



A 10-year follow-up study on suicidal mortality after 1999 Taiwan earthquake



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ABSTRACT

Objective: The long-term impact of natural disasters on suicide in general population and survivors remains uncertain. The present report examined the direction and the length of the influence of an earthquake over suicide across age groups.

Method: We used an interrupted time-series design with non-equivalent no-treatment group to evaluate post-earthquake changes in suicide rates by the standardized mortality ratio.

Results: The time trend changes in suicide rates before and after the earthquake were similar for males and females but different between senior and junior age groups. Gender-specific relative ratios were 0.85 (95%CI: 0.81–0.90) for males and 0.79 (95% CI: 0.72–0.86) for females. Age-gender-stratified relative ratios were 0.61 (95% CI: 0.53–0.70) and 0.69 (95% CI: 0.64–0.75) for males and females aged less than 45 years, respectively. Although the overall suicide mortality increased after the earthquake, the relative suicide risk ratio decreased 31–39% for those aged less than 45 years, which persisted for nearly 10 years after earthquake.

Conclusion: Our study demonstrated that a severe earthquake resulted in a significant decrease in standardized suicide mortality ratios in exposed areas for 10 years compared to unexposed area, particularly in a younger population.

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1. Introduction

Evidence has shown that survivors of a natural disaster such as an earthquake were more susceptible to post-traumatic stress disorders, depression, insomnia, anxiety, and substance abuse than the subjects that were not afflicted (Freedy et al., 1994; Lee et al., 2009; Murphy, 1986; Norris et al., 2002; Warheit et al., 1996). It is still unclear whether disaster-related stress could further lead to an increase in suicide rates among exposed survivors during the post-

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disaster period (Kolves et al., 2013). One study, which simply compared suicide rates 3 years before and after disasters, failed to find a significant increase in post-disaster suicide rates (Krug et al., 1999). This comparison was insufficient to determine the association between disasters and suicide increases because post-disaster suicide rates usually changed with several contemporaneous and socio-demographic factors other than disasters (Kolves et al., 2013; Pridemore et al., 2009). Aoki et al. (2014) modulated the demographic change across the earthquake and investigated suicidal behavior, rather than suicide deaths, in Japan. In the present study, we included a control population, i.e. those not afflicted by disasters, as a contrast group to rule out the confounding effects of socio-demographic factors effects for meaningful comparison. We

utilized a broad model to exam the differences between the general population and unaffected residents for a devastating outcome (i.e., suicide mortality) (Cook and Campbell, 1979; Pridemore et al., 2009).

The 1999 Taiwan earthquake, which created an interruption of the natural suicide series, provided us empirical data to clarify whether there was an increase or decrease in post-earthquake suicide rates in the disaster areas and how lasting the impact was. The impact of this severe earthquake on suicide rate has attracted considerable attention, leading to several studies on immediate and short-term effects on earthquake survivors. These studies have consistently reported that higher suicide rates were observed in the survivor group compared to the control group within a one-year period following the earthquake. This increased suicide rate was higher in affected areas than in other areas or in Taiwan as whole (Chou et al., 2003; Liaw et al., 2008; Lu, 2004; Yang et al., 2005). However, there is still a lack of clarity about the long-term effects of severe disaster on suicide mortality. We proposed to compare rates with a non-equivalent non-treatment group, which consisted of the population unexposed to the 1999 Taiwan earthquake, to study this unsolved yet important public health problem during a 10-year post-disaster period.

2. Material and methods

2.1. The 1999 Taiwan earthquake

At 01:47 on September 21, 1999 (21/09/1999), a powerful earthquake of 7.3 magnitude on the Richter scale struck central Taiwan. It was documented that this earthquake resulted in 51,711 collapsed and 53,768 severely damaged dwellings, which accounted for 2.17% of all households in Taiwan. There were 2347 deaths attributable to earthquake within one month after the quake. Twenty-three townships in Nantou and Taichung Counties were declared disaster areas by the Taiwanese government; these were located near the epicenter and accounted for 82% all casualties and 90% all collapsed homes during the earthquake.

2.2. Study design

We treated the 1999 Taiwan earthquake as an important event on 21/09/1999 for the time series of suicides between 09/1971 and 09/2008. We compared changes in monthly suicide rates over the 336 pre-earthquake months and the 108 post-earthquake months in this design. The exposed group was the 1,407,165 residents living in the 23 townships of the disaster areas based on the information regarding the magnitude of the 1999 earthquake obtained from the website of the Seismological Center, Central Weather Bureau in Taiwan. The unexposed group, which was a non-equivalent no-treatment control group, was the 21,272,898 residents living in the other 333 Taiwanese townships outside the disaster areas.

2.3. Data collection of suicide cases

Monthly suicide counts (ICD-9 codes E950–E959) for both the exposed and unexposed groups between 01/09/1971 and 30/09/2008 were obtained from the Ministry of Health and Welfare, which has routinely collected and published nation-wide death certificates in Taiwan mortality registry since 1970. The post-earthquake suicide deaths were cases between 21/09/1999 and 30/09/2008 and the pre-earthquake suicide deaths were cases between 01/09/1971 and 20/09/1999. Firstly, we compared suicide deaths 30 years before to 10 years after the earthquake for considering the possible natural variations of suicidal rate over decades. Secondly, suicide deaths from 10 years before and after the

earthquake were analyzed in consideration of changing demographic and socio-economic conditions during the equivalent periods.

2.4. Statistical methods

In order to evaluate whether there was a significant increase in suicide rates after the earthquake in the disaster areas, we needed to make simultaneous comparisons in suicide rates between pre-earthquake and post-earthquake periods as well as between exposed and unexposed groups. We first calculated standardized mortality ratios for the exposed group after earthquake (SMR_A) and before earthquake (SMR_B) by calculating the ratios between the observed suicide deaths (O_A and O_B) and the expected numbers of deaths (E_A and E_B). The expected numbers of E_A and E_B were calculated by multiplying the unexposed group's suicide rates by the exposed group's person-years. We then calculated the relative ratio of SMR_A/SMR_B , denoted as RR, to determine whether there was a significant increase in post-earthquake suicide rates in the disaster areas. The Breslow and Day method was used to calculate the confidence intervals of relative ratios (Breslow and Day, 1987).

2.5. Ethical standards

All procedures involved in this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the 1975 Helsinki Declaration, revised in 2008. The institutional review board from the Bureau of Health Nantou County in central Taiwan approved this study. There were no individual clinical records used in this study and thus no written informed consent was needed in this study. In addition, subjects' information was anonymous and de-identified prior to analysis.

3. Results

Rates and relative ratios of suicide at both analyses, using 30 year and 10 years before as difference reference groups, were similar. We therefore presented the findings from the comparison between 30 years before and 10 years after the quake and those from another analysis, which is displayed in Appendix 1 and 2. Figs. 1 and 2 indicate that senior adults (≥ 45 years) had a higher suicide rate than the junior adults (< 45 years) for both gender. The time trend changes in suicide rates before and after the 1999 earthquake were similar for males and females (relative ratio (RR) in all females 0.79, 95% CI 0.72–0.86; in all males 0.85, 95% CI 0.81–0.90). Tables 1 and 2 display the inspection on the long-term relative ratio of suicide by age and gender. The 1999 earthquake was found to have an opposite impact on RRs for the junior and senior groups. For both genders, RRs for age less than 45 years were lower than 1.00 during the post-earthquake period.

Fig. 3 show the changing trends of RRs year by year after the 1999 earthquake, RRs of the junior adults ranged from 0.69 to 0.84 and those of senior adults ranged from 0.80 to 1.08. The relative ratio of suicide mortality between before and after earthquake for age less than 45 years was lower after earthquake when compared with the pre-earthquake period. The risk for senior adults was similar between pre- and post-earthquake periods, except the first post-earthquake year. (The details are displayed in the Appendix 3).

4. Discussion

This study showed that the impact of a severe earthquake on the survivors' suicidal risk was different by age. Previous studies investigating earthquake influences on suicidal mortality have

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