

Stress and well-being in mothers of young children 11 years after the Chernobyl nuclear power plant accident¹

R. E. ADAMS, E. J. BROMET,² N. PANINA, E. GOLOVAKHA, D. GOLDGABER
AND S. GLUZMAN

From the Department of Community and Preventive Medicine, Mt. Sinai School of Medicine, New York and Department of Psychiatry and Behavioral Science, State University of New York at Stony Brook, NY, USA; and Institute of Sociology Academy of Sciences of the Ukraine and Ukraine Psychiatric Association, Kyiv, Ukraine

ABSTRACT

Background. This paper examines the association between exposure to the Chernobyl nuclear power plant explosion and the psychological and physical well-being of mothers with young children. The study also examines whether exposure to Chernobyl increased the vulnerability of mothers to subsequent economic and social stress, and thus represents a unique test of the stress–vulnerability model in a non-Western setting.

Method. The sample consisted of mothers evacuated from the contamination zone surrounding the plant (evacuees) and mothers who had never lived in a radiation-contaminated area (controls). In addition to exposure status, the interview obtained data on perceived economic stress, social stress and stress moderators. The dependent variables were measured by the SCL-90 global severity index (GSI), perceived physical health and number of days unable to work due to illness.

Results. Overall, evacuees reported fewer stressors and greater personal and social resources than control mothers. Nevertheless, evacuees scored higher on the GSI, reported lower perceived physical health and took more sick days relative to control mothers, even after controlling for demographic factors, stressors and stress moderators. Tests of interaction effects were not statistically significant.

Conclusions. The findings confirmed that married women with young children evacuated to Kyiv following the Chernobyl nuclear power plant explosion reported significantly poorer psychological and perceived physical health than controls 11 years later. Although perceived social and economic adversities also affected these outcomes, there was no evidence that exposure to the Chernobyl accident increased the vulnerability of mothers to these stressors, giving support to the additive burden model of stress.

INTRODUCTION

Beginning with the pioneering work of Faris & Dunham (1939), a substantial amount of research in Western countries has established a link between environmental adversities and poor

psychological and physical functioning (e.g. Kessler *et al.* 1985; Thoits, 1995; Kunovich & Hodson, 1999; Yen & Syme, 1999). The evidence has consistently shown that social disorganization and environmental stress, assessed in terms of exposure to trauma, exposure to more ordinary life events, and ongoing strains in and outside of work, are risk factors for poor mental and physical health (Dew *et al.* 1987; Bromet *et al.* 1990; Phelan *et al.* 1991). A primary focus of recent research entails identifying the factors

¹This study is a collaborative project with investigators in Ukraine, where the fieldwork was conducted. The paper follows the original Ukrainian spelling for Chernobyl (Chernobyl) and Kyiv (Kiev).

² Address for correspondence: Dr Evelyn J. Bromet, Department of Psychiatry and Behavioral Science, Putnam Hall-South Campus, State University of New York, Stony Brook, NY 11794-8790, USA.

that intensify or diminish these effects (House & Mortimer, 1990; Thoits, 1995).

In relation to natural and human-made disasters, researchers have documented the adverse psychological and physical health consequences of these highly stressful events in a variety of populations (see, for example, reviews by Warheit, 1988; Rubonis & Bickman, 1991; Bromet, 1995; Bromet & Dew, 1995; Green, 1995; Brewin *et al.* 2000). Although these reviews concluded that increases in psychopathology and physical morbidity could be expected as a result of community disasters, most of this research has not focused on many of the world's worst disasters, which took place in developing countries and where survivors were never studied (Bromet & Dew, 1995; Havenaar & van den Brink, 1997).

Community-wide disasters in non-Western, developing countries may have quite different consequences for survivors when compared to disasters in developed countries. Freedy *et al.* (1992, 1994) suggest that people who experience a natural or technological disaster do not necessarily require psychiatric or medical services in industrialized countries like the United States that have preparedness messages, building codes, rapid response plans and other resources. Such is not the case in non-Western, developing countries. The 1988 Armenian earthquake (Giel, 1998) and the Bhopal cyanide gas accident in India (Murthy, 1990) represent two disasters in industrializing countries where local resources were inadequate to mitigate their negative mental and physical health effects. Loss of life and community disruption may be very severe and long lasting in these situations.

Furthermore, relatively few disaster studies have examined the post-disaster environmental risk factors that can magnify the disaster's adverse effects on well-being. The importance of this issue was initially suggested by Erikson (1976), in his classic study of the 1972 Buffalo Creek flood. The flood, which destroyed an entire community of 5000 people in West Virginia and killed 125 individuals, was linked to depression, anxiety, insomnia and other psychological problems in survivors for as long as 20 years after the event (Erikson, 1976; Gleser *et al.* 1981; Green, 1995). The flood, however, was not just a single traumatic event. As Erikson (1976) showed, it was the destruction

of everyday ways of living that seemed to have the most long-lasting effects on people's well-being. That is, the flood dramatically altered the social circumstances of survivors, mostly for the worse.

Other studies have also shown that the post-disaster environment can be as influential on mental and physical health as the disaster itself (Freedy *et al.* 1993; Norris & Uhl, 1993; Palinkas *et al.* 1993*a, b*; Riad & Norris, 1996; Havenaar & van den Brink, 1997; Brewin *et al.* 2000). Negative life events and chronic strains, which may or may not have been influenced by the disaster, such as unemployment, marital difficulties and reduced social support, have been found to increase depressive and psychiatric symptoms in populations exposed to natural and human-made disasters (Edwards, 1998; Dew *et al.* 1987; Kaniasty & Norris, 1993, 1995; Norris & Uhl, 1993) as well as in general population samples (Dohrenwend, 1998). Although some studies have found that the negative mental and physical health consequences of disasters and the post-disaster environment are of relatively short duration (e.g. McFarlane, 1989), a few studies have indicated that negative effects were evident after 10 years or more (Bromet & Dew, 1995; Green, 1995).

The three most consistent risk factors for physical and mental morbidity in a population experiencing a disaster in Western, developed countries are being female, having a pre-existing psychiatric disorder and greater intensity of exposure (McFarlane, 1987, 1988, 1989; Freedy *et al.* 1992, 1994; Ginzburg, 1993; Havenaar *et al.* 1996). In addition, like other traumatic events (Turner & Lloyd, 1995), disasters can lead to poor mental and physical health because they unleash a cascade of negative life events, lead to increases in chronic strains, and decrease the availability of social and psychological resources (Palinkas *et al.* 1993*b*; Havenaar *et al.* 1996, 1997*a, b*; Kunovich & Hodson, 1999).

Within the context of community-wide technological disasters, two alternative stress process models guide our research. The 'additive burden' model posits that stressful events lead to distress which affects psychological and physical well-being. The model further contends that stressful *events* increase distress in an additive, linear fashion. That is, the number of stressful events in a person's life can simply be added

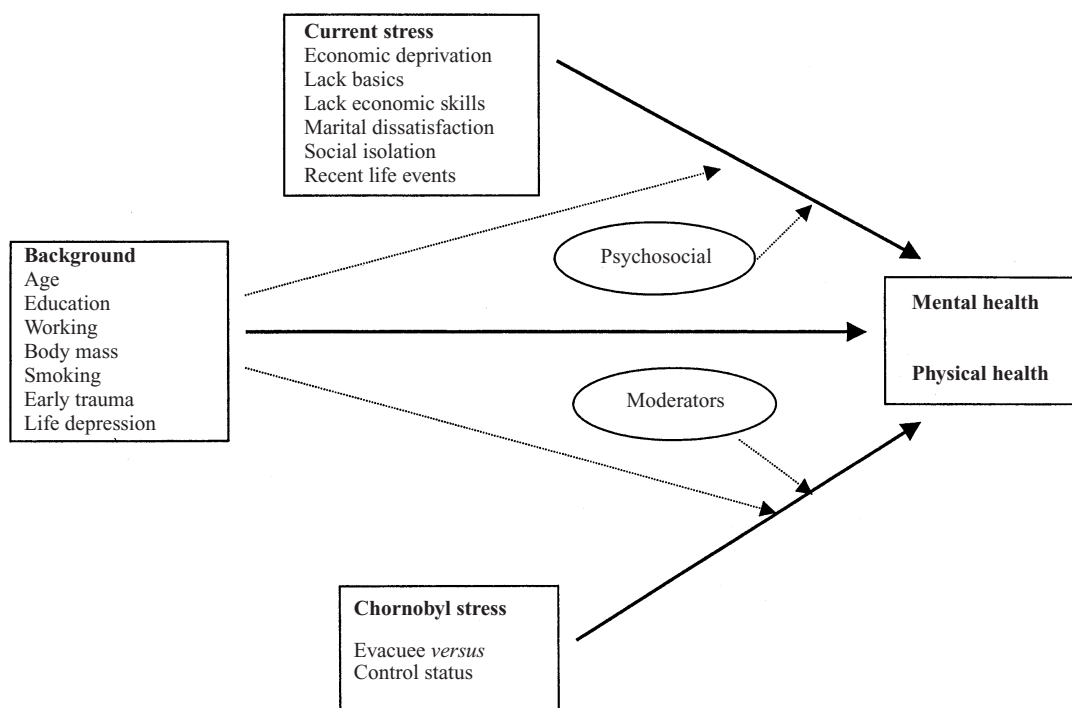


FIG. 1. Graphical representation of the vulnerability model.

together. A person's psychological and physical health suffers the more events he or she experiences. The stress–vulnerability model, on the other hand, argues that certain characteristics or experiences make some people more vulnerable to stress. Stressful events are not additive, but interact with the characteristics or experiences of individuals to increase distress more rapidly among people in the 'vulnerable' group (Dohrenwend & Dohrenwend, 1981). For example, several studies find that not only do women tend to experience more negative life events, relative to men, but that they are also more sensitive to such events. In other words, similar events tend to have a more pronounced effect on women (Thoits, 1995).

The present study incorporates these two stress models and focuses on a sample of women in Kyiv, Ukraine, 11 years after the nuclear power plant explosion at Chernobyl. Ukraine is a compelling laboratory for studying post-disaster environmental risk factors. Since 1991, Ukraine has gone through a period of socio-economic disintegration resulting from the accident and subsequent break-up of the former

Soviet Union, and people's lives have been permanently altered (Braithwaite & Hoopen-gardner, 1997). There has been a decline in life expectancy (especially in men), in the birth rate, and in the standard of living and health care, and an increase in drug and alcohol abuse, crime, suicide and other self-destructive behaviours (Bobak & Marmot, 1996).

In 1997, we conducted an epidemiological study of the psychological aftermath of Chernobyl on mothers and their young children, and assessed an array of socio-economic (lacking basic goods and services) and social environmental (social isolation, negative life events, marital dissatisfaction) adversities. In a previous paper, we found that compared with mothers of classmate controls, mothers evacuated to Kyiv from the contaminated zone around the plant reported significantly more depressive, somatic and post-traumatic stress symptoms (Bromet *et al.* 2000). We have also found that the evacuee mothers perceived their physical health as poorer and took more sick days in the prior year than controls (see below). In this paper, we attempt to explain whether these differences are attributable

to Chernobyl primarily, to differential exposure to other socio-economic or social environmental adversities, or to a combination of evacuee status and these other sources of stress. Specifically, using the vulnerability model as a conceptual guide (Fig. 1), we examine why the evacuee mothers exhibited poorer well-being by analyzing: (a) the direct effects of socio-economic and social environmental stress in the evacuee women and in the controls, adjusting for other known risk factors (demographic characteristics, body mass index, smoking, personal history of depression); (b) the joint effects of group membership (evacuee *versus* control) with these other sources of stress; and (c) the stress-buffering properties of social support and two psychological resources, mastery and self-regard. To our knowledge, this study represents one of the first attempts to test the stress-vulnerability model in a non-Western setting.

METHOD

Sample and context

The Chernobyl nuclear power plant accident began on 26 April, 1986, when two explosions in Unit 4 allowed air to enter the containment chamber, igniting flammable gas and causing a reactor fire. Over the next 10 days, an area of about 1000² km, containing many villages and farms, was heavily contaminated with plutonium, caesium and radioactive iodine. In all, approximately 120000 people primarily from the 30-kilometre zone around the plant were permanently evacuated. Pregnant women were advised to have abortions without being given a clear explanation.

Kyiv is located about 90 km south of Chernobyl and received much less contamination than areas north of the plant although parents in Kyiv experienced some of the trauma associated with the power plant explosion. Evacuees underwent a series of traumas stemming from the knowledge that they had been exposed to high levels of radiation and the often chaotic evacuation and resettlement process. Specifically, once they arrived in Kyiv, the evacuees had difficulty obtaining the required official papers allowing them to live there, and they also struggled for adequate housing and medical benefits. Their physical health concerns

were dismissed as 'radiophobia' (Chinkina, 1991; Buzunov *et al.* 1996; Bard *et al.* 1997). After the collapse of the Soviet Union in 1991, shortages of food, hot water, medicine, job opportunities and other necessities were ubiquitous in Kyiv due to the deteriorating economy of Ukraine. The recession was so severe that real wages declined more than 60% between 1990 and 1993 (Fallon *et al.* 1997). According to a study by the International Monetary Fund (Braithwaite & Hoopengardner, 1997), the official poverty rate as of June 1995 was 29.5%, with urban areas particularly short of food and clothing. Ukraine also experienced a severe outbreak of cholera in 1994 and 1995. Both evacuee and non-evacuee families living in Kyiv had to contend with these events.

The data for the present analyses come from the Stony Brook-Kyiv Chernobyl Project, a collaboration between US investigators and independent scientists in Ukraine. The study focused on families evacuated from the radiation exposed areas around the Chernobyl nuclear power plant and residing in Kyiv in 1997. Families were selected who had a child who was *in utero* to age 15 months (i.e. born between 1 February, 1985, and 31 January, 1987) at the time of the accident. In order to obtain as complete a list of evacuee families as possible, the project integrated three lists: the National Register of Persons Affected by Radiation as a Result of the Chernobyl Accident, Help for Families from Chernobyl, and Children for Chernobyl-For Survival. The National Registry contained 668 children in the target age range and the other two agencies contributed 53 additional names. Of the 721 evacuee children identified on the three lists, 28 no longer lived in Kyiv. After eliminating 15 children who participated in a pilot study, the list was randomized, and subjects were selected sequentially until 300 interviews were completed. A gender-matched classmate from the same homeroom was selected for each evacuee child. The response rates were 92% for the evacuees (300/326) and 85% for the Kyiv controls (300/352).

The present analyses were based on interview data obtained from the mothers from February-May, 1997. Due to the matching of the children, we treated the mothers as matched pairs. Since the present paper also focuses on marital stress (as well as other acute and chronic stresses), the

analysis included only women who were married or living as if married at the time of interview. Thus, 232 pairs form the basis for the bivariate analyses presented below (34 evacuees and 31 controls were separated or divorced at the time of interview and eight additional controls had extensive missing data).

Measures

Standard translation and back-translation procedures were followed for all measures. In addition, instruments developed and previously used in studies in Russia or Ukraine were translated into English. In general, the internal consistency of the measures reported below is comparable to that found in US studies.

Mental and physical health

Current mental health was assessed with the Symptom Checklist-90 Revised (SCL-90-R; Derogatis, 1983; Russian translation provided by Tarabrina *et al.* 1996). The Global Severity Index (GSI), used in the present analysis, represents the average score for the 90 items, providing an overall measure of distress (0 = not at all; 4 = extremely distressed over past 2 weeks) (Cronbach's $\alpha = 0.97$). Two physical health measures were also included: ratings of perceived physical health ('How would you evaluate your health in general?' coded 1 = very bad to 4 = good/excellent); and number of sick days or days spent in bed due to illness in the last year. Due to the highly skewed distribution of sick day reports, we took the natural log of the variable and used the transformed variable in all of the analyses.

Stress

Chernobyl stress was assessed by group status (1 = evacuee; 0 = control). This variable captures differences in disaster exposure, residential relocation and disruption, and degree of health-related anxiety associated with the disaster (Bromet *et al.* 2000).

Three measures of perceived socio-economic strain and three measures of social stress were analysed. The measures of socio-economic strain were: (1) Current Economic Deprivation (six items, including not having enough money to buy the things the family needs or not enough money to feed your children; range = 0–12); (2) Current Lack of Basic Necessities (five items,

including lack of opportunity to buy the most basic food and access to medical care; range = 0–5); and (3) Current Lack of Economic Skills (four items pertaining to lacking skills needed to live under the social conditions of the post-Soviet era; range = 0–4). (The exact wording of the items in these scales is shown in the Appendix.)

The three measures of social stress were: (1) Current Marital Dissatisfaction; (2) Current Social Isolation; and (3) Negative Life Events. Marital Dissatisfaction was assessed using an 8-item scale derived from Spanier (1976) and Pearlin & Schooler (1978) concerning current aspects of the marital relationship. Each item was rated on a 5-point scale. The items were summed, with higher scores indicating greater dissatisfaction ($\alpha = 0.90$). Social Isolation was assessed with two items ('You are alone too much' and 'You do not have enough friends') rated: 0 = not true; 1 = somewhat true; and 2 = very true adapted from Turner *et al.* (1995). The scale was constructed by summing the two items such that higher scores reflected greater social isolation. Number of Negative Life Events in the past year (out of 18) served as a measure of acute stress. Events included not being paid for work (a persistent problem especially in public employees, such as teacher and policemen), home being burgled, or husband being unfaithful (Turner *et al.* 1995).

Stress moderators

Two types of stress moderators were considered, internal resources and social support. The two measures of internal resources were the Self-Regard and Sense of Mastery scales. The Self-Regard scale is a 5-item scale reflecting 'fluctuations in subjective experiences of having an integrated conscious self-concept', during the past week (Horowitz *et al.* 1996, p. 382). The items, rated on a 10-point scale, address respondents' evaluations of their facial appearance, fatigue, physical health, mental health and 'sense of yourself as a whole person'. The items are averaged, and higher scores reflect better self-regard ($\alpha = 0.77$). The Sense of Mastery scale (Pearlin *et al.* 1981) contains seven items rated 1 (strongly agree) to 4 (strongly disagree), with scores indicating current sense of mastery ($\alpha = 0.79$).

Social Support was operationalized by the item: 'In general, do you feel that you have someone whom you can turn to in times of need?'. For this analysis: 0 = never, rarely, or sometimes; and 1 = usually or always.

Background characteristics

Seven background variables were considered: current age; education (high school graduate or less; technical school graduate; university graduate); employment status (working full- or part-time *versus* not working outside the home), body mass index (BMI, weight in kilograms divided by the square of height in metres), current smoking (no; yes), lifetime depression (assessed with a modified, structured version of the depression module of the Structured Clinical Interview for DSM-III-R; Spitzer *et al.* 1992), and exposure to traumas early in life (parental divorce, physical abuse, parental death, parental alcoholism) modified from Turner *et al.* (1995). The trauma scale ranged from 0 to 4. For education, we included two dummy variables for technical school graduate and college graduate. High school or less was the excluded category.

Statistical analysis

Bivariate comparisons of evacuees and controls were conducted using two-tailed paired *t* tests, McNemar χ^2 , and Wilcoxon *z* tests. Correlations were used to summarize the bivariate associations of the background, stress, and moderating variables with the three mental/physical health measures. Examination of frequency distributions and bivariate scatterplots indicated no significant violation of the assumptions underlying linear models. Finally, a series of mixed-level regression equations were estimated to examine the relationship of the predictors to the three dependent variables, using the SAS procedure PROC MIXED (Littell *et al.* 1996; Singer 1998). The mixed-level regression analyses utilized a four-stage procedure, introducing the demographic variables in stage 1, group membership (evacuee *versus* control) and the stress variables in stage 2, and the moderating variables (full model) in stage 3. Interaction terms (moderators \times stress) were entered in stage 4. The mixed models took into account the correlated residuals created by the matched

design of the data collection (Bryk & Raudenbush 1992).

RESULTS

Demographically, the evacuee mothers were similar in age to the controls, but they had significantly less education and were less likely to be working outside the home (Table 1). In terms of health risk factors, fewer evacuees were current smokers, but their overall body mass index was higher. The evacuee mothers were more likely to meet DSM-III-R criteria for lifetime depression, while there was no significant difference in the number of early life traumas.

There were no significant differences between the evacuees and controls with respect to five of the six stress variables (Table 2). The one exception was economic deprivation. For this variable, the controls perceived their economic circumstances as worse compared to evacuee mothers. With respect to the moderating variables, the evacuee mothers expressed significantly lower self-regard, but higher levels of perceived social support. There were no differences between the groups in sense of mastery.

The relatively similar (or better) economic and social stress levels of the evacuees compared to controls did not, however, translate into similar (or better) psychological and physical health. As shown in the bottom portion of Table 2, the evacuees had significantly ($P < 0.001$) higher GSI scores, perceived their health as poorer, and took more sick days than the controls.

Bivariate relationships

The three mental/physical health variables were only modestly intercorrelated, although the coefficients were somewhat higher in the evacuees than the controls (Table 3). The background variables were weakly associated with the health measures, with none of the correlation coefficients exceeding 0.26. The stress variables, particularly economic deprivation, lack of basic necessities, marital dissatisfaction, and social isolation, were significantly related to the GSI. On the other hand, with two exceptions (lack of basic necessities and perceived health, lack of economic skills and sick days), these variables were not significantly associated with perceived

Table 1. Background characteristics of the sample of mothers of young children

	Evacuees (N = 232)		Controls (N = 232)		z or χ^2 *	P
	N	(%)	N	(%)		
Education						
HS graduate	91	(39.2)	83	(35.8)	2.1	< 0.05
Technical school	102	(44.0)	86	(37.1)		
University graduate	39	(16.8)	63	(27.2)		
Employment						
Employed	136	(58.6)	185	(79.5)	25.1	< 0.001
Not employed	96	(41.4)	47	(20.5)		
Smoking status						
Smoker	26	(11.2)	50	(21.6)	8.0	< 0.01
Non-smoker	206	(88.8)	182	(78.4)		
Lifetime depression						
Present	102	(44.0)	69	(29.7)	9.4	< 0.01
Absent	130	(56.0)	163	(70.3)		
	Mean	(S.D.)	Mean	(S.D.)	t†	P
Age	37.2	(4.5)	37.8	(4.5)	1.5	NS
Body Mass Index	27.5	(4.7)	26.5	(4.7)	2.8	< 0.05
Early life traumas	0.6	(0.8)	0.7	(0.9)	-1.1	NS

* McNemar text (χ^2), except for education which uses Wilcoxon Signed Ranks Test (z).
 † Matched pairs, two-tailed t test.

Table 2. Differences between evacuees and controls in stress, personal/social resources, mental health and physical health

	Evacuees (N = 232)		Controls (N = 232)		t †	P
	Mean	(S.D.)	Mean	(S.D.)		
Stress						
Economic deprivation	7.27	(2.99)	8.14	(2.91)	-3.4	< 0.001
Lack basic necessities	2.09	(1.35)	2.19	(1.44)	-0.7	NS
Lack economic skills	1.92	(1.20)	1.90	(1.28)	0.2	NS
Marital dissatisfaction	17.21	(5.87)	18.28	(6.62)	-1.8	NS
Social isolation	0.57	(0.88)	0.62	(1.01)	-0.6	NS
Negative life events	2.69	(1.75)	2.63	(1.78)	0.3	NS
Personal resources						
Self-regard	25.26	(7.08)	27.67	(6.94)	-3.9	< 0.001
Mastery	2.59	(0.43)	2.60	(0.40)	-0.2	NS
Mental health						
Global Severity Index	0.81	(0.47)	0.66	(0.38)	3.8	< 0.001
Physical health						
Perceived health	2.60	(0.62)	2.85	(0.50)	-5.2	< 0.001
Sick days (log)	1.90	(1.43)	1.47	(1.25)	3.3	< 0.001
Social resources	N	(%)	N	(%)	χ^2 *	P
Social support						
High	157	(67.7)	129	(55.6)	6.5	< 0.05
Low	75	(32.3)	103	(44.4)		

† Matched pairs, two-tailed t test.
 * McNemar text (χ^2).

health and sick days. Similarly, except for the relationship between self-regard and perceived health ($r = 0.30$ for evacuees and 0.24 for

controls), the moderators were significantly related only to the GSI. Finally, we performed a series of z tests to examine differences between

Table 3. Pearson correlation coefficients between the independent variables and the three health variables for evacuees and controls (N = 232 pairs)

	SCL-90-R-GSI		Perceived health		Sick days	
	Evacuees	Controls	Evacuees	Controls	Evacuees	Controls
Dependent variables						
SCL-90-R-GSI	1.00	1.00	-0.32***	-0.15*	0.28***	0.16*
Perceived health			1.00	1.00	-0.31***	-0.15*
Background						
Age	0.06	-0.02	-0.10	-0.21***	0.11	-0.13
Technical School grad	0.05	0.05	-0.06	-0.02	0.12	0.07
College graduate	-0.09	0.11	0.08	-0.00	-0.06	0.12*
Mother working	-0.19**	0.01	0.23***	0.04	0.00	0.12
Body Mass Index	0.19**	-0.07	-0.23***	-0.05	0.26***	0.05
Smoking	0.03	0.14*	-0.09	0.09	-0.00	0.02
Early life traumas	-0.02	0.21***	0.07	0.03	-0.14*	0.03
Lifetime depression	0.17**	0.20**	-0.07	0.08	0.10	-0.07
Stress						
Economic deprivation	0.23***	0.21***	-0.06	-0.12	0.02	0.07
Lack basic necessities	0.19**	0.26***	-0.13*	-0.08	0.03	0.07
Lack economic skills	0.01	0.11	0.07	-0.05	-0.14*	0.08
Marital dissatisfaction	0.31***	0.33***	0.01	-0.01	-0.08	0.01
Social isolation	0.30***	0.32***	0.12	-0.11	0.02	0.02
Negative life events	0.06	0.33***	0.00	-0.05	0.05	0.02
Moderators						
Self-regard	-0.43***	-0.43***	0.30***	0.24***	-0.12	-0.02
Mastery	-0.28***	-0.21***	0.04	0.07	-0.08	0.04
Social support	-0.22***	-0.16*	0.12	0.05	-0.05	0.01

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

the correlation coefficients for evacuees relative to controls and found no statistically significant differences for any of the correlation pairs, using a Bonferroni correction ($P < 0.05/54 = 0.001$).

Multivariate analysis

We first examined the relationship of the demographic, stress, and moderator variables to each of the outcomes in a series of regression analyses (Table 4). Overall, as expected from the bivariate correlations, the independent variables did much better explaining variation in the GSI than for either of the physical health variables. With respect to the GSI, the background variables that remained significant were not working outside the home and having a history of depression (Model 1). Adding evacuee status and the six stress measures improved the model, with all but one of the variables (economic skills) being significantly related to the GSI (Model 2). Finally, when the stress moderators were added (Model 3), both lower self-regard and lower mastery were related to higher GSI scores. Model 3 also revealed that greater education, higher BMI, lifetime depression,

evacuee status, higher marital dissatisfaction, greater social isolation, and more life events were associated with increased GSI scores, while working and perceiving less economic skills were associated with lower scores.

Turning to perceived health, age and employment status were significantly related to this outcome in Model 1. Introducing the stress variables did not improve the model, with only evacuee status and lack of basic necessities achieving statistical significance (Model 2). Finally, self-regard was the only significant moderator variable (Model 3). For sick days, technical school graduate and BMI were the only statistically significant background variables (Model 1). Adding the stress measures did not improve the model, with only evacuee status related to increased sick days (Model 2). In Model 3, only two variables, working and evacuee status, were statistically significant. Finally, for all three outcome measures, no significant interactions between perceived stress and the moderators were detected (data not shown).

Thus, group status remained statistically significant even after adjusting for background

Table 4. *Unstandardized coefficients for background, stress, and moderator variables predicting mental and physical health outcomes*

Predictors	Global Severity Index			Perceived health			Sick days		
	Model 1 b (S.E.)	Model 2 b (S.E.)	Model 3 b (S.E.)	Model 1 b (S.E.)	Model 2 b (S.E.)	Model 3 b (S.E.)	Model 1 b (S.E.)	Model 2 b (S.E.)	Model 3 b (S.E.)
Background									
Age	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	-0.02 (0.01)***	-0.02 (0.01)***	-0.02 (0.01)**	0.00 (0.01)	-0.01 (0.01)	0.01 (0.01)
Tech School	0.04 (0.04)	0.05 (0.04)	0.09 (0.04)*	0.00 (0.06)	-0.00 (0.06)	-0.03 (0.05)	0.32 (0.13)*	0.32 (0.13)*	0.35 (0.13)**
College grad	0.00 (0.05)	0.06 (0.05)	0.12 (0.04)**	0.07 (0.07)	0.04 (0.07)	-0.01 (0.07)	0.16 (0.16)	0.19 (0.17)	0.24 (0.17)
Working	-0.13 (0.04)**	-0.11 (0.04)**	-0.10 (0.03)**	0.26 (0.05)***	0.22 (0.05)***	0.21 (0.05)***	0.06 (0.13)	0.14 (0.13)	0.15 (0.13)
BMI	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)**	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	0.04 (0.01)**	0.03 (0.01)*	0.03 (0.01)**
Smoking	0.06 (0.05)	0.05 (0.05)	0.04 (0.04)	0.02 (0.07)	-0.00 (0.07)	-0.02 (0.06)	0.07 (0.16)	0.10 (0.16)	0.09 (0.16)
Early trauma	0.03 (0.02)	0.01 (0.02)	0.02 (0.02)	0.05 (0.03)	0.05 (0.03)	0.04 (0.03)	-0.06 (0.07)	-0.06 (0.07)	-0.05 (0.07)
Depression	0.22 (0.04)***	0.13 (0.04)***	0.09 (0.03)**	-0.08 (0.05)	-0.04 (0.05)	0.00 (0.05)	0.22 (0.12)	0.17 (0.13)	0.14 (0.13)
Stress									
Group		0.15 (0.04)***	0.10 (0.04)**		-0.19 (0.05)***	-0.13 (0.05)*		0.39 (0.13)**	0.33 (0.13)*
Econ depriv		0.01 (0.01)*	0.00 (0.01)		-0.01 (0.01)	-0.00 (0.01)		0.01 (0.02)	-0.00 (0.02)
Lack basics		0.04 (0.01)**	0.03 (0.01)		-0.05 (0.02)*	-0.04 (0.02)		0.08 (0.05)	0.07 (0.05)
Lack ec sk		-0.02 (0.01)	-0.03 (0.01)**		0.04 (0.02)	0.05 (0.02)*		-0.08 (0.05)	-0.09 (0.05)
Marital dissat		0.01 (0.00)***	0.01 (0.00)***		0.00 (0.00)	0.01 (0.00)		-0.02 (0.01)	-0.02 (0.01)
Soc isolation		0.09 (0.02)***	0.09 (0.02)***		-0.03 (0.03)	-0.02 (0.03)		0.03 (0.06)	0.02 (0.07)
Life events		0.03 (0.01)**	0.03 (0.01)**		-0.01 (0.01)	0.01 (0.01)		0.05 (0.04)	0.05 (0.04)
Moderators									
Self-regard			-0.02 (0.00)***			0.02 (0.00)***			-0.02 (0.01)
Mastery			-0.11 (0.04)**			0.04 (0.06)			-0.17 (0.16)
Soc. support			-0.03 (0.04)			-0.00 (0.05)			0.03 (0.13)
Intercept	0.43	-0.14	0.98	3.52	3.70	2.78	0.27	0.04	1.67
-2log L	642.4	566.7	498.9	914.1	934.7	914.8	1831.8	1846.8	1853.3

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

characteristics, other sources of stress, and the stress moderators, indicating that evacuees perceived their mental and physical health more negatively. As a final test of whether evacuee mothers were more vulnerable than controls to the other stressors examined in the study, we conducted eighteen individually-tailored regression analyses in which, after adjusting for the background characteristics, we introduced group membership, one additional stressor (i.e. Economic Deprivation, Lack of Basic Necessities, Lack of Economic Skills, Marital Dissatisfaction, Social Isolation, or Negative Life Events) and the interaction between group membership and the stressor. Thus, 18 separate analyses were performed (three dependent variables times six non-disaster stressors). Given the problem of detecting interactions within multiple regression (McClelland & Judd, 1993), these models maximized the possibility of finding a statistically significant interaction effect. It is noteworthy that, after applying a Bonferroni correction, none of the interaction terms reached statistical significance for any of the three dependent measures.

DISCUSSION

This study provided further confirmation for the adverse psychological consequences of the Chernobyl accident. A large sample of mothers of young children who were evacuated to Kyiv were more distressed and perceived their physical health as poorer than did the controls. However, they did not report greater stress in their lives from other environmental sources, and they were no more reactive to these stressors than the controls.

Beyond examining the continued impact of the accident and evacuation, our primary aim was to assess in a comprehensive fashion the multiple stressors experienced by these women. One question we addressed was whether the evacuee mothers reported more chronic strains, acute life events, and marital problems than controls. Only small differences were observed. Even without such differences, the evacuees could still have been more vulnerable to the effects of these stresses. However, our results failed to support this contention in our sample.

The adverse psychological consequences of the Chernobyl accident have been demonstrated

in other samples (e.g. Ginzburg 1993; Havenaar *et al.* 1996, 1997*a, b*). In a sample living in a contaminated area of Belarus, Havenaar *et al.* (1996) found that 6 years after the disaster, 35.8% of the respondents had a DSM-III-R psychiatric disorder. Only 2.4% met criteria for PTSD, and in all cases, the exposure was an event other than Chernobyl. Their results also showed that women (especially mothers of young children) and the elderly were more vulnerable to the effects of the disaster than men or younger adults.

Another important finding from the Havenaar *et al.* research programme was that the actual physical health of the population had not been directly affected by exposure to radiation and psychosocial stress from Chernobyl, but people from affected areas had significantly higher anxiety levels, health service utilization, and illness behaviour, than a comparison group from an unaffected area (Havenaar *et al.* 1996, 1997*a, b*). Our study added in a consideration of other negative events or chronic strains, but they did not appear to heighten the vulnerability of the Chernobyl sample.

On the other hand, our analyses indicated that people's perceptions of other aspects of the post-disaster environment had an impact on their long-term mental health. Chronic economic and interpersonal strains are an extra burden of stress for people already dealing with the consequences of a community-wide disaster. Shortages of basic food and housing, a characteristic of the post-Soviet Ukraine, could affect both mental and physical health. These stressors, however, had a much weaker relationship to perceived physical health or number of sick days.

It was interesting that increased lack of economic skills was associated not just with distress but also with perceived physical health. This result is compatible with the view that perceptions of the post-disaster Ukrainian social context had an impact on post-disaster mental and physical health, although this effect was not as strong as perceptions about the Chernobyl nuclear power plant disaster itself. This result contrasts with the findings by Dew *et al.* (1987), who showed that women whose husbands were unemployed during a severe recession in Pennsylvania had more psychological symptoms than a comparable group of women who were exposed

to the Three Mile Island nuclear power plant accident. The economic environment played a much more significant role in their worse mental health.

Finally, there was no support for the hypothesis that the psychosocial resources evaluated in our study moderated the impact of stress. Thus, the results were more consistent with the additive burden model (Dohrenwend & Dohrenwend, 1981) in that exposure to Chernobyl, social and economic strains, and negative life events independently explained variation in mental health. None of the current stressors was enhanced by exposure to Chernobyl, and none of the social resource variables moderated the effect of Chernobyl on mental and physical health.

Limitations

The present study results should be viewed in light of its limitations. These include: (1) a restricted sample of mothers, rather than a general sample of evacuees; (2) evacuees who came to Kyiv, rather than a random sample of all people evacuated from the contaminated area around the plant; (3) use of Western measures, which have good reliability, but for which the validity has not been assessed; (4) no pre-disaster measures of the respondents' mental or physical well-being. As with all cross-sectional designs, we also cannot exclude the possibility that mental and physical problems affected the reporting of marital stress, economic hardship and negative life events, rather than the reverse. Although both theoretical and empirical reports suggest that stress leads to distress (e.g. House *et al.* 1988), it is important to emphasize the need for longitudinal research to clarify the causal direction of the relationships reported here and the long-term impact of community-wide disasters for mental and physical health (Green, 1995).

We found no difference between the groups on a number of perceived stressful events and none of the interaction models achieved statistical significance. Perception bias, therefore, does not appear to be a factor influencing our results. Our measures of economic strain (lack of basic necessities and economic skills) have not been employed extensively outside of Ukraine. If future research confirms their validity and reliability in other settings, they appear to be

very useful for assessing the perceived impact of larger economic conditions on the lives of individuals in other countries. Finally, our sample of evacuees was composed of a subgroup of mothers most of whom ignored advice about getting an abortion. This fact may have unknown consequences for the analyses. Thus, the results should be treated with some caution.

A strength of the study is that it incorporated background, stress, and moderator factors in a single analysis and assessed their effects on both mental and self-reported physical health using a matched pairs design. As noted earlier, the clearest findings in the disaster literature are that women and people with pre-existing physical and mental health problems suffer from PTSD, depression, and psychosomatic symptoms in much greater numbers than men or people without a pre-existing problem (McFarlane, 1989; Rubonis & Bickman, 1991; Palinkas *et al.* 1993*a, b*). In a series of studies of firefighters exposed to an Australian bushfire, for example, McFarlane (1987, 1988, 1989) showed that pre-disaster psychopathology was a stronger predictor of post-disaster symptoms than exposure. In the current study, few of the demographic factors included in the study were significantly related to mental or physical health. However, the findings on employment outside the home were consistent with previous US studies, showing that working women have lower distress and higher perceived health compared to non-working women (Thoits, 1995).

The elevated rate of distress in evacuees *versus* controls was significant even after adjusting for potent risk factors, such as education, lifetime depression and smoking, stressors such as marital dissatisfaction, lack of basic necessities, recent negative life events, and moderators such as self-regard, mastery, and social support. Thus, the higher levels of psychological problems and lower perceived health exhibited by evacuees cannot be explained by the bleak economic conditions of Ukraine or by differences in risk factors. The evacuees experienced a number of disaster-related traumas, including exposure to radiation, stress from relocation and integration into life in Kyiv, and persistent worries about their own health and the health of their children. In many ways, their lives have been irrevocably affected by the events emanating from Chernobyl (Bromet *et al.* 2000).

Disasters that disrupt familial and community support systems and prevent the enactment of valued roles should affect psychological health more negatively than those that leave such support systems relatively intact (Freedly *et al.* 1992, 1994; Palinkas *et al.* 1993*a, b*; Kaniasty & Norris, 1996; Kunovich & Hodson, 1999). In their study of the consequences of the Exxon Valdez oil spill on people living in communities along Prince William Sound, for example, Palinkas *et al.* (1993*a, b*) found that the spill itself was not particularly life threatening. The spill and subsequent clean-up did, however, disrupt subsistence food production (e.g. fishing), strained family and community relationships, and increased social inequality, all of which led to increased social tensions, drinking, and domestic conflicts. Individuals living in communities most affected by these changes also reported greater depression, PTSD and anxiety symptoms. Future research should pay particular attention to the disruption of values, roles and social relationships.

The results of this study support Green (1995) and other researchers (e.g. Erikson, 1976) who argue that community-wide disasters, especially technological ones, can have significant long-term effects on survivors' mental and perceived physical health. Our results also support and extend the work of Havenaar *et al.* (1996, 1997*a, b*), as well as other studies of Chernobyl survivors (e.g. Vinamäki *et al.* 1995), in finding significant consequences for psychological and physical well-being several years after the Chernobyl accident even after taking pre- and post-disaster factors into account.

Future studies need to disentangle the web of stress from Chernobyl, including aspects of the evacuation experience, resettlement in Kyiv, and the disruption of social ties to further clarify the effects of this complex event. In their study of victims of Hurricane Andrew, Riad & Norris (1996) found that staying in relocation shelters or with relatives for as little as 1 week increased psychological distress. Higher stress was especially evident for victims who were never allowed to return to their communities. Freedly *et al.* (1992, 1994) also showed that the greater the victims' resource loss, as measured by loss of objects (e.g. car or home), social roles (e.g. work), personal characteristics (e.g. sense of optimism) and energy (e.g. money, time), the

greater their psychological distress and difficulty in adjusting to the post-disaster environment. In our future research, we plan to examine these types of losses in our sample of evacuee mothers and their relationship to mental and physical health.

In conclusion, the Chernobyl disaster had a significant impact on the mothers of young children who had been living near the nuclear power plant. However, it does not appear that they were subsequently more vulnerable to the socio-economic and social stresses that they later endured.

APPENDIX: ITEMS IN SCALES DEVELOPED IN UKRAINE

Financial deprivation (0, not true; 1, somewhat true; 2, very true)

You don't have enough money to buy the things your family needs

Your rent is too much

You don't have enough money to take vacations

You don't have enough money to improve your living situation

You don't have enough money to feed your children well

You don't get paid enough for what you do

Lack basic necessities (1, lacking; 0, not lacking)

Necessary clothes

Good housing

Necessary furniture

Opportunity to buy the most basic food

Lack economic skills (1, lacking; 0, not lacking)

Modern economic knowledge

Modern political knowledge

Legal protection in defending your rights

Skills to live under new social conditions

This research was supported by Grant No. MH51947 from the National Institute of Mental Health. We would like to thank Nicolai Churilov, Director of SOCIS-Gallop in Kyiv and the field staff for conducting the data collection and Andrei Gorbachik of Kyiv Taras Shevchenko University for organizing the data management system. We are very grateful to Ints Calitis and Sergey Fedorinchik for introducing our project to key professional and parent organizations in Kyiv. Lynda Geller, Elena Polenova, Inna Korchack and Lina Jandorf from the State University

of New York at Stony Brook provided important support for the study. We also want to thank Dr Johan Havenaar for his insightful conceptual comments and Joseph E. Schwartz and Chenshu Zhang for their assistance with the analysis. Most of all, we are grateful to the children and mothers who participated in this study.

REFERENCES

- Bard, D., Verger, P. & Hubert, P. (1997). Chernobyl, 10 years after: health consequences. *Epidemiologic Reviews* **19**, 187–204.
- Bobak, M. & Marmot, M. (1996). East–West mortality divide and its potential explanations: proposed research agenda. *British Medical Journal* **312**, 421–425.
- Braithwaite, J. & Hoopengardner, T. (1997) Who are Ukraine's poor? In: *Ukraine: Accelerating the Transition to Market* (ed. P. K. Cornelius and P. Lenain), pp. 61–80. International Monetary Fund, Washington, DC.
- Brewin, C. R., Andrews, B. & Valentine, J. D. (2000). Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *Journal of Consulting and Clinical Psychology* **68**, 748–766.
- Bromet, E. J. (1995). Methodological issues in designing research on community-wide disasters with special reference to Chernobyl. In *Extreme Stress and Communities: Impact and Intervention* (ed. S. E. Hobfoll and M. W. de Vries), pp. 267–282. Kluwer Academic Publishers: Netherlands.
- Bromet, E. J. & Dew, M. A. (1995). Review of psychiatric epidemiologic research on disasters. *Epidemiologic Reviews* **17**, 113–119.
- Bromet, E. J., Parkinson, D. K. & Dunn, L. O. (1990). Long-term mental health consequences of the accident at Three Mile Island. *International Journal of Mental Health* **19**, 48–60.
- Bromet, E. J., Goldgaber, D., Carlson, G., Panina, N., Golovakha, E., Gluzman, S. F., Gilbert, T., Gluzman, D., Lyubsky, S. & Schwartz, J. E. (2000). Children's well-being 11 years after the Chernobyl catastrophe. *Archives of General Psychiatry* **57**, 563–571.
- Buzunov, V. A., Strapko, N. P., Pirogova, E. A., Krasnikova, L. I., Bugayev, V. N., Korol, N. A., Treskunova, T. V., Ledoschuk, B. A., Gudzenko, N. A., Bomko, E. I., Bobyleva, O. A. & Kartushin, G. I. (1996). Epidemiological survey of the medical consequences of the Chernobyl accident in Ukraine. *World Health Statistical Quarterly* **49**, 4–6.
- Bryk, A. S. & Raudenbush, S. W. (1992). *Hierarchical Linear Models*. Sage Publications: Newbury Park, CA.
- Chinkina, O. V. (1991). Psychological characteristics of patients exposed to accidental irradiation at the Chernobyl atomic-power station. In *The Medical Basis of Radiation-Accident Preparedness III: The Psychological Perspective* (ed. R. C. Ricks, M. E. Berger and F. M. O'Hara Jr.), pp. 93–103. Elsevier: New York.
- Derogatis, L. R. (1983). *Symptom Checklist-90-Revised: Administration, Scoring, and Procedures Manual-II*. Clinical Psychometric Research: Towson, MD.
- Dew, M. A., Bromet, E. J. & Schulberg, H. C. (1987). A comparative analysis of two community stressors' long-term mental health effects. *American Journal of Community Psychology* **15**, 167–183.
- Dohrenwend, B. P. (1988). Overview of evidence for the importance of adverse environmental conditions in causing psychiatric disorders. In *Adversity, Stress, and Psychopathology* (ed. B. P. Dohrenwend), pp. 523–538. Oxford University Press: New York.
- Dohrenwend, B. S. & Dohrenwend, B. P. (1981). Life stress and illness: formulation of the issues. In *Stressful Life Events and Their Contexts* (ed. B. S. Dohrenwend and B. P. Dohrenwend), pp. 1–27. Podist: New York.
- Edwards, M. L. K. (1998). An interdisciplinary perspective on disasters and stress: the promise of an ecological framework. *Sociological Forum* **13**, 115–132.
- Erikson, K. T. (1976). *Everything in Its Path*. Simon and Schuster: New York.
- Fallon, P., Hoopengardner, T. & Libanova, E. (1997). Poverty and the Ukrainian labor market. In *Ukraine: Accelerating the Transition to Market* (ed. P. K. Cornelius and P. Lenain), pp. 81–96. International Monetary Fund: Washington, DC.
- Faris, R. E. L. & Dunham, H. W. (1939). *Mental Disorders in Urban Areas*. Häfner: New York.
- Freedy, J. R., Shaw, D. L., Jarrell, M. P. & Masters, C. R. (1992). Towards an understanding of the psychological impact of natural disasters: an application of the conservation resources stress model. *Journal of Traumatic Stress* **5**, 441–454.
- Freedy, J. R., Kilpatrick, D. G. & Resnick, H. S. (1993). Natural disasters and mental health: theory, assessment, and intervention. *Journal of Social Behavior and Personality* **8**, 49–103.
- Freedy, J. R., Saldin, M. E., Kilpatrick, D. G., Resnick, H. S. & Saunders, B. E. (1994). Understanding acute psychological distress following natural disaster. *Journal of Traumatic Stress* **7**, 257–273.
- Giel, R. (1998). Natural and human-made disasters. In *Adversity, Stress and Psychopathology* (ed. B. P. Dohrenwend), pp. 66–76. Oxford University Press: New York.
- Ginzburg, H. M. (1993). The psychological consequences of the Chernobyl accident—Findings from the international atomic energy agency study. *Public Health Reports* **108**, 184–192.
- Gleser, G. C., Green, B. L. & Winget, C. (1981). *Prolonged Psychosocial Effects of Disaster*. Academic Press: New York.
- Green, B. L. (1995). Long-term consequences of disasters. In *Extreme Stress and Communities: Impact and Intervention* (ed. S. E. Hobfoll and M. W. de Vries), pp. 307–324. Kluwer Academic Publishers: Netherlands.
- Havenaar, J. M. & van den Brink, W. (1997). Psychological factors affecting health after toxicological disasters. *Clinical Psychology Review* **17**, 359–374.
- Havenaar, J. M., van den Brink, W., van den Bout, J., Kasyanenko, A. P., Poelijoe, N. W., Wohlfarth, T. & Meijler-Iljina, L. I. (1996). Mental health problems in the Gomel region (Belarus): an analysis of risk factors in an area affected by the Chernobyl disaster. *Psychological Medicine* **26**, 845–855.
- Havenaar, J. M., Rummyantzeva, G. M., van den Brink, W., Poelijoe, N. W., van den Bout, J., Engeland, H. V. & Koeter, M. W. J. (1997a). Long-term mental health effects of the Chernobyl disaster: an epidemiologic survey in two former Soviet regions. *American Journal of Psychiatry* **154**, 1605–1607.
- Havenaar, J. M., Rummyantzeva, G., Kasyanenko, A., Kaasjager, K., Westermann, A., van den Brink, W., van den Bout, J. & Sevelkoul, J. (1997b). Health effects of the Chernobyl disaster: illness or illness behavior? A comparative general health survey in two former Soviet regions. *Environmental Health Perspective* **105** supplement 6), 1533–1537.
- Horowitz, M., Sonneborn, D., Sugahara, C. & Maercker, A. (1996). Self-regard: a new measure. *American Journal of Psychiatry* **153**, 382–385.
- House, J. S. & Mortimer, J. (1990). Social structure and the individual: emerging themes and new directions. *Social Psychology Quarterly* **53**, 71–80.
- House, J. S., Landis, K. R. & Umberson, D. (1988). Social relationships and health. *Science* **241**, 540–545.
- Kaniasty, K. & Norris, F. (1993). A test of the support deterioration model in the context of natural disaster. *Journal of Personality and Social Psychology* **64**, 395–408.
- Kaniasty, K. & Norris, F. (1995). In search of altruistic community: patterns of social support mobilization following hurricane Hugo. *American Journal of Community Psychology* **23**, 1995.
- Kessler, R. C., Price, R. H. & Wortman, C. B. (1985). Social factors in psychopathology: stress, social support and coping processes. *Annual Review of Psychology* **36**, 531–572.
- Kunovich, R. M. & Hodson, R. (1999). Civil War, social integration, and mental health in Croatia. *Journal of Health and Social Behavior* **40**, 323–343.
- Littell, R. C., Milliken, G. A., Stroup, W. W. & Wolfinger, R. D.

- (1996). *SAS System for Mixed Models*. SAS Institute, Inc.: Cary, NC.
- McClelland, G. H. & Judd, C. H. (1993). Statistical difficulties of detecting interactions and moderator effects. *Psychological Bulletin* **114**, 376–390.
- McFarlane, A. C. (1987). Life events and psychiatric disorder: the role of a natural disaster. *British Journal of Psychiatry* **151**, 362–367.
- McFarlane, A. C. (1988). Aetiology of post-traumatic stress disorders following a natural disaster. *British Journal of Psychiatry* **152**, 116–121.
- McFarlane, A. C. (1989). The aetiology of post-traumatic morbidity: predisposing, precipitating and perpetuating factor. *British Journal of Psychiatry* **154**, 221–228.
- Murthy, R. S. (1990). Bhopal. *International Journal of Mental Health* **19**, 30–35.
- Norris, F. H. & Uhl, G. A. (1993). Chronic stress as a mediator of acute stress: the case of hurricane Hugo. *Journal of Applied Social Psychology* **23**, 1263–1284.
- Palinkas, L. A., Downs, M. A., Petterson, J. S. & Russell, J. (1993a). Social, cultural, and psychological impacts of the Exxon Valdez oil spill. *Human Organization* **52**, 1–13.
- Palinkas, L. A., Petterson, J. S., Russell, J. & Downs, M. A. (1993b). Community patterns of psychiatric disorder after the Exxon Valdez oil spill. *American Journal of Psychiatry* **150**, 1517–1523.
- Pearlin, L. I. & Schooler, C. (1978). The structure of coping. *Journal of Health and Social Behavior* **19**, 2–21.
- Pearlin, L., Lieberman, M., Menaghan, E. & Mullen, J. T. (1981). The stress process. *Journal of Health and Social Behavior* **19**, 2–21.
- Phelan, J., Schwartz, J. E., Bromet, E. J., Dew, M. A., Parkinson, D. K., Schulberg, H. C., Dunn, L. O., Blane, H. & Curtis, E. C. (1991). Work stress, family stress, and depression in professional and managerial employees. *Psychological Medicine* **21**, 999–1012.
- Riad, J. K. & Norris, F. H. (1996). The influence of relocation on the environmental, social, and psychological stress experienced by disaster victims. *Environment and Behavior* **28**, 163–182.
- Rubonis, A. V. & Bickman, L. (1991). Psychological impairment in the wake of disaster: the disaster–psychopathology relationship. *Psychological Bulletin* **109**, 384–399.
- Singer, J. D. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. *Journal of Educational and Behavioral Statistics* **24**, 323–355.
- Spanier, G. (1976). Measuring dyadic adjustment: new scales for assessing the quality of marriage and similar dyads. *Journal of Marriage and the Family* **38**, 15–30.
- Spitzer, R. L., Williams, B. W., Gibbon, M. & First, M. (1992). The structured clinical interview for DSM-III-R (SCID). *Archives of General Psychiatry* **49**, 624–629.
- Tarabrina, N., Lazebnaya, E., Zelenova, M. & Lasko, N. (1996). Chernobyl clean-up workers' perception of radiation threat. *Radiation Protection Dosimetry* **68**, 251–255.
- Thoits, P. (1995). Stress, coping and social support processes: Where are we? What Next? *Journal of Health and Social Behavior* Extra Issue, 53–79.
- Turner, R. J. & Lloyd, D. A. (1995). Lifetime traumas and mental health: the significance of cumulative adversity. *Journal of Health and Social Behavior* **36**, 360–376.
- Turner, R. J., Wheaton, B. & Lloyd, D. A. (1995). The epidemiology of social stress. *American Sociological Review* **60**, 104–125.
- Viinamäki, H., Kumpusalo, E., Myllykangas, M., Salomaa, S., Kumpusalo, L., Kolmakov, S., Ilchenko, I., Zhukowsky, G. & Nissinen, A. (1995). The Chernobyl accident and mental well being – a population study. *Acta Psychiatrica Scandinavica* **91**, 396–401.
- Warheit, G. J. (1988). Disasters and their mental health consequences: issues, findings, and future trends. In *Mental Health Response to Mass Emergencies* (ed. M. Lystad), pp. 3–21. Brunner/Mazel, Publishers: New York.
- Yen, I. H. & Syme, S. L. (1999). The social environment and health: a discussion of the epidemiological literature. *Annual Review of Public Health* **20**, 287–308.