

Reasons and trends in youth's suicide rates during the COVID-19 pandemic



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Summary

Background The COVID-19 pandemic posed many mental health challenges to youth through unprecedented infection control measures such as nationwide school closures. Despite this, few studies have investigated trends in suicide among youth during the pandemic, let alone their reasons.

Methods Population-level data on crude monthly suicide rates (2016–2021) and reasons of suicide (2018–2020) among youth aged 10–19 years were obtained from the Japanese Ministry of Health, Labour and Welfare and the National Police Agency, respectively. Using an event study design (with a Poisson regression model to calculate changes-in-changes (CiC) estimates) and interrupted time series analysis, we investigated changes in monthly suicide rates during the first 12 months of the pandemic (May 2020 to April 2021) compared to pre-pandemic levels (May 2016 to March 2020). Additionally, we investigated the changes in reasons of suicide (family-related, mental illness, social concerns, and academic concerns).

Findings In the event study analysis, suicide rates among youth increased during the pandemic relative to pre-pandemic levels, especially between August–November 2020 (e.g., ratio of the suicide rate in November 2020 relative to previous years, 1.86; 95% confidence interval (CI), 1.30 to 2.66). Though suicide levels returned closer to pre-pandemic levels by December 2020, they remained slightly elevated into 2021. In the interrupted time series analysis, suicide rates increased from May to August 2020 (0.099 cases per 100,000 youth per month; 95% CI, 0.022 to 0.176), followed by a decrease from September to December 2020 (-0.086 cases per 100,000 youth per month; 95% CI, -0.164 to -0.009). We observed elevated suicide rates for all major reasons from summer to autumn 2020, especially suicides attributed to family-related problems and social concerns. Furthermore, rates of suicides attributed to mental illness remained higher than pre-pandemic levels into December 2020.

Interpretation Suicide rates among youth remained slightly elevated compared to pre-pandemic levels into 2021. The reasons of the increase in suicide rates were multifactorial, including mental health issues and disruptions in social relationships. During a pandemic, interventions that provide mental support as well as opportunities for regular social interactions to youth may be beneficial.

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Introduction

The coronavirus disease 2019 (COVID-19) pandemic has presented unforeseen challenges to youth, whose lifestyles were drastically changed due to infection control measures such as nationwide lockdowns and school closures.¹ When social distancing constitutes everyday life experiences, protective factors for mental health (e.

Research in context

Evidence before this study

Suicide during the COVID-19 pandemic among youth has been of considerable concern, given that their lifestyles have changed drastically due to lockdowns and school closures. We searched PubMed for articles up to March 31, 2022, with search terms “suicide” AND (“COVID-19” OR “pandemic”) AND (“youth” OR “young people” OR “adolescents”). Studies have extensively investigated the trends in suicide during the pandemic among the general population in Japan and abroad, which found that suicide rates initially decreased compared to previous years but subsequently increased into 2021. As for younger populations, studies have suggested that suicide rates among youth decreased or were unchanged in the first few months of the pandemic compared to pre-pandemic levels, after which suicide rates increased and remained high to the end of 2020. However, trends in suicide rates among youth during the pandemic into 2021 has yet to be fully elucidated, let alone the reasons for these changes in suicide rates among youth. To design effective policy interventions to counteract the negative consequences of social distancing measures on youth, evidence is needed on the reasons why more youth died by suicide during the pandemic.

Added value of this study

This nationwide population-based study provides novel evidence on the trends in suicide rates among youth up to a year since the start of the pandemic, as well as the reasons for the changes in suicide rates. We use data from Japan, where suicide is the number one cause of death for young people. We provide evidence that suicide rates remained slightly elevated compared to pre-pandemic levels into March 2021. Rates of suicides attributed to social concerns, family-related issues, and academic concerns increased from near the end of summer break to November 2020 but returned closer to pre-pandemic levels by the end of 2020. In contrast, rates of suicides attributed to mental health issues remained elevated relative to pre-pandemic levels into the end of 2020.

Implications of all the available evidence

Suicide rates among youth remained elevated relative to pre-pandemic levels one year into the pandemic. The reasons for increases in suicide rates during the pandemic are likely multifactorial, but rates of suicides attributed to mental health issues were particularly increased later into the pandemic. Mental health issues may have been exacerbated due to cumulative stress and decreased access to mental health services, likely stemming from the chronicity of the pandemic. These findings underscore the importance of providing continual mental health support for youth with mental health needs in the pandemic setting.

g., schooling, social support, and community support) are substantially disrupted.¹ These adverse effects of the pandemic on youths’ mental health might be exacerbated by fear of contagion, deaths of friends or family members, self-isolation, and physical distancing.² Thus, suicide among youth has become a topic of concern as the pandemic continues to affect the general population,³ especially in Japan, where suicide has been the number one cause of death for young populations.⁴ Studies have extensively investigated the trends in suicide during the pandemic among the general population in Japan^{5–8} and abroad,^{9,10} which found that suicide rates initially decreased compared to previous years⁵ but subsequently increased into 2021. Of note, two studies provided robust evidence that suicide rates among younger populations in Japan increased later into the pandemic in 2020, after accounting for time trends and seasonality.^{5,8}

However, studies have not provided updated evidence on trends in suicide among youth into 2021, nor have they thoroughly delineated the reasons why more youth may have died by suicide during the pandemic. Investigating the mechanisms for the changes in suicide rates is essential, as one could hypothesize that the social distancing measures and school closures imposed during the pandemic could have affected youth in various, possibly conflicting ways: school closures may have removed certain youth from exposure to stressful social interactions such as bullying in school,¹¹ but they may also have forced youth to remain exposed to adverse experiences at home.¹² Additionally, school is an important social buffer that could reduce inequalities through exposure to culture and knowledge for all students. For effective policy interventions to counteract the negative consequences of lockdowns and school closures during the pandemic on youth, more evidence is needed on the mechanisms by which more youth died by suicide during the pandemic than before the pandemic.

In Japan, national-level school closures were implemented from March to May 2020. Students in Japan are typically on spring break from late March to early April, on summer break from late July to late August, and on winter break from late December to early January. Thus, in 2020, students attended school in-person for only a month between March and August 2020. While the pandemic eventually led to the introduction of online classes in many schools, it is likely that a majority of students did not attend them during the school closures early in the pandemic: according to a survey by the Japanese government, fewer than half of primary or secondary school students reported taking classes online in May 2020.¹³ We hypothesized that such changes in school life, along with the numerous states of emergency declared in Japan in 2020 and 2021, may have caused major disruptions in youths’ lifestyles.

Thus, we conducted the present study to provide updated evidence on the national trends in suicide rates

among youth in Japan during the COVID-19 pandemic into 2021. Furthermore, by examining trends in reasons of suicide, we aimed to provide possible explanations for the changes in suicide rates among youth in Japan during the pandemic.

Methods

Study design, data source, and population

We conducted an observational study to investigate the national trend in suicide rates during the COVID-19 pandemic among youth aged 10-19 years. Japan offers a unique opportunity to investigate this, as the Japanese government collects and releases monthly data on not only the total number of suicides in the nation but also the number of suicides attributable to specific causes or motives.^{4,14} Data on monthly suicides were obtained from Japan's Ministry of Health, Labour and Welfare (MHLW) from April 2016 to April 2021, using the most up-to-date data available.¹⁴ Data on monthly suicides for each reason of suicide from January 2018 to December 2020 were obtained from the suicide statistics collected by the National Police Agency (NPA) and released by the MHLW annually;⁴ for each documented suicide, the NPA registers up to three causes or motives that can be clearly inferred from available evidence such as suicide notes and interviews of the bereaved.¹⁵ Data on the national population for each month were obtained from the Ministry of Internal Affairs and Communications.¹⁶ All data were publicly available (data on suicides, https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00450011&tstat=000001028897&cycle=1&tclass1=000001053058&tclass2=000001053060&result_back=1&tclass3val=0; data on reasons of suicide, https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/hukushi_kaigo/seikatsuhogo/jisatsu/jisatsu_year.html).

Measurements

Crude monthly suicide rates (per 100,000 population) were calculated by dividing the number of suicides by the national population of youth aged 10-19 years. Additionally, we examined trends in suicide rates by different reasons of suicide. The population of all individuals aged 10-19 years living in Japan was used for the total monthly suicide rates and the population of all Japanese individuals aged 10-19 years in Japan was used for the monthly suicide rates for each reason for suicide, owing to the difference in how data are collected by the MHLW and the NPA.^{4,14}

The NPA classifies each cause or motive of suicide into six categories regardless of the age group, and some of the causes or motives in each classification are heterogeneous and may not necessarily belong in the same category in the context of the pandemic.⁴ For instance, "concerns about entrance exams" and

"bullying" are both placed in the "school issues" category, but these two motives of suicide have different meanings in the context of infection control measures imposed during the pandemic: while the former may be related to academic concerns resulting from school closures, the latter is likely influenced by disruptions in social relationships from not seeing peers regularly. Thus, based on the expert opinion of a child psychiatrist with 20+ years of clinical and research experience, we grouped the causes and motives of suicides that were hypothesized to have a meaningful impact on youth in the pandemic setting into four domains: family-related, mental illness, social concerns, and academic concerns. The reasons of suicide we considered were as follows: disagreements with parents, disagreements with other family members, discipline and scolding, being abused, depression, schizophrenia, other mental disorders, disagreements with friends, bullying, romantic relationships, other social relationships, entrance exams, concerns about one's future course, and grades. The family-related domain consisted of suicides attributed to disagreements with parents, disagreements with other family members, discipline and scolding, and being abused. The mental illness domain consisted of suicides attributed to depression, schizophrenia, and other mental disorders. The social concerns domain consisted of suicides attributed to disagreements with friends, bullying, romantic relationships, and other social relationships. The academic concerns domain consisted of suicides attributed to entrance exams, concerns about one's future course, and grades. These causes and motives accounted for about 70% of all documented reasons for suicide among individuals 19 years of age or younger from January 2018 to December 2020, and many of the remaining reasons were classified as "other" and were unspecified.⁴

The beginning of the pandemic was defined as April 2020. In Japan, though the first case of COVID-19 was identified in January, cases began spreading rapidly into April 2020, when a state of emergency was declared. Although there have been no national-level school closures since May 2020, a total of four declarations of a state of emergency (April 7 to May 25, 2020, January 8 to March 21, 2021, April 24 to June 20, 2021, and July 12 to September 30, 2021) have been made as of December 2021, during which restrictions on dining out, social events, and traveling were imposed. Although the government did not punish individuals for not complying with these restrictions, Japan saw drastic declines in public outings, especially during the first few declarations. Even when declarations of emergency were not imposed, the public has been asked to refrain from social gatherings throughout the course of the pandemic. Furthermore, many schools, especially universities, have refrained from giving in-person classes due to concerns of infection, even after the national-level school closures ended.

Statistical analyses

We first plotted the trend in monthly suicide rates during the pandemic (April 2020 to April 2021) compared with rates before the pandemic (April 2016 to March 2020) using means and 95% confidence intervals assuming a normal distribution.

Second, using an event study design, we created a Poisson regression model to estimate the changes in suicide rates (as changes-in-changes (CiC) estimates)¹⁷ for each month during the pandemic compared to monthly suicide rates before the pandemic. We checked that the assumptions of the Poisson model were met by conducting a regression-based significance test for overdispersion by Cameron and Trivedi.¹⁸ The event study design is a widely used method in the economics literature¹⁹ (and recently in the public health literature)^{5,8,20} that estimates the impact of an event on the outcome by comparing the observed outcomes after an event to the expected values estimated based on the pre-event trends. CiC estimates are difference-in-differences estimates in relative scales, representing the relative change of the suicide rate during the COVID-19 pandemic compared with the expected suicide rates estimated from pre-pandemic data. Our model specification is as follows:

$$\log(y_t) = \gamma_t + \delta t + \sum_{r=50}^{60} \mu_r d_t + \varepsilon,$$

where t represents the time in months from May 2016, y_t represents the suicide rate, γ_t is an indicator for calendar time (month fixed effects) to account for seasonality, δt is the linear pre-pandemic trend, μ_r represents the change in outcome relative to the linear pre-pandemic trend at time r (CiC estimate at each pandemic month, which starts at month 50 (May 2020) and ends at month 60 (March 2021)), our parameter of interest, d_t represents a dummy variable equal to 1 if t is equal to r and 0 otherwise, and ε represents the error term. We set April as the reference month, and data from May 2016 to April 2021 were used.

Additionally, we conducted an interrupted time series analysis (ITSA) of monthly suicide rates using data from May 2016 to April 2021, dividing the pandemic period into three periods (May to August 2020, September to December 2020, and January to April 2021) to investigate trends in suicide rates during the pandemic. We fit the following linear regression model:

$$\begin{aligned} y_t = & y_0 + \alpha t + \beta_1 \text{pandemic}_{1,t} + \theta_1 \text{pandemic}_{1,t} T_{1,t} \\ & + \beta_2 \text{pandemic}_{2,t} + \theta_2 \text{pandemic}_{2,t} T_{2,t} \\ & + \beta_3 \text{pandemic}_{3,t} + \theta_3 \text{pandemic}_{3,t} T_{3,t} + \varepsilon, \end{aligned}$$

where t represents the time in months from May 2016, y_t the suicide rate, y_0 the suicide rate in May 2016 (the intercept), $T_{1,t}$ the time in months since April 2020, $T_{2,t}$

the time in months since August 2020, $T_{3,t}$ the time in months since December 2020, $\text{pandemic}_{1,t}$ an indicator for May to August 2020, $\text{pandemic}_{2,t}$ an indicator for September to December 2020, $\text{pandemic}_{3,t}$ an indicator for January to April 2021, and ε the error term. Our parameters of interest are β and θ , which represent the level change and the slope change, respectively, in suicides per 100,000 population in a given period during the pandemic (May to August 2020, September to December 2020, or January to April 2021) relative to pre-pandemic. Additionally, we created a separate model adjusted for the seasonality in suicide rates by introducing a Fourier term to the above linear regression.²¹

Finally, to investigate the changes in reasons of suicide, for each reason of suicide, we used an event study design with Poisson regression models to estimate the changes in suicide rates (as CiC estimates) compared to pre-pandemic (2018 to 2019) for each month between May to December 2020. We also provided confidence intervals adjusted for multiplicity using the Bonferroni method.

All analyses were conducted using R version 4.1.1 (R Project for Statistical Computing), with packages stats and MASS.

Analyses stratified by sex

We plotted the trend in monthly suicide rates by sex during the pandemic (April 2020 to April 2021) compared with rates before the pandemic (April 2016 to March 2020) using means and 95% CIs assuming a normal distribution. Additionally, we used an event study design with a Poisson regression model to estimate the changes in monthly suicide rates by sex. The results of the analyses stratified by sex are available in the supplemental material.

Sensitivity analyses

To check the robustness of the event study analyses, we constructed a linear regression model and a negative binomial regression model to obtain the difference-in-difference estimates and CiC estimates of monthly suicide rates, respectively, for each month during the pandemic compared to the monthly suicide rates before the pandemic. Additionally, we constructed a Poisson regression model without assuming a linear pre-pandemic trend by removing the term δt from the aforementioned Poisson regression. The results of the sensitivity analyses are available in the supplemental material.

Ethical considerations

All data were publicly available, and thus our study was exempt from ethical review as per the University of

Tokyo Graduate School of Medicine's ethical guidelines for research.

Role of the funding source

We obtained funding from the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (Project #10012, TroNa Partnership). The funders were not involved in the study design, data collection, data analysis, interpretation, or writing of the report.

Results

Suicide rates began to increase from June and July 2020 compared to pre-pandemic years, though the estimates were imprecise with wide confidence intervals (Figures 1 and 2). The increase in suicide rates compared to pre-pandemic years was especially large between August and November 2020 (Figure 2), with the largest observed suicide rate relative to the expected suicide rate in November 2020 (ratio of the suicide rate in November 2020 relative to pre-pandemic (CiC estimate), 1.86; 95% confidence interval (CI), 1.30 to 2.66). We also observed increased suicide rates from December 2020 to March 2021, but these increases were smaller than August to November 2020, and the estimates were imprecise with large confidence intervals (Figure 2). For instance, the CiC estimate in March 2021 was 1.36 (95% CI, 0.94 to 1.97). Though the analyses stratified by sex revealed similar results, the increase in suicide rates was more pronounced for females than

males; we observed increased suicide rates among males only in October and November 2020 (e.g., CiC estimate for October, 1.67; 95% CI, 1.08 to 2.57), but we observed larger increases in August, September, and November 2020 among females (e.g., CiC estimate for November, 2.34; 95% CI, 1.31 to 4.19) (Figures S1 and S2). Sensitivity analyses using a linear regression (Figure S3), negative binomial regression (Figure S4), and Poisson regression without assuming a linear pre-pandemic trend (Figure S5) revealed similar trends as the primary event study analysis.

In the ITSA, suicide rates increased sharply from May to August 2020, followed by a decrease from September to December 2020. From January 2021, the trend in suicide rates was similar to pre-pandemic (Figure 3). Both the unadjusted analysis (solid line in Figure 3) and analysis adjusted for seasonality (dotted line in Figure 3) revealed similar results. Here, we present the detailed estimates from the adjusted analysis. In May 2016, the monthly suicide rate was an estimated 0.372 cases per 100,000 youth, and the suicide rate increased by 0.003 cases per 100,000 youth per month (95% CI, 0.001 to 0.004) until April 2020. In the first month of the pandemic period (May 2020), the suicide rate decreased by 0.160 deaths per 100,000 youth (95% CI, -0.378 to 0.057), followed by an increasing trend (relative to pre-pandemic) of +0.099 cases per 100,000 youth per month (95% CI, 0.022 to 0.176) from May to August 2020. In September 2020, the suicide rate was 0.379 deaths per 100,000 youth (95% CI, 0.160 to 0.598) greater relative to pre-pandemic, followed by a decreasing trend of -0.086 cases per 100,000 youth per

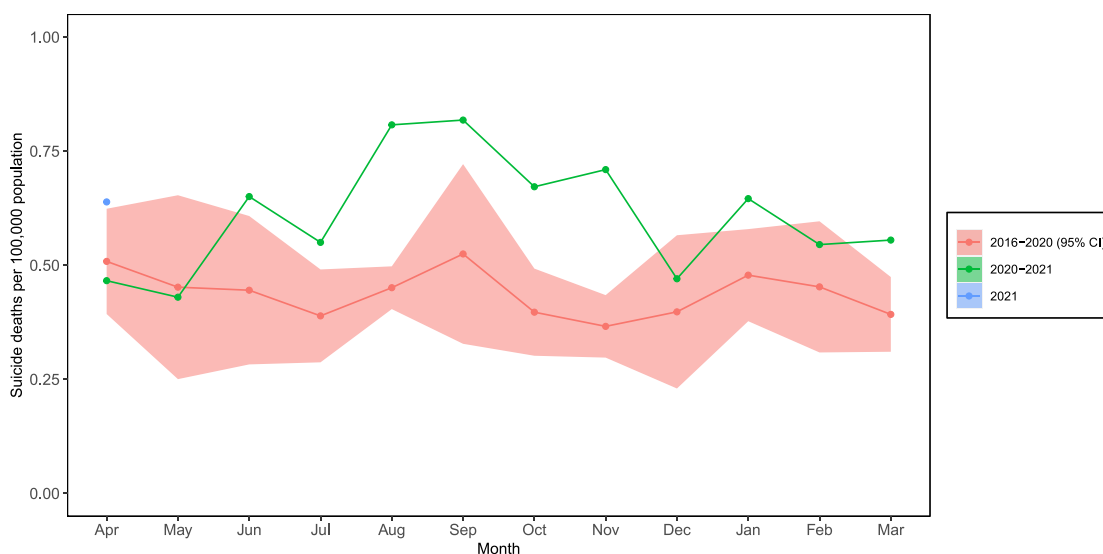


Figure 1. Trends in suicides per 100,000 population among youth.

Shown in green are the monthly suicide rates from April 2020 to March 2021, in blue is the suicide rate in April 2021, and in red are means of monthly suicide rates from May 2016 to April 2020 and their 95% confidence intervals, assuming a normal distribution. CI, confidence interval.

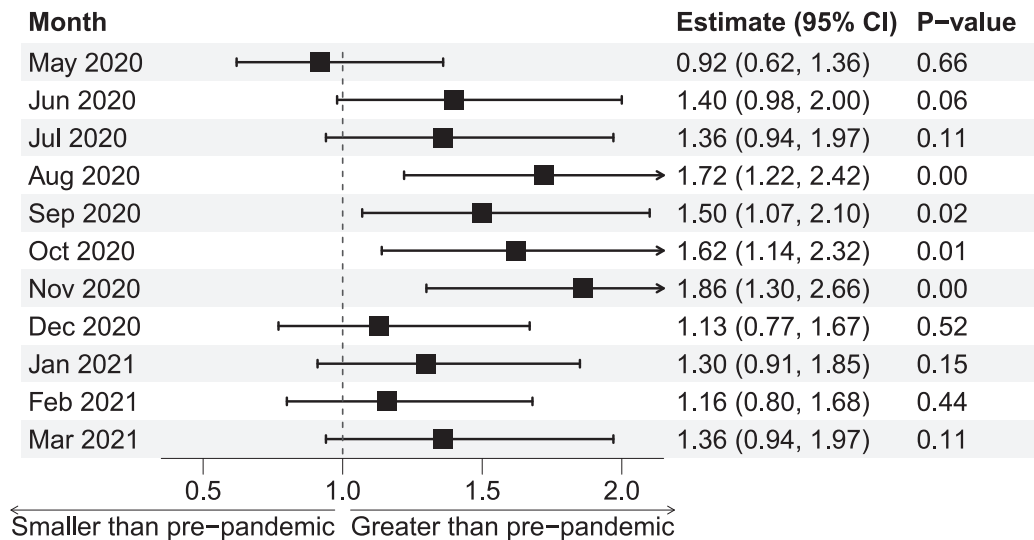


Figure 2. Changes-in-changes (CiC) estimates of suicides per 100,000 population among 10- to 19-year-olds between May 2020 and March 2021 relative to pre-pandemic months.

Shown are CiC estimates under a Poisson regression model using an event study design, 95% confidence intervals, and P-values. CI, confidence interval.

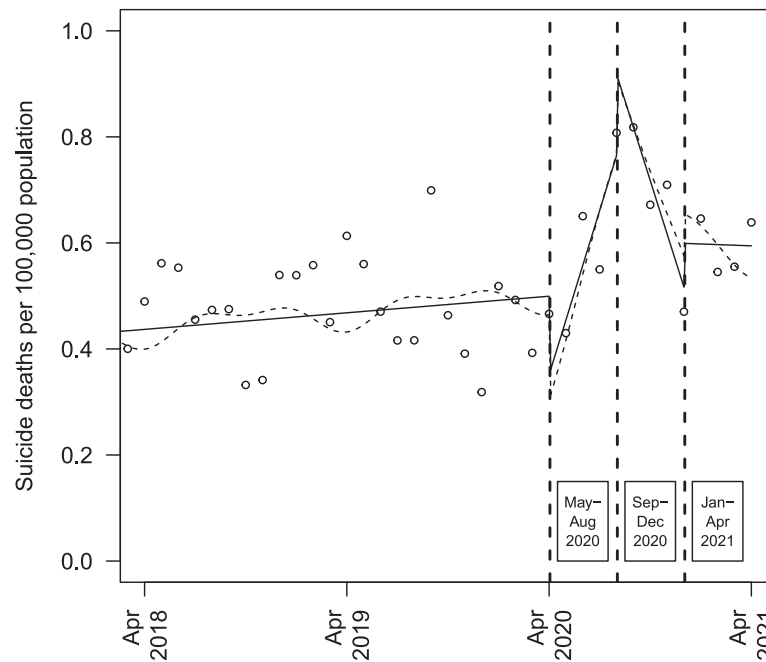


Figure 3. Results of the interrupted time series analysis. Shown are unadjusted results (solid line) and results adjusted for seasonality (dotted line).

In both the adjusted and unadjusted results, suicide rates increased from May to August 2020, followed by a decrease from September to December 2020. From January 2021, the trend in suicide rates was similar to pre-pandemic. Both trends were analyzed using linear regression models. The detailed results of the interrupted time series analyses are available in the supplemental material.

month (95% CI, -0.164 to -0.009) from September to December 2020. In January 2021, the suicide rate was 0.113 cases per 100,000 youth (95% CI, -0.105 to 0.331) greater relative to pre-pandemic, followed by a nearly

stable trend of -0.019 cases per 100,000 youth per month (95% CI, -0.096 to 0.058) from January to April 2021. The full results of the ITSA are available in the supplemental material.

We observed elevated suicide levels for all major reasons (family-related, mental illness, social concerns, academic concerns) from summer to autumn 2020 (Figure 4). Of note, rates of suicides attributed to family-related problems and social concerns were disproportionately higher in August 2020 (CiC estimate for family-related problems, 9.36 [95% CI, 2.13 to 41.18]; CiC estimate for social concerns, 7.13 [95% CI, 1.58 to 32.15]). Furthermore, the increase in rates of suicides attributed to mental illness was prolonged and remained higher than pre-pandemic levels into December 2020 (CiC estimate, 5.12; 95% CI, 1.49 to 17.62). Results were generally consistent after adjusting for multiplicity, though estimates for academic concerns were especially imprecise (Figure S6).

Discussion

Principal findings

Suicide rates among youth in Japan were consistent with suicide rates in the pre-pandemic period in the initial months of the pandemic, but increased from June 2020, peaking in summer to autumn 2020. Suicide rates returned closer to pre-pandemic levels by December 2020. These findings corroborate results from previous studies, which found that suicide rates initially decreased compared to previous years⁵ but subsequently increased later in 2020.^{5,8} We found that suicide rates among youth remained slightly elevated compared to pre-pandemic levels into March 2021. Furthermore, by examining trends rates of suicides attributed to different reasons, we provide explanations for the changes in suicide rates during the pandemic.

Possible explanations of trends in suicide rates during the pandemic

Our finding that suicide rates were not increased in the initial months of the pandemic⁹ but was followed by an increase has been described previously,⁵ although evidence from previous epidemics seem to be more mixed.^{22,23} A similar trend in suicides is commonly seen among people affected by natural disasters and war, a phenomenon termed the “honeymoon effect.”^{24,25} For instance, a group of researchers reported that in the aftermath of the 2011 earthquake and tsunami in Japan, suicide rates in Fukushima, Japan declined in the two years immediately following the disaster but exceeded pre-disaster levels in the third year.²⁶ The authors attributed the initial decline to a “collective feeling of concern and altruism” and the subsequent rise in suicide rates to the setting in of the reality, such as the demoralization and anxiety and changes in lifestyles. This “honeymoon effect” could explain the unelevated suicide rates during the initial months of the pandemic.

The rise in suicide rates in summer to autumn 2020 is likely multifactorial; peaks in suicide rates for each domain compared to pre-pandemic were generally concentrated in summer to autumn 2020. After being away from school for several months during the two consecutive breaks from school (school closure from April to May 2020 and summer vacation from July to August 2020), youth’s stress from having to have to return to school may have been exacerbated. Our finding that rates of suicides attributed to social concerns were high in August 2020 compared to pre-pandemic levels could reflect this. This is in contrast to our hypothesis that school closures may have removed some youth from exposure to stressful social interactions such as bullying in school,¹¹ possibly because stressful social interactions could persist through online interactions (e.g., cyber-bullying). Rates of suicides attributed to social concerns became lower in the months following (September to December 2020), likely because there have been no school closures since. Similarly, rates of suicides attributed to academic concerns rose in June 2020, possibly reflecting youths’ transient stress in keeping up with the school work after being away from school for such a long time. There were no school closures imposed from July and December 2020, which could explain why rates of suicides attributed to academic concerns remained unelevated during this period.

Interestingly, rates of suicides attributed to family-related issues followed a distinct pattern: they peaked in August and November 2020. The reasons for the bimodal pattern could be multifactorial. First, the stay-at-home orders may have increased youth’s exposure to trauma from family members, increasing the risk of many forms of psychopathology, including anxiety, depression, and disruptive behavior. Changes in familial support could explain the sex difference in changes in suicide rates (females experienced greater increases than males). A study that evaluated various risk factors of suicide attempts by sex revealed that the risk factor with the largest sex difference was familial support: low support from one’s family significantly predicted suicide attempts for young women, but was unrelated to suicidal behavior among young men.²⁷ Second, youth may have suffered from not having a wider social circle as a consequence of stay-at-home orders that has persisted over the course of the pandemic. For instance, the Japanese Ministry of Education, Culture, Sports, Science and Technology has recommended limiting extracurricular club activities to a minimum when the infection rates are high.²⁸ Recent evidence suggests that after-school sports programs could improve adolescents’ mental well-being,²⁹ and these social distancing measures could have acted against the mental health of youth.

Though suicide rates declined from December 2020, they remained slightly elevated compared to pre-

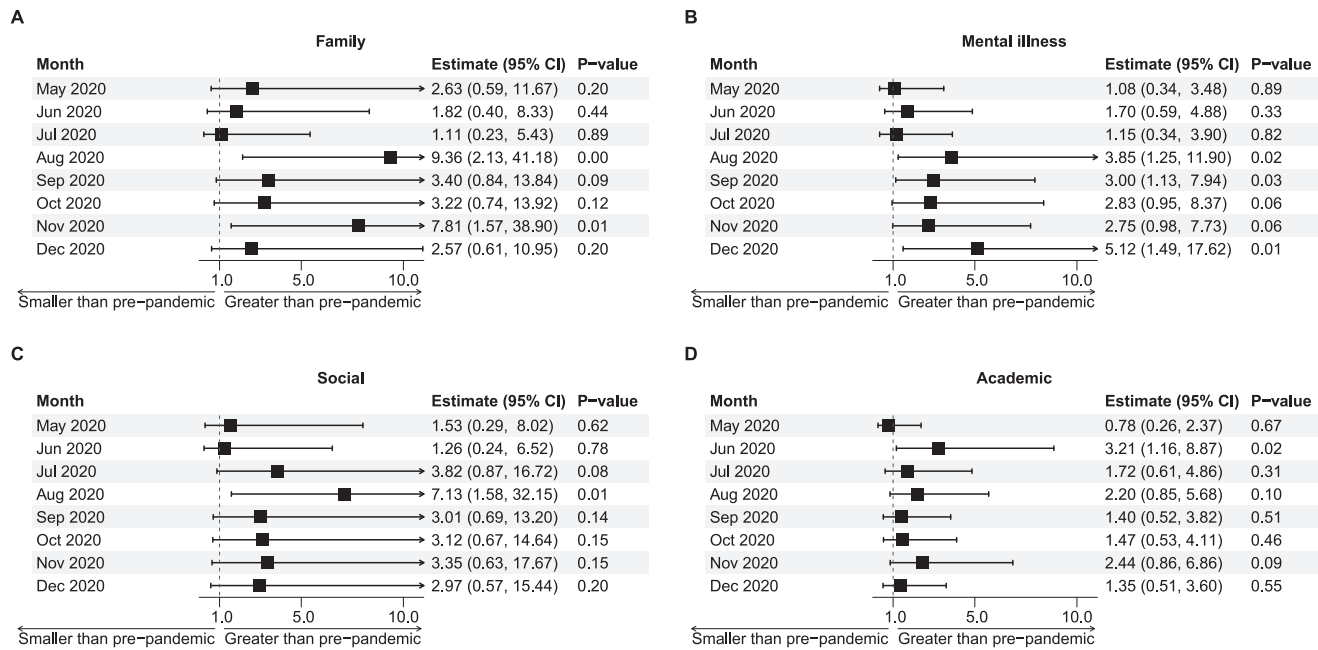


Figure 4. Changes-in-changes (CiC) estimates of suicides per 100,000 population among 10- to 19-year-olds during the pandemic (May to December 2020) relative to pre-pandemic months, by reasons of suicide.

Shown are CiC estimates under a Poisson regression model using an event study design, 95% confidence intervals, and P-values. Each pandemic month is compared to the corresponding pre-pandemic months in 2016 to 2019. For instance, the estimates for May 2020 represent the CiC estimates relative to May 2016, May 2017, May 2018, and May 2019. CI, confidence interval.

pandemic levels into 2021. This could be explained by suicides attributed to mental illness, which were most elevated compared to pre-pandemic levels in December 2020, likely reflecting the cumulative stress due to the chronicity of the pandemic³ as well as the prolonged decrease in the access to mental health services and mental support.^{30,31} First, youth with mental illness are known to have high susceptibility to cumulative stress, and the chronicity of the pandemic may have exacerbated the mental health of these youth.³ Second, severed access to mental health support was a concern to many experts since the start of the pandemic.³² Indeed, patients who presented to pediatric primary care decreased by nearly 50% compared to previous years in May 2020,³³ and it is possible that some youth with mental health disorders did not receive mental health care due to decreased access to health services from concerns of infection.^{34,35} Thus, decreased access to mental health support was likely an exacerbating factor of mental health problems for youth with mental illness.^{34,35} This is a sharp contrast to rates of suicides attributed to social or academic concerns, which appeared to have decreased with more time since the school closure. Hence, cumulative stress and decreased access to mental health care could explain why suicide rates remained slightly higher in 2021 than pre-pandemic.

Strengths and limitations

We provide updated evidence on the trends of suicide rates during the COVID-19 pandemic into 2021 using population-level data. Furthermore, we provide possible explanations of the changes in suicide rates using data on the reasons attributed to the suicides. The robustness of our findings is corroborated through multiple sensitivity analyses. Experts have stressed the importance of considering economic, psychosocial, and health-associated changes induced by the pandemic,³⁶ and, to our knowledge, our study is the largest population-level study to date that addresses this to the extent possible.

Our study should be interpreted in light of several limitations. First, the transportability of our findings to other countries could be unclear. For example, the school closure in Japan has been imposed only once during the pandemic and for a limited duration – from April to May 2020.³⁷ To examine the effects of repeated or chronic school closures, it would be valuable to investigate the trends in youths' suicide and their reasons in countries where school closures lasted for longer durations. Additionally, while we investigated the possible reasons for the changes in suicide rates, it is unlikely that suicide can be attributed to one cause. Furthermore, the classifications of reasons for suicide we used were broad and incorporated a number of reasons, indicating the potential presence of misclassification. Though we tailored the classifications to better fit the

pandemic setting, alternative classifications may have revealed different results.

Future studies and implications

Our study suggests that during a pandemic, interventions that provide mental support as well as opportunities for regular social interactions to youth may be beneficial. Suicide rates remained elevated compared to pre-pandemic levels into March 2021, indicating the need to further monitor suicide rates well into the later phases of the pandemic. For instance, tracking suicides attributed to mental illness would be valuable, as they remained elevated into the end of 2020. Such trends should be interpreted in light of the steadily decreasing COVID-19 cases in Japan as of autumn to winter 2021 (which have hit the lowest levels since the start of the pandemic in autumn 2021) and the easing stay-at-home orders.^{38,39} Though it is unclear how long the effects of the pandemic on suicide may last, previous evidence from disaster medicine, which indicated that natural disasters may be associated with increased suicides at least four years after exposure,⁴⁰ suggests that suicide rates should be monitored at least several years from the start of the pandemic.

Conclusion

Suicide rates among youth were initially unelevated in comparison to pre-pandemic years but increased from summer 2020. Suicide rates returned closer to pre-pandemic levels in winter 2020, but remained slightly elevated compared to pre-pandemic levels into March 2021. The increase in suicide rates may be attributed to mental health issues and disruptions of regular social interactions.

Contributors

Dr Goto conceived the research idea, designed the study, carried out the analyses, interpreted the results, drafted the manuscript, and reviewed and revised the manuscript.

Dr Okubo helped design the study and conducts the analyses, contributed to the interpretation of the results, and made critical revisions of the manuscript.

Dr Skokauskas conceptualized the study, contributed to the interpretation of the results, made critical revisions of the manuscript, and directed the project.

Data access, responsibility, and analysis

Dr Goto, Dr Okubo, and Dr Skokauskas had full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis.

Data sharing statement

All the data used in this study are publicly available.

Declaration of interests

The authors declare no competing interests.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.lanwpc.2022.100567.

References

- Lee J. Mental health effects of school closures during COVID-19. *Lancet Child Adolesc Health*. 2020;4(6):421.
- Gunnell D, Appleby L, Arensman E, et al. Suicide risk and prevention during the COVID-19 pandemic. *Lancet Psychiat*. 2020;7(6):468–471.
- Yao H, Chen J-H, Xu Y-F. Patients with mental health disorders in the COVID-19 epidemic. *Lancet Psychiat*. 2020;7(4):e21.
- Ministry of Health, Labour, and Welfare. Suicide statistics. https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/hukushi_kaigo/seikat_suhogo/jisatsu/jisatsu_year.html. Accessed 23 November 2021.
- Tanaka T, Okamoto S. Increase in suicide following an initial decline during the COVID-19 pandemic in Japan. *Nat Hum Behav*. 2021;5(2):229–238.
- Koda M, Harada N, Eguchi A, Nomura S, Ishida Y. Reasons for suicide during the COVID-19 pandemic in Japan. *JAMA Netw Open*. 2022;5(1):e2145870.
- Horita N, Moriguchi S. Trends in Suicide in Japan Following the 2019 Coronavirus Pandemic. *JAMA Netw Open*. 2022;5(3):e224739.
- Sakamoto H, Ishikane M, Ghaznavi C, Ueda P. Assessment of suicide in Japan during the COVID-19 pandemic vs previous years. *JAMA Netw Open*. 2021;4(2):e2037378.
- Pirkis J, John A, Shin S, et al. Suicide trends in the early months of the COVID-19 pandemic: an interrupted time-series analysis of preliminary data from 21 countries. *Lancet Psychiat*. 2021;8(7):579–588.
- John A, Pirkis J, Gunnell D, Appleby L, Morrissey J. Trends in suicide during the covid-19 pandemic. *BMJ*. 2020;371:m4352.
- Vaillancourt T, Brittain H, Krygsman A, Farrell AH, Landon S, Pepler D. School bullying before and during COVID-19: Results from a population-based randomized design. *Aggress Behav*. 2021;47(5):557–569.
- Kovler ML, Ziegfeld S, Ryan LM, et al. Increased proportion of physical child abuse injuries at a level I pediatric trauma center during the Covid-19 pandemic. *Child Abuse Negl*. 2021;116:104756.
- Cabinet Office. *Survey on Changes in Attitudes and Behaviors During the COVID-19 Pandemic*. 2020. <https://www5.cao.go.jp/keizai2/wellbeing/covid/pdf/shiry02.pdf>. Accessed 23 November 2021.
- Ministry of Health, Labour and Welfare. Vital statistics. <https://www.mhlw.go.jp/english/database/db-hw/vs01.html>. Accessed 23 November 2021.
- Otsuka Y, Horita Y. Statistics on suicides of Japanese workers. *Jpn Labor Rev*. 2013;10:44–54.
- Statistics Bureau, Ministry of Internal Affairs and Communications. Population Estimates. <https://www.e-stat.go.jp/statistics/00200524>. Accessed 23 November 2021.
- Athey S, Imbens GW. Identification and inference in nonlinear difference-in-differences models. *Econometrica*. 2006;74(2):431–497.
- Cameron AC, Trivedi PK. Regression-based tests for overdispersion in the Poisson model. *J Econometrics*. 1990;46(3):347–364.
- MacKinlay AC. Event studies in economics and finance. *J Econ Lit*. 1997;35(1):13–39.
- Okubo Y, Nishi A, Michels KB, et al. The consequence of financial incentives for not prescribing antibiotics: a Japan's nationwide quasi-experiment. *Int J Epidemiol*. 2022:dyaco57.
- Lopez Bernal J, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: a tutorial. *Int J Epidemiol*. 2017;46(1):348–355.
- Zortea TC, Brenna CTA, Joyce M, et al. the impact of infectious disease-related public health emergencies on suicide, suicidal behavior, and suicidal thoughts. *Crisis*. 2021;42(6):474–487.
- Rogers JP, Chesney E, Oliver D, et al. Suicide, self-harm and thoughts of suicide or self-harm in infectious disease epidemics: a systematic review and meta-analysis. *Epidemiol Psychiatr Sci*. 2021;30:e32.
- Kölves K, Kölves KE, De Leo D. Natural disasters and suicidal behaviours: a systematic literature review. *J Affect Disord*. 2013;146(1):1–14.
- Wasserman D. *Oxford Textbook of Suicidology and Suicide Prevention*. Oxford, England: Oxford University Press; 2020.
- Ohto H, Maeda M, Yabe H, Yasumura S, Bromet EE. Suicide rates in the aftermath of the 2011 earthquake in Japan. *Lancet North Am Ed*. 2015;385(9979):1727.
- Lewinsohn PM, Rohde P, Seeley JR, Baldwin CL. Gender differences in suicide attempts from adolescence to young adulthood. *J Am Acad Child Adolesc Psychiatry*. 2001;40(4):427–434.
- Ministry of Education, Culture, Sports, Science and Technology. Hygiene management manual for schools regarding the novel coronavirus infection. https://www.mext.go.jp/content/20211210-mxt_kouhou01-000004520_2.pdf. Accessed 23 November 2021.
- Ho FKW, Louie LHT, Wong WH-S, et al. A sports-based youth development program, teen mental health, and physical fitness: an RCT. *Pediatrics*. 2017;140(4):e20171543.
- Cantor JH, Sood N, Bravata D, Pera M, Whaley CM. The impact of the COVID-19 pandemic and policy response on health care utilization: evidence from county-level medical claims and cellphone data. *Natl Bureau Econ Res*. 2020. <https://www.nber.org/papers/w28131>.
- Ziedan E, Simon KI, Wing C. Effects of state COVID-19 closure policy on non-COVID-19 health care utilization. *Natl Bureau Econ Res*. 2020. <https://www.nber.org/papers/w27621>.
- Moreno C, Wykes T, Galderisi S, et al. How mental health care should change as a consequence of the COVID-19 pandemic. *Lancet Psychiat*. 2020;7(9):813–824.
- Ministry of Health, Labour and Welfare. Response to the new coronavirus infection and its impact on medical fees. <https://www.mhlw.go.jp/content/12404000/000706834.pdf>. Accessed 23 November 2021.
- Carr MJ, Steeg S, Webb RT, et al. Effects of the COVID-19 pandemic on primary care-recorded mental illness and self-harm episodes in the UK: a population-based cohort study. *Lancet Public Health*. 2021;6(2):e124–e135.
- Qi M, Zhou S-J, Guo Z-C, et al. The effect of social support on mental health in chinese adolescents during the outbreak of COVID-19. *J Adolesc Health*. 2020;67(4):514–518.
- Reger MA, Stanley IH, Joiner TE. Suicide mortality and coronavirus disease 2019—a perfect storm? *JAMA Psychiatry*. 2020;77(11):1093.
- United Nations Educational, Scientific and Cultural Organization. Global Monitoring of School Closures Caused by the COVID-19 Pandemic. <http://covid19.uis.unesco.org/global-monitoring-school-closures-covid19/country-dashboard/>. Accessed 23 November 2021.
- Hale T, Angrist N, Goldszmidt R, et al. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). *Nat Hum Behav*. 2021;5(4):529–538.
- Dong E, Du H, Gardner L. An interactive web-based dashboard to track COVID-19 in real time. *Lancet Infect Dis*. 2020;20(5):533–534.
- Krug EG, Kresnow M-J, Peddicord JP, et al. Suicide after natural disasters. *N Engl J Med*. 1998;338(6):373–378.