ORIGINAL RESEARCH

Effects of the July 1997 Floods in the Czech Republic on Cardiac Mortality

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ABSTRACT

Objective: An excess of deaths from cardiac causes are reported after many natural disasters. Despite the fact that floods are the most common and most destructive natural disaster worldwide, little is known about their effect on human health. We analyzed the influence of the greatest floods in the Czech Republic on cardiac mortality in the affected area.

Methods: This was a retrospective case-control study. We analyzed persons whose autopsies proved they had died of cardiac causes during the month of the flood, 2 months before the flood, 1 month after the flood, and during the same period in the 3 previous years.

Results: A total of 207 of 985 autopsy reports met the criteria for inclusion in the study. There were no significant differences in the proportions of men and women ($P = 0.819$) or in age ($P = 0.577$). During the month of the flood, an increase in cardiac mortality was observed; however, the increase was not statistically significant ($P = 0.088$).

Conclusions: According to our findings, the 1997 Central European flood did not significantly affect cardiac mortality. (*Disaster Med Public Health Preparedness*. 2014;8:492-496)

Key words: floods, cardiac mortality, vulnerable populations

In 1997, the Czech Republic, Poland, and Germany were affected by the 1997 Central European flood, known as the Great Flood of 1997 (Figure 1). According to the Emergency Events Database EM-DAT, which is a global database on natural and technological disasters, the Great Flood of 1997 was one of the top 10 natural disasters in the Czech Republic for the 1900 to 2013 period with regard to the number of people killed (29), the total number of people affected (102 107), and the amount of economic damage (US$1 850 000 000).[1] The flood was caused by heavy precipitation that fell from 4 to 8 July 1997. During this period, more than half of the entire year's typical rainfall fell in the catchment area of the Oder and the Morava rivers. Both of these rivers and their tributaries had overflowed to a level approximating a 150- to 500-year flow rate. The flood itself appeared during the first half of July in 1997 (5 to 16 July 1997). The highest flood stage ended on 29 July 1997. The flood affected 538 residential zones in 34 counties in Moravia, Silesia, and the eastern part of the Czech Republic. It destroyed 2151 houses, and another 5625 houses would not be habitable without extensive reconstruction. Many cities remained without electricity or phone service and hundreds of people had to leave their homes.[2]

Studies show that acute mental stress may trigger a cardiovascular event.[3,4] Increased rates of cardiovascular events are typically found after various life stressors, such as early wake-up times,[5,6] work-related stressful events,[7,8] bereavement,[9,10] and community-wide events such as wars,[11,12] terrorist attacks,[13-15] and industrial[16] and natural disasters. An excess of deaths from cardiac causes was reported after the Athens earthquake in 1989;[17] on the day of the Northridge earthquake in Los Angeles, California, in 1994;[18] and also after the 1995 Great Hanshin-Awaji earthquake in Japan.[19] Significant increases in the occurrence of heart failure and in the in-hospital mortality rate of heart failure were also described after the earthquake and tsunami disaster.[20-22]

Floods are the most common and most destructive natural disaster worldwide. Despite this fact, we could not find any similar studies concerning the effect of floods on the cardiovascular system. In industrialized countries, several articles refer to increases in total

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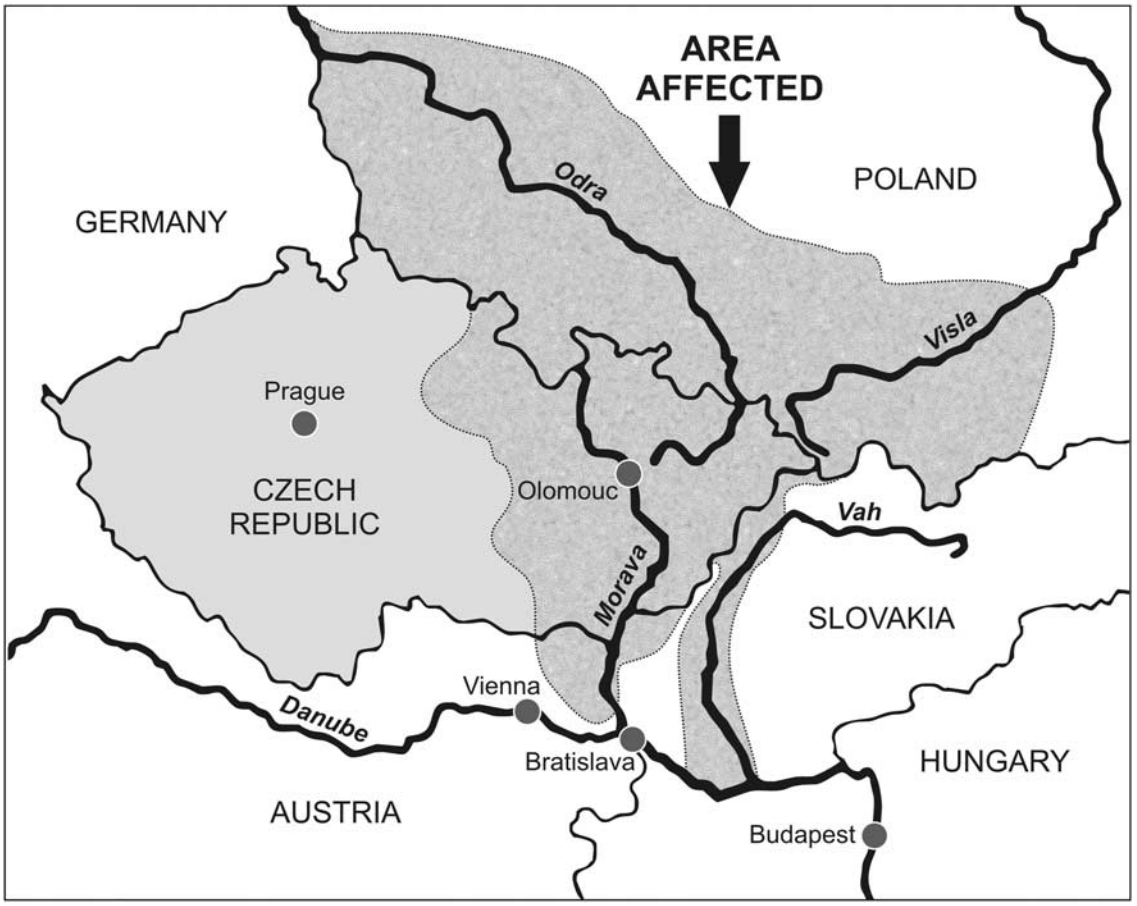
FIGURE 1

Map of Areas Affected by the 1997 Central European Flood. Source: http://povodne.charita.cz/1997/kniha-povodne-1997/



mortality following flood events.[23] However, a study of the 1974 Brisbane floods did not support this.[24] We were therefore interested in whether flood disaster increases the incidence of death from ischemic heart disease and heart failure by use of actual autopsy results. It is known that approximately 50% of all cardiac deaths are sudden, occurring within 1 hour of the onset of symptoms in a person with known or unknown cardiac disease. Most cases of sudden cardiac death have coronary artery disease present at autopsy, although in approximately 50% of cases this disease will not have been clinically apparent prior to death.[4]

METHODS

This was a retrospective case-control study. Data were obtained from the archive of the Institute of Forensic Medicine, Palacky University Olomouc, with permission from the Institute. The Institute of Forensic Medicine investigates sudden, unexpected death, deaths for which it is not possible to unambiguously determine the cause of death and deaths not from natural causes. Each autopsy is conducted by specialists in forensic medicine. These specialists write autopsy reports that are archived. In 1994 to 1997, only paper archiving existed. All autopsy reports had to be reviewed manually. Data collection took place in 2012 to 2013.

The authors (trained medical professionals) personally reviewed all autopsy reports from July 1997, the month of flood; from 1 month after the flood (August 1997); and from 2 months before the flood (May and June 1997). Because no studies concerning the impact that floods have on death from cardiac causes were found, an 8-week follow-up from the beginning of the flood was derived from a study examining the impact of another natural disaster, the 1995 Great Hanshin-Awaji earthquake. The duration of increased cardiac mortality after this earthquake was longer than had been observed with previous earthquakes.[19]

Persons who died of ischemic heart disease (I20-25 of The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, WHO ICD-10) and heart

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failure (I50 of WHO ICD-10) as a cause of death according to performed autopsies were included in the study.

The authors obtained similar data for the corresponding period in the previous 3 years (1994, 1995, 1996). Data were manually entered into the database for analysis.

SPSS software version 15 (SPSS Inc, Chicago, IL) was used for the statistical analysis. The incidence of cardiac death in individual years and other categorical data were compared by using the chi-square test and Fisher's exact test. The Kruskal-Wallis test was used to compare age and the normality of the data was verified by using the Shapiro-Wilk test. Tests were conducted with a significance level of 0.05.

RESULTS

A total of 985 deaths were investigated in the Institute of Forensic Medicine, Palacky University Olomouc, from May to August 1994 to 1997 (Table 1). The inclusion criteria were matched in 207 cases that were included in our study. No significant differences in cardiac mortality from 1994 to 1997 were found ($p = 0.544$). The average age of persons in 1997 was identical to that in 1994–1996 ($p = 0.577$). Also, gender was similar compared to the control period ($p = 0.819$). The basic data are summarized in Table 2.

No significant difference in the distribution of cardiac mortality in individual months was found ($p = 0.088$; Table 3). During the flood in July 1997, 25 persons were found who died from cardiac causes: 18 men and 7 women with an average age of 64.5 years. This was the most cardiac deaths in all the monitored months. Compared with the same months in previous years, there was a noticeable increase (10 in 1994, 7 in 1995, 19 in 1996); however, this increase did not reach statistical significance. The month of the flood month saw more than twice the number of cardiac deaths than the 2 months preceding the flood (10 in May, 9 in June). However, this difference still did not reach the threshold of statistical significance. In the month after the flood, we noticed a decrease in cardiac mortality compared with previous years.

The daily number of deaths from cardiac causes in July 1997 is shown in Figure 2. The exact date of one death was not possible to determine and the most probable date was assessed at 18.7. ± 6 days. During the most critical days (5 to 16 July 1997), nearly one-third of the persons died (28%, 7 persons). However, the greatest number of deaths were recorded in the following week (52%, 13 persons).

Death from ischemic heart disease or the combination of ischemic heart disease and heart failure dominated in all monitored months (Table 4). Heart failure itself was found at a very small percentage. There was no significant difference in the cause of death in individual months.

TABLE 1

Total number of deaths for the year, total number of deaths during the monitored period (May-August), and total number of deaths from cardiac causes during the monitored period (May-August)

	No. of Deaths for the Year	No. of Deaths During the Monitored Period	Deaths from Cardiac Causes During the Monitored Period, No. (%)
1994	662	230	41 (17.8)
1995	730	259	49 (18.9)
1996	710	217	57 (26.2)
1997	793	279	60 (21.5)
Total	2895	985	207 (21.0)

TABLE 2

Total Number, Average Age, and Sex of Persons Who Died of Cardiac Causes, May–August 1994 to 1997

	No.	Age, y	No. of men (%)	No. of women (%)
1994	41	67.3 ± 12.6	29 (70.7)	12 (29.3)
1995	49	66.3 ± 12.0	34 (69.4)	15 (30.6)
1996	57	66.0 ± 11.5	40 (70.2)	17 (29.8)
1997	60	64.2 ± 12.2	46 (76.7)	14 (23.3)
Total	207	65.9 ± 12.0	149 (72)	58 (28)

TABLE 3

Number of Deaths From Cardiac Causes in Individual Months, May to August 1994 to 1997

	No. (%)				
	May	June	July	August	Total
1994	10 (24.4)	10 (24.4)	10 (24.4)	11 (26.8)	41 (100)
1995	19 (38.8)	10 (20.4)	7 (14.3)	13 (26.5)	49 (100)
1996	15 (26.3)	7 (12.3)	19 (33.3)	16 (28.1)	57 (100)
1997	10 (16.7)	9 (15.0)	25 (41.7)	16 (26.7)	60 (100)
Total	54 (26.1)	36 (17.4)	61 (29.5)	56 (27.1)	207 (100)

DISCUSSION

Little is known about the effect that floods have on death from cardiac causes. This study investigated the influence of one of the largest floods in the history of the Czech Republic. Acute mental stressors are now considered acute risk factors for cardiovascular events.[3] In our study, an increase in autopsy-proved deaths from cardiac causes in the month of the flood compared to the 2 previous months was observed. The same trend was also seen when compared with the previous 3 years. However, this increase did not reach statistical significance. The uniqueness of this study is that it included

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FIGURE 2

Daily Number of Deaths From Cardiac Causes in July 1997.

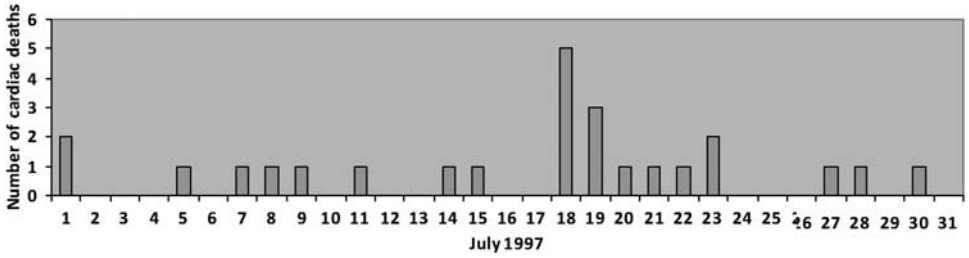

TABLE 4

Number of Deaths According to Cause of Death, May–August 1994 to 1997

Cause of Death	No.			
	1994	1995	1996	1997
Ischemic heart disease	38	42	50	55
Ischemic heart disease + heart failure	3	7	6	4
Heart failure	0	0	1	1

only autopsy-proved deaths from cardiac causes. But this is also a limitation of the study, because not all deaths are autopsied. Because we expected an increase in sudden cardiac deaths, we decided to obtain data from the archive of the Institute of Forensic Medicine, Palacky University Olomouc, which investigates sudden and unexpected death. However, no statistically significant increase was noticed.

The greatest number of deaths were recorded not during the most critical days of the flood, but in the following week. During that time, the flood began to retreat and people started to return to the affected areas. This finding may suggest that facing the aftermath of the flood was a greater stress for the victims than the flood itself.

Research identifying flood-related morbidity and mortality risk factors has revealed that during floods, females, the elderly, and children appear to be at greater risk of psychological and physical health effects, whereas males aged 10 to 29 years may be at greater risk of mortality. Post-flood, those over 65 years of age and males are at an increased risk of physical health effects, whereas females appear at greater risk of psychological health effects.[25] In our study, the elderly and males predominated, which is in line with the most common cause of death, ischemic heart disease. However the age and sex of persons who died of cardiac causes during the flood and control period were similar. This finding may suggest that the monitored increase in deaths occurred among people already at risk of death and that these persons merely died earlier because of the flood. To support this theory, we would expect a decrease in cardiac mortality in the next period. The month after the flood, cardiac mortality did decrease.

While ischemic heart disease increased during the flood, heart failure was autopsy-proved in only a very small percentage and did not show any changes during the time of the flood. The reason for this finding may be again be due to the study's design, which analyzed only autopsied persons from the Institute of Forensic Medicine, Palacky University Olomouc.

Another limitation was that the study was retrospective. The study design did not allow us to obtain information about how the individuals actually experienced the disaster and whether they suffered any material or immaterial damage. It is questionable whether a detailed geographic analysis would provide a different result. The entire catchment area of the Institute of Forensic Medicine in Olomouc was affected by the flood. Analysis would show whether the deceased lived near a swollen river or a tributary, so one could assume greater property damage. However, damage to a particular house or apartment could not be traced.

CONCLUSIONS

Floods are the most common and most destructive natural disaster. Studies concerning their effect on human health are needed in order to prepare preventative strategies. We analyzed the influence of one of the greatest floods in the Czech Republic on cardiac mortality in the affected area by using autopsy results. Despite the observed increase in deaths from ischemic heart disease, the 1997 Central European flood did not significantly affect cardiac mortality.

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