

Somatic Symptoms in Women 11 Years after the Chernobyl Accident: Prevalence and Risk Factors

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Exposure to the Chernobyl nuclear power plant explosion resulted in widespread, persistent somatic complaints, but little is known about the nature and risk factors for these conditions. This study compares the health reports of 300 women evacuated to Kyiv from the contamination zone around the plant and 300 controls with a child in the same homeroom as the evacuees in 1997. The interview addressed somatic concerns, risk factors for poor health, and Chernobyl-related stress. Compared with controls, evacuees reported significantly more health problems and rated their health more poorly overall. These differences remained significant after controlling for demographic and clinical risk factors, including the tendency to amplify physical symptoms. Significantly more evacuees received a diagnosis of a Chernobyl-related illness by a local physician, believed that their health and their children's health had been adversely affected, and were positive for Chernobyl-induced post-traumatic stress disorder. After controlling for these Chernobyl stress variables, the differences in number of health problems commonly attributed to Chernobyl remained significant but differences in general health ratings did not. The perceptions of controls were similar to those of women in a national sample. The relationship between Chernobyl stress and illness was twice as strong in evacuees (odds ratio = 6.95) as in Kyiv controls (odds ratio = 3.34) and weakest in the national sample (odds ratio = 1.64). The results confirm the persistence and nonspecificity of the subjective medical consequences of Chernobyl and are consistent with the hypothesis that traumatic events exert their greatest negative impacts on health in vulnerable or disadvantaged groups. **Key words:** Chernobyl disaster, environmental exposure, epidemiology, female, health, risk factors, somatic symptoms, stress, subjective health, Ukraine. *Environ Health Perspect* 110(suppl 4):625–629 (2002).

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The Chernobyl nuclear power plant accident in northern Ukraine 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 and meltdown. Over the next 10 days, an area of about 1,000 km², containing many villages and farms, was heavily contaminated with plutonium, cesium, and radioactive iodine. An estimated 120,000 people were permanently evacuated. Pregnant women were advised to have abortions without being given a clear explanation, and the evacuation process itself was chaotic. Kyiv, located about 90 km south of Chernobyl, received much less contamination than areas north of the plant and was one of the cities where large numbers of evacuees were resettled.

Except for an increase in thyroid cancer in children and adolescents, no confirmed effects on specific aspects of health have yet been reported (1). However, as has occurred after similar events, such as the Three Mile Island (TMI) nuclear power plant accident near Harrisburg, Pennsylvania USA, rumors proliferated about adverse health effects, and evacuees and inhabitants of contaminated regions reported excess morbidity and medical service use (2). In contrast to the growing understanding in the West of the relationship of extreme stress to physical health (3), the

somatic symptoms manifested by evacuees and inhabitants of the contaminated regions were dismissed locally with diagnoses such as “radiophobia” (1,4,5) and vegetative dystonia, also known as vascular dystonia, the official diagnosis given for symptom clusters involving headache, fatigue, dizziness, changes in blood pressure, and abdominal pain believed to stem from Chernobyl-related worry (6).

Basic questions regarding the nature, extent, and specific risk factors for subjective health sequelae after the Chernobyl accident remain unanswered (1). The study described here attempts to fill this gap using data from the Stony Brook–Kyiv Chernobyl Project, a collaboration between U.S. investigators and independent scientists in Ukraine, in which health and mental health interviews were conducted in 1997 with mothers of young children evacuated to Kyiv from the 30-km exclusion zone, and with Kyiv controls. In this article, we compare the health reports of evacuee and control mothers and examine the relationships between Chernobyl stress perceptions and health in each group. We further test whether the differences in health problems between evacuees and Kyiv controls can be explained by demographic characteristics, general clinical risk factors, and/or beliefs about the impact of the accident. One limitation of our study design is that the Kyiv

controls were also adversely affected by the accident. To verify that the Kyiv controls held views that were similar to those of the general population, we included a subset of items in a national survey conducted in November 1998 by the Kiev International Institute of Sociology (KIIS; see below). This survey drew a national probability sample of 1,606 adults, among whom 276 were mothers in the same age range as those in the study sample. In this article, we compare their self-ratings of health and attitudes toward Chernobyl with those of the Kyiv controls as well as evaluate the relationship between Chernobyl stress reports and perceived health in this sample.

Methods

Subjects and Design

The target group comprised families evacuated from the 30-km exclusion zone around the Chernobyl nuclear power plant with a child born between 1 February 1985 and 31 January 1987. Because no complete list of these evacuees existed, a sampling frame was created for the study by combining registrants on 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. [For more details, see Bromet et al. (7).] Of 721 families with a child in the target age

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The original Ukrainian spellings of Chernobyl and Kyiv are used throughout this article.

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range, 693 resided in Kyiv in 1997 when the fieldwork took place. The list of families was randomized, and families were selected sequentially until 300 interviews were completed.

Most of the families were from Pripyat (80.7%), a town built near Chornobyl to house the workers and their families; the remaining families were from small villages and towns within the 30-km zone (19.3%). The majority reported either being outdoors or having their windows open at various times of the day on 26 or 27 April (94.8% of village families, 86.8% of Pripyat families). All but four of the families were evacuated in April–May 1986, and 85.9% arrived in Kyiv that same year.

The control group comprised gender-matched classmates and their mothers. Most of the controls (87.0%) were in Kyiv when the accident occurred. The response rates were 92% for the evacuees (300 of 326) and 85% for the controls (300 of 352).

The median number of children was two, and the median number of household members was four in the separate Pripyat, village, and Kyiv groups.

The study was conducted in two phases. In the first phase, the women (and their children) were interviewed in their apartments after providing written informed consent. The interviewers were employed by SOCIS-Gallop, an independent survey research firm in Kyiv, and were trained over a 1-week period in the instruments for the study. The fieldwork, conducted between February and May 1997, was closely monitored by random telephone recalls with 10% of the respondents, weekly individual supervisory meetings, and random home visits by the American investigators to evaluate the quality of the work. There was no evidence of any procedural problems. The second phase took place at a clinic where the children were given physical examinations and their mothers completed a family health questionnaire ($n = 275$ evacuees and 272 controls completed phase 2).

Measures

Standard translation and back-translation procedures were followed for all measures. American instruments were translated into Russian and Ukrainian, and Russian measures were translated into English and Ukrainian. Most of the interviews were conducted in Russian (81.4% of evacuees and 79.1% of controls). The internal consistency of the measures was comparable with that reported for U.S. populations.

Perceived health. The assessment battery contained a chronic disease checklist, general appraisals about health status, and a somatization scale. The chronic disease checklist was included in the family health questionnaire administered during phase 2. Two indices

were created for the present analysis: number of nonspecific conditions that were not routinely attributed to Chornobyl (chronic colds, high blood pressure, heart disease, kidney disease, and gynecologic diseases), and chronic conditions that were widely attributed to Chornobyl (vegetative dystonia, chronic fatigue, memory problems, thyroid disease, trouble with immune system). Following the criteria for multisomatoform disorder (8), high symptom impairment was defined as three or more symptoms. Other measures (included in phase 1) were the number of sick days or days spent in bed because of illness in the last year; the Medical Outcomes Study (MOS) self-rating of health (9) on a 5-point scale (excellent, very good, moderate, bad, very bad); the 12-item somatization subscale of the *Symptom Checklist-90-Revised (SCL-90-R)* (10,11), rated 0 (not present in the last week) to 4 (extremely bothered); and the Illness Worry Questionnaire (12), a nine-item additive questionnaire rated yes or no. The health variables were moderately intercorrelated. The range was $r = 0.20$ (general symptoms with illness worry) to $r = 0.46$ (somatization with self-rating of health). The median correlation coefficient was 0.32, and only one other correlation was above 0.40 (somatization with Chornobyl conditions; $r = 0.44$).

Demographic and clinical risk factors. The demographic variables included age (median = 37; range = 28–55 years), education, employment status (working full time or part time vs. not working outside the home), and perceived standard of living, rated on a scale from 0 (lowest) to 10 (highest). The clinical risk factors included body mass index (BMI, weight in kilograms divided by the square of height in meters; overweight defined as > 29); current smoker; lifetime depression, based on a modified version (13) of the Structured Clinical Interview for the *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed. rev.) (14); and the five-item Illness Amplification scale (15), rated 0 = did not bother me to 4 = bothered me very much.

Chornobyl concerns. The last section of the phase 1 interview focused on concerns about Chornobyl, including health issues, post-traumatic stress responses, behavioral changes, and general risk perceptions. Five health issues were included in this report: whether a doctor told the respondent that she had a Chornobyl-related health problem; whether the respondent believed that her own or her children's health were very much affected by Chornobyl (vs. somewhat or no; fewer than 10% said no to these questions); whether she thought that the health of future generations would be adversely affected (very vs. somewhat or no); and whether the respondent was pregnant at the time of the accident. To assess post-traumatic stress, a

proxy post-traumatic stress disorder (PTSD) measure was created from the 22-item version of the Impact of Events scale (16) administered with the instruction to indicate level of distress regarding Chornobyl over the past month. Proxy PTSD was defined as endorsing the requisite symptoms for a *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.) (17) diagnosis (e.g., at least one intrusion, three avoidance, and two hyperarousal symptoms). Behavioral changes were assessed by whether the respondent stopped picking mushrooms or stopped walking in the forest near Kyiv because of fear about radiation exposure. Finally, general risk perception was assessed by whether the respondent believed that Kyiv was currently a safe place to live (yes or no); whether she believed that the consequences of the accident are worse than she feared versus the same or not as bad; and a seven-item Distrust in Authorities scale created for the study, in which respondents rated their level of distrust (1 = distrust completely to 5 = trust completely) in government, scientists studying Chornobyl consequences, doctors, Chornobyl plant management, foreign relief organizations, Ukrainian grassroots organizations helping with Chornobyl, and the media. The scale score represented the average rating.

National Survey

KIIS is an independent survey research organization modeled after the Institute for Survey Research at the University of Michigan.

KIIS periodically conducts national surveys and invites researchers from around the world to submit items. In the fall of 1998, we included 10 items in a national sample of 1,606 individuals 16 or more years of age. The data were obtained via face-to-face interview. The sampling design had four stages: *a*) random selection of cities and rural areas; *b*) random selection of postal districts within the selected population points; *c*) random selection of streets, buildings, and apartments inside each postal district to select respondents; and *d*) random selection of respondents within households. The response rate was 78%.

Of the 1,606 participants, 276 were mothers in the same age range (28–55 years) as the Chornobyl study participants. Half were interviewed in Russian and the others in Ukrainian. Only 5% were living in Kyiv. Our items were translated into Russian and Ukrainian by KIIS staff and back-translated into English by D. Goldgaber. The present analysis focuses on three key health and attitude items: self-rating of health (same scale as above), belief that health was very much affected by Chornobyl, and being diagnosed by a doctor with vascular dystonia (one of the items included in the Chornobyl health problems index).

Analytic Plan

Prevalence rates of the health indices were compared between the evacuees and controls. Unless indicated otherwise, continuous variables were dichotomized using a median split; cut points are specified in the tables. Univariate and multivariate logistic regression was used to model crude and adjusted odds ratios (ORs) of the health end points considered in this article. Independent variables were selected for inclusion in the multiple logistic regression if the difference between evacuees and controls was significant at $p < 0.001$.

Results

Comparison of Evacuees with Kyiv Controls

The evacuee mothers reported worse health than controls on all six measures (Table 1). The differences were particularly striking for the Chernobyl conditions, with one-third of evacuees versus fewer than 10% of Kyiv controls reporting three or more disorders. The only measure on which the differences failed to reach statistical significance was the Illness Worry scale. Overall, both groups perceived their health as rather poor, with close to 40% of evacuees and one-quarter of controls rating their health as bad or very bad.

Demographically, the evacuees were somewhat younger (median age, 37 years) than the controls (median age, 38 years), and fewer evacuees than controls graduated from university or worked outside the home ($p < 0.001$). The evacuees rated their standard of living as somewhat better than did the controls ($p < 0.05$). Although fewer evacuees were smokers, more of them had a high BMI and lifetime episodes of major depression (Table 2). The differences in illness amplification were particularly striking, with 60% of evacuees scoring above the median compared with 39% of controls.

We next examined whether the differences in perceived health remained significant after controlling for the four risk factors on which the groups differed at $p < 0.001$ (education, employment status, depression, and illness amplification). With two exceptions, the differences between evacuees and Kyiv controls remained statistically significant. Specifically, the adjusted ORs and 95% confidence intervals (95% CIs) were as follows: three or more Chernobyl conditions (OR = 4.56; 95% CI = 2.60–8.06); *SCL-90-R* somatization scale (OR = 1.85; 95% CI = 1.25–2.73); self-rating of health as bad (OR = 1.78; 95% CI = 1.19–2.68); and three or more general medical conditions (OR = 1.70; 95% CI = 1.04–2.80). The two exceptions were sick days (OR = 1.40; 95% CI = 0.97–2.03) and the Illness Worry scale (OR = 1.00; 95% CI = 0.68–1.46).

As expected, there were large and significant differences between the evacuees and controls in their perceptions about the legacy of Chernobyl (Table 3), especially regarding health issues. Significantly more evacuees than controls believed that Chernobyl very much affected their own and their child's health and the health of future generations. Similarly, evacuees were also more likely to indicate that the consequences of the accident were worse than they had feared. In addition, twice as many evacuees (18%) met proxy PTSD diagnostic criteria compared with controls (9.7%). On the other hand, when asked about behavioral issues (picking mushrooms, walking in the woods) and certain general attitudes (distrust in authorities, safety of living in Kyiv), the differences between the groups were not statistically significant. Similar proportions had been pregnant at the time of the accident.

Most important, 55% of evacuees compared with 19% of controls said yes to the question, "Did a doctor ever tell you that you had a Chernobyl-related health problem?" We note that in evacuees, receiving a Chernobyl-related diagnosis was not significantly related to demographic factors, smoking, or BMI. However, it was significantly associated with lifetime depression and illness amplification. Specifically, 52.1% of the evacuees who were told that they had a Chernobyl-related health problem met criteria for lifetime depression, compared with 39.7% who said no to this question (OR = 1.66; 95% CI = 1.04–2.62); 68.1% of evacuees reporting such a "diagnosis" scored high on illness amplification compared with

50.7% who said no (OR = 2.07; 95% CI = 1.30–3.32).

The stress perceptions that were most strongly related to the health variables were being diagnosed with a Chernobyl-related condition, beliefs that your health and your child's health were very much affected by Chernobyl, and proxy PTSD ($p < 0.001$). These relationships were stronger in evacuees than in controls. For example, 62.4% (183 of 133) of evacuees who believed that their health was very much affected by Chernobyl, compared with 19.3% (32 of 166) of women who thought their health was only somewhat or not affected, rated their general health as bad/very bad (OR = 6.95; 95% CI = 4.13–11.71). Among Kyiv controls, 43.1% (25 of 58) of women who believed that their health was very much affected and 18.5% (44 of 238) of those who thought their health was somewhat or not affected rated their health as bad/very bad (OR = 3.34; 95% CI = 1.81–61.7).

Not surprisingly, the stress indicators were strongly related to one another. Thus, in examining whether the differences in perceived health shown in Table 1 remained significant after controlling for Chernobyl stress, we computed separate logistic regression analyses for the three stress variables that most significantly ($p < 0.001$) differentiated between evacuees and controls. The group differences on somatization, Chernobyl health conditions, and sick days remained significant (adjusted ORs, $p < 0.05$). However, the adjusted ORs for self-rating of health and general medical conditions were not significant.

Table 1. Prevalence (%) of poor health in evacuees and controls.

Health indicators	Evacuees		Controls		Unadjusted OR (95% CI)
	Total	Prevalence (%)	Total	Prevalence (%)	
≥3 nonspecific chronic conditions	275	24.7	272	14.7	1.91 (1.24–2.94)**
≥3 Chernobyl-linked conditions	275	32.4	272	8.1	5.44 (3.29–9.00)***
≥7 sick days in past year	299	54.5	298	43.0	1.59 (1.15–2.20)**
Health bad or very bad	299	38.5	300	23.3	2.05 (1.44–2.93)***
High somatization (<i>SCL</i> > 1.25)	300	55.3	300	34.3	2.37 (1.70–3.29)***
High illness worry (score > 3)	300	46.3	300	39.0	1.35 (0.98–1.87)

** $p < 0.01$; *** $p < 0.001$.

Table 2. Differences between evacuees and controls in demographic and clinical risk factors.

Characteristics	Evacuees		Controls		Unadjusted OR (95% CI)
	Total	Rate (%)	Total	Rate (%)	
Demographic variables					
Age < 37 years	300	46.0	300	39.0	1.33 (0.96–1.84)
Not university graduate	300	86.3	299	73.2	2.31 (1.52–3.50)***
Not employed	300	39.0	297	20.2	2.53 (1.75–3.64)***
Low standard of living	300	38.7	300	46.7	0.72 (0.52–1.00)*
Clinical risk factor					
High BMI (>29)	300	35.3	300	29.0	1.34 (0.95–1.89)
Current smoker	300	14.0	300	21.0	0.61 (0.40–0.94)*
Lifetime depression	300	46.7	300	33.0	1.78 (1.28–2.47)***
High illness amplification (>0.86)	300	60.3	300	38.7	2.41 (1.73–3.34)***

* $p < 0.05$; *** $p < 0.001$.

Comparison of Kyiv Controls with Survey Respondents

To determine if Kyiv controls held views similar to those of the general population of Ukraine, we compared their responses to self-ratings of health and fears about Chernobyl with those from a national survey sample of mothers ($n = 276$) in the same age range. Similar distributions were found, with 23.3% of controls and 23.9% of survey respondents rating their health as bad or very bad (only one control and four survey respondents rated their health as excellent), 19.6% of controls and 22.1% of survey respondents believing that their health was very much affected by Chernobyl, and 27.6% of controls and 26.6% of survey respondents reporting a diagnosis of vascular dystony.

To determine whether the relationship between self-ratings of health and the belief that Chernobyl had very much affected health was similar, we performed the same contingency table analysis with the survey respondents as noted above for evacuees and controls. Although the two variables were strongly related in the latter two groups, they were not significantly associated in the survey respondents (Figure 1). That is, among survey respondents who believed that their health was very much affected, 31.6% (18 of 57) rated their health as bad or very bad; among those who thought their health was somewhat or not affected, 21.9% (48 of 219) rated their health as bad (OR = 1.64; 95% CI = 0.86–3.13).

Discussion

The results of this study indicate that 11 years after the explosion at Chernobyl, women with young children evacuated to Kyiv experienced substantially poorer health than did Kyiv

controls. The reports of the controls resembled those of women living in other parts of Ukraine. Increased morbidity was reflected in subjective perceptions of health status, higher rates of general as well as Chernobyl-specific medical conditions, bed disability days, and somatization symptoms. The high prevalence rates in the evacuees could not be explained by demographic and clinical risk factors, including the tendency to amplify physical symptoms. Although the evacuees were significantly more concerned with potential health effects of Chernobyl and were more often diagnosed by a local physician with a Chernobyl-related disease, adjusting for these stressors did not explain the differences between the groups on somatization, Chernobyl-linked health complaints, and sick days but did explain the differences in self-ratings of health and general medical conditions.

There have been numerous studies showing that individuals exposed to traumatic events are more likely to report poor health and excess morbidity (18). Havenaar et al. (19) concluded that subjective health reports associated with Chernobyl are linked to psychological stress. In fact, the relationship was strongest in the evacuees (OR = 6.95), half the size but still significant in the Kyiv controls (OR = 3.34), and weakest and nonsignificant in the national sample living outside Kyiv (OR = 1.64). These results are consistent with the hypothesis that traumatic events exert their greatest negative impact on health in vulnerable or disadvantaged groups (20).

A number of labels have been given to patients who believe that their physical symptoms are caused by an environmental exposure. For example, the term environmental somatization syndrome (ESS) has been suggested for patients presenting with dizziness, fatigue, palpitations, headache, and pain

attributed to an environmental or ecological exposure (21). In Ukraine, the diagnosis of radiophobia was given for a similar constellation of symptoms. This diagnosis had a negative impact, however, because it came to be seen as a pejorative dismissal of real psychological and physiological suffering. Although the same authors recommend that medical professionals avoid statements that foster a patient's belief in etiologic connections between disease and environment (21), labels such as ESS and radiophobia have precisely this effect. Thus, it is important, as Misao and colleagues (22) stated after the bombing of Hiroshima and Nagasaki, that physicians approach patients with compassion and empathy and, we would add, avoid using meaningless labels that will frustrate and anger the population affected by exposure, whether actual or perceived.

Although this study had several strengths, including the nature of the sample and the quality of the data collection, it also has some limitations. First, like the vast majority of trauma studies (18), the health information is based on self-report rather than independent physical examination. There is thus the potential for bias. However, by adjusting for level of illness amplification, we attempted to adjust for this bias. It is thus instructive that the differences between evacuees and controls remained significant. Second, we did not attempt to engage in dose reconstruction, which would have required a very detailed interview schedule (thus imposing an unjustifiable burden on our respondents), because the variability in doses in such a high-exposure area would be relatively low, and the focus of our research was not on the biological effects of radiation exposure. In this regard, it is important to note that recall bias is a serious problem for retrospective reports about exposure; Southwick et al. (23) showed that recall of exposure over time is both inconsistent and systematically associated with symptom reporting.

A third limitation relates to the cross-sectional design. It is not possible to determine whether the health reports are consequences of

Table 3. Differences between evacuees and controls in perceptions of Chernobyl concerns.

Chernobyl concern	Evacuees		Controls		Unadjusted OR (95% CI)
	Total	Rate (%)	Total	Rate (%)	
Health concerns					
Diagnosed with Chernobyl-related condition	299	54.5	299	18.7	5.20 (3.60–7.52)***
Think health very affected by Chernobyl	300	44.7	296	19.6	3.31 (2.30–4.78)***
Think child's health very affected by Chernobyl	300	58.3	299	29.8	3.30 (2.36–4.63)***
Think health of future generations adversely affected (very)	299	71.6	299	60.5	1.64 (1.17–2.31)**
Pregnant at time of accident	300	36.7	299	29.4	1.39 (0.99–1.95)
Post-traumatic response					
Proxy PTSD	300	18.0	300	9.7	2.05 (1.27–3.32)**
Behavioral changes					
Do not walk in woods around Kyiv	296	37.5	300	34.3	1.15 (0.82–1.60)
Stopped picking mushrooms	299	69.2	299	68.6	1.03 (0.73–1.46)
General risk perceptions					
Think Kyiv is not a safe place to live	294	74.5	297	77.1	1.15 (0.79–1.68)
Consequences worse than feared	298	55.0	292	44.2	1.55 (1.12–2.14)**
High distrust in authorities	300	51.7	300	49.7	1.08 (0.79–1.49)

** $p < 0.01$; *** $p < 0.001$.

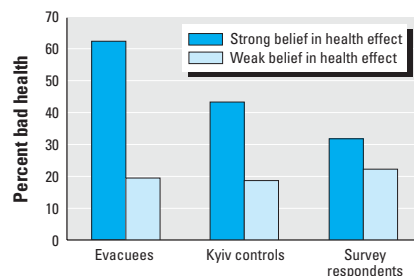


Figure 1. Relationship between the belief that Chernobyl very much affected one's health and reporting bad/very bad health in evacuees, Kyiv controls, and national survey respondents.

the Chernobyl perceptions or antedated Chernobyl and led to heightened concerns about its health effects. Fourth, because the study focused only on women with children, it is not possible to extrapolate the results to women who never had children or had abortions after the accident, or to men.

Despite these limitations, the findings are noteworthy for two reasons. First, this is one of the few studies to examine the long-term health outcomes of a disaster. Most disaster research has been conducted within 1 year of an event (24), and the available long-term cohort studies of traumas are primarily focused on veterans of war (25) or survivors of horrific events such as the Holocaust (26) or the Cambodian massacre (27). Second, we were able to compare the relationship between stress and subjective health in a highly vulnerable group (evacuees), a less vulnerable group (Kyiv controls), and a relatively unaffected group (national sample).

The findings suggest that one of the legacies of Chernobyl is a heightened sense of susceptibility to illness. Our findings confirm previous results on the relationship of real or perceived environmental exposure to symptoms in other vulnerable populations, including occupational groups exposed to solvents and other chemicals in the workplace, populations affected by TMI, Persian Gulf veterans, women with silicone breast implants, and patients with functional somatic syndromes, such as multiple chemical sensitivity and sick building syndrome (28). The nonspecific nature of the symptom reports, as described in this article, is also consistent with findings from longitudinal studies of Hiroshima and Nagasaki (22,29), TMI (30), war veterans (25), and other disasters and community traumas (3,18). Regardless whether the subjective reports are medically confirmed, somatic distress can have medical and functional consequences (31) and thus deserves long-term research attention.

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