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Summary Paper

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#### Analysis of Deaths and Injuries in Oklahoma Caused by the May 3, 1999 Tornadoes

Several studies done between 1980 and 1995 reported that “persons who died in tornadoes were generally older than persons who survived”. Those same studies also go on to report that there were higher rates of death and injury connected with being inside mobile homes, outdoors, or in a motor vehicle when a tornado approaches; in addition, the majority of direct tornado deaths are immediate and occur at the scene. Those deaths result from multiple injuries, head injuries, chest injuries, asphyxia (suffocation), and heart attacks. Among those who are seriously injured, the most common types of injuries include fractures, brain injuries, and deep wounds/gashes.

Following a tornado outbreak in May 1999 in Oklahoma, Sheryll Brown, Pam Archer, Elizabeth Kruger, and Sue Mallonee, all members of the Oklahoma State Department of Health (OSDH), wrote an article for the American Meteorological Society Journal entitled, “Tornado-Related Deaths and Injuries in Oklahoma due to the 3 May 1999 Tornadoes”, summarizing their results of a field study they conducted. The article used information from the earlier studies “to help estimate what kinds of injuries should have occurred in those who died and those who survived”; furthermore, they also wrote about when each person was injured (before, during, or after the tornadoes struck). Their article is divided up into three main categories: methods, results, and discussion though some of the categories also have sub headings.

Brown, Archer, Kruger, and Mallonee performed a retrospective study and they designed and utilized three different assessments. Those assessments included 1) an overall injury assessment to establish person who died or were treated at a hospital for tornado-related injuries; 2) an overall community survey among a sample of residents who lived in severely damaged neighborhoods; 3) a random telephone survey among the general population affected areas.

From all of their research conducted, Brown et al said, “Overall a total of 45 people died, and 645 were injured as a result of the tornado and its aftermath”. In their study, the deaths and injuries are categorized into three areas, 1) Injuries during tornado preparation; 2) Injuries after the tornado; and 3) injuries & deaths during the tornado (the area related to injuries and deaths during the tornado is broken down into several smaller categories)

According to their study, Brown et al said, “The lowest amount of injuries/deaths that occurred during tornado preparation”. One person died, and twenty-six others were injured as they were preparing or attempting to protect them self from the tornado. Almost 80% of the injuries occurred when the person was trying to get in the storm shelter; besides cuts and scraps, examples of nonfatal injuries included falling down stairs, having the door to the shelter close on part of their body such as a finger, and when someone fell while running to the storm shelter. Their study next looked at injuries and deaths that occurred after the tornadoes moved through the area (after refers to injuries that occurred after the storms moved through the area, but not during the actual storms/tornadoes).

According to the figures from Brown et al’s study, “one person died and 39 people were injured after the tornadoes moved the area”. Most of the injuries were minor, and took place as the people were coming out of their storm shelters to view tornado damage. Injuries included puncture wounds such as stepping on a nail, muscle strains such as lifting heavy items, and fractures; however, the one death was because a person who didn’t want to leave their home lit several candles and didn’t realize that there was a gas leak, and the combination of the two led to a flash fire, which the person was severely burned and later died at a hospital.

Whereas two people died and 65 were injured before or after the tornado, the overwhelming majority of deaths and injuries occurred during the tornado itself. According to their study and other figures from the OSDH, Brown et al said, “Forty deaths and more than 500 injuries occurred during the actual storms/tornadoes”. The category of injuries during the tornado is divided into two sub categories: 1) nonfatal injuries; and 2) fatal injuries; in addition to this, their study also looked at the locations of all people injured (fatally or non-fatally) when the tornado struck (meaning where they took shelter as the tornado hit their location). Their study first looked at nonfatal injuries, and all of the following numbers were found in the field studies done by Brown et al.

A total of 512 people were injured during the tornado of which 376 (74%) were treated at a hospital and 134 (26%) were actually admitted to a hospital (information for the remaining 2 people was unavailable to the study). The average stay for those admitted to a hospital was from 4-7 days, although 60% were hospitalized for less than 4 days. Brown et al said, “A total of almost 2,300 injuries were recorded among survivors; in addition, the average hospitalized person suffered 8 injuries, while the average non-hospitalized person suffered only 3.” The most common type of injury suffered among survivors was soft tissue injuries (82% of all survivors), followed by fractures (23%), brain injuries/trauma (19%), and other miscellaneous injuries.

The most common soft tissue injuries were: upper and lower extremities (50%), followed by head/neck/face (24%), and 26% for all other parts of the body; however, 117 survivors suffered a total of 169 fractured bones. The most common areas/locations of fractured bones by % were: upper extremities (32), lower extremities (29), chest/ribs (15), and face/neck or back (12 each). Brown et al said, “That of the 80 people hospitalized with bone fractures, approximately 40% had more than one fractured bone”. Brown et al also stated that 96 survivors suffered brain injuries/trauma; in addition, the most common brain injuries by number of people who suffered them were brain contusions/hemorrhages (24) and skull fractures (15). Other miscellaneous injuries were foreign body (12%), sprains (16%), and eye injuries (10%).

The final section of nonfatal injuries of their study dealt with the causes of injuries. Brown et al put a table in their study of the causes of injuries among those who were hospitalized and those who were treated and released. According to that table (labeled table two in their study) the most common causes of injuries among both categories was unspecified flying/falling debris; in addition, there was a much higher percentage of cause of injury of those hospitalized than those who weren't among the following causes: picked up by tornado (43 vs. 6), falling wood and boards (20 vs. 8), and being hit by an object (16 vs. 9).

The last few paragraphs have dealt with the injuries suffered by those who survived the tornado itself; however, the next paragraph deals with the injuries among the 45 people who perished in the tornado disaster. The ages of people who died ranged from 3 wks to 94 yrs, with the average being 47 yrs old. Brown et al found some various stats about those who died; moreover, Brown et al said, “46% were either 35-44 yrs old or older than 65, 58% of those who died were females, and no African Americans died”. A total of 436 injuries were recorded among those who died (an average of about 11 per person). The most frequent injuries suffered by percentage were: soft-tissue injuries (90), fractured bones (78), brain injuries (43), lung injuries (23), and internal organ injuries (10); likewise, the most likely causes of death by percentage were: multiple injuries (50), head injuries (23), chest trauma (18), and traumatic asphyxia (10).

To help aid in future tornado safety research Brown et al looked at the specific locations of where 27 of the 40 people who perished in the storms where at when they were killed (house, shelter, outdoors, etc.). According to their results, “19 (70%), were not in a place recommended for storm shelter; accordingly, eight were in a mobile home, seven were outdoors (two under an overpass and five were running for cover), two were in a room with

exterior walls and windows, one was in an upstairs apartment, and one was in a motor vehicle”. Among the 8 (30%) who were in a recommend place of shelter, five were in a closet and the other three were in a bathroom.

So far in their article, Brown et al has talked about injuries and deaths and statistics related to location and when they occurred in relation to the tornado (before, during, or after). Brown et al included one final component in their study. They looked at the tornado warnings that were issued that day and asked a random survey of people in three different surveys to tell them how they were warned about the tornado. 200 people were polled using the follow-up questionnaires, 450 people were polled using the community survey, and 1000 people were polled through a random telephone survey. According to table 4 in the study, the number one way most received warning was via television (more than 80% in all three surveys), number two was via warning siren (more than 50% in two of three surveys), and less than 5% received no warning in two of three surveys (10% in the third survey).

After the study was completed, Brown et al discussed possible sources of error and/or omissions to the study. Brown et al said, “This study underestimates the total number of people injured in that it does not include people treated at an emergency medical triage station, people treated at a physician’s office, or people who sustained injuries and did not seek medical treatment.” Other sources of error Brown et al discussed were: 1) Due to the rapid influx of patients, physicians were unable to document all injuries suffered by all persons; 2) Some of the surveys done via mail were returned because the homes that were at that particular address were either destroyed or were uninhabitable; and 3) With any disaster, Brown et al says, “The type of population affected, including gender distribution, racial distribution, kinds of property, and overall demographics, are probably reflective of the existing characteristics of the geographic area.” Despite those sources of errors, Brown et al felt that they could still make some accurate conclusions.

Brown et al based some conclusions on what they had dug up in the study. “Consist with other reports, we found that the average age of persons who died was significantly higher than those who survived; furthermore, injuries caused by becoming airborne, or by being hit by falling debris were more likely to result in hospitalization than any other causes.” However, Brown et al added, “The data did not support previous reports of an increased risk of death in motor vehicles.” They also concluded that television broadcasts were effective in reaching most of the population in the path of the tornadoes; however, to finish their study, Brown et al made some prevention recommendations for future tornadoes.

Brown et al said, “80% of the population in the storm’s path heeded warnings and took shelter an average of 30 minutes before the tornadoes struck; nevertheless, a major challenge for preventing tornado deaths & injuries is to get all of the public to heed warnings and to take proper action in a timely manner.” Brown et al’s study also made a few suggestions. First, it is recommended to cover skin with heavy clothing such as a sweater or jacket to prevent soft-tissue injuries. Second, because of the number of head injuries, this study recommends using a bike or motorcycle helmet to protect the head. Third, putting shoes on the feet will protect the feet from injury during escape. Finally, the study recommends the public to just use common sense and not to do something stupid that could potentially injure or even kill them. Brown et al hopes that by taking these safety precautions, the odds of surviving a tornado increase; furthermore, Brown et al hopes that, “studies like this will help to lessen the number and severity of injuries and deaths in future tornadoes.”