Hurricane Sandy (New Jersey): Mortality Rates in the Following Month and Quarter

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Objectives. To describe changes in mortality after Hurricane Sandy made landfall in New Jersey on October 29, 2012.

Methods. We used electronic death records to describe changes in all-cause and cause-specific mortality overall, in persons aged 76 years or older, and by 3 Sandy impact levels for the month and quarter following Hurricane Sandy compared with the same periods in earlier years adjusted for trends.

Results. All-cause mortality increased 6% (95% confidence interval [CI] = 2%, 11%) for the month, 5%, 8%, and 12% by increasing Sandy impact level; and 7% (95% CI = 5%, 10%) for the quarter, 5%, 8%, and 15% by increasing Sandy impact level. In elderly persons, all-cause mortality rates increased 10% (95% CI = 5%, 15%) and 13% (95% CI = 10%, 16%) in the month and quarter, respectively. Deaths that were cardiovascular disease–related increased by 6% in both periods, noninfectious respiratory disease–related by 24% in the quarter, infection-related by 20% in the quarter, and unintentional injury–related by 23% in the month.

Conclusions. Mortality increased, heterogeneous by cause, for both periods after Hurricane Sandy, particularly in communities more severely affected and in the elderly, who may benefit from supportive services. (*Am J Public Health.* 2017;107:1304–1307. doi:10.2105/AJPH.2017.303826)

On October 29, 2012, Hurricane Sandy made landfall in New Jersey causing widespread damage.[1,2] We used death registry data to describe changes in mortality rates in New Jersey following Hurricane Sandy.

METHODS

We studied persons whose primary residence was New Jersey and elderly residents aged 76 years or older.

Data Sources

The Electronic Death Registration System[3] is a Web-based system for reporting and certifying deaths. Records are processed through the Mortality Medical Data System,[4,5] which assigns *International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10),* codes[6] to underlying causes of death and up to 20 additional *ICD-10* codes. We obtained 2008 to 2013 death records and 2010 US Census data.[7]

Sandy Impact Level

Sandy Community Impact Score is a municipality-level score combining electricity outages, residential and commercial damage, and Federal Emergency Management Agency municipal assistance.[8] Municipalities were ranked by Sandy Community Impact Score, and Sandy impact levels were defined: the lowest impact level covers 60% of the population, and intermediate and highest impact levels encompasses the next 2 quintiles.

Time Periods

We used a calendar with October 28, 2012 (the day before storm landfall), as a reference point. We defined 2 study periods: Sandy month (October 28, 2012–November 27, 2012) and Sandy quarter (October 28, 2012–January 27, 2013). For the Sandy month, the comparison period was October 28 to November 27 during 2009 to 2011; the prestudy period was the 11 months preceding the Sandy month (November 28, 2011–October 27, 2012); and the precomparison period was November 28 to October 27 during 2008 to 2011. Periods for the Sandy quarter analysis were similarly defined (Figure A, available as a supplement to the online version of this article at http://www.ajph.org).

Outcomes

We studied all-cause and noninfectious respiratory, infectious, cardiovascular disease, unintentional injury, and carbon monoxide poisoning deaths. Table A (available as a supplement to the online version of this article at http://www.ajph.org) provides *ICD-10* codes.

Statistical Methods

Because of Poisson model deviance greater than 3 for monthly all-cause mortality and

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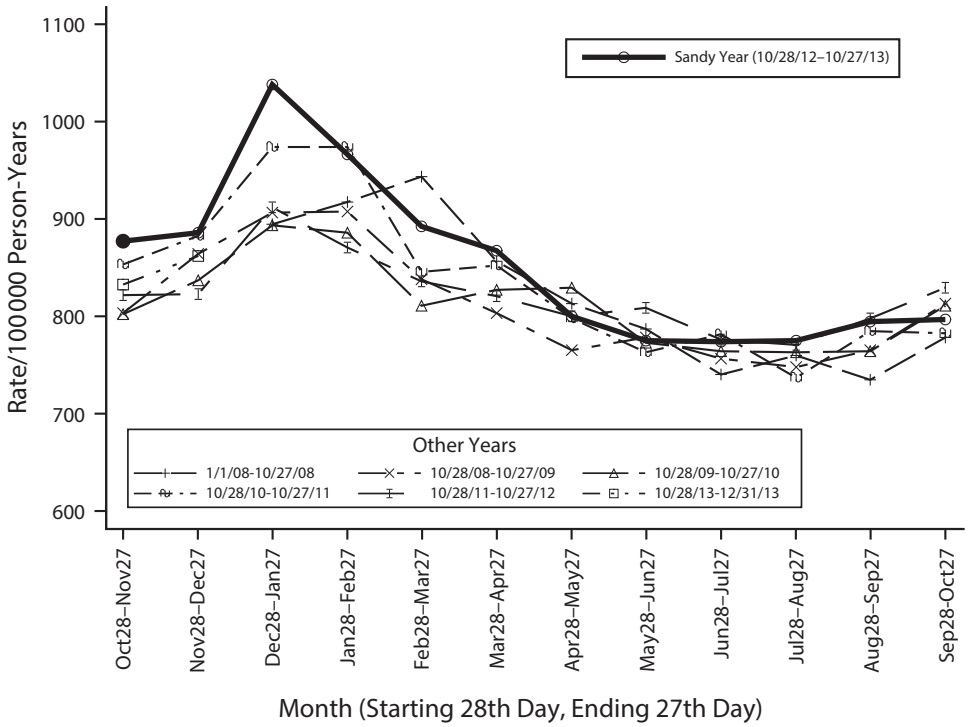

Note. We used negative binomial regression to estimate death rates after grouping deaths into months that begin on the 28th day of the month.

FIGURE 1—Estimated All-Cause Mortality Rates After Hurricane Sandy by Month: New Jersey, 2008–2013

heterogeneous population sizes and time intervals, we used negative binomial regression to estimate death rates, with log-population × time interval offset.

Estimated unadjusted relative risks (RRs) contrasted Hurricane Sandy month or quarter with the comparison period. The seasonality and time trend adjusted RR adjusted the RR by the prestudy versus precomparison period ratio.

We used SAS version 9.4 (SAS Institute, Cary, NC) GENMOD to fit models with repeated measures. Robust variance estimates were used to calculate SEs. *P* values were 2-sided, and changes in rates were tested at the 5% significance level.

RESULTS

Many, but not all, of the highly affected municipalities bordered the Atlantic Ocean (Figure B, available as a supplement to the online version of this article at http://www.ajph.org). Additional details for all of the following outcomes are provided in Tables B and C (available as a supplement to the online version of this article at http://www.ajph.org).

All-Cause Mortality

Figure 1 illustrates monthly New Jersey all-cause mortality from 2008 to 2013. For the Sandy month, all-cause mortality was 875 (95% confidence interval [CI] = 813, 941) per 100 000 person-years with an adjusted RR of 1.06 (95% CI = 1.02, 1.11; *P* = .006) and for the Sandy quarter was 932 (95% CI = 869, 1000) per 100 000 person-years with an adjusted RR of 1.07 (95% CI = 1.05, 1.10; *P* < .001).

For the Sandy month, all-cause mortality excesses increased with Sandy impact level (adjusted RR = 1.05, 1.08, and 1.12) but were not statistically significant. However, the Sandy quarter excesses showed a gradient by Sandy impact level (adjusted RR = 1.05, 1.08, and 1.15), and each was significant.

Among the elderly, Sandy month all-cause mortality was 8638 (95% CI = 8032, 9289) per 100 000 person-years and was significantly elevated (adjusted RR = 1.10; 95% CI = 1.05, 1.15; *P* < .001), and Sandy quarter all-cause mortality was 9306 (95% CI = 8723, 9929) per 100 000 person-years and also was significantly elevated (adjusted RR = 1.13; 95% CI = 1.10, 1.16; *P* < .001), showing an increasing gradient of excess by increasing Sandy impact level (adjusted RR = 1.06; *P* = .06; 1.13; *P* = .015; and 1.22; *P* = .005 for the Sandy month; and adjusted RR = 1.10, 1.15, 1.21; all *P* < .001 for the Sandy quarter).

Noninfectious Respiratory Deaths

The noninfectious respiratory cause death rate during the Sandy month was 58 (95% CI = 51, 66) per 100 000 person-years with an adjusted RR of 1.08 (95% CI = 0.96, 1.22; *P* = .24) and during the Sandy quarter was 73 (95% CI = 67, 80) per 100 000 person-years with a significant overall adjusted RR of 1.24 (95% CI = 1.15, 1.33; *P* < .001), and within each increasing Sandy impact level, the adjusted RR was 1.22, 1.33, and 1.22 (all *P* < .05).

The noninfectious respiratory disease death rate among the elderly for the Sandy month was 661 (95% CI = 587, 746) per 100 000 person-years with an adjusted RR of 1.10 (95% CI = 0.96, 1.26; *P* = .19)

and for the Sandy quarter was 818 (95% CI = 757, 885) with an adjusted RR of 1.27 (95% CI = 1.17, 1.38; $P < .001$).

Infectious Disease Deaths

For the Sandy month, the infectious cause death rate was 52 (95% CI = 46, 59) per 100 000 person-years with a nonsignificant adjusted RR of 1.06 (95% CI = 0.94, 1.19; $P = .34$) and for the Sandy quarter was 62 (95% CI = 57, 67) per 100 000 person-years with an adjusted RR of 1.20 (95% CI = 1.12, 1.29; $P < .001$), and within each increasing Sandy impact level, the adjusted RR was 1.19 ($P = .001$), 1.19 ($P = .09$), and 1.25 ($P = .007$).

The elderly died of infectious causes during the Sandy month at a rate of 532 (95% CI = 469, 604) per 100 000 person-years, a statistically nonsignificant excess (adjusted RR = 1.06; 95% CI = 0.91, 1.24; $P = .44$), and during the Sandy quarter at a rate of 649 (95% CI = 600, 703) per 100 000 person-years with an adjusted RR of 1.21 (95% CI = 1.10, 1.33; $P < .001$).

Cardiovascular Disease Deaths

Cardiovascular disease mortality during the Sandy month was 282 (95% CI = 260, 306) per 100 000 person-years with an adjusted RR of 1.06 (95% CI = 1.00, 1.13; $P = .06$) and during the Sandy quarter was 300 (95% CI = 280, 321) per 100 000 person-years, which was significantly elevated (adjusted RR = 1.06; 95% CI = 1.02, 1.10; $P = .005$).

The cardiovascular disease mortality rate for the elderly was 3234 (95% CI = 2990, 3499) per 100 000 person-years for the Sandy month with an adjusted RR of 1.10 (95% CI = 1.02, 1.18; $P = .011$). The cardiovascular disease mortality elevation among the elderly persisted for the Sandy quarter with rate of 3473 (95% CI = 3276, 3682) per 100 000 person-years (adjusted RR = 1.10; 95% CI = 1.06, 1.15; $P < .001$).

Unintentional Injury Deaths

The unintentional injury mortality rate for the Sandy month was 34 (95% CI = 30, 39) per 100 000 person-years with an adjusted RR of 1.23 (95% CI = 1.05, 1.44; $P = .015$) and for the Sandy quarter was 32 (95% CI = 29, 35) per 100 000 person-years with an adjusted RR of 1.10 (95% CI = 0.99, 1.21; $P = .07$).

The elderly died of unintentional injuries during the Sandy month at a rate of 127 (95% CI = 98, 164) per 100 000 person-years, a statistically nonsignificant excess (adjusted RR = 1.33; 95% CI = 0.96, 1.84; $P = .10$), and during the Sandy quarter at a rate of 121 (95% CI = 104, 142) per 100 000 person-years with an adjusted RR of 1.26 (95% CI = 1.02, 1.56; $P = .032$).

Carbon Monoxide Poisoning Deaths

Six carbon monoxide–related deaths occurred during the Sandy month and—although double that expected (adjusted RR = 2.2; 95% CI = 0.3, 16.8)—was nonsignificant.

DISCUSSION

We found a 6% increase in 1-month and 7% increase in 3-month all-cause mortality after Hurricane Sandy. Excess mortality was consistent with that in other studies.[9,10] Noninfectious respiratory and infectious disease death excesses were significantly higher for the Sandy quarter but not month, consistent with longer disease processes or lag in development of harmful exposures. For cardiovascular disease mortality, we observed an excess for the quarter. Unintentional injury death excesses were greatest during the Sandy month. Elderly persons were especially vulnerable, as were those living in communities with the greatest storm impact.

Study Limitations

Our methods assumed the absence of other major events. However, in late August 2011, Hurricane Irene hit New Jersey, followed by a northeaster in late October 2011. We also used 2010 US Census data for all periods.

Hurricane Sandy impact level is a municipality-level measure. Individuals might have evacuated during the storm, those residing in areas that sustained the greatest damage may not have returned, and some exposures may be workplace related.

We tested numerous outcome and subgroup combinations without adjusting for multiplicity.

Summary

Mortality increased, heterogeneous by cause, for the 1- and 3-month periods after Hurricane Sandy, particularly in communities more severely affected and in the elderly.

PUBLIC HEALTH IMPLICATIONS

Our findings, if confirmed by other approaches, can inform planning and response to disasters. Services may need to be extended beyond the immediate aftermath of the disaster, particularly to the elderly and those living in heavily affected areas. AJPH

CONTRIBUTORS

All authors conceptualized and designed the study, revised the article, and approved the final version of the article. S. Kim drafted the article. S. Kim and M. Rajan analyzed the data.

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HUMAN PARTICIPANT PROTECTION

This study was approved by the Rutgers University Newark institutional review board and by the Rowan University institutional review board (which serves as the institutional review board for the New Jersey Department of Health).

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