

ORIGINAL ARTICLE



Time series analysis of the suicide attempts assisted by firefighters from 2017 to 2021 in São Paulo, Brazil

Análise de séries temporais das tentativas de suicídio atendidas por bombeiros de 2017 a 2021 em São Paulo, Brasil

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ABSTRACT

Objective: This study aimed to analyze the time trends of suicide attempts assisted by the Fire Department of the Military Police of the State of São Paulo (Corpo de Bombeiros da Polícia Militar do Estado de São Paulo — CBPMESP) from 2017 to 2021, between sexes. **Methods:** This is an ecological study of 11,435 suicide attempts assisted by CBPMESP calls from January 2017 to December 2021. Three seasonal auto-regressive integrated moving average with exogenous (SARIMAX) models were adjusted considering total population, only men, and only women. **Results:** The total occurrences of suicide attempts were stationary in the prepandemic period but had an increased growth pattern after the pandemic began. This trend was higher among men, due to (1) lower assistance of suicide attempts during early pandemic than in the prepandemic period and (2) significant increased assistance after the beginning of vaccination against COVID-19, followed by a decrease, but with a tendency to increase, in the long-term pandemic. **Conclusion:** Our results indicate a growth in the long-term suicide attempts during COVID-19. The beginning of vaccination was not considered significant in the reduction of CBPMESP attendances. These results corroborate the need for a multisectoral national suicide prevention strategy to mitigate the effects of the pandemic on mental health in the State of São Paulo.

Keywords: Suicide attempted. Emergency. Sex. COVID-19.

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INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has affected the countries of the world differently. Evidence shows that each country faced different consequences according to public health and adopted health measures¹. In countries with inequalities, including Brazil, the impacts caused by socioeconomic disparity, political and financial instability, demographic density, and low investment in science and technology² have expanded the effects of the pandemic on people's lives and finances and on the country's reputation abroad³⁻⁵.

The integration of mental health policies into health measures is currently being discussed to avoid negative consequences of future pandemics¹. The effects of social isolation and quarantine during the COVID-19 pandemic on mental health are greatly similar to those of traumatic events⁶. Studies suggest that pandemic-related difficulties and sufferings do not necessarily increase suicide-related deaths in short term⁶. However, a meta-analysis with 308,596 participants assessed the hypothesis that these factors increase suicidal behaviors (e.g., suicidal ideation, suicide attempts, and self-mutilation) and found that about 2.4 out of 20 individuals in the general population experienced suicidal ideation during the COVID-19 pandemic⁷. Rates of suicidal behavior increased during the pandemic, especially among young people and women from nondemocratic countries.

Several studies have reported on trends of suicides and suicide attempts in the world during the pandemic. These studies ranged from information on the early pandemic in specific countries⁸⁻¹⁴, trend analyses of over 6 months in specific countries¹⁵⁻¹⁹, and trend analyses in multiple countries^{20,21}. Others analyzed trends of emergency calls in Japan²² and information from chat-based crisis hotlines in Israel²³.

In Brazil, a cross-sectional study²⁴ found results on the increased risk of suicide in a psychosocial public healthcare center in southern Brazil. However, results for the State of São Paulo are still incipient. This state has about 45 million inhabitants and 645 municipalities, corresponding to 31.5% of all national gross domestic product (GDP). Moreover, the State was a pioneer in vaccination against COVID-19, and about 90.0% of its population had the complete vaccination schedule in June 2022²⁵.

The State of São Paulo is home to the most populous city in Latin America, the city of São Paulo, which has marked social inequalities in mortality from COVID-19, that is, higher mortality rates for individuals with lower schooling, higher household clustering, lower income, and higher concentration of subnormal areas⁵. The city has a higher prevalence of mental disorders than other cities worldwide, which include anxiety disorders (19.9%), mood disorders (11%), impulse control disorder (4.3%), and substance use (3.6%)²⁶.

Studies show that vaccination campaigns in some countries resulted in significant improvements in mental health²⁷ and were associated with declines in perceived risks of infection, hospitalization, and death²⁸. We hypothesized that rates of suicide attempts increased in São Paulo during the COVID-19 pandemic and decreased after the start of vaccination, considering that the state's high prevalence of mental disorders is associated with the effects of social isolation and quarantine on mental health. To verify this hypothesis, this study analyzed the time trends of suicide attempts assisted by the Fire Department of the Military Police of the State of São Paulo (Corpo de Bombeiros da Polícia Militar do Estado de São Paulo — CBPMESP), from 2017 to 2021, between sexes. CBPMESP is one of the institutions responsible for the emergency care of suicide attempts in the State of São Paulo.

METHODS

Design and population

This is an ecological study and a time series analysis of the suicide attempts assisted by CBPMESP, seeking to assess the impact of the COVID-19 pandemic on these attempts. In total, 11,435 attempted suicide calls responded by the CBPMESP from January 2017 to December 2021 were analyzed. Data on the suicide attempt calls were obtained from the Operational Data System (SDO) of CBPMESP's Operational Coordination. Services are considered closed after the call response information are filled. The firefighter fills such information as part of the emergency response service in the same shift of the occurrence within a maximum of 3 days from the initial registration. The Secretariat of Public Security reviews all data on technical and operational services provided by CBPMESP.

Emergency calls to the Corpo de Bombeiros da Polícia Militar do Estado de São Paulo

CBPMESP receives assistance requests to victims of suicide via emergency calls (193). Following the call, firefighters are dispatched for on-site assistance, where they can encounter nonfatal or fatal suicide attempts. In case of a fatal suicide attempt (when death is verified by a medical doctor or by a firefighter), the victim is referred for identification and forensics under Public Security. In case of a nonfatal suicide attempt, the firefighter acts to rescue the individual. Once rescued, victims are immediately referred to the health services in their area of coverage under the Department of Health.

Data linearization

Several entries in the database may consist of more than one emergency call (193) for the same case, given the time elapsed before the Fire Department arrives, and other

factors related to the context of suicide attempt calls. The database obtained for this research thus had more than one entry for each call of attempted suicide.

A linearization process was conducted by classifying the identification (id) of the victim and temporal variables (i.e., year, month, day of the week, and initial time of the call) to analyze data on the calls. Data lines were then aggregated by "id" and new variables dependent on this aggregation were measured, especially the length of victim assistance. This was measured by the difference, in minutes, between the time of the assistance of the first committed firefighter vehicle and the maximum final hour. Other variables were related to the first line by "id". This procedure mainly determined the period of the day when the assistance began (early morning, morning, afternoon, and night) and allowed us to count the number of suicide attempts per month, year, and sex.

Variables

For analyses, the suicide attempts were used as outcome variable. The COVID-19 cases data were obtained from the Brazilian Ministry of Health and used as endogenous variable²⁹. To describe the occurrences of suicide attempts, we considered the "Prepandemic Period": from January 2017 to February 2020; the "Pandemic Prevaccination Period": from March 2020 to January 2021; and the "Postvaccination Period": from February 2021 to December 2021. The independent variables included were sex (male and female); age group (≤ 7 , 8–14, 15–29, 30–59, and ≥ 60); suicide attempt call (death and rescue); and attempt details (hanging, jumping, poisoning, white gun, firearm, and jumping in front of a car).

Two "dummy" variables were created to assess the effect of the pandemic on the time series, in the State of São Paulo, namely, (1) indicator of the beginning of the COVID-19 pandemic, categorized with value "0" from January 2017 to January 2020 (prepandemic) and with value "1" from February 2020 to December 2021 (after the first COVID-19 case), and (2) indicator of the beginning of vaccination, categorized with value "0" from January 2017 to January 2021 (prevaccination) and value "1" from February 2021 to December 2021 (after vaccination began).

Time window

A 60-month time window (January 2017 to December 2021) was used, comprising the three years before the first case of COVID-19 in Brazil was notified, and the last month of data on suicide attempts provided by CBPMESP.

Statistical analyses

We performed a descriptive analysis of the sample characteristics and period accordingly, using the Pearson's chi-square (χ^2) test for comparisons. All $p < 0.05$ values were considered statistically significant. The statistics presented are percentage and absolute frequency.

Three SARIMAX models were adjusted³⁰ to assess our hypothesis, considering the total population, only men, and only women. The chosen methodology allows modeling the time series, capturing trends and seasonality, as well as the insertion of exogenous factors, such as intervention variables. The Box-Cox transformation³¹ was performed in each series to meet the model's assumptions (stationarity and normality), and so differences were assessed. An interactive method was used to identify the best fit of the model without considering intervention variables, based on the significance of parameters and information criteria such as Akaike Information Criterion (AIC). A parameterization was then defined for each time series (models A, B, and C). Model A is estimated without intervention variables, model B with the pandemic variable, and model C with the vaccination variable. The likelihood ratio test was performed to assess changes in the trends of the time series, analyzing the statistical significance of the intervention, i.e., the pandemic and the beginning of vaccination. The test consists of comparing the fit of the models with and without the intervention, identifying what best explains the historical series. All tests were evaluated at 5% significance and using the R programming language³².

Ethical considerations

The Research Ethics Committee of the Universidade Federal de São Paulo (protocol 2466300120, March 5, 2020) approved this study.

RESULTS

From January 2017 to December 2021, CBPMESP recorded 11,435 occurrences of suicide attempts, of which 7,016 were attempted by men, 4,397 by women, and 22 by indeterminate sex. Suicide attempt occurrences were 6,322 in Prepandemic Period, 2,296 in Pandemic Prevaccination Period, and 2,817 in Postvaccination Period. From February 2020 to December 2021, the State of São Paulo recorded 4,456,108 cases of COVID-19. In all periods, men were more prevalent in suicide attempts, and there was a higher prevalence of rescues as well (Table 1).

The total occurrences of suicide attempts were stationary in the prepandemic period but had an increased growth pattern after the pandemic began. This pattern was maintained after vaccination started (Figure 1). The decomposition of the trends of each series (total, men, and women) indicated an inflection point over time with changes in the growth trend. Visual inspection could not identify a clear trend of seasonality in the time series between the years, because there is no clear pattern that is repeated. It is necessary to test the parameterization in the models (Figure 2). However, the number of occurrences assisted by CBPMESP at the end of each year slightly increased.

Table 2 shows the model results. All series indicated significant seasonality. Moreover, we identified diverse ef-

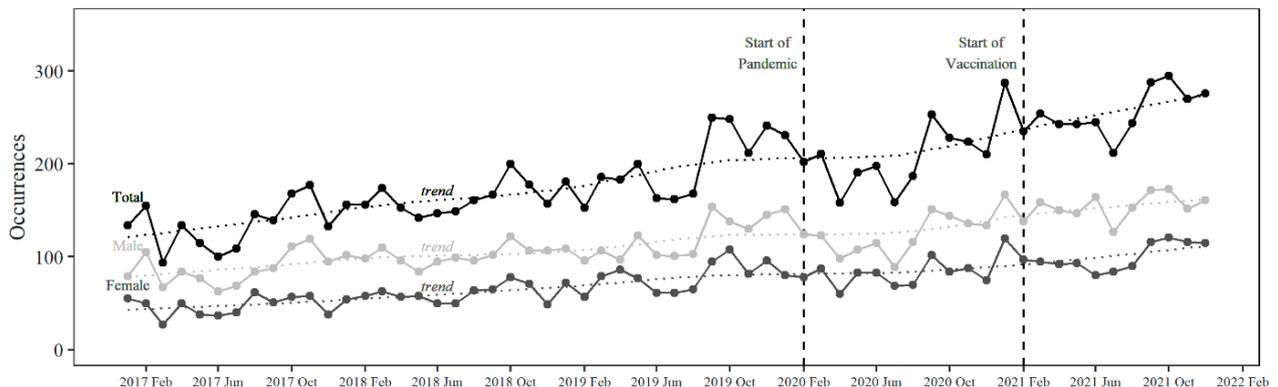
Table 1. Characteristics of suicide attempt calls responded by the Corpo de Bombeiros da Polícia Militar do Estado de São Paulo, from 2017 to 2021, State of São Paulo (n=11,435).

	Prepandemic period % (n)	Pandemic prevaccination period % (n)	Postvaccination period % (n)	p-value*
Total	55.3 (6,322)	20.1 (2,296)	24.6 (2,817)	
Sex*				
Male	63.7 (2,478)	60.2 (1,380)	60.2 (1,693)	0.003
Female	36.3 (1,414)	39.8 (913)	39.8 (1,120)	
Age group (years)				
≤7	0.3 (14)	0.1 (1)	0.2 (6)	0.134
8-14	1.8 (86)	1.8 (42)	1.7 (48)	
15-29	38.3 (1,803)	41.1 (941)	40.3 (1,134)	
30-59	54.4 (2,257)	51.4 (1,177)	52.1 (1,467)	
≥60	5.2 (244)	5.6 (127)	5.7 (160)	
Suicide attempt call†				
Death	16.2 (990)	14.5 (327)	13.5 (377)	0.003
Rescue	83.8 (5,134)	85.5 (1,934)	86.5 (2,409)	
Attempt details				
Hanging	14.8 (934)	14.0 (321)	14.8 (415)	0.088
Jumping	1.7 (108)	1.3 (30)	1.1 (32)	
Poisoning	6.4 (407)	5.4 (123)	5.9 (167)	
White gun	21.2 (1,336)	20.9 (480)	19.6 (552)	
Firearm	13.5 (854)	14.2 (327)	15.1 (425)	
Jumping in front of a car	42.4 (2,679)	44.2 (1,015)	43.5 (1,226)	

Operational Data System. Statistics presented are percentage and absolute frequency. Prepandemic period: from January 2017 to February 2020, Pandemic prevaccination period: from March 2020 to January 2021, and Postvaccination period: after February 2021; *Pearson's chi-square (χ^2); †There are 22 missing - indeterminate sex.

a. Suicide attempts

jan2017-dec2021, São Paulo



b. COVID-19 cases

feb2020-dec2021, São Paulo

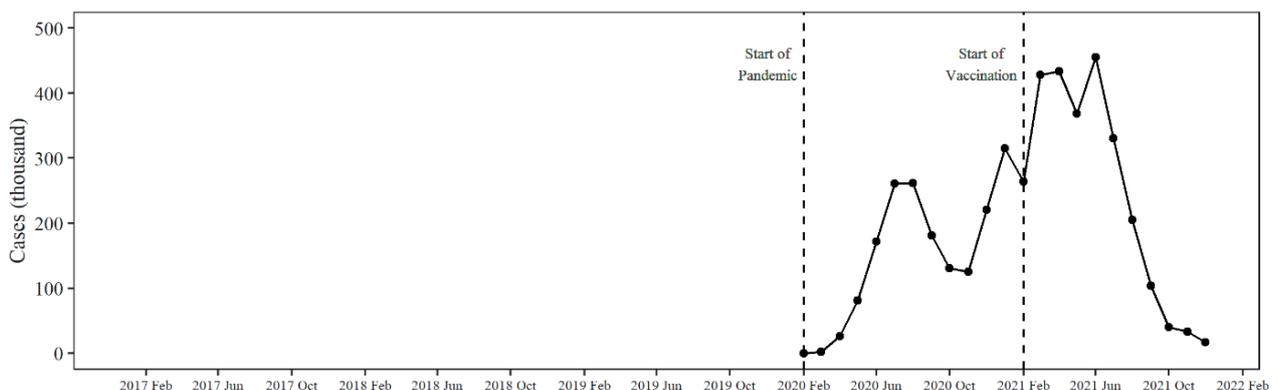


Figure 1. Time series of occurrences of suicide attempts attended by the Fire Department and cases of COVID-19, State of São Paulo (January 2017 to December 2021).

fects of the pandemic and vaccination and different parameterizations among all models, indicating changes in the temporal evolution of the number of suicides attempted be-

tween sexes. The likelihood ratio test allowed verifying that the pandemic significantly influenced the time series of the number of males and total suicide attempts and that the

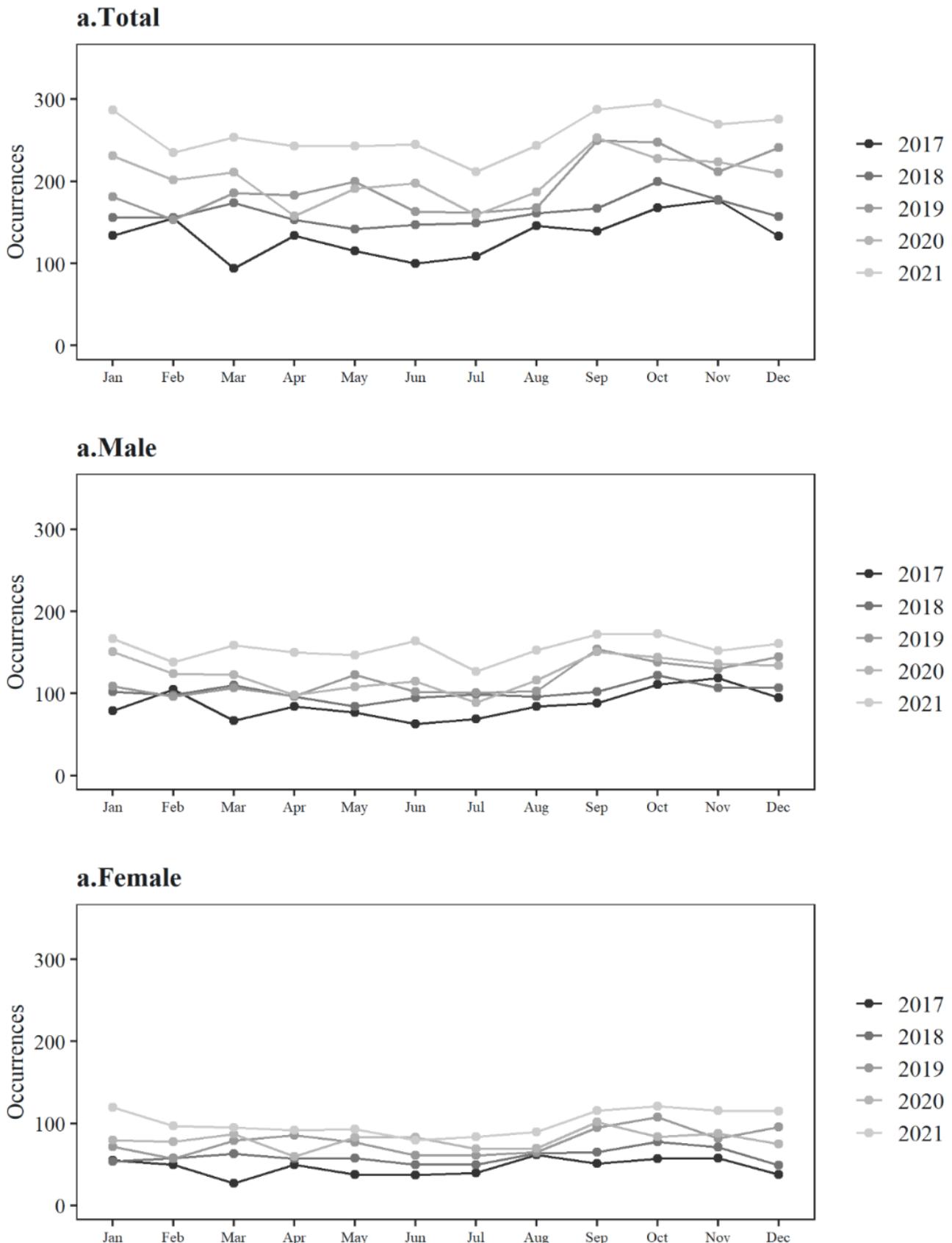


Figure 2. Seasonality of occurrences of suicide attempts attended by the Fire Department according to month, sex, and year, State of São Paulo (January 2017 to December 2021).

vaccination is not significant for both sexes. The negative coefficient showed a tendency of inverse growth of suicide attempts, indicating a deceleration of the series for men. Only male series had statistical significance for vaccination. The positive coefficient indicated a trend of increased occurrences, even after the beginning of immunization in the State of São Paulo. Model B had the best fit, indicated by the AIC, demonstrating that it is most adequate to represent the structure of the data series.

DISCUSSION

Our study is the first to show the annual trends of suicide attempts assisted by CBPMESP emergency teams during 2 years of COVID-19 pandemic in the State of São Paulo, Brazil. Suicide attempts were stationary in the prepandemic period and showed an increased growth pattern for all occurrences after the beginning of the pandemic. This trend was higher among men, due to (1) lower assistance of suicide attempts during early pandemic than in the prepandemic period and (2) significantly increased assistance after the beginning of the vaccination against COVID-19 followed by a decrease, but with a tendency to increase, in the long-term pandemic.

Regarding the trend of increasing suicide attempts in the State of São Paulo from 2017 to 2021, our results corroborate with a meta-analysis of 54 studies⁷ and with a study by Habu et al., in Japan²². These showed significantly increased suicide attempts and related emergency dispatches. The decreased number of assistances to suicide attempts in São Paulo corroborates with findings described by emergency teams, such as in Michigan⁹, USA, where emergency call as-

sistances decreased in 39.9% during the first phase of the COVID-19 pandemic compared to previous years.

Evidence described an increased incidence of suicide attempts, especially among women⁷. However, in the State of São Paulo, men had a higher prevalence of suicide attempts in long term. This variability over suicide ideation has already been described among high- and middle-income countries²¹, with a converging pattern to an increased prevalence of suicide attempts during the COVID-19 pandemic. However, in Peru, another country in South America, the suicide curve for men also increased after a period of lockdown, indicating how social context affects the occurrences³³.

Studies on the early pandemic had already discussed the need for long-term monitoring of the consequences of the pandemic⁷. Most indicated a stationary model or even case reduction⁸, similarly to this study. To discuss the long-term events in the State of São Paulo, we hypothesized that two remarkable moments of the government's response to the pandemic would address the structural inequities of health, social context, and decreased suicide attempts: the approval of emergency economic measures for the whole country by the Ministry of Citizenship in March 2020 and the beginning of vaccination in February 2021. Emergency economic measures aimed at the social protection of vulnerable Brazilians during the pandemic included the suspension of deadlines for registration inquiry and review, blockages, suspensions and cancellations of benefits and other processes of the Bolsa Família, and the approval of emergency financial assistance, a benefit of R\$ 600.00 (USD 119.66) provided to ensure the population with a minimum income.

Between March and April 2020, the number of suicides attempts among men decreased after the government be-

Table 2. Seasonal auto-regressive integrated moving average with exogenous models with the best performance to explain the time series of occurrences of suicide attempts attended by Corpo de Bombeiros da Polícia Militar do Estado de São Paulo, according to the evaluation of interventions (pandemic and vaccination), State of São Paulo (January 2017 to December 2021).

Model	Variable	Total			Men			Women		
		ARIMA (0,1,1) (1,0,0) [12]			ARIMA (0,1,1) (1,0,0) [12]			ARIMA (0,1,1) (1,0,0) [12]		
		Estimate	Standard error	p-value	Estimate	Standard error	p-value	Estimate	Standard error	p-value
Model A	MA1	-0.746	0.201	<0.001	-0.554	0.115	<0.001	-0.719	0.096	<0.001
	SAR1	0.452	0.126	<0.001	0.482	0.122	<0.001	0.319	0.147	<0.001
	Constant	0.406	0.186	0.033						
	AIC	394.79			532.76			203.82		
Model B	MA1	-0.694	0.093	<0.001	-0.640	0.102	<0.001	-0.734	0.086	<0.001
	SAR1	0.551	0.127	<0.001	0.529	0.123	<0.001	0.358	0.153	<0.001
	Dummy pandemic	-8.680	3.870	<0.001	-32.1	13.2	0.018	-0.900	0.819	<0.001
	AIC	393.26			529.84			204.68		
Model C	MA1	-0.706	0.140	<0.001	-0.648	0.156	<0.001	-0.750	-0.750	<0.001
	SAR1	0.538	0.129	<0.001	0.533	0.125	<0.001	0.343	0.151	<0.001
	Dummy vaccination	6.300	5.430	0.251	21.7	19.0	0.258	0.597	0.919	<0.001
	AIC	396.26			533.63			205.44		
Likelihood ratio test (A vs. B)		χ^2		p-value	χ^2		p-value	χ^2		p-value
Pandemic intervention (A vs. B)		1.524		<0.001	4.922		0.026	1.144		0.284
Vaccination intervention (A vs. C)		1.473		<0.001	1.125		0.288	0.382		0.536

MA: moving average; SAR: SARIMAX model; AIC: Akaike information criterion.

gan to pay social benefits; however, this decrease did not continue throughout the year. Moreover, suicide attempts increased in 2021 even after a vaccination schedule was implemented in the State of São Paulo. These differences can be discussed from two perspectives. First, the perspective of barriers in access to health services for COVID-19. The city of São Paulo, the largest city in Latin America and the State of São Paulo, suffered from social inequalities during the pandemic, with higher mortality rates among black and mixed-race men (>81 and >45%, respectively) and young/older adults, associated with a high prevalence of mental disorders²⁶. Second, of the prominent social gradient caused by COVID-19 in this region, that is, socioeconomic indicators worsened with increased mortality rates from COVID-19⁵.

Discussing deaths of despair in this context is essential since the pandemic created a chronic situation of economic insecurity in a state with unequal responses to the event and evident inequities. Deaths from despair reflect the loss of a long-term lifestyle, reinforcing the hypothesis that self-destructive health behaviors, including suicide, are associated with social and economic factors underlying the context of life^{34,35}. Arena et al.³⁶ stated that timely structural social interventions were needed so that countries such as the United States and the United Kingdom would not be forced to deal with other health causes, including suicides, deaths from despair, overdose, and food insecurity. Unfortunately, our results indicate increased suicide attempts as a long-term reflection of prolonged period of confinement, worsening of the financial crisis, postponement of several personal plans, cumulative effect of losses of lives, and additional barriers to accessing mental health services, among others, health and social inequities in the State of São Paulo during the COVID-19 pandemic.

Limitations

Our work has limitations. This is a study with secondary data, collected while firefighters were on-site. Information collected about socioeconomic and health data, including social vulnerabilities, mental disorders, and other relevant information to understand the biopsychosocial conditions of the victims, are not part of the call reports. Moreover, CBPMESP has no further information on the victims after they are taken to the health services located where the attempt took place. Our data could, therefore, have underestimated the occurrence of fatal suicide attempts.

The increased number of suicide attempts assisted by CBPMESP directly affects the rates of Brazilian suicide mortality. Our results indicate an increase in the long-term suicide attempts during COVID-19. The beginning of vaccination was not considered significant in the decrease in CBPMESP attendances. These results corroborate the need for a multisectoral national suicide prevention strategy to mitigate the effects of the pandemic on mental health in the State of São Paulo.

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RESUMO

Objetivo: Analisar as tendências temporais das tentativas de suicídio atendidas pelo Corpo de Bombeiros da Polícia Militar do Estado de São Paulo (CBPMESP) de 2017 a 2021, entre os sexos. **Métodos:** Estudo ecológico de 11.435 tentativas de suicídio atendidas pelo CBPMESP de janeiro de 2017 a dezembro de 2021. Três modelos autorregressivos integrados e de médias móveis sazonais multiplicativos com variáveis explicativas (SARIMAX) foram ajustados considerando-se a população total, apenas homens e apenas mulheres. **Resultados:** As ocorrências totais de tentativas de suicídio foram estacionárias no período pré-pandemia, mas tiveram um padrão de crescimento aumentado após o início da pandemia. Essa tendência foi maior entre os homens, seguindo o seguinte padrão: (a) menor ocorrência de tentativas de suicídio entre homens no início da pandemia quando comparado ao período pré-pandemia; e (b) aumento significativo das ocorrências após o início da vacinação contra COVID-19 no Estado de São Paulo, seguido de queda, mas com tendência de aumento na pandemia de longo prazo. **Conclusão:** Nossos resultados indicam aumento nas tentativas de suicídio em longo prazo durante a COVID-19. O início da vacinação não foi considerado significativo na diminuição dos atendimentos do CBPMESP. Esses resultados corroboram a necessidade de uma estratégia nacional multissetorial de prevenção ao suicídio para mitigar os efeitos da pandemia na saúde mental no Estado de São Paulo.

Palavras-chave: Tentativa de suicídio. Emergência. Sexo. COVID-19.

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