Mortality of Kauai Residents in the 12-Month Period following Hurricane Iniki

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On September 11, 1992, Hurricane Iniki struck Kauai leaving all residents without electricity and telephone services and damaging 70% of the homes. This study examined the hypothesis that Hurricane Iniki increased the mortality of Kauai residents by comparing mortality data for the 5 years preceding Hurricane Iniki with mortality data for the 12 months immediately following. Although the overall mortality rate was increased in the post-Iniki period, the only significant increase was in the rate of diabetes mellitus-related deaths (relative risk = 2.61, 95% confidence interval 1.44–4.74). Hurricane Iniki did not appear to significantly increase the risk of dying of Kauai residents in the 12 months immediately following the disaster. Am J Epidemiol 1996;144:188–91.

diabetes mellitus; disasters; mortality; natural disasters; wounds and injuries

On September 11, 1992, a hurricane classified as a category III/IV storm on the Saffir-Simpson Hurricane Scale struck Hawaii with the eye passing directly over the island of Kauai. Hurricane Iniki produced sustained winds of 145 mph (232 km/hour), measured gusts to 175 mph (280 km/hour), and storm tides 6 feet (1.8 m) above normal (1, 2). Kauai, with an estimated 1992 population of 54,200 (3), sustained approximately 2.2 billion dollars in property damage (Ronald Matsumura, Hawaii Civil Defense Agency, personal communication, 1994). Seventy percent (14,350) of Kauai’s housing units were damaged, 50 percent of them sustaining major damage (2). No residents of Kauai were unaffected by the hurricane since all were left without electrical or telephone services. Four months passed before electricity, telephones, and water were restored to all parts of Kauai (1, 2).

The medical literature contains studies describing mortality occurring during and immediately following several natural disasters (4–14). However, as Logue et al. (15) point out, disasters may cause long-term health consequences that can affect mortality for ≥1 year after the event. A search of the literature provided only a few studies of delayed mortality related to disasters (16, 17). On Kauai, one death was directly attributed to Hurricane Iniki, and five others identified in the week following were thought to be related (2). These deaths were most obviously related to the disaster, but deaths occurring later may also have been influenced by Hurricane Iniki. This study tests the hypothesis that Hurricane Iniki was associated with increased mortality in the 12-month period following the hurricane.

MATERIALS AND METHODS

Mortality data for residents of Kauai for the 5-year period 1987–1991 were obtained from tables in the annual statistical report released by the Office of Health Status Monitoring, Hawaii Department of Health (18–21). Data for the years 1987–1990 were published, but 1991 data were unpublished. Mortality data for the 12-month period immediately following Hurricane Iniki (October 1, 1992, through September 30, 1993) were obtained directly from the database of the Office of Health Status Monitoring. Mortality data for Kauai were available for the sex, age, and cause of death based on the International Classification of Diseases, Ninth Revision (22). Deaths of residents of Kauai occurring in areas other than Kauai were included in the analysis, but deaths of nonresidents occurring on Kauai were excluded.
For analysis, the deaths were classified by age according to four categories: 0–19 years, 20–44 years, 45–64 years, and ≥65 years. Deaths were also classified by the sex and cause of death using the International Classification of Diseases, Ninth Revision, codes listed on the death certificate. The primary cause of death was selected and coded by the same nosologist at the Office of Health Status Monitoring for the entire period of interest.

Estimates of Kauai’s resident population for the years 1987 through 1993 were obtained from the Hawaii State Department of Business, Economic Development, and Tourism (3). The breakdown of Kauai’s resident population by age and sex for intercensal years was not available. The same proportions existing in data from the 1990 US Census were applied to these years to determine the denominators for rates and the expected number of deaths. Therefore, the annual age-adjusted death rates for the 6-year period could not be done.

The relative risks of dying in the 12-month period immediately following Hurricane Iniki compared with dying in the 5-year period prior to Iniki were calculated using Epi Info (23). The person-years of exposure were used to take into account the changing population of Kauai from year to year and to provide a more meaningful comparison of data between the 5-year period and the 1-year period.

RESULTS

A total of 397 Kauai residents died in the 12-month period following Hurricane Iniki for an annual mortality rate of 720.4 deaths per 100,000 residents. In the 5 years preceding the hurricane, an average of 333 Kauai residents died each year for an overall mortality rate of 665.5 deaths per 100,000 residents per year. The risk of dying for Kauai residents was increased in the 12 months following Hurricane Iniki, but not significantly increased (table 1). When looking at the monthly trends of mortality for the post-Iniki period, we found that 221 deaths occurred in the first 6 months compared with 195 deaths in the second 6 months (relative risk = 1.13, 95 percent confidence interval 0.94–1.37). This was not statistically significant nor was the chi-square for linear trend for the entire 12-month period significant (p > 0.05).

Mortality rates were increased for both sexes in the 12 months following Hurricane Iniki when compared with those during the 5 years preceding Iniki; however, these increases did not reach statistical significance (table 1). Males had higher mortality rates than did females in both the pre- and post-Iniki study periods with similar male/female ratios in both periods (814 male deaths per 100,000 vs. 513 female deaths per 100,000 in the pre-Iniki period and 859 male deaths per 100,000 vs. 578 female deaths per 100,000 in the post-Iniki period).

In both the pre- and post-Hurricane Iniki periods, the mortality rates increased with increasing age. In the 12 months following the hurricane, mortality increased for all age groups except the 45- to 64-year group. However, none of these changes was statistically significant (table 1).

The six leading causes of death for Kauai residents remained the same in both the pre- and post-Hurricane Iniki study periods: heart disease, neoplasm, respiratory illness, injury, stroke, and diabetes mellitus. The mortality rates were increased in the 12-month post-Iniki period for all these causes of death except heart disease. Only the increased deaths from diabetes mellitus in the post-Iniki period reached statistical significance (relative risk = 2.61, 95 percent confidence interval 1.44–4.74) (table 1).

DISCUSSION

Following the massive devastation of Kauai by Hurricane Iniki and the extended displacement and interruption of daily routine for most residents, the overall mortality rate and most other mortality rates were increased in the post-Iniki period, but not significantly

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<tr>
<th>TABLE 1. Comparison of the risk of death of Kauai residents in the 12 months following Hurricane Iniki, 1992, with the risk of death in the 5 years preceding the hurricane, 1987–1991</th>
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<tbody>
<tr>
<td><strong>Cause of death</strong></td>
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<td>Injury</td>
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<td>Diabetes mellitus</td>
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† Median annual deaths in the pre-Iniki period, 1987–1991.‡ Number of deaths in the 12-month post-Iniki period.§ Relative risk compares the risk of dying in the 12-month period following Iniki with the risk of dying in the 5-year period preceding Iniki.
increased. When analyzing mortality data by sex, age group, and cause of death, we found that the only significant finding was an increase in mortality from diabetes mellitus in the post-Iniki period.

Several reasons may exist for the failure of this study to support the hypothesis that Hurricane Iniki significantly increased the mortality of Kauai residents. Despite the massive property damage and disruption of services, Hurricane Iniki may not have increased the stress of Kauai residents greatly enough to affect mortality, or other factors not controlled for in the study lessened the amount of stress experienced by Kauai residents. The latter reason appears to be the most plausible. Outside factors that could have reduced stress include the monetary and real goods provided by governmental and private disaster agencies, translocation of people off Kauai until utilities were restored, limited disruption of medical care and supplies, and mutual community support following the disaster.

The increase in diabetes-related deaths in the post-Hurricane Iniki period is thought to be real as opposed to an artifactual increase related to the reporting process. The Centers for Disease Control and Prevention reported a 14 percent national increase in deaths from diabetes from 1988 to 1989 (24). This increase was felt to be related to two revisions in the US standard certificate of death. Diabetes-related deaths on Kauai increased from 1989 to 1990, possibly related to the revisions in the standard certificate of death, but they returned to the previous level in 1991 before Hurricane Iniki struck Kauai. Diabetes-related deaths on Kauai increased 161 percent after Iniki, a much greater increase than the 14 percent artifactual increase observed nationally.

The increase in diabetes-related deaths may be related to an inability to maintain adequate control of glucose in the post-Hurricane Iniki period. Many diabetics need multiple medical products such as insulin, medications, and glucose-monitoring supplies. Disruption of medical services and supplies may have led to a delay in necessary treatment or prevented routine medical checkups. Food supplies were limited after Iniki and may have contributed to poorer control of diabetes, especially in the diabetics who have greater difficulty controlling their diabetes.

Several limitations occur with this study. The most significant problem is the small size of the study population and the small number of deaths occurring each year. When mortality data are broken down into smaller categories, especially by cause of death, one or two extra deaths could shift the study results. This problem is minimized by using 5 years of mortality data in the pre-Hurricane Iniki period that would help smooth out any unusual events occurring in a particular year. Extending this study beyond the 12-month period for the post-Iniki period would do the same. However, this technique was not chosen because the recovery of the island of Kauai continued and because the post-Iniki disruption of daily life activities decreased with time.

The other limitation in this study is the lack of validity of the cause of death obtained from the death certificate. Other studies have noted problems with obtaining the cause of death in this manner (25, 26). However, because mortality data from the same location are compared over two time periods, this misclassification bias, if present, would be similar for both groups unless the recording practices of physicians or the medical examiner changed over the period 1987–1993. Also limiting misclassification bias is the use of one nosologist to record the cause of death for vital statistics in Hawaii for the entire period of study.

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