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RISK FACTORS FOR DEATH IN THE 1 MARCH 1997 ARKANSAS TORNADOES

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ABSTRACT

Field surveys were made two weeks after tornadoes killed 26 persons in Arkansas, USA, on 1 March 1997. Surveys were completed for samples of persons killed (n=25) and persons in the paths of the tornadoes but survived (n=73) to determine whether there were differences in personal characteristics, behavior, or location between the two groups. Fourteen of the 25 deaths were in mobile homes, four in frame homes, two each in commercial buildings, vehicles, and outdoors, and one in a garage. Risk factors for death included being in an above-ground room with windows, being in a room where the roof, wall, or floor was blown away, and being hit by debris. Divorced persons formed a larger portion of deaths (22%) than of those who survived (1%). There was no significant difference between deaths and survivors in age, gender, race, education, disability, or time between first becoming aware of the tornado and the tornado striking.

INTRODUCTION

Tornadoes on 1 March 1997 killed 26 people in Arkansas. We conducted field research in the disaster area following the storms to assess risk factors associated with death among persons in the tornado paths.

Adverse health effects of natural disasters do not occur randomly within a population but occur in a pattern clustered in time, in space, or in certain groups of persons (Binder and Sanderson, 1987). Knowledge of the attributes of persons killed by tornadoes, their behavior as the

tornado approached, and the circumstances of death, when compared to those who were not killed, may be useful to evaluate tornado preparedness programs, safety rules, and warning methods (Sanderson, 1989). That information identifies high risk groups and high risk behaviors that could be used to improve tornado preparedness and warning.

White and Haas (1975, p. 276) observed that geographic differences in tornado death rates were not explained by differences in tornado occurrences. They suggested that regional differences in death rates could be caused by differences in tornado severity, urbanization, building construction, preparedness, hospital facilities, warning systems, and the distinctive behavioral characteristics of individuals.

Previous studies of weather disasters have shown fatality rates varied with age (Moore, 1958; Centers for Disease Control, 1985; Carter, Millson, and Allen, 1989; Schmidlin and King, 1995), sex of the victim (Beelman, 1967; Glass et al, 1980; Schmidlin, 1993), and the victim's ethnicity (Moore, 1958, Perry et al, 1982; Aguirre, 1988). Previous experience with the hazard, access to warnings, and the location when the tornado struck have also been shown to affect risk of death.

An analysis of 155 tornado deaths occurring over a forty-year period in Ohio revealed that young boys and elderly women had a relatively high rate of death (Schmidlin, 1993). However, data from death certificates cannot provide information on the behavior of the victims as the tornado approached, type of warning received, or experience with tornadoes. Comparable information on those who were in the tornado path, but were not killed, is also not available years after the event.

To seek this detailed information on those who die in tornadoes and those who survive, we initiated a research project several years ago to collect data soon after tornado disasters. Collection of data soon after a disaster allowed us to gather and preserve information that will be lost in coming years.

In the first case, we conducted field research one week after the Georgia and Alabama Tornadoes of March 1994 (Schmidlin and King, 1995). A survey was completed for those who died (n=20) and for a sample of survivors (n=31) of the tornadoes. Fifteen of the 20 deaths were in rural

mobile homes. Those who died were older than survivors, more likely to be in a room above ground with windows, less likely to be listening to the television, had less warning time, and were more likely to have been struck by an object than survivors. Although National Weather Service (NWS) warnings preceded all of the killer tornadoes and 2/3 of survivors had a radio or TV on in the hour before the tornadoes struck, 68% became aware of the approaching tornado only by seeing or hearing the tornado. This gave little time for action.

The purpose of the present research is to obtain information on persons who died in the March 1997 Arkansas tornadoes and those who survived, to build upon our 1994 field work in Georgia and Alabama.

RESEARCH QUESTION

What locations, personal attributes, or behaviors increase the risk of death to persons in tornadoes?

THE 1 MARCH 1997 ARKANSAS TORNADOES

At least 15 tornadoes struck across Arkansas on the afternoon of Saturday 1 March 1997 with a total track length of about 400 km. There were 26 deaths and about 400 injuries (Centers for Disease Control, 1997). Tornado warnings were issued for a total of 34 counties, and fatalities occurred in five counties. Each county was under a tornado warning when the fatalities occurred, with a range of warning lead time from 18 to 32 minutes.

The tornadoes struck across wide areas of Arkansas. Much of the paths were forested and rural. Other tornadoes went through small communities, such as Arkadelphia and Jacksonport, and another struck portions of suburban Little Rock, missing the Little Rock Airport by just

1000 m.

FIELD METHODS

We entered the field on 11 March for four days of field work. Prior to traveling to Arkansas, we collected information on the fatalities from county coroners, funeral homes, and the *Arkansas Democrat-Gazette* World Wide Web site. Preliminary information on the tornado tracks was available from the National Weather Service Little Rock Web site. We traveled to Little Rock with two colleagues, Kent State University geography graduate students Barbara Hammer and Yuichi Ono. The first day of field work focused on northern Arkansas, the second day in Saline and Pulaski counties, the third day in Arkadelphia, and the fourth day again in Saline and Pulaski counties. Clearances were received from local authorities, where needed, to enter the disaster areas.

A survey (Schmidlin and King, 1995; available from Schmidlin) was completed for fatalities (n=25) by obtaining information from a coroner, funeral home director, relatives, or neighbors. A survey was also completed for each survivor we encountered (n=73). Survivors were sought who were in the same structure with someone who died or at sites adjacent to the fatalities. Most surveys were completed in person. A small number were completed by telephone after we returned from the field work.

DATA ANALYSIS

Data were analyzed using SPSS statistical software to test the null hypothesis that the responses to the survey questions did not differ between those who were killed and those who survived. A t-test was used to test for a difference in age between the two groups and the chi-square test was used on the categorical data. The hypothesis of no difference was rejected if $p < 0.10$. Responses of "refused" or

"unknown" were considered missing in the analysis.

RESULTS

There were four deaths in frame houses, 14 in mobile homes, two each in commercial buildings, vehicles, and outdoors, and one in a garage. Average age in the two samples was 43 years with no statistically significant difference between deaths and survivors. There was also no significant difference between deaths and survivors in gender (52% female), race (80% white), education (40% had some college), or time between first becoming aware of the tornado and the tornado striking (60% less than one minute), or in the presence of a mental or physical condition that affected response (17%).

There was a significant difference ($p=0.004$) in marital status. Although about 60% of both survivors and deaths were married, 39% of survivors were never married and only 1% were divorced, while 17% of deaths were never married and 22% were divorced.

For persons in a structure, there was a significant difference ($p<0.001$) between deaths and survivors in their location within the structure. All of the deaths occurred in rooms above ground with windows. Among survivors, 51% were in a room above ground with windows, 31% were in a room above ground without windows, and 18% were in a room below ground without windows.

There was also a significant difference ($p<0.001$) between deaths and survivors in whether a wall was gone, the roof blown off or collapsed, or the floor blown off or collapsed in the room they were in, or whether they were hit by anything inside the building. In rooms where deaths occurred, 100% lost the roof, 95% lost a wall, 70% had the floor blown away, and 100% of deaths were hit by debris. In rooms where survivors were located, 59% lost the roof, 35% lost a wall, 26% had the floor blown away, and 41% of survivors were hit by debris. One-third of survivors were taking shelter behind or under furniture or a stairway, and 22% used a rug or blanket to cover themselves.

There was no difference between deaths and survivors in the method of becoming aware of the tornado. About 61% first became aware of the tornado when they saw or heard the funnel, 21% first became aware of the tornado through a warning on the radio or television, and 13% were told of the tornado by a friend, neighbor, or relative. Warning sirens sounded in some communities, but, in one neighborhood where four deaths occurred, the siren was commonly mistaken for a train whistle on the tracks that crossed through the community. No one reported use of a NOAA weather radio to first receive the warning, although a weather radio was reported in about 14% of the homes.

Telephones, televisions, and radios were present in virtually all of the homes of deaths and survivors. Information on whether deaths had a radio or TV on in the hour before the tornado struck was generally not available. Among survivors, 73% had a television on at some time during the hour before the tornado struck, but only 6% had a radio on in the hour before the tornado. About 20% of survivors had practiced what to do if a tornado approached, and 10% had been directly affected by a tornado before.

There were two deaths in motor vehicles. A man died when his car was blown off Interstate 30 and flipped onto its roof. He was alone in the car. A woman died in a pickup that was blown over in suburban Little Rock. Two other women in the pickup survived. It is not known whether the two deaths were wearing seat belts. Carter et al (1989) suggested that persons increase their chance of surviving a tornado in a vehicle by wearing a seat belt, even if the vehicle is rolled over by the wind. Five survivors in our sample were in vehicles when the tornado struck, two had their seat belts on, all were in the front seat, and three of their cars were moving when the tornado hit. None of the survivors' cars was moved by the wind and none of the survivors were ejected from the car.

There were two deaths outdoors. These two men ran together from a mobile home and took shelter lying down in a depression where they were crushed by a fallen tree. We found no other people who were outdoors when the tornado struck.

DISCUSSION

These results clearly indicate the importance of protection by a building in preventing deaths. All deaths to persons in buildings occurred when above ground rooms disintegrated or collapsed, most often in mobile homes. As reported also in our earlier results (Schmidlin and King, 1995), survivors more often took the recommended action of moving to an underground shelter or to a room without windows that protected them from lethal debris. However, few survivors took the recommended action of hiding under heavy furniture and covering with a blanket. We earlier reported that few survivors of the 1994 Georgia tornadoes took these precautions, leading to the conclusion that these simple steps should be reinforced in tornado preparedness programs.

The two persons killed outside fled from a mobile home and were crushed under a tree. The two deaths in vehicles came when their vehicles were rolled over by the wind. The relative risk between being in a vehicle or being outdoors during a tornado remains unknown (Schmidlin and King, 1996).

Government warnings preceded the tornadoes by 18 to 32 minutes, and nearly all persons had access to radio and television. Few (6%) of the survivors had a radio on in the hour before the tornado but 73% had a TV on, indicating the latter may be a more efficient means of conveying warnings. The importance of television in conveying warnings was also found in our earlier research in Georgia (Schmidlin and King, 1995).

In spite of the early warning and wide use of television, 61% of the survivors said they first became aware of the tornado when they saw or heard the funnel, giving only a short time to seek shelter. These results are similar to those from Georgia after the March 1994 tornadoes (Schmidlin and King 1995). There was some suggestion among survivors of the Arkansas tornadoes that the long warning lead time and numerous severe weather watches and warnings for dozens of counties over several hours caused some "numbing" to the situation and a sense that immediate danger was lacking.

Underground storm shelters are fairly common in rural Arkansas, but

one family said they did not have time to reach the shelter 20 m from the house. They became aware of the tornado only as they saw the funnel and immediately sought shelter in their hallway. They survived as the house was destroyed (F3).

At least two mobile home parks with 30-50 units each were totally destroyed with a total of five deaths. Neither of the mobile home parks had underground shelters, so most residents fled in their vehicles and took shelter in frame houses of friends or relatives a few miles away. That action, although contrary to NWS and Red Cross instructions to leave mobile homes and "lie down in a ditch or depression," clearly prevented many injuries and saved many lives.

This research found several results similar to those we reported earlier from Georgia and Alabama tornadoes and a few contrasts with those results. Differences may result from the geographic and temporal setting of the disasters. Continued collection of this `quick response' data will provide a stable and reliable database from a variety of situations from which general conclusions may be drawn.

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