J Occup Health 2005; 47: 523–532

Journal of Occupational Health

Field Study

The Health of Volunteer Firefighters Three Years after a Technological Disaster

Mattijn MORREN[1], C. Joris YZERMANS[1], Ruth M.A. van NISPEN[1] and Stephan J.M. WEVERS[2]

[1]NIVEL, Netherlands Institute for Health Services Research and [2]Regio Twente, Emergency Services Department, the Netherlands

Abstract: The Health of Volunteer Firefighters Three Years after a Technological Disaster: Mattijn MORREN, *et al*. NIVEL, Netherlands Institute for Health Services Research, the Netherlands—On May 13, 2000, a firework depot exploded in a residential area of the city of Enschede, The Netherlands. Many disaster workers responded, including volunteer firefighters, a group that has received little attention in disaster research. This study examined the presence of health problems in volunteer firefighters who were involved in disaster work, three years after the disaster. Furthermore, it was investigated whether demographic characteristics and disaster exposure predicted health problems. The study population consisted of 246 volunteer firefighters who were deployed in disaster work and 71 non-deployed controls. These firefighters completed a questionnaire which inquired about their perceived health and health change, physical symptoms, post-traumatic stress, mental health problems, and health care utilization. Three years after the disaster, no health differences emerged between deployed and non-deployed firefighters. Good health and health improvement over the previous year were reported. Respondents who encountered more distressing experiences during disaster work or carried out more direct disaster-related recovery tasks reported more mental health problems and health care utilization. However, the most reliable predictors of health problems were distressing experiences unrelated to the disaster in personal life or during work. Three years after the disaster, the health of volunteer firefighters involved in the disaster work was not much impaired, possibly because aftercare was available and utilized. Nevertheless, disaster exposure was associated with elevated post-traumatic stress symptoms and mental health care utilization. Health care workers should direct specific attention to the treatment and prevention of post-traumatic stress symptoms in cases of major accidents or disasters. *(J Occup Health 2005; 47: 523–532)*

Key words: Disasters, Rescue work, Volunteer firefighters, Occupational exposure, Psychological problems, Physical symptoms, The Netherlands

On the afternoon of May 13, 2000, three explosions struck the city of Enschede, The Netherlands. A firework depot storing 117 tons of heavy fireworks detonated in a residential neighborhood, causing rampant fire and massive destruction. Twenty-two lives were lost and over 900 people were injured; around 400 families lost their homes. The Dutch government declared the explosion a national disaster and an extensive survey was launched to study its health consequences[1)].

The physical and mental health consequences of disasters are well documented, and mostly concern victims who were exposed directly to the disaster[2, 3)]. In recent years, interest in personnel involved in rescue and recovery operations has increased. These disaster workers are sometimes referred to as the 'forgotten'[4)] or 'hidden'[5)] victims. They perform tasks that expose them to a range of stressors, and include police officers, firefighters, medical personnel, and salvage and demolition workers. Evidence shows that disaster workers face all kinds of health problems, including physical[6–8)], psychiatric[9, 10)], psychological[7, 11)], and social problems[12)].

Studies investigating disaster workers' health vary considerably with respect to the nature of the disaster, relevant health outcomes and type of disaster work. However, most studies have focused on *professional* rescue and recovery personnel[13)]. Volunteer assistance in disaster work is, however, indispensable considering the impact of disasters, and may be organized (e.g., the Red Cross or volunteer firefighters) or non-organized (e.g., civilians who happen to be present). On average, professionals are better prepared and more experienced to operate under strenuous conditions than volunteers; which is not to say that volunteers are unprepared[14)]. Training and experience shield disaster workers from potential adverse health effects

Received Dec 27, 2004; Accepted Jul 27, 2005
Correspondence to: M. Morren, NIVEL, Netherlands Institute for Health Services Research, P.O. Box 1568, NL-3500 BN Utrecht, The Netherlands (e-mail: M.Morren@nivel.nl)

of disasters[15]. Accordingly, it is often reported that professional disaster workers present fewer health problems than survivors[12, 15–18]. Although equivalent findings have been obtained for volunteer disaster workers[16, 19], they are relatively scarce. Several risk factors have been associated with post-disaster morbidity, including a higher degree of exposure, a history of mental disorder, female gender, younger age, low social support, and lower socio-economic status[2, 3].

Many rescue workers involved in the aftermath of the Enschede firework explosion were volunteers. Among them were a few hundred trained volunteer firefighters from the region, and this has allowed us to study the long-term impact of the disaster on the health of these volunteer firefighters. The present study investigates the disaster exposure and health of volunteer firefighters some three years after the Enschede firework explosion. More specifically, we examined which disaster-related experiences volunteer firefighters faced, both with respect to tasks they carried out and distressing events they experienced. Furthermore, we investigated whether this disaster exposure and certain demographic characteristics are associated with higher levels of physical and psychological health problems. This study is part of a larger project investigating the health consequences of the Enschede firework explosion in victims and disaster workers[1, 20]. The aim of this study was to investigate the physical and mental health of volunteer firefighters who were involved in rescue and recovery operations, three years after the disaster.

Methods

Background

In the Netherlands, five out of six firefighters are volunteers. Although most of these volunteer firefighters have a regular day job besides their work for the fire department, they are on call regularly and participate in the same activities as professionals. Volunteers also receive the same training as professional firefighters and a number of admission requirements must be met, including good health and a good physical condition, and a vocational education with math and science. In addition, they must attend weekly practice sessions and regular schooling (http://www.brandweer.nl)[21].

Study population

Twelve of the 14 fire departments involved in the rescue and recovery operation following the firework explosion agreed to participate in this study, implemented three years post-disaster. A questionnaire was distributed among the volunteer firefighters of these departments (n=663), which could be returned via stamped return envelope. An information letter clarified the purpose of the study, and it was explained that participation was voluntary and anonymous. The average response rate for all fire departments was 48% (n=317). The gender and age distribution of participants were comparable to other studies of firefighters in the Netherlands[21, 22]. Two groups of firefighters were distinguished based on their involvement in disaster work: a deployed group (n=246) and a non-deployed control group (n=71).

Exposure

Deployed volunteer firefighters indicated their disaster-related experiences on a list of 9 tasks and 12 distressing events associated with disaster work. Other unlisted tasks or experiences could be reported separately. All respondents reported whether or not they had experienced disaster-unrelated distressing events since the disaster (10 items); again, other experiences could be reported separately. If possible, responses on other-items were recoded as one of the enlisted tasks or experiences.

The lists of tasks and experience items were then subjected to exploratory factor analysis to cut the number of variables. Factors were drawn using principal components factor extraction with oblique (oblimin) rotation. The number of factors to be extracted was determined using the eigenvalue ≥1.0 criterion[23], and the scree test[24]. The task items were grouped into 2 factors, *direct tasks* (5 items) and *indirect tasks* (4 items), representing tasks related to immediate or longer-term effects of the explosion. The disaster-related distressing experience items delivered one 10-item factor representing *disaster-related events*. Two items were removed: "Received injury", and "Other". The disaster-unrelated distressing experience items yielded two factors, *work-related events* (9 items) and *personal events* (1 item; e.g., death or serious illness of family or friends/relational problems). Exposure scores were calculated by summing items in each scale; non-deployed firefighters received a score of 0 on the three disaster-related scales.

Health

Physical health: Physical health was assessed in two ways. Firstly, respondents completed two items of the RAND-36[25], on general health perception and health change. Secondly, they indicated whether or not any of 20 symptoms had troubled them before and after the disaster, including the last week. These symptoms were combined into five symptom clusters: (1) psychological; (2) musculoskeletal; (3) gastrointestinal; (4) respiratory; and (5) other. Also, the presence of at least one symptom (i.e., any symptoms) and the mean number of symptoms (i.e., mean symptoms) were calculated.

Mental health: The *Post-Traumatic Stress Disorder self-rating scale* (PTSD-srs)[26] is based on the Structured Interview for post-traumatic stress disorder (PTSD)[27]. If someone has experienced a traumatic event, the PTSD-srs is used to establish whether PTSD can be diagnosed according to the DSM-IV criteria[28]. This is the case if at

least 1 of 5 re-experiencing, 3 of 7 avoidance, and 2 of 5 hyperarousal symptoms are displayed. Item scores were summed to obtain a total score (range=0–17); likewise, subscale sum scores were obtained. The PTSD-srs has good reliability and acceptable validity[26]. Only deployed participants completed the PTSD-srs.

The *Symptom Checklist* (SCL)[29, 30] was used to examine the presence of symptoms in the preceding week. The SCL holds 90 items in nine subscales, four of which were administered in the present study: anxiety (10 items), depression (16 items), hostility (6 items), and sleeplessness (3 items). Items are answered on a 5-point frequency scale from not at all (1) to very often (5). The validity and reliability of the Dutch version are good, and Dutch references are available[30, 31].

Health care utilization: Respondents indicated whether they visited the following health care professionals after the explosion: family practitioner, occupational health physician, medical specialist, psychiatrist, physiotherapist, psychosocial worker, social worker, or other. This was adapted from a study by Van der Velden and colleagues[32].

Statistical analyses

Demographic and exposure differences between deployed volunteer firefighters and non-deployed controls were examined with *t*- and χ^2-tests. Pre-post disaster changes in physical and psychological problems were tested using McNemar tests for related samples and paired *t*-tests. To examine whether mental health symptoms were elevated in the deployed volunteer firefighters, we compared their SCL-scores with normative data of firefighters from a city elsewhere in the Netherlands[33]. This reference group of firefighters had not been exposed to the Enschede disaster or any other major incident, and did not differ from the deployed volunteers with respect to gender and age.

Multivariate linear and logistic regression analyses were used to examine whether demographics and exposure predicted the health indices. On step 1, gender, age (per 10 yr), education, marital status, and length of service with the department (per 10 yr) were entered into the analysis. On step 2, deployment status and the exposure scales were entered into the equation. This allowed us both to test whether or not demographic variables would predict health outcomes, and to control demography in examining whether exposure would affect health. For each predictor, standardized β coefficient (β; in linear regression) or odds ratio (OR; in logistic regression), and 95% confidence intervals (CIs) were computed. Note that the regression analyses predicting the PTSD-srs total or subscale scores were executed with deployed firefighters only. Therefore, in these analyses deployment status was dropped from the equation. Additionally, in predicting the symptom clusters, any symptoms, and mean symptoms, the three disaster-related exposure scales were entered as interaction with time of symptom presentation (before or after the disaster).

Results

Most respondents were males (95.3%), married or cohabiting (86.8%), and had a basic or intermediate level of education (85.6%). The mean age was 40.9 yr (*SD*=7.9; range=23–58 yr). On average, the volunteers had been in service with the fire department for 13.8 yr (*SD*=8.6; range=0–32 yr). The occupational background of the respondents varied widely. Deployed volunteer firefighters were more likely to be male and married or

Table 1. Demographic characteristics of deployed and control volunteer firefighters

		Deployed (*n*=246)		Controls (*n*=71)	
Characteristics		*n*	%	*n*	%
Gender	**				
Female		7	2.8	8	11.3
Male		239	97.2	63	88.7
Age	***	42.7	(6.9)[a]	34.5	(8.0)[a]
Marital status	**				
Single/divorced/widowed		220	89.4	55	77.5
Married/cohabiting		26	10.6	16	22.5
Educational level					
Basic (primary or secondary school)		95	38.9	21	30.9
Intermediate (vocational training)		116	47.5	35	51.5
High (college/university)		33	13.5	12	17.6
Service years	***	16.1	(7.4)[a]	5.8	(7.2)[a]

[a]Mean score (SD). χ^2 or *t* test is significant at *p<0.05, **p<0.01, ***p<0.001.

Table 2. Tasks and experiences of deployed volunteer firefighters during disaster work

	n	%
Tasks	2.2	(1.1)[a]
Direct	1.4	(0.9)[a]
1. Extinguishing operations	209	85.0
2. Replace units of fire department	55	22.4
3. Recover deceased victims	51	20.7
4. Rescue victims	26	10.6
5. Evacuate victims	19	7.7
Total direct tasks	222	90.2
Indirect	0.6	(0.8)[a]
1. Remove debris/demolition	48	19.5
2. Remove asbestos	43	17.5
3. Security of the disaster site	32	13.0
4. Clear roads	23	9.3
Total indirect tasks	110	44.7
Residual item		
1. Other	45	18.3%
Distressing experiences		
Disaster-related events	2.2	(1.5)[a]
1. Heavily damaged, destroyed or burning houses/cars	235	95.5
2. Dying or deceased victim(s)	78	31.7
3. Injured adults	61	24.8
4. Dying or deceased colleague(s)	49	19.9
5. Explosions	29	11.8
6. Screaming people	24	9.8
7. Injured children	21	8.5
8. Victim(s) among family, friends or acquaintances	19	7.7
9. Seriously injured people	18	7.3
10. Adults searching for their child(ren) or family	13	5.3
11. Children searching for their parents	1	0.4
Total disaster-related events	240	97.6
Residual items		
1. Received injury	2	0.8
2. Other	5	2.0

[a]Mean score (*SD*). *N*=246.

cohabiting than controls (both χ^2s>6.8; *p*s<0.01). They were also older and had more service years than controls (both *t*s>8.4; *p*s<0.001), probably because 63.8% of non-deployed controls joined the fire department after the disaster. The level of education was comparable in both groups (Table 1).

Disaster exposure

Disaster-related tasks and distressing experiences: Deployed volunteer firefighters carried out an average of 2.5 different tasks (range=1–7). Most deployed firefighters carried out one or more direct tasks (90.2%), mostly extinguishing operations, whereas almost half were involved in indirect tasks (44.7%). On average, they carried out 1.4 direct and 0.6 indirect tasks (Table 2). All but six firefighters reported experiencing distressing disaster-related events, with a mean of 2.2. In most cases, this concerned being faced with heavily damaged property, and injured, dying or deceased people. Only 2 volunteer firefighters reported being injured (Table 2).

Disaster-unrelated distressing experiences: Compared to controls, a higher percentage of deployed volunteer firefighters experienced work-related distressing events. Personal events were experienced to the same extent. Deployed volunteers experienced more different work-related events [$t(315)=5.0$; $p<0.001$]; four events seemed to account for this.

Table 3. Disaster-unrelated distressing events in deployed and control volunteer firefighters after the firework explosion

	Deployed (*n*=246)		Controls (*n*=71)	
	n	%	*n*	%
Distressing experiences, unrelated to the disaster				
Work-related events[a]	1.6	(1.2)	0.9	(0.9)***
1. Fire incident involving deceased / injured victims	145	58.9	23	32.4**
2. Fire incident involving deceased / injured children	15	6.1	5	7.0
3. Extend help to seriously injured victims	163	66.3	28	39.4**
4. Fire incident involving deceased / injured colleagues	12	4.9	0	0.0
5. Fire incident involving danger to your own life	6	2.4	0	0.0
6. Exposure to dangerous chemicals	12	4.9	1	1.4
7. Injured in fire incident	5	2.0	2	2.8
8. (Threat of) explosion	31	12.6	2	2.8*
9. Smoke inhalation	16	6.5	0	0.0*
Total	216	87.8	39	54.9***
Personal events	73	29.7	17	23.9

χ^2 or *t* test is significant at *p<0.05; **p<0.01, ***p<0.001. [a]Mean score (*SD*) is reported. *N*=317.

Table 4. Self-reported physical and psychological symptoms before and after the disaster

	Before the explosion		After the explosion	
	n	%	*n*	%
Psychological	*43*	*13.6*	*67*	*21.1**
Burn-out / overworked	16	5.0	14	4.4
Depression	7	2.2	15	4.7
Fatigue / exhaustion	16	5.0	44	13.9***
Sleeping problems	11	3.5	27	8.5**
Tenseness / anxiety	12	3.8	24	7.6*
Musculoskeletal	*77*	*24.3*	*92*	*29.0*
Ankle / foot	12	3.8	13	4.1
Back	42	13.2	54	17.0
Elbow / wrist / hand	11	3.5	18	5.7
Knee	21	6.6	21	6.6
Neck / shoulder	26	8.2	42	13.2*
Gastrointestinal	*20*	*6.3*	*22*	*6.9*
Intestines	13	4.1	18	5.7
Peptic ulcer	8	2.5	4	1.3
Respiratory	*28*	*8.8*	*56*	*17.7***
Coughing fits / shortness of breath	13	4.1	28	8.8**
Throat problems	21	6.6	45	14.2***
Other	*104*	*32.8*	*121*	*38.2*
Chest pain	5	1.6	14	4.4*
Ear	15	4.7	18	5.7
Eye	6	1.9	17	5.4*
Headache / migraine	56	17.7	67	21.1
High blood pressure	17	5.4	16	5.0
Skin	34	10.7	42	13.2
Any symptoms	147	46.4	175	55.2**
Mean symptoms[1]	1.1	(1.8)	1.7	(2.5)***

McNemar or *t* test for related samples indicate that frequencies or means before and after May 13 differ significantly at *p<0.05, **p<0.01, ***p<0.001, two-tailed. *N*=317.

Table 5. Demographic characteristics and exposure as predictors of physical and psychological symptoms

	Psychological		Musculoskeletal		Gastrointestinal	
	OR	*CI*	*OR*	*CI*	*OR*	*CI*
Demographics						
Female gender	4.09	1.67–10.04**	2.33	0.97–5.61	3.81	1.22–11.90*
Age (per 10 yr)	0.64	0.39–1.05	0.87	0.58–1.33	0.68	0.32–1.45
Married/cohabiting	1.27	0.63–2.57	1.22	0.67–2.24	1.37	0.45–4.20
Service (per 10 yr)	1.62	1.04–2.52*	1.49	1.03–2.16*	1.39	0.70–2.74
Intermediate education	0.86	0.52–1.43	0.81	0.54–1.24	0.83	0.38–1.80
High education	2.02	1.11–3.68*	1.40	0.82–2.39	1.36	0.54–3.43
Time (post-disaster)	1.74	1.13–2.70*	1.30	0.90–1.88	1.26	0.65–2.45
Exposure						
Work-related experiences	1.11	0.91–1.36	1.46	0.97–2.19	1.26	0.95–1.68
Personal experiences	2.46	1.54–3.93***	0.86	0.41–1.78	2.48	1.23–5.01*
Time × work-related experiences	1.12	0.75–1.69	0.83	0.59–1.15	0.88	0.50–1.55
Time × personal experiences	2.51	0.98–6.45	1.56	0.69–3.53	1.65	0.41–6.69
Time × deployed	0.74	0.15–3.60	0.59	0.15–2.25	0.13	0.01–1.44
Time × direct tasks	0.85	0.47–1.52	1.12	0.70–1.79	1.27	0.53–3.04
Time × indirect tasks	0.79	0.44–1.42	1.22	0.73–2.04	1.58	0.64–3.91
Time × disaster-related experiences	1.34	0.92–1.95	1.26	0.94–1.69	1.29	0.77–2.16

	Respiratory		Any symptom		Mean	
	OR	*CI*	*OR*	*CI*	β	*CI*
Demographics						
Female gender	5.58	2.18–14.28***	2.05	0.83–5.06	0.18	0.09–0.26***
Age (per 10 yr)	0.72	0.41–1.26	1.22	0.84–1.76	–0.06	–0.20–0.08
Married/cohabiting	1.19	0.53–2.64	1.08	0.64–1.81	0.02	–0.07–0.10
Service (per 10 yr)	1.36	0.82–2.25	0.97	0.70–1.35	0.14	0.00–0.27*
Intermediate education	1.64	0.91–2.96	0.75	0.52–1.08	0.01	–0.08–0.10
High education	1.85	0.88–3.88	1.38	0.82–2.30	0.14	0.05–0.22**
Time (post-disaster)	2.29	1.37–3.83*	1.45	1.05–2.02*	0.14	0.06–0.09***
Exposure						
Work-related experiences	1.31	1.06–1.63*	1.24	1.05–1.46*	0.11	0.03–0.20**
Personal experiences	1.32	0.76–2.28	2.42	1.64–3.58***	0.21	0.13–0.28***
Time × work-related experiences	1.05	0.68–1.63	0.89	0.64–1.24	0.08	–0.08–0.23
Time × personal experiences	2.38	0.73–7.76	2.68	1.21–5.94*	0.19	0.07–0.31**
Time × deployed	0.67	0.10–4.25	1.64	0.51–5.28	–0.17	–0.42–0.07
Time × direct tasks	1.00	0.51–1.93	0.98	0.62–1.55	0.10	–0.08–0.28
Time × indirect tasks	0.91	0.45–1.81	0.99	0.58–1.68	0.04	–0.09–0.16
Time × disaster-related experiences	1.17	0.75–1.81	1.01	0.76–1.34	0.16	–0.01–0.34

OR or standardized β coefficient is significant at *p<0.05, **p<0.01, ***p<0.001.

Physical health

General health and health change: Nearly all respondents (97%) were satisfied with their own health, which they perceived as good to excellent; this was independent of deployment status [$\chi^2(4)=6.0$; *ns*]. When asked to compare their health now with one year earlier, deployed firefighters less often reported at least some improvement compared to controls (9.0% vs. 22.8%), and more often that their health was the same [85.7% vs. 70.0%; $\chi^2(4)=12.0$; $p=0.02$]. The regression analyses showed that respondents with fewer service years were more likely to report health improvement over the last year (β=0.20; CI, 0.00–0.26), and that those who experienced personal events perceived their health to be worse (β=0.15; CI, 0.03–0.27).

Physical symptoms: The percentage of respondents reporting symptoms in the five symptom clusters after the firework explosion increased significantly compared

Table 6. Mental health symptoms and post-traumatic stress in deployed volunteer firefighters and a reference group of firefighters

	Deployed volunteers (n=243)	Reference group (n=130)
SCL		
Anxiety	10.80 (2.30)	10.86 (1.49)
Depression	17.77 (4.39)	18.54 (4.56)
Hostility	6.37 (1.18)	6.69 (1.17)*
Sleeplessness	3.48 (1.24)	3.95 (1.63)**
PTSD-srs	1.15 (1.92)	
Avoidance	0.40 (0.75)	
Hyperarousal	0.12 (0.47)	
Reexperiencing	0.61 (1.05)	

Group means differ at *p<0.05; **p<0.01.

to before the disaster (Table 4). This was most evident for fatigue/exhaustion, sleeping problems, coughing fits/shortness of breath, and throat problems (McNemar test for related samples, ps<0.01). Similarly, this was shown for the psychological and respiratory clusters [McNemar test for related samples, p<0.01], any symptoms [McNemar test for related samples, p=0.002; Table 5], and mean symptoms [t(316)=4.4; p<0.001]. Female gender, service years, and high education were associated with increased symptoms in various clusters and with mean symptoms.

Irrespective of whether respondents suffered from pre- or post-disaster symptoms, personal events predicted psychological and gastrointestinal symptoms, and work-related events predicted respiratory symptoms. While both disaster-unrelated exposure scales predicted any and mean symptoms, only personal distressing events was positively associated with reporting any new symptoms [OR=2.68; CI, 1.21–5.94] and an increase in the number of symptoms [β=0.19; CI, 0.07–0.31]. No such increase was observed for the disaster-related exposure scales (see Table 5).

Mental health

Post-Traumatic Stress: Only two deployed volunteer firefighters conformed to the diagnosis of PTSD (i.e., 0.9% of valid cases). Mean total and subscale scores were not related to demographic characteristics or deployment group (Table 6). However, having experienced a personal event was associated with more hyperarousal (β=0.16; CI, 0.04–0.28), re-experiencing (β=0.20; CI, 0.07–0.33), and the total score (β=0.21; CI, 0.09–0.33). Positive relationships emerged between direct tasks and re-experiencing (β=0.16; CI, 0.00–0.31), and between disaster-related events and avoidance (β=0.22; CI, 0.07–0.37), hyperarousal (β=0.16; CI, 0.01–0.30), re-experiencing (β=0.21; CI, 0.05–0.37), and total post-traumatic stress (β=0.24; CI, 0.09–0.38).

Mental health problems: Deployed volunteer firefighters reported fewer mental health problems on all SCL scales than the reference group of firefighters who were not involved in the firework disaster; these differences were significant only for hostility and sleeplessness (Table 6). No significant gender or deployment group differences emerged (ts<0.8; ps>0.4).

Again, the regression analyses revealed no differences between the deployed and control group. The demographic variables produced few effects, only firefighters with a high educational level reported more anxiety, depression, and sleeplessness compared to those with basic education (βs range from 0.13–0.22; ps<0.05). Furthermore, while none of the disaster-related exposure variables significantly predicted SCL scores, personal distressing events predicted anxiety (β=0.23; CI, 0.11–0.34), depression and hostility (both βs=0.22, CIs=0.10–0.33), and sleeplessness (β=0.18; CI, 0.06–0.29). Work-related events predicted anxiety (β=0.13; CI, 0.00–0.26), depression (β=0.18; CI, 0.06–0.31), and sleeplessness (β=0.14; CI, 0.01–0.27). Only marginal significance was attained for the positive association between depression, hostility, and sleeplessness, on the one hand, and disaster-related events, on the other (βs range from 0.13 to 0.14; ps<0.10).

Health care utilization: All together, 64.7% of the volunteer firefighters visited a health care professional after the disaster. More specifically, 59% visited family practitioners, 31% occupational health physicians, 27% medical specialists, 24% physiotherapists, 6% social workers, 4% psychosocial workers, 3% psychiatrists, and 1% other health care providers.

The regression analyses revealed that neither deployment status nor demographic characteristics predicted visits to health care professionals. However, respondents who experienced post-disaster personal distressing events paid more visits to psychosocial workers (OR=22.5; CI, 3.4–147.7), social workers

(OR=5.0; CI, 1.5–16.9), medical specialists (OR=3.2; CI, 1.7–5.9), and family practitioners (OR=2.1; CI, 1.2–3.7). In addition, personal events predicted contact with any health care professional (OR=1.8; CI, 1.0–3.3) and the number of health care professionals visited (β=0.21; CI, 0.10–0.33; p<0.001). Work-related experiences only led to more visits to occupational health physicians (OR=1.3; CI, 1.0–1.6). However, indirect tasks predicted visits to psychiatrists (OR=2.9; CI, 1.0–8.1), and any health care professional (OR=1.5; CI, 1.0–2.3). Disaster-related events were associated with visiting psychosocial (OR=1.7; CI, 1.0–2.9) or social workers (OR=1.6; CI, 1.1–2.4).

Discussion

This study examined the three-year post-disaster health of volunteer firefighters involved in disaster work after the Enschede firework explosion, and the relationship of demographic characteristics and disaster-exposure with health problems. The most notable finding was that deployed volunteers did not present many health problems; in fact, their health was found to be quite comparable to that of non-deployed controls. Both groups were quite satisfied with their current health, and a large majority felt their health had improved over the last year. This was reflected in similar health care utilization and mental health problems of both groups. Less than one percent of the deployed volunteers met the DSM-criteria of PTSD, which is lower than reported in previous studies of volunteer firefighters[14, 34] or other volunteer disaster workers[35]. However, these studies took place shortly after the disaster. In a study of disaster workers six years after a plane crash, there were no cases of PTSD[18]. For comparison, recent studies report a lifetime prevalence of PTSD in the general population of 7.8% in the USA[36], and 5.6% in Sweden[37]. Preliminary findings indicate that the lifetime prevalence of PTSD in the Netherlands is about 8%[38].

The prevalence of mental health problems was similar among deployed and non-deployed volunteer firefighters. Moreover, deployed volunteers not only presented lower levels of anxiety, depression, hostility, and sleeplessness compared to the general Dutch population[30], but also compared to a reference group of firefighters who had no disaster experience[33]. Compared with victims, it has been reported that the health of disaster workers is less impaired[2, 18]. Furthermore, deployed volunteer firefighters in the present study reported more physical symptoms (notably psychological), compared to controls[6, 11]. It should be noted, however, that both groups differed in demographic composition and level of disaster-unrelated exposure. Thus, to rule out confounding we controlled these variables in the regression analyses after which the residual difference in psychological symptoms disappeard. Unfortunately, as Berríos-Torres and Trout[6] did not record pre-disaster symptoms it is uncertain whether their findings reflect a true symptoms increase. However, a recent study using occupational health records in which pre-disaster symptoms were known suggests, in fact, that such an increase does occur[7].

While deployment alone was unrelated to health problems, disaster-related experiences predicted post-traumatic stress symptoms, such as avoidance behavior, hyperarousal, and re-experiencing of traumatic events. In addition, fulfilling tasks related to the acute consequences of the explosion, like fire extinguishing, rescuing victims or recovering bodies, predicted re-experiencing symptoms and health care utilization, notably psychiatric care. Such a dose-response relationship between exposure to and number of stressors during disaster work, on the one hand, and subsequent health, on the other hand, has been well documented in disaster literature[2, 3]. Also, several recent studies linked disaster-exposure to increased use of mental health care facilities[39, 40]. The most reliable predictors of health problems in the present study seemed to be work-related distress, and particularly personal distressing experiences. This corresponds with previous results showing that post-disaster stressful life events and work stress are associated with psychiatric morbidity[35, 41].

This study has several limitations. It is possible that selection bias occurred if volunteer firefighters without post-disaster health problems were less inclined to return the questionnaire. Those with more health problems may have been more likely to resign post-disaster, but this seems unlikely because there was no difference in the percentage of resignations found in the current study and elsewhere in the Netherlands[22]. Furthermore, recall bias may have occurred because the study was carried out three years after the explosion. Tasks and distressing experiences with the highest impact were probably reported more often, especially when they were more recent. Also, it is unclear to what degree the retrospective assessment of physical symptoms before and after the disaster was accurate. Given the cross-sectional nature of this study, we should be cautious to conclude that there is a causative relationship between the firework explosion and health. This is a fundamental problem in disaster research, because it would not be ethical to carry out a controlled trial, and because of the unexpected nature of disasters, prospective studies that allow pre-post disaster comparisons are scarce[42].

Notwithstanding these limitations, this study is one of a few focusing specifically on the post-disaster health of volunteer firefighters involved in rescue and recovery operations. Their health seemed to be modestly impaired at most, and they reported even less psychiatric problems than the general population. This strongly indicates that volunteer firefighters, like professional disaster workers, may enjoy resiliency to the negative health effects of

disaster[16]. This resiliency may result from self-selection or certain individual characteristics (e.g., hardiness or optimism)[3]. Several studies showed that professionals in general tend to present fewer health problems than volunteers[16, 19]. Further study is required to examine by which mechanism volunteer disaster workers are protected against psychological problems. In addition, aftercare was available, and utilized by almost half of the deployed firefighters, which may also have contributed to the prevention of health problems[33]. Nevertheless, exposure to the explosion's aftermath was positively related to mental health care utilization and post-traumatic stress, over and above distressing experiences unrelated to the disaster. This may suggest that the prevention of PTSD and related symptoms should receive particular attention, using one of the therapeutic methods available[2].

Acknowledgments: This study was supported by a grant from the Netherlands Ministry of Health, Welfare, and Sports. We wish to thank Yvonne Luyten-de Thouars for assistance with data collection, and Peter Verhallen of The Netherlands Institute for Fire Service and Disaster Management (Nibra) for advice. We highly appreciate the cooperation of the department commanders, and all volunteer firefighters who kindly completed the questionnaire.

References

1) J Roorda, WA van Stiphout and R Huijsman-Rubingh: Post-disaster health effects: strategies for investigation and data-collection experiences from the Enschede firework disaster. J Epidemiol Commun H 58, 982–987 (2004)
2) CL Katz, L Pellegrino, A Pandya, A Ng and LE DeLisi: Research on psychiatric outcomes and interventions subsequent to disasters: a review of the literature. Psychiatry Res 110, 201–217 (2002)
3) FH Norris, MJ Friedman, PJ Watson, CM Byrne, E Diaz and K Kaniasty: 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. Psychiatry 65, 207–239 (2002)
4) DH Duckworth: Psychological problems arising from disaster work. Stress Med 2, 315–323 (1986)
5) DA Alexander: Psychological intervention for victims and helpers after disasters. Br J Gen Pract 40, 345–348 (1990)
6) SI Berríos-Torres, JA Greenko, M Phillips, JR Miller, T Treadwell and RM Ikeda: World Trade Center rescue worker injury and illness surveillance, New York, 2001. Am J Prev Med 25, 79–87 (2003)
7) AJE Dirkzwager, CJ Yzermans and FJM Kessels: Psychological, musculoskeletal, and respiratory problems and sickness absence before and after involvement in a disaster: a longitudinal study among rescue workers. Occup Environ Med 61, 870–872 (2004)
8) DM Feldman, SL Baron, BP Bernard, BD Lushniak, G Banauch, N Arcentales, KJ Kelly and DJ Prezant: Symptoms, respirator use, and pulmonary function changes among New York City fire-fighters responding to the World Trade Center disaster. Chest 125, 1256–1264 (2004)
9) H Thiel de Bocanegra and E Brickman: Mental health impact of the World Trade Center attacks on displaced Chinese workers. J Trauma Stress 17, 55–62 (2002)
10) RJ Ursano, CS Fullerton, TC Kao and VR Bhartiya: Longitudinal assessment of posttraumatic stress disorder and depression after exposure to traumatic death. J Nerv Ment Dis 183, 36–42 (1995)
11) D Trout, A Nimgade, C Mueller, R Hall and GS Earnest: Health effects and occupational exposures among officer workers near the World Trade Center disaster site. J Occup Environ Med 44, 601–605 (2002)
12) CR Marmar, DS Weiss, TJ Metzler, KL Delucchi, SR Best and KA Wentworth: Longitudinal course and predictors of continuing distress following critical incident exposure in emergency services personnel. J Nerv Ment Dis 187, 15–22 (1999)
13) CR Marmar, DS Weiss, TJ Metzler and KL Delucchi: Characteristics of emergency services personnel related to peritraumatic dissociation during critical incident exposure. Am J Psychiat 153, 94–102 (1996)
14) AC McFarlane and P Papay: Multiple diagnoses in posttraumatic stress disorder in the victims of a natural disaster. J Nerv Ment Dis 180, 498–504 (1992)
15) CS North, L Tivis, JC McMillen, B Pfefferbaum, EL Spitznagel, J Cox, S Nixon, KP Bunch and EM Smith: Psychiatric disorders in rescue workers after the Oklahoma City bombing. Am J Psychiat 159, 857–859 (2002)
16) A Dyregrov, JI Kristoffersen and R Gjestad: Voluntary and professional disaster-workers: similarities and differences in reactions. J Trauma Stress 9, 541–555 (1996)
17) FH Norris, MJ Friedman and PJ Watson: 60,000 disaster victims speak: Part II. Summary and implications of the disaster mental health research. Psychiatry 65, 40–60 (2002)
18) CJ Yzermans, GA Donker, H Becker and M Oosterhek: Long-term psychological consequences of an air disaster: a six year follow-up study (submitted for publication)
19) S Ersland, L Weisæth and A Sund: The stress upon rescuers involved in an oil rig disaster: "Alexander L. Kielland" 1980. Acta Psychiatr Scand 80, 38–49 (1989)
20) CJ Yzermans, GA Donker, JJ Kerssens, AJE Dirkzwager, RJH Soeteman and PMH ten Veen. Health problems of victims before and after disaster; a longitudinal study in family practice. Int J Epidemiol 34, 820–826 (2005)
21) Statistics Netherlands. Brandweerstatistiek 2003 [Fire statistics 2003]. Voorburg/Heerlen, Statistics Netherlands, 2004.
22) Grievink L, Van der Velden P, Christiaanse B, Dijkema MBA, Dusseldorp A, Stellato RK, Fournier M, Drogendijk AN and Dorresteijn AM. Gezondheid Reddingswerkers Vuurwerkramp Enschede [The health

of rescue workers of the Enschede fireworks disaster]. Zaltbommel/Bilthoven: IvP/RIVM, 2002.
23) HF Kaiser: The application of electronic computers to factor analysis. Educ Psychol Meas 20, 141–151 (1960)
24) Cattell RB. The scientific use of factor analysis in behavioural and life sciences. New York: Plenum Press, 1978.
25) Hays RD, Prince-Embury S and Chen H. RAND-36 health status inventory. San Antonio TX: The Psychological Corporation, 1998.
26) IV Carlier, RD Lamberts, AJ van Uchelen and BP Gersons: Clinical utility of a brief diagnostic test for posttraumatic stress disorder. Psychosom Med 60, 42–47 (1998)
27) Davidson JRT, Kudler HS and Smith R. Assessment and pharmacotherapy of posttraumatic stress disorder. In: Giller JEL, ed. Biological assessment and treatment of posttraumatic stress disorder. Washington, DC: American Psychiatric Press, 1990: 205–236.
28) American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th ed. Washington, DC: American Psychiatric Association, 1994.
29) Derogatis LR. SCL-90. Administration, scoring, and procedures manual I for the R(evised) version. Baltimore: John Hopkins University School of Medicine, 1977.
30) Arrindell WA and Ettema JHM. SCL-90. Handleiding bij een multidimensionele psychopathologie-indicator [SCL-90. Manual to a multidimensional psychopathology indicator]. Lisse: Swets & Zeitlinger, 1986.
31) Evers A, Van Vliet-Mulder JC and Ter Laak J. Documentatie van tests en testresearch in Nederland [Documentation of tests and test research in the Netherlands]. Assen: Van Gorcum, 2000.
32) Van der Velden PG, Grievink L, Dusseldorp A, Fournier M, Stellato RK, Drogendijk AN, Dorresteijn AM and Christiaanse B. Gezondheid getroffenen vuurwerkramp Enschede [The health of victims of the Enschede firework disaster]. Zaltbommel/Bilthoven: IvP/RIVM, 2002.
33) BA Christiaanse, PG van der Velden, FGH Marcelissen, RJ Kleber, AM Dorresteijn, AN Drogendijk, AJ Roskam, BPR Gersons, L Grievink, M Olff and M Meewisse: The effects of disaster and post disaster stress on psychological problems of fire fighters: a longitudinal controlled study (submitted for publication).
34) RA Bryant and G Harvey: Posttraumatic stress reactions in volunteer firefighters. J Trauma Stress 9, 51–62 (1996)
35) RS Epstein, CS Fullerton and RJ Ursano: Posttraumatic stress disorder following an air disaster: a prospective study. Am J Psychiat 155, 934–938 (1998).
36) RC Kessler, A Sonnega, E Bromet, M Hughes and C Nelson: Posttraumatic stress disorder in the national comorbidity survey. Arch Gen Psychiat 52, 1048–1060 (1995)
37) Frans Ö. Posttraumatic Stress Disorder (PTSD) in the general population. Acta universitaits uppsaliensis. Comprehensive summaries of uppsala dissertations from the Faculty of Social Sciences 129. Uppsala: Faculty of Social Sciences, 2003.
38) Olff M and De Vries GJ. Prevalence of trauma and PTSD in the Netherlands. Poster presentation, 20th Annual Meeting of International Society for Traumatic Stress Studies. New Orleans: ISTSS, 2004.
39) CS Fullerton, RJ Ursano and L Wang: Acute stress disorder, posttraumatic stress disorder, and depression in disaster or rescue workers. Am J Psychiat 161, 1370–1376 (2004)
40) YK Yang, TL Yeh, CC Chen, CK Lee, IH Lee, LC Lee and KJ Jeffries: Psychiatric morbidity and posttraumatic symptoms among earthquake victims in primary care clinics. Gen Hosp Psychiatry 25, 253–261 (2003)
41) D Wagner, M Heinrichs and U Ehlert: Prevalence of symptoms of posttraumatic stress disorder in German professional fire fighters. Am J Psychiat 155, 1727–1732 (1998)
42) SA Reijneveld, MR Crone, FC Verhulst and SP Verloove-Vanhorick: The effect of a severe disaster on the mental health of adolescents: a controlled study. Lancet 362, 691–696 (2003)