Disaster-Related Posttraumatic Stress Disorder and Physical Health

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Objective: To examine the relationship between posttraumatic stress disorder (PTSD) and self-reported as well as physician-recorded physical health in a sample of survivors (n = 896) of a man-made disaster, using a longitudinal design that included predisaster health data. Most studies on the relationship between PTSD and physical health are cross-sectional and use self-reported physical health outcomes. **Methods:** A surveillance using the electronic medical records of survivors' family practitioners (FPs), 1 year predisaster until 4 years postdisaster, was combined with a survey, 3 weeks and 18 months postdisaster. Self-reported PTSD and self-reported physical health were assessed at 18 months postdisaster. FP-recorded physical health problems in the subsequent 2 years were classified according to the International Classification of Primary Care. Multiple regression analyses were used to describe the relationships between PTSD and physical health. **Results:** After adjusting for demographics, smoking behavior, and predisaster physical health, PTSD was significantly associated with FP-recorded vascular, musculoskeletal, and dermatological problems, and with all self-reported physical health aspects. Prospectively, PTSD signaled an increased risk of new vascular problems (odds ratio = 1.92; 1.04–3.55). **Conclusions:** This study suggests an effect of PTSD in the development of vascular problems. The results imply that clinicians should be alert that disaster survivors with PTSD can suffer from comorbid medical problems as well. **Key words:** posttraumatic stress disorder, physical health, cardiovascular, disaster, prospective.

EMRs = electronic medical records; **FP** = family practitioner; **ICPC** = International Classification of Primary Care; **PTSD** = posttraumatic stress disorder; **srs-PTSD** = Self-Rating Scale for Posttraumatic Stress Disorder; **DSM-IV** = Diagnostic and Statistical Manual of Mental Disorders, 4th Edition; **SCL-90-R** = Symptom Checklist-90 Revision; **RAND-36** = Short Form Health Survey-36.

INTRODUCTION

On May 13, 2000, a fireworks depot exploded in a residential area in Enschede, Netherlands. Consequently, a large part of the neighborhood was destroyed, leaving 500 uninhabitable houses and nearly 1000 damaged ones. This resulted in the necessary relocation of approximately 1200 residents. Twenty-three persons, including four fire fighters, were killed, and about 1000 people were injured. After the disaster, a large-scale monitoring study was started to investigate the health problems of the affected residents and rescue workers as well as the need for health care (1). The present study examined the relationship between posttraumatic stress disorder (PTSD) and physical health problems among the adult survivors of this disaster.

Disasters can have substantial and prolonged effects on both the psychological and physical health of survivors (2–4). PTSD is probably the most commonly studied psychological disorder in the aftermath of disasters and is characterized by having persistent intrusive memories about the traumatic event, by persistently avoiding stimuli associated with the trauma, and by experiencing persistent increased arousal (5). In a comprehensive review, Galea and colleagues concluded that the prevalence of PTSD among directly exposed survivors of disasters is approximately 30% to 40% (2).

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Psychological and physical health problems can be interrelated. It has been argued that PTSD may have an important effect on a person's physical health (6). Especially chronic PTSD may negatively affect physical health because it has been associated with adverse changes in neuroendocrine system functioning, such as altered cortisol, catecholamine, and thyroid hormone levels (7–13). A large body of research has examined the relationship between stressful life events and physical health. Less is known, however, about the physical health effects associated with stress reactions after exposure to extreme stressors, such as disasters. Research on the relationship between PTSD and physical health has mainly used self-reported physical health outcomes (14), either assessed as self-reports of chronic medical disorders or physical symptoms, or more general ratings of health-related quality of life. These studies consistently demonstrated a significant and positive association between PTSD and self-reported physical health problems (15–18).

More objective assessments of health are physicians' diagnoses and laboratory data. However, until now, few studies examined the relationship between PTSD and physical health using physician-diagnosed health problems as an outcome. Two studies on Vietnam, World War II, and Korea war veterans examined PTSD in relationship to physician-diagnosed medical disorders (19,20). PTSD was associated with more physician-diagnosed medical disorders (19), and with an increased onset of physician-diagnosed arterial, gastrointestinal, dermatological, and musculoskeletal disorders (20). Furthermore, patients with PTSD from medical centers of the Department of Veterans Affairs were more likely to have physician-diagnosed circulatory and musculoskeletal disorders, than were patients without PTSD (21). The results of these studies were observed even after potential confounders (e.g., age, smoking behavior, alcohol use, and body mass index) were statistically controlled. Several other studies among male veterans that used objective measures (e.g., laboratory results and electrocardiograms) also observed a relationship between PTSD and cardiovascular problems (22–24).

Longitudinal studies that examined the relationship between PTSD and physical health are rare, and information on the health status before the trauma is almost always unavail-

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able. Additionally, only a few studies used objective health outcomes and these studies also had some limitations. a) Although the study of Schnurr et al. (20) was longitudinal, combat-related PTSD was not measured at study outset but approximately 20 to 30 years postcombat—after many of the medical conditions had already occurred. b) The studies examined primarily (male) military populations. The present study investigates the relationships between PTSD and physical health with a longitudinal design, including predisaster health data, in a sample of survivors of a man-made disaster. Data from two sources were combined: a survey and the electronic medical records (EMRs) of survivors' family practitioners (FPs). In this way, we could examine if survivors with PTSD 18 months postdisaster were at an increased risk of both self-reported and FP-recorded physical health problems. Because of the longitudinal design of the FP data, we could also examine if PTSD was associated with the onset of new physical health problems.

METHODS

Subjects

After the fireworks disaster, the Ministry of Health, Welfare and Sports implemented two types of studies (1). First, a longitudinal surveillance was started using the EMRs of the survivors' FPs (25). In the Netherlands, FPs have fixed patient lists and every person is registered with just one family practitioner, who must first be consulted if referral to secondary care is required. In the surveillance, 73% of the FPs in the city of Enschede participated and together they covered 89% of all survivors. All data on health problems presented to the FP from 1 year before the disaster until almost 4 years postdisaster were extracted from the EMRs in an anonymous format. Data collection procedures were in accordance with the privacy protection guidelines of the Dutch Data Protection Authority.

Second, a longitudinal survey was launched in which self-report questionnaires were completed by affected residents (all ≥18 years) at three waves after the disaster (26,27). Three weeks postdisaster (wave 1), 1567 residents completed the questionnaire (estimated response rate = 35%); 1116 of those participated 18 months after the disaster (wave 2) (response rate = 71%). Before the start of each survey, the Medical Ethical Committee of the Netherlands Organization for Applied Scientific Research (TNO, Zeist) approved the study protocol, and informed consents were obtained from all respondents.

In this investigation, these two studies were combined, which resulted in 896 disaster survivors who participated in the survey at wave 1 and wave 2 (and provided complete data on the PTSD measure) and who were registered with the participating FPs as well. These 896 survivors were compared with the adult survivors (i.e., ≥18 years) of the surveillance who did not participate in the survey ($n = 7488$). The 896 survivors of the present study did not differ significantly from the other survivors with respect to age and insurance type. Compared with the other survivors, more survivors participating in both the survey and the surveillance were female (50.0% versus 46.2%; $\chi^2 = 4.42$; degrees of freedom (df) = 1; $p < .05$) and had to relocate due to the disaster (16.3% versus 7.9%; $\chi^2 = 68.08$; $df = 1$; $p < .0001$).

Instruments

Family Practitioners' Data

The EMRs of the general practices were used. After each contact with a patient, FPs electronically registered the presented health problems. All information on symptoms and diagnoses was classified according to the International Classification of Primary Care (ICPC), which is compatible with both the International Classification of Diseases and the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) (28). For the present study, individual ICPC codes were combined in the following clusters of physical health problems: cardiovascular, musculoskeletal, gastrointestinal, respiratory, dermatological, headache, and fatigue. These clusters were chosen based on literature linking traumatic exposure to poor health (20,29) and because these clusters were prevalent enough for data analysis. The clusters included ICPC codes for medical disorders as well as symptoms. When the cause of the presented complaint(s) can be determined, the FP will register the corresponding medical diagnosis (e.g., bronchitis). A FP will register symptoms when he or she cannot (yet) determine the cause of the complaints (e.g., coughing). Similar to the study of Schnurr et al. (20), we wanted to examine in depth the clusters cardiovascular and gastrointestinal, with a subdivision in hypertensive, ischemic, and arterial problems, and lower and upper gastrointestinal problems. However, the numbers were only large enough to examine the subcluster arterial/vascular problems (e.g., peripheral vascular disease, atherosclerosis, varicose veins, and edema). For each cluster, it was calculated if a person had presented one or more problems to the FP in a given period. Those who were registered in the general practice but did not visit the FP received a score of 0. The current study investigated physical health problems presented to the FP in the 2 years after the PTSD assessment, and examined the prevalence and incidence of these physical health problems (the latter relating to problems present in the 2 years after the PTSD assessment and not present previously).

In addition to the presented health problems, data on the following demographic characteristics were available: gender, age, immigrant status, and type of health insurance (i.e., private versus public). The latter variable was used as an indication for socioeconomic status; until 2006, people in the Netherlands had private health insurance when their income was above a certain level.

Self-Report Questionnaires

The Self-Rating Scale for PTSD (srs-PTSD) was used to assess disaster-related PTSD at 18 months after the disaster (30). The srs-PTSD contains 17 items corresponding to the DSM-IV diagnostic criteria for PTSD, and it assesses the severity of each item in the preceding 4 weeks. To meet the criteria for a PTSD diagnosis, a person must display at least one of five reexperiencing symptoms, three of seven avoidance symptoms, and two of five hyperarousal symptoms. The srs-PTSD has good reliability and validity (30,31). Cronbach's α coefficient for this sample was 0.93.

At 18 months postdisaster, somatic complaints were assessed using the "somatization" subscale (12 items) of the Dutch version of the Symptom Checklist-90-R (SCL-90-R) (32). A 5-point Likert scale (1 = not at all; 5 = very much) was used to measure the severity of these symptoms in the preceding week. Therefore, a higher score on the subscale represents a higher degree of somatic complaints. The validity and reliability of the Dutch SCL-90-R have proven to be satisfactory. Cronbach's α coefficient for the present population was 0.92.

A Dutch translation of the Short Form Health Survey-36 (RAND-36) was used to measure the general health status 18 months postdisaster (33). Five subscales of the RAND-36, which most closely represented physical health problems, were included in the present study: a) role limitations in work or daily life due to physical health problems (4 items); b) bodily pain (2 items); c) physical functioning (10 items); d) general health (5 items); and e) vitality (4 items). A higher score on the RAND-36 scales represents a better functioning; for instance, a high score on the bodily pain scale indicates the absence of pain. Cronbach's α coefficients for this sample ranged from 0.82 for the vitality scale to 0.92 for physical functioning.

At 3 weeks and 18 months postdisaster, a questionnaire inquired about current smoking behavior (34). Those who indicated that they smoked on both times were classified as (persistent) smokers.

Data Analyses

To examine the relationships between PTSD at 18 months postdisaster and physical health problems, multiple regression analyses were used. Multiple linear regression analyses were performed with the self-reported physical health problems (SCL-90 and RAND-36) as dependent variables. Multiple logistic regression analyses were used with FP-recorded physical health problems in the 2 years after the PTSD assessment as dependent variables.

The independent variable was PTSD at 18 months postdisaster. Either β coefficients or odds ratios (ORs) with 95% confidence intervals were presented, and the analyses were adjusted for age, gender, insurance type, immigrant status, and smoking behavior. Because the EMRs provided information on health problems presented to the FP before the disaster, we also adjusted for predisaster physical health problems in the analyses regarding the FP-recorded health problems. Multiple logistic regression analyses were also used to estimate the incidence of physical health problems (i.e., new onset in the 2 years after the PTSD assessment); this was only calculated for FP-rated health problems.

RESULTS

Population Characteristics

On average, the survivors were 44-years-old (SD = 14.42; range = 17–83) at the time of the disaster; half of them were male (50%); and 71% had public health insurance. The minority of the survivors were single (28%) and 16% had finished a high educational degree (i.e., university or vocational college). Sixteen percent (n = 146) of the survivors were of foreign origin, of which 65 came from Turkey, 19 from Europe, and 62 from other parts of the world.

PTSD

Eighteen percent (n = 160) of the survivors reported such a score on the Self-Rating Scale for PTSD that they met the criteria for PTSD 18 months postdisaster. In the period after the disaster, the FPs also diagnosed psychological health problems—the most frequently recorded problems included acute and chronic stress reactions, sleeping disorder, anxious feelings, and depressive disorder. These four problems constituted 68% of all registered postdisaster psychological problems.

PTSD and Physical Health

Survivors with PTSD reported more physical health problems on the self-report questionnaires. Compared with survivors without PTSD, survivors with PTSD reported more bodily pain, a poor physical functioning, more limitations in their lives due to physical problems, and more somatic complaints (Table 1). Furthermore, survivors with PTSD had less energy than non-PTSD survivors.

Compared with non-PTSD survivors, survivors with PTSD were more than twice as likely to be diagnosed by their FP with vascular problems, even when adjusted for personal characteristics, immigrant status, smoking behavior, and predisaster vascular problems (OR = 2.12) (Table 2). Survivors with PTSD were also more often diagnosed with dermatological and musculoskeletal problems than survivors without PTSD.

Compared with those without PTSD, survivors with PTSD reported on average a greater number of physical health problems as well (4.88 ± 4.29 (mean ± standard deviation (SD)) versus 3.00 ± 2.94; $t = -6.67$; $df = 894$; $p < .001$).

Additionally, we looked at the incidence of FP-rated physical health problems. Again, the survivors with PTSD at 18 months postdisaster were almost twice as likely to develop new vascular health problems in the 2 years after the PTSD assessment, after adjustment for demographics, smoking behavior, and predisaster physical health problems (Table 2). For the other FP-recorded physical health problems, no differences between survivors with PTSD and without PTSD were found with respect to new physical health problems.

DISCUSSION

Most prior work on the relationship between PTSD and physical health problems was cross-sectional in nature, used self-reported health outcomes, and concerned (male) military veterans. The present study enhances our knowledge by examining this relationship with a longitudinal design in a sample of disaster survivors. The results show that disaster survivors with PTSD at 18 months postdisaster were at an increased risk of FP-rated physical health problems in the subsequent 2 years. PTSD was significantly associated with FP-recorded vascular, musculoskeletal, and dermatological problems. These relationships were observed even when demographic characteristics, smoking behavior, and predisaster physical problems were statistically controlled. These findings were consistent with previous studies using physician's diagnoses, which also found significant associations between PTSD and cardiovascular, musculoskeletal, and dermatological problems among military veterans and among patients exposed to a diversity of stressful life events (19–21). Contrary to the study of Schnurr et al. (20), we did not find a statistically significant association between PTSD and gastrointestinal problems. Several explanations for this difference are possible, such as variations in

TABLE 1. Relationships Between Disaster-Related PTSD (18 Months Postdisaster) and Self-Reported Physical Health Problems

Self-Reported Health Problems[a]	PTSD Mean ± SD	No PTSD Mean ± SD	β^b	SE B	95% CI
Bodily pain (RAND-36)	51.3 ± 27.4	78.1 ± 23.2	−22.11	2.20	−26.43 to −17.79
Physical functioning (RAND-36)	62.5 ± 28.8	83.2 ± 21.6	−15.63	1.99	−19.56 to −11.71
Role limitations Physical (RAND-36)	38.0 ± 41.8	74.3 ± 36.5	−32.08	3.92	−39.77 to −24.39
General health (RAND-36)	38.0 ± 20.4	65.8 ± 21.2	−22.50	1.90	−26.23 to −18.78
Vitality (RAND-36)	32.7 ± 18.9	60.2 ± 19.2	−23.47	1.75	−26.90 to −20.03
Somatic complaints (SCL-90-R)	31.9 ± 12.0	17.3 ± 6.1	11.84	0.67	10.53 to 13.15

PTSD = posttraumatic stress disorder; SD = standard deviation; SE B = standard error of unstandardized β coefficient; CI = confidence interval; RAND-36 = Short Form Health Survey-36; SCL-90-R = Symptom Checklist-90 Revision.

[a] A higher score on the RAND-36 represents better functioning, whereas a higher score on the SCL-90-R scale represents more somatic complaints.

[b] Unstandardized β coefficients adjusted for age, gender, insurance type, immigrant status, and smoking behavior.

TABLE 2. Relationships Between Disaster-Related PTSD (18 Months Postdisaster) and Subsequent FP-Rated Physical Health Problems

Physical Health	Physical Health Problems[a]				OR[c]	95% CI	New Physical Health Problems[b]				OR[c]	95% CI
	PTSD		No PTSD				PTSD		No PTSD			
	n	%	*n*	%			*n*	%	*n*	%		
Cardiovascular—total	51	31.9	197	26.9	1.23	0.78–1.94	23	14.4	95	13.0	1.11	0.65–1.89
Cardiovascular—vascular	27	16.9	56	7.7	2.12	1.23–3.68	20	12.5	45	6.2	1.92	1.04–3.55
Respiratory	74	46.3	224	30.6	1.46	0.99–2.16	35	21.9	128	17.5	1.09	0.69–1.73
Gastrointestinal	69	43.1	191	26.1	1.44	0.96–2.17	29	18.1	123	16.8	0.96	0.59–1.56
Dermatological	74	46.3	235	32.1	1.55	1.05–2.27	39	24.4	149	20.4	1.15	0.74–1.78
Musculoskeletal	111	69.4	387	52.9	1.59	1.07–2.38	27	16.9	127	17.4	0.94	0.57–1.53
Headache	31	19.4	58	7.9	1.60	0.93–2.77	22	13.8	47	6.4	1.58	0.87–2.90
Fatigue	23	14.4	82	11.2	1.24	0.72–2.14	17	10.6	68	9.3	1.07	0.58–1.96

PTSD = posttraumatic stress disorder; FP = family practitioner; OR = odds ratio; CI = confidence interval.
[a] Health problems present in the 2 years after the PTSD assessment.
[b] Health problems present in the 2 years after the PTSD assessment, and not present previously.
[c] Adjusted for age, gender, insurance type, immigrant status, smoking behavior, and predisaster physical health problems.

methods, design and populations, or variations with respect to the traumatic stressor. It is also possible that part of the veteran population had been exposed to toxicological agents, whereas no indications were found for the presence of relevant toxins in the aftermath of the disaster of the present study (1). Furthermore, Schnurr and colleagues only found a significant relationship for lower gastrointestinal problems (20); in the present study, we were not able to make a subdivision in lower and upper gastrointestinal problems.

Because of the longitudinal design of the FP data, we could examine new physical health problems, which developed in the follow-up interval after the PTSD assessment and were not present before. A significant association was found for new vascular problems. In this case, the PTSD preceded the onset of the vascular health problems, suggesting a potential effect of PTSD in the development of such problems. An alternative explanation for such a relationship may be that survivors with PTSD are more closely monitored by their FP and, for instance, have their blood pressure measured more frequently. In this case, new physical problems may be discovered earlier among survivors with PTSD than among those without PTSD. To draw firm conclusions about a potential causal effect of PTSD in the development of vascular problems, additional longitudinal studies are needed. Another prospective study, although based on self-reported physical symptoms, found that PTSD at baseline was related to an increased likelihood of first onset of conversion symptoms (e.g., amnesia, loss of voice, and fainting) and pain symptoms (e.g., pain in extremities, back pain, and joint pain) during a 5-year follow-up interval (35).

Although PTSD was significantly associated with musculoskeletal and dermatological problems in the 2 years after the PTSD assessment, no significant relationship was found for new musculoskeletal and dermatological problems in this period. This suggests that these physical health problems had already developed in the interval between the disaster and 18 months thereafter. Because we were not able to assess PTSD before 18 months postdisaster, we do not know exactly when the PTSD had developed; therefore, it remains unclear if PTSD preceded the musculoskeletal and dermatological problems.

In addition to FP-recorded health problems, we observed that the survivors with PTSD evaluated their self-reported physical functioning and health-related quality of life as more negative than did the survivors without PTSD. This finding was in line with previous reports (14,17–19,36). According to the norms of the SCL-90-R for the Dutch general population, the average score on the somatization scale was high (females) to very high (males) for the survivors with PTSD, whereas survivors without PTSD reported an average (females) to slightly above average (males) score (32). For the RAND-36, no Dutch norms are available. However, compared with the mean scores of a Dutch national sample, the survivors with PTSD scored 21 to 38 points lower on the five RAND-36 scales, and therefore reported lower levels of functioning (37). Survivors without PTSD reported mean scores that differed between 0.2 and 8 points from this national sample.

An important question is how PTSD may influence physical health. Different mechanisms have been proposed to affect the association between PTSD and physical health, such as a direct effect through PTSD's associated neurobiology (e.g., a decreased immune function, alterations in hormone systems), as well as an indirect effect through cognitive and behavioral mechanisms, such as coping, increased health risk behaviors (e.g., increased smoking or alcohol abuse), and a heightened symptom perception among people with psychological problems (7,14). It is expected that multiple mechanisms will contribute in a complex, interacting way to the association between PTSD and physical health. Until now, however, the question of how exactly PTSD affects physical health remains still unanswered. For instance, research on the biological correlates of PTSD, e.g., cortisol, epinephrine, or dopamine, has not yet produced consistent results (6,12). To further unravel this issue, more longitudinal and controlled studies on the relationships between PTSD and physical health

are needed that use objective health indicators, such as physician-diagnosed disorders, physical examinations, or laboratory data.

Some methodological limitations of the present study need to be considered. A first concern is the representativeness of the study sample. The present study represents a relatively small group of all survivors involved in the disaster—namely, those who participated in the survey at both times and were also enrolled in the surveillance. It is possible that selection has occurred, which may limit the generalizability of the results. A comparison of the respondents of the present study with survivors participating only in the FP surveillance (this group represented 89% of all survivors) showed two significant differences, suggesting that women and severely affected survivors (i.e., those who had to relocate) may have been slightly overrepresented in the present study. Therefore, the results may be especially true for female and relocated survivors, and less generalizable for all survivors.

Second, we were not able to assess PTSD shortly after the disaster. PTSD was only assessed 18 months postdisaster. Therefore, no information was available with respect to the onset or duration of PTSD. Also, the length of follow-up was relatively short. It has been argued that especially chronic PTSD may negatively affect physical health in the long run. Previous studies including physician-diagnosed problems examined veteran populations approximately 20 to 30 years after their combat experience and therefore had an opportunity to investigate these long-term relationships (7,20). Possibly, with a longer timeframe, we might have found additional significant relationships. Furthermore, individual physical health problems had to be combined into broad clusters of health problems because of low prevalence rates. This means that the clusters of health problems included both medical diagnoses and more subjective physical symptoms. Therefore, no conclusions on specific medical conditions as recorded by the FP can be drawn.

Finally, PTSD was measured with a self-report questionnaire instead of a structured clinical interview, which is generally considered the gold standard. However, sensitivity and specificity of the Self-Rating Scale for PTSD in relationship to the structured clinical interview for PTSD were found to be good (30).

An important strength of the present study was the longitudinal study design including predisaster health data, which resulted in an additional confirmation of a relationship between PTSD and vascular problems, even when controlled for prior vascular problems. Another strength is the fact that information on physical health was obtained from two different sources: self-report measures and FP registrations. The present study investigated survivors of a man-made disaster. To our knowledge, the present study is the first study in the field of exposure to extreme stressors, which examined PTSD in relationship to physical health in a nonmilitary population using physician-recorded health outcomes. Thus, the present study adds important knowledge on the relationship between PTSD after exposure to extreme stressors and physical health.

The results imply that clinicians should be alert that disaster survivors with PTSD can suffer from comorbid medical problems as well. Especially in primary care, such survivors may initially present physical problems, and at the same time they may suffer from PTSD. If the relationship between PTSD and certain medical problems turns out to be causal, then early interventions aimed at preventing or reducing PTSD symptomatology might result in decreased healthcare costs for medical conditions.

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