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Research paper

Diurnal variation in suicide timing by age and gender: Evidence from Japan across 41 years

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ABSTRACT

Background: Previous research on hourly diurnal variation in suicide frequency has often suffered from geographical and time-span limitations in the data. We studied diurnal and daily variations of suicide by analyzing a large dataset based on the national death registry in Japan between 1974 and 2014.

Methods: The diurnal and daily patterns of 873,268 suicide deaths over 41 years were examined by sex and age group through Poisson regression and visual inspection. We also investigated whether these patterns are related to Japan's economic conditions.

Results: Suicide by middle-aged males was most frequent in the early morning especially on Mondays after the end of Japan's high growth period. We also observed large midnight peaks in suicides among young and middle-aged males. The proportion of early morning suicide deaths by young and middle-aged males increased as the country's unemployment rose. Females and elderly males were more likely to die by suicide during the day than at night.

Limitation: Our study examined time of death, not time of suicide attempt. It is possible that there is a discrepancy between the two.

Conclusions: Different subpopulations die by suicide at different times of the day and days of the week. Time patterns of suicide varied considerably over time, suggesting that they cannot be explained by biological circadian rhythm alone. Our findings suggest that the patterns are partly explained by economic conditions. Future suicide prevention efforts should consider the time patterns of suicide unique to each subpopulation, especially when economic growth is depressed.

1. Introduction

A large number of studies have accumulated evidence for the existence of cyclical changes in the frequency of suicide across time. Many scholars have examined seasonality in suicide and have shown that its frequency typically increases in the spring and early summer months but that this pattern varies across regions, subpopulations, and methods (e.g. Ajdacic-Gross et al., 2010; Altamura et al., 1999; Chew and McCleary, 1995). The days of the week have also been shown to generate a cyclical change: suicide tends to be more frequent on Mondays or the first workday of the week, and conversely is less likely to occur on weekends (Maldonado and Kraus, 1991; Massing and Angermeyer, 1985; Nishi et al., 2000; Zonda et al., 2009). In some studies, this pattern was found to be more pronounced among males (Hassan, 1994; Weinberg et al., 2002) or was found only among the middle-aged (McCleary et al., 1991).

Compared to seasonal and daily changes, less attention has been directed to diurnal change in the frequency of suicide. While Barraclough (1976) found that suicide did not exhibit a diurnal pattern among residents of England, others have reported that more suicides took place during certain times of the day. Railway suicide, for example, peaked in the mornings and evenings in Germany (Erazo et al., 2004), a pattern that has been shown to be stable across two time periods a decade apart (Lukaschek et al., 2014). Evening and morning peaks of railway suicide have been also found in the Netherlands, with the exact peak in time shifting according to the season (van Houwelingen and Beersma, 2001).

Furthermore, these diurnal patterns appear to vary by gender, age, and chronological time period. Analyzing data from Italy between 1994 and 1997, Preti and Miotto (2001) found that peaks in suicide deaths

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vary depending on age. Individuals older than 45 years old tended to die by suicide in the morning hours, regardless of sex, while those between the ages of 14 and 24 tended to die by suicide between 16:00 and 19:00. Maldonado and Kraus (1991) found that peaks in suicide deaths in Sacramento County, in the U.S., differed according to sex and age. While male suicides in Sacramento County peaked between 08:01 and 12:00, female suicides peaked between 12:01 and 16:00. Additionally, suicide deaths of those younger than 35 peaked just after midnight between 1945 and 1964 but just before midnight between 1965 and 1983. This shift in the suicide peak among young adults suggests that diurnal patterns of suicide might have changed over time.

The findings of these studies imply that suicide incidence has been more prevalent during the daytime, except for younger people, who might tend to die by suicide at night. Yet this conclusion needs further scrutiny, because the populations under study were typically very small in size and confined to a single region in a particular time period. Of the nine studies that have focused on the diurnal variation of suicide (Barraclough, 1976; Erazo et al., 2004; Gallerani et al., 1996; Lukaschek et al., 2014; Maldonado and Kraus, 1991; Preti and Miotto, 2001; van Houwelingen and Beersma, 2001; Vollen and Watson, 1975; Williams and Tansella, 1987), only two used national-level data that included suicide deaths by all methods. In addition, the study period in these two national-level studies averaged six years, which is too brief to discern suicide trends. Size and geographical limitations of samples in prior studies make it difficult to draw conclusions about patterns of suicide that can be generalized to even the specific country under study.

This study seeks to improve our understanding of the time patterns of suicide by examining a large-scale dataset based on the national death registry in Japan between 1974 and 2014. While our analysis rests on a dataset from a single country, it includes 873,268 records of suicides over a long period of time. In contrast to earlier studies that rely on data from specific regions within countries, such as Sacramento County in the U.S., and limited time periods, such as 1994–1997, we are able to offer more generalizable evidence of diurnal changes in the frequency of suicide. The large dataset also allowed us to examine the possibility that patterns of suicide vary by subpopulations and time periods.

In this study, we first investigated time patterns of suicide by sex and age group by examining the frequency of suicides by time of day and day of the week. We also estimated a Poisson regression model in which the frequency of suicide deaths in each hour of the week was regressed on dummy variables that denoted a particular time period within a week. This analysis has allowed us to estimate difference in the frequency of suicides between 0:00 and 3:59, for instance, as compared to reference hours, while controlling for effects that the day of the week might have on the frequency of suicides. In addition, we explored whether diurnal patterns of suicide have changed over time and also whether these changes are related to macroeconomic conditions.

2. Method

The suicide data used in this study were obtained from death records preserved in the Vital Statistics of Japan. The Vital Statistics data were collected for administrative purposes by the Ministry of Health, Labour and Welfare, and were anonymized and de-identified by the Ministry. Individual death records between 1974 and 2014 were made available for research purposes by the Ministry.

The Vital Statistics data are based on death certificates issued by physicians and subsequently reported to the local government where the residency of the deceased is registered. The records cover all reported deaths in Japan. The information in the death records includes the date of birth, the date of death, the place where the death was reported, marital status, and the underlying cause of death based on the International Classification of Diseases (ICD) 8/9 standard (up to 1994) and the ICD-10 standard (1995 to present).

Our analysis focused on deaths by suicide (ICD-8/9: E950-E959, ICD-10: X60-X84). In Japan, all suicides (including suspected cases) are reported to the police, and a doctor along with the police examines the circumstances to determine the cause of death before the doctor issues a death certificate. We excluded certain suicide records, based on several criteria. First, we excluded deaths of non-Japanese citizens as well as of individuals whose place of death was outside of Japan. Second, we omitted death records that lacked information on the date or hour of death, since this was needed for the purpose of our analysis. Third, we excluded those under 19 years old from the analysis, because of the small number of suicide incidents in this age group. Fourth, we disregarded death records that lacked valid information on the place where the death was reported, because this lack of information indicates that some of the circumstances surrounding the deaths were unknown, and it is likely that the authorities did not have definite information about the deceased.

Individual death records were then aggregated by hour of the day, separately for each day of the week. Suicide deaths were pooled according to hour and day of the week, instead of a yearly time series, for instance, because our focus is on the diurnal variation of suicide. Thus, the unit of analysis is hour of the day by day of the week, and so the number of observations was 168 (=7 days in a week * 24 h in a day). Because the time pattern of suicide was likely to differ by subpopulation, the total number of suicides per hour on each day of the week was calculated separately for sex and three age groups: ages 20–39, 40–65, and 66 and over. In addition, this calculation was done separately for two chronological periods, 1974–1994 and 1995–2014, to explore the possibility that the time patterns of suicide have changed over time. These two periods correspond respectively to strong and weak periods for the Japanese economy: Japan experienced a sustained economic boom during the first period, and recession for considerable parts of the second. During 1974–1994, the average unemployment and GDP growth rate were 2.3% and 2.9%, respectively, whereas they were 4.3% and 0.8% during 1995–2014, according to the Statistics Bureau of Japan and the World Bank.

Using the aggregated individual death records, we conducted two types of analysis. First, we plotted the frequencies of suicide deaths against a scale representing the day of the week and the time of day. The scale started at 0:00 midnight on Sunday, increased by increments of one hour, and ended at 23:59 on Saturday. We sought to identify whether any diurnal pattern existed within each of six groups. In addition, we explored whether the time pattern of suicide by each sex/age group differed between the periods of economic upturns and downturns.

Second, we estimated a Poisson regression model where the frequency of suicides was regressed on dummy variables for days of the week and time periods of the day, to examine what time of day and day of the week people in each subgroup were more likely to die by suicide and whether this pattern changed between the periods of 1974–1994 and 1995–2014. There were six day-of-week dummy variables, respectively denoting Sunday, Monday, Tuesday, Wednesday, Thursday, and Friday; the baseline category was Saturday. Thus, each of the estimated coefficients on the dummy variables showed the likelihood of suicide happening on a particular day of the week compared to in the reference period, Saturday. The regression model also included five time-of-day dummies denoting the following time periods: 0:00 to 3:59, 4:00 to 7:59, 8:00 to 11:59, 12:00 to 15:59, and 16:00 to 19:59; the baseline category was 20:00 to 23:59. Thus, the estimated coefficients for the time period dummies indicate the likelihood of suicide in those time periods compared to the baseline period after taking into account any differences in number of suicides that might exist across days of the week. To facilitate the interpretation of the Poisson regression results, we converted the Poisson regression coefficients to incidence rate ratios (IRRs).

After conducting the above analyses, we tested more explicitly whether the diurnal pattern of suicide was related to the macroeconomic condition of the country by examining the association

between the proportion of suicides occurring at certain hours of the day and the annual unemployment rate. For this part of the analysis, we first calculated the total number of suicides that occurred at particular hours of the day (e.g., 4:00–7:59) in each year and divided it by the total number of suicides in the year to determine the percentage of suicides that occurred at a particular time period of the day. We calculated the percentages separately for the six sex/age groups. Because the percentages were calculated by year, the number of observations was 41 (1974 to 2014) for each sex/age group in this part of the analysis. We used the annual unemployment rate, obtained from the Statistics Bureau of Japan, as a measure of the general economic conditions, and examined its association with the percentage of suicides that occurred during a particular time of the day. All analyses were conducted using Stata/MP software (version 15; StataCorp, College Station, TX).

3. Results

The Vital Statistics data included death records of 1,033,027 individuals who died by suicide between 1974 and 2014. We excluded 120,072 cases for lack of information on the date or hour of death and 39,687 cases for the other reasons previously described. Ultimately, our analysis was based on 873,268 cases of suicide that occurred during our study period of 41 years. The most common method of suicide was hanging (62.22%), followed by jumping from heights (8.82%) and exposure to gas (8.18%). Table 1 reports summary statistics on the total number of suicides for each of the six sex/age groups, aggregated by hour of the day by day of the week.

Fig. 1 shows the frequencies of suicides by males plotted against the time of day from Sunday to Saturday. The left and right panels represent the number of male suicides by three age groups during 1974–1994 and 1995–2014, respectively; the dashed line in each graph denotes midnight (0:00) on each day of the week.

Fig. 1 indicates that the time patterns of suicides varied across age groups and have changed between 1974–1994 and 1995–2014. The top panels indicate that suicides by males aged 20–39 were most frequent around midnight and less frequent during daytime than at night between 1974 and 1994. This pattern became less evident between 1995 and 2014, when the timing of suicides came to show two peaks around midnight and early morning. The middle panels indicate that suicide by males aged 40–65 followed a cyclical pattern during the day between 1974 and 1994. However, during the second period, which experienced economic downturn, a noticeable peak was observed in the early morning, especially on Mondays; the pattern is similar to the pattern found among young males, but the morning peaks were much more pronounced among middle-aged males. In addition, middle-aged men were also likely to die by suicide around midnight in both study periods. In contrast to these two age groups, the bottom panels of Fig. 1 indicate that suicides among elderly males exhibited neither midnight nor early morning peaks; rather, their suicides were concentrated around noon, and to a lesser degree in the morning. This pattern did not change much between the two periods.

Table 1
Summary statistics

	Mean	SD	Min	Max	N
Male, 20-39 between 1974-1994	485.488	118.141	279	952	168
Male, 20-39 between 1995-2014	440.393	99.546	233	772	168
Male, 40-65 between 1974-1994	754.440	156.868	479	1095	168
Male, 40-65 between 1995-2014	999.196	253.080	606	1988	168
Male, 66- between 1974-1994	294.024	96.378	154	545	168
Male, 66- between 1995-2014	430.720	121.827	245	688	168
Female, 20-39 between 1974-1994	232.452	47.268	141	345	168
Female, 20-39 between 1995-2014	194.440	35.780	115	290	168
Female, 40-65 between 1974-1994	371.083	101.876	208	603	168
Female, 40-65 between 1995-2014	343.560	86.889	206	578	168
Female, 66- between 1974-1994	335.440	120.947	144	626	168
Female, 66- between 1995-2014	315.988	94.127	149	507	168

Note: The data represents the number of suicides aggregated for years 1974-2014 by the day of the week and time of the day stratified by subpopulation and time period. Source: Death records, the Vital Statistics of Japan, 1974-2014

Fig. 2 shows the frequencies of suicides by females across time of the day from Sunday to Saturday. The scale of the *y*-axis is different from the one in Fig. 1 because of fewer female suicides. The top panels indicate that suicide by females aged 20–39 was relatively frequent around midnight between 1974 and 1994, which was similar to the time pattern of suicides found among males in the same age group. However, the midnight peak disappeared by the second period of our study. Other graphs in Fig. 2 indicate that the general time pattern of female suicides resembled that of elderly males. Females aged 40–65 and 66 years and over were more likely to die by suicide during early morning and afternoon, including noon, and this pattern was consistent throughout the week and also across the two time periods.

Figs. 3 and 4 report the estimated results of the Poisson regression analysis—Fig. 3 for males and Fig. 4 for females. As in Figs. 1 and 2, the left panels focus on suicides during 1974–1994, while the right panels show the results for 1995–2014. The *y*-axis indicates six dummy variables for the day of the week and five dummy variables denoting time periods of the day; the baseline categories (Saturday and 20:00–23:59) are also shown in the figures, to facilitate comparison. The *x*-axis shows the IRR with the 95% confidence interval.

The graphs in Fig. 3 clearly suggest that the day of the week played an important role in suicide timing for males. In all age groups, suicide was least frequent on weekends and most frequent on Mondays. Working-age males were particularly vulnerable on Mondays between 1995 and 2014: their likelihood of suicide was higher on Mondays by 40% (95% CI: 1.36–1.43) among males aged 20–39 and by 55% (95% CI: 1.52–1.58) among males aged 40–65 than on Saturdays.

Fig. 3 also indicates that the peak time period for suicide varied considerably by age groups, on any day of the week. Several noticeable patterns emerged in Fig. 3. First, the top panel shows that males aged 20–39 were more likely to die by suicide by 22% (95% CI: 1.19–1.25) during 1974–1994 and by 34% (95% CI: 1.31–1.38) shortly after midnight (between 0:00 to 03:59) compared to the baseline period (20:00 to 23:59). In the second half of the study period, they were also more likely to die in the early morning (04:00 to 07:59), by 28% (95% CI: 1.26–1.32). However, they were less likely to die during business hours, especially between 08:00 and 11:59, throughout our study period. Similarly, middle-aged men were 57% (95% CI: 1.55–1.60) more likely to die by suicide between 04:00 to 07:59, compared to the baseline period, between 1995 and 2014. Third, suicides by males aged 66 years and over were much more likely to occur during daytime, and they were most vulnerable between 12:00 to 15:59. For example, the IRR was higher by 95% (95% CI: 1.89–2.00) between 1995 and 2014. The IRRs did not seem to differ much between the two periods, however.

The estimation results presented in Fig. 4 suggest that days of the week did not seem to have a strong influence on women's decision to die by suicide, except that they were most likely to die on Monday in all age groups; however, the time of day does seem to affect their decision. Females of all ages were more likely to die in the afternoon, with this pattern most pronounced for females older than 40 years old. The likelihood of suicide between noon and 16:00 by women aged between 40 and 65 was 70% higher (95% CI: 1.65–1.75) during 1974–1994 and 77% higher (95% CI: 1.72–1.82) during 1995–2014 compared to the baseline hours (20:00 to 23:59). Similarly, suicide by women 66 and older was almost twice as likely to happen in the early afternoon as in the baseline hours. For example, the IRR during 12:00–15:59 was higher by 106% (95% CI: 2.00–2.13) in the first period and by 98% (95% CI: 1.91–2.04) in the second period.

Finally, we investigated whether the diurnal patterns of suicide were affected by economic conditions, by examining the association

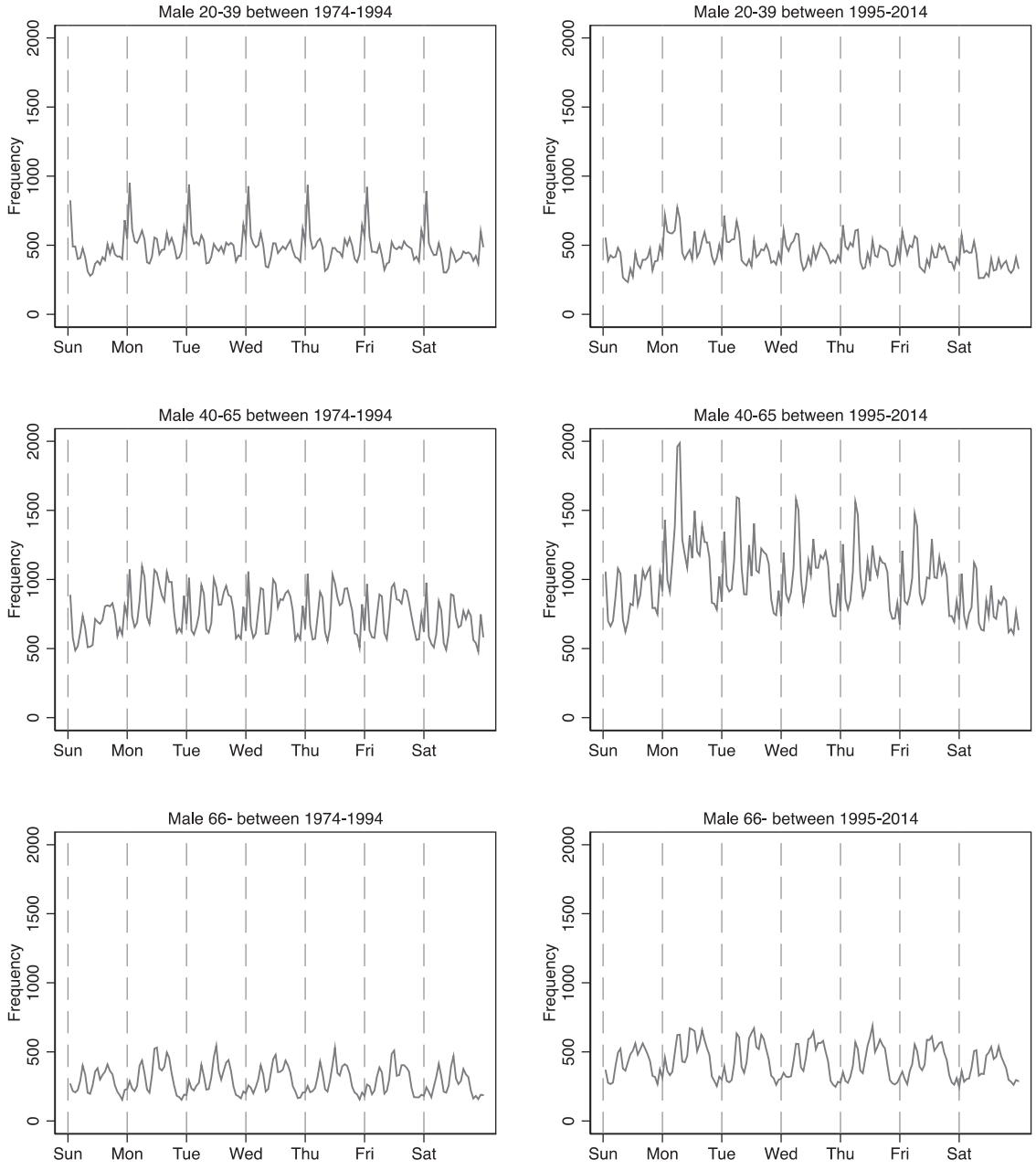

Fig. 1. The frequency of suicides by males across hours within a week.

between the frequency of suicides at particular hours of day and the annual unemployment rate. Our focus here was on the proportion of suicides that occurred between 4:00 and 7:59, because there was a discernible increase in suicide frequency in the early morning among males aged 20–39 and 40–65 in the second period of our study, which coincided with low economic growth. Fig. 5 presents the scatterplots by sex/age group. Each data point represents one year. According to the two top left panels in Fig. 5, the fraction of working-age men (aged 20–39 and 40–65) who chose to take their own lives in the early morning (4:00–7:59), as opposed to other times of the day, increased as the unemployment rate rose: the correlation coefficients between the annual unemployment rate and the percentages of suicides occurring during 4:00–7:59 were 0.82 (p-value = 0.000) for men aged 20–39 and 0.91 (p-value = 0.000) for men aged 40–65. In contrast, we found no strong correlation between the two variables among senior males and young females; however, a significant negative correlation between the unemployment rate and the proportion of suicides did occur in early morning among middle-aged females (correlation coefficient −0.67 and p-value 0.000) and senior females (correlation coefficient −0.42 and the p-value 0.007). When we conducted the same analysis for days of the week, we found a similar but weaker positive relationship between the unemployment rate and the percentage of suicides on Monday. We found no statistically significant relationship between the unemployment rate and the percentage of suicides during other hours of the day or other days of the week. These results are available upon request.

4. Discussion

Previous research on hourly diurnal variation in suicide frequency

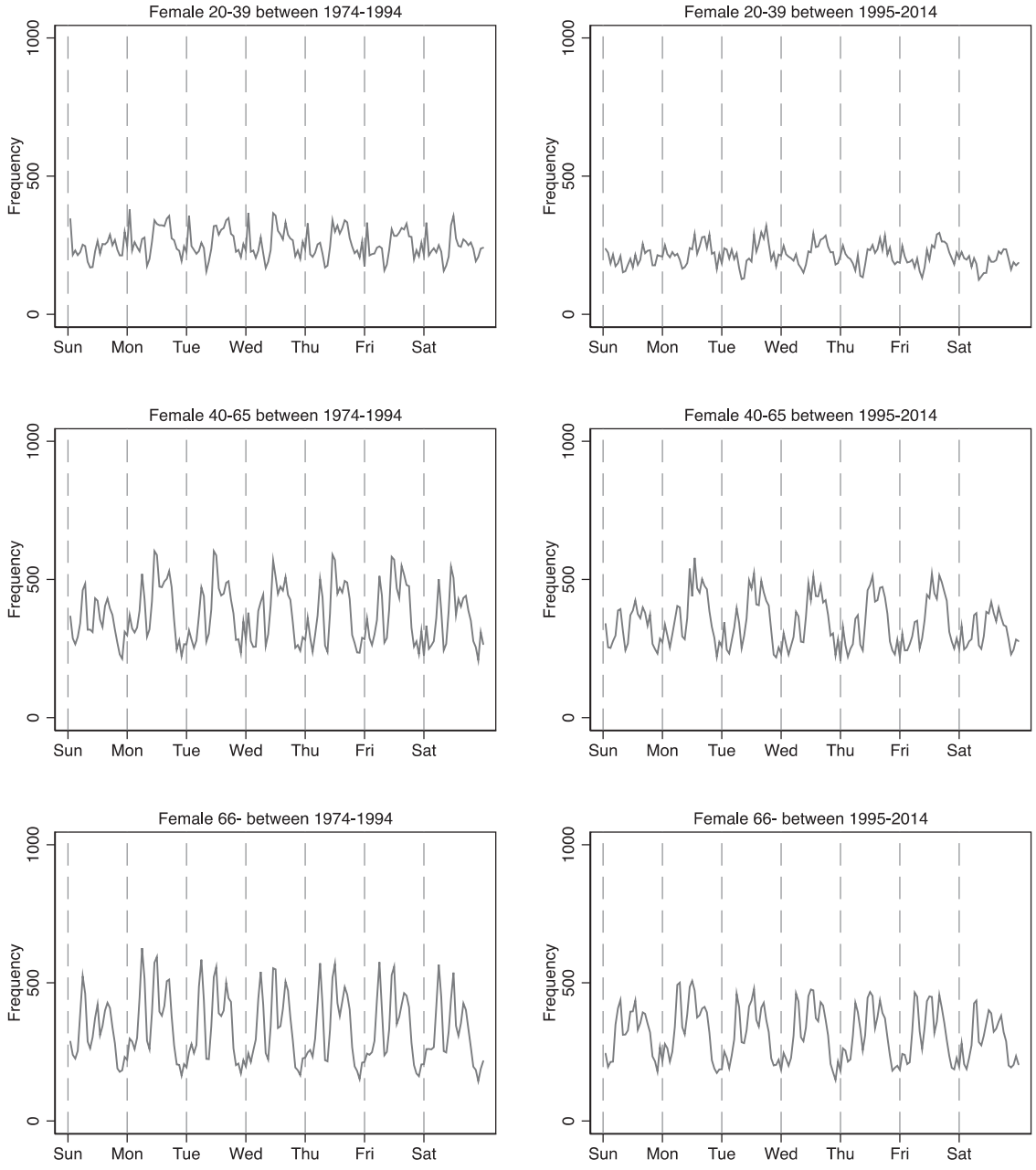

Fig. 2. The frequency of suicides by females across hours within a week.

often suffered from geographical and time-span limitations in the data. This paper addressed these limitations by analyzing the patterns of more than 800,000 suicide deaths in Japan over a period of 41 years. As such, we were able to examine whether the hourly and daily patterns of suicide varied by subpopulation and time period.

We found that working-aged males were most likely to die by suicide on Monday mornings as compared to other times. We also observed large midnight and early morning peaks in suicides among young and middle-aged males. The magnitude of peaks during early morning and on Monday was particularly pronounced during the period of economic downturn. In addition, the proportion of suicide deaths by young and middle-aged males that occurred in early morning increased as the country's unemployment rose. Overall, the results of the present study strongly indicated that the diurnal and daily variations in suicide by working-age males were likely to be particularly affected by the country's macroeconomic conditions.

In contrast, our analysis suggested that suicides by females were not concentrated on any day of the week, although they were most likely to die on Mondays. We also found that females as well as elderly males were more likely to die by suicide during the day than at night. Thus, our results are consistent with earlier findings that suicide tends to occur during the daytime (e.g. Maldonado and Kraus, 1991), but our findings also indicated that the diurnal patterns vary greatly by demographic group and overall macroeconomic conditions.

Our results are also consistent with some of the findings of past studies that reported Monday peaks in suicide (Maldonado and Kraus, 1991; Massing and Angermeyer, 1985; Nishi et al., 2000; Zonda et al., 2009). However, these previous studies did not consider the possibility that the diurnal timing of suicide could vary across days of the week and by subpopulation, whereas our study constitutes the first research

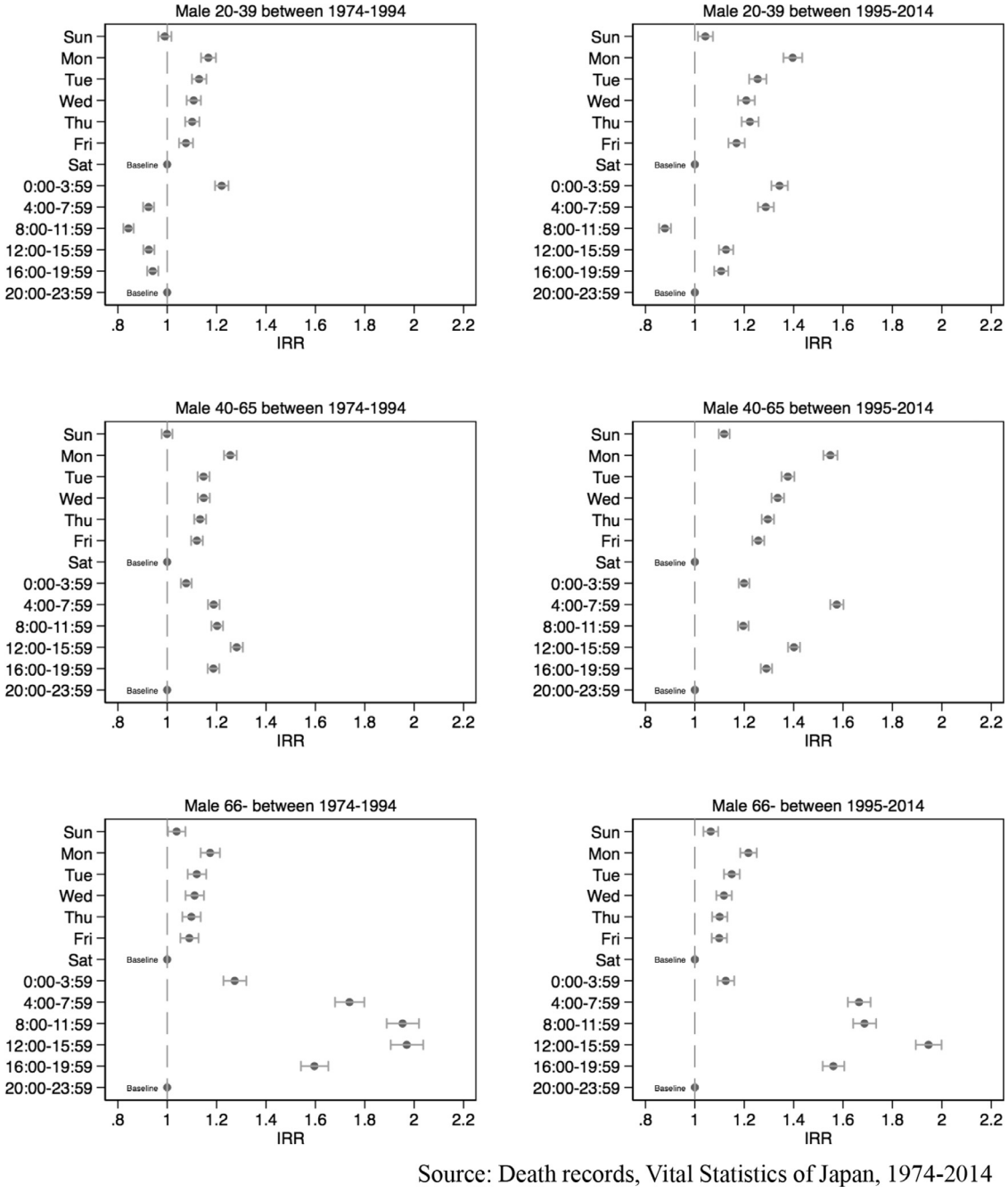

Fig. 3. IRR for suicide deaths by males across hours within a week.

showing that suicides by working-age males are most likely to happen Monday morning, right before normal working hours start.

The results of our analysis also indicate that reasons behind people's decision to take their own lives may play a role in determining the time of suicide. We found that working-age males in Japan were most likely to die by suicide on Monday mornings, especially after Japan's period of high economic growth had ended. Because Monday is the first day of the work week for most people, especially established full-time workers, such a pattern suggests that some of their suicides might have been in part associated with work or a reluctance to go to work. Suicides due to work-related issues are common in Japan, especially among working-age males (Sawada et al., 2017). An analysis of suicide methods (data not shown in this paper, but available upon request) revealed that the most common methods of suicide by middle-aged males on Mondays were hanging and then gas intoxication, suggesting that they are likely to have died by suicide at home before starting work on Monday.

The present study makes an additional contribution to the literature by providing evidence that suggests that the cyclical nature of suicide occurrence may be more reflective of suicide opportunities, as argued by Chew and McCleary (1994), than of biological circadian changes, as others have proposed (Chatzittofis et al., 2013; Kamali et al., 2012; Matheson et al., 2015; O'Connor et al., 2017, 2016; Pandey, 2013). For example, Monday peaks might occur because suicidal persons were not able to attempt suicide during the weekend, when friends and family members are more likely to be present. Where the diurnal variation in suicide is concerned, it is possible that more suicides might occur in the morning after family members leave for work, or at night when more people are asleep.

This theory of suicide opportunities is consistent with some of our

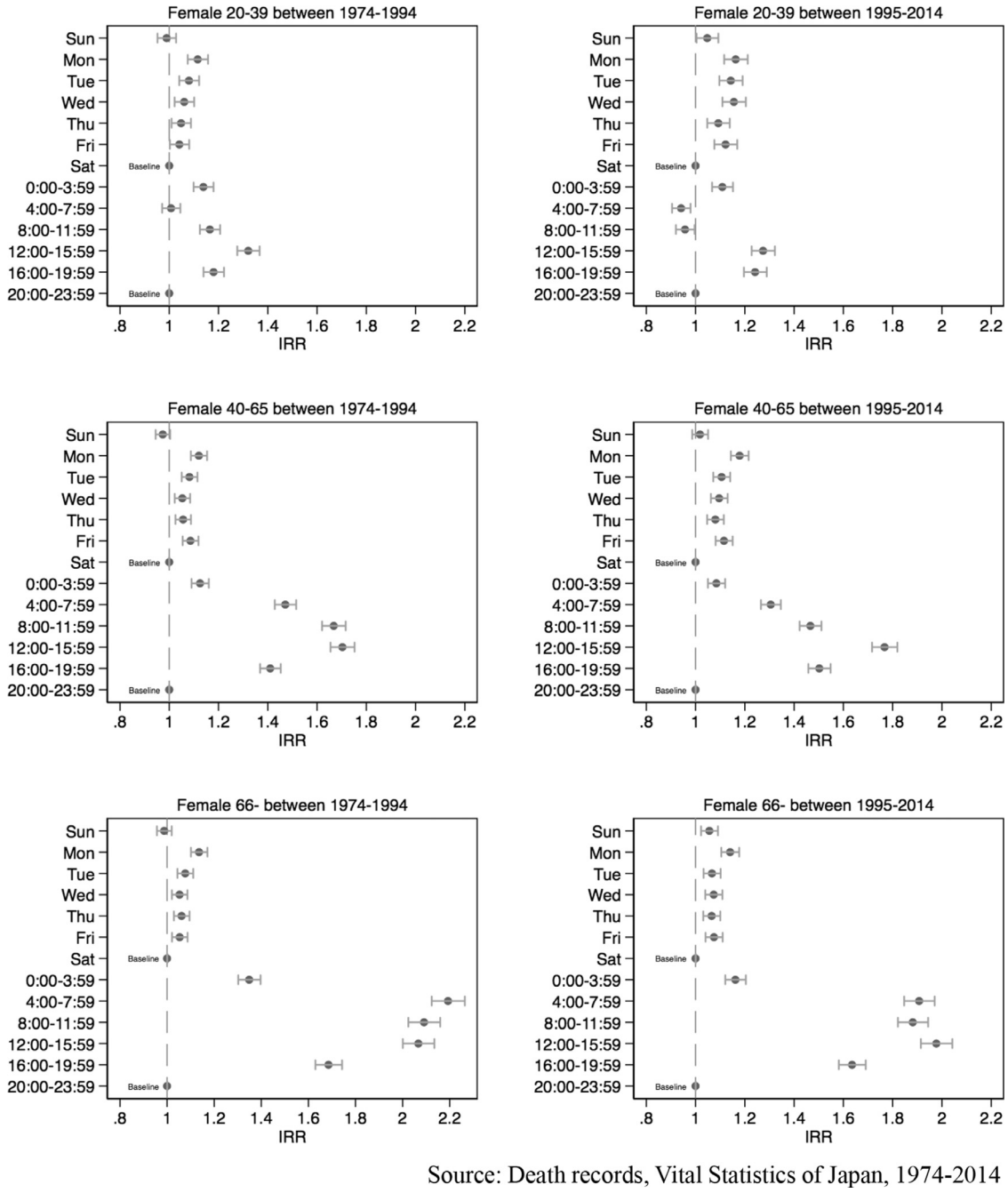

Fig. 4. IRR for suicide deaths by females across hours within a week.

findings. In Japan, the timing of suicide has differed systematically across subpopulations in a way that implies that suicidal patterns were mediated by opportunities to kill oneself, instead of some biological circadian rhythm. People who are more likely not to hold jobs, such as the elderly of both genders and middle-aged women, were more likely to die by suicide in the daytime compared to evening hours between 20:00 and midnight, when other family members might be around. Availability of opportunities may also explain the Monday and midnight peaks observed among non-elderly males in this study.

The present study has several important policy implications. First, our findings suggest that suicide prevention policies can be informed by behavioral traits associated with high-risk subpopulations. Suicide prevention efforts during commuting hours, especially on Mondays, may prove effective given the elevated risk of suicide among working-age men at the beginning of the weekday, especially when the economy is weak. Similarly, given that young working-aged males were at greater risk of killing themselves at night, support services targeting this demographic group would be more effective reaching out to them during those hours.

In contrast, in the case of the middle-aged and the elderly, the availability of support services should be focused in the morning and early afternoon, when people in these groups are more likely to take their own lives. However, crisis hotlines in Japan do not necessarily offer services during these hours; for example, in areas outside of Tokyo, where there are more middle-aged and elderly people than younger people, not all crisis helplines operate 24 h a day. For example, *Inochi no Denwa*, a nationwide suicide prevention telephone service, operates only from noon onward in 11 prefectures (Federation of Inochi No Denwa, 2016).

Some limitations of our study should be mentioned. First, it is

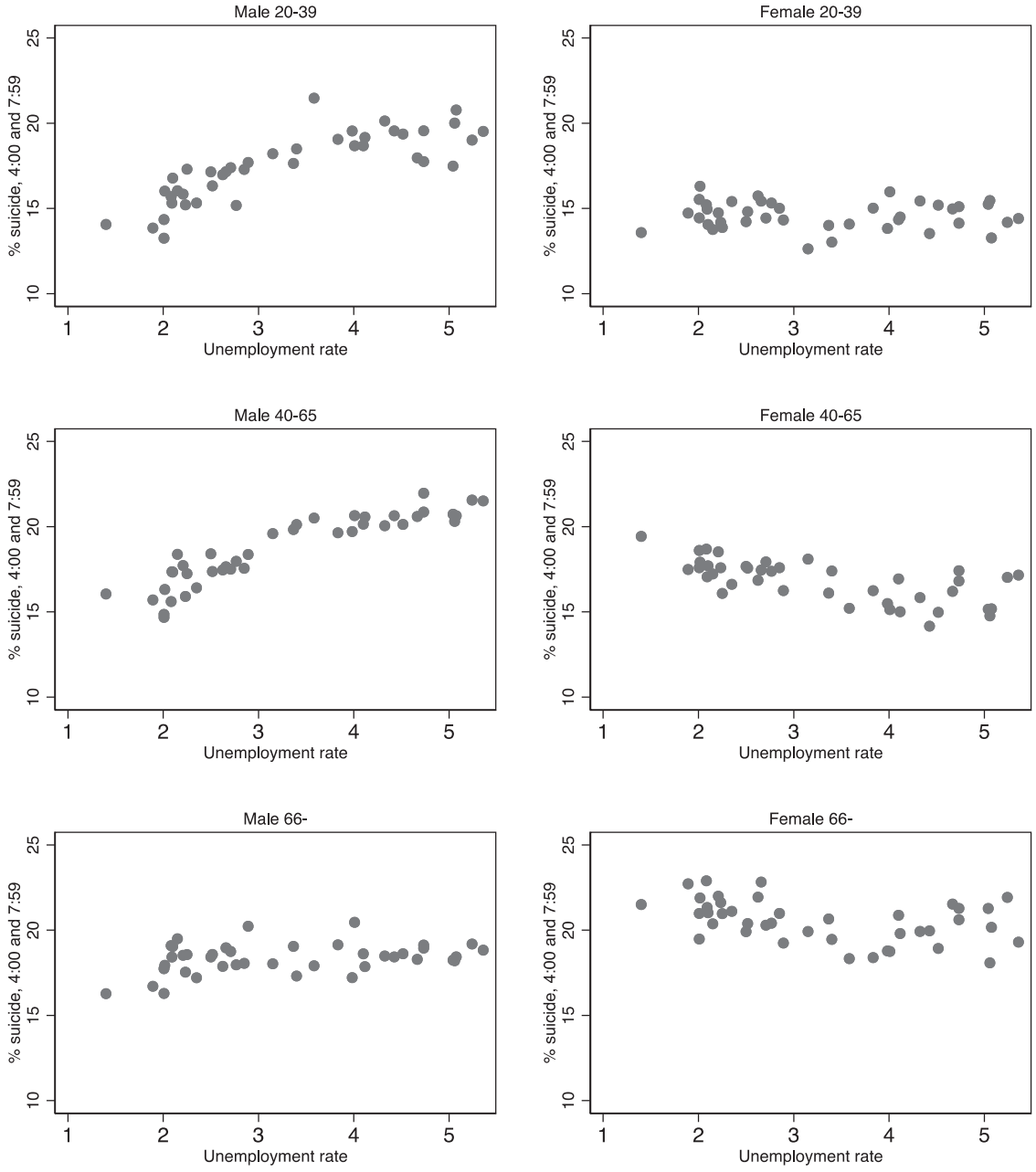

Fig. 5. Annual unemployment rate and the percentage of suicides that occurred between 4:00–7:59.

possible that some of the reported times of death in our data were estimates, as accuracy of reported time of death may depend on the method of suicide, the medical technology available at that time, and the living arrangements or other circumstances of the deceased at the time of death, which can affect the speed at which their bodies were discovered. For example, the suicide attempts of married people may be more likely to be found relatively quickly by their spouses and their times of death might have been recorded more accurately compared to those of unmarried people. However, we obtained similar results when we analyzed married and non-married individuals separately, suggesting that these results are not heavily affected by reporting errors. Similarly, it is possible that changes in public attitudes might have affected the number of deaths reported as suicides, especially given the long temporal horizon of the dataset. However, this possibility is less likely to have affected our findings substantially because, unlike certain other countries that have had legislation and a strong social stigma against suicide, for example, the Republic of Ireland prior to 1993 (Hughes, 2012), there has been no law criminalizing suicide in Japan that could distort the reporting of suicide.

On a related note, it is possible that our findings were affected by the relatively large number of excluded cases. As noted above, about 10% of suicide cases were dropped from our analysis due to unknown date or time of death. If suicide deaths by certain methods were more likely to be dropped from the analysis, because the exact timing of death is harder to identify for those methods, and if they were likely to happen at a certain time of the day, the inclusion of these cases might affect our findings. Similarly, it is possible that certain suicides might be disguised as accidents and hence not be included in the dataset. However, in the case of Japan, such cases are likely to be negligible, because suicide incidents are always investigated by the police.

Second, our study examined time of death, not time of suicide attempt. It is possible that there is a discrepancy between the two, especially if one uses a suicide method that does not result in immediate death. The time of suicide attempt may be more relevant than the time of death for the purpose of devising prevention strategies; studying the time of suicide attempts using ambulance data, for instance as in Motohashi (1990), would be more suitable for that purpose. It should be noted, however, that about 70% of suicides in our data were by hanging or jumping, which presumably does not involve delayed death.

Third, even though the patterns of suicide deaths suggest that the occurrence and timing of suicide deaths were heavily influenced by employment conditions, we were not able to test for this relationship, because complete employment data were not part of the Vital Statistics death records.

Despite these limitations, the present study offers important evidence regarding timing of suicide based on large-scale death records over a span of more than 40 years. The findings suggest that different subpopulations die by suicide at different times of the day and on different days of the week. Furthermore, this study presented evidence showing that these time patterns of suicide can vary considerably over time, and that this change seems to be affected by economic conditions for certain subpopulations. Future suicide prevention efforts should consider the time patterns of suicide observed in this study, especially during the period of the weak economy. Furthermore, since the timing of suicide seems to be mediated by economic and employment conditions, research on the relationship between the circadian rhythm of the hypothalamic–pituitary–adrenal (HPA) axis and the diurnal timing of suicide incidence should take into consideration specific socio-economic factors relevant to the subpopulations under study.

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Conflict of interest

All authors declare that they have no conflicts of interest.

Authors' contributions

MU and TM analyzed the Vital Statistics data. JB reviewed previous literature. JB, TM, and MU interpreted the results and wrote the manuscript. All authors have read and approved the final manuscript.

Acknowledgment

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2018.09.030.

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