The COVID-19 pandemic immediately increased the suicide rate in Kobe, Japan, especially among populations without psychiatry and primary care physician visits: Interrupted time-series analysis using a population-based database

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Abstract

Background

Japan has one of the lowest numbers of deaths due to coronavirus disease (COVID-19). However, the annual number of suicides increased for the first time in 2020, after a downward trend since 2007.

Objective

This study aimed to identify high-risk populations and assess the impact of medical visits on suicide trends in Japan following the COVID-19 pandemic.

Method

This quasi-experimental study used a population-based database from Hyogo Prefecture between 2012 and 2022. Interrupted time-series analyses were used to identify immediate and slope changes in the monthly number of suicides during the exposure period (2020-2022) compared with the control (2012-2019). The analysis was stratified according to the status of psychiatric department and primary care physician visits.

Results: A total of 2181 cases were included. Two-thirds of the cases were male, with a median age of 54. Primary care physicians and psychiatric history were present in 69% and 40% of the patients, respectively. The level change was 4.46 (95%CI; 1.83, 7.09), 3.04 (95%CI; 1.45, 4.64), and 3.07 (95%CI; 0.60, 5.53), in the overall, no primary care physician visit, and no psychiatric visits groups, respectively, which were significant. The level change was not significant in the groups with primary care and psychiatric department visits, at 1.07 (95%CI; -0.84, 2.98) and 0.64 (95%CI; -1.05, 2.33), respectively. The slope changes were not significant in any group.

Conclusion: This study suggests that visits to a medical institution may have helped prevent the rapid increase in suicides during the early stages of the COVID-19 pandemic.

Introduction

The coronavirus disease (COVID-19) pandemic has significantly affected global health, with over six million deaths reported worldwide. Japan was one of the first countries to be affected, experiencing its first case in January 2020. The swift spread of the disease prompted the Japanese government to implement measures, such as border closures, social distancing, and mask mandates. These initiatives, along with high vaccination rates, have helped Japan combat successive waves of infection and achieve one of the lowest infection and mortality rates globally. However, the pandemic has also triggered substantial behavioural changes, including reduced non-essential travel, increased social isolation, and adherence to mask mandates. These factors have contributed to economic hardship, social isolation, and an increase in mental health issues, including suicide.
Japan has one of the highest suicide rates among developed nations, with an average of 20,000 deaths annually. (Sher, 2020; Varnik, 2012) Notably, young people and older men are disproportionately affected. Existing factors contributing to this statistic include hesitation and the societal stigma surrounding mental health resources. (Takano & Osaka, 1999) Furthermore, the limited involvement of primary care physicians in managing mental illnesses has long been recognised. (Ohtsuki et al., 2010) This confluence of factors underscores the seriousness of Japan's challenges with suicide, which the COVID-19 pandemic may have exacerbated.

In 2020, Japan witnessed a 15% increase in suicides compared to the previous year, marking the first such increase in 11 years. (Tanaka & Okamoto, 2021; Yoshioka, Hanley, Sato, & Saijo, 2022) This increase was particularly pronounced among younger individuals and women. (Bersia et al., 2022) Despite this alarming trend, few studies have examined the COVID-19 pandemic's short- and long-term impact on suicide trends.

Therefore, this study aimed to identify high-risk populations and assess the impact of medical visits on suicide trends in Japan following the COVID-19 pandemic using real-world data. Thereby, we aimed to reveal discrepancies between the supply and demand for mental health services during times of crisis, inform the development of efficient intervention methods, and clarify the role of medical institutions in mitigating the mental health consequences of future pandemics. Learning from the COVID-19 pandemic's impact on mental health is crucial for building resilience and preventing future crises.

**Methods**

**Design**

We conducted a quasi-experimental study using an interrupted time-series analysis.

**Data and Population**

The Hyogo Medical Examiner's Office conducts inquests and medical examinations in accordance with the Autopsy Preservation Act of Kobe City. (Ajiki, Fukunaga, Saijoh, & Sumino, 1991) This centre covers all unnatural deaths, including all suspected suicide, injured, and non-endogenous cases, as well as deaths with undetermined ethology or discovered outside of hospitals, in Kobe City, except the northern and western districts. The population covered by the office is approximately one million, and the age distribution (11.8% under 15, 59.4% 15-64, 28.9% 65 and over) is similar to the demographics of Japan (11.9% under 15, 59.5% 15-64, 28.6% 65 and over). (Statistics Bureau Ministry of Internal Affairs and Communications, 2021) Information obtained during autopsies is used in clinical and preventive medicine to improve public health. Approximately 70% of the autopsies performed included a toxicological investigation. The cases investigated by the office accounted for 10.6% of all deaths in the covered area. (Prefecture, 2023)

**Main outcome**
The main outcome of this study was the number of monthly suicide cases in Kobe. Data from January 2011 to December 2022 were collected and analysed.

**Baseline variables**

In our study, we considered the baseline variables related to demographic, clinical, and investigative factors. The data included age, sex, activities of daily living (ADL), living alone or not, and each suicide victim’s status of visits to the primary care and psychiatric department, as well as their method and reason for suicide. ADL were dichotomised as independent or non-independent. We classified the reasons for suicide into work-related, health-related, family related, school-related, grief for the future, and psychiatric diseases. Multiple reasons for suicide could be selected. The presence or absence of regular visits to primary care physicians and psychiatric departments were also recorded. Comorbidities including mental illness were also recorded, however, this information was not based on standardized diagnostic criteria such as International Classification of Diseases, 10th revision (ICD-10) or Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5). This information was verified through on-site police inspections, environmental investigations including family registers, interviews with family members, and hospital visits. Suicide methods were extracted from autopsy results and death certificates.

**Statistical analysis**

We used interrupted time-series (ITS) analysis to examine the impact of the COVID-19 pandemic on suicide rates (Bernal, Cummins, & Gasparrini, 2017). ITS analysis is a quasi-experimental design used to evaluate the impact of interventions or exposures that occur at a particular point in time, and is based on the assumption that the outcome variable follows a predictable trend in the absence of an intervention. The impact of the intervention is estimated by comparing the actual trend of the outcome variable after the intervention with the predicted trend. The ITS analysis has several strengths that make it a valuable tool for evaluating the impact of interventions on public health (McDowall, McCleary, & Bartos, 2019). The ITS analysis can be used to evaluate the impact of interventions and exposures in real-world settings, with real-world populations. This makes the results of the ITS analysis more generalizable and applicable to real-world practice than those of randomized controlled trials, which are often conducted in controlled settings with highly selected populations. ITS analysis does not require a randomized controlled trial, which can be expensive and time-consuming.

\[ y = b_0 + b_1 \cdot \text{time} + b_2 \cdot \text{intervention} + e \]

The coefficient \( b_1 \) represents the difference in the slope of the trend before and after the pandemic. The coefficient \( b_2 \) represents the immediate change in the outcome variable after the intervention.

We defined the pandemic period as the period between January 2020 and December 2022. We used ITS analysis to estimate the immediate change in suicide rates after the COVID-19 pandemic as well as the
changes in trends between the pre-pandemic and pandemic periods. We also conducted a subgroup analysis to identify populations at a considerable risk of suicide during the pandemic. We stratified the data by age, sex, and the presence of follow-up in psychiatric hospitals and primary care physicians. Because stratification into more than two categories decreases the statistical power, we dichotomized the age at the median. Subsequently, we conducted sensitivity analyses for the main analysis and subgroup analysis using different cutoffs for the pre-pandemic and pandemic periods. The period from December 2019 to March 2020 was set as the implementation term, and the periods before and after the implementation term were compared. In this study, a p-value < 0.05 was considered to be statistically significant. All statistical analyses were performed using STATA 18 MP software (Stata Corp, TX, USA).

Results

Figure 1 presents a flowchart of the case selection. Among 15531 unnatural death cases, after excluding 3256 cases whose addresses were outside the sampling regions and 10492 cases who had causes of death other than suicide, 2181 cases were included in this study, consisting of 558 and 1623 cases for the pandemic and pre-pandemic periods, respectively.

Table 1 presents the baseline characteristics of the included cases. Among these, 1438 (66%) were male, with a median (inter-quartile range) age of 54 years (40-70). Single-person households were present in 907 cases (42%), the presence of a primary care physician was observed in 1513 cases (69%), and 870 cases (40%) had visited a psychiatric hospital. More than 95% of the patients displayed independent ADLs, and no major changes were observed before or after the COVID pandemic. The most common method of suicide was hanging (57%), followed by falling from a height (24%). Regarding the reasons for suicide, 24% had work-related issues, 20% had an illness, 12% had family discord, 7% were pessimistic about the future, and 2% had academic difficulties.

The results of the main analysis are shown in Figure 2. ITS analysis showed that there was a significant immediate increase in the monthly number of suicides in Kobe City during the COVID-19 pandemic (immediate change; 4.46, 95% confidence interval [CI]:1.83-7.09). There was no significant decrease in the slope of the trend in suicide rates after the pandemic (trend change; 0.01, 95%CI: -0.12, 0.14). Subgroup analysis showed that the increase in suicide rates after the COVID-19 pandemic was particularly pronounced among younger people and those lacking access to mental health care or primary care physicians (Figure 3). The immediate change in suicide rates among people aged 11-54 years was 3.07 (1.31, 4.82) cases per month, compared to 1.38 (-0.54, 3.30) cases per month among people aged 55 years or older. The immediate change in suicide rates among people who had not visited a psychiatric hospital in the year prior to their death was 3.07 (0.60, 5.53) cases per month, compared to 0.64 (-1.05, 2.33) cases per month among people who had done so. The immediate change in suicide rates among people who had not visited primary care in the year prior to their death was 3.04 (1.45, 4.64) cases per month, compared to 1.07 (-0.84, 2.98) cases per month among people who had done so.

Discussion
Our findings suggest that the COVID-19 pandemic significantly impacted suicide rates in Kobe City, Japan. Subgroup analysis showed that the increase in suicide rates was particularly pronounced among younger people and those who lacked regular access to mental health care or primary care physicians. The sensitivity analyses showed consistent results (Supplementary Figure 1 and 2).

The results of this study indicate that the increase in suicide rates appeared shortly after the COVID-19 pandemic. These findings are consistent with those of other studies that have shown an increase in suicide rates in various countries during the COVID-19 pandemic, including the United States, Canada, and Japan. (Tanaka & Okamoto, 2021) (Farooq, Tunmore, Wajid Ali, & Ayub, 2021) Several factors, such as increased anxiety, disruption of social resources, and deteriorating mental health during the COVID-19 pandemic have been reported as a potential cause of increased suicide rates. (Sher, 2020) In this study, the monthly numbers of suicide increased at the beginning of the pandemic, when COVID-19 had barely appeared in Hyogo Prefecture. However, the trend changes were not significant in the overall or subgroup categories. These results suggest that anxiety over COVID-19 infection, stress from uncertain medical information, and pessimism about the future, rather than COVID-19 incidence itself, may have majorly influenced suicide rates. (Pirkis et al., 2021; Yan, Hou, Li, & Yu, 2023)

In particular, this study suggests that increased suicide may be more likely to occur among younger (aged 11-54) populations, a population that lacks a physician for regular visits, and populations with mental illness. Previous studies have found that the number of patients visiting psychiatry departments in Japan increased by 15–20% during the pandemic, and 80% of psychiatry departments reported overcrowding. (Nagib et al., 2023; Oka et al., 2021; Sakamoto, Ishikane, Ghaznavi, & Ueda, 2021) The overcrowding of psychiatry departments especially serious for children and adolescents, and may result in a decreased quality of care. (Tateno, Inagaki, Saito, Guerrero, & Skokauskas, 2017) This is likely due to several factors, including increased demand for mental health care, decreased availability of mental health services, and financial barriers to mental health care. Other factors are stigma and a lack of public education about mental health. Individuals with mental illness are often unaware of the signs and symptoms of mental health problems or the importance of seeking professional help. (Tsuchiya & Takei, 2004) Individuals who struggle with mental health issues or other difficulties may feel shame seeking help, as they may want to avoid burdening their families or communities. (Tateno et al., 2009) The combination of increasing rates of mental illness and psychiatric overcrowding, behavioural restraints limiting access to medical care, and hesitation to seek care due to stigma may have contributed to an increase in suicides. Proactive outreach programs were also effective, such as brief mental health screening during routine checkups for physical health concerns; collaboration with schools, workplaces, and community centres for educational workshops on recognizing mental health issues and developing campaigns to normalize seeking help for mental health concerns; and destigmatization like physical checkups. Addressing the rise in suicides likely requires a multipronged approach to combat stigma around mental health.

The COVID-19 pandemic has intensified discussions around mental health vulnerability in middle-aged adults. Increased work demands, caregiving responsibilities due to school closures, and marital
difficulties are some of the stressors that emerged during this unprecedented time. (McGinnis, 2018) These factors, coupled with biological changes and societal tendency to overlook mental health struggles in midlife, can lead to delayed help-seeking behaviours. Research supports this notion, highlighting issues like work-life conflict due to remote work, the need for constant supervision of children learning at home, a rise in domestic violence, and social isolation – all of which can significantly impact mental well-being. Acknowledging the vulnerabilities and unique challenges faced by middle-aged adults during the pandemic is crucial for developing effective support systems and fostering help-seeking behaviors that can prevent further negative outcomes.(Chan, Shang, Brough, Wilkinson, & Lu, 2022)

It has also been suggested that primary care visits may act as a buffer against the impact of the early stages of the COVID-19 pandemic. Japan has very good accessibility to medical facilities, with more frequent visits than in other countries.(World Health Organization., 2008) However, in various countries, including Japan, behavioural changes have led to an extreme decrease in visits to healthcare facilities in the early stages of the COVID-19 pandemic.(Williams et al., 2020) Although this could be attributed to a decline in actual medical demand due to a decrease in infections other than COVID-19, uncertainties about infection and restrictions on action by the government may have had a greater impact. particularly in the early stages of the pandemic.(Makiyama et al., 2021; Tanoue et al., 2022) Although telemedicine was temporarily permitted, reduced opportunities for face-to-face medical care triggered reduced opportunities for both verbal and nonverbal medical communication. Patients with regular outpatient visits likely had an opportunity to discuss their psychiatric symptoms, but reduced opportunities to connect with medical care may have failed to suppress the process that led to suicide among those without regular outpatient visits.

The findings of this study suggest that patients who regularly visit medical institutions may have a reduced risk of suicide during the COVID-19 pandemic. Younger individuals are less likely to have underlying or chronic diseases and are less likely to regularly visit medical institutions. Therefore, it may be necessary for them to contact medical institutions outside the framework of chronic disease treatment. Adolescence is a period that is more susceptible to change because it is critical for brain development and socialization.(Harrison, Carducci, Klein, & Bhutta, 2022) There is also a risk of care transition due to care fragmentation at the time of switching from paediatric care to general internal medicine care.(Campbell et al., 2016) During periods of notable change, such as the COVID-19 pandemic, generations more susceptible to anxiety can experience marked shifts in behaviour. To mitigate these negative effects, anxiety and negative perceptions must be addressed.

Additionally, in Japan, where the threshold for visiting a psychiatrist is high, individuals with mild conditions or at low risk visit primary care physicians first.(van den Broek, van Boven, Bor, & Uijen, 2018) Although the frequency of treatment for psychosomatic diseases by primary care physicians in Japan has been estimated to be lower than that in other countries, our study suggests that primary care physicians play a vital role in reducing suicide risk.(Ohtsuki et al., 2010) Therefore, a more established training system for psychosomatic diseases and improvements in reimbursement for treating mental illness can help primary care physicians strengthen mental health treatment efficiency in the future.
Considering the current conditions of overcrowded psychiatric facilities and the high frequency of outpatients in primary care, mental illness interventions by primary care physicians can lead to improvement, including policies to reduce the extreme frequency of medical visits in primary care, as well as sufficient reimbursement to ensure that time is allocated to patients in need of priority care.

The strength of this study is that it uses a population-based database, and the demographic characteristics of the study sample are similar to those of Japan. The database, comprising 10.6% of the total deaths in the designated area, encompasses all confirmed and suspected suicide cases that are subject to legal inspection at the office. There are only a few facilities in Japan that possess the capability to conduct inspections on all suicide cases within their respective sampling areas. Furthermore, studies have reported a significant underestimation of suicides due to misclassification based on death certificates. Consequently, because this study used real-world data with the diagnosis of suicide by professionals, it can be considered to have a high degree of generalisability.

However, the limitations of this study include: 1) the possibility of misclassification of suicide, 2) the risk of mental illness caused by COVID-19 infection, 3) the fact that this study was not a comparative study using a target group, such as a randomised control trial, and 4) lack of detailed code of mental illnesses. The possibility of misclassification was considered to be low because each case in this study was finally judged by a certified forensic pathologist after the investigation of the surrounding situation, including the neighbours, family, and medical professionals, by police inspection divisions. It is less likely that the proportion of misclassification changed between before and during the pandemic, therefore, selection bias may be inconsequential. Regarding the risk of mental illness caused by COVID-19 infection, it is unknown whether each suicide case was actually diagnosed with COVID-19. In the case of suicide cases in 2022, when the pandemic had spread to one-third of the population, the impact of mental illness caused by COVID-19 and the subsequent increase in suicide frequency could not be clarified in this study. However, COVID-19 was not prevalent in Hyogo Prefecture until the beginning of 2022 (Supplementary Figure 3); thus, it may have had a negligible impact on the immediate increase observed in this study. Thirdly, this was a quasi-experimental study without randomisation. It is difficult to capture the true impact of behavioural change on each subject in this study, although the implementation was considered challenging owing to the pandemic situation during this study. Finally, our database had enough information to code the mental illness based on DSM-5, therefore, we could not the effect of specific mental disorders on suicide rates.

Conclusion

Using real-world data, this study estimated the short- and long-term effects of the COVID-19 pandemic on suicide frequency. The increasing frequency of suicide since the early stages of the pandemic was also confirmed. In addition, the frequency of suicide is higher among younger people. However, there was no sharp increase in the frequency of suicide among those with a history of visiting a psychiatrist or primary
care physician. These findings highlight the importance of proactive measures to connect patients with primary care in peacetime. Additionally, addressing the substantial gap between the limited supply of mental health services and the significant demand is crucial to mitigate the rise in suicide rates triggered by COVID-19 related behavioural changes.

Declarations

Author contributions

DM collected, analysed, and interpreted the data and wrote the original draft of the manuscript. All authors critically revised the manuscript for important intellectual content, and read and approved the final manuscript.

Acknowledgments

None.

Disclosure statement

The authors declare no potential conflicts of interest.

Data availability statement

Data are available from the corresponding author DM upon reasonable request.

Ethical consideration

The Ethics Committee for Epidemiology of Hiroshima University approved the study protocol (approval number: E2020-2024).

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References


**Tables**

Table 1 Baseline characteristics of suicide cases
<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Pre-pandemic</th>
<th>Pandemic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=2,181</td>
<td>N=1,623</td>
<td>N=558</td>
</tr>
<tr>
<td>Age, Median(IQR)</td>
<td>54 (40-70)</td>
<td>55 (40-69)</td>
<td>53 (40-70)</td>
</tr>
<tr>
<td>Male, N (%)</td>
<td>1,438 (66%)</td>
<td>1,079 (66%)</td>
<td>359 (64%)</td>
</tr>
<tr>
<td>Primary care physician, N (%)</td>
<td>1,513 (69%)</td>
<td>1,128 (70%)</td>
<td>385 (69%)</td>
</tr>
<tr>
<td>Psychiatry visit, N (%)</td>
<td>870 (40%)</td>
<td>654 (40%)</td>
<td>216 (39%)</td>
</tr>
<tr>
<td>Living alone, N (%)</td>
<td>907 (42%)</td>
<td>670 (41%)</td>
<td>237 (42%)</td>
</tr>
<tr>
<td>Independent ADL, N (%)</td>
<td>2,074 (95%)</td>
<td>1,541 (95%)</td>
<td>533 (96%)</td>
</tr>
<tr>
<td>Reason for suicide, N (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychiatry diseases</td>
<td>813 (37%)</td>
<td>611 (38%)</td>
<td>202 (36%)</td>
</tr>
<tr>
<td>Work-related</td>
<td>521 (24%)</td>
<td>395 (24%)</td>
<td>126 (23%)</td>
</tr>
<tr>
<td>Health-related</td>
<td>441 (20%)</td>
<td>330 (20%)</td>
<td>111 (20%)</td>
</tr>
<tr>
<td>Family-related</td>
<td>268 (12%)</td>
<td>214 (13%)</td>
<td>54 (10%)</td>
</tr>
<tr>
<td>Grief for future</td>
<td>143 (7%)</td>
<td>116 (7%)</td>
<td>27 (5%)</td>
</tr>
<tr>
<td>School-related</td>
<td>44 (2%)</td>
<td>28 (2%)</td>
<td>16 (3%)</td>
</tr>
<tr>
<td>Suicide method, N (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hanging</td>
<td>1,244 (57%)</td>
<td>927 (57%)</td>
<td>317 (57%)</td>
</tr>
<tr>
<td>Fall from height</td>
<td>519 (24%)</td>
<td>373 (23%)</td>
<td>146 (26%)</td>
</tr>
<tr>
<td>Poisoning</td>
<td>118 (5%)</td>
<td>94 (6%)</td>
<td>24 (4%)</td>
</tr>
<tr>
<td>Drowning</td>
<td>81 (4%)</td>
<td>49 (3%)</td>
<td>32 (6%)</td>
</tr>
<tr>
<td>Running into traffic</td>
<td>91 (4%)</td>
<td>70 (4%)</td>
<td>21 (4%)</td>
</tr>
<tr>
<td>Stabbing</td>
<td>56 (3%)</td>
<td>48 (3%)</td>
<td>8 (1%)</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>50 (2%)</td>
<td>44 (3%)</td>
<td>6 (1%)</td>
</tr>
<tr>
<td>Others</td>
<td>19 (1%)</td>
<td>15 (1%)</td>
<td>4 (1%)</td>
</tr>
</tbody>
</table>

In cases of death due to multiple reasons, all reasons were counted. N, number; IQR, interquartile range; ADL, activities of daily living.

**Figures**
Among 15531 cases, after excluding 3256 cases whose addresses were outside the sampling regions and 10492 cases who had causes of death other than suicide, 2181 cases were included in this study. Of these, 558 and 1623 died by suicide during the COVID-19 and pre-pandemic periods, respectively.

**Figure 1**

Flowchart of case selection
Figure 2

Result of interrupted time-series analysis before and during the COVID-19 pandemic

The data show the trends in the monthly number of suicides between January 2012 and December 2022 in Kobe, Japan. The solid lines indicate the approximate lines for the exposure and target periods and each plot shows the actual number of suicides per month. The difference in the intercepts before and during the pandemic was analysed as a level change, whereas the difference in the slopes before and during the pandemic was analysed as a trend change.
The level and trend changes for age (dichotomous), sex, living status, and hospital visits to psychiatric hospitals and primary care physicians are shown, with 95% confidence intervals. The level change represents the intercept, an increase or decrease between December and January 2020, which was distinct from the ongoing trend. A value > zero indicates an immediate increase in the number of suicide cases during the pandemic. The trend change represents the difference in the slope before and during the COVID-19 pandemic. A value greater than zero indicates an increase in the slope of suicide cases during the pandemic.
Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryFigure1v2.tif
- SupplementaryFigure2v3.tif
- SupplementaryFigure3v2.tif