学　位　論　文

Correlation between Suicide and Meteorological Parameters

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Correlation between suicide and meteorological parameters

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ABSTRACT

Objective: The aim of this study was to investigate the link between suicide and meteorological parameters in the 23 wards of Tokyo, Japan.

Materials and methods: Monthly data (from January 2008 to December 2012) of suicide stratified by the type of suicide, i.e. hanging, drowning and jumping, were obtained from the Tokyo Medical Examiner's Office official web site. Monthly meteorological parameters (atmospheric pressure, air temperature, humidity and daylight hours) in the 23 wards of Tokyo were also used for the required period. The effects of meteorological parameters on suicide were explored.

Results: The number of suicides was 110.4 ± 14.7 (80–149) for men and 55.6 ± 9.1 (41–87) for women in the 23 wards of Tokyo, Japan. The mean air temperature was 16.6 °C ± 7.7 °C (4.8–29.6 °C). The number of suicides by drowning for men was significantly and positively correlated with air temperature, and weakly and positively correlated with humidity. In addition, the number of suicides by drowning for men was significantly and negatively correlated with atmospheric pressure.

Conclusions: The number of suicides by drowning was associated with meteorological parameters, especially in men, in the 23 wards of Tokyo, Japan.

1. Introduction

Suicide has become a serious public health challenge in Japan recently, as well as in the worldwide. For example, about 30 thousand people committed suicide in Japan over the last 15 years [1]. It is well known that suicide is associated with many factors such as psychiatric disorders, and socio-economic and life style factors [2–4]. Approaches to suicide prevention include targeting these high-risk groups and population strategies.

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Climate change, including global warming, is also a serious global problem. We have shown a relationship between air temperature and health problems in Japan [5,6]. In addition, there are some reports about the relation between suicide and meteorological parameters [7–18]. The evidence implies that meteorological factors tend to affect the number of suicides. Evaluation of the risk factors for total number of suicides is obviously most important for preventing suicides. However, the link between meteorological parameters and suicides stratified by almost common types of suicide might be also important and that has not been fully explored in Japan.

Therefore, in this study we evaluated the relationship between the total number of suicides, the number of suicides stratified by the type of suicide and various meteorological parameters in the 23 wards of Tokyo, Japan, where suicide is accurately defined as unnatural death.

2. Materials and methods

2.1. Study area

The 23 wards of Tokyo make up the core and most populous areas of the city. In May 2014, the population exceeded 9 million, and the population density is about 14,600/km^2.

2.2. Suicide

Monthly data (from January 2008 to December 2012) on suicide deaths in the 23 wards of Tokyo were obtained from the Tokyo Medical Examiner's Office, Tokyo Metropolitan Government, Japan [19–23]. The Tokyo Medical Examiner's Office is responsible for conducting postmortem examinations and determining the cause of death for all cases of unnatural death within the 23 wards of Tokyo [24]. The total number of suicides and the number of suicide deaths stratified by the type of suicide (i.e. hanging, drowning and jumping), as well as sex were used for this analysis.

2.3. Meteorological parameters

Monthly data on meteorological parameters in the 23 wards of Tokyo for the required period were obtained from the official website of the Japan Meteorological Agency [25]. The observation spot was centrally located. Monthly meteorological parameters such as land atmospheric pressure (hPa), mean air temperature (°C), mean of the highest temperature (°C), mean of the lowest air temperature (°C), highest air temperature (°C), lowest air temperature (°C), mean humidity (%), lowest humidity (%) and daylight hours (hours/month) were used for analysis.

2.4. Statistical analysis

Data are expressed as mean ± standard deviation (S.D). Comparisons among more than three groups were performed by ANOVA and Scheffe's F test. Correlation analysis was used to determine the linear relationship among continuous variables. $P < 0.05$ was considered statistically significant. Multiple regression analysis was also used to adjust for confounding factors.

3. Results

Data on suicide and meteorological parameters from January 2008 to December 2012 are summarized. A total of 6625 deaths in men and 3335 deaths in women due to suicide were observed. The total numbers of suicides per month were 110.4 ± 14.7 for men and 55.6 ± 9.1 for women. The numbers of suicides by hanging, drowning and jumping were 68.5 ± 11.4, 3.4 ± 2.2 and 18.0 ± 4.7 for men and 29.8 ± 9.0, 2.7 ± 1.7 and 12.4 ± 3.9 for women. Land atmospheric pressure was 1009.5 ± 3.1 hPa and the mean air temperature was 16.6 °C ± 7.7 °C. The mean highest air temperature, mean lowest air temperature, highest air temperature, lowest air temperature, mean humidity, lowest humidity and daylight hours were 20.2 °C ± 7.7 °C, 13.3 °C ± 8.0 °C, 26.3 °C ± 6.9 °C, 8.8 °C ± 7.4 °C, 60.1% ± 9.8%, 21.4% ± 10.3% and 161.8 ± 35.2 hours/month, respectively.

A comparison of suicides by months and sex for 5 years is shown in Table 1. There were no significant differences in the total number of suicides or the number of suicides stratified by the type of suicides (hanging, drowning and jumping). However, the number of suicides by drowning in September (5.2 ± 2.9) was higher than that in January (2.0 ± 2.3) and November (2.0 ± 0.7), but not at a significant level.

Next, we evaluated the relationship between suicide and meteorological parameters by simple correlation analysis (Table 2). The total number of suicides in men was weakly and positively correlated with mean air temperature, mean of the highest air temperature, mean of the lowest air temperature and the highest air temperature. The total number of suicides for women was weakly and negatively correlated with land atmospheric pressure. The number of suicides by drowning for men was significantly and negatively correlated with land atmospheric pressure, and significantly and positively correlated with mean air temperature (Figure), mean of the highest air temperature, mean of the lowest air temperature, the highest air temperature and the lowest air temperature. Weak and positive associations between suicide by drowning and humidity were also noted. The number of suicides by drowning for women was weakly and positively correlated with air temperature parameters. However, significant relationships between other suicide and meteorological parameters were not noted.

Finally, multiple regression analysis was performed, and the number of suicides by drowning for men was used as a dependent variable and land atmospheric pressure, mean air temperature, mean humidity and daylight hours were used as independent variables to adjust for confounding factors. However, this analysis revealed no significant factors having an impact on suicide rates.

4. Discussion

As for the relationship between suicide and air temperature, Hiltunen et al. [7] reported that a temperature change over 5

Table 1 – Comparison of suicides among months in the 23 wards of Tokyo, Japan.

Month	Total		Hanging		Drowning		Jumping	
	Men	Women	Men	Women	Men	Women	Men	Women
January	102.8 ± 10.0	50.8 ± 7.4	65.4 ± 8.1	25.6 ± 6.7	2.0 ± 2.3	1.2 ± 0.8	17.4 ± 5.6	12.4 ± 4.7
February	105.0 ± 7.9	51.4 ± 3.4	65.6 ± 7.8	26.0 ± 4.4	2.2 ± 0.4	2.2 ± 1.6	16.2 ± 2.5	13.2 ± 4.7
March	112.4 ± 10.9	54.6 ± 5.8	68.8 ± 9.5	28.6 ± 1.1	2.4 ± 1.9	2.6 ± 1.3	16.6 ± 4.7	11.2 ± 2.6
April	110.8 ± 11.3	55.4 ± 4.7	63.0 ± 9.8	27.4 ± 3.5	2.6 ± 2.1	3.6 ± 1.5	23.0 ± 4.0	12.4 ± 3.0
May	121.4 ± 20.1	61.6 ± 15.4	75.2 ± 19.1	36.4 ± 18.4	3.4 ± 0.5	2.4 ± 2.1	19.0 ± 3.0	13.0 ± 6.4
June	123.6 ± 15.8	59.8 ± 11.9	74.6 ± 13.8	32.2 ± 11.6	5.0 ± 2.6	3.0 ± 1.2	18.6 ± 3.6	14.0 ± 6.1
July	112.2 ± 23.8	58.6 ± 14.3	73.8 ± 19.8	28.2 ± 12.7	4.4 ± 2.5	3.8 ± 0.4	16.4 ± 5.4	15.2 ± 5.2
August	109.2 ± 10.7	55.2 ± 9.0	66.2 ± 5.3	29.2 ± 9.3	4.6 ± 3.1	3.4 ± 1.3	20.2 ± 5.6	12.0 ± 4.1
September	111.8 ± 11.6	54.6 ± 7.2	68.6 ± 3.2	31.0 ± 6.8	5.2 ± 2.9	3.2 ± 1.1	20.4 ± 5.6	12.0 ± 2.2
October	108.0 ± 16.6	57.8 ± 8.2	68.4 ± 11.1	35.2 ± 3.5	3.4 ± 2.6	2.6 ± 2.3	16.2 ± 3.2	10.0 ± 3.1
November	110.8 ± 12.9	51.2 ± 5.0	71.2 ± 10.0	29.2 ± 5.6	2.0 ± 0.7	2.0 ± 1.7	18.6 ± 4.9	11.6 ± 2.1
December	97.0 ± 11.7	56.0 ± 11.4	61.2 ± 10.4	28.2 ± 12.6	3.6 ± 1.7	2.6 ± 3.1	13.2 ± 2.5	11.8 ± 1.3

days was associated with the suicide rate of men in the Helsinki region. Lee et al. also reported that seasonality with a spring peak was evident in suicidal death regardless of gender or age. However, ambient temperature was positively correlated with suicide after adjusting for trend and seasonality [8]. Grjibovski et al. [9] showed that an increase in the mean air temperature by 1 °C was associated with an increase in suicide by 2.1% in Astana, Kazakhstan. In addition, a higher frequency of suicidal deaths was observed in warm weather with low relative humidity [12]. In Japan, suicide mortality has seasonal

Table 2 – Correlation analysis between suicides and meteorological parameters in the 23 wards of Tokyo, Japan.

	Land atmospheric pressure		Mean air temperature		Mean of the highest air temperature	
	r	P	r	P	r	P
Total number of suicides (men)	−0.233	0.0726	0.286	**0.0269**	0.285	**0.0273**
Total number of suicides (women)	−0.292	**0.0237**	0.233	0.0731	0.234	0.0724
Number of suicides by hanging (men)	−0.181	0.1654	0.221	0.0897	0.219	0.0926
Number of suicides by hanging (women)	−0.171	0.1913	0.178	0.1732	0.175	0.1812
Number of suicides by drowning (men)	−0.441	**0.0004**	0.439	**0.0004**	0.441	**0.0004**
Number of suicides by drowning (women)	−0.250	0.0544	0.312	**0.0153**	0.315	**0.0142**
Number of suicides by jumping (men)	−0.002	0.9864	0.233	0.0729	0.241	0.0637
Number of suicides by jumping (women)	−0.212	0.1039	0.129	0.3273	0.138	0.2930
	Mean of the lowest air temperature		The highest air temperature		The lowest air temperature	
	r	P	r	P	r	P
Total number of suicides (men)	0.277	**0.0319**	0.324	**0.0116**	0.245	0.0592
Total number of suicides (women)	0.225	0.0832	0.247	0.0568	0.211	0.1049
Number of suicides by hanging (men)	0.213	0.1027	0.249	0.0546	0.208	0.1107
Number of suicides by hanging (women)	0.173	0.1873	0.201	0.1229	0.163	0.2147
Number of suicides by drowning (men)	0.438	**0.0005**	0.408	**0.0012**	0.448	**0.0003**
Number of suicides by drowning (women)	0.310	**0.0160**	0.322	**0.0120**	0.328	**0.0104**
Number of suicides by jumping (men)	0.229	0.0778	0.209	0.1083	0.177	0.1763
Number of suicides by jumping (women)	0.124	0.3453	0.097	0.4599	0.116	0.3772
	Mean humidity		The lowest humidity		Daylight hours	
	r	P	r	P	r	P
Total number of suicides (men)	0.220	0.0912	0.081	0.5402	−0.089	0.5010
Total number of suicides (women)	0.195	0.1356	0.135	0.3036	0.010	0.9391
Number of suicides by hanging (men)	0.141	0.2840	0.100	0.4466	−0.032	0.8112
Number of suicides by hanging (women)	0.174	0.1830	0.123	0.3477	−0.073	0.5796
Number of suicides by drowning (men)	0.299	**0.0205**	0.356	**0.0053**	0.153	0.2440
Number of suicides by drowning (women)	0.243	0.0619	0.191	0.1428	0.074	0.5748
Number of suicides by jumping (men)	0.185	0.1562	0.082	0.5332	0.070	0.5941
Number of suicides by jumping (women)	0.019	0.8830	0.047	0.7215	0.210	0.1075

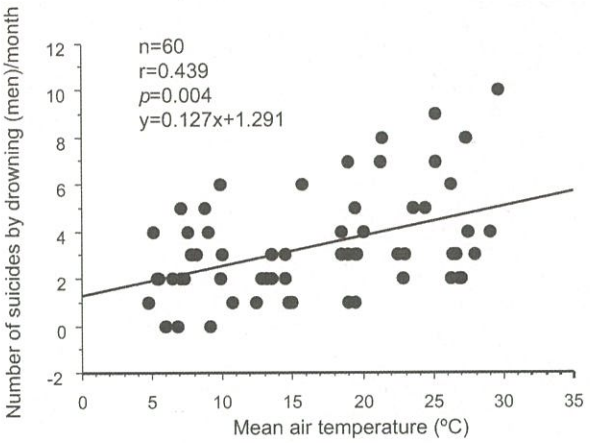

Figure – Correlation between the number of suicides by drowning in men and mean air temperature.

characteristics and it varies from year to year, with the highest occurrence in April, as well as in the first part of the week [13]. Likhavar et al. [13] found that when temperature increased, the suicide mortality increased on the same day. In turn, Inoue et al. [14] found that annual age-adjusted suicide rates were found to have a significant inverse correlation with annual mean air temperature in some prefectures of Japan. In this study, we firstly and accurately evaluated the link between suicide stratified by the type of suicide and meteorological parameters in the 23 wards of Tokyo, Japan. As in most previous reports, we found significant and positive relationships between the number of suicides by drowning and air temperature parameters in men by using monthly data. Multiple regression analysis showed that impact of air temperature was the highest among the variables. In addition, we also found weak relationships between the total number of suicides and air temperature in men, and between the number of suicides by drowning and air temperature parameters in women. From the single regression line, an increase in mean air temperature by 1 °C corresponded to an increase in 0.127 of the number of suicides by drowning per month for men in the 23 wards of Tokyo, Japan. Compared with a report by Inoue et al., we used monthly data and this may affect the difference in the relation between suicide and air temperature.

There are also reports showing a link between suicide and other meteorological parameters such as atmospheric pressure. Hiltunen et al. [15] reported that daily atmospheric pressure could have an impact on suicidal behavior, especially on suicide attempts by men. Yang et al. [16] also reported that suicide was inversely associated with pressure. Maximum pressure was significantly lower in the days with higher suicidal risk, and changes in meteorological factors may be a trigger for suicide attempts [17]. In this report, the number of suicides by drowning in men was significantly and negatively correlated with atmospheric pressure. Taken together, our findings may be of research interest for future studies to better understand the timing of suicide interventions and effective preventive strategies.

Potential limitations remain in this study. First, we used an ecological study. The link among the number of suicides and meteorological parameters, which was noted in this study, may not apply to the link among individuals. Second, detailed daily and individual (i.e. age and sex) data about suicide could not be obtained and analyzed in this study. Therefore, we could not evaluate the link between suicide and meteorological parameters as accurately as we wished. Third, we could not explain a gender difference or a clear mechanism between suicide and meteorological parameters. Tada et al. [26] also reported the sex differences of suicide related to meteorological parameters, and some speculated mechanisms are presented [27]. Fourth, other risk factors i.e. health disorders, economic condition and family disputes might affect the suicide, and only meteorological parameters would not be like the basic reason of suicides. Nevertheless, further ongoing studies are urgently required to prove such a link.

5. Conclusions

In this study, we explored the link between suicide stratified by the type and meteorological parameters in the 23 wards of Tokyo, Japan. Although the total number of suicides was not clearly associated with meteorological parameters, it is worth noting that the number of suicides by drowning was associated with meteorological parameters, especially in men.

Conflict of interest

The authors state no conflict of interest.

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