

Papers

# Disaster threat: Preparedness and potential response of the lowest income quartile

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## Abstract

For a community to manage hazards successfully, those who are responsible for planning and implementing responses to a disaster threat situation must understand the social and economic realities of populations at risk. A random sample survey of residents in the vicinity of a US Army chemical weapons storage depot in Alabama confirms that those in the lowest quartile of household income (i.e., less than US \$25,000 in 1999) differ in important ways from the rest of the sample. Using economic status as a grouping variable resulted in identifying a concentration of individuals with special needs. This group differed significantly from the remainder of the sample as to demographic and attitudinal characteristics, hazard knowledge and concerns, emergency preparedness, and emergency decision-making and their likelihood of taking protective actions. Respondents in the lowest income quartile reported greater restrictions in physical abilities, fewer community contacts, a heightened concern about area hazards, and limited resources for taking preparedness and response actions.

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## 1. Introduction

This study examines the preparedness and potential response behaviors reported by members of households in a northeastern Alabama, US community facing the threat of a possible chemical release from a US Army depot. The study occurred in the context of state emergency response planning for the unlikely event of a release during storage or incineration of a portion of the national chemical weapons stockpile. In this study, economic strata of the sample were analyzed to identify any population-specific needs and behaviors with relevance for emergency response planning. Within the low-income group, additional demographic variables emerged that suggest increased potential risk.

This study illustrates the value of learning about a community's at-risk populations in advance of a potential event so that appropriate emergency preparedness activities

and response planning can take place. In the discussion that follows, we situate our work in existing literature, describe the contextual setting in which the study occurred, outline our methods and findings, and offer recommendations for research, policy and practice. Given that chemical hazards in many communities have increased over time and that evacuation compliance can reduce deaths (Cutter, 1991), understanding potential behaviors of those presumably most vulnerable should prove insightful. Strategies for enhanced preparedness and targeted outreach campaigns can then be developed and implemented to facilitate and reinforce appropriate protective actions (Metz et al., 2005).

## 2. Literature review

In this examination, household preparedness serves as the dependent variable. Existing literature finds that, in general, households fail to prepare for most hazards and are especially unprepared for chemical hazards (Tierney et al., 2001). Studies have yet to understand household preparedness among those presumed at highest risk, that is,

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socially and economically vulnerable populations (Quarantelli, 1984). For this study, we define vulnerability as “the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard” (Wisner et al., 2004, p. 11).

Key independent variables that indicate social vulnerability include income, gender, race and ethnicity, age, geographic location, homeownership, education, health status and special needs (Heinz Center, 2002; Enarson et al., 2003; Tierney et al., 2001; Sattler et al., 2000; Drabek, 1996). Logically, one’s personal context, particularly the lack of key resources such as health, education or income increases vulnerability (Fothergill and Peek, 2004). Demographic variables serve as predictors as well, with one’s age (very young or very old), one’s gender (being female), or one’s race/ethnicity (i.e., not belonging to the dominant group) increasing vulnerability (Pine et al., 2002; Fothergill et al., 1999; Mulilis, 1999; Phillips, 1993; Perry, 1985; Morrow and Phillips, 1999; Quarantelli, 1993). Situational variables also increase vulnerability; for example, living in a rural area or being a renter increases risk (Morrow, 1999). Further, having special needs such as a disability exacerbates vulnerability to a threat (Van Willigen et al., 2002; Dow and Cutter, 2002).

Presumably, each additional disabling condition that affects an individual increases his/her vulnerability. Thus, a low-income elderly woman in poor health would presumably be more vulnerable than a younger low-income woman in good health. Similarly, a poor, rural renter may lack income or shelter options (Heinz Center, 2002). Separating economic effects from other variables, such as race, disability, and age, remains a significant challenge (Fothergill and Peek, 2004; Tierney et al., 2001). Unfortunately, only minimal research has been focused on the likely role played by combinations of these factors (Tierney et al., 2001).

Further compounding demographic, situational and contextual variables, vulnerable populations also appear to receive, perceive and interpret risk differently both within and across groups (Lindell and Perry, 2004; Perry and Mushkatel, 1986). For example, persons that are deaf may not even receive warnings to the general population (Wood and Weisman, 2003). Racial and ethnic minorities may not find authorities transmitting risk messages to be credible (Perry and Mushkatel, 1986; Legates and Biddle, 1999). Women may want to respond immediately to risk communications, whereas men may be more likely to eschew a warning (Enarson and Morrow, 1998).

How communities choose to manage the increased vulnerability of some population groups carries important implications for those facing chemical hazards (Mileti, 1999). Effective disaster planning requires understanding both the vulnerability issues and the potential behavioral responses of those at risk (Tierney et al., 2001; Drabek, 1996; Lindell and Perry, 1992; Auf der Heide, 1989; Drabek, 1986; Quarantelli, 1985; Cutter et al., 2003a;

Cutter et al., 2003b; Dynes, 1994). Understanding and assessing the prevalence of vulnerabilities within a specific context is the purpose of this examination, an effort with implications for future research and for the practice of emergency management.

### 3. Context

A community in northeastern Alabama provided an opportunity to identify those at-risk and to investigate levels of household preparedness and anticipated reactions to a potentially disastrous event (Metz et al., 2005, 2002). The Anniston Army Depot (ANAD) is one of seven US Army depots located within the continental USA that currently host stockpiled chemical weapons that are both being incinerated and awaiting destruction. ANAD stores more than 2000 tons of chemical weapons agent (nerve and vesicant agents). ANAD is situated approximately 70 miles east of Birmingham and 100 miles west of Atlanta, Georgia. Fig. 1 shows the area around the depot with the designated response zones and population centers. Approximately 31,000 households, or 75,000 persons, are located within the Immediate Response Zone (IRZ), with a radius extending 13–16 km from the depot. The IRZ includes two counties, and the major population center is the City of Anniston, with a 2004 population estimated at 24,000. In the unlikely event of an accident that carries potentially deadly chemicals off-site, residents would have only a short time to receive a warning and undertake a protective action (i.e., evacuation or sheltering).

In assuring community leaders of maximum protection for the general population from the consequences of an agent release off the depot, the US Army and the Federal Emergency Management Agency sought to mitigate the effects of an accident to the extent practicable, defined as ensuring individual risk of no greater than “one fatality in 2,500,000 years” (US Department of the Army and Federal Emergency Management Agency, 2000). This study and

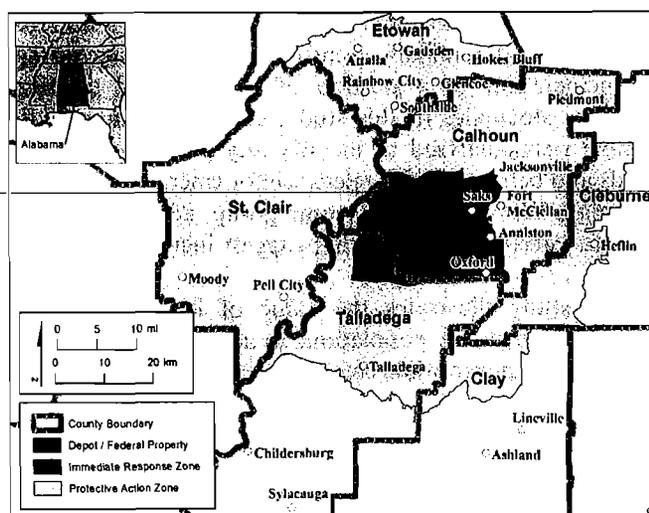


Fig. 1. Anniston Army Depot and Surrounding Area.

special emergency preparation efforts that followed were undertaken in an effort to afford persons with special needs a level of protection equivalent to that afforded the general population.

#### 4. Methodology

Argonne National Laboratory, working with the University of Alabama at Birmingham (UAB),<sup>1</sup> conducted a 10% random sample survey of the estimated 31,000 households in the IRZ from May through November 1999. A major goal was to provide baseline data to the Alabama Emergency Management Agency, the sponsor, on persons with special needs. The Chemical Stockpile Emergency Preparedness Program (CSEPP) Planning Guidance (see Federal Emergency Management Agency and US Department of the Army, 1996) defined persons with special needs as persons with sensory, mobility, or mental impairment and/or individuals with special equipment needs because of medical conditions; chronically ill persons; individuals who do not own or have access to an automobile; and unattended children who would need assistance in the event of an accident.

With a goal of surveying 3100 IRZ households, a sample of approximately 4300 addresses was extracted from a commercial database so that after deleting businesses, nonfunctioning numbers, addresses lacking phone numbers, and some cases of dubious eligibility, a sample set of 3159 households remained. During the survey process, 2776 persons were interviewed. In most cases, the respondents identified themselves as either the head of household or the special-needs person's caregiver. Some 80% of the respondents were interviewed by telephone; the remainder, who could not be reached by telephone despite multiple attempts, were interviewed in person. After deleting incomplete surveys and responses of persons determined to be residing outside of the IRZ boundaries, 2460 surveys remained—a response rate of almost 80%. While there were a number of no-contact cases due to listed addresses no longer being occupied by the listed person, a clear majority of the households that refused interviews lived in locations marked by poverty conditions. In addition, some interviews were refused in cases where a younger family member or relative was acting as guardian of an older or dependent person. The socio-demographic variables of gender, ethnicity, and median household income were roughly similar among the responding households and the general population of the two counties covered, as compared to the US Census 1998 General Profile. Researchers were unable to profile the socio-demographic variables of the non-responders, nor their intended behaviors.

<sup>1</sup>UAB took primary responsibility for survey design and construction, while Argonne National Laboratory assumed responsibility for data collection and analysis.

The survey collected the usual socio-demographic data along with attitudinal and other data relevant to emergency planning. The approximately 100 questions, 25 of which had multiple parts, required an average of 1 h and 20 min to complete. Quality control was maintained by a 20% supervisory sampling of on-going phone surveys, and a supervisor callback for each realized in-person interview ensured survey consistency, as did data entry using a computer-assisted telephoning system that allowed statistical analyses of interviewer exchanges. Seventeen survey cases were listed as “missing”, that is, where the source could not be identified, producing a less than 1.0% processing error.

To identify key variables and possible relationships, the data were explored using frequencies, cross-tabulations, and correlation analysis. This data exploration identified a segment of the sample, distinguished by household income level, which appears to differ substantially from the remainder of the sample in terms of emergency-related knowledge, preparedness, and response characteristics. These quantitative data rank among the few demographic profiles available for at-risk populations. Given the results of the data exploration effort, the analysis that follows focuses on the households in the lowest quartile of the income distribution, defined as those with household incomes lower than \$25,000 in 1999. Descriptive statistics for household income for the 2178 respondents who reported income are given in Table 1. The mean income for the entire sample population was almost \$39,000.

Table 2 compares the demographic profile of the lowest income quartile to the sample as a whole. The lowest quartile includes 43% of the sample households with special-needs individuals who reported that they require assistance in an emergency. Within this group there was a high proportion of persons over age 64 who self-rated their health as poor or fair; these are designated the “frail elderly” in the analysis. Together, households with frail elderly or with persons indicating a need for evacuation assistance and households with persons in both of these categories account for about 34% of households in the lowest income quartile compared to 16% of the entire sample.

We conducted statistical analyses using *t*-tests for differences in quartile means and  $\chi^2$ -tests for differences

Table 1  
Descriptive statistics for 1999 household income for the sample ( $n = 2,178$  cases for which income was reported)

Statistic	Value (\$1000s)
Mean	38.9
Standard deviation	33.3
Minimum	2.0
Lowest quartile	25.0
Median	30.0
Upper quartile	55.0
Maximum	400.0

Table 2  
Composition of the lowest quartile of household income compared to the total sample, among those reporting income

Category <sup>a</sup>	Lowest income quartile		Total sample	
	N	% <sup>a</sup>	N	% <sup>b</sup>
Frail elderly	80	15	154	7
Frail elderly/special-needs household	58	11	79	4
Special-needs household	42	8	112	5
Other	359	67	1833	85
Total	539	101	2178	101

<sup>a</sup>The following definitions were used: (1) Frail elderly = age over 64 and self-rating of health as poor or fair; (2) frail elderly/special-needs household = household with someone in categories 1 and 3; (3) special-needs household = someone in household is unwilling or unable to leave or evacuate; (4) other = not in categories 1 through 3.

<sup>b</sup>Percentages do not sum to 100% due to rounding.

in the distribution of responses among data categories. Since these statistical tests tend to become increasingly significant as sample size increases and the number of respondents in this study is large, most test statistics are highly significant. In this situation, it is the absolute magnitude of (significant) differences between group responses that may be most notable. Percentages given in the tables that follow represent the percentage of respondents for whom household income was reported.

## 5. Research findings

The research findings focus on demographic and attitudinal characteristics, hazard knowledge and concerns, emergency preparedness, and emergency decision-making and likelihood of taking protective actions in an emergency. Analyses consider the total sample and two subgroups based on economic status—those with lowest quartile of household income and the remainder (upper three quartiles) of the total sample.

### 5.1. Demographics and attitudinal characteristics

Relevant demographic characteristics are compared in Table 3 using *t*-tests for the means of characteristics of each group.

**Race and Ethnicity:** The lowest income quartile has a significantly higher proportion (33%) of Black respondents compared to the remainder of the sample (18%).

**Gender:** Females comprise a significantly greater proportion of the lowest quartile (73%) than of the rest of the sample, which is 56% female.

**Education:** The lowest income quartile had significantly less education: a mean of 11.6 years (roughly equivalent to high school graduation) compared with 13.6 years for the remainder.

Table 3  
Comparison of demographic characteristics for the lowest income quartile with the remainder of the sample

Response	<i>t</i> -value ( <i>p</i> )	Lowest income quartile ( <i>n</i> = 539)	Remainder ( <i>n</i> = 1639)
Reported race = Black	7.16 (0.00)	32.8%	18.3%
Gender = Female	7.07 (0.00)	73.4%	56.5%
Mean years of education	-13.71 (0.00)	11.6	13.6
Currently married	-16.80 (0.00)	27.6%	66.5%
Single-person household	12.10 (0.00)	40.9%	16.5%
Children under age 16	-4.12 (0.00)	28.0%	37.7%

Table 4  
Comparison of health status and activity measures for the lowest income quartile with the remainder of the sample

Question and responses	Lowest income quartile (%)	Remainder (%)
<i>Health status</i> $\chi^2 = 261$ ( $p = 0.00$ )		
Excellent	10.1	21.2
Very good	13.8	33.3
Good	27.1	28.0
Fair	25.9	12.2
Poor	23.1	5.3
<i>Self-reported community involvement</i> $\chi^2 = 36$ ( $p = 0.00$ )		
Very involved	19.4	28.9
Involved	32.5	36.1
Not very involved	31.0	24.2
Not involved	17.2	10.8
<i>Feel helpless to deal with problems of life</i> $\chi^2 = 62$ ( $p = 0.00$ )		
Strongly agree	4.4	3.9
Agree	35.2	20.0
So-so	5.3	3.6
Disagree	46.1	56.2
Strongly disagree	9.1	16.4

**Marital status:** Persons in the lowest income quartile are significantly less likely to be currently married (27.6%) than the remainder of the sample (66.5%). The presence of marital partners may contribute to higher income status for a household because of the effect of having two wage earners. Consistent with lower rates of current marriage, the lowest income quartile has a substantially higher percentage of single-person households (40.9%) compared to the rest of the sample (16.5%).

**Children:** Households in the lowest income quartile are significantly less likely to have children under 16 years of age in the home (28.0%) compared with higher income households (37.7%). Investigation of the composition of the lowest income quartile households with children indicated that households where the parent was under the age of 21 accounted for only a small percentage of these households.

Reported health status and activity measures are compared across the lowest income quartile and the remainder in Table 4.

**Health:** The survey asked respondents to self-select among five categories of health status from excellent to poor. Differences between the two groups were significant (based on a Pearson  $\chi^2$ -test), with 49% of the lowest income quartile reporting “poor” or “fair” health compared to 18% of the rest of the sample.

**Community involvement:** Differences in community involvement are also significant, with the lowest income quartile reporting less involvement. Community involvement was defined as people’s informal interactions within a community and was operationalized through such self-reported items as attending local events, participating in local elections, and going to places of worship.

**Coping skills:** The lowest income quartile and the remainder also contrast strongly in regard to their self-reported competence to cope with life’s problems. Persons in the lowest income quartile are significantly more likely than the rest of the respondents to report feeling helpless, though a majority of people in both groups report not feeling helpless.

Demographic results confirm the higher concentration of specific at-risk populations within the lower income quartile, signaling an alert to emergency management agencies. If coupled with reduced levels of preparedness and/or abilities to respond, the situation would thus demand that emergency management agencies prioritize at-risk populations for outreach and capacity building.

## 5.2. Hazard knowledge and concerns

The mean self-reported residential distances from the chemical storage site are similar for the two groups evaluated: 8.7 and 8.8 miles (14 and 14.2 km), respectively.<sup>2</sup> If other aspects of their lives were equal, the two groups might be expected to have similar levels of concern related to a potential major chemical accident. However, the first question in Table 5 shows that persons in the lowest income quartile are significantly more likely to express high levels of concern about a chemical weapons accident. Nearly three-quarters of the lowest income quartile report being “concerned” or “very concerned” about a major accident. This finding may be associated with the tendency toward feelings of helplessness shown in Table 4, reflecting the lowest quartile’s greater proportion of persons who are older, live under more difficult economic conditions, or have more health impairments.

The second question in Table 5 pertains to knowledge of emergency planning and warning systems, which are part of the CSEPP. Though more concerned about an accident, respondents in the lowest income quartile are significantly more likely to report being “little informed” or “not at all

Table 5

Hazard knowledge and concerns: a comparison of the lowest income quartile with the remainder of the sample

Question and responses	Lowest income quartile (%)	Remainder (%)
<i>How concerned about a major chemical accident?</i> $\chi^2 = 34$ ( $p = 0.00$ )		
Very concerned	48.2	39.5
Concerned	24.4	19.1
Somewhat concerned	10.7	18.1
Little concerned	9.5	14.0
Not at all concerned	7.2	9.3
<i>How well informed do you feel about CSEPP?</i> $\chi^2 = 38$ ( $p = 0.00$ )		
Well informed	3.9	10.6
Informed	10.1	13.8
Somewhat informed	18.2	20.4
Little informed	27.7	24.6
Not at all informed	40.1	30.5

informed” regarding CSEPP. This may be a result of fewer social and community contacts (see Table 4), which means fewer opportunities for receiving information about the environmental hazard (Lindell and Perry, 1992). It is notable, however, that a majority of the remainder of the sample also feels poorly informed (55% in the “little” or “not at all” categories), possibly because, at the time of the survey, chemical weapons incineration was not especially newsworthy (Nisbett and Ross, 1980). Consistent with the lowest income quartile’s perception of being uninformed, a significantly lower percentage of the lowest income quartile, 65% versus 71% of the remainder ( $t = 2.29$ ,  $p = 0.02$ ), correctly identified the weekday on which the emergency sirens are tested.

## 5.3. Emergency preparedness

Responses to selected questions related to emergency preparedness issues are summarized in Table 6. The first two questions pertain to access to emergency preparedness information. In regard to participation in preparedness classes, about 61% of the lowest income quartile and 68% of the remainder express a willingness to attend classes. Conversely, a slightly higher percentage of the lowest income quartile (21% versus 15%) indicates that they would definitely or probably not be willing to attend classes. This response is consistent with the greater tendency toward feelings of helplessness reported by respondents in the lowest income quartile (Table 4). It may be that the extent to which individuals believe that they control their own lives or what happens to them is directly related to their perceived ability to undertake protective actions (Sims and Bauman, 1972).

To provide information regarding recommended emergency actions, county emergency management agencies have mailed annual calendars, brochures, evacuation route maps, and other explanatory materials to each household; information is also printed in area telephone books and has

<sup>2</sup>Differences were nonsignificant in a  $t$ -test of the mean distances for the two groups.

Table 6  
Emergency preparedness: a comparison of the lowest income quartile with the remainder of the sample

Question and responses	Lowest income quartile (%)	Remainder (%)
<i>Would you participate in preparedness classes?</i> $\chi^2 = 20$ ( $p = 0.00$ )		
Definitely yes	29.5	32.6
Probably yes	31.0	35.0
Maybe	18.8	17.3
Probably not	11.0	10.3
Definitely not	9.7	4.8
<i>Received a CSEPP calendar?</i> Yes. $t = -3.68$ ( $p = 0.00$ )		
	33.5	42.5
<i>Able to hear warning siren from inside home?</i> $\chi^2 = 6$ ( $p = 0.05$ )		
Yes, all the time	80.7	76.0
Sometimes	14.5	16.7
No, never	4.9	7.3
<i>Have an emergency plan for family?</i> Yes. $t = -5.27$ ( $p = 0.00$ )		
	11.9	22.3
<i>Have an emergency preparedness kit?</i> Yes. $t = -4.70$ ( $p = 0.00$ )		
	7.4	15.3
<i>Times with no car available?</i> $\chi^2 = 27$ ( $p = 0.00$ )		
Always	2.9	1.7
Frequently	5.1	2.6
Sometimes	9.5	4.6
Rarely	5.8	6.3
Never	76.8	84.7
<i>Neighbor would help if car is unavailable?</i> Yes. $t = -3.44$ ( $p = 0.00$ )		
	37.0	53.9
<i>Times when children home alone?</i> $\chi^2 = 3.6$ ( $p = 0.30$ )		
Frequently	7.4	5.9
Sometimes	12.8	13.5
Rarely	8.7	14.2
Never	71.1	66.4
<i>Have arrangements if accident occurs while children are alone?</i> Yes. $t = -0.85$ ( $p = 0.40$ )		
	30.2	37.1

been presented in area newspapers. In spite of this effort to disseminate information, less than half of either group reported receiving the calendar, as shown in the second question in Table 6. Comparing the two groups, the lowest income quartile is significantly less likely to report having received a calendar. Responses to questions regarding receipt of the other materials are similar to the rates of receipt reported for the calendars. Thus, since people in the lowest income quartile are less willing or less able to attend classes that explain preparedness action and report less recall of mailed materials, it may take concerted, focused and/or innovative efforts to reach them with emergency preparedness information.

**Hearing warnings:** With regard to their ability to hear the emergency warning sirens, the lowest income quartile is slightly more likely to hear the siren from inside their home and the differences are statistically significant. This could be due to the concentration of those in the lowest income

Table 7  
Intent to take protective actions: a comparison of the lowest income quartile with the remainder of the sample<sup>a</sup>

Question and Responses	Lowest Income Quartile (%)	Remainder (%)
<i>If I learn of an accident, I would...</i> $\chi^2 = 9.8$ ( $p = 0.00$ )		
Act at once	50.7	58.5
Seek more information	49.3	41.5
<i>To obtain more information, I would ...</i>		
Turn on local TV, $t = 2.98$ ( $p = 0.00$ )	89.8	81.9
See what neighbors are doing, $t = 3.26$ ( $p = 0.00$ )	47.7	36.2
Call relative or friends, $t = 2.64$ ( $p = 0.00$ )	59.5	49.9
<i>If accident while children at school, I would...</i> $\chi^2 = 7.7$ ( $p = 0.02$ )		
Try to pick them up myself	76.8	70.0
Leave them in care of school	23.2	29.8
<i>In the event of an accident, I will help my neighbors.</i> $\chi^2 = 11$ ( $p = 0.02$ )		
Strongly agree	26.6	32.6
Agree	68.6	61.7
Disagree	3.1	3.3
Strongly disagree	0.2	1.1
<i>If authorities advised evacuation, would you...</i> $\chi^2 = 6$ ( $p = 0.18$ )		
Definitely leave	85.1	85.3
Probably leave	12.1	13.0
Probably not leave	2.1	0.8
Definitely not leave	0.4	0.5
<i>In case of evacuation, would you...</i> $\chi^2 = 72$ ( $p = 0.00$ )		
Stay in a motel/hotel	16.3	35.9
Stay with friends/relatives	59.3	50.1
Stay in a public shelter	24.4	14.1
<i>If authorities advised using a community shelter, would you go?</i> $\chi^2 = 26$ ( $p = 0.00$ )		
Definitely go	60.0	48.4
Probably go	29.9	34.0
Probably not go	5.7	9.6
Definitely not go	4.1	7.2

<sup>a</sup>For some questions, responses of small numbers of undecided respondents have been omitted from the table, though not from the statistical analysis.

quartile in more urbanized areas with the densest coverage of outdoor warning sirens. The effectiveness of the sirens is evidenced by the fact that over three-quarters of both groups report hearing them. However, once they receive the warning, the patterns of warning confirmation differ between the two groups, as discussed below in relation to Table 7.

**Readiness:** Two questions addressed actions already taken to prepare for protective action. The remainder of the sample was twice as likely as the lowest income quartile to answer that they have a plan for family protection in case of a major accident or that they have prepared a kit of necessities for such an event. However, only a small minority of the sample has made these preparations; most people in both groups had neither a plan nor a kit of

necessities. This situation exists despite relatively high levels of concern about an accident at the chemical weapons site. It is an alarming situation considering research that shows that if one wants to evacuate, the absence of a plan for doing so is sufficient to hinder any adaptive response (Perry, 1985). Clearly, an effort to assist households with such preparedness seems advisable.

*Transportation:* With regard to the availability of transportation to evacuate the area or to reach a community shelter, the lowest income quartile was significantly less likely to have a car readily available. Researchers elsewhere have found that those who do not own vehicles are most likely to obtain assistance in evacuating from the same people who routinely help them on a daily basis (Tierney et al., 2001). In the survey, a series of questions attempted to identify sources of help in situations when a car is unavailable. The two groups showed no difference in their expectations of aid from relatives (50%) and friends (30%); however, previous disaster studies have shown that evacuation in cars belonging to relatives and friends occurs infrequently (Lindell and Perry, 1992), a problem noted with poor female-headed families in particular (Enarson and Morrow, 1997). As to expectations of aid from neighbors, the lowest income quartile had significantly lower (37%) expectations of such aid than the remainder of the sample (54%). Evacuation planners should not automatically assume that people without vehicles will receive informal assistance (Tierney et al., 2001).

*Children in self-care:* When respondents in households with children were asked about the possibility that children might be left alone, about 20% of households in each group indicated that children are frequently or sometimes left alone (no significant difference). Responding to a question regarding emergency planning for children, the majority of households in each group lacked plans for coping with an accident if it were to occur while children are alone. The percentage of those having such plans was slightly lower for the lowest income quartile but the difference was nonsignificant.

#### 5.4. Emergency decision making and likelihood of taking protective actions

Table 7 summarizes responses by the lowest income quartile and the remainder of the sample regarding emergency decision-making and their likelihood of taking various protective actions. Though these responses indicate intended actions, the assumption that intended actions will actually occur or even become possibilities for under-resourced households is problematic. However, useful information for planning purposes can be gleaned from these questions. For example, more than 70% of all respondents indicated that they would attempt to pick up their children at schools. Should the majority of parents attempt to retrieve their children, such behaviors could seriously gridlock school bus evacuation routes or prevent

successful sealing of school buildings against contaminated air. Given the intention of parents to try to pick up their children, either adapting school planning or conducting public education campaigns would be advisable. In terms of statistical tests, the greatest differences between the groups were found in their information-seeking actions and potential destinations in the event of an evacuation.

*Warning response and information-seeking:* The survey inquired about how respondents would likely seek information before taking protective action in the event of an accident. As shown in Table 7, the lowest income quartile households suggest they would be significantly more likely than the remainder of the sample to seek more information before taking action, a finding consistent with other research on evacuation decision-making (Mileti, 1999). Proximity to the perceived threat may also positively increase the number of sources used as well as the form of communication preferred (Diggory, 1956).

Respondents who indicated that they would seek more information were then asked what information sources they expect to use. The second question in Table 7 addresses alternative ways of confirming the warning message, such as gathering further information, and establishing a warning belief (Perry et al., 1981). One research initiative found that more than 80% of warning recipients tried to confirm the first warning with at least one additional information source (Perry and Greene, 1983).

In this survey, the lowest income quartile and the remainder were about equally likely to indicate that they would (1) turn on radio news (nearly 70%) and (2) call police or 9-1-1 (nearly 50%). However, the lowest income quartile appears significantly more likely to turn on local TV channels or to check with neighbors, relatives, and friends before taking action, a finding that has previously been associated with gender and race/ethnicity variables (Lindell and Perry, 2004; Legates and Biddle, 1999). Although most people in both groups (more than 80%) indicate that they would turn to radio or TV news for information and instructions, there are also strong indications that both groups have a propensity to call others, thus delaying evacuation compliance, not an unexpected finding (Tierney et al., 2001). As noted before, differences between stated behavioral intent and likely behaviors could be addressed and potentially reduced through an educational outreach effort targeting these at-risk populations. A desired outcome of such a program would be to reduce time spent in confirmation behavior and expedite taking protective action.

*Children:* Respondents with children in the home were asked about their likely actions if an accident were to occur while the children were in school. One county's annual calendar provides residents with the following instructions: "Do not attempt to pick up children from school. You might cause traffic congestion. Schools will be evacuated by zone, if necessary". Less than 30% of each group indicated that they would leave their children in the care of

the school. Most reported that they would try to pick up the children themselves or try to get someone else to pick them up; while the difference in the percentages preferring this action is relatively small, it is significantly higher for the lowest income quartile. Research studies have indicated that under actual circumstances, separated families become anxious and attempt to reunite before evacuating (Perry, 1985).

*Helping behavior:* A series of questions concerned the respondent's commitment to helping various categories of others in the case of an accident. Most people indicated a willingness to help neighbors (fourth question in Table 7), a finding consistent with numerous studies reporting high levels of pro-social behavior (Tierney et al., 2001). However, the rate of commitment for the lowest income quartile is significantly lower. This may reflect a realistic view of their capabilities given their typical characteristics of advanced age, poor health, and lack of transportation.

*Anticipated evacuation rates:* Most members of both income groups indicated that they would follow authorities' advice to evacuate the area, and statistical analysis showed no significant differences between the groups. Annual calendars distributed to people living near the depot advised residents that they should "not waste time gathering personal items such as photo albums" before evacuating. This advice on the part of authorities is intended to encourage people to move swiftly. For both groups, the self-estimated mean time needed to prepare to leave their homes after hearing of an accident is about 10 min. Considering both groups together, 25% estimated that they could leave in 3 min, over 50% in 5 min, and 75% in 10 min. These estimates represent a more rapid potential mobilization than has been found in other situations—one that has not been tested in a local public drill. In a study of evacuations caused by hazardous materials releases, 60% of one community's residents evacuated within 10 min, while 85% of another community evacuated in less than 30 min after receiving the warning (Sorensen, 1991). Another researcher estimated that the distribution of evacuation times for a population would be 15% at 10 min, 50% at 20 min, 83% at 30 min, and 100% at 40 min (Lindell and Perry, 1992). These estimates vary by hazard and context. Communities with prior disaster experience, for example, evacuate at faster rates (Baker, 1991; Phillips, 1992).

*Intended evacuation destination:* Significant differences between the income groups were found regarding potential destinations in an evacuation. Responses of the remainder of the sample indicated that these persons are more than twice as likely to stay in a hotel or motel (36% compared to 16% for the lowest income quartile) and relatively unlikely to stay in a public shelter (14%). In contrast, persons in the lowest income quartile reported being substantially more likely to stay with friends or relatives (59%) or in a public shelter (24%). CSEPP Planning Guidance (US Department of the Army and Federal Emergency Management Agency, 1994) estimates that approximately 15% of an evacuating

population is likely to use a public shelter, a finding slightly in excess of comparable contexts (e.g., see Phillips, 1992). Higher rates of use would be expected if evacuees are older or poorer than the general population, a finding consistent with other shelter use studies (e.g., see Phillips, 1998; Yelvington, 1997). This estimate is substantiated by the survey data.

The greater propensity of the lowest income quartile to use public shelter facilities is also shown in the last question in Table 7. If using a community shelter is the recommended protective action, persons in the lowest income quartile indicate that they are significantly more likely to comply. Within the lowest income quartile, differences in the proportions of the frail elderly and of households with individuals with special needs who intend to use public shelters are not statistically significant. However, other studies find that age, when influenced by income, gender and race, will increase the propensity of these populations to use shelter (Tierney et al., 2001).

## 6. Summary and conclusions

Documentation of vulnerability within specific contexts prior to a disaster is rare in the scientific literature. Below, we review the findings vis-à-vis the existing literature and make suggestions for future disaster research and the practice of emergency management.

### 6.1. Implications for research

The lowest income quartile reported substantially more concern about a major chemical accident, a finding comparable to studies on other low-income groups as well (Fothergill and Peek, 2004; Lindell and Perry, 2004). Despite their elevated concern, the lowest income group reported fewer preparedness behaviors, which is also consistent with the literature (Tierney et al., 2001). Lower income groups also reported they would be likely to solicit additional information before evacuating, a behavior that may be influenced by multiple variables such as the greater concentration of women, elderly, and minorities in this quartile (Heinz Center, 2002; Mileti, 1999; Russell et al., 1995).

Lower income households in this study lack transportation resources, a dilemma observed during evacuation for Hurricane Katrina in the US. However, it is clear that researchers need to study transportation decision making further as "the rationale for the household decisions is not well-documented" (Dow and Cutter, 2002, p. 14). Compounding the evacuation transportation challenge, lower income households in this study did not expect as much aid from family and friends although they did expect to stay with them after evacuating. As expected, lower income households reported they would be more likely than higher income households to use public shelters, also consistent with prior research (Dawson, 1993; Yelvington, 1997; Phillips, 1993). Thus, a relatively high percentage of the

vulnerable population might relocate to public shelters in an evacuation for a sustained period of residence (Morrow, 1999). The frightening reality of a deadly chemical agent release (however, unlikely) could prompt residents of areas subject to evacuation to travel further than anticipated if transportation resources become available to them.

A number of research questions remain. To start, behavioral intent may not necessarily coincide with actual behavioral response during a chemical accident or any other disaster. Researchers could employ comparable scenarios, such as hazardous materials transportation accidents, to assess behavioral response among vulnerable populations. Respondents in the lowest income quartile were less likely to want to attend classes on creating a home shelter environment and to have a family plan or preparedness kit; additional research is needed to learn why lower income groups did not want to do so. Identifying strategies that motivate and support preparedness efforts among those most vulnerable is advisable. The low-income households in this study expect to engage in confirmatory behavior if a protective action or evacuation order is issued. Warning messages that personalize the risk tend to increase compliance rates (Lindell and Perry, 2004). Consequently, additional research should investigate delivering tailored warning messages designed to reach the most vulnerable populations. Finally, more systematic efforts to understand the cumulative and interactive effects of multiple variables would be beneficial, as the income variable alone remains insufficient to understand behavioral intent and actual response.

### 6.2. *Emergency management practice*

In the community described here, emergency managers provided hazard information to residents through mail delivery of annual calendars that described emergency planning, emergency alert and notification procedures, family emergency planning procedures, county emergency planning efforts, protective action options, and CSEPP. In addition, presentations were made at community events and to special audiences; other public information items were also distributed. Local newspapers often featured stories and editorials about ANCA (Bragg and Wilson, 2002; Landers, 2002). Despite these extensive efforts, local low-income households still expected to engage in confirmatory behavior before taking action. The implications for emergency management are clear: preparedness, outreach and educational efforts must target those at highest risk repeatedly and thoroughly. Research literature suggests that such efforts should be done through credible authorities, social networks, and in ways that engage those at risk (NHRAIC, 2002).

Researchers have advocated that empowering those at-risk to become co-involved in emergency preparedness and response planning can make a difference. Practitioners might employ “participatory processes to help build inclusiveness of gender, age, and race-based groups, and

those with disabilities into consensus-building public meetings, discussions, and workshops related to mitigation and disaster response” (Heinz Center, 2002, p. 110; see also NHRAIC, 2002). Including marginalized groups may positively influence the perceived efficacy of those at risk, thus motivating higher compliance rates (Feldman, 1990). At the very least, involving those at risk with local authorities should serve to increase trust and credibility, both of which are necessary to decrease confirmation-seeking behaviors and motivate compliance.

However, getting persons with low incomes to participate in planning may be problematic considering that respondents indicated a general lack of transportation resources. Emergency management agencies might address this problem by developing partnerships with agencies possessing transportation resources or by promoting “help networks” of nearby neighbors, friends, and relatives who would provide transportation, thus increasing protective actions for the lowest quartile.

Finally, pre-planning special-needs shelters to accommodate persons with disabilities and the frail elderly is essential. Given the presumably cumulative effects of income levels plus rural location plus impaired health/disability levels, the percentage seeking public sheltering under the circumstances reported here is expected to be high. Special-needs shelters might need to be located at scattered locations with varying distances from the evacuation zone to accommodate demand due to the lack of transportation resources and to reduce trauma among the elderly by remaining in proximity to their community.

### 6.3. *Conclusion*

This study of the lowest income quartile provides insights to guide emergency preparedness and response planning for a very vulnerable segment of the community. Public confidence in a community’s emergency plans may increase if residents are assured that everyone, even the most vulnerable, is being included in a credible planning process and the resulting plans correspond to the community’s specific needs. Actively involving those at risk should also address the theoretical origins of this problem, namely, a “lack of personal control over potential outcomes” among lower-income households (Fothergill and Peek, 2004). Involving at-risk populations in defining, learning about and testing appropriate resources for preparedness and response would presumably heighten compliance as well.

As noted elsewhere (e.g., Cutter et al., 2003a, p. 243), social vulnerability is “most often described using the individual characteristics of people”, the strategy that was used here to identify those at greatest risk for special assistance and training by emergency management authorities. Such research documents the presence of individuals at-risk and identifies potential points of intervention for practitioners. However, the significantly higher concentration of at-risk groups within the lowest income quartile

clearly demonstrates that vulnerability does not occur due simply to chance. Understanding why inequalities exist demands further investigation. Social inequality research, such as that based on sociological conflict theory, suggests that some of the findings reported here may be influenced by the larger socio-economic structure (Tierney et al., 2001; Peacock and Ragsdale, 1997; Cutter, 2005). Social problems, such as poverty, inherently serve as the driving forces behind vulnerability. Merely developing programs to motivate preparedness and protective actions then is insufficient. Continually addressing the conditions that render people vulnerable is part of the solution.

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