CHAPTER 9

Evaluation of Mental Effects of Disaster, Mount St. Helens Eruption

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Introduction

The Mount St. Helens eruption on May 18, 1980 with subsequent ash fall, flooding, and potential long-term threat created a unique chance to study the behavioral responses to disaster. Many factors contributed to this scientific opportunity. This was a disaster of significant proportion with potentially serious consequences to life, health, and property, especially in Cowlitz County, Washington, immediately to the west of Mount St. Helens. While a major volcanic eruption is uncommon in the continental United States, the periodic or persistent threat of flooding became the greatest concern from this event, giving this disaster generic characteristics similar to many others. The title of a Mount St. Helens article, "Come Hell and High Water,"[1] captured the significance of this dual aspect.

Since Mount St. Helens and other northwest volcanoes lie in close proximity to major population centers, there was considerable interest in the scientific community to record and study the health effects associated with the eruption. With the funding of the research consortium for the study of Biological Effects of Volcanic Ash (BEVA), there was an opportunity to investigate the mental health consequences of the Mount St. Helens eruption on a community-wide basis. This chapter reviews the theoretical model and methodology for this psychiatric disaster study and presents preliminary findings. We also review selected studies from other nonvolcanic disasters and initial studies covering psychosocial aspects of the Mount St. Helens disaster.

Review of the Literature

In any disaster, exposed individuals may be expected to suffer emotional stress and potentially detrimental physical and mental health consequences. These reactions may be the result of real or anticipated loss of life, physical injury, damage, or economic loss. There have been numerous studies which investigated the psychological consequences of disasters. Nevertheless, there is no consensus regarding the specific nature, degree, and persistence of mental health effects. There would seem to be no reason to assume that the emotional consequences experienced by communities or victims of volcanic activity would be significantly different from those involved in other disaster or collective stress events. Kinston and Rosser[2] have summarized the literature addressing psychiatric repercussions of disaster-related stress. Another excellent review of the research regarding the epidemiology of the physical and mental health effects of disaster has been presented by Logue, Melick, and Hansen.[3]

There are several primary issues in the field of psychosocial disaster research. These involve: the nature of the disaster response, the duration and significance of behavioral and emotional changes, pre-morbid physical and mental health, the mediating influences of perception and interpersonal networks, the predisposing influence of pre-disaster psychosocial and economic status, and identifiable high-risk populations. In any disaster situation, pre-morbid health and

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attitudinal factors affect the way individuals deal with the stress. The elderly and the very young as well as those with pre-existing physical and mental health problems are thought to be at greater risk of emotional complication during and after disasters. Cultural factors and previously learned responses to stress may be a determinant of emotional reaction. Beliefs about and perceptions of the disaster event may also affect responses. Employment and economic factors must be considered. The nature and duration of pre-disaster warning along with individual, family, and community preparedness either may accelerate or mitigate both physical and emotional response.

Berren, Beigel, and Ghertner[4] suggest that a number of variables should be considered in assessing emotional response to disasters. Their model of disaster classification addresses the following questions:
- Is the event an act of nature or a purposeful event?
- Is the disaster of long or short duration?
- Is the personal impact of the disaster high or low?
- Is the potential for recurrence high or low?
- Is the control over similar future events high or low?

For example, using this classification, the Mount St. Helens disaster would be an act of nature, of long duration, with varying degrees of personal impact, high potential for recurrence, and low control over the future. Their model would suggest that it could be expected to have a greater impact than a more predictable disaster of less significance and of shorter duration. In comparing the Mount St. Helens eruption to other disasters it is useful to keep these variables in mind.

Some of the earliest work regarding psychiatric complications of disaster emerged from the treatment of survivors of the Coconut Grove Nightclub fire in which almost 500 people were killed. Cobb and Lindemann[5] reported on the adjustment of 32 casualties who were treated at Massachusetts General Hospital and revealed that 44 per cent of these survivors suffered emotional complications during the immediate post-disaster period. The most common problems were reactions to bereavement. From his work with this population, Lindemann[6] developed a detailed symptom profile of the mourning response, a classical description of the phenomenology of acute grief. In addition, Adler[7] followed a different cohort of 46 survivors from the same disaster. He found that emotional complications persisted for at least nine months in 28 per cent. In spite of a limited number of subjects, little control for interrater reliability, and high rates of physical injury among the bereaved, these studies remain highly influential in the field.

One of the most frequently cited studies dealing with long-term emotional consequences of disaster stemmed from the psychiatric investigation of the 1972 Buffalo Creek flood in West Virginia. This Appalachian community was destroyed when a slag dam gave way, killing 125 and leaving 500 homeless. At the request of the law firm retained by the 654 survivors, psychiatric evaluation teams were called to assess for the court the psychiatric impairment victims had suffered as a result of the flood. This study employed observations of family interactions and psychoanalytically oriented family

interviews. The findings of the investigation were reported in a special section of the *American Journal of Psychiatry*.[8] The authors noted widespread psychiatric impairment which persisted for at least two years after the disaster. This "traumatic neurotic syndrome" included symptoms of unresolved grief, survivor shame, impotent rage, and hopelessness. It is referred to as the "Buffalo Creek Syndrome." Titchener and Kapp[9] further concluded that many of the coping strategies which the victims employed actually preserved their symptoms causing disabling mental health changes. In addition to the individual responses of those who lived through the experience, the collective trauma severely damaged the social bonding and support of the community as a whole. The extensive research on the prolonged psychosocial effects of the Buffalo Creek flood have more recently been summarized by Gleser, Green, and Winget.[10] The absence of baseline rates and the litigation which followed the Buffalo Creek disaster complicated the interpretations of findings and limited their applicability to other disasters. Certainly, community-wide litigation in any disaster has the potential to contaminate the assessment of disaster impact. It provides a strong reinforcement for secondary gain. Other weaknesses of the Buffalo Creek research include the use of unstructured interviews and issues of interrater reliability.

Many other researchers have reported the "disaster syndrome," a dazed state common in the post-disaster period. The phases of the disaster syndrome have been labeled as: heroic (the immediate response), honeymoon (stage of recovery optimism), disillusionment (the onset of bitterness and disappointment), and reconstruction. These stages are seldom discrete and usually overlap and vary in duration and intensity. This variation may be dependent on individual and community resources and the nature and degree of impact of the disaster event. Farberow,[11] Horowitz,[12] and Frederick[13] describe the specific phases of this disaster syndrome in significant detail.

In a disaster study currently underway at Times Beach, Missouri, Robbins, et al,* had a pre-disaster psychiatric epidemiological survey against which to measure individual and population-based changes following the disaster. There is a need to fund such pre/post-psychosocial studies in situations where premonitory periods can be identified (e.g., severe weather regions, earthquake regions, volcanoes) or where man-made threats post potential hazards (e.g., near proposed nuclear power sites, waste dumps, etc.).

The reports of the mental health effects of the Three Mile Island (TMI) nuclear accident currently represent the only published research which has utilized a standardized lifetime psychiatric interview among disaster victims.[14,15] Bromet and her colleagues also utilized a control community and inventoried social support as a mitigating factor in mental health adjustment to the disaster situation. They surveyed three groups suspected to be at high risk: mothers of preschool children living within 10 miles of the plant, workers at the TMI plant, and psychiatric outpatients in the area. Their findings indicated that mothers of preschool children who lived in the area were at greater risk for anxiety and depression than a control group in an unaffected community. The two other suspected high-risk groups showed no significant differences in psychiatric symptoms between subjects in the exposed and control communities.

In spite of this research, there remains marked disagreement about the nature and extent of behavioral response to

disaster stress. The debate can be characterized by defining two opposing assumptions that have served as the basis for drawing conclusions from the research findings. One group's position holds that the impact of disasters creates severe, lasting psychological consequences that may cause individual impairment in the short- and long-term adjustment of susceptible individuals. This assumption can be called an "individual trauma view" and represents a biomedical perspective. The second group's position maintains that the negative psychological impact may be minimal and has been overstated. The latter assumption can be called a "social fabric view," and represents a sociological viewpoint. In general, psychiatric studies of disaster have supported the former view, but the conclusions have been criticized for having a diagnostic method based on unstructured interviews, poor interrater reliability, variable sampling procedures, and litigation as confounding factors. Studies which support the second position have not demonstrated a positive correlation between disaster and psychiatric morbidity. They have relied more heavily on non-specific measures of distress and demoralization, usually by assessing short-term symptoms of anxiety and depression.

Review of the Mount St. Helens Studies

We have reviewed all reports from the initial psychosocial studies of the Mount St. Helens disaster. These papers covered a variety of issues including perception, needs, agency planning, warning, attribution, impact, and response.[16-28] Six selected behavioral studies are summarized here. The studies were by mail, telephone, or field survey method. None were controlled.

Green, Perry, and Lindell[21] investigated citizen perception of the threat of volcanic hazard during the early eruptive period. They conducted telephone interviews during April 5–7, 1980 with 173 (76 per cent) of 228 subjects randomly selected from seven communities along the Lewis and Cowlitz Rivers within a 40 mile radius of Mount St. Helens. This was the only study conducted during the premonitory, early eruptive phases (prior to the major May 18, 1980 eruption). Fifty-one (29 per cent) respondents felt that it was likely that volcanic activity would threaten their personal safety or property. Only one subject felt endangered by the possibility of an explosive eruption. The majority felt that a disaster requiring evacuation was unlikely. On the other hand, over half of these respondents were receiving mass media, volcanic-related information at least four times a day. Forty-six per cent had made no preparation for evacuation. Those who did make evacuation plans lived in closer proximity to the volcano. The findings indicate a limitation of general media exposure for disaster preparedness by the total population, especially if the intended message is not focused or closely coordinated among public agencies.

Roberts, Dillman, and Mitchell[22] studied victims' attribution of causality and perception of lack of control two months post-eruption. They evaluated the self-report to questionnaires from 900 households in Eastern Oregon during the summer of 1980. While 78 per cent of their subjects indicated a feeling of internal control, 44 per cent felt unable to protect themselves from the ash fallout. A positive feeling of control was held by persons with better current physical health status and higher levels of education. Eighty-three per cent of subjects felt fatalistic about the event, while 67 per cent accepted the scientifically based theories explaining its cause. Roberts concluded that the majority of respondents experienced a loss of control during the disaster but regained

a sense of mastery in coping with the disaster's effects. There was no indication about the method of selecting respondents within households.

Working with a federal grant from the National Institute of Mental Health, the Washington Department of Social and Health Services assessed the mental health needs of 138 disaster victims following the eruption in "Project Ash Lift."[24] These clients experienced a variety of disaster-related losses: four experienced the death of a family member or friend, five had a major injury, 45 experienced temporary unemployment, and 56 had a loss of personal property. Most clients exhibited stages of the disaster syndrome with symptoms of anxiety and depression. Many victims focused on feelings of frustration and anger in having to deal with the bureaucracy of federal disaster assistance programs. Since "Project Ash Lift" was primarily a training project in disaster intervention for mental health workers, these reported disaster victims were a limited group representing those who sought clinic treatment.

Leik, et al,[25] studied family stress in seven Western Washington communities. They conducted telephone interviews of 152 households six months following the major eruption and did a follow-up interview with 138 of these six months later. Using random digit dialing, they also selected 60 families from three Washington sites for in-depth home interviews. Thirty of these families were reinterviewed 12 months post-eruption. They found an increased score on a self-report stress graph in the immediate post-disaster period. It was highest for households in close geographic proximity to the mountain. Although stress ratings lessened in subsequent months, they again increased in the late fall of 1980, possibly due to predictions of massive flooding on the Cowlitz River. No family in this survey indicated that they planned to move because of the possibility of future volcanic eruptions. Leik noted that mental health clinics in three local sites reported no change in caseloads which could be directly attributable to Mount St. Helens, but also indicated that all clinics were working to capacity prior to the May 18th eruption. The study has several significant limitations. It was not controlled for seasonal variation and utilized stress measures that were subjective, nonspecific, and unvalidated.

Murphy[26,27] studied the relationship between symptoms and stressful life events in bereaved, property loss, and control groups. She mailed questionnaires or conducted structured interviews 11 months after the major eruption. Her sample of 155 subjects included: relatives or friends of deceased disaster victims, individuals who experienced property loss, and a comparison group matched for sex, age, occupation, and geographic location. When compared with controls, bereaved subjects reported significantly higher levels of stress and lower levels of mental health, but not physical health, as measured by a present-state symptom scale (SCL-90). Persons who lost their permanent homes reported high rates of stress, but compared to control subjects they did not report significantly higher levels of depressive and somatic symptoms, or adverse physical health. The present-state measure of symptoms employed in this study did not measure symptom states that may have occurred in the immediate post-eruptive period and were in remission at the time of the interview.

Adams and Adams[28] conducted a pre- and post-disaster comparison of disaster stress reaction in the Eastern Washington community of Othello. They studied utilization of a mental health crisis line, mental health clinic appointments, hospital emergency room visits, district court cases, police records of domestic violence, and utilization of community alcohol rehabilitation services. Their findings demonstrated that the post-disaster utilization patterns increased substantially for services to mentally ill clients (235.8 per cent), crisis calls (79.2 per cent), emergency room visits (21 per cent), domestic violence (45.6 per cent), and arrests (up to 27 per cent). They concluded that "substantial evidence from this investigation suggests that the Mount St. Helens ashfall disaster has resulted in an extensive stress-reaction effect on the community of Othello and its surrounding area. The evidence indicates that a disaster of this sort is likely to increase physical and psychosomatic illness, alcohol-related problems (although such may not be reflected in driving patterns), aggression and violence, and family stress, thus placing a tremendous burden on local physical and mental health providers. Furthermore, the relatively enduring (three to four months) nature of such effects suggests that health providers are likely to continue to experience increased demands on their professional time and skills for months to come" [page 258]. Limitations of this study are the lack of a comparison community and a method which utilized public service contact rates during a time when the region was emerging from a major economic recession.

Greenberg, a news editor, attempted to discount the potential serious and lasting psychological effect of this volcanic disaster in an editorial entitled "Don't Give the Volcano Credit for Mental Ills,"[29] which stated, "The menace of uncritically retailed psychologizing is that it fails the public and encourages the crackpots. Suspension of skepticism isn't warranted just because someone claiming the authority of science says something is so. It's as simple as that." Mr. Greenberg's article reiterates the long-standing controversy concerning the extent and permanence of psychological distress following disaster. His opinion is on the side of those who conclude that stress response to disaster is short-term, nonspecific, and without long-term consequences for behavioral and health adjustment. The findings from our behavioral studies following the Mount St. Helens disaster contradict his conclusion.

Study Conceptualization

The major theoretical viewpoints from previous disaster research provided numerous criteria for our methodological consideration in the design of this study. Our goals were to include:

1. both the sociological (social fabric view) and the biomedical (individual trauma view) perspectives;
2. a community-wide population sample;
3. utilization of an accepted instrument for the identification of psychiatric syndromes in addition to the measure of nonspecific symptoms of anxiety and depression;
4. a description of the onset and duration of post-traumatic stress disorders;
5. a control community comparison; and
6. research in the absence of major, community-wide litigation which could bias responses.

The primary objective of this research was to document mental health reactions to the disaster and to explore a number of important hypotheses. In this paper we will present the pattern of psychiatric disorders that are disaster-related. In subsequent analyses we will address other hypotheses that are stated as key questions.

1. How is mental health adjustment related to (volcanic) disaster
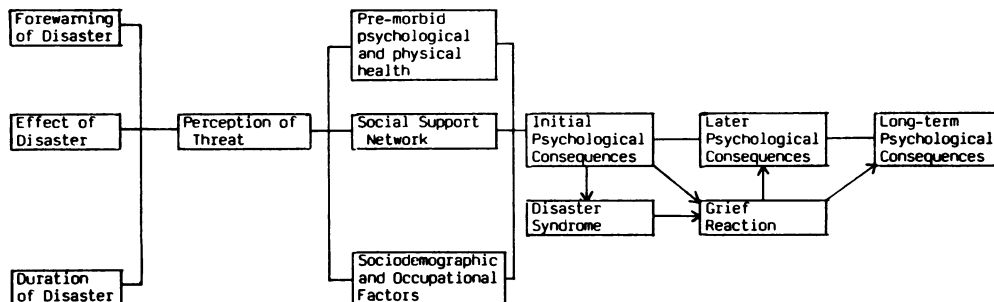2. How are the severity and chronicity of previous mental

FIGURE 1—Model for Mental Health Consequences of Natural Disasters

and physical illness related to mental health adjustment after a disaster stress?

3. How are sociodemographic, economic, and occupational factors related to behavioral adaption to disaster?
4. How are interpersonal support networks related to mental health adjustment?
5. How is an individual's perceptions of volcanic activity as a life threatening event related to mental health adjustment?
6. How is an individual's proximity to the hazards related to mental health adjustment?
7. How are the perceived interpersonal and social changes caused by the disaster related to mental health adjustment?
8. How are the losses from the disaster related to mental health adjustment?
9. How is psychological well-being related to mental health adjustment of persons affected or threatened by volcanic eruptions?

Our theoretical model of mental health consequences of natural disasters is presented in Figure 1. It is an attempt to integrate both the individual-trauma and social-fabric views. It includes the three critical areas affecting the psychological consequences of disaster as summarized by Perry and Lindell.[30] Those are the characteristics of the individual, characteristics of the social system, and the individual's impact from the disaster. This model provides our conceptual framework for the mental health study of the Mount St. Helens disaster.

Methodology

The uniqueness of the research opportunities associated with the Mount St. Helens disaster was not just the rarity of a volcanic eruption itself. It occurred at a time when there had been a major advance in the mental health field through the development of a new criteria-based diagnostic system for identification of psychiatric syndromes. Furthermore, this new development had been adapted for application in epidemiology field research. Throughout the 1970s, the American Psychiatric Association had been developing a revised psychiatric nosology based on a requirement of multiple criteria for each diagnosis. This new diagnostic system was tested extensively for interrater reliability and published as the *Diagnostic and Statistical Manual,* Third Edition (DSM III)[31] in 1981. At the same time the National Institute of Mental Health, through several universities, developed a field interview protocol, patterned after DSM III and designed for field administration by trained paraprofessionals, entitled the "Diagnostic Interview Schedule" (DIS).[32] The DIS is composed of a series of behavior question subgroups that define specific psychiatric syndromes with lifetime

prevalence age at onset, and duration of symptoms. The disaster study by Bromet[14,15] at Three Mile Island had utilized systematic diagnostic criteria. However, that research was completed before the DIS was published. Given the controversies in the fields of behavioral science and disaster research, the coincidental Mount St. Helens eruption and the development of this new research method created an opportunity to investigate more thoroughly patterns of the disaster response.

The psychiatric study involved two rural northwest logging communities, Castle Rock, Washington together with the adjacent Toutle River Valley, and Estacada, Oregon along with the surrounding Eagle Creek postal district. The former area was severely affected by the eruptive activity of Mount St. Helens and served as our exposed community. Our control community, Estacada, represented a comparable northwest community which was unaffected by the eruptions of Mount St. Helens.

All respondents were required to be between 18 and 79 years of age, Caucasian, and continuously residing in the study area since May 18, 1980. In addition, only single family or non-institutional small group residences were included in the study. A two-stage sampling procedure was used to select respondents. In Oregon, a systematic random sample of households was first drawn from residence lists which were compiled from a variety of sources. One subject was selected from each household using a sampling scheme designed to provide a final sample whose age-sex distribution reflected that of the population as a whole.[33] The interviews took place from 38 to 42 months after the May 18 eruption (July 1–October 31, 1983).

In Washington State, we first screened tax assessor records to identify a group of households that experienced significant residental damage. Using this information, we stratified the experimental sample, including all "damaged" households, plus a systematic random sample from among the remaining households. After our initial interviews were completed, we identified all individuals who reported either significant residential damage, a total dollar loss of at least $5,000, or the death of a family member or other relative due to Mount St. Helens. We then attempted to interview a member of the opposite sex in all such households having at least two eligible adults. This resulted in an additional 60 subjects, giving a total sample size of 1,025. We divided the subjects into three groups: high exposure, low exposure, and control on the basis of information obtained from their questionnaires. Specifically, the 138 subjects who suffered at least $5,000 in Mount St. Helens-related property loss or death to a family member of close relative were defined as *high exposure.* The remaining 410 subjects in the exposed community were classified as *low exposure,* and the 477

TABLE 1—First Year Post-disaster Onset Rates for MSH-Disorders

Sex	% Control (N)	% Low Exposure (N)	% High Exposure (N)	95% Confidence Interval for High-Control
Males	0.9 (227)*	2.5 (198)	11.1 (54)	0.6, 19.8
Females	1.9 (212)	5.6 (177)	20.9 (67)	8.1, 29.9

*Sample sizes indicate "at-risk" population for new onsets post-disaster. Subjects having prior onsets are excluded.

TABLE 2—Relative and Attributable Risks for First Year Post-disaster Onsets of MSH-Disorders

	Relative Risk		Attributable Risk	
	Low Exposure	High Exposure	Low Exposure	High Exposure
			%	%
Males	2.8	12.3	1.6	10.2
Females	2.9	11.0	3.7	19.0
Females vs Males*	0.1, 7.6	0.1, 5.9	−3.5, 7.7	−6.4, 23.9

*95% confidence intervals for ratio of relative risks and difference in attributable risks.

Oregon subjects constituted the *control* group. Thus, the classification of subjects from the disaster community into high or low exposure groups were based on major criteria. We were able to externally validate these criteria through tax assessor records or double sample confirmation for approximately 80 per cent of subjects.

Characteristics of the sample were carefully compared for sex, age, household income, education, marital and employment status. Overall, the control and low exposure samples were comparable. One notable exception was female employment status. Although the unemployment rates for the two groups were similar, more Oregon than Washington women were in the workforce. Fifty-nine per cent of the low exposure Washington women were not seeking work as compared to only 43 per cent among the control (Oregon) women. By contrast with these two exposure groups, the high exposure group was older, more affluent, and more likely to be married.

For purpose of data analysis, we used the age-at-onset information obtained through the DIS to retrospectively estimate onset rates for each psychiatric disorder prior to the time of interview. In this way we were able to distinguish between new onsets of psychiatric disorders following the eruption of Mount St. Helens (MSH) and the recurrence of symptoms associated with onsets which occurred prior to the eruption. While we cannot discount the possibility of recall bias, its effects were presumably comparable across exposure groups so that between group comparisons should be valid. A recent study by Loftis and Marburger[23] would suggest that the effects of recall bias may have been reduced in this type of study which utilized retrospective reporting in association with a landmark event.

Results

Preliminary analysis of our data has found three disorders to be significantly associated with disaster stress: generalized anxiety, major depression, and post-traumatic stress disorder. We shall refer to these three psychiatric disorders as the "MSH-Disorders." Exposed females demonstrated elevated onset levels for all three disorders, while males only evidenced elevated levels of generalized anxiety disorder.

Table 1 shows onset rates for the MSH-Disorders for the first year post eruption for both males and females. Only the 935 subjects without a prior history of one of the MSH-Disorders are included. For both sexes, the data show a significant, stepwise increase in onset rates from the control to low to high exposure groups. Furthermore, for each exposure category, the onset rates observed among the women were approximately twice as high as those seen among the men.

Table 2 summarizes these findings in terms of both relative risk and attributable risk for the two exposed populations as compared to the control group. Both quantities are useful measures of association for describing the relationship between exposure to a suspected risk factor and disease onset. Relative risk (RR) is the ratio of rates in exposed relative to non-exposed individuals and reflects the multiplicative effect of exposure upon morbidity. Attributable (or excess) risk (AR) is defined as the difference in disease onset between exposed and non-exposed individuals and measures the additional incidence among exposed subjects which is associated with exposure. Attributable risk is often the more important measure from a public health standpoint, although relative risk is frequently the better measure for describing the risk factor effects. The data in Table 2 provide an illustration of this point. Both males and females showed very similar patterns for relative risk, with rates three times as high as those for controls in the low-exposure groups, and 11–12 times as high among individuals in the high-exposure categories. However, from a public health perspective, the attributable risk clearly shows that there were almost twice as many new cases among females as among males. This is because, even though the relative risks for males and females were not significantly different, the onset rate among women in the Oregon control group during the first year post-MSH was 1.9 per cent versus 0.9 per cent for Oregon men. Overall, the observed onset patterns for both sexes were highly significant based on a chi-square test for trend.[34] Logistic regression analysis[35] showed no significant differences in relative risk between the sexes, but did indicate that the relative risks for both exposure groups were significantly greater than 1.

Further examination of the post-eruption onset pattern for the MSH-Disorders showed that all of the disaster-related onsets appeared to occur within the first two years following the disaster. Among individuals experiencing a new onset of one of the MSH-Disorders following the eruption, the tendency was for duration of symptoms to be greatest among the high exposure subjects. The total number of new cases was small, however, and these differences were not statistically significant. For those individuals with generalized anxiety or depression prior to the eruption, symptom recurrence rates post-disaster for one or more of the MSH-Disorders were significantly higher for exposed women but not for exposed men.

An important question in any disaster study is whether the effects of the disaster stress are limited to specific subgroups in the population such as the elderly or the unemployed. Table 3 presents first year post-disaster onset rates for females, broken down by age, physical health history, and concern over family finances. The latter item is a surrogate for employment status, since so few subjects were unemployed. All respondents were asked how often since the eruption they had been worried about their financial situation

TABLE 3—First Year Post-disaster Onset Rates for MSH-Disorders, Females

	% Control (N)	% Low Exposure (N)	% High Exposure (N)	95% Confidence Interval for High-Control
Age (years)				
18–35	2.8 (71)*	1.6 (64)	12.5 (16)	−10.8, 30.2
36—50	2.4 (82)	13.5 (52)	37.9 (29)	15.2, 55.8
over 50	0 (59)	3.3 (61)	4.6 (22)	−7.6, 16.8
Concern over finances				
Low	1.6 (125)	4.3 (116)	20.4 (44)	5.2, 32.5
High	2.3 (87)	8.2 (61)	21.7 (23)	−0.5, 39.3
Prior physical health problem				
No	3.0 (101)	3.9 (77)	25.0 (28)	3.4, 40.7
Yes	0.9 (111)	7.0 (100)	18.0 (39)	3.1, 31.0

*Sample sizes indicate "at-risk" population for new onsets; subjects having prior onsets are excluded.

or that of their immediate family. The question was asked because of the report by Bromet at Three Mile Island of high anxiety about potential layoffs among the control community. Individuals responding "often" or "very often" were classified as having high concern. As seen in the Table, for each subgroup high exposure subjects reported higher onsets of the MSH-Disorders than did control subjects. Among low exposure subjects, onset rates were typically intermediate and consistent with the concept of a dose-response pattern. Due to small numbers in some subgroups, the confidence intervals should only be regarded as approximate. Similar results were seen for men.

Even though significant disaster-related morbidity occurred across all segments of the population, it is still reasonable to ask whether certain subgroups were especially susceptible to the effects of the disaster stress. For the variables shown in Table 3, we hypothesized that the elderly, those with high concern over finances, and those reporting prior physician-diagnosed physical health problems were at higher risk and would be particularly susceptible to the effects of the disaster stress.

Table 4 reexpresses these data in the form of relative risks for the high and low exposure groups relative to the control group. For age, relative risks could not be calculated for the over age 50 group because none of the Oregon female control subjects in this age range experienced a comparable disorder in the first year post-eruption. For the 18–35 and 36–50 age groups, relative risks increased with both increasing age and increasing exposure. Our data agree with recently published findings of national patterns in psychiatric epidemiology[36] that cross-sectionally measured psychiatric morbid-

TABLE 4—Relative Risks for First Year Post-disaster Onsets of MSH-Disorders, Females

	Low Exposure	High Exposure
Age (years)		
18–35	0.6	4.5
36–50	5.6	15.8
over 35 vs under 35*	0.6, 168.3	0.3, 37.7
Concern over finances		
Low	2.7	12.8
High	3.6	9.4
High vs Low*	0.1, 13.0	0.1, 6.5
Prior physical health problem		
No	1.3	8.3
Yes	7.8	20.0
Yes vs no*	0.4, 80.2	0.2, 26.9

*95% confidence interval for ratio of relative risks.

ity rates decrease in later years after increasing through the 30s and 40s. The reasons for this pattern are not clear, although the influence of survivor and cohort differences should be considered. For both physical health history and concern over finances, the relative risks associated with low exposure were highest among the suspected high-risk subgroups. For high levels of exposure, the results were inconsistent. Although none of the differences in relative risks between subgroups were significantly different, this pattern is consistently appearing as we analyze and identify additional susceptible subgroups. It suggests the possibility that in the high exposure groups the disaster impact is so intense that it saturates the "at risk" population and thus overrides the variables that more accurately identify high-risk individuals and subgroups at the low exposure level. This finding provides evidence for risk-group variability at different levels of stress exposure in influencing psychiatric morbidity.

Another important issue in disaster research is the distinction between bereavement and other forms of response. The Diagnostic Interview Schedule distinguishes between depression associated only with bereavement and other forms of depression, and only the latter are included in our definition of the MSH-Disorders. However, in our definition of high exposure we did not distinguish between respondents who sufferd a major property loss and those who lost a family member or other relative due to the eruptive activity of MSH. There were 15 subjects in the latter category, half of whom also had major residence damage. An additional 58 subjects reported an MSH-related death of a friend. Of these, nine were classified as high exposure, 47 as low exposure, and two were control subjects. Only limited information was available in other, non-Mount St. Helens-related deaths.

To examine the influence of a significant death, we reanalyzed the data excluding the 73 subjects who reported a Mount St. Helens-related death. For both males and females, the data still showed a statistically significant, dose-related pattern of onsets for the MSH-Disorders in the first year following the eruption. Among the men, the onset rates were 0.9 per cent, 2.3 per cent and 8.9 per cent for the control, low and high exposure groups respectively. The corresponding rates among the women were 1.9 per cent, 4.4 per cent, and 22.2 per cent. Among the 73 subjects who reported deaths, eight reported an onset of one of the MSH-Disorders in the first year post-eruption. These included eight cases of generalized anxiety disorder and one overlapping case of depression. An additional seven of these subjects reported an onset of generalized anxiety disorder

prior to the eruption. Of the 73, only two reported the onset of a depressive disorder secondary to bereavement.

Conclusions

The onset pattern of the MSH-Disorders demonstrates a significant influence by this disaster stress on three major psychiatric syndromes. These disorders were defined by a criteria-based diagnostic method that has demonstrated inter-rater reliability. The outcome thus addresses the "individual-trauma" versus "social-fabric" debate and supports the former. The differential response in the three exposure groups is evidence for a broadly held, but seldom demonstrated, assumption that the behavioral response to disaster stress will follow a dose-response pattern. The higher rate among women is not surprising since the MSH-Disorders are depression-anxiety syndromes that are more common among women in all studies of psychiatric epidemiology. In addition, the pattern of normal bereavement did not influence the outcome.

There is a trend for the duration of symptoms of the MSH-Disorders to persist longer if the subject was exposed to the greatest degree of disaster stress. In addition, when we analyze the relative risk of the three exposure groups, it appears that the "at-risk" population became saturated for developing new onsets of stress syndromes only if they received the highest dose of stress. This pattern may mask the identification or confirmation of suspected risk groups in disasters unless they are observed at variable levels of stress intensity.

Using estimates of relative risk may aid in the search for susceptible subgroups as demonstrated in the identification of several predictive subject characteristics in this study. Relative risk was greater for females who are older, concerned over finances, and have a prior physical health problem. In future analyses we will continue to more precisely define these risk groups. We hope that this type of study can improve the identification of those individuals who are most susceptible to significant psychiatric syndromes following major disaster stress. During premonitory periods preceding infrequent (volcanic eruptions) or common (severe weather) natural disasters, it is important to identify highly susceptible or vulnerable individuals and groups for intervention efforts in advance of the actual disaster. We hope that this study will assist public health efforts and public agencies in future disaster intervention efforts.

Summary

This psychiatric epidemiology study following the Mount St. Helens volcanic disaster revealed a significant morbidity for psychiatric disorders. The increased prevalence showed a dose response pattern in three population groups. The findings are reported as relative and attributable risk for the two exposed populations as compared to a control group. Patterns of significant risk are presented for sex, age, and for victims with pre-existing physical illness. The research utilized a new criteria-based interview schedule for the identification of psychiatric disorders. The methodology is reviewed in the context of the controversies and assumptions within the field of behavioral response to disaster stress. There are important implications for public health planning and intervention.

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