



Research paper

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

Jeremy Boo^a, Tetsuya Matsubayashi^b, Michiko Ueda^{c,*}^a Graduate School of Political Science, Waseda University, Building No. 3, 1-6-1 Nishiwaseda, Shinjuku-ku, Tokyo 169-8050, Japan^b Osaka School of International Public Policy, Osaka University, 1-31 Machikaneyama, Toyonaka, Osaka, 560-0043, Japan^c Faculty of Political Science and Economics, Waseda University, Building No. 3, 1-6-1 Nishiwaseda, Shinjuku-ku, Tokyo 169-8050, Japan

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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

* Corresponding author.

E-mail addresses: jeremyboo@fuji.waseda.jp (J. Boo), matsubayashi@osipp.osaka-u.ac.jp (T. Matsubayashi), mueda@waseda.jp (M. Ueda).<https://doi.org/10.1016/j.jad.2018.09.030>

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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; Lukaszek 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

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