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## The impact of the COVID-19 pandemic on suicide mortality in Spain: Differences by sex and age

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### ABSTRACT

**Background:** Variations in suicide following the initial COVID-19 pandemic outbreak were heterogeneous across space, over time, and across population subgroup. Whether suicide has increased during the pandemic in Spain, a major initial COVID-19 hotspot, remains unclear, and no study has examined differences by sociodemographic group.

**Methods:** We used 2016–2020 data on monthly suicide deaths from Spain's National Institute of Statistics. We implemented Seasonal Autoregressive Integrated Moving Average (SARIMA) models to control seasonality, non-stationarity, and autocorrelation. Using January 2016–March 2020 data, we predicted monthly suicide counts (95 % prediction intervals) between April and December 2020, and then compared observed and predicted monthly suicide counts. All calculations were conducted for the overall study population and by sex and age group.

**Results:** Between April and December 2020, the number of suicides in Spain was 11 % higher-than-predicted. Monthly suicide counts were lower-than-expected in April 2020 and peaked in August 2020 with 396 observed suicides. Excess suicide counts were particularly salient during the summer of 2020 – largely driven by over 50 % higher-than-expected suicide counts among males aged 65 years and older in June, July, and August 2020.

**Discussion:** The number of suicides increased in Spain during the months following the initial COVID-19 pandemic outbreak in Spain, largely driven by increases in suicides among older adults. Potential explanations underlying this phenomenon remain elusive. Important factors to understand these findings may include fear of contagion, isolation, and loss and bereavement – in the context of the particularly high mortality rates of older adults during the initial phases of the pandemic in Spain.

### 1. Introduction

The initial COVID-19 pandemic outbreak profoundly impacted the mental health and wellbeing of the general population. A large body of evidence indicates increases in the overall population prevalence of mental health symptoms after April 2020 – especially for symptoms of depression and anxiety (Prati and Mancini, 2021; Robinson et al., 2022), potentially due to stressors driven by the pandemic. At the same time, representative longitudinal surveys highlight remarkable variation in

the mental health effects of the pandemic across population subgroups (Brunoni et al., 2021; Budimir et al., 2021; Daly and Robinson, 2021; Hyland et al., 2020; Pieh et al., 2021; Wang et al., 2020), across space (Budimir et al., 2021; Czeisler et al., 2021), and over time (Brunoni et al., 2021; Daly and Robinson, 2021; Wang et al., 2020).

Initially, there was generalized concern that suicide mortality might also increase substantially (Reger et al., 2020; Sher, 2020). Surprisingly, an early interrupted time-series analysis found that suicide mortality remained stable or dropped in all 21 countries under study between

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April and July 2020 (Pirkis et al., 2021). Subsequent studies including up to December 2020, however, have highlighted substantial heterogeneity in suicide trends across place: Suicide rates dropped or remained unchanged in most study locations (Leske et al., 2021; Partonen et al., 2022; Radeloff et al., 2021), but reports indicate increases in (i) suicide rates in Nepal between April 2020 and May 2021 (compared to 2019 as reference period and including month-fixed effects to account for seasonality and year-fixed effects to account for long-term trends) (Acharya et al., 2022), (ii) suicide counts in Puerto Rico, and Vienna, Austria between April and October 2020 (compared to expected counts using interrupted time-series analysis and accounting for seasonality) (Pirkis et al., 2021), (iii) suicide counts in Japan between July and October 2020 (compared to the corresponding period in the four prior years and accounting for underlying trends) (Tanaka and Okamoto, 2021), and (iv) additional preliminary evidence of crude increases in suicide counts in 2020 compared to 2019 in India (Menon et al., 2022) and compared to 2017 in Poland (Rogalska and Syrkiewicz-Świtala, 2022). It is important to note that common limitations of most studies examining changes in suicide during the pandemic include use of short time periods (e.g., comparing suicide rates in 2020 vs. 2019) and suboptimal assessment and control for common threats to validity in time series analyses – e.g., autocorrelation, nonstationarity, and seasonality (Shumway and Stoffer, 2011).

Spain was initially one of the countries hardest hit by the pandemic – with the highest recorded COVID-19 incidence across Europe (European Centre for Disease Prevention and Control, 2020) during the spring of 2020 forcing a nation-wide stay-at-home order between March 15 and May 4 (Spain's Official National Bulletin [Boletín Oficial del Estado], n.d.). Global Burden of Disease estimates suggest that Spain was among the top 5 European countries in terms of increase in prevalence of major depressive and anxiety disorders following onset of the pandemic (COVID-19 Mental Disorders Collaborators, 2021). However, whether Spain's suicide rate, traditionally one of the lowest among high-income countries (OECD, 2021), increased following the onset of the pandemic remains unclear. Two studies have compared suicide risk in Spain between 2019 and 2020. First, a population-based study found no evidence of an increase in suicide mortality rates in 2020 in the Spanish region of Catalonia (Pérez et al., 2021). A subsequent nation-wide study also reported no annual differences but suggested slightly increased rates during the 2020 summer months (de la Torre-Luque et al., 2022). No studies have used longer study periods to assess changes on suicide mortality following the pandemic onset in Spain while accounting for pre-existing trends (i.e., non-stationarity) and seasonality, two common threats to validity in time-series analysis (Shumway and Stoffer, 2011).

In light of the heterogeneity of findings on suicide during the COVID-19 era, examining population subgroups can provide important insights to understand the dynamics of suicide risk during the pandemic: The impact of the pandemic on suicide should be heterogeneous across demographic groups due to differences in prevalence and vulnerability to stressors generated by the pandemic.

Further, investigating variations in suicide trends across population groups can help identify emerging high-risk groups and guide public health and clinical decision making (Martínez-Alés et al., 2022b). Sex and age differences in variations in suicide mortality during the initial phases of the pandemic may exist based on sex- and age-specific effects of certain pandemic-specific stressors with potential impact on suicide risk. Predicting the direction of potential sex- and age-specific effects of the pandemic on suicide, however, is difficult as evidence regarding the sex- and age-specific distribution and impact of mental health stressors during the pandemic is mixed (i.e., heterogeneous across space and over time) and sometimes contradictory (Hajek et al., 2022; Patel et al., 2022; Sojli et al., 2021; Zaninotto et al., 2022).

As of September 2022, of a total 49 population-based studies assessing variations in suicide following the initial pandemic outbreak, the roles of sex and age on suicide trends were examined, respectively, within 29 and 20 studies. While most studies reported no evidence of

differences by sex or age group, two observations, the first one pertaining to several locations across the globe and the second one specific to Japan, stand out. First, during the summer and fall of 2020, the COVID-19 pandemic had a marked impact on adult suicide in several regions (e.g., across sex and age in Mexico city) (Borges et al., 2022a, 2022b), with research indicating suicide increases among adults aged 65 years and older in Guangdong (China) (Zheng et al., 2021), Taiwan (Chen et al., 2022), Mexico, Austria (Pirkis et al., 2022), and Brazil (Ornell et al., 2022); and specifically among males aged 65 years and older in Brazil (Orellana and de Souza, 2022) and the regions of Rhineland-Palatinate, in Germany, and Emilia-Romagna, in Italy (Wollschläger et al., 2021), Croatia, and Austria (Pirkis et al., 2022). These findings confirm early calls for specific suicide prevention efforts targeted towards older individuals (Wand et al., 2020). Second, in Japan, early suicide increases were largely driven by increases among young males and females of all ages (Watanabe and Tanaka, 2022) – and especially females aged 20–39 years (Anzai et al., 2021). Reasons underlying these sex and age patterns in suicide mortality remain elusive at present time.

The roles of sex and age on suicide variations following the initial COVID-19 pandemic outbreak in Spain have not been studied. Here we used 2016–2020 suicide mortality data from Spain to investigate whether suicide mortality increased during the initial phases of the pandemic and to examine potential differences by sex and age.

## 2. Methods

### 2.1. Data source

We obtained 2016–2020 all-cause mortality data from Spain's National Institute of Statistics (Instituto Nacional de Estadística. (National Statistics Institute), n.d.). These publicly available and de-identified data consist of International Classification of Disease, Tenth Revision (ICD-10) codes indicating the underlying cause of death as recorded in death certificates by medical examiners and stored in Spain's single cause-of-death National Mortality Registry. For each death, we additionally retrieved information on sex (male/female) and age in years. Following previously implemented practices, we selected suicide deaths based on presence of ICD-10 codes X60–84 or Y87.0. Study procedures were approved by the Institutional Review Board of the Carlos III Health Institute, Madrid, Spain.

### 2.2. Analyses

During the initial pandemic outbreak, recorded COVID-19 transmission rates peaked in Spain towards the end of March 2020 (Working group for the surveillance and control of COVID-19 in Spain, 2020). We used January 2016–March 2020 data to model trends of monthly suicide counts and forecast the expected monthly number of suicides between April and December 2020. We assumed constant denominators as Spain's population number and distribution remained roughly unchanged during the study period (Instituto Nacional de Estadística. (National Statistics Institute), n.d.). Then, to assess whether monthly suicide counts were higher than expected, we compared forecasted and observed monthly suicide counts between March and December 2020. All analyses were conducted for monthly suicides overall and by sex and age group.

Monthly adult suicide counts typically follow a seasonal pattern, with increases in late spring and summer and decreases in the winter, and autocorrelation across observations. Therefore, we implemented time series analysis (Shumway and Stoffer, 2011). We used seasonal autoregressive integrated moving averages (Seasonal ARIMA or SAR-IMA) models – superior to other time series analyses (e.g., segmented regression) in presence of seasonality and autocorrelation (Schaffer et al., 2021). SARIMA models are defined by the formula  $(p, d, q) \times (P, D, Q, s)$ , where  $p$  indicates the non-seasonal autoregression order,

$d$  indicates the non-seasonal differencing, and  $q$  indicates the non-seasonal moving average; while  $P$  indicates the seasonal autoregression order,  $D$  indicates the seasonal differencing,  $Q$  indicates the seasonal moving average, and  $s$  indicates the time span of the seasonal pattern. This procedure allowed us to model the data generating process while taking into account seasonality and trends (Shumway and Stoffer, 2011).

Each time series analysis was conducted following three steps (Shumway and Stoffer, 2011). We first assessed the mean, variance, and seasonality of suicide counts between January 2016 and March 2020 examining graphical representations of the temporal trends. Second, we obtained autocorrelation function (ACF) and partial autocorrelation function (PACF) plots to assess the presence of seasonality and trends. Third, we implemented the SARIMA models. For the main results, we selected model parameters using the `auto.arima` function in R, a variation of the Hyndman-Khandakar algorithm (Hyndman and Khandakar, 2008) – based on a combination of unit root tests, minimization of the Akaike Information Criterion (AIC), and maximum likelihood estimation to obtain the most parsimonious SARIMA model. Using the resulting SARIMA parameters, we modelled the observed number of suicides between January 2016 and March 2020, plotted the model-predicted number of suicides between January 2016 and March 2020, and forecasted the expected number of suicides and 95 % Prediction Intervals (95 % PI) between April and December 2020. For each model, we checked whether residuals deviated from white noise by examining the resulting residuals – including ACF plots of the residuals and  $p$ -values for the Ljung-Box statistic across different time lags.

We conducted four sets of sensitivity analyses. First, to assess the potential for model misspecification errors, we repeated all procedures selecting SARIMA model parameters manually instead of using the `auto.arima` command. To that end, we identified a set of potential combinations of parameters based on examination of ACF and PACF plots of the time series and selected the combination with the best fit as indicated by the lowest AIC and Bayesian Information Criterion (BIC) (Shumway and Stoffer, 2011). Second, we examined the ability of SARIMA models to predict suicide outside of the period following the initial pandemic outbreak. To that end, we used January 2016–July 2019 data to predict monthly suicides and 95 % PI for the August–December 2019 period and compared them to observed monthly suicide counts. Third, we repeated all procedures using the period between January 2010 and March 2020 for predictions – to examine the extent to which choice of the 2016–2020 period had impacted our results. Fourth, we repeated all models after excluding foreign-born individuals – given that in Spain foreign-born status has been associated with changes in suicide mortality in recent years (Martínez-Alés et al., 2022a) and foreign-born individuals are disproportionately represented in younger age groups. All analyses were conducted using R version 4.1.1 (R Core Team, 2019).

### 3. Results

#### 3.1. Descriptive analyses

Between 2016 and 2020, 18,132 suicides were recorded in Spain – 13,481 among males and 4651 among females, 726 among individuals aged 15–24 years, 4385 among individuals aged 25–44, 7103 among individuals aged 45–64, and 5918 among individuals aged 65 years and older. The mean (standard deviation) monthly suicide counts were 302.2 (34.1) overall; 224.7 (27.8) among males and 77.5 (10.7) among females; and 73.1 (10.6) among individuals aged 25–44, 118.4 (14.4) among individuals aged 45–64, and 98.6 (16.6) among individuals aged 65 years and older.

Fig. 1 represents time trends in monthly suicides in Spain between January 2016 and December 2020. Overall, monthly suicides ranged between 235 suicides in November 2018 and 396 in August 2020. As expected, monthly suicide counts followed a robust seasonal pattern every year, peaking in spring and summer months and decreasing over

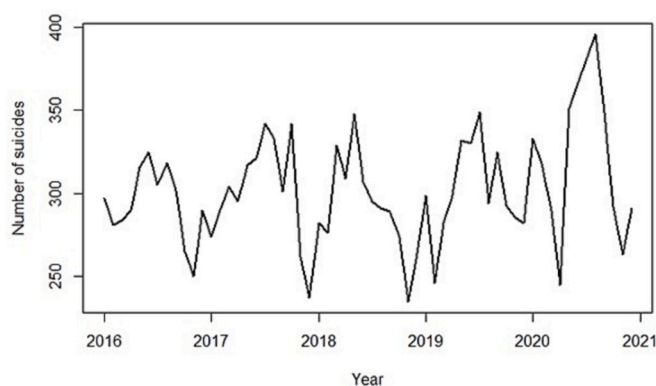


Fig. 1. Monthly suicide counts in Spain between January 2016 and December 2020.

the winter. Importantly, compared to previous years, in 2020 there was a marked increase in monthly suicides that extended between late spring and early fall (Supplementary Fig. S1).

#### 3.2. Forecasting models and excess suicide assessment

Supplementary Table S1 summarizes the parameters used to specify SARIMA models for 2016–2020 monthly suicide counts in Spain, overall and across sex, age group, and foreign-born status. Of note, monthly suicide counts among individuals aged 15–24 were very low and relatively unstable – ranging between 5 and 18 monthly suicides in July and September 2020, respectively; and there was no seasonal component. We did not conduct further analyses in this age group.

Overall, between April–December 2020, there were 2934 suicide deaths in Spain – an excess of 301 suicides (33.4 per month) for a +11 % (95%PI: +1 %, +23 %) higher than forecasted suicide count. Age group- and sex-specific results for the whole forecasting period indicate age and sex patterns: Differences between observed and forecasted suicide counts were +13 % (95%PI: +4 %, +23 %) among males but +6 % (95%CI: –7 %, +21 %) among females; and +15 % (95%PI: +1.4 %, +30 %) among individuals aged >65 years old but +3.5 % (95%CI: –6 %, +14 %) and +5 % (95%CI: –7 %, +18 %) among individuals aged 45–65 and 25–44 years old, respectively.

Fig. 2 represents observed and predicted monthly suicide counts for the 2016–2020 period in Spain. For forecasted months (April–December 2020), we also include 95 % PI. Monthly suicide counts were 17 % lower than predicted in April 2020 and higher than predicted between May and September 2020. Notably, the excess number of suicides was highest (over 30 % higher than predicted) in July and August 2020.

Supplementary Figs. S2 and S3 represent sex-specific 2016–2020 observed and predicted monthly suicide counts. Fig. 3 and Supplementary Table S2 summarize observed and predicted (95 % PI) monthly suicide counts between April and December 2020 in Spain and the difference between predicted and observed suicides, overall and by sex. Figs. 4 and 5 and Supplementary Tables S3 and S4 summarize observed and predicted (95 % PI) sex-specific monthly suicide counts between April and December 2020 in Spain, presented by age group.

We found particularly salient suicide increases in older males. There were lower-than-predicted male suicide counts in April 2020 in all groups aged <65 years. Among males aged 65 and older, on the contrary, suicide counts in April 2020 remained roughly in line with predictions – that is, there was no discernible early phase of suicide risk decrease among older males. Between May and September 2020, male suicide counts were higher than predicted, peaking in June, July, and August 2020 (+32 %, +36 %, and +36 %, respectively). Suicides were remarkably higher than predicted among males aged 65 years and older in June, July, and August 2020 (+56 %, +53 %, and +52 %, respectively). Last, suicides among older males were 19 % lower than

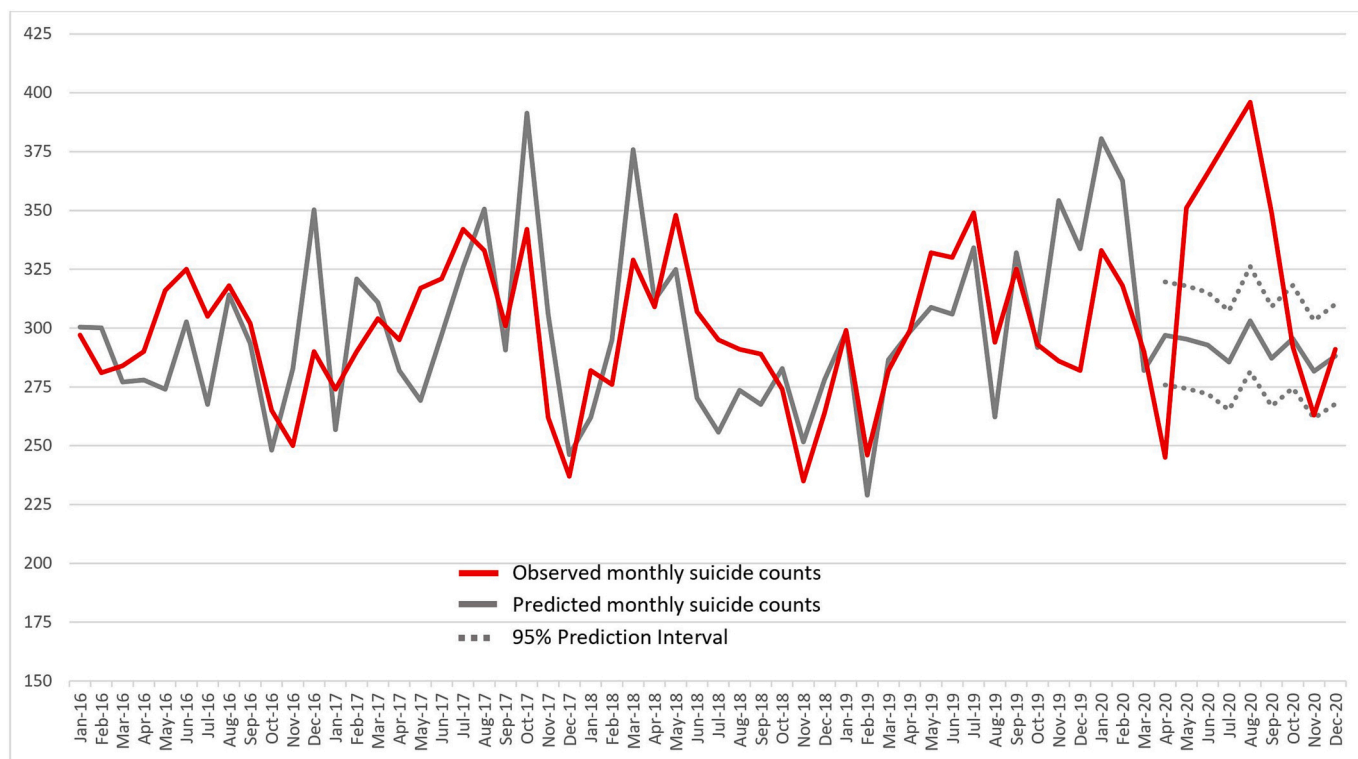


Fig. 2. Observed and predicted suicides in Spain between January 2018 and December 2020, including 95 % prediction intervals for the April–December 2020 period.

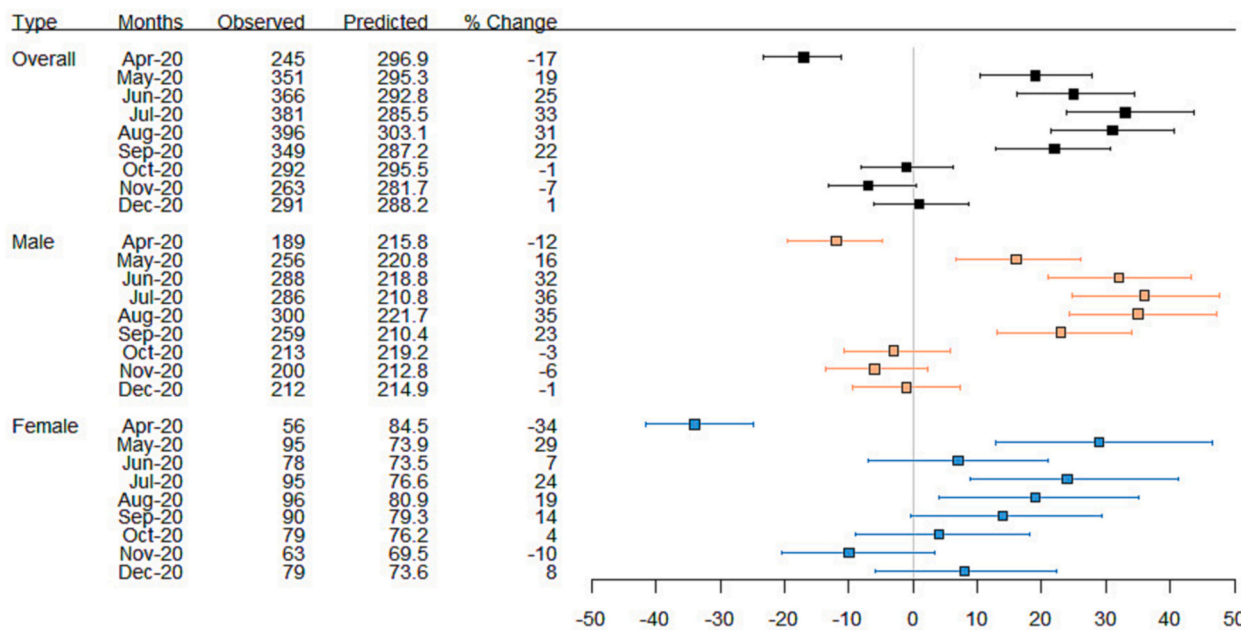


Fig. 3. Observed and predicted monthly suicides between April and December 2020 in Spain, overall and by sex.

predicted in October 2020.

Among females, suicide counts were lower than predicted across age groups in April 2020 (−34 % overall). Female suicide counts were also higher than predicted over the summer, although to a lesser magnitude than among males – e.g., female suicide counts were 19 % higher than predicted in August 2020. Between age group differences were less marked among females than in males, though female suicide in the 65 years and older group peaked in August 2020 with a striking 66 % excess

of suicide deaths. Suicides among older females were 34 % lower than predicted in December 2020.

Results from the first sensitivity analysis, where we defined SARIMA parameters based on examination of ACF and PACF plots and comparison of AIC and BIC, did not differ from main results, suggesting robustness to potential model misspecifications. The second sensitivity analysis, examining the ability of SARIMA models to predict suicide during the late summer and fall of 2019, suggested good forecasting

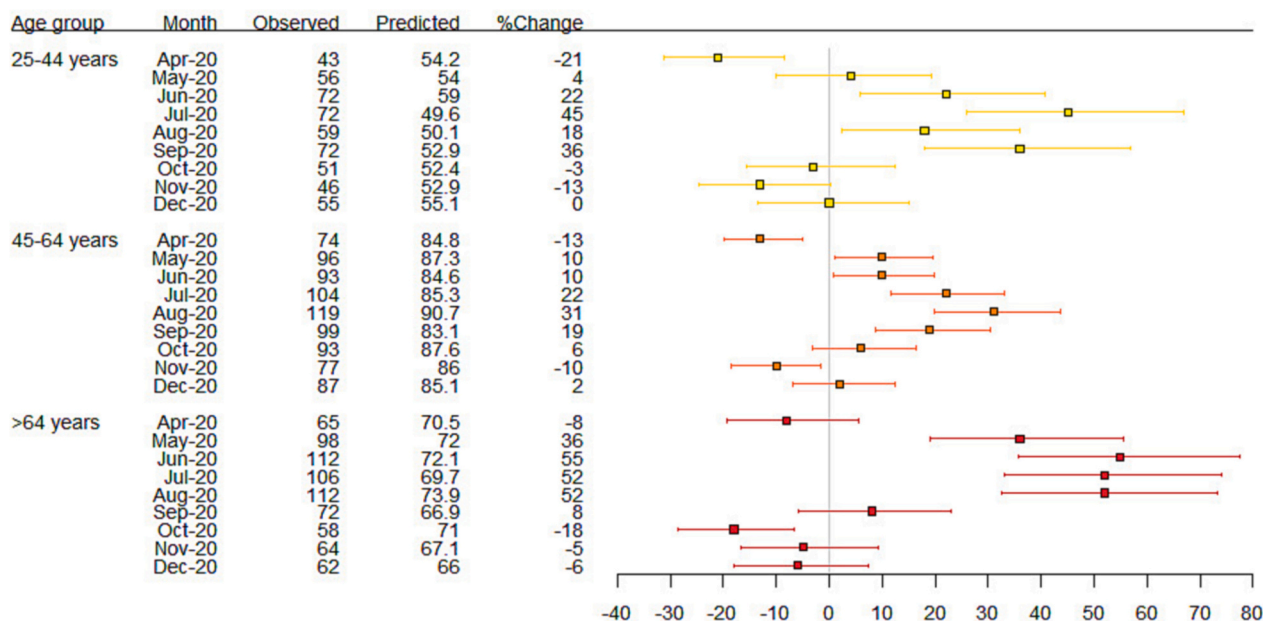


Fig. 4. Observed and predicted monthly male suicides between April and December 2020 in Spain by age group.

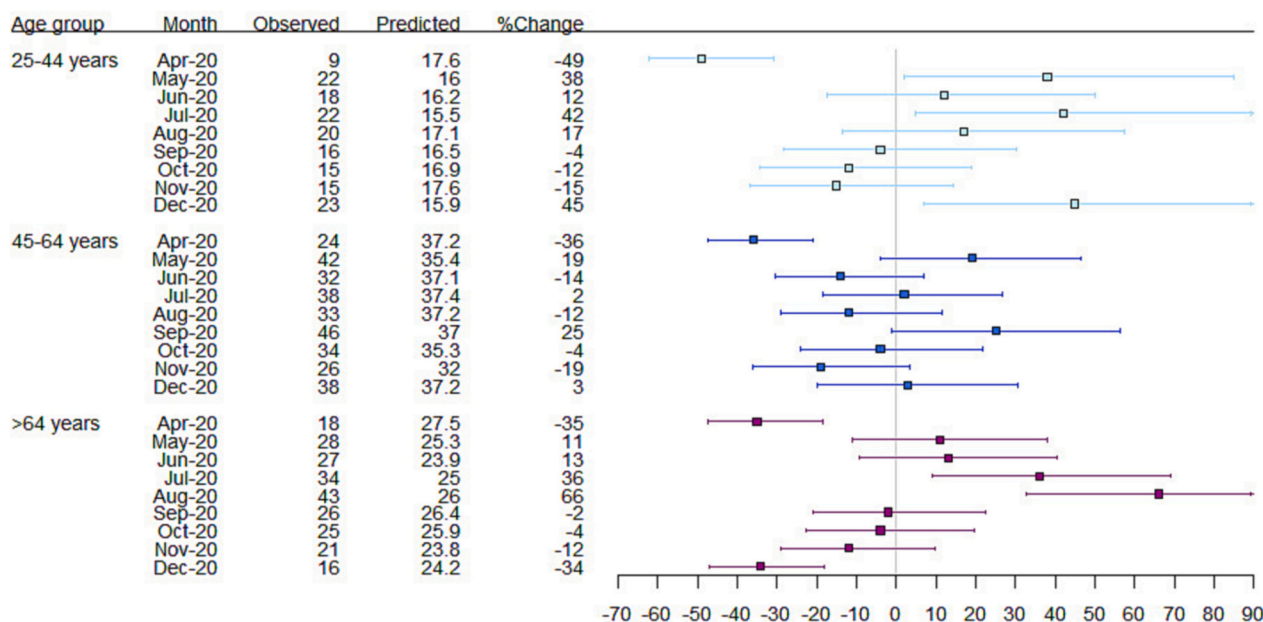


Fig. 5. Observed and predicted monthly female suicides between April and December 2020 in Spain by age group.

performance (Supplementary Fig. S4). In the third sensitivity analysis, using January 2010–March 2020 instead of January 2016–March 2020 as reference period did not affect findings. In the fourth sensitivity analysis, results after exclusion of foreign-born individuals indicated even more salient higher-than-expected suicide counts among males aged 65 years and older in June and July 2020 (+71 % and + 70 %, respectively) and no evidence of excess suicide counts among females aged 25–64 years during any recorded month. Results for males aged 25–64 years and females aged 65 years and older were roughly similar before and after exclusion of the foreign-born.

#### 4. Discussion

We assessed the difference between observed and predicted monthly

suicides in Spain following the initial COVID-19 pandemic outbreak. We found the number of monthly suicides in Spain to be lower than predicted in April 2020 and higher than predicted between May and September 2020, overall and in virtually all sociodemographic groups as defined by sex and age. Suicide counts peaked in Spain between July and August 2020, with suicide counts over 30 % higher suicide than predicted. Excess suicides during the summer of 2020 in Spain were largely driven by remarkably higher-than-predicted suicide counts among older males – with over 50 % higher monthly suicide counts than predicted between June and August 2020. This study confirms that suicide increased during the initial phases of the pandemic in Spain by quantifying monthly differences between observed and predicted suicide counts – after accounting for autocorrelation, non-stationarity (i.e., underlying trends) and seasonality. In addition, we provide

sociodemographic group-specific estimates of monthly variations in suicide following the onset of the pandemic, highlighting the importance of suicide among older individuals and especially older males. These results should enhance our understanding of the ways in which the pandemic impacted suicide risk in vulnerable population subgroups and help guide public health and clinical suicide prevention efforts.

The finding that suicide counts were overall lower than expected in April 2020, immediately following the initial pandemic outbreak in Spain, is in keeping with reports from countries and regions across the globe (Faust et al., 2021; Pirkis et al., 2021; Tanaka and Okamoto, 2021). Interpreting these temporary decreases in suicide mortality is challenging, as suicide decreases were not expected (Reger et al., 2020; Sher, 2020) based on the socioeconomic stressors brought about by the pandemic and on increases in population-level prevalence of mental health symptoms (Prati and Mancini, 2021; Robinson et al., 2022) and suicidal thoughts (Czeisler, 2020). On the one hand, suicide mortality can decrease in the early aftermath of certain major adverse societal events – including some natural disasters (Matsubayashi et al., 2013), wars (Thomas and Gunnell, 2010), genocides (Lester, n.d.), terrorist attacks (Claassen et al., 2010), or pandemics (Bastiampillai et al., 2021; Gaddy, 2021). Emile Durkheim's foundational work on suicide highlighted how wars and other major societal disruptors can result in temporary increases in social cohesion, sometimes referred to as “pulling together” effect (Bastiampillai et al., 2021) that can lead to decreases in suicides (Durkheim et al., 1966). On the other hand, not all major societal crises are followed by initial decreases in suicide: immediate suicide increases of variable magnitude are characteristic of large economic depressions – e.g., the great 1929–1939 depression in the US (Luo et al., 2011), the post-soviet economic collapse (Brainerd, 2001), or the 2008 economic recession in Europe (Barr et al., 2012; De Vogli et al., 2013; Stuckler et al., 2011) and the US (Reeves et al., 2012). Increases in suicide were also present after the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak in Hong Kong – at least among older adults (Cheung et al., 2008).

Suicide counts, however, were higher than predicted throughout the summer and early fall of 2020. This finding, confirming prior reports that suggest increases in suicide in Spain in 2020 compared to 2019 (de la Torre-Luque et al., 2022), does not lend itself to easy interpretation – especially since suicide did not increase following the initial pandemic outbreak in the majority of countries and regions across the globe (Pirkis et al., 2021). An explanation to why the initial lag between the pandemic outbreak and increases in suicide was seemingly shorter in Spain than in other regions – e.g., Japan (Tanaka and Okamoto, 2021) also remains elusive at present time. Examining the impact of the pandemic on Spain's economy, the hardest hit across Europe with a – 10.8 % negative change of rate of gross domestic product (GDP) in 2020 (National Accounts and GDP [WWW Document], n.d.), may help understand this finding. Reasons for the disproportionate economic impact of the pandemic in Spain remain under debate, but the large direct contribution of tourism to Spain's economy played an important role. In Spain, tourism provided 12.3 % of GDP and 12.7 % of employment in 2018 (Ministry of industry, trade and tourism - COVID-19 news [WWW Document], n.d.) - leading the Organization for Economic Cooperation and Development in both metrics (OECD, 2020). In 2020, in the context of travel restrictions, stay-at-home mandates, and other contagion containment measures, tourism in Spain fell by an unprecedented 72.4 % (Moreno-Luna et al., 2021). Largely as a result of this, the unemployment rate increased progressively by 4 % in March 2020, 11 % in June 2020, and 18 % in September 2020. There is long-standing evidence that economic downturns can increase suicide risk (Reeves et al., 2012; Tapia Granados and Diez Roux, 2009), an effect partially mediated by increases in unemployment (Stuckler et al., 2011) and moderated by welfare systems and labor market protection (Norström and Grönqvist, 2015). Two observations may support a potential role of unemployment in excess suicide during the initial phases of the pandemic: First, suicide peaked in July and August 2020 – coinciding with (what should have been) peak tourism

season in Spain. Second, our sensitivity analysis excluding foreign-born individuals suggests that excess suicides among females aged 25–44 years during summer 2020 were driven almost exclusively by suicides among foreign-born females. According to official registries, the March–June 2020 increase in unemployment rate among foreign-born women aged 35–44 years was more than two-fold greater than that of native-born counterparts (10.4 % vs. 4.7 % increases, respectively) (Instituto Nacional de Estadística. (National Statistics Institute), n.d.). Because the association between unemployment and suicide is moderated by labor market protection, these results should generate debate regarding the role of welfare systems on suicide risk among socioeconomically vulnerable groups during major economic downturns.

Our main finding was that strikingly high suicide counts in individuals aged 65 and older, especially among older males, largely drove higher-than-predicted monthly suicide counts during summer 2020 in Spain – in line with what has been reported in Mexico (G. Borges et al., 2022a, 2022b), China (Zheng et al., 2021), Taiwan (Chen et al., 2022), Italy, Germany (Wollschläger et al., 2021), Austria, Croatia (Pirkis et al., 2022), and Brazil (Orellana and de Souza, 2022; Ornell et al., 2022). This finding may be related to older people's increased vulnerability to COVID-19 mortality as well as to certain pandemic-related social stressors. As mentioned, Spain was one of the hardest hit countries by the initial pandemic wave (European Centre for Disease Prevention and Control, 2020), leading to the temporary collapse of healthcare delivery (Condes et al., 2021; Martínez-Alés et al., 2021) and resulting on the third largest reduction in life expectancy in 2020 across Europe (after Bulgaria and Lithuania) (Islam et al., 2021). Importantly, COVID-19 incidence and mortality were much higher among older adults than for the rest of the population during the initial outbreak in Spain, one of the countries with the highest proportion of older adults (PRB, 2022): Between January and May 2020, population mortality rates due to COVID-19 were 0.06 % and 1.2 % for people aged <65 and ≥ 65 years. Spain's 2020 reduction in life expectancy was almost entirely driven by increased mortality in the ≥80 years age groups (Aburto et al., 2022). Accordingly, several pandemic-related stressors were seemingly more intense among older than younger groups of the population – including but not limited to fear of contagion and death, loss and bereavement of partners and close friends, or isolation due to social distancing measures and erosion of the sense of community with loss of informal structures of emotional support (Hernández-Calle et al., 2020). There is long-standing evidence that self-reported mental health and perceptions of social support are strongly associated among older individuals (White et al., 2009). In addition, and perhaps more importantly to explain our results, death of a close relative has long been considered an important risk factor for suicide, especially during the earliest phases of bereavement (Ajdacic-Gross et al., 2008). The association between death of a partner and suicide becomes stronger with older age and is particularly salient among older males (Mogensen et al., 2016), which may explain the gendered pattern we observed in suicide risk among older people in Spain. A Danish population-based study found older males' suicide risk immediately following death of the spouse to be 15-fold higher the risk of middle-aged married counterparts (Erlangsen, 2004). Thwarted belongingness and perceived burdensomeness, key concepts within prevailing psychological theories of suicide (Van Orden et al., 2010), may help understand the process through which risk of suicide among older males increases following widowhood – especially in the context of the COVID-19 pandemic, with social distancing limiting social and family contact. Importantly, even though increases in suicide among older men during the initial pandemic months have been reported in some locations, this has not been a generalized finding across the globe. Surveillance coupled with comparisons across contexts should help further understand why suicide rates among older males only increased in specific places. One potential explanation is economic stress: In Spain, where grandparents play a cornerstone role in family economy (Meil et al., 2018) and >35 % of households are sustained by older people's retirement pensions, the downstream economic effects of the pandemic

might have brought about unprecedented economic and psychological stress to older people. Importantly, widowhood also generates substantial economic stress: On average, survivor pensions in Spain amount to <52 % of the deceased's retirement pension total (Spain - Employment, Social Affairs & Inclusion - European Commission [WWW Document], n.d.).

Preventing suicide among high-risk older individuals can be challenging because of age-specific risk factors that function as barriers for help-seeking – such as social disconnectedness and isolation (Martín-María et al., 2021) or disability (e.g., hearing impairment or walking difficulties) (Koo et al., 2019). Our findings should emphasize the importance of developing and implementing age-friendly suicide prevention strategies (e.g., strategies deployed within general medicine or geriatric facilities) and preventing social disconnectedness through early, proactive social care evaluation (Van Orden and Conwell, 2011).

This study raises more questions than it answers. However, these findings may enhance understanding of the potential causal mechanisms underlying increases in suicide in Spain during the initial phases of the pandemic, underscoring the importance of acting upon the socioeconomic and political drivers of suicide following major societal crises. Additionally, these results highlight the importance of enhancing access to care during suicidal urges. There is indirect evidence that delivery of emergency psychiatric care was somewhat disrupted during the initial phases of the COVID-19 pandemic in Spain (Hernández-Calle et al., 2020). Barriers in access to social and clinical help during suicidal crises are particularly concerning among older adults due to reasons such as social disconnectedness (Martín-María et al., 2021) or physical impairment (Koo et al., 2019). Development, deployment, and scale-up of easy to access, older age-friendly, and culturally adaptive mental healthcare and suicide-specific interventions is paramount for suicide prevention efforts during major adverse societal crises.

#### 4.1. Limitations

This study has some notable limitations. First, suicide mortality data are subject to potential certification error (Bakst et al., 2016; De Leo, 2015). Second, while our sensitivity analyses seemingly endorse choice of type of time series analysis and of SARIMA parameters, suggesting robustness to potential modelling decisions and model misspecification, we cannot rule out potential mistakes modelling the underlying data generating structure of our time series. Third, we did not examine separately different events taking place during the spring and summer of 2020 (i.e., onset of the pandemic, adoption of contagion control measures, etc.) – hence this study is not equipped to test the potential causal effect of each of these events on suicide increases. Fourth, we used monthly suicide counts, rather than rates. However, Spain's population has remained roughly stable in terms of number and age distribution between 2016 and 2020 (Instituto Nacional de Estadística. (National Statistics Institute), n.d.). Moreover, considering the striking COVID-19 mortality experienced by older adults during spring 2020 in Spain, use of suicide counts instead of rates probably biased results towards the null hypothesis in this age group. Fifth, the data did not allow for examination of additional potentially vulnerable groups with important implications for public health decision making – such as low SES individuals, racial/ethnic minorities, frontline workers, or people living with mental disorders. Sixth, while we considered Spain as a whole unit of analysis, there were important differences across Spanish regions in terms of both COVID-19 incidence (Trias-Llimós et al., 2020) and negative economic impact (Moreno-Luna et al., 2021). Future research should examine the geographical variation in suicide across regions in Spain in 2020.

#### 5. Conclusion

In conclusion, we found higher-than-predicted suicide counts during the late spring, summer, and early fall of 2020 in Spain, revealing that

the timing and patterns of suicide following the initial pandemic outbreak largely did not follow expectations. By identifying particularly salient periods and demographic groups, we enhance understanding of the potential drivers of puzzling suicide dynamics during the COVID-19 pandemic. In particular, we found that early increases in suicide in Spain were largely driven by striking increases in suicide among older individuals – especially older males. These findings have important implications for suicide prevention and should highlight the importance of (i) interpreting early declines in suicide following the initial pandemic outbreak with caution, (ii) acting upon the social drivers of suicide increases, and (iii) enhancing access to and quality of mental healthcare for suicide prevention during major adverse societal events (Cook et al., 2019).

#### Author contributions

GMA, TLC, KK, and ES designed the study. GMA, TLC, and KK performed the statistical analysis. GMA wrote the first draft. All authors revised the draft, providing important intellectual content. All authors revised and approved the final version.

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#### Declaration of competing interest

The authors declare no competing interests.

#### Data availability

The data that support the findings of this study are publicly available upon reasonable request from Spain's National Institute of Statistics ([www.ine.es](http://www.ine.es)).

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jad.2023.02.115>.

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