

## ORIGINAL ARTICLE

# Suicide after and during the COVID-19 pandemic in Mexico City

Guilherme Borges,<sup>1</sup>  José Angel Garcia,<sup>2</sup> Mark Sinyor,<sup>3,4</sup> Matthew J. Spittal,<sup>5</sup> Oliva Lopez-Arellano,<sup>6</sup> Jane Pirkis<sup>5</sup>

<sup>1</sup>Instituto Nacional de Psiquiatria Ramon de la Fuente, Mexico City, Mexico. <sup>2</sup>Centro de Investigación y Docencia Económicas, Mexico City, Mexico. <sup>3</sup>Department of Psychiatry, Sunnybrook Health Sciences Centre, Toronto, Canada. <sup>4</sup>Department of Psychiatry, University of Toronto, Toronto, Canada. <sup>5</sup>Centre for Mental Health, Melbourne School of Population and Global Health, University of Melbourne, Melbourne, VIC, Australia. <sup>6</sup>Mexico City Ministry of Health, Mexico City, Mexico.

**Objectives:** Prior research has indicated that no increase in suicides occurred immediately following the declaration of the COVID-19 emergency in Mexico City. Here we examine longer-term overall suicide trends and trends according to basic demographic groups.

**Methods:** We used interrupted time-series analysis to model trends in monthly suicides before COVID-19 (January 1, 2010 to March 31, 2020), comparing the expected number of suicides both overall and according to age and sex with the observed number of suicides for the remainder of 2020 (April 1, 2020 to December 31, 2020).

**Results:** There was an overall increase in suicides during the first 9 months of the pandemic, with a rate ratio of 2.07 (1.86-2.31). The increase began in the early months of the pandemic and remained stable and high after June 2020. Men and women, younger people (< 45) and older people (≥ 45) were affected. The increase was especially high among older women (RR = 3.33; 2.04-5.15).

**Conclusions:** The increase in suicides in Mexico City is worrying and highlights the need to strengthen economic development, mental health, and well-being programs. Suicides among older women should be closely monitored. There is an urgent need to expand primary health care services to include robust suicide prevention and treatment options.

**Keywords:** Suicide; Mexico City; COVID-19; epidemiology

## Introduction

On March 30, 2020, all non-essential activities were suspended in Mexico due to the COVID-19 pandemic, and on March 31, a national emergency was declared. Mexico, a country with almost 130 million people, has since suffered a great deal as a result of the pandemic. By December 31, 2020, Mexico had reported more than 140,000 deaths from COVID-19.<sup>1</sup> Mexico City, the country's capital and largest city, with some 9.2 million inhabitants, suffered the greatest number of COVID-19-related deaths during this period (29,767 deaths by the end of 2020).<sup>2</sup>

Excess mortality data associated with the pandemic in Mexico is stark.<sup>3,4</sup> Since the pandemic began, Mexicans, as a group, have shown a particular susceptibility to death from COVID-19 due to comorbid conditions. Contributors to this excess mortality include diabetes and hypertension, which are associated with the high prevalence of overweight in the Mexican population,<sup>5</sup> as well as respiratory diseases, which are associated with the high

prevalence of tobacco consumption and dependence<sup>6,7</sup> in the country. While initial scientific attention was understandably focused on the large excess mortality due to COVID-19 itself, to understand the full context it is also important to analyze the pandemic's potential effects on other causes of death. Its impact on suicide is of particular relevance because suicide is known to be associated with traumatic events, and suicide rates have increased in the context of large natural disasters like earthquakes and other recent epidemics.<sup>8-10</sup> Therefore, the possible link between COVID-19 and suicide requires investigation.

Early during the COVID-19 pandemic, a group of international researchers called attention to the possibility of increased suicide rates but noted that such an increase was not inevitable.<sup>11</sup> It was not until recently, however, that robust data on changes in suicide rates during the pandemic were available at scale. Our own international study of 21 countries (including 16 high income and five upper-middle income countries) concluded that, after reviewing data from the first few months of the pandemic, "there does not appear to have been an increase in

suicides since the pandemic began.”<sup>12</sup> In particular, early data did not indicate an increase in suicides in Mexico City. It was beyond the scope of that study to examine the possible longer-term impact of COVID-19 on suicide, but we did identify a small number of locations where suicides increased as 2020 progressed<sup>10</sup> including Japan, where early reductions in suicide were followed by longer-term increases.<sup>13</sup>

It was also beyond the capacity of our study to perform sub-group analyses.<sup>12</sup> This is important because trends may differ for different groups. Again, taking Japan as an example, the apparent more recent effect of COVID-19 on suicide was not uniform, with the largest increase found among young women (< 40 years of age).

Here, we aim to go beyond our initial inquiry with a more comprehensive analysis of the association between the COVID-19 pandemic and suicides in Mexico City,<sup>12</sup> examining longer-term patterns of suicide and potential differential effects according to basic demographic groups (sex and age).

## Methods

### *Data sources*

To determine suicide trends between January 2010 and December 2020, we sourced monthly suicide counts, by age and sex, for Mexico City from cause-of-death records in the main Mexican statistical bureau (Instituto Nacional de Estadística y Geografía).<sup>14,15</sup> Suicides were identified by ICD-10 codes X60-X84.

### *Statistical analyses*

We calculated the mean number of monthly suicides before (January 1, 2010 to March 31, 2020) and during (April 1, 2020 to December 31, 2020) the pandemic in Mexico City for the total population and according to age and sex subgroups. The subgroups were men, women, people aged < 45 years, people aged  $\geq$  45 years, and the four-corresponding age-sex strata. We plotted trends over time for each of these groups along with a moving average filter (averaged over the prior and following 2 months).

As with our earlier study,<sup>12</sup> we used time-series analysis with adjustments for time trends and seasonality to model trends in monthly suicides before the COVID-19 pandemic.<sup>16</sup> We did this by first estimating the baseline trend in suicides using the pre-pandemic data. This pre-pandemic model was then used to estimate the expected trend in suicides during the COVID-19 period (April 1, 2020 to December 31, 2020) assuming the pandemic had not occurred. This was our counterfactual model. We then compared this expected number with the observed number during the same period by calculating a rate ratio (RR) and its 95%CI. The RR was defined as the expected number of suicides divided by the observed number of suicides, with standard error defined as 1 divided by the square root of the observed number of suicides. We followed this modelling strategy for the time-series of total suicides and the above-defined subgroups.

The models were fitted using Poisson regression and accounted for possible over-dispersion using a scale parameter set to the model's  $\chi^2$  value divided by the residual degrees of freedom. To account for the possibility that the relationship between suicides and time may be non-linear (i.e., the suicide rate not being constant over time), we modelled the effect of time as a non-linear predictor. We did this by fitting fractional polynomials to the data. Fractional polynomials allow for greater flexibility than linear and quadratic functions, which are limited in the range of curves that can be fit to the data. They also allow for logarithmic functions and for powers to be repeated. Thus, we fit fractional polynomial models to each time series using two powers. This allowed 44 different models of the data, with the best fitting selected. Seasonality was accounted for with Fourier terms (pairs of sine and cosine functions).<sup>16</sup> This allowed for possible short-term, periodic trends in the data.

To better understand the cumulative effects of the pandemic on suicide across the total population, we also performed a month-by-month analysis for the pandemic epoch spanning April 1, 2020 (the 1st month into the pandemic) to December 31, 2020 (9 months into the pandemic). This permitted us to closely inspect how different periods in the pandemic affected (or not) suicide mortality in 2020. Thus, we could also determine whether a particular month produced (or not) a sharp increase in suicide mortality and whether it decreased thereafter. To do so, we compared the cumulative number of suicides up to each month with the expected number, and again calculated RRs to estimate the difference between these two values. All analyses were performed in Stata (version 16.1).

### *Ethics statement*

Our analysis used available data, without individual identifiers. The National Institute of Psychiatry ethics committee approved this study. The data provided to the first author (GB) lacked personal identifiers, and the analysts (JAG and MJS) only had access to a limited dataset that contained the data in tabular format. This dataset is included in Supplementary Material S1, available online-only.

## Results

Table 1 shows a summary of the number of suicides in the pre-COVID-19 period (123 months) compared with those during the COVID-19 period (9 months). For the total population, the mean number of suicides increased from 30.4 to 37.8 per month. Differences were apparent when we analyzed suicides by age/sex groups, with all sub-groups showing higher mean numbers of suicides during the pandemic period.

Figure 1 shows time series plots of suicide counts in Mexico City since January 2010 (overall, by sex, by age group, and finally by sex/age group). Starting with the total population at the top of this figure, the pre-pandemic data demonstrate a strong downward trend beginning in 2015-2016, followed by an upward trend beginning in

**Table 1** Mean number of suicides per month, Mexico City

Group	Pre-COVID <sup>†</sup>	COVID <sup>‡</sup>
Total population (years old)	30.4 (9.4)	37.8 (8.7)
≥ 45	7.9 (3.4)	10.8 (4.1)
< 45	22.5 (7.3)	27.0 (6.6)
Men (years old)	23.7 (7.9)	29.8 (8.6)
≥ 45	6.5 (3.2)	8.8 (3.7)
< 45	17.2 (6.2)	21.0 (6.9)
Women (years old)	6.6 (2.9)	8.0 (2.1)
≥ 45	1.6 (1.3)	2.2 (0.8)
< 45	5.3 (2.6)	6.0 (1.9)

Data presented as mean number of suicides per month (SD).

<sup>†</sup> January 1, 2010 to March 31, 2020, n = 123 months.

<sup>‡</sup> April 1, 2020 to December 31, 2020, n = 9 months.

early 2019. The data also display evidence of seasonality, as well as age and sex differences, with more suicides among young people, young men in particular.

Figure 2 shows the summary results of our Poisson models (see Table S1, available as online-only supplementary material, for full results). For the total population, there was a 107% increase in suicides during the first 9 months of the pandemic (RR = 2.07, 95%CI 1.86-2.31), an excess of 176 suicides. When we inspected sex and age groups, the main results were that the increase was most prominent in older women (RR = 3.33, 95%CI 2.04-2.24). Younger women were not affected (RR = 1.29; 0.97-1.68), and both younger and older men were affected (joint RR = 2.21, 95%CI 1.96-2.50).

Figure 3 presents the evolution of RR by cumulative monthly period. The total number of suicides began increasing immediately after the 1st month of the pandemic (April 2020), peaked in June and remained high for the rest of 2020. While some small monthly changes occurred in RR estimates, the suicide deaths were generally double the number expected during most of the following months.

## Discussion

This study's key finding is that suicide increased during the first 9 months of the pandemic in Mexico City, particularly among older women and men of all ages. The total number of suicides had doubled by June 2020 and remained high thereafter (up to December 2020).

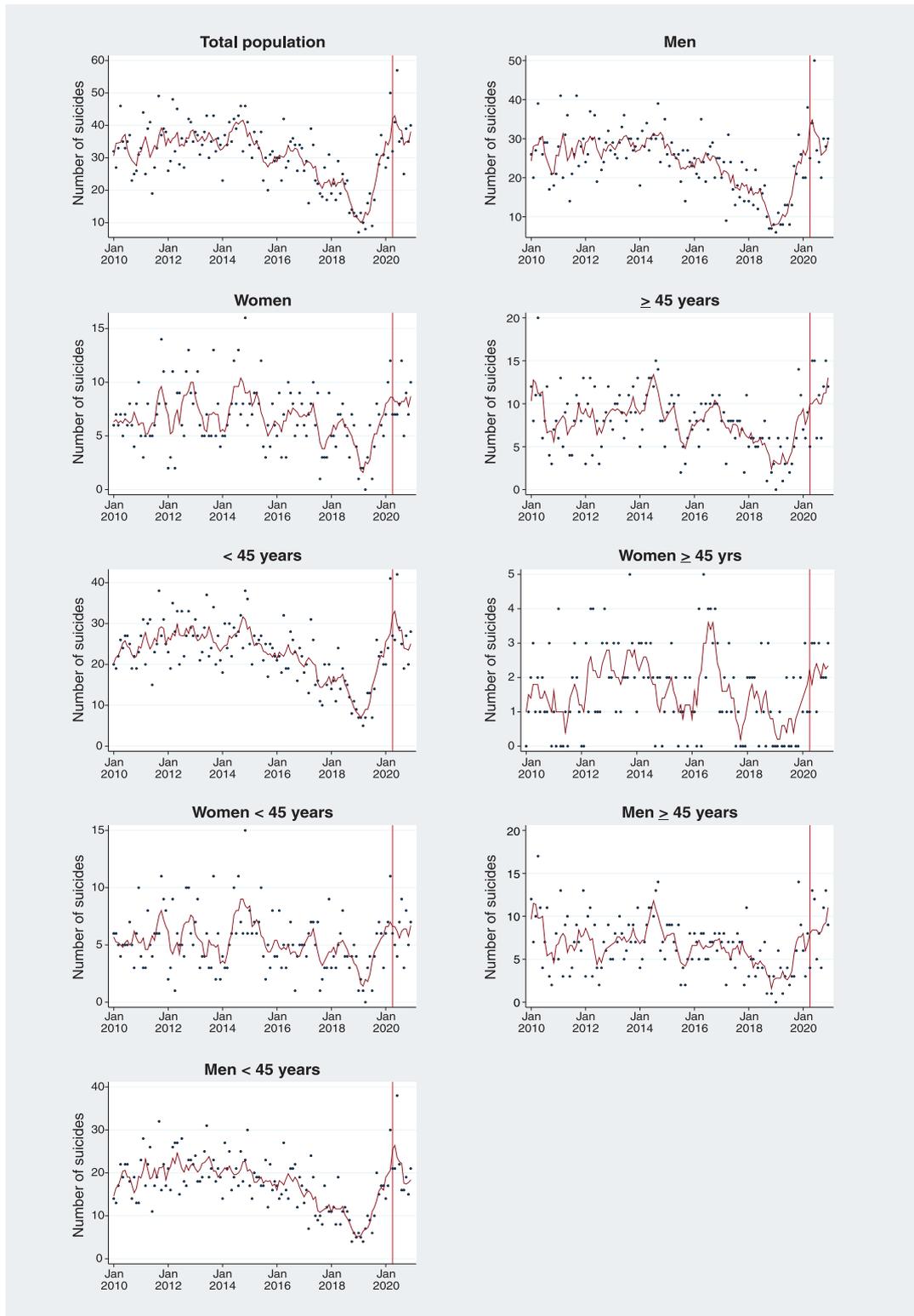
Our results add to the international literature in several ways. First, they are in contrast to data showing an initial pattern of no change or a reduction in suicides in many countries.<sup>12,17,18</sup> Unfortunately, they add Mexico City to the small number of regions and countries where suicides increased in the 1st year of the pandemic.<sup>10,13</sup> Relatively little research into the impact of COVID-19 on suicide has been conducted in Latin America, although one study was conducted in Peru,<sup>18</sup> and Peruvian data were included in our international study.<sup>11</sup> Unlike the study in Peru, another upper-middle income country in Latin America,<sup>18</sup> we found an increase in suicide rates. However, our study only covered a single large metropolitan area. Further analyses of long-term trends throughout Mexico are an

important avenue of future research that will help contextualize our findings.

Secondly, our findings suggest that the increase in suicides may not have been homogenous and indeed differed according to sociodemographic groups.<sup>19,20</sup> Our findings by sex warrant particular consideration. The largest increase in the total number of suicides was found among men (147 of the 176 extra suicides during the period) given that, in most of Mexico, men die by suicide in much larger numbers than women. However the largest proportionate increase occurred among older women. These findings contrast with those reported in Japan, where the largest increase in suicides occurred among young women<sup>13</sup>; the similarity between the two findings is that older women in Mexico and younger women in Japan are historically the age and sex groups with the lowest suicide rates in their respective countries.<sup>21,22</sup>

The finding that most suicides during the pandemic continued to occur among men was consistent with expectations. In addition to historical sex differences in rates, men in Mexico City have suffered from high levels of unemployment during the pandemic.<sup>23</sup> For many men, fulfilling the role of main economic provider may have been extremely challenging during the pandemic. Data on the employment status of suicide decedents were not available to us, but future research should consider more in-depth and detailed information, potentially complementing suicide mortality data with psychological autopsy approaches.

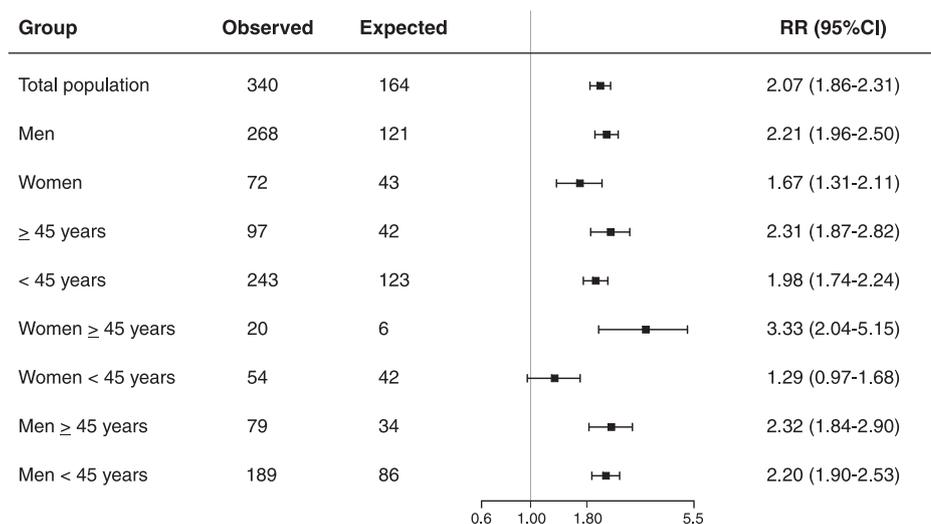
In contrast to men, young women in Mexico still have more traditional gender roles at home, where their primary responsibilities typically involve raising and providing emotional support to children. This traditional role among women, which may be considered protective against suicide, has probably increased in importance during the lockdown and extended pandemic period, during which home-schooling was common. On the other hand, the demands on women have increased, with more children staying home and experiencing greater emotional distress during the lockdown. Moreover, because living in extended family arrangements (with siblings and/or grandparents) is still common in Mexico, female heads of households may have received extended family support, which could have been an additional buffer and



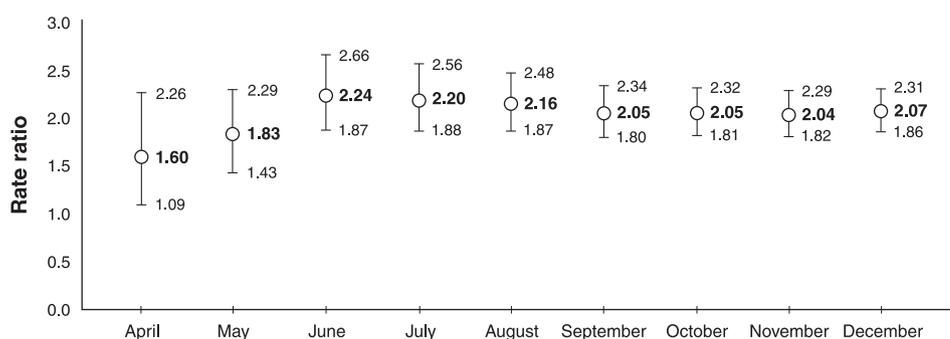
**Figure 1** Time series plots of monthly suicides, Mexico City.

coping mechanism during the COVID-19 lockdown. Young women are more likely to currently have a young child and this may confer protection against suicide in this age group.<sup>24,25</sup>

The economic hardships suffered by young women in Mexico City during the pandemic may also have been less severe than those experienced in places like Japan, where unemployment disproportionately affected women



**Figure 2** Observed and expected number of suicides, rate ratios (RR) and 95% CIs, Mexico City.



**Figure 3** Cumulative rate ratios and 95% CIs for observed/expected (Jan 2010-March 2020) suicides in Mexico City, April 2020 to December 2020.

during the lockdown.<sup>26</sup> It is not immediately apparent why the greatest effect on RR occurred among older Mexican women, but it can be speculated that, given that most had passed the age of childbearing/child-rearing, they may have been more prone to suffer from unemployment. Future studies should determine whether Mexican women aged  $\geq 45$  years are more often employed outside the home than those aged  $< 45$  years. Future study designs that include psychological autopsies could also help clarify the factors that contributed to this finding, although they must be interpreted with a strong note of caution, given the low baseline number of suicides in this demographic. As presented in the Supplementary Material S1, there were a total of 20 suicides in older women from April to December 2020. During the same months in 2017, 2018, and 2019 there were eight, 11, and six suicides, respectively. However, there were 28 suicides from April to December 2016. Therefore, more longitudinal data and data from other regions could help contextualize whether our finding represents a meaningful increase related to the pandemic or is confounded and/or represents a type I error.

It is worth noting here that our results about the short-term effects of the pandemic on suicides in Mexico City differ from what we reported in our previous international study.<sup>12</sup> Our current study used official mortality data, whereas our previous study used more limited suicide data from Mexico City's Justice Department. The time frame covered by the previous data was also shorter, which meant that although our prior analyses also controlled for underlying trends and seasonality, the current analysis did so with a greater degree of accuracy. In our international study, we included a note of caution that early data from some regions might undercount suicides and, thus, underestimate the potential impact of the pandemic on suicide. The present data would seem to support that this was the case, at least for Mexico City. These results call for continuous monitoring of suicide trends in Mexico, as elsewhere,<sup>13</sup> since lockdown policies and economic hardship may have an extended and cumulative effect on the mental health of the population,<sup>27</sup> in addition to the caution necessary when drawing conclusions from early data. As the pandemic continues, studies on medium and longer-term suicide trends are a key next step.

The increase in suicides in Mexico City – particularly the large number of excess suicides in men (who already accounted for the majority of suicides) – is worrying and reinforces the need to strengthen suicide preventive programs. It is critical to invest in economic programs to counter the impact of unemployment. Active labor market programs, for example, have been shown to mitigate the impact of economic recession on suicide, presumably by buffering the effects of income loss and financial hardship.<sup>28,29</sup> In general, public policy in Mexico City during the pandemic was to maintain prior programs that targeted the poorest residents and add additional, even if small, assistance to patients and families directly affected by COVID-19.<sup>30</sup> Again, the degree to which these policies may or may not have impacted suicide risk among those who received support is worthy of future study.

Consideration must also be given to maintaining and improving the mental health and well-being of the population, particularly men who, as a group, traditionally use mental health resources less than women.<sup>31</sup> Mexico City has been broadening its health programs based on primary care interventions, a model that has been recommended to achieve efficient mental health care.<sup>32</sup> These efforts should also include a focus on suicide prevention. While this is not a new issue and most would agree with such primary care-based models, Mexico's current model for mental health care is still centered on large specialized psychiatric hospitals. A great deal of effort and considerable resources are needed to reframe the delivery of services to increase focus on prevention and primary care options for initial mental health treatment, including suicidal thoughts and behaviors. It is particularly challenging to implement such changes during a pandemic, and this has been especially hard for health care professionals in Mexico.<sup>33</sup> Refocusing programs on long-distance delivery of services (telemedicine) could be a next step in intervention,<sup>34</sup> but implementing such approaches<sup>35</sup> is challenging for upper-middle income countries.

Our study had some limitations. The results are only applicable to one relatively small, but heavily inhabited, region of Mexico and we cannot generalize them to other cities, regions, or countries. Although our results may not be generalizable to the rest of Mexico or other nearby regions (e.g., other parts of Latin America), they nevertheless represent a meaningful addition to our very limited knowledge about how the pandemic has impacted suicide in low-middle income countries. Mexico City, one of the largest metropolitan areas in the world, has been heavily affected by COVID-19. Future research on other large metropolitan areas highly affected by COVID-19 will help determine whether the experience of Mexico City was common to other locations or an outlier. While we must be concerned about underestimating the potential impact of the pandemic on suicide due to the undercounting of deaths, we must also include a note of caution about overestimating its impact. In Japan, for example, one unresolved question is whether the increase in suicides among young women was influenced by the widely reported deaths of two prominent celebrities immediately

prior to the increase in mid-2020.<sup>11</sup> Our study is likewise a natural experiment that may be confounded by other events unrelated to the pandemic and, thus, our results must be interpreted cautiously.

In a prior study that included Mexico City, we used data from the Justice Department, which was only available for a shorter period of time and included only suicide counts for the total population, with no breakdown by demographics.<sup>12</sup> For this current study, as stated in the Methods section, we used final data on ICD-10 mortality as reported by our main statistical bureau, which included age/sex information and is available for longer periods pre- and post-pandemic. By using relatively up-to-date data and highly refined epidemiologic analyses, we found that suicide increased among male and older female residents of Mexico City. The city should advance toward its goals of incorporating primary care in mental health and should include suicide prevention and treatment in general practitioner settings in its mental health program, together with economic development efforts.

## Disclosure

The authors report no conflicts of interest.

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