

## Depression after exposure to stressful events: lessons learned from the severe acute respiratory syndrome epidemic

Xinhua Liu<sup>a</sup>, Meghana Kakade<sup>b</sup>, Cordelia J. Fuller<sup>b</sup>, Bin Fan<sup>b</sup>, Yunyun Fang<sup>c</sup>, Junhui Kong<sup>c</sup>, Zhiqiang Guan<sup>d</sup>, Ping Wu<sup>a,b,e,\*</sup>

<sup>a</sup>*Mailman School of Public Health, Columbia University, New York, NY*

<sup>b</sup>*New York State Psychiatric Institute, New York, NY*

<sup>c</sup>*Beijing University of Chinese Medicine, Beijing, China*

<sup>d</sup>*National Institute for Social Insurance, Beijing, China*

<sup>e</sup>*College of Physicians and Surgeons, Columbia University, New York, NY*

### Abstract

**Aim:** The aim of the study was to examine, among hospital employees exposed to an outbreak of severe acute respiratory syndrome (SARS), post-outbreak levels of depressive symptoms and the relationship between those depressive symptom levels and the types of outbreak event exposures experienced.

**Methods:** In 2006, randomly selected employees (N = 549) of a hospital in Beijing were surveyed concerning their exposures to the city's 2003 SARS outbreak and the ways in which the outbreak had affected their mental health. Subjects were assessed on sociodemographic factors, on types of exposure to the outbreak, and on symptoms of posttraumatic stress disorder and depression.

**Results:** The results of multinomial regression analyses showed that, with other relevant factors controlled for, being single, having been quarantined during the outbreak, having been exposed to other traumatic events before SARS, and perceived SARS-related risk level during the outbreak were found to increase the odds of having a high level of depressive symptoms 3 years later. Altruistic acceptance of risk during the outbreak was found to decrease the odds of high post-outbreak depressive symptom levels.

**Conclusions:** Policy makers and mental health professionals working to prepare for potential disease outbreaks should be aware that the experience of being quarantined can, in some cases, lead to long-term adverse mental health consequences.

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### 1. Introduction

The history of humanity has been marked by the impact of many fearsome epidemics of infectious disease. At the start of the 21st century, the international community experienced a similarly frightening public health emergency, on a global scale, with the spread of severe acute respiratory syndrome (SARS). Severe acute respiratory syndrome was an unusual corona virus-based pneumonia that spread rapidly [1]. The SARS epidemic demonstrated that one effect of globalization has been to make it possible for an infectious disease to travel from one continent to another in a matter of hours and

highlighted the importance of international coordination of efforts to respond to novel outbreaks of infectious disease. It was first detected in November 2002 in China's Guangdong province and eventually affected more than 25 countries. China was one of the most severely affected countries, and Beijing was among the world's most heavily affected cities, according to the World Health Organization's summary report [2,3].

Because of the high infectious potential and mortality rate of the disease, the disaster of the SARS epidemic led to panic and anxiety in the affected countries [3–6]. Health care workers were at elevated risk of becoming infected with SARS and represented more than 20% of those who actually contracted the disease [3].

Studies of the SARS outbreaks that occurred in Canada, Taiwan, and Hong Kong found that the enormous emotional burden carried by those health care workers who were on the

\* Corresponding author. Columbia University-NYSPI, 1051 Riverside Dr, Unit 43, New York, NY 10032. Tel.: +1 212 543 5190; fax: +1 212 781 6050.  
E-mail address: [pw11@columbia.edu](mailto:pw11@columbia.edu) (P. Wu).

front lines of the battle against the disease led to psychologic morbidity for many of them [4,7,8]. The mental disorder that is most commonly linked, in the literature, to disaster-related experiences is posttraumatic stress disorder (PTSD), but studies have also found that, among those with PTSD after a disaster, comorbid depression is common [9,10]. A few studies [7,11–13], including one of Hong Kong's SARS outbreak [7], have specifically examined levels of depressive symptoms among health care workers affected by disaster. Health care workers in Hong Kong who had worked closely with patients with SARS during the SARS outbreak were found to have relatively high levels of depressive symptoms 1 year later [7].

Subjective perceptions regarding the degree of danger to which one is being exposed can differ widely among individuals with objectively similar levels of disaster exposure. These subjective perceptions may be more strongly associated with an individual's subsequent psychologic morbidity than more objective measures of danger [14]. In a study of individuals exposed to an oil spill, for example, individuals' subsequent levels of depression and anxiety were more strongly related to their perceptions regarding the degree to which the spill had posed a threat to their health than to their actual degree of exposure to the oil [15]. Previous studies of the SARS epidemic, however, have not examined the relationship between subjective perceptions of outbreak-related risk and subsequent levels of depressive symptoms.

In general, little is known about which factors may be associated with protection against depression after a disaster. Although altruistic intent to help has been shown to be protective against postdisaster PTSD [16–18], the few studies that have looked at its effects on postdisaster depression have produced inconsistent findings [19,20].

To help fill the research gaps described above, the present study (1) examines the relationship between specific types of exposure of Beijing hospital employees to the city's SARS outbreak and their subsequent levels of depressive symptoms and (2) assesses the role of perceived SARS-related risk and altruistic acceptance of risk in levels of depressive symptoms 3 years later, controlling for other factors including levels of PTSD symptoms.

## 2. Methods

### 2.1. Sample

In 2006, 3 years after Beijing's SARS outbreak, 549 employees of a major Beijing hospital that had been affected by SARS—a stratified random sample of the hospital's employee population—were surveyed. Using the hospital's employee rosters, the sample was stratified by profession and by age group. The physician and nurse groups were further stratified by level of work exposure to the SARS outbreak, according to the types of hospital units in which they had worked during the outbreak. Those who had worked in units

where contact with patients with SARS had been frequent and intense, such as SARS wards, fever clinics, the department of infectious diseases, or the emergency department, were classified as having had “high work exposure.” Physicians and nurses falling into the high-work exposure category were oversampled. Hospital employees aged 35 to 55 years were also oversampled. The survey's participants completed a self-report questionnaire. The response rate was 83%. Further details of its sampling and study procedures are available elsewhere [18,21].

This study was carried out in full compliance with the institutional review boards of the New York State Psychiatric Institute and the Beijing University of Chinese Medicine. Written informed consent was obtained from all participants before participation in the study.

### 2.2. Measures

#### 2.2.1. Exposure to the SARS outbreak

Hospital employees answered questions about their SARS outbreak event exposures, including work exposure, any quarantining, and having had a friend or close relative contract SARS (“relative or friend contracted SARS”).

*2.2.1.1. Work exposure.* *High work exposure* was defined as having worked in a high-risk location, such as a SARS ward, fever clinic, infectious disease department, emergency department, pulmonary medicine department, or x-ray lab, between January and June 2003.

*2.2.1.2. Any quarantining.* Selection for quarantining generally resulted from a judgment, on the part of the responsible authorities, that the selected individual was at relatively high risk for actually contracting SARS, and, as a result, for infecting others with the disease, because he or she either had close contact with infected individuals or exhibited some of the symptoms of SARS. Health care staff who were quarantined but who were not ill, generally continued to work, caring for patients with SARS, while quarantined.

*2.2.1.3. Relative or friend contracted SARS.* was defined as having one or more family members or friends who developed SARS.

#### 2.2.2. Other exposure to traumatic events

Subjects were asked about exposure, before the SARS outbreak, to any of 5 potentially traumatic types of events, including severe injury in violent circumstances, witnessing a death or serious injury of a close friend or family member, and living through a major disaster. This instrument was modified from a questionnaire used in trauma exposure surveys conducted in the United States [22,23]. The pre-SARS exposure summary variable was coded as “yes” if the respondent responded affirmatively to any of these questions.

### 2.2.3. During-outbreak perceptions of SARS-related risks

Ten questionnaire items were used to assess hospital employees' perceptions, during the 2003 outbreak, of the SARS-related risks that they had been facing; the items were adapted from those used in a previous study assessing the psychologic impact of SARS on hospital employees in Taiwan [4]. Nine of these items addressed respondents' during-outbreak perceptions of SARS-related threat: I believed that my job was putting me at great risk; I felt extra stress at work; I was afraid of falling ill with SARS; I felt I had little control over whether I would get infected or not; I thought I would be unlikely to survive if I were to get SARS; I thought about resigning because of SARS; I was afraid I would pass SARS on to others; My family and friends were worried that they might get infected through me; People avoided my family because of my work [4]. The positive responses on these items were counted to produce a Perceived SARS-related Risk Scale score. The scores ranged from 0 to 9. Cronbach  $\alpha$  for the scale was 0.71, indicating good internal consistency.

The 10th item, "Because I wanted to help the SARS patients, I was willing to accept the risks involved," was used as a measure of altruistic acceptance of risk.

### 2.2.4. Current high-stress job

To control for the impact of the relative stressfulness of a subject's current job on his or her current depressive symptom level, a variable was created to indicate whether the subject was currently working in a work unit where stress levels would tend to be high, such as an intensive care unit, infectious disease department, or emergency department, at the time when the survey was conducted.

### 2.2.5. Psychopathology

**2.2.5.1. Level of depressive symptoms.** The Center for Epidemiologic Studies Depression Scale (CES-D) was used to assess the subjects' past-week depressive symptoms [24]. The Chinese version of the CES-D has been validated in Chinese populations and used in several studies [25,26]. Respondents were asked to choose from 4 possible responses in a Likert format, with 0 for "rarely or none of the time (less than 1 day)," 1 for "some or a little of the time (1-2 days)," 2 for "occasionally or a moderate amount of time (3-4 days)," and 3 for "most or all of the time (5-7 days)." The scores on this 20-item scale range from 0 to 60, with a higher score reflecting a higher level of depressive symptoms. It has been suggested that a CES-D score of 16 or more indicates the presence of depressive symptoms [24]. A score of 25 or higher has been found to be strongly associated with major depression [27], and this number has been used as a cutoff point to indicate a high level of depressive symptoms [28]. For the current study, the hospital employees were divided into 3 depressive symptom level groups according to their CES-D scores: (1) those with CES-D scores lower than 16, (2) those with CES-D scores between 16 and 24, and (3) those with CES-D scores of 25 or higher.

**2.2.5.2. Level of posttraumatic stress symptoms.** The Impact of Event Scale-Revised (IES-R) [29], a self-report measure assessing subjective distress resulting from a traumatic life event, was adapted for use in this study to assess PTSD symptoms experienced by the subjects at any time during the 3-year period after the SARS outbreak. The IES-R has 22 items, each with a Likert rating scale from 0 to 4. The total score has a range of 0 to 88. The IES-R has been translated into, and validated in, Chinese [4,30,31]; a score of 20 or more was interpreted here—as suggested by previous studies of populations affected by traumatic events [32,33]—to indicate a high level of PTSD symptoms.

### 2.2.6. Demographics

Information about subjects' age, sex, marital status, educational level, and family income was also obtained in the survey.

### 2.3. Analyses

$\chi^2$  Analysis was used to detect bivariate associations between each of the categorical predictors and the categorized depressive symptom level outcome variable; analysis of variance was used to compare, among the depressive symptom level categories, the means of a quantitative variable. A multinomial logistic regression analysis was then conducted, in 3 steps, with the 3-category depressive symptom level variable being used as the outcome variable. In model 1, 3 variables measuring exposure to the SARS outbreak (exposure at work, any quarantining, and relative or friend got SARS) were entered into the equation, with the sociodemographic variables and prior exposure to trauma also being included as control variables. In model 2, level of perceived SARS-related risk and the binary variable representing altruistic acceptance of risk were added into the model. In model 3, the PTSD symptom level variable and the current high-stress job indicator were added. This analysis was undertaken to assess the possible mediating effects, in the relationship between the exposure variables and the depressive symptom level outcome variable, of perceived risk, altruistic acceptance, and level of PTSD symptoms.

Appropriate weights were used in all the analyses to account for the sampling scheme and to obtain valid statistical inferences.

## 3. Results

### 3.1. Bivariate analyses

Approximately three fourths of the sample was women; 35% were between the ages of 36 and 45 years; 32% were older than 45 years. Approximately 25% reported having worked in locations where contact with patients with SARS was common, whereas 19% had been quarantined either at work or at home during the SARS outbreak. Nine percent of respondents reported that a friend or close relative had contracted SARS. Of the 549 hospital employees, about

77.2% had CES-D scores lower than 16 and so were considered to have a low level of depressive symptoms. About 14.0% of the hospital employees had CES-D scores between 16 and 24 and were, thus, considered to have moderate levels of depressive symptoms. The remaining 8.8% had CES-D scores of 25 or higher. The members of this group were considered to have high levels of depressive symptoms.

Table 1 shows the characteristics of the 3 groups of hospital employees—those with low, moderate, and high current levels of depressive symptoms. The results of the bivariate analysis (Table 1) indicate that, among the sociodemographic factors, younger age and being single were associated with higher levels of depressive symptoms in this sample. About 60% of those having high depressive symptom levels were 35 years old or younger, whereas 31% of those with CES-D scores lower than 16 were in this age range. About one third of those with high depressive symptoms were single, whereas only 10% of those with low CES-D score were single. With regard to the event exposure variables, both work exposure and any quarantining during the outbreak were strongly associated with current level of depressive symptoms. For example, among the group with the highest CES-D scores, 56% had worked in locations where staff had high levels of exposure to patients with SARS; and nearly 60% had been quarantined; whereas less than a quarter of those with low CES-D scores (21.3%) had worked in high exposure locations; and only 14.9% of the low depressive symptoms group had been quarantined. Having had a relative or friend contract SARS, on the other hand, was not significantly associated with level of depressive symptoms. Exposure to other traumatic events before the SARS outbreak was significantly associated with higher levels of depressive symptoms. The respondents' perceived levels of SARS-related risk during the outbreak were also significantly and positively associated with their current levels of depressive symptoms, whereas altruistic acceptance of SARS-related risk was negatively associated with depressive symptom levels. Having experienced high levels of posttraumatic stress symptoms during and after the outbreak was strongly associated with current depressive symptom levels. Finally, the results also indicate that subjects who were currently working at relatively high-stress jobs also tended to report more current depressive symptoms.

### 3.2. Multinomial regression analysis

To further elucidate the relationship of our outcome of interest, that is, current level of depressive symptoms, with outbreak event exposures, risk perceptions, and level of PTSD symptoms, multinomial logistic regression analyses were conducted (Table 2). Table 2, part A, reports the findings from the analysis comparing those having high depressive symptom levels (CES-D scores of 25 or higher)

Table 1  
Bivariate associations between level of depressive symptoms and related factors (n = 549)

	CES-D score range			<i>P</i> <sup>b</sup>
	Below 16 (n = 424) <sup>a</sup> (%)	16 to 24 (n = 77) (%)	25 or higher (n = 48) (%)	
<b>SOCIODEMOGRAPHIC MEASURES</b>				
Sex				
Male	24.8	24.5	10.8	.0916
Female	75.2	75.5	89.2	
Age group (y)				
35 and younger	30.7	34.1	59.6	.0003
36–45	34.1	41.1	29.1	
46 and older	35.2	24.8	11.3	
Marital status				
Single	9.9	8.6	33.0	<.0001
Divorced/ separated	4.0	5.8	2.3	
Married	86.1	85.6	64.7	
Education				
High school or lower	63.2	74.2	66.7	.1738
More than high school	36.8	25.8	33.3	
Household income (¥)				
<20,000	16.3	13.0	19.8	.0221
20,000–39,999	30.3	14.0	23.5	
40,000–69,999	31.0	37.4	24.4	
70,000+	22.4	35.7	32.3	
<b>OUTBREAK EXPOSURE MEASURES</b>				
High work exposure				
Yes	21.3	23.0	56.3	<.0001
No	78.7	77.0	43.7	
Any quarantining				
Yes	14.9	14.8	59.5	<.0001
No	85.1	85.3	40.6	
Relative or friend got SARS				
Yes	7.9	9.8	16.4	.1435
No	92.1	90.2	83.6	
<b>OTHER TRAUMATIC EXPERIENCE PRE-SARS</b>				
Yes	11.1	16.4	24.8	.0173
No	88.9	83.6	75.2	
<b>DURING-OUTBREAK SARS-RELATED PERCEPTIONS</b>				
Perceived risk level, mean (SD)	3.37 (0.11)	4.31 (0.25)	5.58 (0.31)	<.0001
Altruistic acceptance				
Yes	69.6	57.7	45.8	.0011
No	30.4	42.3	54.2	
<b>HIGH LEVEL OF PTSD SYMPTOMS</b>				
Yes	4.9	19.7	40.0	<.0001
No	95.1	80.3	60.0	
<b>CURRENT STRESSFUL JOB STATUS</b>				
Yes	4.7	7.7	16.8	.0146
No	95.3	92.3	83.2	

<sup>a</sup> Weighted n.

<sup>b</sup>  $\chi^2$  Analysis was used to test for differences in the categorical variables, and analysis of variance for differences in the continuous variables, among the depressive symptom level groups.

with those having low depressive symptom levels (CES-D scores of less than 16). In model 1, controlling for age, sex, marital status, family income, and prior exposure to

Table 2  
Multinomial logistic regression models predicting levels of depressive symptoms

	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)
<b>A. High depressive symptom level group (CES-D <math>\geq</math>25) as compared with low depressive symptom level group (CES-D <math>\leq</math>16)</b>			
<i>Sex</i>			
Female	1.81 (0.64-5.11)	1.47 (0.49-4.40)	1.83 (0.57-5.90)
Male	1	1	1
<i>Age group (y)</i>			
35 and younger	1.33 (0.43-4.15)	0.60 (0.18-2.05)	0.71 (0.20-2.50)
36-45	1.75 (0.60-5.05)	0.98 (0.31-3.05)	1.06 (0.32-3.48)
46 and older	1	1	1
<i>Marital status</i>			
Single	4.35 (1.65-11.42)	5.47 (1.85-16.14)	5.38 (1.84-15.78)
Divorced/ separated	1.14 (0.15-8.86)	0.92 (0.11-7.69)	0.83 (0.09-7.76)
Married	1	1	1
<i>Household income (¥)</i>			
<20,000	1	1	1
20,000-39,999	0.64 (0.22-1.86)	0.55 (0.17-1.81)	0.60 (0.18-2.04)
40,000-69,999	1.03 (0.36-2.91)	0.83 (0.27-2.55)	0.83 (0.25-2.80)
70,000+	1.32 (0.46-3.81)	1.05 (0.34-3.25)	0.93 (0.28-3.10)
<i>Pre-SARS traumatic experience</i>			
Yes	3.39 (1.47-7.84)	4.21 (1.72-10.31)	4.95 (1.97-12.39)
No	1	1	1
<i>High work exposure</i>			
Yes	2.22 (1.00-4.92)	1.93 (0.83-4.50)	2.24 (0.86-5.84)
No	1	1	1
<i>Any quarantining</i>			
Yes	4.90 (2.19-10.99)	5.06 (2.12-12.10)	4.84 (1.95-12.02)
No	1	1	1
<i>Relative or friend got SARS</i>			
Yes	0.88 (0.31-2.46)	0.78 (0.26-2.34)	0.48 (0.14-1.60)
No	1	1	1
<i>High perceived SARS-related risk<sup>a</sup></i>			
		1.54 (1.27-1.86)	1.38 (1.13-1.69)
<i>Altruistic acceptance</i>			
Yes		0.26 (0.12-0.56)	0.30 (0.14-0.66)
No		1	1
<i>High level of PTSD symptoms</i>			
Yes			7.40 (2.83-19.36)
No			1
<i>Current stressful job status</i>			
Yes			0.60 (0.16-2.19)
No			1

Table 2 (continued)

	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)
<b>B. Moderate depressive symptom level group (CES-D <math>\leq</math>25 and <math>\geq</math>16) as compared with low depressive symptom level group (CES-D <math>\leq</math>16)</b>			
<i>Sex</i>			
Female	1.08 (0.59-1.97)	1.00 (0.54-1.85)	1.05 (0.56-1.97)
Male	1	1	1
<i>Age group (y)</i>			
35 and younger	1.55 (0.75-3.19)	1.10 (0.52-2.35)	1.10 (0.51-2.36)
36-46	1.78 (0.94-3.34)	1.42 (0.74-2.72)	1.26 (0.65-2.44)
46 and older	1	1	1
<i>Marital status</i>			
Single	1.23 (0.46-3.29)	1.28 (0.47-3.46)	1.23 (0.45-3.36)
Divorced/ separated	1.63 (0.53-5.00)	1.38 (0.45-4.26)	1.20 (0.38-3.82)
<i>Household income (¥)</i>			
<20,000	1	1	1
20,000-39,999	0.57 (0.22-1.43)	0.57 (0.22-1.45)	0.52 (0.20-1.35)
40,000-69,999	1.68 (0.76-3.70)	1.53 (0.68-3.43)	1.50 (0.66-3.38)
70,000+	2.00 (0.89-4.49)	1.83 (0.80-4.17)	1.66 (0.72-3.84)
<i>Pre-SARS traumatic experience</i>			
Yes	1.42 (0.70-2.89)	1.44 (0.70-2.96)	1.52 (0.73-3.15)
No	1	1	1
<i>High work exposure</i>			
Yes	1.02 (0.52-2.01)	0.98 (0.50-1.94)	0.85 (0.40-1.82)
No	1	1	1
<i>Any quarantining</i>			
Yes	0.84 (0.38-1.84)	0.79 (0.35-1.77)	0.74 (0.32-1.72)
No	1	1	1
<i>Relative or friend got SARS</i>			
Yes	1.18 (0.49-2.84)	1.12 (0.46-2.74)	0.93 (0.37-2.34)
No	1	1	1
<i>High perceived SARS-related risk<sup>a</sup></i>			
		1.20 (1.06-1.35)	1.16 (1.03-1.32)
<i>Altruistic acceptance</i>			
Yes		0.57 (0.33-0.97)	0.59 (0.34-1.01)
No		1	1
<i>High level of PTSD symptoms</i>			
Yes			3.64 (1.64-8.08)
No			1
<i>Current stressful job status</i>			
Yes			1.30 (0.39-4.38)
No			1

<sup>a</sup> Continuous variable.

other traumatic events, the effect of any quarantining remained statistically significant, with an adjusted odds ratio (AOR) of 4.90 (95% confidence interval [CI], 2.19–10.99;  $P = .0001$ ); high work exposure, however, had a smaller effect size here (AOR, 2.22; 95% CI, 1.00–4.92;  $P = .05$ ). Single respondents were more likely than married respondents to have high depressive symptom levels (AOR, 4.35; 95% CI, 1.65–11.42;  $P = .0029$ ). Having been exposed to other traumatic events before SARS was significantly associated with high depressive symptom levels (AOR, 3.39; 95% CI, 1.47–7.84;  $P = .004$ ). In model 2, perceived risk level during the SARS outbreak and altruistic acceptance of risk were added into the regression equation. Both of these variables were found to be significantly associated, although in opposite directions, with high depressive symptom levels. Specifically, higher during-outbreak-perceived SARS-related risk levels appeared to increase the odds of having a high current level of depressive symptoms (AOR, 1.54; 95% CI, 1.27–1.86;  $P < .0001$ ), whereas altruistic acceptance of SARS-related risk appeared to decrease those odds (AOR, 0.26; 95% CI, 0.12–0.56;  $P = .0005$ ). In the third and final model, a high PTSD symptom level was found to be significantly associated with a high depressive symptom level (AOR, 7.40; 95% CI, 2.83–19.36;  $P < .0001$ ). With regard to the other factors that had been previously identified as significant predictors, their associations with high depressive symptom levels remained essentially the same, except that the effect of high work exposure became nonsignificant in model 2, when perceived risk and altruistic acceptance of risk were included in the equation, and remained nonsignificant in model 3, when PTSD symptom level and the current high-stress job indicator were also included.

Part B of Table 2 compares those with moderate levels of depressive symptoms (CES-D score between 16 and 24) with those with low levels of depressive symptoms (CES-D score less than 16). As expected, fewer factors were found, in this analysis, to be significantly predictive of group membership. The results from model 1 indicate that, with the sociodemographic factors controlled for, no significant differences were found between the 2 groups with regard to their SARS outbreak exposures. The 2 perception measures, that is, during-outbreak-perceived levels of SARS-related risk and altruistic acceptance of risk, added in model 2 each emerged as significantly predictive of group membership. The pattern of the associations found here is similar to that of the comparison between the high and low depressive symptoms groups, but the effect sizes are smaller. In model 3, when the PTSD symptom level and current high-stress job variables were entered into the equation, PTSD symptom level was also found to be significantly associated with level of depressive symptoms (AOR, 3.64; 95% CI, 1.64–8.08;  $P = .0017$ ). The effect of during-outbreak-perceived risk remained significant in model 3 (AOR, 1.16; 95% CI, 1.03–1.32;  $P = .0183$ ), whereas the effect of altruistic acceptance

of risk was slightly attenuated and of only marginal significance ( $P = .0583$ ).

#### 4. Discussion

Using data from a survey of the employees of a hospital in Beijing that was affected by the 2003 SARS outbreak, this study examined hospital employees' levels of depressive symptoms, 3 years after the outbreak, in relation to the levels and types of outbreak exposures that they experienced during the outbreak and to their perceptions at that time of SARS-related risk.

Of our 4 trauma exposure measures, representing exposures either to the outbreak or to other potentially traumatic experiences, we found that 3, that is, having worked in locations where exposure to patients with SARS was common, having been quarantined during the outbreak, and having been exposed to a violent incident or disaster before the outbreak, were significantly predictive of current level of depressive symptoms. A relative or friend having contracted SARS, on the other hand, was not found to be predictive of a respondent's current level of depressive symptoms. In the regression analyses, when the effects of these types of exposures were examined simultaneously, 2, that is, having been quarantined and pre-SARS trauma exposure, emerged as significant predictors of high levels of depressive symptoms. Their effects still held even after the PTSD symptom level and current high-stress job variables were also controlled for.

That quarantining was found to be predictive of a high level of depressive symptoms, even 3 years after the outbreak, in this sample is consistent with the results of previous studies examining the mental health effects of SARS outbreak exposures. Studies of health care workers affected by the SARS outbreaks in Toronto, Canada, and in Taiwan found quarantining experience to be predictive of subsequent general psychologic distress [32,34–37]. In these studies, increased SARS-related fear, loss of social support, and increased stigmatization by individuals who now saw these health care workers as more likely, compared even with other health care workers, to be sources of disease infection [34] were found to be aspects of the quarantine experience that helped to explain quarantined individuals' elevated levels of psychologic distress [32,34,37,38].

It is likely that in Beijing, too, these aspects of quarantining helped lead to quarantined hospital workers' higher depressive symptom levels 3 years after the outbreak. In China, as in Canada and Taiwan, selection, during the SARS epidemic, of health care staff for quarantining generally resulted from a judgment, on the part of the responsible authorities, that the selected individuals were at relatively high risk for actually contracting SARS—either because their work assignments brought them into close contact with infected individuals or because they had

exhibited some of the symptoms of SARS. Employees' own fears of dying from the disease and of losing family members to it would, thus, have tended to be especially strong at the time when they were quarantined.

China's quarantining policies were, however, somewhat different from Taiwan's, and considerably different from Canada's, in ways that may have led Chinese health care workers to have even higher levels of SARS-related fear, compared with their Canadian counterparts, and might also have affected their perceptions of social support somewhat differently. Unlike in Canada, quarantining in China was often a group affair. Healthy hospital staff could be selected to be quarantined together with hospital patients and were often required to continue working, caring for those patients, while quarantined [39]. These quarantined health care staff would have known that, even if they had not already been infected with SARS, they would, because of being placed in these situations, remain at high risk of eventually becoming infected because of their continued contact with patients with SARS. However, those who continued working in these settings may also have experienced the satisfaction of knowing that they continued to play an important role in society that would have been valued by many of the patients they worked with. Again unlike their Canadian counterparts, however, most of the quarantined hospital employees in our sample experienced a period of at least 10 days of being unable to see or be with their families at all. (The median length of the quarantine periods was 14 days.) This aspect of their quarantining may have led to especially severe distress, but its effects are difficult to measure with any precision.

Stigmatization has been shown to potentially have long-term effects on individuals' psychologic well-being. Robertson et al [34] found that some of the health care workers who had experienced stigmatization during Toronto's SARS outbreak continued, even after the outbreak ended, to worry that others would continue to react to them as they had during the outbreak. Among bereaved parents, stigmatization experienced in the aftermath of a child's death has been found to be predictive of the parents' depressive symptom levels even 10 years later [40].

Thus, it is likely that the relatively high post-outbreak levels of depressive symptoms found among the quarantined respondents in the current study resulted from several factors associated with quarantining, including the elevated sense of danger associated with being quarantined, reduced social support, and increased stigmatization.

Pre-outbreak traumatic experience was also found, in our study, to be predictive of post-outbreak level of depressive symptoms. This is somewhat in contrast to the finding of our previous study of the same hospital employee population [18], which focused on post-outbreak symptoms of PTSD. In that study, pre-SARS traumatic experience was not found to be predictive of later SARS-related PTSD symptom levels. On the surface of it, the direction of this contrast seems surprising because traumatic experiences have frequently been found to be more strongly predictive

of PTSD than of depression [41–44]. It must be noted, however, that the IES-R, the instrument that we used to measure PTSD symptoms, was, like most instruments, designed to measure only PTSD symptoms associated with memories of a single specific event or set of events—in this case, the SARS outbreak. The respondents were not asked about PTSD symptoms they might currently be having because of sudden or violent traumas experienced before the SARS outbreak. It should also be noted that although the SARS outbreak was indeed a highly stressful, often traumatic, and life-threatening experience for those affected by it, the types of stressful events it engendered were somewhat different in nature from those mentioned in the instrument that was used to measure traumas had before SARS. The instrument had been adapted from one used in previous disaster research [23,45]. The events described in the prior trauma instrument are generally sudden, noisy, and violent ones, unlike SARS, which caused harm to its victims in ways that were long-term rather than short-term and comparatively subtle, slow, and quiet. In this sense, the stresses caused by the SARS epidemic would not be expected to be evocative of the types of stresses mentioned in the prior trauma questions. Thus, perhaps it is not really surprising to find that the prior trauma items were, in our sample, predictive of respondents' later depressive symptoms but unrelated to their later symptoms of SARS-related PTSD. Some of our respondents may, unbeknownst to us, have been having either clinical-level or subthreshold PTSD syndromes linked to their memories of events that occurred before the SARS outbreak, which in turn may have been contributing to their relatively high levels of depressive symptoms. Future studies examining the psychologic effects of both recent and less recent traumatic experiences should consider the similarities and differences found between various types of traumatic experiences in designing their survey instruments.

The associations of perceived risk and altruistic acceptance of risk with level of depressive symptoms were also examined in this study. Previous studies conducted in Canada, Hong Kong, and Singapore found perceived SARS risk to be associated with subsequent outbreak-related PTSD symptoms [46–48]. In the current study, perceived risk was found to be associated with higher levels of depressive symptoms 3 years after the outbreak, even when controlling for PTSD symptom level. Reported altruistic acceptance of risk, on the other hand, was found to decrease the odds of having a high current level of depressive symptoms, even with control for exposure, PTSD symptoms, and socio-demographic factors, suggesting a buffering effect of altruistic acceptance of risk on the development of depressive symptoms after exposure to the outbreak.

This study is limited by its cross-sectional nature; in addition, it was not possible for us to perform a true control-group comparison because no employee of the hospital—or 2003 Beijing resident—was completely without exposure to the SARS outbreak. It is also limited by its use of the

CES-D to measure depressive symptoms because this measure is not actually diagnostic of major depression.

The findings do, however, provide valuable information for policy makers and mental health professionals worldwide regarding the psychologic impact of an infectious disease outbreak. Our results support previous research indicating that hospital staff and other individuals who, spend time in quarantine because of an infectious disease outbreak, may be at elevated risk for depression, even over the long term. Appropriate mental health treatment services should be offered to such individuals.

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