization region experiencing a continuous increase in suicide mortality, with rates rising 17% since 2000 and surpassing 100,000 deaths in 2021.[2] Recent analyses of global trends among youth aged 10–24 years have documented

alarming increases in several regions, with particularly pronounced rises among female adolescents in the United States (+6.7% annually, 2007–2017), the United Kingdom (+8.5% annually since 2012), and Central-Latin America.[3] In the United States, suicide rates for female adolescents rose more rapidly than for males between 1999 and 2020, a shift largely attributed to the use of more lethal methods.[4] In Brazil, suicide rates have increased steadily over the past two decades, reaching 6.6 per 100,000 inhabitants in 2019.[5] Awareness campaigns alone appear insufficient: a recent analysis of the national Yellow September suicide prevention campaign (Setembro Amarelo) found no association with changes in suicide mortality trends from 2000 to 2019. [6] Understanding the modifiable health system factors associated with these rising rates is essential for evidence-based prevention.

Research has identified several health system factors potentially associated with suicide mortality at the population level. Cross-national studies examining psychiatric workforce density have yielded conflicting findings: some report protective associations, particularly among women,[7] whereas others find positive or null associations, suggesting potential reverse causality whereby regions with higher burden attract more professionals.[8] Evidence on psychiatric bed availability is similarly mixed, with United States (U.S.) studies linking declining bed availability to rising suicide rates,[9] while cross-national analyses report inconsistent relationships.[10] Research on health care contacts before suicide death has demonstrated that over 80% of individuals access health services in the year before death, with most visits occurring with other health professionals rather than mental health professionals, highlighting opportunities for identification and intervention.[11,12] The role of consultation-liaison psychiatry in general hospitals has been recognized as potentially critical for suicide prevention, though empirical evidence at the population level remains limited.[13] Socioeconomic determinants, including gross domestic product per capita and income inequality, have shown complex and sometimes paradoxical relationships with suicide mortality that vary substantially by context.[14,15]

Despite this evidence base, critical gaps limit our understanding of effective prevention strategies. First, most studies have examined individual health system factors in isolation, without accounting for their simultaneous contributions or potential confounding factors. Second, spatial econometric

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methods that appropriately account for geographic clustering and regional dependencies have rarely been applied to suicide research in low- and middle-income settings.[16,17] Third, cross-sectional designs predominate, limiting inference about temporal relationships and potential lagged effects of health system changes on mortality outcomes. Fourth, Latin America remains substantially underrepresented in the global suicide prevention literature despite carrying a significant and growing burden. In Brazil specifically, while community-based mental health services have expanded substantially since the 2001 psychiatric reform,[18,19] rigorous evaluations of their impact on suicide mortality are lacking.

The present study addresses these gaps by examining the spatiotemporal distribution of suicide mortality across the 19 Regional Health Care Networks of São Paulo State, Brazil, from 2012 to 2022. Brazil's landmark National Mental Health Policy (Law 10.216/2001) reformed mental health care by shifting from hospital-based to community-based models.[18] The Psychosocial Care Network (RAPS), established in 2011, and its Psychosocial Care Centers (CAPS) provide multidisciplinary services with specialized modalities for children, adolescents, and substance use disorders.[19] However, evaluations suggest substantial heterogeneity in implementation quality across regions, with evidence indicating that CAPS coverage is associated with reduced hospitalizations for suicide attempts but not with suicide deaths.[20,21] São Paulo, the most populous state in Latin America with over 45 million inhabitants, provides an ideal setting for this analysis given its well-established mortality surveillance system and heterogeneous distribution of mental health resources across urban and rural regions. Using spatial panel regression models with fixed effects and one-year lagged specifications, we simultaneously evaluated associations between suicide rates and CAPS coverage, psychiatric bed availability, psychiatrist and psychologist density, and regional gross domestic product per capita. By employing methods that account for both unobserved regional heterogeneity and spatial dependence, this study provides actionable evidence to guide suicide prevention resource allocation in middle-income settings.

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Methods

Study Design and Geographic Units

This spatial panel ecological study examined associations between mental health service availability, socioeconomic factors, and suicide mortality in São Paulo State from 2012 to 2022. This period encompasses the consolidation of Brazil's Psychosocial Care Network (RAPS) implementation and largely precedes major disruptions from the COVID-19 pandemic. The units of analysis were the 19 Regional Health Care Networks (RRAS), administrative divisions used for health planning and resource allocation. RRAS were chosen over municipalities to reduce rate instability from small populations and to align with policy-relevant geographic units. Each RRAS is identified by a reference municipality, with RRAS 6 comprising the municipality of São Paulo in its entirety.

Data Sources and Variables

Annual data for the 19 RRAS were compiled from official sources. The dependent variable, suicide mortality (ICD-10 X60–X84), was obtained from the Mortality Information System, with population denominators from the SEADE Foundation via the State Health Department platform (Tabnet SES). Crude annual suicide rates per 100,000 inhabitants were used in panel regression models to preserve within-unit temporal variation. For descriptive epidemiology, direct age-standardized rates were calculated using the 2010 Brazilian Census population as standard. It should be noted that suicide deaths may be subject to underreporting and misclassification in Brazil, though mortality data quality in São Paulo State is considered high.[22,23]

Independent variables included gross domestic product (GDP) per capita and health system indicators from the National Registry of Health Establishments (CNES). Key indicators comprised: coverage of Psychosocial Care Centers (CAPS), calculated as a weighted index per 100,000 inhabitants following Ministry of Health Ordinance No. 325/2008;[24] psychiatric bed rates; and density of clinical and hospital psychologists, and psychiatrists across service types (public health system, CAPS, general hospitals, specialty hospitals), all expressed per 100,000 inhabitants. Geospatial boundary data for RRAS

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(SIRGAS 2000 coordinate reference system) were obtained as ESRI Shapefiles from the State Health Department.

Statistical Analyses

Analysis proceeded in three stages. First, descriptive epidemiology characterized demographic patterns of suicide across São Paulo and its 19 RRAS, calculating age-standardized and age-specific rates, proportions, male-to-female ratios, and percentage changes by age and sex, marital status, and education. For specific high-growth trends and gender comparisons, such as those observed in the 10–14 age group, statistical significance was further validated using Z-tests for proportions and rate ratios to rule out randomness; 95% confidence intervals (95% CI) and p-values were derived from the standard error of log-transformed rates.

Second, exploratory spatial data analysis assessed geographic patterns. A first-order Queen contiguity spatial weights matrix was constructed, defining neighbors as units sharing borders or vertices, then row-standardized.[25] Global Moran's I was calculated annually to test overall spatial autocorrelation. Local Moran's I (LISA) cluster maps identified statistically significant local clusters (High-High, Low-Low) and spatial outliers (High-Low, Low-High).

Third, panel regression models were estimated using a progressive strategy. A baseline fixed-effects model controlled for time-invariant unobserved characteristics by analyzing within-unit variation. A spatial error model with fixed effects was then estimated to address residual spatial autocorrelation, selected based on Lagrange Multiplier specification tests.[26] Finally, lagged models using one-year lagged independent variables addressed potential reverse causality and allowed time for health system changes to influence mortality.[27]

Multicollinearity was assessed using variance inflation factors; all retained predictors showed VIF < 5.0.

Analyses were conducted using R version 4.5.1 computer software, with packages splm for spatial panel models, spdep for spatial weights and autocorrelation tests, plm for panel data estimation, and car for multicollinearity diagnostics.

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Ethical Considerations

This study used exclusively aggregated, publicly available data and is exempt from ethics committee approval per Brazilian National Health Council Resolution CNS 510/2016.

Results

Descriptive Epidemiology

Between 2012 and 2022, the age-standardized suicide rate in São Paulo State increased from 4.78 to 6.32 per 100,000 inhabitants, representing a 32.2% rise over the study period (Figure S1). Suicide rates were consistently higher among males (8.0 to 10.9 per 100,000) than females (2.3 to 2.7 per 100,000), with a male-to-female ratio of 4.1 in 2022. The overall male-to-female rate ratio for the entire 2012–2022 period was 3.91 (95% CI: 3.79–4.02; $p < 0.001$), reflecting a sustained gender disparity throughout the decade (Table 1). Age- and sex-specific analyses revealed the highest rates among adult men aged 20–39 years (15.81 per 100,000 in 2022) and 40–59 years (13.69 per 100,000).

Table 1. Sex-Specific Suicide Rates, per 100,000 inhabitants, State of São Paulo, 2012-2022

Year	Male Suicide Rate	Female Suicide Rate	Male-to-Female Suicide Rate Ratio
2012	8.0	2.3	3.5
2013	8.4	2.1	4.0
2014	8.7	2.1	4.2
2015	8.8	2.2	4.0
2016	8.7	2.1	4.1
2017	9.2	2.4	3.9
2018	9.7	2.5	3.9
2019	9.9	2.5	3.9
2020	9.4	2.6	3.6
2021	10.6	2.8	3.8
2022	10.9	2.7	4.1

The most striking finding was the sharp increase in suicide mortality among the 10–14 age group for both sexes; while male suicide rates in this bracket rose by 214.0%, female adolescents experienced a 331.6% increase, from 0.19 (95% CI: 0.00–0.40) to 0.82 (95% CI: 0.34–1.31) per 100,000. Although absolute

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rates remained lower than in older groups, the trend was highly significant (Z = 2.47; *p* = 0.013) (Table S1). This finding aligns with global trends documenting alarming increases in suicide deaths among young females in the Americas.[3,4] Notably, female adolescents showed higher suicide rates than males in seven RRAS (Guarulhos, São Paulo, Santos, Bauru, Barretos, Piracicaba, and Araraquara), a highly anomalous pattern given typical male predominance in suicide mortality.

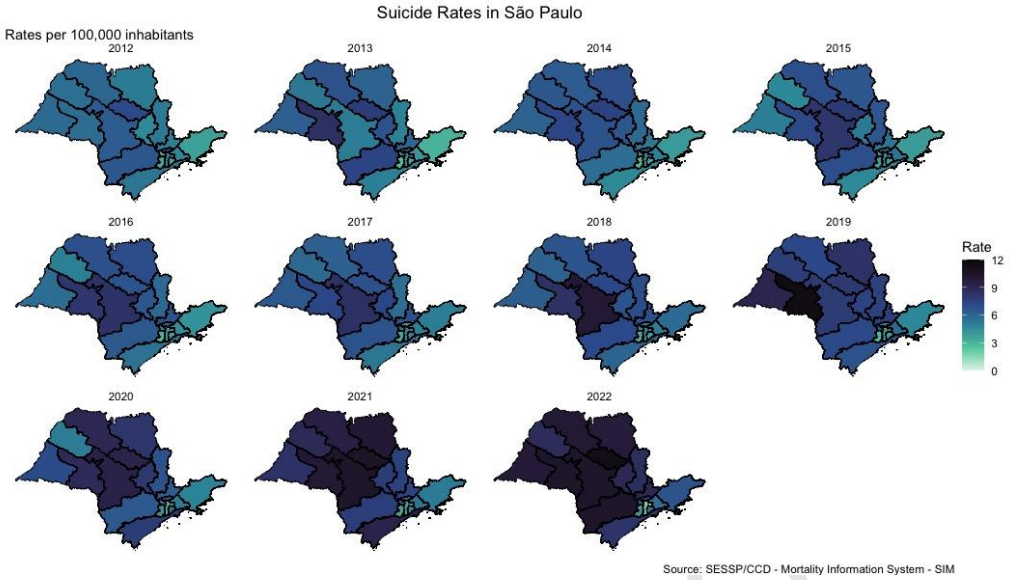
Considerable heterogeneity in suicide rates was observed across the 19 RRAS in 2022, ranging from 1.76 (RRAS 6, São Paulo) to 11.04 per 100,000 inhabitants (RRAS 18, Araraquara), indicating marked regional inequalities (Table S2). Suicide was more frequent among single individuals (47.8% in 2022) and those with 8-11 years of schooling (41.4%). CAPS coverage increased statewide from 0.80 to 1.17 per 100,000 inhabitants (46.2%) between 2012 and 2022, with RRAS 3 (Franco da Rocha) showing the largest increase (278%).

Spatial Patterns

Exploratory spatial data analysis revealed significant spatial clustering of suicide mortality. Global Moran's I tests indicated statistically significant positive spatial autocorrelation for nearly every year (Table S3), confirming that suicide rates were geographically clustered rather than randomly distributed. LISA cluster maps identified persistent High-High clusters (elevated rates surrounded by elevated rates) in Central-West (RRAS 09-Bauru), Northwest (RRAS 12-São José do Rio Preto), and Northeast (RRAS 18-Araraquara) macro-regions, and Low-Low clusters in Greater São Paulo including RRAS 02 (Guarulhos) and RRAS 06 (São Paulo). This pattern of higher rates in inland regions and lower rates in the metropolitan area remained consistent throughout the study period (Figure 1).

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Figure 1. Spatial-temporal evolution of crude suicide mortality rates per 100,000 inhabitants across Regional Health Care Networks (RRAS), São Paulo State, 2012–2022.



The maps show the spatial distribution of suicide rates across São Paulo's regions for each year from 2012 to 2022. Colors represent suicide rates per 100,000 inhabitants, ranging from 0 (light green) to 12 (dark blue/black). Data source: SESSP/CCD - Mortality Information System (SIM).

Panel Regression Analysis

The baseline fixed-effects model explained 53% of within-unit variance (within-$R^2 = 0.53$). Psychiatrist density in the public health system (SUS) demonstrated a significant protective association with suicide rates ($\beta = -0.20$, SE = 0.09, $p < 0.05$), while psychiatrists in general hospitals showed a marginally significant protective effect ($\beta = -0.27$, SE = 0.14, $p = 0.059$). Contrary to expectations, positive associations were observed for GDP per capita ($\beta = 0.00004$, $p < 0.05$), psychiatrists in CAPS ($\beta = 0.79$, $p < 0.01$), clinical psychologists ($\beta = 0.12$, $p < 0.01$), and hospital psychologists ($\beta = 0.67$, $p < 0.001$). CAPS coverage and psychiatric bed rates were not statistically significant in this non-spatial specification (Table 2).

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Table 2. Comparative Summary of Spatial and Panel Fixed Effects Models on Suicide Rates

Variable	FE panel model	Spatial FE model	Spatial FE model (1-year lag)
Spatial error rho	NA	−0.12 (p=0.27)	0.05 (p=0.61)
CAPS coverage rate	−0.01 (0.79)	−0.53 (0.45)	0.18 (0.49)
Psychiatric beds rate	0.003 (0.01)	−0.01** (0.00)	−0.01* (0.01)
Psychiatrists in CAPS	0.79** (0.25)	NA	NA
Psychiatrists in General ED	0.01 (0.50)	NA	NA
Psychiatrists in General Hospitals	−0.27 · (0.14)	NA	NA
Psychiatrists in Specialized Hospitals	0.20 (0.18)	NA	NA
Psychiatrists in SUS	−0.20* (0.09)	−0.15* (0.06)	−0.17* (0.07)
Clinical Psychologists	0.12** (0.04)	0.16*** (0.03)	0.18*** (0.03)
Hospital Psychologists	0.67*** (0.19)	0.75*** (0.18)	0.42* (0.19)
GDP per capita	0.00004* (0.00002)	0.00006 *** (0.00001)	0.00007 *** (0.00001)

Notes: Coefficient estimates with standard errors in parentheses. NA indicates variable not included in the model. Spatial fixed-effects models use a KKP spatial error specification. For coefficients of small magnitude, additional decimal places are retained. P values are indicated by significance codes: *** p < 0.001; ** p < 0.01; * p < 0.05; · p < 0.10.

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The spatial error model yielded a non-significant spatial error parameter (λ = −0.12, p = 0.27), indicating that the included covariates and fixed effects adequately explained the spatial clustering initially observed. Coefficient estimates remained broadly consistent, though the psychiatric bed rate became significantly protective (β = −0.01, p < 0.01).

The lagged model, addressing potential reverse causality, confirmed the non-significance of the spatial error term (λ = 0.05, p = 0.61). Significant protective associations persisted for lagged psychiatrist rate in the public health system (β

= −0.17, p < 0.05) and lagged psychiatric bed rate (β = −0.01, p < 0.05). Positive associations with GDP per capita and psychologist density persisted across specifications. CAPS coverage remained non-significant in all models (Table 2).

Discussion

In this spatial panel analysis of 19 Regional Health Care Networks over 11 years, we found that suicide rates in São Paulo State increased by 32%, with a particularly alarming 332% rise among female adolescents aged 10–14 years. Psychiatric workforce density in the public health system and psychiatric bed availability emerged as protective factors, while community mental health coverage showed no association with suicide mortality. The positive correlations observed for GDP per capita and psychologist density likely reflect regional disparities in reporting or reverse causality. Notably, while GDP per capita shows a high statistical significance (p < 0.001), its infinitesimal coefficient (β = 0.00006) in the spatial error model indicates that its contribution to suicide rate variance is marginal compared to the substantial effect sizes observed for hospital psychologists in the same specification (β = 0.75, p < 0.001) (Table2). This discrepancy suggests that while socioeconomic development may subtly influence death notification quality, the strong association with professional density is more likely an artifact of service concentration in high-demand, high-reporting urban centers, rather than a causal risk factor. These findings suggest that psychiatric expertise and acute care capacity may be more critical for population-level suicide prevention than community service expansion alone. The protective association between psychiatrist density in the public health system (β = −0.20) and lower suicide rates aligns with previous cross-national research demonstrating negative associations between psychiatrist availability and suicide mortality.[7] The finding that this association was robust across non-spatial, spatial, and lagged model specifications strengthens confidence in its validity. The marginally significant protective effect of psychiatrists in general hospitals (β = −0.27, p = 0.059) is particularly noteworthy given Brazil's ongoing psychiatric reform, which has progressively established psychiatric wards within general hospitals as an alternative to isolated psychiatric institutions.[28] These integrated units ensure rapid access to specialized care during psychiatric

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crises, a period of exceptionally elevated suicide risk, as demonstrated by meta-analytic evidence showing suicide rates of 100–200 times higher than the general population in the weeks following psychiatric discharge.[29] The emergence of psychiatric bed rates as a significant protective factor in spatial and lagged models (β = −0.01) provides complementary evidence that acute care capacity matters for suicide prevention, consistent with U.S. research linking declining psychiatric bed availability to rising suicide rates.[9]

The absence of a protective association for CAPS coverage contrasts with the theoretical expectation that community mental health services should reduce suicide mortality. This null finding aligns with previous Brazilian research showing that CAPS coverage is associated with reduced hospitalizations for suicide attempts but not with suicide deaths.[20] Several factors may explain this apparent paradox. First, substantial heterogeneity exists in CAPS service quality and implementation across Brazil, with one study in São Paulo city identifying 457 different mental health activities across just 10 centers.[21] Second, Brazilian mental health policy has historically prioritized access metrics over treatment effectiveness indicators.[21,30] Third, the weighted CAPS coverage index, as an aggregate measure, may mask the potential effects of specific CAPS modalities and their distinct associations with suicide. This is particularly relevant given that CAPSi specifically targets children and adolescents, the group in which we observed the sharpest percentage increase in suicide rates, yet its specific impact may be diluted within the overall coverage index. Fourth, the positive association we observed for psychiatrists in CAPS (β = 0.79) likely reflects reverse causality: regions with higher suicide burden may hire more professionals in response. These findings collectively suggest that coverage expansion and awareness campaigns alone are insufficient; quality improvement, standardized risk assessment protocols, and seamless integration with hospital-based acute care are essential.

The positive association between GDP per capita and suicide rates exemplifies the well-documented “happiness-suicide paradox” observed in high-income contexts.[14] Rather than suggesting that economic development itself increases suicide risk, this finding likely reflects two mechanisms. First, relative deprivation theory posits that frustration arising from social comparison in unequal societies drives suicide risk, a hypothesis strongly supported by

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Brazilian evidence linking the Gini index to municipal suicide rates.[15] High regional GDP can mask severe income inequality, making GDP a proxy for the true underlying risk factor: social fragmentation generated by inequitable development. Second, wealthier regions typically have more robust vital registration systems, potentially inflating apparent suicide rates relative to poorer regions with higher underreporting.[22,23] This ascertainment bias is particularly relevant in middle-income settings where surveillance capacity varies substantially across regions.

The 332% increase in suicide rates among female adolescents aged 10–14 years warrants urgent attention. This finding aligns with global trends documenting rising adolescent suicide rates, with particularly steep increases among females in multiple high- and middle-income countries.[3] In the United States, suicide by hanging and asphyxiation increased by 5.9% annually among female adolescents from 1999 to 2020, with firearm suicides rising sharply after 2007.[4] The observation that female adolescents showed higher rates than males in seven RRAS is highly anomalous and demands targeted etiological research. Previous Brazilian evidence has linked adolescent suicide rates to socioeconomic inequality, particularly among females.[31] Potential contributing factors, including changes in suicide methods, domestic violence exposure, and adolescent pregnancy, could not be examined in this ecological analysis but represent critical directions for future research.

Several limitations warrant consideration. First, as an ecological study, associations observed at the regional level cannot be inferred to apply at the individual level. However, our research question specifically concerns regional-level health system factors, making ecological analysis appropriate. Second, potential delays in consolidating 2022 mortality data, particularly for the municipality of São Paulo, and measures of service availability were proxy indicators that did not capture service quality, accessibility, or actual utilization. Third, differential underreporting of suicide across regions with varying vital registration capacity may have confounded associations with GDP.[22,23] However, this would bias toward the null for health service factors, suggesting our protective estimates may be conservative. Fourth, the 11-year study period partially overlaps with the COVID-19 pandemic, though 2020-2022 represented only three of eleven years analyzed.

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These findings carry important implications for suicide prevention policy in middle-income settings. First, strategies should prioritize strengthening psychiatric workforce capacity within the public health system and ensuring adequate acute psychiatric care through general hospital psychiatric units. Second, community mental health policy should shift focus from coverage expansion to quality metrics and standardized protocols for suicide risk assessment and management. Third, addressing income inequality may represent a distal but potent intervention for reducing population-level suicide burden. The geographic patterns identified, persistent high-risk clusters in inland regions, particularly among certain demographic groups, provide an evidence base for targeted resource allocation. In conclusion, suicide rates in São Paulo State rose substantially over the past decade, with psychiatric workforce availability and acute care capacity emerging as key modifiable protective factors. The alarming increase among young females and persistent regional disparities demand urgent, targeted prevention efforts.

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Disclosure

The authors declare no conflict of interest.

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Data availability statement

Data used in this study are publicly available from:

Tabulator of the State Department of Health (Tabnet SES-SP):

https://www.saude.sp.gov.br/links/informacoes-de-saude-tabnet

Social, economic, and demographic data for municipalities and regions of São Paulo State (SEADE Foundation):

https://tabnet.saude.sp.gov.br/deftohtm.exe?tabnet/populacao2.def

Mortality Information System (SIM, State Secretary of Health):

https://tabnet.saude.sp.gov.br/deftohtm.exe?tabnet/sim_ccd.def

2010 Brazilian Census population data:

https://datasus.saude.gov.br/populacao-residente

National Registry of Health Establishments (CNES) via Tabnet SES-SP:

https://www.saude.sp.gov.br/links/informacoes-de-saude-tabnet

National Registry of Health Establishments (CNES) via Ministry of Health (Tabnet DATASUS):

https://datasus.saude.gov.br/informacoes-de-saude-tabnet

Psychosocial Care Centers (CAPS) coverage from the São Paulo State Department of Health Indicator Matrix:

https://tabnet.saude.sp.gov.br/deftohtm.exe?tabnet/ind46_matriz.def

Author contributions

MCVN; JMS; MMS; RFD; JJM contribute to: Conceptualization, Data Curation, Investigation, Formal Analysis Writing – Original Draft and Writing – review & editing and EA contributes to Conceptualization, Formal Analysis Writing – Original Draft and Writing – review & editing. RFD and JJM also contributed to Supervision. All authors have read and approved the final version of this manuscript to be published.

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Supplementary Material

Spatiotemporal Patterns and Determinants of Suicide in a Brazilian State: An Eleven-Year Ecological Study

Figure S1. Age-Standardized Suicide Rate and CAPS Coverage Rate per 100,000 inhabitants, São Paulo State, 2012-2022……..……....……..……...1

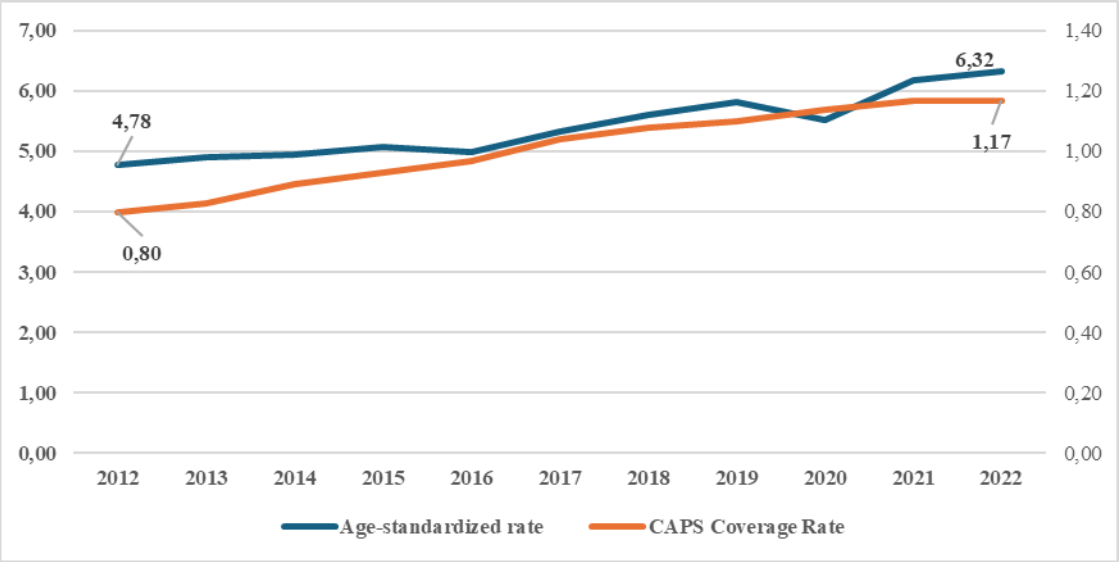
Table S1. Suicide Rate by Sex and Age Group per 100,000 inhabitants and percentage change, State of São Paulo, 2012 to 2022……...……..…….2

Table S2. Age-Standardized Suicide Rate per 100,000 inhabitants by Regional Health Care Networks (RRAS), by reference municipality and macro-region, State of São Paulo, 2022…….....…….3

Table S3. Annual Global Moran's I and p-values for suicide mortality across the 19 RRAS (2012-2022)……..……..……..…...4

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Figure S1. Age-Standardized Suicide Rate and CAPS Coverage Rate per 100,000 inhabitants, São Paulo State, 2012-2022



This graph presents the trends over time for the age-standardized suicide rate and the CAPS coverage rate in São Paulo State from 2012 to 2022. Suicide rates (blue line) and CAPS coverage rates (orange line) are both expressed per 100,000 inhabitants.

Table S1 Suicide Rate by Sex and Age Group per 100,000 inhabitants and percentage change, State of São Paulo, 2012- 2022

	Suicide Rate, Male Sex, by Age Group					Suicide Rate, Female Sex, by Age Group				
	10-14 years	15-19 years	20-39 years	40-59 years	60 years and over	10-14 years	15-19 years	20-39 years	40-59 years	60 years and over
2012	0.36	4.88	11.23	10.76	8.97	0.19	2.31	2.51	3.41	2.58
2013	0.80	4.06	12.72	10.61	9.08	0.57	1.70	2.33	3.28	2.21
2014	0.37	3.78	12.43	11.55	9.87	0.58	1.72	2.38	3.27	1.84
2015	0.63	5.13	12.22	10.95	11.45	0.39	2.51	2.86	2.87	2.16
2016	0.96	6.26	11.50	11.41	10.77	0.47	1.89	2.70	2.90	1.93
2017	0.78	6.32	12.37	11.79	11.49	0.95	2.05	3.03	3.17	2.10
2018	1.19	8.01	13.19	11.69	11.50	0.90	2.88	3.40	2.80	2.29
2019	0.81	8.82	14.19	12.10	10.23	1.48	2.72	3.43	3.21	1.76
2020	0.34	8.28	12.40	11.78	11.26	0.93	3.80	3.53	3.11	1.95
2021	0.49	8.01	14.61	13.28	11.79	1.25	3.51	3.62	3.59	2.31
2022	1.15	7.47	15.81	13.69	10.39	0.82	4.15	3.61	3.10	2.14
Percentage change	214.01	53.06	40.79	27.20	15.84	331.6	80.0	44.0	-9.1	-17.3

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Table S2 Age-Standardized Suicide Rate per 100,000 inhabitants by Regional Health Care Networks (RRAS), by reference municipality and macro-region, State of São Paulo, 2022

RRAS	Standardized rate
RRAS 01 Santo André- South-Southeast	5.35
RRAS 02 Guarulhos- South-Southeast	5.64
RRAS 03 Franco da Rocha- South-Southeast	7.30
RRAS 04 Cotia- South-Southeast	3.84
RRAS 05 Osasco- South-Southeast	6.10
RRAS 06 São Paulo- South-Southeast	1.76
RRAS 07 Santos- South-Southeast	8.26
RRAS 08 Sorocaba- South-Southeast	9.98
RRAS 09 Bauru- Central-West	10.39
RRAS 10 Marília- Central-West	9.98
RRAS 11 Presidente Prudente- Central-West	9.65
RRAS 12 São José do Rio Preto- Northwest	9.33
RRAS 13 Barretos- Northwest and Northeast	9.08
RRAS 14 Piracicaba- Central East	8.41
RRAS 15 Campinas- Central East and Northeast	7.88
RRAS 16 Jundiaí- Central-East	8.19
RRAS 17 Taubaté- South-Southeast	6.46
RRAS 18 Araraquara- Northeast	11.04
RRAS 19 Araçatuba- Northwest	8.40

Table S3 Annual Global Moran's I and p-values for suicide mortality across the 19 RRAS (2012-2022)

Year	Moran's I	P
2012	0.021	0.288
2013	0.160	0.059
2014	0.582	<0.001
2015	0.361	0.001
2016	0.353	0.002
2017	0.434	<0.001
2018	0.425	<0.001
2019	0.465	<0.001
2020	0.401	0.001
2021	0.498	<0.001
2022	0.527	<0.001

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