Special Article

SUICIDE AFTER NATURAL DISASTERS

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ABSTRACT

Background Among the victims of floods, earthquakes, and hurricanes, there is an increased prevalence of post-traumatic stress disorder and depression, which are risk factors for suicidal thinking. We conducted this study to determine whether natural disasters affect suicide rates.

Methods From a list of all the events declared by the U.S. government to be federal disasters between 1982 and 1989, we selected the 377 counties that had each been affected by a single natural disaster during that period. We collected data on suicides during the 36 months before and the 48 months after the disaster and aligned the data around the month of the disaster. Pooled rates were calculated according to the type of disaster. Comparisons were made between the suicide rates before and those after disasters in the affected counties and in the entire United States.

Results Suicide rates increased in the four years after floods by 13.8 percent, from 12.1 to 13.8 per 100,000 ($P<0.001$); in the two years after hurricanes by 31.0 percent, from 12.0 to 15.7 per 100,000 ($P<0.001$); and in the first year after earthquakes by 62.9 percent, from 19.2 to 31.3 per 100,000 ($P<0.001$). The four-year increase of 19.7 percent after earthquakes was not statistically significant. Rates computed in a similar manner for the entire United States were stable. The increases in suicide rates were found for both sexes and for all age groups. The suicide rates did not change significantly after tornadoes or severe storms.

Conclusions Our study shows that suicide rates increase after severe earthquakes, floods, and hurricanes and confirms the need for mental health support after severe disasters. (N Engl J Med 1998;338: 373-8.)

DISASTERS, both natural and man-made, affect millions of people around the world every year. In the United States about 1.5 million households experience injury or suffer property damage each year as a result of floods, tornadoes, hurricanes, or earthquakes.[1] The immediate physical health consequences of disasters have been well described.[2,3] Increased respiratory, gastrointestinal, and cardiovascular symptoms have also been reported for up to five years after a disaster.[4,5]

The degree to which disasters cause mental health problems is still being debated.[6,7] Some studies show only minimal mental health effects, if any.[8-10] Most studies, however, show evidence of psychological sequelae after disasters. Post-traumatic stress disorder, depression, insomnia, anxiety, and problems such as substance abuse and domestic violence have been reported.[11-15] There may be greater psychological consequences for women, for younger victims, and for victims of disasters with many casualties.[6,11,16] Although temporary symptoms are more common than severe long-term reactions,[10,17] the psychological sequelae can persist for up to three to five years after a natural disaster.[18,19] Psychological reactions may result from the stress caused directly by the disaster (e.g., the death or injury of family members or loss of property, financial assets, or employment), as well as from the disruption of the social fabric of community life.[20] Psychological reactions may also result from stress caused by the processes of applying for assistance, obtaining housing, or filing for insurance reimbursement.[21,22]

Psychological consequences such as post-traumatic stress disorder and depression have been the subjects of previous research, but less is known about suicide. Two studies have described a decreased incidence of suicide during wars.[23,24] Studies analyzing the effects of natural disasters on suicide rates have yielded insufficient information, primarily because they have focused only on suicidal ideation or because they have looked at single disasters with populations too small to allow significant comparisons to be made between predisaster and postdisaster suicide rates.[20,25,26]

Given the link between disasters and depression[11,13,18] and the link between depression and suicide,[27,28] it is reasonable to expect a relation between disasters and suicide rates. We examined suicide rates in U.S. counties where single natural disasters occurred. We addressed several questions: Do suicide

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rates increase after severe natural disasters? If so, when do these increases occur, and do they vary according to the type of disaster? What groups, if any, are at increased risk for suicide after a natural disaster?

METHODS

Data Set

A major disaster is declared when the president of the United States determines that the damage caused by any natural catastrophe is of sufficient severity and magnitude to warrant federal disaster assistance to supplement the resources available from states, local governments, and disaster-relief organizations.[29] From a list of all the events declared to be major disasters between 1975 and 1993, provided by the Federal Emergency Management Agency, we initially selected U.S. counties affected by a single natural disaster each, excluding counties with disasters of man-made origin. Disasters that occurred in Alaska and in the U.S. Territories were excluded — the former because of changes in the codes of the Federal Information Processing Standards,[30] which made electronic matching impossible, and the latter because complete data on suicide were not available. To avoid the possible compound effect of multiple disasters within a short time, any county with more than one disaster declaration was also eliminated.

We narrowed the period for disasters to the years 1982 through 1989 to allow for a three-year base-line period for disasters that occurred in 1982 and a four-year follow-up period for disasters that occurred in 1989. The final list consisted of 377 counties (12 percent of the counties in the United States) affected by a single disaster each between 1982 and 1989, in which no other disaster had occurred for at least seven years before and four years after the single disaster. Of the 377 counties, 308 (82 percent) were affected by floods, 24 by hurricanes, 24 by severe storms, 15 by tornadoes, 4 by earthquakes, and 2 by severe winter weather.

County-specific monthly numbers of suicides from 1979 to 1993 were obtained from the National Center for Health Statistics Multiple Cause of Death Data File.[31] Monthly population totals were obtained by computing the differences between the annual population totals (as of July 1) from the National Center for Health Statistics Compressed Mortality File for 2 consecutive years and applying 1/12 of the observed population change to each month cumulatively over the 12 months of each year. Data were linked to the 377 counties affected by disasters according to state and county Federal Information Processing Standards codes. For each county, data for the 36 months before and the 48 months after the disaster were retained. The data were then aligned around the month in which the disaster occurred. Once aligned, the data were grouped into three 12-month periods before the disaster (years −3, −2, and −1) and four 12-month periods after the disaster (years +1, +2, +3, and +4). Note that calendar years have no meaning after alignment. For example, for each county, year −3 represents the 12 months that began 3 years before the county's disaster, regardless of when the disaster occurred.

For comparison purposes, we made similar calculations for the entire United States. For each disaster, the monthly suicide rates in the United States were collected for the three years before and the four years after the disaster. When several counties were affected by the same disaster, the U.S. data were counted only once. This resulted in 44 U.S. records — one for each disaster. The U.S. data were then aligned in the same manner as the data for the 377 counties affected by disasters.

Statistical Analysis

The data were structured so that there was one record per county. The suicide rates were computed by adding the numerators (the numbers of suicides) and the denominators (the populations) for all counties eligible for inclusion in the study, dividing, and then multiplying the result by 100,000, just as one would compute a rate for the entire United States. This approach is similar to computing a weighted average of county-specific rates. Annual suicide rates and rates for the entire predisaster and postdisaster periods per 100,000 population were calculated according to the type of disaster and for all the disasters combined. The differences between rates and the percent change in rates were computed, along with 95 percent confidence intervals.[32]

Because suicides are infrequent, we assumed the rates of suicide followed a Poisson distribution. The difference between two rates was assessed with the use of a z-test.[33] Two rates were considered to differ significantly if the P value was less than 0.05 or if the percent change in the corresponding 95 percent confidence interval did not include zero. Because no significant differences were found among the three annual predisaster rates for any type of disaster, these rates were pooled and compared with the rates for each year after the disaster separately, to determine the onset and duration of any possible increase. The differences between predisaster and postdisaster suicide rates were also calculated according to sex and age (10 to 29 years, 30 to 59 years, and ≥60 years).

RESULTS

In the 377 counties, for all disasters combined, the suicide rates increased by 13.8 percent (95 percent confidence interval, 7.7 to 20.2 percent; $P<0.001$) during the four-year postdisaster period (Table 1), whereas the suicide rates in the entire United States increased only 1 percent during the same period. Although we found no statistically significant increases in the affected counties after tornadoes or severe storms, we did find that suicide rates increased substantially after floods, hurricanes, and earthquakes. We focus on these latter types of disasters in what follows.

Floods

Before floods, the suicide rate for the 308 affected counties (12.1 per 100,000 population) was similar to that for the United States as a whole (12.3 per 100,000 population). After floods, there was an increase of 13.8 percent (95 percent confidence interval, 6.1 to 22.1 percent; $P<0.001$) in the suicide rate in the counties affected, whereas the rate for the United States as a whole remained stable (Table 1). As compared with the pooled predisaster rate, there were significant increases in suicide rates, ranging from 9.1 to 24.3 percent, in each of the four postflood years (Fig. 1), with the highest rate occurring in the fourth year after the disaster.

Hurricanes

As in the counties affected by floods, the rate of suicide before hurricanes in the 24 counties that experienced them (12.0 per 100,000 population) was similar to that in the entire United States (12.4 per 100,000 population). Although the U.S. rate remained stable (+0.1 percent), in the 24 counties affected by hurricanes there was a combined increase of 18.9 percent (95 percent confidence interval, 4.2 to 35.7 percent; $P=0.01$) in the suicide rate during the four years after hurricanes (Table 1). However, this rate was elevated only for the first two years after hurricanes, to 15.7 per 100,000 (an increase of 31.0

TABLE 1. PREDISASTER AND POSTDISASTER SUICIDE RATES PER 100,000 POPULATION ACCORDING TO THE TYPE OF DISASTER, 1982 TO 1989.*

TYPE OF DISASTER	PREDISASTER SUICIDES		POSTDISASTER SUICIDES		PERCENT CHANGE (95% CI)†	DIFFERENCE IN RATES (95% CI)†	P VALUE
	no.‡	rate§	no.‡	rate§			
All disasters							
Affected counties (n=377)	2365	12.3	2761	14.0	+13.8 (7.7 to 20.2)	1.7 (1.0 to 2.4)	<0.001
United States		12.3		12.5	+1.0	0.1	<0.001
Floods							
Affected counties (n=308)	1438	12.1	1680	13.8	+13.8 (6.1 to 22.1)	1.7 (0.8 to 2.6)	<0.001
United States		12.3		12.5	+1.3	0.2	<0.001
Hurricanes							
Affected counties (n=24)	398	12.0	489	14.3	+18.9 (4.2 to 35.7)	2.3 (0.5 to 4.0)	0.01
United States		12.4		12.4	+0.1	0.0	0.84
Earthquakes							
Affected counties (n=4)	145	19.2	173	23.0	+19.7 (−4.0 to 49.2)	3.8 (−0.9 to 8.4)	0.11
United States		12.3		12.4	+0.4	0.0	0.53
Severe storms							
Affected counties (n=24)	245	11.3	281	12.4	+10.3 (−7.1 to 0.9)	1.2 (−0.9 to 3.2)	0.26
United States		12.5		12.4	−1.1	−0.1	0.02
Tornadoes							
Affected counties (n=15)	137	12.2	134	12.1	−0.8 (−21.8 to 26.0)	−0.1 (−3.0 to 2.8)	0.95
United States		12.3		12.5	+1.8	0.2	<0.001

*Disaster-specific information is not presented for the two counties that experienced severe winter weather. CI denotes confidence interval.

†Values were calculated by subtracting the predisaster suicide rates from the postdisaster suicide rates. The differences are statistically significant at the 0.05 level if $z \geq 1.96$, where $z = (rate_{post} - rate_{pre}) / \sqrt{(rate^2_{pre}/deaths_{pre}) + (rate^2_{post}/deaths_{post})}$.

‡Values are the average annual numbers of suicides.

§Values are the average annual suicide rates per 100,000 population.

percent), and was followed by a decline to the base-line level for the remaining two years (Fig. 2).

Earthquakes

The base-line suicide rate for the few counties affected by earthquakes was higher than that for the United States as a whole (19.2 percent and 12.3 percent, respectively). All four counties are located in the western United States, where suicide rates are known to be high. Although the U.S. suicide rate remained stable (+0.4 percent), the rate in the counties affected by earthquakes increased more during the four-year postdisaster period than the rates in the counties affected by the other types of disaster studied (19.7 percent). This increase was not statistically significant, however (95 percent confidence interval, −4.0 to 49.2; P=0.11) (Table 1). There was a significant increase in the suicide rate from base line during the first year after the earthquake, to 31.3 per 100,000 (an increase of 62.9 percent, P<0.001), after which the rate returned to the base-line level (Fig. 3).

Age- and Sex-Specific Suicide Rates

For the types of disaster and years for which we found significant postdisaster increases in suicide rates, we examined whether these increases were greater for a particular sex or age group to determine whether prevention programs should target a specific group. The suicide rate increased 21.8 percent (95 percent confidence interval, 13.9 to 30.3 percent; P<0.001) for men and 14.5 percent (95 percent confidence interval, 0.5 to 30.5 percent; P=0.04) for women. The suicide rate increased 24.9 percent (95 percent confidence interval, 11.6 to 39.8 percent; P<0.001) in the 10-to-29-year-old group, 18.4 percent (95 percent confidence interval, 8.3 to 29.3 percent; P<0.001) in the 30-to-59-year-old group, and 18.3 percent (95 percent confidence interval, 5.2 to 32.9 percent; P<0.01) in the group 60 years of age or older. The specific analyses according to age and sex showed that younger men and older women appeared to be most severely affected, but the differences were not statistically significant.

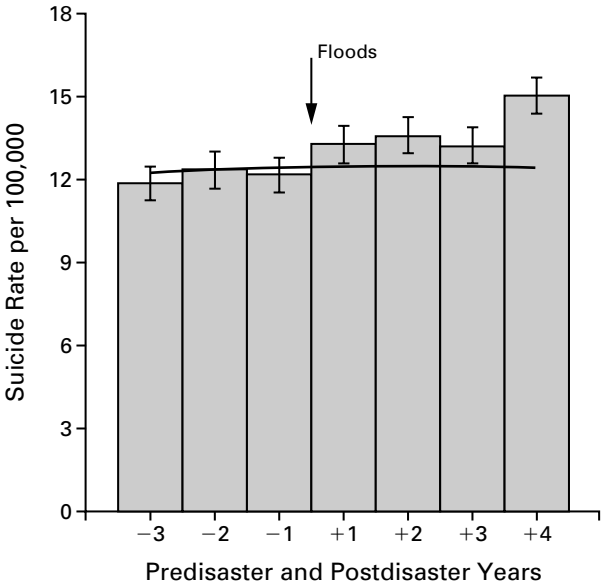

Figure 1. Suicide Rates before and after Floods in 308 Counties and the United States, 1979 to 1993.

The gray bars represent county rates, and the I bars represent the 95 percent confidence intervals for these rates. The black horizontal curve represents the rates for the United States as a whole. The floods occurred between 1982 and 1989.

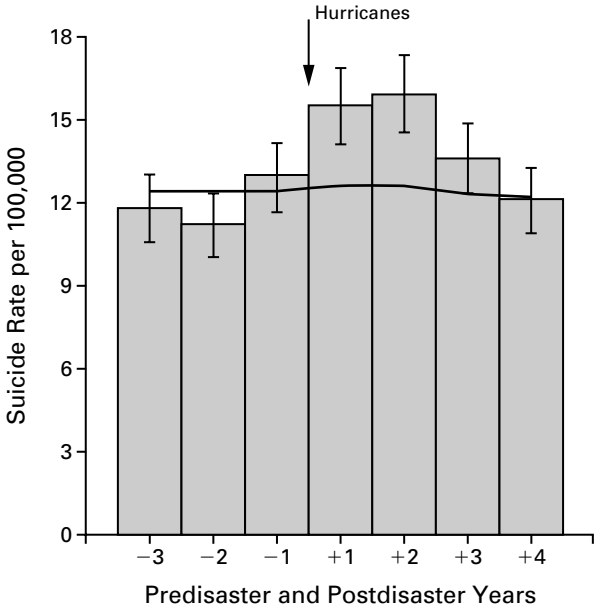

Figure 2. Suicide Rates before and after Hurricanes in 24 Counties and the United States, 1979 to 1993.

The gray bars represent county rates, and the I bars represent the 95 percent confidence intervals for these rates. The black horizontal curve represents the rates for the United States as a whole. The hurricanes occurred between 1982 and 1989.

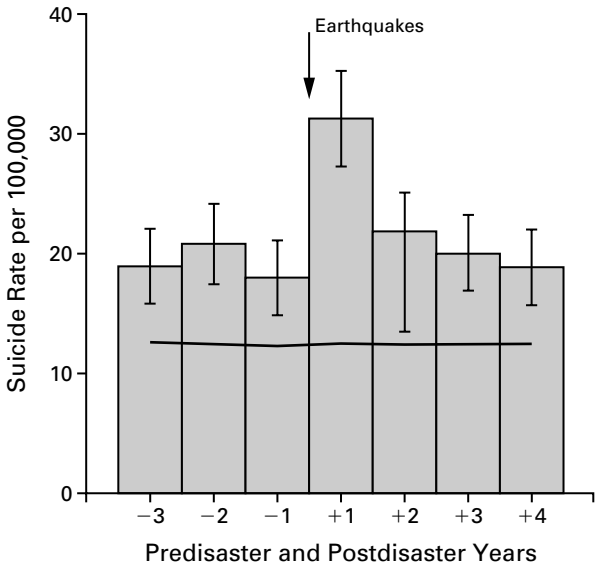

Figure 3. Suicide Rates before and after Earthquakes in Four Counties and the United States, 1979 to 1993.

The gray bars represent county rates, and the I bars represent the 95 percent confidence intervals for these rates. The black horizontal curve represents the rates for the United States as a whole. The earthquakes occurred between 1982 and 1989.

DISCUSSION

This study shows that suicide rates increase after severe floods, hurricanes, and earthquakes. Overall, the suicide rate increased by 13.8 percent during the four years after a severe natural disaster. Although increases were observed for the first 12 months after all three types of disaster, the duration and magnitude of these increases varied according to the type of disaster. Increases in suicide rates were found for both sexes and for all age groups. During the same period, suicide rates in the United States as a whole remained stable.

There are several possible reasons why people may commit suicide after a natural disaster, even months or years later. The victims of disasters may be injured or may lose family members, friends, property, or jobs. Even people who incur no direct losses can be affected by a disaster.[34] At least as important as the consequences of the immediate physical effect of a disaster are the long-lasting alterations of day-to-day life and the disruption of social networks.[35] Stores, bars, clubhouses, or churches — places where people found friends and support — may have been destroyed. After natural disasters, factors such as bereavement, property loss, and the disruption of social networks have been associated with mental-health problems,[6,35] including depression and hopelessness,[11,13,18] which are known risk factors for suicide.[25] Strong social support is a protective factor

against suicide.[25] However, research shows a decrease in feelings of social support and belonging after natural disasters.[36]

Some of the disaster-specific findings of our study, such as the differences in the magnitude and duration of the increase, are surprising. Why do suicide rates increase for at least four years after floods, two years after hurricanes, and only one year after earthquakes? One possible explanation may be that floods recur more often than earthquakes. If the counties included in our study were affected by other floods (those not declared a federal disaster) during the four-year postdisaster period, this could have affected the suicide rates. Another possible explanation may be that floods cause more damage than other disasters; victims of floods report four times as many injuries and three times as much financial loss as the victims of hurricanes and earthquakes.[1] Flood victims are also more likely to take on loans than victims of hurricanes and earthquakes.[1] It is possible that loans delay some of the psychological consequences, by bringing temporary relief to the victims, but leave financial burdens long after everything seems to have returned to normal. Self-reported data indicate that feelings of depression increase with the amount of debt incurred after a natural disaster.[1] Other points that may need to be considered are the facts that different types of disasters are covered by different insurance systems, and that the destructive effects of floods, especially on agriculture, last a long time.

Our study has several strengths not shared by some previous studies of the psychological effects of disasters.[37] The study population was large. At the time of the disasters, 19,453,900 people lived in the 377 counties included in our study. Base-line information was available, which allowed us to compare suicide rates after the disasters with the rates before the disasters. We also compared the suicide rates of the affected counties with those of a control group (the entire United States).

Despite these strengths, several limitations should be noted. First, our study included only four years of follow-up, a period too short to allow us to determine the duration of the increase in the suicide rate after severe floods. Second, only four counties in our study had experienced earthquakes. Because of this, the differences we found in counties affected by earthquakes may not be generalizable. Third, the counties included in our study may have been affected by other natural disasters not declared federal emergencies during the study period. Fourth, we included only counties that received assistance from the federal government after natural disasters. This assistance presumably included financial and mental health support that may have reduced the incidence of suicide caused by the disaster. Fifth, although some counties may have been only partially affected by a disaster, our study considers the population of the whole county as victims of the disaster. This factor may explain some of the differences in the magnitude of the increases according to the type of disaster. Most of these limitations suggest that our findings underestimate the effect of natural disasters on suicide rates.

In our study we excluded counties with more than one declared disaster each, making it impossible to estimate the effect of recurrent disasters. However, to get some sense of the effect of multiple disasters on suicide rates, we created a new data set with which to perform two additional analyses. First, we selected the 70 counties each of which had been affected by two disasters separated by no more than 24 months. We found a statistically significant increase of 14.8 percent from the predisaster rate to the rate during the first two years after the second disaster. Second, we selected the 15 counties each affected by two disasters separated by 35 to 37 months. We found that the rate increased by 9.3 percent during the three years after the first disaster and by 15.4 percent during the four years after the second disaster. Even though in the latter analysis the changes were not statistically significant (probably because of the small number of counties involved), the direction of these changes was consistent with the observation that suicide rates are elevated after natural disasters.

Our study suggests that mental health support is needed after severe disasters, that it should be available for varying periods, and that it should take into account the needs of various age groups. Prevention could include providing social support and facilitating aid to victims. In addition, disaster-prone areas could be targeted for programs that reduce the conditions that predispose people to commit suicide. Another way to prevent the suicides attributable to natural disasters is to prevent the disasters. Building flood walls or decreasing deforestation are examples of ways to prevent floods. When the disaster cannot be avoided, its impact can sometimes be minimized. Warning systems for hurricanes and buildings that resist earthquakes can lessen the impact of disasters and may reduce adverse effects on mental health, including suicide.

Each year in the United States millions of people lose property, sustain injuries, or die as a result of natural disasters. Our study shows that suicide is also an important health outcome of natural disasters. Though much more information is needed to elucidate fully the reasons why some people commit suicide after a natural disaster, much can be done to prevent or lessen the impact of natural disasters and ultimately to reduce the number of disaster-related suicides.

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