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## Physical and mental health shortly after a disaster: first results from the Enschede firework disaster study

Irene van Kamp<sup>1</sup>, Peter G. van der Velden<sup>2</sup>, Rebecca K. Stellato<sup>1</sup>, Jan Roorda<sup>3</sup>, Jeanne van Loon<sup>4</sup>, Rolf J. Kleber<sup>5</sup>, Bertold B. R. Gersons<sup>6</sup> and Erik Lebet<sup>1</sup>

<sup>1</sup> Centre for Environmental Health Research (MGO), National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

<sup>2</sup> Institute for Psychotrauma (IvP), Zaltbommel, The Netherlands

<sup>3</sup> Twente Regional Health Authority (GGD, Regio Twente), The Netherlands

<sup>4</sup> Centre for Prevention and health Care Research (PZO), National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

<sup>5</sup> Department of Clinical Psychology, Utrecht University, Utrecht, The Netherlands

<sup>6</sup> Department of Psychiatry, AMC, University of Amsterdam, Amsterdam, The Netherlands

**Correspondence:** Irene van Kamp, PO Box 1, 3720 BA Bilthoven, The Netherlands, tel: +31 0 30 274 3222; fax: +31 0 30 274 4451; e-mail: irene.van.kamp@rivm.nl

### Abstract

**Objectives:** Two to three weeks after the explosion of a fireworks storage facility in a residential area (May 2000, Enschede, The Netherlands) we assessed the self-reported physical and mental health among those affected by the disaster. **Methods:** A questionnaire survey was conducted among 3792 residents, passers-by, and rescue workers, who were involved in and/or affected by the disaster and were  $\geq 18$  years of age. **Results:** At least 30% of those affected by the disaster reported serious physical and mental health problems 2–3 weeks after the explosion. Compared with reference values in the general Dutch population, high scores were found for somatic symptoms, sleeping problems, and restrictions in daily functioning due to physical and mental problems, such as anxiety, depression, and feelings of insufficiency. The strength of these differences varied between groups, based on the level of involvement and the level of being affected. **Conclusions:** Results indicate that the fireworks disaster had a substantial impact on the health of those affected by the disaster. The health impact was most pronounced for residents and passers-by and also for rescue workers living in the affected area, but to a lesser degree. Physical and mental health problems were strongly associated with the shocking experiences during and shortly after the disaster.

### Introduction

Disasters are by nature sudden events that strike a large number of people, and consequences on the physical and mental health are broad and can persist for many years. Disasters resemble disease outbreaks and share with such epidemics an increased 'burden' on the health care system.<sup>1</sup> It is generally assumed that by assessing the extent of the demand for care and monitoring the course of the health effects after a disaster, the long-term risk of chronic health effects could be reduced. Research has shown that in addition to psychological effects, such as anxiety, depression, avoidance, and intrusion,<sup>2</sup> people can be confronted with various physical reactions after a disaster.<sup>3</sup> Recent reviews indicate that there are remarkable similarities in symptoms reported after a disaster, often referred to as medically unexplained physical symptoms,<sup>4–6</sup> such as fatigue, muscle pain, dizziness, and gastric troubles.<sup>6,7</sup>

On 13 May 2000, in the late afternoon, a series of three fireworks explosions occurred in Enschede, The Netherlands. A residential area (100 acres) near the city centre, with  $\approx 500$  houses, was destroyed and 22 people were killed. Approximately 1000 inhabitants were injured and the material loss amounted to more than €500 million. Environmental measurements shortly after the disaster indicated that it was highly improbable that people

were exposed to dangerous concentrations of various substances related to fireworks and fire in general.<sup>8</sup>

However, based on earlier experiences in the Netherlands the government decided to launch a health survey into the short-term and long-term effects of the Enschede disaster. When in 1992 an airplane crashed in a residential area in Amsterdam, no such rapid health survey was organized. Uncertainty about exposure to toxic substances due to inadequate and contradictory information in the media caused mistrust and fear in the residents, and years later health symptoms were still attributed to the disaster. In 1999, a parliamentary committee recommended the rapid assessment of immediate health effects after a disaster.<sup>6,9-12</sup> A health examination study, commissioned by the Ministry of Health, Welfare and Sports, was conducted 3 weeks after the Enschede disaster. The primary purpose of this study was to collect information that would otherwise have been lost on the exposure to shocking and potentially traumatic events, and to collect blood and urine for the measurement of trace elements indicative of exposure to firework related toxic substances. A second purpose was to make a rapid assessment of the immediate health effects by means of a questionnaire. In this way the survey aimed to communicate acknowledgement of mental and physical health problems and to contribute to a sense of social support and a 'caring government'. All of this was developed under enormous time pressure and therefore are without simultaneous measurements in a control population comparable in terms of demographics.

Initial results, based on a sample, were reported in July 2000 to the public, 10 weeks after the disaster took place, and a full report was issued in April 2001. The survey was the first activity in a comprehensive research project, which consisted of a questionnaire-based follow-up survey and monitoring of health problems, relying on reports of health care professionals. The survey was repeated 18 months and 4 years later in the framework of the Enschede Firework Disaster Health Surveillance Project (GGVE). Monitoring was conducted over a 4-year period by general practitioners, and by local mental health, occupational health and youth health care services.<sup>8</sup>

This paper documents the results of this rapid, initial study and focuses on the physical and mental health problems of adult survivors immediately after the disaster. The main questions are

- i. What is the physical and mental health of the affected population immediately after the fireworks disaster compared with national reference values?
- ii. What are the differences in health problems among the groups affected by the disaster (resident, rescue worker and passer-by)?
- iii. What are the differences in health problems among the groups affected in relation to exposure to traumatic experiences?

## **Subjects and methods**

### **Target population**

The target population consisted of inhabitants of the affected area, rescue workers (mainly firefighters, police officers, and ambulance personnel), and other affected people (passers-by and owners of shops in the area). The number of potential participants in the health survey was estimated to be ~9000, of which ~3500 were rescue workers.<sup>7</sup>

### **Data collection**

People were requested to participate in multiple ways. Residents of the affected areas were primarily reached through letters, and rescue workers were approached through their employers. In addition several announcements for the survey were made through the local media. Due to the mass destruction of houses it was not clear whether all potential respondents were reached and thus informed about the research project. Data collection took place between 31 May and 7 June at Twenthe Air Force Base, close to the city of Enschede, in a research centre that was built up especially for this project. Participants were bussed from the town to the Air Force base and were given a verbal introduction (which was available in five languages) to the study procedures. After that, they registered and signed informed

consent forms. After all these requirements were fulfilled blood and urine samples were collected and a comprehensive questionnaire was completed by all the participants  $\geq 18$  years of age. As some rescue workers came from Germany and as many immigrants lived in the affected area, the questionnaire was available in four different languages (Dutch, Turkish, English, and German) and (native speaking) interpreters were present to clarify questions or to assist in completing the questionnaire. For Arabic-speaking participants the Dutch questionnaire was given and there were native speakers available who helped them with completing the questionnaire. Social workers, psychologists, and physicians were present to support participants at any stage of the survey. The project was approved by a medical ethics committee (TNO, Leiden, The Netherlands).

### **Assessment of health symptoms**

The questionnaire contained questions concerning demographics and lifestyle, perceived mental and physical health before and after the disaster, and the respondent's location and experiences during and in the hours just after the disaster. The questions concerning health addressed quality of life and general health (RAND-36)<sup>13</sup>, general physical health symptoms (VOEG: a measure of self-reported health)<sup>14</sup>, subjective sleep quality [Groninger Sleep Quality Scale (GSKS)]<sup>15,16</sup> chronic disorders, acute symptoms (primarily respiratory symptoms), and symptoms that people had attributed to the disaster. The inventory of mental health symptoms focused on a broad variety of symptoms that are relevant in case of exposure to shocking (traumatizing) events, such as depression, anxiety, hostility, insufficiency and mistrust (SCL-90),<sup>17</sup> and intrusions and avoidance reactions [impact of event scale (IES)].<sup>18,19</sup> Most of the instruments used were validated and are often administered in Dutch health surveys and trauma studies.

### **Assessment of exposure**

Exposure was defined in terms of the degree to which respondents were involved in or affected by the disaster. Research suggests that exposure to traumatic events increases with the degree of involvement.<sup>20,21</sup> There were three main groups of affected people: residents, rescue workers, and passers-by. The group of rescue workers was further divided into rescue workers who resided in the disaster area, rescue workers from Enschede, and rescue workers from outside of Enschede. Altogether five groups were considered.

An important feature of the fireworks explosion in Enschede was the enormity of the damage to houses and buildings. Thus 70% of the residents and 40% of the residents who were also rescue workers sustained at least some damage to their homes. In 24 and 7% of the cases, respectively, the damage was severe and irreparable. Respondents also had physical injuries; lost family members, friends, or colleagues (9%); and many experienced severe anxiety during or just after the disaster (32%). These three aspects were used to estimate exposure to traumatic events.

### **Statistical analysis**

The scale scores on the RAND-36 were dichotomized using one standard deviation below the Dutch (reference) sex-specific mean as the cut-off point. The GSKS and the VOEG were dichotomized using one standard deviation above the reference mean as the cut-off. For the SCL-90, subscales were dichotomized ('high' to 'extremely high' versus a lower score) using the gender-specific norm tables.<sup>17</sup>

Three individual questions measuring COPD<sup>22,23</sup> were used to determine the existence of respiratory symptoms. Presence of asthma was defined as having at least one of the three asthma-related symptoms. Presence of physical health problems before the disaster was defined as having one or more problems from a list of 13 chronic diseases. For the IES a cut-off point of 26 was used.<sup>19,24</sup> All prevalences were expressed in the percentage of participants with an unfavourable value ('health complaint') compared with the Dutch reference data.

In order to answer the first research question, the physical and mental health data were indirectly standardized only for gender; national reference data broken down simultaneously by age and gender were not available. Standardized morbidity rates (SMRs) were calculated by dividing the prevalence of observed health symptoms by the expected prevalence of health

symptoms (based on sex-specific rates from surveys in the general Dutch population). Confidence intervals for the SMRs were constructed using the normal approximation to the binomial distribution; the upper and lower 95% bounds of the observed prevalence were divided by the expected prevalence. For the RAND-36 and the VOEG, no information was available on the percentage of people in the general population with a score above or below the cut-off value. Assuming a Gaussian distribution, ~15.9% would have a health complaint as defined by a score one standard deviation below or above the sex-specific population mean.

To answer the second research question, the unadjusted prevalence of physical and mental health problems was calculated for the five different groups. Logistic regression models were used to estimate the prevalence of health problems among exposure groups after adjusting for age, gender, immigrant status, level of education, smoking, and physical and mental health before the disaster.

To answer the third research question, groups were formed on the basis of three core potentially traumatic experiences owing to the disaster: severely damaged/destroyed house; severe injuries to self or loss of an important person (friend, family member, or colleague); and severe anxiety felt during the first hours after the disaster. Unadjusted odds ratios of health problems in relation to these potentially traumatic events were calculated and logistic regression models were used to estimate the odds ratios of health problems for each experience, after adjusting for degree of involvement, age, gender, immigrant status, level of education, smoking, and physical and mental health before the disaster.

## Results

In total, 4192 people participated in the survey; 390 were excluded from the analysis because their age was <18 years (313) or because the questionnaire was incomplete (87), which resulted in 3792 questionnaires suitable for analysis. The response was estimated<sup>7</sup> to be ~30% for the residents and 8–46% for rescue workers in the different subgroups. The demographic composition of the participating residents was fairly comparable to that of all the residents of the disaster area. Males, young people, and people >65 years of age were relatively under-represented.<sup>8</sup>

In contrast with other health surveys in the Netherlands<sup>25</sup> the participation of ethnic minorities, in particular people with a Turkish background, was extremely good, forming 30% of all the participants. More than half of the participants were professionally involved with the disaster (56% rescue workers, 40% residents, 3% passers-by and 1% unknown).

In table 1 the characteristics of the study population and subgroups are presented. The residents and passers-by are comparable in terms of mean age, gender, level of education, and percentage of non-native Dutch. In contrast, the groups of rescue workers from in and outside Enschede consisted primarily of men under the age of 45 years. The level of education was also higher in these groups. Rescue workers from the disaster area showed more resemblance with the residents.

**Table 1** General characteristics of participants, broken down by the degree of involvement

Characteristic	Resident disaster area	Rescue worker and resident	Rescue worker Enschede	Rescue worker outside Enschede	Passer-by
<i>N</i>	1447	120	316	1698	130
Gender male (%)	44.6	77.5	85.8	90.8	57.7
Age (%)					
18–24 years	12.5	8.3	8.6	7.1	27.7
25–44 years	45.6	55.8	58.5	68.8	42.3
45–64 years	32.1	33.3	32.9	24.1	25.4
≥65 years	9.8	2.5	–	–	4.6
Mean age, years (SD)	42.2 (15.3)	40.6 (10.8)	38.8 (10.4)	38.2 (8.7)	36.8 (15.2)
Educational level (%)					
None	21.1	6.9	6.6	1.2	18.1
Low	31.7	37.1	31.5	31.0	33.1
Middle	30.9	36.2	48.5	56.6	34.6
High	16.3	19.8	13.4	11.2	14.2
Occupational level (%)					
None	52.6	21.2	10.2	7.0	51.6
Low	19.9	26.6	31.4	15.2	21.4
Middle	17.9	41.6	49.2	70.8	21.4
High	9.6	10.6	9.2	7.0	5.6
Non-native Dutch (%)	29.7	17.9	7.8	3.6	23.6
Current smoker (%)	38.8	47.9	45.4	32.9	45.3
Chronic illness (%)	46.3	31.3	25.4	16.8	42.9
House heavily damaged (%)	23.8	7.0	–	–	–
Sustained personal injury (%)	7.4	6.8	3.9	0.5	13.5
Lost a loved one (%)	6.0	7.6	13.2	2.2	5.6
Felt intense anxiety (%)	64.9	30.0	18.0	4.4	70.8

Self-reported physical and mental health before the disaster (measured retrospectively) varied strongly among the five subgroups of survivors. Specifically, the prevalence of some chronic disorders was relatively high among residents and passers-by (table 1). The differences are primarily related to the specific composition of subgroups. Rescue workers are mainly male, young and 'physically fit for the job'.

#### Acute physical health directly after the disaster

Thirty-five percent of the residents and rescue workers from the disaster area, 45% of the passers-by and 23% of the remaining rescue workers reported that they suffered one or more acute symptoms within the first 24 h after the explosion. Coughing and irritation of throat, respiratory tract, eyes, and nose were often mentioned. Moreover, residents and passers-by frequently reported earaches, tinnitus, shortness of breath, and vertigo. The rescue workers who wore facial protection or a surgical mask during the rescue activities (31%) reported significantly fewer acute symptoms, such as irritation of nose, throat, and respiratory tract, and coughing and ear aches. For the other symptoms (shortness of breath, dizziness, tinnitus, and chest pain) no differences were found.

#### Physical and mental health problems 2–3 weeks after the disaster

The reported health problems are summarized in table 2. Two to three weeks after the explosion, the prevalence of most of the physical health problems was higher than in the reference population. SMRs were largest for sleeping problems, poor social functioning, emotional and physical role limitations, and general physical health symptoms (VOEG). A decrease was found in the rates of poor general health, bodily pain, asthma symptoms, or

mistrust. Of the residents and passers-by 45% attributed their health problems to the disaster, this was 12% among rescue workers.

**Table 2** Percentages and SMR of health complaints after the disaster, total population SMR

Complaint	Observed percentage	Reference percentage <sup>a</sup>	Cut-off points	SMR (95% CI)
Poor social functioning, RAND-36	37.2	15.9	<61.6	2.34 (2.24–2.43)
Role limitations, physical, RAND-36	30.2	15.9	<40.1	1.90 (1.80–1.99)
Role limitations, emotional, RAND-36	40.1	15.9	<49.4	2.52 (2.42–2.63)
Bodily pain, RAND-36	12.2	15.9	<51.5	0.77 (0.70–0.83)
Poor general health perceptions, RAND-36	17.2	15.9	<50.0	1.08 (1.00–1.16)
>5 (subjective) complaints, VOEG	29.0	15.9	>5	1.80 (1.71–1.89)
Asthma symptoms	13.0	16.8	1 or more	0.76 (0.68–0.85)
Severe sleeping problems, GSKS	29.0	11.0	>3	2.95 (2.77–3.13)
Phobic symptoms, SCL-90	24.8	20.0	>8/>10 <sup>a</sup>	1.24 (1.17–1.31)
Anxiety symptoms, SCL-90	25.0	20.0	>14/>18	1.25 (1.18–1.32)
Depression symptoms, SCL-90	28.3	20.0	>22/>28	1.42 (1.34–1.49)
Feelings of insufficiency, SCL-90	26.5	20.0	>18/>16	1.32 (1.25–1.40)
Mistrust, SCL-90	15.2	20.0	>27/>30	0.76 (0.70–0.82)
Hostility, SCL-90	28.7	20.0	>7/>8	1.43 (1.36–1.51)
Total score, SCL-90	23.6	20.0	>131/>150	1.18 (1.11–1.25)

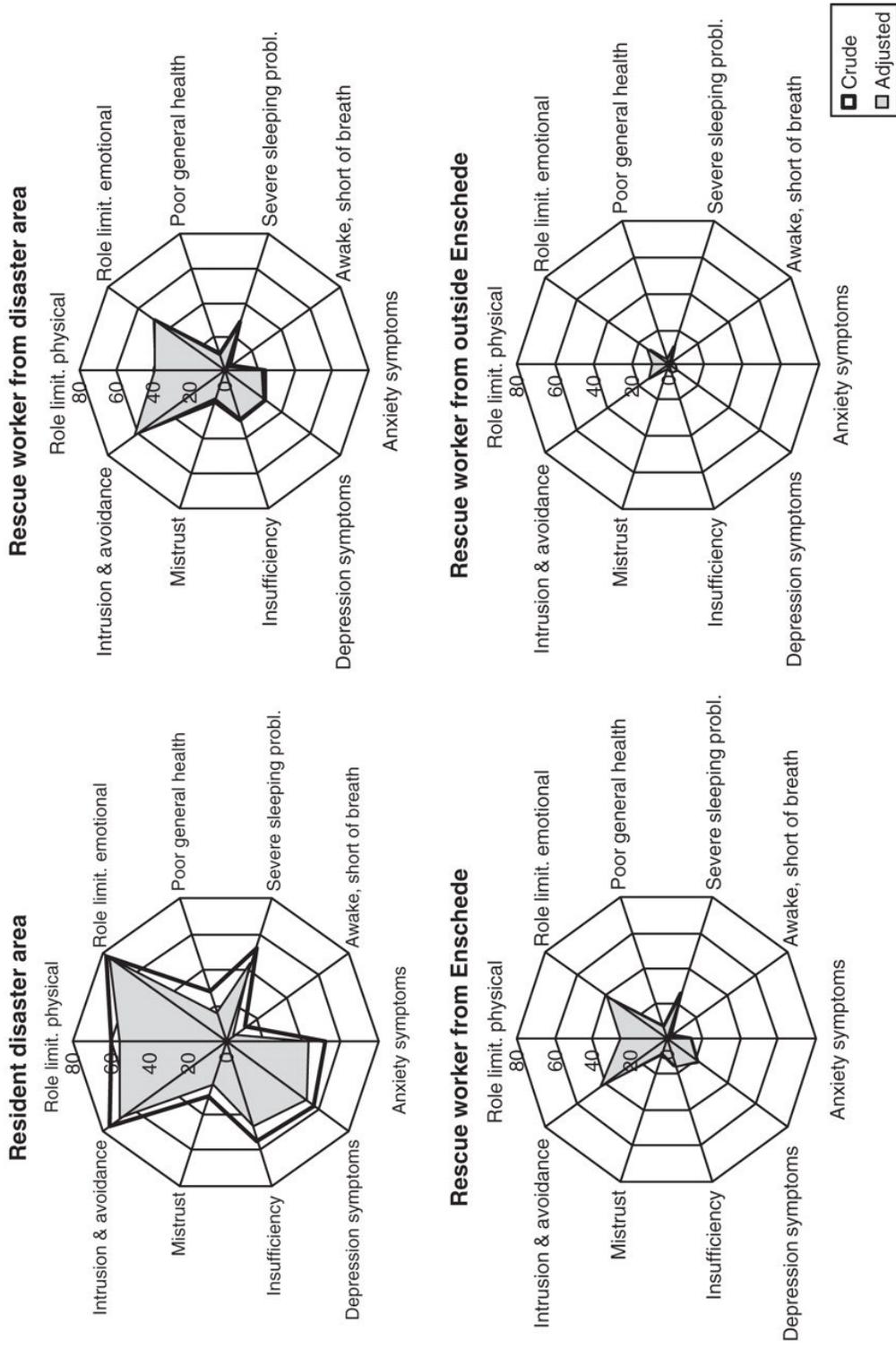
a: Cut-off values for the SCL-90 are gender specific; the first score given is the cut-off for men, the second is for women

Of all the participants, at least 30% experienced poor social functioning. In comparison with the Dutch general population differences were found for somatic symptoms and for role limitations due to physical or emotional problems. These latter were reported twice as often as in the general population. Poor health was reported by 17% of the participants. The score was somewhat higher than in the reference population. Subjective health symptoms were present nearly twice as often and severe sleep problems about three times as often among participants as in the reference population. The prevalence of asthma symptoms and bodily pain was lower than what was expected on the basis of national reference data. Mental health symptoms were experienced by 25–29% of the participants. Symptoms of depression and hostility were most prevalent, but symptoms of anxiety, phobic reactions, and feelings of insufficiency were also higher than in the general population.

#### Physical and mental health and degree of involvement

Figure 1 shows the crude and adjusted prevalence for the selection of physical and psychological health problems after the disaster in four subgroups of participants. The prevalence of physical health problems was highest among residents and passers-by and lowest among rescue workers from outside Enschede. Most of these differences between the groups persisted after adjustment for known confounders, with the exception of respiratory problems, bodily pain, and use of medication. The pattern for the prevalence of mental health problems in the subgroups is comparable to that found for physical health problems (see

figure 1). Three weeks after the explosion the prevalence of mental health problems was high, specifically among residents of the disaster area and passers-by. More than 50% reported symptoms of anxiety, depression, serious sleeping problems, feelings of insufficiency, and hostility. Nearly 75% reported disaster-related reactions of intrusion and avoidance. The prevalence of mental health symptoms was lower among rescue workers from the disaster area and rescue workers from Enschede. The rescue workers from outside of Enschede scored systematically lower on all scales. This remained the case even after the adjustment for relevant confounders.



**Figure 1** Patterns of prevalences for the selection of physical and mental health symptoms (crude and adjusted) for four groups of participants

**Physical and mental health in relation to shocking events**

Survivors whose house was damaged, who lost a relative, friend or colleague or sustained physical injury, or experienced severe anxiety during the disaster were more often confronted with physical and mental health problems. The prevalence of most physical and mental health problems was two to three times higher among respondents who experienced such traumatic events than those who did not. Table 3 presents the crude and adjusted odds ratios of physical and mental health symptoms categorized by experiences.

**Table 3** Odds ratios (crude and adjusted<sup>a</sup>) for health complaints after the disaster due to shocking experiences

Complaint	House damaged		Self injured or lost an important person		Severe anxiety shortly after the disaster	
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Poor social functioning, RAND-36	6.8 (5.3, 8.8)	2.4 (1.8, 3.2)	3.4 (2.6, 4.3)	2.1 (1.6, 2.8)	6.7 (5.6, 7.9)	2.2 (1.8, 2.8)
Role limit, physical, RAND-36	7.7 (5.8, 10.2)	2.0 (1.4, 2.7)	3.5 (2.7, 4.6)	2.3 (1.7, 3.2)	7.7 (6.5, 9.2)	2.1 (1.7, 2.7)
Role limit, emotional, RAND-36	10.5 (7.4, 14.9)	2.0 (1.4, 3.0)	3.7 (2.8, 4.9)	2.1 (1.5, 2.9)	11.9 (9.8, 14.4)	3.1 (2.4, 3.9)
Bodily pain, RAND-36	5.8 (4.4, 7.6)	1.9 (1.4, 2.6)	4.8 (3.6, 6.3)	3.8 (2.7, 5.3)	8.1 (6.3, 10.3)	2.2 (1.6, 2.9)
Poor health perception, RAND-36	6.9 (5.3, 9.0)	2.2 (1.6, 3.0)	2.5 (1.8, 3.3)	1.5 (1.0, 2.1)	7.7 (6.1, 9.6)	2.0 (1.5, 2.7)
Subjective health complaints, VOEG	5.8 (4.5, 7.4)	2.0 (1.5, 2.6)	3.1 (2.4, 3.9)	1.9 (1.4, 2.6)	6.7 (5.7, 8.0)	1.9 (1.6, 2.4)
Severe sleeping problems, GSKS	6.2 (4.8, 8.0)	2.0 (1.5, 2.7)	2.8 (2.2, 3.6)	1.7 (1.3, 2.3)	6.3 (5.4, 7.5)	2.1 (1.7, 2.5)
Wheezing without cold	3.4 (2.4, 4.8)	1.9 (1.3, 2.8)	1.8 (1.2, 2.7)	1.2 (0.8, 1.8)	3.1 (2.3, 4.0)	1.2 (0.9, 1.8)
Awoken attack shortness of breath	5.5 (3.9, 7.6)	2.2 (1.5, 3.3)	2.3 (1.5, 3.4)	1.4 (0.9, 2.2)	5.6 (4.2, 7.7)	1.7 (1.1, 2.4)
Asthma symptoms	4.4 (3.3, 5.8)	2.2 (1.5, 3.0)	2.2 (1.6, 3.0)	1.4 (1.0, 2.1)	4.1 (3.3, 5.1)	1.5 (1.1, 2.0)
Medication use	2.5 (2.0, 3.3)	1.2 (0.9, 1.6)	2.3 (1.8, 3.0)	1.7 (1.3, 2.3)	2.7 (2.3, 3.1)	1.1 (0.9, 1.4)
Sedative use	4.3 (3.2, 5.8)	1.5 (1.1, 2.1)	2.0 (1.4, 2.8)	1.2 (0.8, 1.8)	5.7 (4.4, 7.3)	1.6 (1.2, 2.1)
Complaints attributed to disaster	5.0 (3.9, 6.5)	1.9 (1.4, 2.5)	3.8 (3.0, 4.9)	2.4 (1.8, 3.2)	6.3 (5.4, 7.5)	2.3 (1.9, 2.9)
Phobic symptoms, SCL-90	8.9 (6.9, 11.6)	2.5 (1.9, 3.4)	3.1 (2.4, 4.0)	1.8 (1.4, 2.5)	10.0 (8.3, 12.0)	2.9 (2.3, 3.7)
Anxiety symptoms, SCL-90	10.1 (7.7, 13.2)	2.7 (2.0, 3.6)	2.9 (2.2, 3.7)	1.6 (1.2, 2.2)	11.1 (9.2, 13.3)	2.8 (2.2, 3.5)
Depression symptoms, SCL-90	11.9 (8.9, 15.9)	3.2 (2.3, 4.4)	3.0 (2.3, 3.8)	1.7 (1.2, 2.3)	10.1 (8.4, 12.0)	2.8 (2.2, 3.5)
Feelings of insufficiency, SCL-90	11.1 (8.4, 14.6)	2.9 (2.2, 4)	2.8 (2.2, 3.7)	1.6 (1.2, 2.2)	9.8 (8.2, 11.7)	2.4 (1.9, 3.0)
Mistrust, SCL-90	8.2 (6.3, 10.6)	2.8 (2.1, 3.8)	2.2 (1.7, 3.0)	1.3 (0.9, 1.8)	7.9 (6.4, 9.9)	2.4 (1.8, 3.2)
Hostility, SCL-90	7.3 (5.7, 9.5)	2.4 (1.8, 3.2)	2.6 (2.1, 3.4)	1.5 (1.1, 2.0)	6.7 (5.6, 7.9)	2.2 (1.8, 2.7)
High total score, SCL-90	10.5 (8.0, 13.8)	2.9 (2.1, 4)	3.0 (2.3, 3.9)	1.8 (1.3, 2.5)	10.2 (8.5, 12.3)	2.6 (2.1, 3.3)
Intrusion and avoidance, IES	9.5 (6.9, 13.1)	1.9 (1.3, 2.8)	3.1 (2.4, 3.9)	1.6 (1.2, 2.2)	12.9 (10.7, 15.4)	3.6 (2.8, 4.5)

a: Adjusted for degree of involvement, age, gender, immigrant status, level of education, current smoking status, and self-reported chronic illness and psychological problems before the disaster

Logistic regression analysis indicated that, after adjustment for potential confounders (degree of involvement, age, gender, immigrant status, level of education, smoking, and physical and mental health before the disaster), people who experienced a shocking event scored unfavourably on all RAND-36 scales, reported more sleep symptoms, used more tranquilizers, and scored high on all SCL-90 scales and the intrusion and avoidance scale. Adjusted odds ratios for most health problems ranged from 1.5 to 3 for people who experienced a shocking event compared with those who did not. Of additional interest are the extremely high associations between the IES scale and all SCL-90 scores, ranging from 0.58 to 0.78.

## Discussion

The purpose of this study was to gather information on potential exposure, otherwise lost, and to make a rapid assessment of the immediate health effects of the fireworks disaster in order to adequately provide health care organizations with the data and information required to help the survivors of the disaster.<sup>26,27</sup> We designed this study in part in accordance with the recommendations of previous studies for a rapid survey after a disaster.<sup>27-31</sup>

Results show that survivors report considerably more physical and mental health symptoms than expected according to the national reference data. Moreover, a large group attributed these health problems to the disaster. Of all the respondents 30–40% experienced limitations in their daily activities as a result of their physical health problems. The prevalence of poor perceived general health, respiratory symptoms, use of medication, pain symptoms, and mistrust was comparable to the national data. The prevalence of asthma symptoms was actually lower than expected. This is in line with the findings of an earthquake study,<sup>32</sup> in which fewer attacks were observed among asthma patients; this is sometimes explained as an effect of cortisol. Many participants reported mental health problems that limited their activities, and 23–29% were confronted with feelings of anxiety, depression, or feelings of insufficiency, which is moderately high in comparison with the national reference data.

There are clear differences in the impact of the disaster based on the respondent's degree of involvement. The impact was most pronounced for the residents of the disaster area and passers-by, to a gradually lesser extent for rescue workers who were also residents of the disaster area or the municipality where the disaster took place, and lowest among rescue workers from outside Enschede. These groups differ not only many aspects, such as exposure to life-threatening situations, earlier professional experiences, and the material and social impact of the disaster, but also on activity during and after the disaster, which is hypothesised to decrease the prevalence of PTSD.<sup>2</sup>

The high prevalence of health problems can be interpreted as a consequence of a chaotic and stressful period immediately after the disaster and can thus be interpreted as normal reactions to an abnormal situation. However, previous research indicates that a substantial number of problems will continue, or develop, into specific disorders, such as post-traumatic stress disorder. Important determinants for these chronic problems are prior trauma, prior adjustment, material loss and relocation after the disaster, and perceived social support.<sup>20,21</sup> Results in this study suggest that those who experienced trauma in terms of injury, loss and/or severe anxiety, as well as people who score high on the IES scale are the most at risk. The follow-up at 1.5 and 4 years after the disaster, in the framework of the Enschede Firework Disaster Health Surveillance Project (GGVE), will provide further information about the development of these health problems.

Post-traumatic stress disorder (PTSD) could not yet be established, because according to the criteria for PTSD (APA and DSM-IV-TR) the symptoms should be present for at least 1 month. High scores on the intrusion and avoidance scale (IES) are an indication of serious post-traumatic disturbances and predictive of the development of PTSD.<sup>24</sup> Of the five subgroups 75% of the residents, 57% of the resident rescue workers, 40% of the rescue workers from Enschede, 10% of the rescue workers from outside Enschede, and 68% of the passers-by reported strong disaster-related intrusion and avoidance reactions. In comparison, 24% of Dutch victims of a shipping disaster had a high IES score 1 month after the accident.<sup>33</sup> Research<sup>34</sup> has shown that victims with an acute stress disorder (ASD) score much higher on

IES. In this study, symptoms of ASD have not been sorted, but the high scores on the IES strongly indicate that many victims showed symptoms of an ASD.

This study was prepared in a very short period of time during the chaotic aftermath of the disaster, the study population is very heterogeneous, and the health problems refer to a specific condition (a disaster). Therefore this study has several limitations that are inherent to the nature of the event and recruitment procedure. At the time of the first survey there was no proper definition of the heterogeneous group of survivors after the disaster. Second, there was no full registration of residents and rescue workers and other survivors available. Third, it was difficult to invite participants for the survey. As a consequence it was impossible to accurately determine the non-response and subsequent bias.<sup>8</sup> On the basis of follow-up data and additional non-response analysis it was afterwards shown that participation was somewhat biased and the prevalence of health problems in the total affected population may be somewhat overestimated. Nonetheless, the study provides valuable information on the health problems of survivors of a disaster.

Finally, despite the relatively rapid health assessment after the disaster, it still proved time-consuming to provide the health care organizations with the required information. One of the recommendations of a panel of experts who examined the causes of, and responses to, the Enschede fireworks disaster was to establish a centre for health research on the problems that follow disasters to allow for immediate preparedness for future disasters.

The impact on the health of those affected by the disaster was substantial, especially for residents and passers-by and to a lesser degree for rescue workers from the affected area. The prevalence of physical and mental health problems was highest among those who experienced shocking experiences during and shortly after the disaster. Both of these groups of affected people were the primary focus for health care and monitoring in the years following the disaster.

#### Key points

- The physical and mental health problems of adult survivors immediately after a firework disaster in the Netherlands.
- Survivors of this disaster reported considerably more physical and mental health symptoms than the general population, based on extrapolation from national reference data.
- These physical and mental health problems were strongly associated with shocking experiences during and shortly after the disaster.
- Rapid assessment after a disaster can provide valuable information and data on the health problems of survivors.

Such information can be used by health care organizations to help the survivors of the disaster in a better way, possibly preventing the development of some chronic health problems.

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