THE LONG-TERM AFTERMATH OF THE AMSTERDAM AIR DISASTER:
PSYCHOLOGICAL WELLBEING OF PROFESSIONALLY INVOLVED RESCUE WORKERS

Anke B. Witteveen
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Introduction
INTRODUCTION

Chapter 1

The Amsterdam Air Disaster

On Sunday evening of the fourth of October 1992, an El Al Boeing 747 cargo aircraft crashed, after having lost two of its engines, into apartment blocks of the suburb ‘the Bijlmermeer’ in Amsterdam [1]. Rescue workers immediately reacted: fire fighters tried to extinguish the fire, searched for and rescued people and cleaned up the area, whereas police officers secured the surroundings of the disaster, brought survivors to safety and provided first aid. Some of these rescue workers also assisted in identification of human remains and personal belongings. While executing their tasks at the disaster site, rescue workers, particularly fire fighters, were confronted with the gruesome sight of extensive destruction, bewildered inhabitants of the Bijlmermeer and dead or, although few, injured victims. Several days after the crash, when the rubble was cleared and the remains of the cargo aircraft were transported to a hangar at Schiphol Airport (Amsterdam) for further investigation into the cause of the crash, the total number of victims was calculated. Unless the considerable uncertainty about the number of deaths in the first days and weeks after the air disaster, the final calculation revealed that the air disaster in Amsterdam killed 39 inhabitants of the Bijlmermeer and all four crew members of the aircraft. In addition, 266 apartments were destroyed and many people lost their homes.

The aftermath of the Amsterdam air disaster can be characterized as complex and chaotic [2]. In the first period of approximately two to three years after the disaster, the focus in relief work was predominantly on the psychological aftereffects of the disaster and on providing aftercare services for the victims (e.g., arranging for shelter). For instance, victims and people who witnessed of the disaster (including police officers) were informed about posttraumatic stress disorder (PTSD) and, if necessary, some form of trauma intervention was provided. According to a study conducted six months after the air disaster, the prevalence of PTSD among a convenience sample of 136 victims was estimated at 26% [3]. Of these victims, 44% suffered from partial PTSD. In this first period, the psychological aftereffects and aftercare (debriefing) among rescue workers, i.e., 100 police officers, involved in rescue and assistance work, were also studied. Based on questionnaires and structured interviews, Carlier and Gersons found that in 1993, 13% had problems coming to terms with the air disaster, 5% appeared to suffer from temporary problems such as acute PTSD, whereas 2% still suffered from PTSD on a second measurement in 1994 [4]. Another 6% had other psychological problems, such as anxiety disorders and depression, and 20% of the police officers had posttraumatic stress symptoms, but no full-blown PTSD. In this period the first rumors about potential health effects due to toxic exposure arose in the public. Several investigating agencies (e.g., the municipal public health service), however, concluded that the quantity of dangerous toxic material in the plane could not have caused any public health problems [5].

While in these first few years (1992-1994) after the air disaster most attention was paid to the psychological aftercare and to issues about what had caused the disaster and who was responsible for it, the second period from 1995 to 1999 was characterized by increasing rumors and suspicions about potential effects on the health of those exposed to the disaster [2]. Several factors gave rise to these suspicions and rumors. For instance, the cockpit voice recorder was never found (although voice recorders are designed to survive crashes and to be easily found), part of the depleted uranium used as balance weight in the aircraft was never recovered, and it was also speculated that the aircraft contained military goods with potential toxic substances. At the same time a gradually increasing number of residents of the Bijlmermeer and involved rescue workers were worried about their health and some, publicly, linked their physical symptoms to their involvement and exposure at the site of the air disaster. Whereas the immediate response of public authorities was evaluated by a crisis research team as adequate and positive [6, 7], the public authorities did not respond quickly and decisively to these growing suspicions about physical health effects of the disaster and journalists and action groups became determined to find out what information on the disaster was being held back by the authorities. Among the fire fighters and police officers the waxing and waning of concerns inside their own departments, might also have played an important role. Overall, these
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various chaotic and often contradictory actions of the government accompanied by extensive media coverage about unresolved issues and, specifically, a work climate of worries about health due to exposure to the air disaster might have been stressful for rescue workers involved [5, 8].

The issue of the Bijlmermeer air disaster was discussed again in the Dutch Parliament in 1997, and the Minister of Health recommended an exploratory research to estimate the extent and the nature of the health complaints attributed to the disaster. In 1998 general practitioners were interviewed to investigate whether an increase in disaster-related illnesses could be detected from the patients’ medical files [9]. In addition, 846 persons involved in the disaster reported one or more health complaints by phoning a special call center at the Amsterdam Medical Center (AMC) (44% were rescue workers, predominantly fire fighters and police officers). Of this group, 11% suffered from partial PTSD, whereas 1% suffered from full-blown PTSD. Concerning the health complaints, predominantly general physical complaints (tiredness), psychological complaints, respiratory problems, skin problems and problems with movement were reported. Investigation of the general practitioners’ medical files showed that in the immediate aftermath of the disaster most health problems of rescue and assistance workers were mental ones, whereas during the course of the years after the disaster more general and specific physical complaints in rescue workers were noticed. The researchers concluded that most of the symptoms attributed to the disaster by patients have been reported to their GP, who related only a small proportion of these to the disaster. The authors concluded that generally a link between the diversity of health problems and the air disaster could not be established [9, 10].

In 1998, a Parliamentary inquiry was started to determine the causes of the crash, the calamity suppression and recovery, the content of the cargo, and the consequences of the crash on the health (psychological, e.g., PTSD, and physical health problems) of those exposed [1]. Societal interest in this inquiry was enormous and during the inquiry several media hypes emerged [8]. For instance, a statement was made concerning a cover-up about an unknown toxic agent on board of the airplane and although this statement later turned out to be false, the media emphasized the potential cover-up. For those involved in the disaster, this information (reinforced by the media) might have been stressful, e.g., for rescue workers who were not warned to take the necessary precautions at the time of the disaster. In their conclusions the members of the Parliamentary Inquiry Committee recommended a serious and extensive investigation into the health problems of residents and rescue workers and their potential relation to the disaster [1].

THE EPIDEMIOLOGICAL STUDY AIR DISASTER AMSTERDAM

Around the time that the Parliamentary inquiry was started (i.e., in 1998), the employers of fire fighters and police officers in Amsterdam decided that the health status of their employees involved in the air disaster should be assessed. The employer of the hangar workers of Schiphol airport and government representatives of the affected residents of the Bijlmermeer and volunteer (rescue-) workers joined this initiative and all persons involved in the disaster were offered a medical examination. The occupational health service of fire fighters and police officers (KLM Health Services) was assigned to carry out this investigation. Simultaneously, the KLM Health Services approached the Institute for Research in Extramural Medicine (EMGO Institute) to carry out an epidemiological study, which was started in 2000. In this epidemiological study all professional fire fighters who were, according to company records, employed in the Amsterdam fire department and the police officers who were employed in the Amsterdam–Amstelland regional police force at the time of the air disaster and who were still in employed in 2000, were invited to participate. In addition, because almost the entire fire department had been exposed to the disaster, fire fighters who started working in the fire department after the disaster had taken place were also invited to participate in the study. Hangar workers, who were involved in the transport, security and sorting of the wreckage of the aircraft in the hangar where the wreckage was placed and their not-involved colleagues, were also part of this epidemiological study. In the current thesis, however, we do not report on the hangar workers because they were differently and less directly exposed to the air disaster than fire fighters and police officers. For instance, they were not exposed to the potential traumatic events and tasks
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at the disaster site, while the primary interest of this thesis is psychological distress, such as PTSD, due to exposure to the air disaster. This epidemiological study was also designed to assess the health of residents of the Bijlmermeer, unfortunately however, this part of the investigation had to be canceled due to low response rates. An ongoing study, i.e., the Longitudinal Aging Study Amsterdam, however, had pre-disaster and several post-disaster observations of health in older residents of the Bijlmermeer and of older residents living further away from the disaster site. It was therefore possible to study changes in health over time and relate them to the disaster. Although more negative changes in health, specifically in mobility, were observed in residents living closest to the air disaster site, the disaster-related health decline was small and only noticeable shortly after the disaster [11].

Summarized, the current thesis reports on the long-term psychological health status of fire fighters and police officers occupationally involved in the air disaster. These results are part of a larger study: the Epidemiological Study Air Disaster Amsterdam (ESADA) i.e., the epidemiological study into the long-term psychological and physical health status of professionally involved fire fighters, police officers and hangar workers. In addition to the current thesis that primarily investigates psychological distress in the aftermath of the air disaster, another thesis has investigated the physical health effects of the 1992 air disaster in professional assistance workers [12].

AIMS OF THIS THESIS

Disasters are sudden unusual events with a potential risk for those involved to develop health problems, such as PTSD or posttraumatic distress and other (comorbid) psychological (and physical) health problems (e.g., depression and anxiety). Research on the effects of disasters has primarily focused on the immediate survivors of disaster. Over the past two decades interest in the psychological health status of rescue workers, who have a high risk of exposure to critical incidents, has grown. The question remains whether rescue workers are at a high risk to develop long-term psychological distress following exposure to an unusual event such as an air disaster or, instead, are relatively resilient for psychological distress and do not suffer from long-term negative psychological wellbeing, due to for instance pre-employment screening and regular assessments of psychological and physical health.

The aim of the current thesis was to examine and to evaluate the psychological health status of fire fighters and police officers 8.5 years after occupational exposure to the Amsterdam air disaster. Occupationally exposed fire fighters and police officers are expected to have more symptoms than fire fighters and police officers not occupationally exposed to the disaster. In the ESADA historic registers of occupationally involved and non-involved rescue- and hangar workers are used to define the study population and this study may therefore be referred to as a historical cohort study. However, the ESADA is strictly speaking a cross-sectional study because exposure status and psychological distress were based on self-reports 8.5 years after the air disaster.

In this cross-sectional study the following questions were studied:
1) Do occupationally exposed rescue workers (i.e., fire fighters and police officers) differ from non-exposed colleagues regarding psychological distress, i.e., (symptoms of) PTSD and other (general) psychological distress (e.g., anxiety, somatic complaints and fatigue) 8.5 years after the air disaster? Which background-related and exposure-related (risk) factors are associated with the potential long-term psychological distress among exposed rescue workers?
2) Do occupationally exposed rescue workers differ from non-exposed rescue workers regarding self-reported health and laboratory outcomes 8.5 years after the air disaster?
3) Do occupationally exposed police officers differ from non-exposed colleagues regarding self-reported negative life events experienced in the pre- and particularly in the post-disaster period? Is the number and nature of pre- and/or post-disaster negative life events associated with psychological distress, and is this association significantly stronger for exposed than for non-exposed police officers?
4) Are potential differences between occupationally exposed rescue workers in self-reported physical health linked to the nature and extent of the psychological distress of exposed rescue workers?

5) Do occupationally exposed rescue workers (i.e., fire fighters and police officers) differ from non-exposed colleagues regarding the level of the stress hormone cortisol? Is the level of the stress hormone cortisol associated with (symptoms of) PTSD among exposed rescue workers?

**OUTLINE OF THIS THESIS**

**Chapter 2** presents a comprehensive review of studies reporting on psychological distress among rescue workers in the aftermath of disasters. The studies are evaluated regarding outcomes, risk factors, sampling issues, assessment instruments, and disaster characteristics in order to accurately determine the place and value of the current thesis and its findings in relation to the literature. The findings of the review are related to the findings of this thesis in the Discussion section (Chapter 11). In **Chapter 3** the design of the ESADA is described and discussed. In the Discussion section characteristics of the design are related to the findings of the research questions of this thesis. In **Chapters 4 and 5** the psychometric properties of the self-report instruments of posttraumatic stress are studied. More specifically, in **Chapter 4** the utility of the instruments in screening for PTSD is evaluated and in **Chapter 5** the same screening measures are evaluated regarding the dimensions underlying the posttraumatic stress response of fire fighters and police officers exposed to the air disaster, and discriminant and convergent validity of both instruments. Findings related to the psychometric properties of the instruments are related to the findings of the research questions in the Discussion section. In **Chapter 6** the outcome measures of psychological distress of the exposed fire fighters and police officers are evaluated and compared to the outcome measures of non-exposed colleagues 8.5 years after occupational exposure to the air disaster. In addition, disaster-related exposure among fire fighters and police officers is evaluated, and associations between (degree of) exposure and other background factors with psychological distress of fire fighters and police officers are studied. **Chapter 6** focuses on the first research question of the thesis. **Chapter 7** explores differences on measures of several physical health outcomes, several psychological health outcomes, and hematological and biochemical laboratory values and urinalysis outcomes between exposed and non-exposed fire fighters and police officers. This chapter focuses on the second research question of the thesis. In **Chapter 8** differences regarding pre- and post-disaster life events between exposed and non-exposed police officers are assessed and evaluated. In this chapter, possible associations between negative life events and several outcomes of psychological distress in exposed police officers compared to non-exposed police officers are also explored. In **Chapter 8** the third research question is examined. In **Chapter 9** the relationship between disaster exposure and the occurrence of multiple long-term physical symptoms among professional fire fighters and police officers is examined. In addition, the potential mediating or moderating role of posttraumatic stress symptoms in this relationship was explored. This chapter focuses on the fourth research question. In **Chapter 10** differences in basal cortisol levels from saliva obtained from exposed and non-exposed fire fighters and police officers were examined. In addition, associations between salivary cortisol concentrations and PTSD symptoms (related and unrelated to the disaster) among exposed fire fighters and police officers are examined. This chapter focuses on the fifth research question. In **Chapter 11** the results of the five research questions are summarized and their implications are discussed, i.e., methodological considerations and the relevance of the findings of the thesis are discussed and recommendations for future research are made.
REFERENCES


PSYCHOLOGICAL DISTRESS OF RESCUE WORKERS RESPONDING TO DISASTERS: A REVIEW OF THE LITERATURE

AB Witteveen

Submitted
ABSTRACT

**Objective:** Over the past two decades interest has been growing in the mental health of rescue workers who have a high risk of exposure to traumatic events and disasters. A literature review was conducted to explore the prevalence of posttraumatic stress disorder (PTSD) and other outcomes of psychological distress and its correlates or risk factors in rescue workers following disaster exposure.

**Methods:** A literature search from January 1980 to December 2004 was conducted on online databases (Pubmed, Psychlit, PILOTSdatabase).

**Results:** Across the 37 studies of rescue workers involved in 27 different disasters across various developed countries, prevalence rates of PTSD, posttraumatic distress and other psychological and psychiatric outcomes varied greatly. Overall, prevalence rates ranged from 5% to 20%, with a few rare peaks of 40% probably due to sample characteristics and procedures. Risk factors such as degree of exposure, single life status, comorbid psychiatric disorders and pre- and post-disaster negative life events were consistently related to higher levels of post-disaster psychiatric morbidity. However, some studies were contradictory regarding the potential risk or protective effect of a particular factor on psychological distress. Although type of disaster (i.e., technological vs. natural) did not clearly explain differences in outcome and risk factors between the studies, characteristics of the disaster and rescue work, and sampling and assessment methods appeared to be more important than type of disaster.

**Conclusions:** The findings of this review show that involvement in rescue work after disasters results in varying levels of specific and non-specific psychological distress and psychosocial consequences in the acute and the long-term aftermath. Methodological issues predominantly clarify the differences across studies regarding post-disaster morbidity and risk factors in rescue workers. The review shows that specific disaster characteristics, such as higher exposure to grotesque death, appear to result in a higher risk of post-disaster distress in rescue workers. In general, however, rescue workers appear relatively resilient following exposure to disasters.
1 INTRODUCTION

Approximately fifty percent to two thirds of the general population will experience a traumatic event at some point in their lives. Estimates of the lifetime prevalence of trauma (and posttraumatic stress) concern primarily surveys undertaken in Western societies, mainly in the USA [1, 2]. In the National Comorbidity Survey, 19% of men and 15% of women reported a life time experience of disaster [1]. However, higher prevalences can be expected in more remote parts of the world more frequently exposed to natural and/or technological disasters and terrorist attacks. Disasters are distinguished from other traumatic events by their magnitude. Furthermore, they have immediate implications for a large proportion of individuals, and generally overwhelm and disrupt the social and political fabric of communities. Disasters can be divided into natural and technological (or man-made) disasters. The impact of natural disasters is usually immediate and clearly visible, whereas technological disasters are caused by humans and more often have a slowly evolving, uncertain and not always readily perceptible impact. A pioneer in the field of disaster psychiatry was Edouard Stierlin [3, 4]. He focused on the most disturbed victims of disaster but also on the normal response of individuals who, although exposed to extreme adversity in man-made and technological disasters, appeared to be extremely resilient when it comes to their mental health.

Disasters are traumatic events that have always been known to cause anxiety, arousal and avoid ance [5]. In 1980, psychological problems after exposure to a traumatic event, such as a large-scale disaster, have been introduced as posttraumatic stress disorder (PTSD) into the official classification of psychiatric disorders, i.e., the Diagnostic and Statistical Manual-III (DSM-III) [6]. The disorder’s criterion symptoms in the current DSM-IV-TR are defined in terms of their connection with a traumatic event (the A or ‘stressor’ criterion) [7]. An individual suffering from PTSD experienced an event that involved an actual or threatened death or serious injury, or a threat to the physical integrity of self or others (criterion A1) and responded to this event with intense fear, helplessness or horror (criterion A2). The traumatic event is persistently reexperienced through one or more symptoms such as recurrent and distressing recollections or dreams of the event (criterion B). Individuals suffering from PTSD persistently try to avoid stimuli associated with the trauma and display numbing of general responsiveness, as indicated by three or more symptoms such as efforts to avoid thoughts, feelings or conversation associated with the trauma (criterion C), and they also suffer from increased arousal as indicated by two or more symptoms such as irritability or outburst of anger or hypervigilance (criterion D). The symptoms of criteria B, C, and D persist more than one month (criterion E) and cause clinically significant distress or impairment in social, occupational or other important areas of functioning (criterion F).

PTSD is the most frequently studied and most common psychiatric condition in response to disasters and other traumatic events. Varying prevalence rates of PTSD in the community have been reported, i.e., ranging from 1% to 14% [1, 2, 8-10]. These differences in prevalence rates across studies are, among other factors, due to whether the rates apply to current (e.g., past month) prevalence or lifetime PTSD, and whether or not PTSD is assessed following exposure to one (or more) traumatic events.

PTSD and its research has been based on several widely-held assumptions [11]. The initial response to trauma is generally assumed to be a normal response to an abnormal event [12]. Other assumptions of the post trauma stress response imply that the initial response after the trauma may continue into chronic symptoms (including partial or subthreshold PTSD), and that there is correspondence between posttraumatic stress and milder forms of stress (e.g., other symptoms of anxiety or depression) [12]. More specifically, comorbidity rates of PTSD with affective, anxiety, and substance abuse disorders are high [1], [13]. Some of this comorbidity might be an artifact due to the overlap of PTSD symptoms with features of depression and anxiety [14].

Recently, three reviews of studies of PTSD and mental health effects following exposure to disasters have been published. Norris et al. reviewed the results of 160 samples of disaster victims (e.g., children, adults, rescue workers) with respect to disaster type, disaster location, outcomes, risk factors and overall severity [15]. Among all samples, rescue workers were most resilient. Katz et al.
reviewed studies on the association of treatable psychiatric conditions with disasters, and on specific therapeutic interventions for these conditions [16]. Pre-existing mood and anxiety disorders appeared to be a risk for further psychopathology after disasters. Galea et al. reviewed 192 studies that addressed the epidemiology of PTSD after disasters regarding methodology, prevalence and incidence, PTSD correlates, and disaster type [17].

Up till now most attention in observational studies and reviews has been focused on the response of survivors to disasters. There is, however, a growing interest in the responses of rescue workers who have a relatively high chance of being involved in a large-scale accident or a disaster at some point in their careers and, as part of their jobs, are repeatedly exposed to stressful situations. Responding to a disaster can be particularly stressful for rescue and assistance workers because they are exposed to mass destruction, multiple mutilated bodies, and they may suffer from the stress of their role as a help provider [18, 19]. Angelo Hesnar d (1914) was the first researcher to describe post-traumatic stress reactions among rescue workers after two explosions on two French ships in 1907 and 1911 [20], and subsequently others have described the psychological distress of rescue workers during the 1960s and 1970s following several other disasters as well [21-23].

The overall aim of the present review was to gain insight into the mental health of rescue workers following disasters. The following questions were posed to provide a basis on which further research could be based:

- What are the prevalence rates of PTSD, subthreshold PTSD, posttraumatic distress, and other psychological and psychiatric outcomes in rescue workers following exposure to disasters?
- What risk factors or correlates in rescue workers have been found to be associated with PTSD and other signs of psychological distress in rescue workers following disasters?

The answers to these two questions are discussed taking into account methodological and disaster characteristics of the studies:

- What sampling issues might play a role in the findings across studies?
- What assessment instruments of exposure, PTSD and other psychological distress are used and (how) do these relate to the findings across studies?
- What follow-up duration was used and how does this relate to the outcomes and findings?
- Which disaster-related characteristics might play a role in the findings across studies?

2 METHODS

2.1 Literature search strategies

A literature review was performed using online databases (Pubmed, Psychinfo, and PILOTS database) and, in addition, references of selected articles and three previous reviews on the psychological impact and interventions after disasters were screened [15-17]. The following (combinations of) keywords and terms were used: disaster, rescue workers, disaster workers, police, fire fighters, trauma, mental health, PTSD, posttraumatic stress, and psychological distress. The inclusion criteria for the papers were as follows: each study must be (1) published in English from 1980 to December 2004 (because PTSD was first codified as a disorder in 1980), (2) report on the prevalence of posttraumatic stress disorder or other psychiatric morbidity among rescue workers and (3) refer to a specific disaster. Studies that report on the same sample and disaster and that come from the same research group [24-34] were counted as separate studies. However, overlapping methodologies and outcomes across these studies were not treated separately. Studies with purely qualitative study designs were excluded (e.g., [35]).
2.2 Data

The literature search produced 37 studies meeting the inclusion criteria. These articles assessed the prevalence of PTSD, posttraumatic distress, and other psychological and psychiatric outcomes in rescue workers involved in 27 different disasters across various developed countries. Several studies additionally assessed correlates and risk factors of the adverse mental health outcomes found in rescue workers. The findings of the studies were evaluated and discussed in terms of their methodology and disaster characteristics.

3 Results

3.1 Outcome measures of psychiatric morbidity

3.1.1 Posttraumatic stress disorder and acute stress disorder

Table 1 outlines the disaster and sample characteristics and designs (e.g., follow-up duration) of 37 studies conducted between 1980 and 2004 that assessed the psychological responses to disasters among rescue workers. Studies predominantly focused on the psychological responses in the immediate aftermath, i.e., within one month [33, 36-45] and/or psychological responses two to four months after the disaster [24, 25, 33, 36, 40, 45-50]. Important to note is the fact that the studies of post-disaster traumatic distress with assessment(s) within the first month, strictly speaking, do not assess PTSD because, by definition, symptoms of PTSD persist more than one month. However, in acute stress disorder (ASD), as defined in the DSM-IV, symptoms occur from four days to four weeks post trauma and three major symptom groups of PTSD are included (i.e., intrusion, avoidance, and hyperarousal). ASD differs from PTSD in the sense that at least three dissociative symptoms need to be present in diagnosing ASD, and this disorder starts somewhere within the first 30 days after the disaster and resolves relatively quickly (i.e., within 30 days). As can be seen in Table 2, ASD prevalence rates differed across studies, e.g., 26% and 5%, respectively, among rescue workers involved in two different large-scale plane crashes [39, 47], and 9% prevalence of ASD within 9-16 days after rescue work at the Chi-Chi earthquake in Taiwan [43]. Others, who did not assess ASD specifically, reported around 10% posttraumatic distress among rescue workers at initial assessment (i.e., at or within one month) [32, 37, 40, 41], or a high transient level of distress as high as 20% to 30% [36, 45]. Various prevalence rates of PTSD or a high level of posttraumatic distress have been reported in studies with assessment point(s) in the first half year after the disaster: i.e., none [24, 25, 40], around 5% [39], around 10% [32, 33, 51, 52], around 20% [28, 36, 46, 53] and sporadically spectacular figures of 40% moderate to severe posttraumatic distress [54]. Assessments of PTSD symptoms and PTSD from 7 months to approximately 1 year post disaster, revealed prevalence rates of 20% [28, 47, 55], around 10% [36, 51] or a low rate of 2% [32, 33].

In studies on the long-term aftermath (i.e., approx 2-4 years post-disaster) prevalence rates of PTSD or symptomatology were basically around 10% [25, 31]. For instance, comparable prevalence rates of 12% and 13% disaster-related PTSD were found among rescue workers 2.5 to 3 years after the Oklahoma bombing [31] and an air crash [36]. Two studies report severe PTSD levels approximately 2-3 years post-disaster of 40%, i.e., among police officers after the Hillsborough football stadium disaster [56] and in volunteer recovery workers after an airline disaster [57].

Taken together, varying PTSD prevalence rates and rates of high levels of posttraumatic distress among rescue workers in the first year after involvement in a disaster have been reported (i.e., around 5% to 20%, and sporadically a figure of 40%). However, these prevalence rates are lower than prevalence rates of PTSD in the first year among survivors of disasters, i.e., ranging from 25% to 75% [17]. In the late-term aftermath of disasters, a range of prevalence rates of PTSD and post-
traumatic distress in rescue workers has also been found. In contrast with studies on survivors or victims of disasters [58], there are hardly any studies on late-term posttraumatic distress (6-10 years) of rescue workers after responding to a disaster experienced many years previously.

### TABLE 1. DATA ON NATURAL AND MAN-MADE/TECHNOLOGICAL DISASTERS AND THE RESCUE WORKERS INVOLVED

<table>
<thead>
<tr>
<th>DISASTER</th>
<th>YEAR</th>
<th>DISASTER CHARACTERISTICS</th>
<th>SAMPLE CHARACTERISTICS</th>
<th>DESIGN</th>
<th>STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine accident Libanon</td>
<td>1994</td>
<td>Mine accident involving a Swedish UN platoon of mine clearing team; one member was severely injured another slightly.</td>
<td>$N = 31$ UN soldiers of the mine clearing team</td>
<td>5 days, and 2 and 9 months</td>
<td>Aardal-Eriksson et al. (2001)</td>
</tr>
<tr>
<td>Piper Alpha oilrig disaster</td>
<td>1988</td>
<td>167 deaths: several months after explosion 105 bodies were still missing. 73 bodies were recovered, many others in poor condition</td>
<td>$N = 71$ police officers involved in body handling and 53 controls</td>
<td>pre-, and 3 months, and 3 year post disaster</td>
<td>Alexander &amp; Wells (1991) Alexander (1993)</td>
</tr>
<tr>
<td>Major rail accident, Denmark</td>
<td>1988</td>
<td>8 (young) people were killed and 73 injured</td>
<td>$N = 77$ rescue workers (police, fire men, ambulance crew)</td>
<td>3 and 7 months</td>
<td>Andersen et al. (1991)</td>
</tr>
<tr>
<td>Airline crash in Newfoundland</td>
<td>1985</td>
<td>All 248 soldiers and 8 crew members killed</td>
<td>$N = 131$ assistance workers providing practical and emotional assistance</td>
<td>6 and 12 months</td>
<td>Bartone et al. (1989)</td>
</tr>
<tr>
<td>WTC attacks, New York</td>
<td>2001</td>
<td>Total number killed: 2,819</td>
<td>Heterogeneous group of 1,138 rescue/ recovery workers and volunteers e.g., utilities and sanitation workers, first responders.</td>
<td>15 months</td>
<td>Centers for control and disease prevention (2004)</td>
</tr>
<tr>
<td>Chi-Chi earthquake Taiwan</td>
<td>1999</td>
<td>&gt; 2400 deaths; &gt; 8000 injured; &gt;30 000 homes destroyed</td>
<td>$N = 84$ fire fighters</td>
<td>5 months</td>
<td>Chang et al. (2003)</td>
</tr>
<tr>
<td>Apartment building explosion</td>
<td>1983</td>
<td>1 died, 1 comatose, 11 hospitalized and &gt; 100 homeless</td>
<td>$N = 79$ rescue, fire, and medical personnel and police officers; $N = 53$ at the scene, $N = 26$ at the hospital.</td>
<td>5 months</td>
<td>Durham et al. (1985)</td>
</tr>
<tr>
<td>Bus crash</td>
<td>1988</td>
<td>12 children and 4 adults killed; many others sustained serious injuries</td>
<td>$N = 43$ voluntary and professional rescue workers Voluntary: on scene private citizens, Red Cross workers, fire brigade. Professional: police, fire rescue personnel and health personnel</td>
<td>1 and 13 months</td>
<td>Dyregrov et al. (1996)</td>
</tr>
<tr>
<td>Explosion super-tanker, Denmark</td>
<td>1994</td>
<td>6 deaths, 15 injured</td>
<td>$N = 270$ workers of the tanker</td>
<td>6 months</td>
<td>Elklit (1997)</td>
</tr>
<tr>
<td>Plane collision at the Ramstein Air Force Base</td>
<td>1988</td>
<td>70 spectators killed; 500 injured; severity of burns delayed identification</td>
<td>$N = 355$ military medical health care workers workers from two military bases (Ramstein and Landstuhl). Personnel at Landstuhl had previous disaster work experience.</td>
<td>6, 12 and 18 months</td>
<td>Epstein et al. (1998)</td>
</tr>
<tr>
<td>Alexander L. Kieland oilrig disaster</td>
<td>1980</td>
<td>42% of 212 oil rig workers were rescued. 76% of rescuers reported they were in danger during rescue work</td>
<td>Total $N = 134$ rescuers: $N = 24$ rescuers were professional; $N = 101$ non-professional; $N = 9$ not classified</td>
<td>9 months</td>
<td>Ersland et al. (1989)</td>
</tr>
<tr>
<td>United Airlines DC-10 Airplane crash</td>
<td>1989</td>
<td>112 died; 59 were seriously injured, and 184 survived</td>
<td>$N = 207$ exposed disaster workers from the airport disaster and $N = 421$ unexposed rescue response workers from other airports</td>
<td>2, 7 and 13 months</td>
<td>Fullerton et al. (2004)</td>
</tr>
<tr>
<td>Flight 427, Pittsburgh</td>
<td>1994</td>
<td>134 people killed on impact</td>
<td>$N = 31$ disaster workers Members of an Air National Guard Unit</td>
<td>1 week and 6 months</td>
<td>Grieger et al. (2000)</td>
</tr>
</tbody>
</table>
### Table 1. Data on natural and man-made/technological disasters and the rescue workers involved (Continued)

<table>
<thead>
<tr>
<th>DISASTER</th>
<th>YEAR</th>
<th>DISASTER CHARACTERISTICS</th>
<th>SAMPLE CHARACTERISTICS</th>
<th>DESIGN</th>
<th>STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Chi earthquake Taiwan</td>
<td>1999</td>
<td>&gt; 2400 deaths; &gt; 8000</td>
<td>N = 252 rescue workers</td>
<td>1 month</td>
<td>Guo et al. (2004)</td>
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<td></td>
<td></td>
<td>injured; &gt; 30,000 homes</td>
<td>(i.e., N = 167 fire</td>
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<td></td>
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<td>destroyed</td>
<td>fighters with formal</td>
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<td>training in rescue</td>
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<td>operations and N =</td>
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<td>85 soldiers who had no</td>
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<td>training in rescue work)</td>
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<tr>
<td>Hotel fire, Norway</td>
<td>1986</td>
<td>14 died in the fire; 54</td>
<td>N = 58 non-professional</td>
<td>1 assessment</td>
<td>Hytten &amp; Hassle (1989)</td>
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<td>hospitalized; 68 rescued</td>
<td>fire fighters from 6</td>
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<td>different industrial</td>
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<td>companies contributed</td>
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<td>to fight the fire</td>
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<tr>
<td>Avalanche, Norway</td>
<td>1994</td>
<td>One soldier died; one</td>
<td>N = 133 at 2 weeks; N =</td>
<td>2 weeks and 4</td>
<td>Johnsen et al. (1997)</td>
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<td></td>
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<td>severe</td>
<td>94 also at follow-up; N =</td>
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<td></td>
<td></td>
<td>hypothermia; several</td>
<td>49 rescuers, N = 39</td>
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<td></td>
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<td>injured</td>
<td>victims and N = 138</td>
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<td>controls all from the</td>
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<td>same Army Company</td>
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<td>themselves with a toxic</td>
<td>personnel involved in</td>
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<td>drug (including young</td>
<td>transporting and</td>
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<td>children)</td>
<td>identifying the bodies</td>
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<td>and N = 76 controls</td>
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<td>Chi-Chi earthquake Taiwan</td>
<td>1999</td>
<td>&gt; 2400 deaths; &gt; 8000</td>
<td>N = 1,104 rescue workers</td>
<td>2 months</td>
<td>Liao et al. (2002)</td>
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<td>injured; &gt; 30,000 homes</td>
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<td>destroyed</td>
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<tr>
<td>Polyvinyl chloride (PVC) fire</td>
<td>1985</td>
<td>Fire fighters and civilians</td>
<td>N = 64 exposed fire</td>
<td>5/6 weeks</td>
<td>Markowitz (1989)</td>
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<td>transported to hospital</td>
<td>fighters and N = 22</td>
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<td>after inhalation of toxic</td>
<td>non-exposed fire fighters</td>
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<td>substances (hydrogen</td>
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<td>chloride); protecting</td>
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<td>masks were ordered only</td>
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<td>nature became evident</td>
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<tr>
<td>Ash Wednesday Bush Fire disaster</td>
<td>1983</td>
<td>75 deaths and widespread</td>
<td>N = 469 fire fighters;</td>
<td>4,11, 29 months;</td>
<td>McFarlane (1988)</td>
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<td>damage to houses and land</td>
<td>subdivided into a high</td>
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<td>risk group, no symptoms</td>
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<td></td>
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<td>control group,</td>
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<tr>
<td>Oklahoma bombing</td>
<td>1995</td>
<td>168 deaths, including 19</td>
<td>N = 181 volunteer fire</td>
<td>34 months</td>
<td>North et al. (2002a)</td>
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<td></td>
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<td>children and 1 person</td>
<td>fighters</td>
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<td></td>
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<td>who died in rescue effort.</td>
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<td>North et al. (2002b)</td>
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<td>Over 220 buildings</td>
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<td>sustained damage.</td>
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<td>Bingol, earthquake</td>
<td>2003</td>
<td>176 deaths, 521 were</td>
<td>N = 44 rescue workers</td>
<td>2 months</td>
<td>Ozen &amp; Sir (2004)</td>
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<td>wounded</td>
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<tr>
<td>Discotheque fire, Sweden</td>
<td>1998</td>
<td>63 deaths; 200 injured.</td>
<td>N = 41 police officers</td>
<td>18 months</td>
<td>Renck et al. (2002)</td>
</tr>
<tr>
<td>Collapse 13-story building, Kuala</td>
<td>1993</td>
<td>70 deaths in a 13 storey</td>
<td>N = 123 fire fighters</td>
<td>within 1 month</td>
<td>Saroja et al. (1995)</td>
</tr>
<tr>
<td>Lumpur, Malaysia</td>
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<td>collapsed apartment block</td>
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<tr>
<td>Flight 427, Pittsburgh</td>
<td>1994</td>
<td>134 people killed on</td>
<td>N = 118 rescue workers</td>
<td>4/8 weeks, 6, 9 and</td>
<td>Schooler et al. (1999)</td>
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<td>impact</td>
<td>(professional and</td>
<td>12 months</td>
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<td>non-professional) 59%</td>
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<td>volun-teeled; 35% as part</td>
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<td>of their jobs; 6% gave no</td>
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<td>answer</td>
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<tr>
<td>Hillsborough football stadium</td>
<td>1989</td>
<td>95 spectators were ‘crushed’</td>
<td>N = 70 police officers</td>
<td>one assessment</td>
<td>Sims and Sims (1998)</td>
</tr>
<tr>
<td>disaster</td>
<td></td>
<td>to death</td>
<td></td>
<td>between 1-2 years</td>
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<tr>
<td>Air crash, Swiss Air</td>
<td>1998</td>
<td>229 passengers killed on</td>
<td>N = 13 volunteer disaster</td>
<td>3 years</td>
<td>Stewart et al. (2004)</td>
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<tr>
<td>impact</td>
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<td>impact</td>
<td>workers recruited from</td>
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<tr>
<td>Mount Erebus aircraft</td>
<td>1979</td>
<td>257 passengers killed at</td>
<td>N = 180 recovery and</td>
<td>initially, 3 and 20</td>
<td>Taylor and Frazer (1982)</td>
</tr>
<tr>
<td>impact</td>
<td></td>
<td>impact</td>
<td>identification workers</td>
<td>months</td>
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</tr>
<tr>
<td>Explosion USS Iowa naval ship</td>
<td>1989</td>
<td>All 47 people in the gun</td>
<td>initially and 3 months;</td>
<td>1, 4, and 13 months</td>
<td>Ursano et al. (1999)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>turret died</td>
<td>100 of them also at 20</td>
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<td>months</td>
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</tbody>
</table>
3.1.2 Other (general) psychological distress

In addition to PTSD and symptoms of posttraumatic stress, other outcomes of psychological distress such as (symptoms of) anxiety or depression or other affective disorders have been found in the aftermath of disasters as well [47, 53, 55, 59]. It is important to note that part of these other psychiatric disorders co-occur with PTSD, such as depression and anxiety disorders in disaster samples (e.g., victims) [15, 16]. In addition, PTSD itself includes several symptoms that overlap with depressive or anxiety disorders, e.g., numbing and sleep disturbances.

Table 2 underscores that depression and/or anxiety have also been found among rescue workers [29, 47, 49, 55, 56]. A longitudinal study of cohorts of fire fighters found major depression (10%) to be the second most prevalent disorder next to PTSD [29]. Moreover, a depression rate of 16% was found among rescue workers involved in an airline disaster compared to 10% among non-exposed rescue workers [47]. Phobic anxiety (19%) was the most common psychological distress disorder among rescue workers after the Chi-Chi earthquake [49], and obsessive-compulsive disorder is another outcome of disaster involvement among rescue workers [29, 49, 55].

Not all studies of rescue workers found depression or anxiety as a result of exposure to disasters. Ursano et al. [32] found no difference in depression rates among exposed rescue workers compared with the normal adult population, and Alexander & Wells [25] found no increase in the anxiety and depression scores before and after body handling duties in a disaster.

Some studies reported specifically on comorbidity of PTSD with depression and anxiety and other general distress in rescue workers after a disaster [29, 46]. For instance, McFarlane et al. [29] found that among fire fighters with PTSD, 51% also fulfilled criteria for major depression. Generalized anxiety and panic disorders were reported by 39% and 37%, respectively, of the fire fighters who suffered from a high level of posttraumatic distress.

General distress and a mix of mental and psychosomatic distress, including depression, anxiety and somatization, has been found in response to disasters with alleged or real exposure to toxic or chemical materials as well [60, 61]. Among the studies currently under review, however, only one study evaluated and found significantly high levels of demoralization and specific emotional distress among fire fighters exposed to such a disaster (i.e., a chemical fire) compared to the non-exposed [48]. Although excluded from the current review, one study reported memory deficits in police rescuers three years after the Tokyo subway sarin attack; this finding was unrelated to posttraumatic and general distress [62].

Occasionally, prevalence of alcohol abuse and alcohol dependence has been studied among rescue workers involved in disaster work [30, 31, 55-57]. Overall it appears that no new alcohol abuse or dependence cases emerged after involvement in disasters, whereas alcohol consumption among

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**Table 1. Data on natural and man-made/technological disasters and the rescue workers involved (Continued)**

<table>
<thead>
<tr>
<th>DISASTER</th>
<th>YEAR</th>
<th>DISASTER CHARACTERISTICS</th>
<th>SAMPLE CHARACTERISTICS</th>
<th>DESIGN</th>
<th>STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Chi earthquake Taiwan</td>
<td>1999</td>
<td>&gt; 2400 deaths; &gt; 8000 injured; &gt;30,000 homes destroyed</td>
<td>N = 187 military rescue workers and N = 83 military personnel not involved</td>
<td>initial (16 days); and 1 month</td>
<td>Yeh et al. (2002)</td>
</tr>
<tr>
<td>Innerstate (I-880) freeway collapse during San Francisco earthquake</td>
<td>1989</td>
<td>42 people died, many were injured.</td>
<td>N = 198 rescue workers (I-880 group)</td>
<td>N = 140 Bay Area controls also exposed to the air disaster but not involved in rescue operations</td>
<td>N = 101 San Diego controls</td>
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</tbody>
</table>
those rescue workers who were already drinkers increased after disasters and was associated with PTSD, most specifically with the two PTSD dimensions re-experiencing and hyperarousal [30, 56, 57].

As criterion F in the DSM-IV suggests, (symptoms of) PTSD (might) cause clinically significant distress or impairment in social, occupational or other important areas of functioning. Some studies have reported on social dysfunction and reduced job functioning in rescue workers after disasters [26, 27, 30, 46, 55, 56, 63].

| TABLE 2. PSYCHIATRIC SEQUELA AND THEIR RISK FACTORS AND ASSESSMENT TOOLS PER STUDY |
|----------------------------------------|-------------------------------------|---------------------------------|
| STUDY                                   | PSYCHIATRIC MORBIDITY T1            | FOLLOW-UP T2, T3, T4            |
| Aardal-Eriksson et al. (2001)           | Five days after the accident, 50% reported substantial posttraumatic distress. Based on debriefing sessions, a psychiatrist judged that none met the DSM-III-R criteria of PTSD. | Posttraumatic distress of the high-impact group was reduced, accompanied by an increase in morning and a decrease in evening cortisol levels at 2 and 9 months. |
| Alexander & Wells (1991), Alexander (1993) | No high levels of posttraumatic stress. 26% reported intrusive flashbacks at 3 months. Adequate coping strategies. | 9% had intrusive flashbacks at 3 years. Anxiety and depression not significantly increased from pre- to post-disaster |
| Andersen et al. (1991) | 10% probable PTSD, 18% probable psychiatric case at 3 months | AT 7 months similar (slightly increasing) levels of distress were found |
| Bartone et al. (1989) | Dose effect between exposure measured at 6 months | Increased negative health consequences at 12 months. Dose response effect between exposure and well-being, symptoms and illness |
| Centers for control and disease prevention (2004) | 51% met criteria for a clinical mental health evaluation; 20% PTSD; 6% depression, panic, and generalized anxiety; 10% alcohol abuse; problems in social functioning 15%, in work 14% and home 13% | Social support and hardiness interact in modulating the effects of exposure on illness |
| Chang et al. (2003) | 16.7% and 21.4% for general psychiatric morbidity and PTSD, respectively. | Coping responses as distancing, escape-avoidance and longer job experience associated with higher risk for posttraumatic distress |
| Durham et al. (1985) | 80% had at least one symptom of PTSD: 10% had at least 8 of 21 PTSD symptoms. Intrusive thoughts were present in 74% of those working with or searching for victims. | Degree of exposure: workers on scene had more PTSD symptoms than those at the hospital |
| Dyregrov et al. (1996) | 25% of voluntary helpers high posttraumatic distress level vs 13% among professionals at 1 month. | Voluntary more avoidance at 13 months. A decline in IES intrusion and IES total scores was significant from 1 to 13 months |
| Eikilt (1997) | 41% had a moderate to severe stress reaction; degree of traumatisation was higher in those who had a more ‘audience position’ than in those who were directly hit by the disaster. | Social support was protective against severity of stress reaction. Training in disaster work did not protect against adversity. |
| Epstein et al. (1998) | PTSD: 8% at 6 months | PTSD: 12% at 12 months PTSD: 7% at 18 months | Risk factors for PTSD were uncompleted college, working with burn victims, and experience of more stressful life events in 6 months after disaster | DSM PTSD-IV scale (incl. SCI-90-R and IES) |


<table>
<thead>
<tr>
<th>Study</th>
<th>Psychiatric morbidity T1</th>
<th>Follow-up T2, T3, T4</th>
<th>Correlates/risk factors</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ersland et al. (1989)</td>
<td>24% reported poor mental health due to the disaster at 9 months; only most experienced rescuers had a low health risk compared to others. 80-90% coped well with the task.</td>
<td>-</td>
<td>-</td>
<td>IES; Coping Questionnaire</td>
</tr>
</tbody>
</table>
| Fullerton et al. (2004) | ASD: 26% exposed vs. 2% non-exposed  
Overall, 40% exposed vs. 20% unexposed had ASD, depression (13 months) or PTSD. | PTSD 13 months: 17% exposed vs. 2% non-exposed  
Depression 7 months: 16% vs. 10%  
Depression 13 months: 22% vs. 13% | Risk factors for ASD were being younger and single. Higher exposure, acute stress disorder and previous disaster experience were risk factors for developing PTSD | Validated measure of ASD (Staab et al., 1996); DSM PTSD-IV scale (incl. SCI-90-R and IES); ZSDS |
| Grieger et al. (2000) | ASD: 5% at 1 week | PTSD: 6 months (5%) | ASD was prognostic of later PTSD | SASRQ; DSM PTSD-IV scale (incl. SCI-90-R and IES) |
| Guo et al. (2004) | PTSD prevalences of 19.8% and 31.8% among professional and non-professional rescue workers, respectively. | - | - | DTS-C; SPAN |
| Hytten & Hassle (1989) | 47% reported that the fire was worst they ever experienced, 80% thought to have coped with the job (fairly) well; 10% reported a high level of posttraumatic distress and disturbing stress reactions during the task. | - | Debriefing was evaluated as helpful to some degree or to a high degree by almost all 39 men in debriefing. | IES; Questions on coping and stressfulness of the disaster |
| Johnsen et al. (1997) | 10%, 9% and 4% of, respectively, rescuers, victims and controls had posttraumatic stress reactions at 2 weeks. Exposed showed higher symptom levels than controls. | At follow-up no rescuers showed posttraumatic distress, whereas 2% of the non-exposed and 12% of the victims exposed posttraumatic distress. | - | IES; PTSS |
| Jones (1985) | Guyana disaster workers reported significantly more short-term dysphoria than controls, which was more pronounced among younger aged helpers (< 25), among non-whites, non-officers, and among those more exposed to the bodies. | - | - | Unvalidated questionnaire on emotional self-assessment |
| Liao et al. (2002) | General psychological distress (16%); most common was phobic-anxiety (19%), hostility (18%), obsessive-compulsive symptoms (16%), depression (15%), paranoid ideation (14%), interpers. sensitivity (13%); anxiety (11%) | - | Personality traits (neuroticism), pre-disaster life events, and older age positively associated with psychological distress. | BSRS; MPI; Family APGAR |
| Markowitz (1989) | Significantly higher levels of demoralization and specific emotional distress among exposed than non-exposed. | No reduction of symptoms over time in a subsample (n = 55) assessed T1 and T2. | - | PERI (demoralization) Unvalidated measure of emotional distress |
| McFarlane (1988) | Posttraumatic temporarily acute distress was found in 9%, 21% had posttraumatic distress later developing into more chronic forms. | At 4, 11, and 29 months 21% had more chronic PTSD; At 42 months the high-risk subgroups: 13% PTSD, 5% borderline PTSD, 10% major depression (compared to 3.5% psychiatric morbidity among controls). PTSD remained significant in 56.5% of the high-risk group. | PTSD was associated with greater property loss and comorbidity with panic and phobic disorders and depression (51%); Affective disorder was associated with pre- and post-disaster negative life events. | IES; DIS; GHQ-12 EPI |
| McFarlane & Papay (1992) | At 4, 11, and 29 months 21% had more chronic PTSD; At 42 months the high-risk subgroups: 13% PTSD, 5% borderline PTSD, 10% major depression (compared to 3.5% psychiatric morbidity among controls). PTSD remained significant in 56.5% of the high-risk group. | PTSD was associated with greater property loss and comorbidity with panic and phobic disorders and depression (51%); Affective disorder was associated with pre- and post-disaster negative life events. | IES; DIS; GHQ-12 EPI |
| North et al. (2002a) | 13% disaster-related PTSD; 24% alcohol disorders no new cases after bombing. | PTSD and alcohol use disorders associated with poorer functioning. PTSD associated with reduced job satisfaction. | DIS DSM-III-R with disaster supplement |
| North et al. (2002b) | 13% disaster-related PTSD; 24% alcohol disorders no new cases after bombing. | PTSD and alcohol use disorders associated with poorer functioning. PTSD associated with reduced job satisfaction. | DIS DSM-III-R with disaster supplement |
| Ozen & Sir (2003) | 25% disaster-related PTSD | PTSD and quality of life were comorbid with anxiety (state and trait), depression, and less work productivity; | CAPS; STAI-I and II; BDI; Q-LES-Q; EWPS |
### Table 2. Psychiatric sequela and their risk factors and assessment tools per study (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Psychiatric Morbidity T1</th>
<th>Follow-up T2, T3, T4</th>
<th>Correlates/Risk Factors</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renck et al. (2002)</td>
<td>Around 5% (1-3 police officers) had a clinically high psychological distress level or posttraumatic stress at 18 months. High correlation between symptoms. Most officers showed reduced social functioning.</td>
<td>-</td>
<td>Older, single, and female police officers had higher posttraumatic stress levels. 75% thought debriefing was positive.</td>
<td>PTSS; IES-R; GHQ-28</td>
</tr>
<tr>
<td>Saroja et al. (1995)</td>
<td>6% (n = 7) classified as 'cases' on the general health questionnaires (GHQ)</td>
<td>-</td>
<td>Comorbidity: 5 out of 7 rescue workers with high GHQ scores had a high level of disaster-related posttraumatic stress on the IES as well</td>
<td>IES; GHQ</td>
</tr>
<tr>
<td>Schooler et al. (1999)</td>
<td>Rescue workers with uncued crash-related intrusions had higher distress levels on the GSI at 6 months than rescue workers with cued intrusions, no disaster-related intrusions</td>
<td>Those with uncued crash-related intrusions had higher distress levels on the IES at 9 and 12 months as well</td>
<td>-</td>
<td>IES; ITQ; GSI</td>
</tr>
<tr>
<td>Sims and Sims (1998)</td>
<td>44.3% severe PTSD, 41.4% moderate, 14.3% none. Alcohol consumption increased in those already drinkers; social functioning in work and marriage deteriorated with increased severity.</td>
<td>-</td>
<td>Severity of PTSD associated with depression and anxiety.</td>
<td>Interview and diagnosis based on DSM-III-R; HADS</td>
</tr>
<tr>
<td>Stewart et al. (2004)</td>
<td>46% met DSM-IV criteria for PTSD</td>
<td>-</td>
<td>PTSD was positively correlated with coping-motivated drinking and with alcohol use to forget.</td>
<td>MPSS; COPE; DMQ; Semi-structured interviews</td>
</tr>
<tr>
<td>Taylor and Frazer (1982)</td>
<td>30% transient high stress level initially</td>
<td>20% high stress at 3 months; 12% still under stress at 20 months</td>
<td>Stress levels reduced if emotional-debriefing was introduced as routine matter.</td>
<td>Clinical interviews; POPS; SCAG; HSCL</td>
</tr>
<tr>
<td>Ursano et al. (1999)</td>
<td>Probable PTSD in 11% at 1 month. Body-handlers reported more posttraumatic stress symptoms, somatization and hostility than non-body-handlers at 1 month.</td>
<td>10% and 2% at, resp., 4 and 13 months.</td>
<td>Identification with the deceased as a friend risk factor for PTSD (-symptoms) and somatization</td>
<td>DSM PTSD-IV scale (incl. SCI-90-R and IES); ZDS</td>
</tr>
<tr>
<td>Ursano et al. (1995)</td>
<td>ASD: 9% from both groups in 9-16 days compared to 16% of the controls (n.s.)</td>
<td>At 2 weeks 9% and 16% of the rescue workers and controls, respectively, had ASD. 1-month prevalence rates were in the range of 2-3%.</td>
<td>Nitric oxide was lower in subjects with ASD than in controls.</td>
<td>PTSD-I; IES; DASS</td>
</tr>
<tr>
<td>Weiss et al. (1995)</td>
<td>The I-880 group reported higher exposure, greater immediate threat appraisal and more sick days 1.5 years after the disaster. The three groups did not differ on current psychiatric symptoms. 9% had symptoms levels typical of psychiatric outpatients.</td>
<td>Those who had moderate to severe posttraumatic distress at initial assessment (1.5 years) continued to have moderate to severe stress 3 years after disaster the I-880 group</td>
<td>Rescue workers with more catastrophic exposure and dissociations at time of critical incident were at risk for continuing symptoms of distress 3-5 years after exposure.</td>
<td>IES; M-PTSD</td>
</tr>
<tr>
<td>Marmet al. (1996)</td>
<td>The I-880 group reported higher exposure, greater immediate threat appraisal and more sick days 1.5 years after the disaster. The three groups did not differ on current psychiatric symptoms. 9% had symptoms levels typical of psychiatric outpatients.</td>
<td>-</td>
<td>-</td>
<td>IES; SAS-SR</td>
</tr>
<tr>
<td>Marmet al. (1999)</td>
<td>-</td>
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</table>

**Notes:**
- **APGAR** = adaptability, partnership, growth, affiliation and resolve; **BHQ** = Body Handling Questionnaire; **BSRS** = Brief Symptom Rating Scale based on the SCL-90-R; **BS** = Bradburn Scale of psychological wellbeing; **CAPS** = Clinician Administered PTSD Scale; **CHQ** = Chinese Health Questionnaire; **COPE** = 14 distinct types of coping strategies; **CSS** = Crisis Support Scale; **CSQ** = Coping Styles Questionnaire; **CT** = Coping Questionnaire; **DASS** = Depression and Anxiety Stress Scale; **DIS** = Diagnostic Interview Scale based on DSM-III-R or DSM-IV; **DMQ** = Drinking Motives Questionnaire; **EG** = Eysenck Personality Inventory; **EWPS** = Endicott Work Productivity Scale; **GHQ** = General Health Questionnaire; **GSI** = Global Severity Index; **HADS** = Hospital Anxiety and Depression Scale; **IES** = Impact of Event Scale; **ITQ** = Intrusive Thoughts Questionnaire; **MINI** = Mini International Neuropsychological Interview; **MPSS** = Modified PTSD Symptoms Scale; **POPSS** = Physicians Outpatient Psychopathology Scale; **Q-LES-Q** = Quality of Life Enjoyment and Satisfaction Questionnaire; **SAS-SR** = Zung-Self-rating Depression scale; **SCAG** = Social Adjustment Scale- Self Report; **SCID** = Scale of Cognitive Functioning; **SDS** = Sheehan Disability Scale; **SPAN** = startle, physiological arousal, anger, and numbness extracted from the DTS to measure severity of PTSD; **STAI-1** = State Anxiety Inventory; **STAI-2** = Trait Anxiety Inventory; **WCQ** = Ways of Coping Questionnaire; **ZDS** = Zung-Self-rating Depression scale; **ZSDS** = Zung-Self-rating Depression scale; **FACTS** = Mississippi Scale for Combat-Related PTSD; **MPI** = Maudsley Personality Inventory; **MQ** = Mortuary Questionnaire; **MPSS** = Modified PTSD Symptoms Scale; **PCL** = PTSD symptom Check List; **PHQ** = Patient Health Questionnaire; **PERI** = Psychiatric Epidemiology Research Interview; **PHQ** = Patient Health Questionnaire (e.g. anxiety, depression); **PTSS** = PTSD interview; **PTSS-T10**; **Posttraumatic Symptom Scale;** **QLES-Q** = Quality of Life Enjoyment and Satisfaction Questionnaire; **SAS-SR** = Social Adjustment Scale- Self Report; **SCAG** = Scale of Cognitive Functioning; **SL-90-R** = Symptom Check List 90 revised; **SDS** = Sheehan Disability Scale; **SPAN** = startle, physiological arousal, anger, and numbness extracted from the DTS to measure severity of PTSD; **STAI-1** = State Anxiety Inventory; **STAI-2** = Trait Anxiety Inventory; **WCQ** = Ways of Coping Questionnaire; **ZDS** = Zung-Self-rating Depression scale; **ZSDS** = Zung-Self-rating Depression scale.
3.2 Risk factors or correlates

Factors that have been found to correlate with or to increase the risk of PTSD and other general psychological distress following disasters are discussed: i.e., pre- (e.g. person’s stable characteristics), peri-, (characteristics of the disaster), and post-traumatic factors (e.g. fear of toxic exposure) [64]. Studies on psychobiological outcomes that correlate with PTSD are reviewed separately.

3.2.1 Pre-traumatic factors

Several pre-traumatic factors were associated with PTSD or other post-disaster psychiatric morbidity: i.e., personality traits as neuroticism [25, 29, 49], older age [28, 29, 49, 50, 53, 54, 63] and, in contrast, younger age [47, 65], single life status, female gender [47, 63], lower education [51] and non-white ethnicity [65]. Among the studies that found ‘younger age’ to be a risk factor of psychological distress, higher levels of psychological distress among younger rescue workers only applied to distress in the short-term aftermath (e.g., ASD) [36, 47, 65]. Assessments made relatively long after disasters, revealed increased or higher levels of psychological distress in older rescue workers [36, 65].

Several studies included items on pre-disaster stressful life events [28, 49, 54, 56, 63] and prior critical incident or disaster exposure [25, 42, 47, 49, 51, 54, 59] in order to assess the influence of these factors on post-disaster psychological distress or to control for these factors. Some studies simply report on the proportion of rescue workers who had previous disaster exposure [32, 66]. Information on critical incident exposure is sometimes used to complete the (PTSD) measures [26, 27, 34, 65]. In addition, job experience of rescue workers is another factor that might be correlated with post-disaster psychological distress [53].

Although previous disaster exposure and job experience have been found to predict and/or correlate with subsequent post-disaster psychological distress, the results are contrasting across studies. Some studies report that those without or with fewer years of experience in disaster rescue work had higher levels of posttraumatic distress compared to those who had more disaster and rescue experience [26, 34, 37, 41, 42, 59], whereas, in contrast, previous disaster exposure was associated with higher post-disaster psychological distress in several other studies [47, 49, 53, 54]. For instance, Fullerton et al. reported that exposed disaster workers with previous disaster experience were six times more likely to develop PTSD, even after adjusting for exposure to the disaster. Other studies do not confirm the association between previous disaster experience and psychological distress [25, 27], or report that a higher level of distress was only present in the inexperienced rescue workers when they also had greater exposure to human remains [65]. Some studies reported that distress did not vary according to the extent of previous training [41].

Across studies a positive association between pre-disaster negative life event(s) and PTSD and psychological distress was found [28, 29, 49, 54, 56, 63]. The association depends, however, on how life events were defined, i.e., as traumatic event according to the A criterion of PTSD or as every day life stressors. The studies currently under review predominantly assessed the latter type of life events that can happen in everyday life (i.e., socio-occupational or financial changes such as divorce or being fired). This type of pre-disaster life event was associated with higher scores on trait neuroticism, with chronic psychiatric disorders [28] and with virtually every psychological outcome measure [49, 63]. Those who had several comorbid disorders were also more likely to have experienced negative life events before the disaster [29].

3.2.2 Peri-traumatic factors

An important peri-traumatic factor that played a role in post-disaster development of symptoms was type and degree of exposure [26, 34, 47, 51, 52, 65]. Overall, higher PTSD levels or general psychological distress were found in rescue workers with more intense disaster exposure [34, 66], i.e., exposure to the dead [32, 40, 41, 57, 65], numbing or dissociation during rescue work [27, 33, 40, 41, 51, 65], assisting survivors [47], greater property loss [28, 29], being in danger during rescue work [52, 59] and physical fatigue and time pressure during the rescue operation [41]. The duration
of disaster exposure was another factor associated with post-disaster psychological distress [31, 56]. In one study higher distress levels were not related to higher exposure levels in rescue workers compared to controls; however, these controls were exposed to traumatic incidents other than the disaster [27]. Alexander and Wells found, over time, that anxiety levels did not rise after body handling [24, 25].

3.2.3 Post-trauma factors
Post-trauma factors that are associated with post-disaster PTSD and psychological distress in rescue workers were; acute stress disorder [39, 47], uncued disaster-related intrusions [38], comorbidity with other psychiatric disorders [29, 46], inadequate coping responses such as escape-avoidance and coping-motivated drinking [53, 57], and post-disaster negative life events [29, 51, 63] (Table 2). Social support [54, 66] and post-disaster (emotional) debriefing appeared to be associated with reduced stress levels [36, 41, 63]. Although debriefing was generally evaluated as positive and helpful by the rescue workers it was, however, not clear from these studies (due to methodological aspects) whether debriefing was significantly associated with lower or reduced stress levels. Moreover, the efficacy of this intervention is currently the source of much debate (see for a review on this topic Wagner et al. [67]).

3.2.4 Biological correlates
The human stress response to threatening situations has been studied over the past decades by means of a number of experimental laboratory procedures. Findings on neural and endocrine interactions suggest a difference between PTSD subjects and non-PTSD control groups. For instance, PTSD after traumatic exposure is known to be related to alterations in the hypothalamic-pituitary-adrenal axis, as reflected by low (basal) cortisol levels [68, 69]. Animal studies have shown that anxiety and stress were associated with a decreased activation of the nitric oxide (NO)-cascade that is involved in the release of the stress hormone ACTH [70].

Only two studies in the current review included psychobiological markers in rescue workers following exposure to disasters. In the study of Aardal-Eriksson significant correlations between cortisol levels and posttraumatic distress were found, whereas over time the levels of distress subsided and correlations with cortisol levels were no longer significant [45]. Although these findings indicate that cortisol levels are associated with posttraumatic distress, the direction of the association between PTSD and cortisol has found to be inconsistent over the previous years, i.e., some found lower levels of cortisol in subjects with PTSD compared to controls [69], others found higher cortisol levels [71] or no differences at all. In the study of Yeh et al. [43], rescue workers with ASD had somewhat lower NO concentrations than controls; however, the results were not statistically significant and more studies of NO and its relation to the HPA-axis in rescue workers are needed.

4 DISCUSSION AND CONCLUSION

4.1 Discussion of methodological issues

4.1.1 Sampling issues
The above findings are discussed here and related to the specific sample characteristics of the studies because various subgroups of rescue workers differ in exposure characteristics and this, in turn, might be related to post-disaster psychiatric outcome.

Table 1 shows that four studies reported on homogenous samples of police officers [24, 25, 56, 63], eight on fire fighters [28-31, 41, 44, 48, 53], nine on identification and rescue workers [32, 33, 36-39, 47, 52, 57] and four on military samples [43, 45, 51, 65]. Another six studies reported on heterogeneous samples of rescue workers including police officers, fire fighters, military rescue workers and emergency service personnel [27, 34, 42, 49, 50, 55], whereas in five studies the sample con-
Chapter 2

sisted of assistance workers providing emotional and practical aid [66], or included non-professional on-scene helpers sometimes closely related to the victims [40, 45, 54, 59]. From these 37 studies it did not appear that prevalence rates of PTSD and psychological distress varied according to the specific subgroup of rescue worker (e.g., police officers or fire fighters).

One important factor, however, that seems to be related to the prevalence rates of post-disaster psychological symptoms is whether samples consisted of volunteer or professional rescue workers. Among the samples that consisted (at least partially) of non-professional rescue workers, relatively high prevalence rates of PTSD and posttraumatic distress were found and were always higher when specifically compared to those of professional rescue workers [37, 38, 40, 41, 57, 59, 65]. This difference between professional and volunteer workers may be explained by the fact that volunteer workers are less prepared to confront the horrific scenes of disasters, are not pre-selected and/or trained by an employer, and do not belong to a permanent body of rescue workers with whom they can share their disaster experience.

The sampling procedure is another factor that can greatly affect the prevalence of posttraumatic stress and post-disaster psychological distress, and can easily incorporate response bias. Among the studies under review the response rates of rescue workers who were involved in the disaster ranged from 60 to 70% [37, 50, 53, 63] to around 80 to 90% at first assessment [19, 33, 36, 38, 40, 41, 48, 52, 59, 66]. One study had low response rates of exposed (38%) and unexposed rescue workers (22%), while a non-response analysis was not performed [65]. Although the other studies reported similar response rates, it was unclear exactly how many recovery and rescue workers were actually involved in the disaster and what proportion of the total number of involved rescue workers was contacted [26-29, 34, 39, 43, 49, 51, 54, 55]. In several studies rescue workers who were previously (and voluntarily) debriefed by the researchers during rescue work were approached [24, 25, 42, 44, 45]. Furthermore, in some studies a volunteering subsample of the total group involved in the disaster responded to active recruitment by researchers and advertisements [30, 31, 57], or a specific subgroup of those with the most intense exposure was selected [28, 29, 56]. Few studies included a non-response analysis attempting to overcome the previous reported bias in response and, subsequently, in results [26, 27, 47].

The sample sizes varied substantially between studies, ranging from 13 [57] to 1,138 recovery and rescue workers [55]. Although larger samples are better because the probability of errors is minimized, the accuracy of population estimates is maximized, and the generalizability of the results is increased, a type I error (i.e., finding a relationship when in fact no relationship exists) might be incorporated in studies with large sample sizes when multiple relationships are tested. In addition, large sample sizes are more often heterogenous regarding several (risk) factors and, if not controlled for, such factors might influence the reliability of the outcomes.

4.1.2 Assessment procedures

4.1.2.1 Assessment of exposure

Overall, assessment instruments in trauma research can be divided into scales with a primary focus on the A criterion of PTSD (the traumatic event), specifically criterion A1, and those with a particular focus on the B, C, and D criteria. Some measures, such as highly structured clinical interviews, capture all criteria of PTSD of the DSM (i.e., DSM-III, DSM-III-R, and DSM-IV) [6, 72, 73].

As stated previously, type and degree of exposure to traumatic cues at the disaster scene correlate with PTSD and psychological distress [27, 34, 47, 51, 52, 65]. Primarily, an unvalidated scale of critical incident exposure at the disaster site (at least criterion A1) was used, i.e., whether or not rescue workers were exposed to at least one event at the disaster site that involves actual or threatened death or serious injury, or threat to the physical integrity of self or others [38, 40, 44, 45, 47, 53, 55, 63]. In most studies the degree of exposure was also assessed, such as the duration and type of exposure [26, 28, 29, 34, 37, 50, 54, 57, 66]. Several studies (retrospectively) assessed the A2 trauma criterion, i.e., emotional reactions and on-scene cognitions of rescue workers at the time
of the disaster [27, 30, 31, 37, 41, 42, 52, 59, 63, 65]. In some studies associations of disturbing emotions, thoughts and peri-traumatic numbness with PTSD and post-disaster psychological distress were also assessed [27, 33, 40, 41, 51, 65]. Helpful cognitions during disaster work were, for instance, giving meaning to the event [52] and/or keeping thoughts on the practical tasks at hand [37]. Retrospectively measuring the emotional reactions at the disaster site might help to select rescue workers at risk for psychological problems. For instance, greater feelings of helplessness in rescue work appears to be a risk factor for subsequent PTSD and distress [56]. Some studies were somewhat unclear as to how they measured the (degree of) exposure [39, 43, 48, 49] or had a more qualitative way of assessing exposure (e.g., with an unstructured or semi-structured clinical interview) [36, 38, 56, 57], whereas a specifically developed questionnaire to assess exposure and involvement in disaster rescue work was also used [24-27, 34].

Taken together, proper assessment of the A criterion (i.e., the disaster), and not only the A1 criterion of PTSD but also A2, might increase the ability to assess disaster-related PTSD and enable disaster management to focus on those disaster characteristics and personal reactions that increase the risk for post-disaster adjustment problems.

4.1.2.2 Assessment of PTSD

In the current review, five studies used a structured interview to assess PTSD: i.e., the National Institute of Mental Health Diagnostic Interview Schedule (NIMH-DIS; [74]) [31, 75], the Psychiatric Epidemiological Research Interview (PERI; [76]) [48], the Clinician Administered PTSD Scale (CAPS; [77]) [46] and the PTSD interview (PTSD-I; [78]) [43]. Other studies in the current review assessed PTSD with a rather unvalidated or semi-structured interview [56, 57]. The advantage of using a structured interview, like the CAPS or the PTSD-I, is that all PTSD criteria (including the stressor criterion) and fluctuations of PTSD symptoms severity over time can be assessed. These instruments have good psychometric reliability and validity. However, the major drawback of clinical interviews is that they are time consuming. Therefore, self-rating scales have clinical utility to assess PTSD, especially in large samples. PTSD among rescue workers following disaster has been assessed with several different standardized scales that more or less closely follow the DSM symptom criteria, i.e., the PTSD symptom Check List (PCL; [79]) [55], the Davidson Trauma Scale (DTS; [80]) [42], the Posttraumatic Symptom Scale (PTSS; [81]) [40, 45, 63], the Modified PTSD Symptom Scale (MPSS; [82]) [57] or the Mississippi Scale for Combat-Related PTSD (M-PTSD; [83]) [26, 27]. Most of these measures have been found reliable and valid [84].

Some studies assessed the prevalence of (probable) PTSD among rescue workers with a so-called multimethod approach. Studies with a multimethod approach use a measure of general distress (e.g., SCL-90-R), a PTSD scale specifically linked to the disaster (e.g., the IES), and additional items of criteria B, C, and D of PTSD not covered by the standardized questionnaires [32, 33, 39, 47, 51]. With such an approach all dimensions of PTSD are assessed in a more thorough manner than with only one measure of PTSD. Another advantage of this approach is that prevalence rates of PTSD in un-exposed control groups can be assessed with the PTSD items from scales not specifically linked to the disaster [47]. Other studies also used multiple measures of PTSD, general distress and socio-occupational functioning and linked these outcome measures to specifics of the disaster in order to assess a high level of disaster-related posttraumatic distress [26, 27, 34].

The most frequently used scale among the 37 studies currently under review was the original Impact of Event Scale (IES, [85]) [24, 25, 28, 29, 32, 33, 37-41, 43-45, 47, 50, 51, 53, 54, 59]. At the time the IES was developed (i.e., shortly before PTSD was introduced in the DSM-III and the ICD-9) there was a clear notion that stress in response to traumatic events followed an oscillating pattern of intrusions of the trauma and avoidance along with emotional numbing [12, 86]. The IES more or less follows the criteria B and C of PTSD with its 7 items on intrusion and 8 items on avoidance in relation to the stressor criterion (criterion A), but lacks hyperarousal symptoms and was not intended for use as a screening measure of PTSD. Nonetheless, most researchers have set a cut-off to obtain a clinically relevant prevalence rate of moderate to high levels of distress probably indicative of PTSD. For instance, in the current review, several studies used a cut-off of 19/20 for the IES to indicate a
moderate to severe level of posttraumatic distress in response to a disaster among rescue workers [37, 39, 41, 50, 54] [45], whereas others used a range of cut-off points, e.g., 25/26 indicative of PTSD [44, 53]. A revised version tapping also hyperarousal symptoms, the IES, was developed by Weiss and co-authors with data from emergency service personnel involved in rescue work [34]. Of the studies currently under review only one used the IES-R [63].

In comparing the prevalence rates of PTSD across studies, the diagnostic accuracy of the PTSD scales that have been used, is of great importance. Sensitivity and specificity rates and cut-off values of most of the PTSD scales used in the studies currently under review have been assessed against the diagnosis of PTSD with a structured interview by a clinician. For instance, the PCL-C and the DTS-C (i.e., the Chinese version used in the study of Guo et al. [42]) both yielded good concurrent validity against a PTSD diagnosis with structured interviews by clinicians, like the CAPS [87, 88]. The best cut-off point to achieve optimum sensitivity and specificity, however, may vary across settings and samples and depends on whether priority is given to sensitivity or to specificity. For instance, Horowitz suggested that a score of 19 or higher indicates clinical concern [89] and this score yielded high sensitivity and acceptable specificity in predicting DSM-IV PTSD in a study by Wohlfarth et al. [90]. Results of this same study, however, showed that a score of 35 was also acceptable yielding high specificity and only acceptable sensitivity. Other studies exploring the diagnostic accuracy and the optimal cut-off value of the IES also recommended a cut-off value of 35/36 indicating PTSD [91, 92]. For researchers it might be important to keep in mind that an IES cut-off value of 19 might produce an increased estimation of cases with potential PTSD (i.e., relatively few cases will be missed; however, false positives also occur), whereas a cut-off value of 35 might produce a decreased prevalence of cases with potential PTSD (i.e., those who really have PTSD are indeed selected; however, there is a higher chance of false negatives).

4.1.2.3 Assessment of (general) psychological distress

The General Health Questionnaire (GHQ), i.e., a measure of psychiatric impairment [28, 37, 44, 45, 50, 56, 63, 75] and the Symptom Check List-90(-R) [26, 27, 32-34, 39, 47, 51] were frequently used as measures of (more general) psychological distress (i.e., symptoms of anxiety, depression, somatic complaints). Other more predated studies used self-report scales like the Hospital Anxiety and Depression Scale (HADS), the Hopkins Symptoms Checklist (HSC) or other health questionnaires to assess symptoms of general distress [24, 25, 36, 49, 53, 55, 56]. A few studies used an additional measure specifically assessing depression and/or anxiety, such as the Zung Self-rating Depression Scale [32, 33, 43, 47] or the State Anxiety Inventory [46]. It is important to note that these measures do not assess psychological distress in specific relation to the stressor criterion (i.e., the disaster); however, associations between disaster-related posttraumatic distress and general distress can be assessed (e.g., [46]) and if an un-exposed control group is used prevalence rates can be compared (e.g., [47]). Additional information, e.g., on risk factors or correlates, was gathered with several different scales. For instance, personality was assessed with the Maudsley Personality Inventory (MPI) [49] or the Eysenck Personality Inventory [24, 25, 29, 56].

4.1.3 Measurement points and follow-up duration

Of the 37 studies, 20 assessed the rescue workers at two or more time points: nine studies reported on symptoms of PTSD and/or general psychological distress at two different assessment points [26, 27, 37, 39, 40, 43, 48, 50, 66], six studies on three different time points [32, 33, 36, 45, 47, 51], three studies included four post-disaster assessment points [28, 29, 38], and in two studies pre-disaster symptom levels of psychological distress were assessed [24, 25]. As shown in Table 1, time one assessment point took place relatively shortly after the disaster in most studies, whereas the second follow-up assessment was predominantly 6 months to one year post-disaster, and a third or fourth follow-up was done when at least the first year was passed [32, 33, 37, 38, 47, 66]. In some studies participants were re-assessed after 2-3 years [24-29, 34, 48]. The problem with a time one assessment within one month post-disaster is that, strictly speaking, PTSD cannot be assessed. ASD can be assessed and this is a risk factor for later development of PTSD.
In most studies a reduction of PTSD, PTSD symptoms and general psychological distress at follow-up was found [32, 33, 36, 37, 40, 43, 45, 51]. However, a minority of the studies reported similar symptom levels at follow-up [26, 27, 38, 48, 50], and some studies even reported increasing psychological distress at follow-up [47, 66]. Increasing psychological distress at follow-up of assistance and rescue workers in the studies of Bartone et al. [66] and Fullerton et al. [47] might, to a certain extent, be influenced by a follow-up at or around the first anniversary of the disaster, i.e., 12 months and 13 months post-disaster, respectively. One study reported that delayed onset of psychiatric disorders in rescue workers was more common than acute psychological distress [28].

Most studies evaluated in the current review had cross-sectional designs with respect to possible risk factors. From a methodological point of view, these so-called risk factors are, strictly speaking, correlates and might be predictors as well as outcomes of disaster exposure. This methodological drawback could be overcome by pre-disaster assessments. However, only one study included a pre-disaster assessment of a risk factor, i.e., personality [25]. Pre-disaster assessment is difficult since disasters strike suddenly. Nonetheless, professional rescue workers could be assessed on a regular basis, of course with guarantees regarding confidentiality of the data.

4.1.4 Confounding

In case of assessment of post-disaster psychological distress with a design that includes comparisons between exposed subjects and non-exposed control groups, adjustment for the potential confounding effect of one or more of the above mentioned (risk-) factors may be needed, especially when these factors are related to both the exposure and the outcome and are not distributed equally between groups. Although most studies do report on demographic- and disaster-related factors when they compare groups of subjects with groups of controls, they sometimes fail to adjust for these potentially confounding factors [40, 42, 43, 52] or it is decided not to adjust for these factors because no significant differences between subjects and (matched) controls were found to be present [24, 25, 32, 48]. Overall, only a few studies actually incorporated sound adjustment for factors such as marital status or previous disaster experience in their analyses [27, 34, 47, 65].

4.1.5 Disaster characteristics

Of the 37 studies currently under review 26 reported on rescue workers involved in technological or man-made disasters, i.e., rescue workers involved in explosions and/or collapsed buildings or oil rigs [24, 25, 32, 33, 44, 45, 52, 54, 59], rescue workers involved in terrorist attacks/bombings [30, 31, 55], air disasters [36, 38, 39, 47, 51, 57, 66], a rail or bus accident [37, 50], large (hotel or discothèque) fires [41, 63], mass violence (i.e., a mass suicide, or a football stadium disaster [56, 65]) or a fire with toxic substances [48]. Eleven studies reported on rescue workers involved in natural disasters such as earthquakes [26, 27, 34, 42, 43, 46, 49, 53], bushfire disasters [28, 29] or an avalanche [40].

It has been suggested that man-made/technological disasters have different and more marked consequences than natural disasters, at least in primary victims [15, 17]. Technological disasters would induce psychopathology of longer duration [93]. However, Rubonis & Bickman [94] found through statistically reviewing the literature, that natural disasters induced higher psychiatric morbidity rates across victims than man-made disasters. In the current study, higher post-disaster distress and PTSD among rescue workers as a consequence of the kind of disaster involved in (i.e., natural or technological) was not clearly obvious. More important, differences in sampling between these two types of disasters might explain the differences found in PTSD prevalence across natural and technological disasters [17], and disasters cannot always clearly be attributed to a specific cause (natural or technological), or may be caused by multiple factors.

The setting and circumstances of the disaster and rescue work more likely influence PTSD prevalence rates across studies. For instance, highly contrasting prevalence rates of PTSD of 5% and 44% were found in two samples of police officers either involved in a discotheque fire or in a football stadium disaster [56, 63]. Both samples of police officers faced severely injured and dead victims
(i.e., burned victims and victims ‘crushed’ by the crowd, respectively); however, the police officers involved in the football stadium disaster appeared to be much more affected by the disaster than those involved in rescue work at the discotheque fire, probably because they saw people die in front of them while feeling extremely helpless and powerless to prevent this.

The number of casualties in disasters might also predict the degree of post-disaster PTSD and psychological distress. In technological disasters the number of casualties (i.e., deceased victims) ranged from less than 10 ([45, 48, 50, 54]) to over 1,000 [55, 65]. In natural disasters the numbers of casualties ranged from one in an avalanche [40] to over 2,400 in earthquakes [42, 43, 49, 53]. Earthquakes and a large bushfire resulted in relatively high prevalence rates of PTSD (i.e., 20-30%) and psychological distress [28, 29, 42, 46, 53], not only because they involve the most victims but because earthquakes and bushfires may also have hit the personal environment of rescue workers. The number of casualties, however, does not always predict the degree and duration of post-disaster psychological adversity in rescue workers. For instance, in a large polyvinyl fire nobody died, but fire fighters involved in the rescue operation suffered from ongoing emotional distress with no reduction of symptoms after 20 months. In such a specific disaster, exposure to toxic substances (without ready use of protecting masks) might have caused the fire fighters to be concerned and anxious about the consequences for their own health and (consistent with other studies of victims exposed to disasters with toxic exposure) such psychological distress can be long-lasting (e.g. [60]). Disasters with a human intent, such as the Oklahoma bombing and the WTC attacks in New York City, also result in relatively high prevalence rates of PTSD in rescue workers, i.e., 20 to 40% [31, 55, 56, 65]. Studies of rescue workers involved in rescue and clean-up operations after an air disaster with a relatively high number of casualties resulted in PTSD prevalence rates ranging from 5% [39], 10% [51] to almost 20% [47]. These somewhat lower rates might be because most rescue workers arrive at a scene were most victims on the plane have died on impact and they are thus not exposed to victims fighting for their lives and the stress of helping them. One study reported a PTSD prevalence of 46% after an air disaster; however, this rate may not be generalizable because sampling characteristics differed greatly from that of other studies (i.e., a small sample of volunteer rescue workers) [57]. Bus crashes or rail accidents with a relatively small number of young casualties (i.e., young adults or children) appear to be relatively traumatic to rescue workers as well, resulting in PTSD prevalence rates around 10% [37, 50].

4.2 Limitations

Some limitations of the current review need to be addressed. First, in the current review virtually all studies between 1980 and 2004 reporting on psychological distress among rescue workers involved in a disaster were included; however, because several studies were not particularly well designed (e.g., regarding sampling procedures, measurement) this made comparisons across studies relatively difficult. However, we did not exclude the studies with more qualitative designs or less optimal methodologies because the aim of the review was to provide comprehensive insight into the current state of the literature. By this approach we were, for instance, able to evaluate methodological issues that potentially bias the outcomes of certain studies, or stress the importance of studies that include a large proportion of the exposed rescue workers and unexposed rescue workers.

Second, the current review only included studies in the English language, which might have limited the generalizability of the findings. For instance, most studies in the current review were conducted and designed in developed countries, primarily the USA, Australia and the northwestern part of Europe (e.g., Scandinavia, Great Britain), and some in the more developed parts of Asia (Malaysia, Taiwan, Turkey).

Third, we have included studies with a wide variety of mental health outcome measures, i.e., categorical and continuous measures of PTSD, posttraumatic distress and other psychological and psychiatric disorders (e.g., anxiety, depression, ASD). This approach might have decreased clarity and made comparisons of outcomes across studies more difficult. However, this approach was chosen because the current review aimed to be as comprehensive as possible regarding the total range of psychological distress among rescue workers after disasters.
4.3 Conclusions

The results can be summarized according to the two main questions of our review. First, the current review shows that, overall, prevalence rates of PTSD, and other psychiatric disorders and general psychological distress vary across studies (ranging from approximately 5% to 20%). Rarely did more than one third of the rescue worker population suffer from a moderate to high level of post-disaster psychological distress and, if this was the case, bias in sampling procedures or measurement flaws might account for this high level of psychiatric morbidity. The varying prevalence rates across studies appear to be a function of differences in sampling procedures, measures of psychiatric morbidity, specific disaster characteristics, degree of exposure of the rescue workers, and follow-up duration. In general, symptoms of most of the rescue workers decreased over time, whereas in a few studies the problems of the rescue workers persisted and showed no sign of symptom reduction.

Second, over the past two decades several risk factors for psychological distress could be identified from the studies. Regarding the pre-disaster factors, some consistently correlate with higher post-disaster PTSD or psychological distress (e.g., single life status, non-white ethnicity). Pre-disaster life events were also related to post-disaster PTSD. The directions of the associations of other pre-disaster factors were more ambiguous (e.g., previous training or disaster experience). The most important peri-traumatic risk factor was the extent and type of exposure to the disaster. Several post-traumatic risk factors could be also identified across studies (e.g., post-disaster life events, acute stress disorder, comorbid psychiatric disorders and coping responses). It is important to note that some of these factors are also outcomes of the disaster exposure (e.g., post-disaster life events, ASD, cortisol).

The results across studies were linked to and discussed with regard to methodological and disaster characteristics. For instance, it became clear that in most studies exposure and risk factors have been examined retrospectively and this might have distorted some of the findings. The current review did not indicate that the prevalence of PTSD and other (general) psychological distress differed according to the disaster type (i.e., technological versus natural disasters). In particular (disasters with “grotesque death” e.g., with a human intent and/or multiple casualties such as earthquakes) appeared to result in relatively high prevalence rates of PTSD.

This review indicates that disasters result in varying levels of specific and non-specific psychological distress and psychosocial consequences in the acute and the more long-term aftermath of rescue workers involved in assisting, saving and identifying victims of disasters. This review clarifies methodological issues that play a role in accurately assessing post-disaster morbidity in rescue workers, and gives directions as to what issues need to be taken into account before assessing psychological distress and risk factors in rescue workers after disasters to enable comparisons across studies. For instance, there are only few studies that adjust for potential confounding (risk-) factors when exposed subjects are compared to non-exposed controls. The results also indicate what specific disaster and sample characteristics are important in order to readily acknowledge a higher risk for (long-term) post-disaster distress in rescue workers after disasters.
REFERENCES


EPIDEMIOLOGICAL STUDY AIR DISASTER IN AMSTERDAM (ESADA): STUDY DESIGN

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ABSTRACT

Background: In 1992, a cargo aircraft crashed into apartment buildings in Amsterdam, killing 43 victims and destroying 266 apartments. In the aftermath there were speculations about the cause of the crash, potential exposures to hazardous materials due to the disaster and the health consequences. Starting in 2000, the Epidemiological Study Air Disaster in Amsterdam (ESADA) aimed to assess the long-term health effects of occupational exposure to this disaster on professional assistance workers.

Methods/Design: Epidemiological study among all the exposed professional fire-fighters and police officers who performed disaster-related task(s), and hangar workers who sorted the wreckage of the aircraft, as well as reference groups of their non-exposed colleagues who did not perform any disaster-related tasks. The study took place, on average, 8.5 years after the disaster. Questionnaires were used to assess details on occupational exposure to the disaster. Health measures comprised laboratory assessments in urine, blood and saliva, as well as self-reported current health measures, including health-related quality of life, and various physical and psychological symptoms.

Discussion: In this paper we describe and discuss the design of the ESADA. The ESADA will provide additional scientific knowledge on the long-term health effects of technological disasters on professional workers.
1 INTRODUCTION

In the early evening of October 4th, 1992, an El Al Boeing 747-F cargo aircraft lost two of its engines just after take off from Schiphol Airport and crashed into two apartment buildings in the Bijlmermeer, a densely populated suburb of Amsterdam (the Netherlands) [1]. The air disaster killed 43 people, and destroyed 266 apartments [1,2]. Fire fighters and police officers were called to the scene to extinguish fires, to search and rescue people, to assist in the identification of human remains and personal belongings, to secure the surroundings and to clean-up the devastated area. Many of them were faced with bewildered residents and extensive destruction, and some witnessed dead or injured victims. Within a few days the wreckage of the aircraft was transported to a hangar at Schiphol Airport, where employees (i.e. ‘hangar workers’) sorted and inspected the wreckage.

In the extensive aftermath of the disaster, rumors and questions arose about the cause of the accident, the contents of the cargo, potential exposure to hazardous materials, and health consequences [2,3]. Every now and then the media highlighted stories of individual victims, as well as uncertainties about potential exposures during the disaster [4]. One of the major topics concerned exposure to depleted uranium from the aircraft’s balance weights, particularly because some of the depleted uranium has never been recovered from the rubble [1]. However, the authors of a retrospective risk analysis "considered it improbable that the missing uranium had indeed led to the reported health complaints" [5]. Nonetheless, it appeared that a growing number of exposed workers and affected residents reported health complaints, which some of them attributed to the disaster [6]. Public and political unrest thus waxed and waned in the aftermath of the disaster [2,3]. Eventually, a parliamentary inquiry, that was held in 1998, recommended an epidemiological study on the health effects of the disaster [1].

About the same time, in 1998, the employers of professional fire fighters and police officers in Amsterdam decided to start an independent assessment of the health status of professional workers involved in the disaster. The mayor of Amsterdam assigned their occupational health service, the KLM Health Services, to organize this assessment. The employer of the hangar workers at Schiphol Airport joined this initiative, as did government representatives of the affected inhabitants and volunteer workers. It was decided to offer a medical examination to all people involved in the air disaster, residents as well as assistance workers, and that an epidemiological study would be performed simultaneously by the Institute for Research in Extramural Medicine (EMGO Institute). In this paper we report on the design of the epidemiological study among professional assistance workers: the Epidemiological Study Air Disaster in Amsterdam (ESADA). Unfortunately, the epidemiological study among residents had to be cancelled, due to low response rates.

The ESADA is the first epidemiological study that has ever been conducted after a major technological disaster in the Netherlands. The aim of this study is to assess the long-term psychological and physical health effects of occupational exposure to the air disaster in Amsterdam on professional assistance workers, i.e. fire fighters, police officers and hangar workers. Based on the scientific literature on the health effects of disasters, the main hypotheses of the ESADA concern unexplained physical symptoms [7-12], and post-traumatic stress symptoms and associated psychological symptoms [13-15]. Due to the fact that the ESADA originated partly from societal concerns, we considered it necessary to also include some additional outcomes that will answer questions for some of the affected people, which, in turn, might help to reassure them. These societal questions relate to depleted uranium, Mycoplasma species and carnitine levels in plasma. The first of these questions stems from the concerns about the depleted uranium from the aircraft’s balance weights, described above. The other two questions are primarily based on an alleged resemblance between the symptoms of some of the people affected by the air disaster in Amsterdam and the symptoms of patients with chronic fatigue syndrome (CFS) and Gulf War (I) Syndrome (GWS). Although some authors may have suggested a link between these syndromes and Mycoplasma species [16-21] or carnitine deficiency [22-26], others have rejected the existence of such links [27-29].

In this paper we describe and discuss the design of the ESADA. More details on the (organization of the) ESADA can be found on its website [30].
2 Methods / Design

2.1 Design

The ESADA is designed as a historical cohort study, in which the health of the professional fire-fighters, police officers and hangar workers who were occupationally exposed to the 1992 air disaster in Amsterdam is compared with the health of reference groups of workers with the same jobs and employers at the time of the disaster, but who were not occupationally exposed to this disaster.

2.2 Study population

The ESADA study population consisted of professional fire-fighters, police officers and hangar workers. Eligible subjects had to (1) sign informed consent; (2) have sufficient mastery of the Dutch language to fill in the questionnaires; and (3) belong to one of the following three occupational groups:

1) All professional fire-fighters who were, according to company records, employed in the Amsterdam fire department at the time of the disaster. Additional professional fire-fighters who started working in this fire department after the disaster were also invited to participate in the study, as almost the entire fire department had been exposed to the disaster.

2) All police officers (i.e. constables, warrant officers, sergeants and their supervisors) who were, according to company records, employed in the Amsterdam-Amstelland regional police force on the date of the disaster (October 4th, 1992), and were still employed there on the 1st of January 2000.

3) All the hangar workers registered as working for one of the departments involved in the transport, security and sorting of the wreckage on the date of the disaster (October 4th, 1992), and who reported to have been involved in these activities; as well as a random sample, matched with their colleagues for age, sex, department and job title, who were also registered as working for these departments on 30th November 1992, but who did not report to have been involved in any disaster-related activities.

2.3 Procedures and data-collection

The study design was approved by the two independent Medical Ethics Committees of the medical facilities involved in this project: the VU University Medical Center (VUmc) and the 'Onze Lieve Vrouwe Gasthuis' (OLVG) in Amsterdam. Potential participants were initially informed about the study via announcements in staff magazines, after which they were approached via personal letters, and eventually by telephone. All participants signed informed consent and participated voluntarily. Data were collected at the Prinsengracht out-patient clinic of the OLVG from January 2000 to March 2002, i.e. on average 8.5 years after the disaster. In addition, data on about half of the hangar workers were collected at Schiphol Airport for logistic reasons. Trained medical research assistants checked that the questionnaires had been completed, measured body height and weight, drew blood samples, and assisted with the collection of urine and saliva samples. A team of administrative employees carried out the data-entry of the questionnaires. Data of each participant were entered twice by two of these employees independently, after which inconsistencies were reviewed and any mistakes rectified. All remaining problems in the interpretation of data, such as dubious handwriting, were consistently resolved by one of the authors (AH, PS or AW).

Blood, saliva and urine samples were dealt with according to standard procedures for collection, transportation, storage and laboratory analysis. Laboratory technicians could have been aware that the samples were from the ESADA, but they were blinded for exposure and health status. The laboratories were all certified according to accredited Dutch standards.
2.4 Occupational exposure to the disaster

All participants were asked to fill in a questionnaire on occupational exposure to the air disaster. This questionnaire addressed several specific disaster-related tasks, and also the total time spent on these tasks and the location in which they were performed (e.g. on or near the disaster site, in the hangar where the wreckage was temporarily placed, or elsewhere). They were also asked to describe any other disaster-related task(s) that they had performed. Answers to the latter question were categorized (by PS and AW). The questionnaire also covered disaster-related psychosocial events in a number of items on personal experiences during the disaster (e.g. "were you in life-threatening danger?", "did you see the disaster scene during the first hours after the crash?", and "were any of your family members injured?").

These personal records of occupational exposure to the disaster were used to define 'exposed' workers, i.e. those who reported at least one disaster-related task, and 'non-exposed' workers, i.e. those who did not report any disaster-related tasks.

In addition to comparing exposed and non-exposed workers, we examined exposure-response relationships among exposed workers, in which level of exposure is characterized by the type of tasks and psychosocial events and the duration of exposure. As an additional dimension of level of exposure, we took into account the differences in potential psychotraumatic impact of exposure items, based on criterion A1 of the diagnostic criteria for Post Traumatic Stress Disorder (PTSD; American Psychiatric Association [APA]; Diagnostic and Statistical Manual of Mental Disorders-IV-Text Revision [DSM-IV-TR, 2000]) [31]. This criterion states that “the person has experienced, witnessed, or been confronted with an event or events that involve actual or threatened death or serious injury, or a threat to the physical integrity of oneself or others”. Five experts on PTSD from different universities and psychiatric hospitals independently rated the likelihood of potentially psychotraumatic disaster-related tasks and events to meet this criterion on a 4-point Likert Scale ranging from 1='very unlikely' to 4='very likely'. Subsequently, we assumed that items with a mean item score of three or higher met the A1 criterion for PTSD (i.e. A1 tasks and events), as opposed to items with a lower mean score (i.e. non-A1 tasks and events). Table 1 lists the disaster-related tasks and the psychosocial events according to their potential psychotraumatic impact.
2.5 Main health outcomes

2.5.1 Self-reported health measures:

- **Post-traumatic stress symptoms:** (a) The Dutch 22-item Self-Rating Inventory for PTSD (SRIP) [32-34] and, among exposed subjects only, (b) The 15-item Dutch version of the Impact of Event Scale (IES), which addressed post-traumatic stress symptoms with explicit reference to the air disaster in Amsterdam [35-37].

- **General mental health:** (a) The 90-item Symptom Checklist (SCL-90) [38,39]; (b) The 12-item General Health Questionnaire (GHQ-12) [40].

- **Fatigue and associated symptoms:** The 20-item Checklist Individual Strength (CIS) [41,42].

- **Health-related quality of Life:** The MOS 36-item Short-Form Health Survey (SF-36) [43,44].

- **Chronic conditions:** One questionnaire assessed the current presence and history of the following chronic conditions, which are considered to have a significant impact on well-being: diabetes; stroke, brain hemorrhage or infarction; heart attack; other heart problems (such as heart failure, or angina pectoris); cancer; chronic osteoarthritis (wear) of the hip or knee joints; hypertension;
asthma, chronic bronchitis or lung emphysema (Chronic Obstructive Pulmonary Disease [COPD]); serious or persistent intestinal disorders (longer than 3 months); chronic stomach disorders, stomach or duodenal ulcers; serious or persistent back complaints (including hernias); chronic inflammation of the joints (chronic rheumatism, rheumatoid arthritis). Workers with these chronic conditions were subsequently asked in what year the onset was, to determine whether this was before the disaster took place.

- **Physical symptoms**: Multiple questionnaires were used to assess the current presence of various physical symptoms, such as a number of respiratory, musculoskeletal, and skin symptoms.

- **Attribution of current problems to the air disaster in Amsterdam and its aftermath**: Another questionnaire assessed the extent to which exposed workers related any of their current physical, psychological or practical/financial problems to the air disaster and its aftermath. Those who attributed physical symptoms to the disaster and its aftermath were asked to specify these symptoms.

### 2.5.2 Laboratory outcomes

#### General laboratory tests [45]

- **Hematological and blood chemical outcomes**: hemoglobin, leukocyte count, differential count, platelet count and mean corpuscular volume (Sysmex SE 9000, TOA medical electronics Co. ltd); potassium (Roche Modular ISE900, Roche Diagnostics); creatinine, alkaline phosphatase, gamma-glutamyl transferase, alanine aminotransferase, creatine kinase and C-reactive protein (Roche Modular P800, Roche Diagnostics); ferritin and thyroid stimulating hormone (Centaur, Bayer Diagnostics); 2-microglobuline (IMx Abbott).

- **Autoantibodies**: nuclear antigen antibodies, anti-double stranded DNA antibodies [46], Immunoglobulin (IgM) rheumatoid factor [47], antineutrophil cytoplasmic antibodies [48,49], and cardiolipin antibodies [50,51].

- **Urine outcomes**: creatinine (Hitachi 747, Roche Diagnostics GmbH, Mannheim, Germany); microalbumin (Beckman Array 360 system); and 2-microglobuline (IMx Abbott); screening for protein, glucose, pH, blood and leukocytes (teststrip Boehringer Mannheim B.V.), followed by microscopic evaluation of the urinary sediment if indicated.

- **Saliva outcome**: cortisol concentration (Wizard 1470, Perkin Elmer).

#### Additional laboratory tests with respect to the societal questions:

- **Uranium 238**: concentration in urine (Inductively Coupled Plasma-Mass Spectrometry [ICP-MS] analyser, Finnigan Mat Element) and, at concentrations above 50 ng/l or above 50 ng/g creatinine, also the ratio of uranium 235/238 isotopes [52].

- **Total and free carnitine**: concentration in blood plasma (Mira Plus, Roche Diagnostics)[53,54].

- **DNA of any Mycoplasma species**: presence in peripheral blood mononuclear cells (DNA-isolation, Magna Pure, Roche Diagnostics; real time PCR, Taqman, Applied Biosystems); positive samples were subsequently evaluated for the presence of DNA of *Mycoplasma fermentans* [55,56].

### 2.5.3 Self-reported socio-demographic characteristics

- **Age**: at time of assessment in years.

- **Sex**: male or female.

- **Ethnicity**: categorized into those who considered themselves as European (i.e. Dutch, British, Dutch/Irish, Dutch/Chinese, Dutch/Indonesian, Portuguese, Spanish, Dutch/ Spanish and European), and others (e.g. Moroccan, Turkish, Surinam).
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- **Level of education**: highest level of education completed, categorized as: high (higher vocational education, university); medium (intermediate vocational education, higher general secondary education, or pre-university education); and low (no education, elementary school, lower vocational education, or lower general secondary education).

- **Current executive function**: yes (i.e. supervising one or more people) or no.

- **Level of physical activity**: the total number of hours spent each week on physical activities such as physical exercise, gardening and housekeeping, classified into high, medium and low according to the 33rd and 66th percentiles.

- **Alcohol consumption**: Usual and exceptional consumption of alcoholic beverages, classified into: none; light-moderate; and (extremely) excessive, i.e. consumption of (a) six or more glasses on 9-20 days a month and on 3-4 days in the last week, (b) four or more glasses on at least 21 days a month and on at least 5 days in the last week, and/or (c) more than six glasses a day, on a weekly basis.

- **Cigarette-smoking**: categorized as: never, former smoker, and current smoker.

- **Negative life events**: the number of reported negative life events, based on a questionnaire which specified 13 such events and also included two open-ended questions in which other events could be described. Subjects were asked to indicate whether any of these events happened to them before or after the disaster.

3 DISCUSSION

In recent years there has been increasing scientific and societal interest in the health consequences of man-made, technological disasters, i.e. a collective stressful experience with a sudden onset due to technological failure. Technological disasters have had psychiatric consequences [13-15,57], such as PTSD, as well as medical consequences, in particular those of toxic exposures [58-61]. In addition to direct toxic health effects, the mere suspicion and fear of exposure to hazardous materials can also take its toll on the quality of physical, psychological and social well-being in the community [62-64].

Technological disasters strike unexpectedly and suddenly, which puts time-pressure on researchers to develop study protocols, gather exposure data, call in multidisciplinary experts, and obtain financial resources for immediate epidemiological research. Disaster researchers may also have to deal with complicated socio-political and legal aspects. In addition, they have to face a number of methodological problems. These difficulties include: (a) defining the entire potentially ‘affected’ population and appropriate reference groups; (b) contacting potential participants, particularly in the case of evacuation and hospitalization; low response rates; usually without data on non-respondents [65]; (c) collecting exposure data immediately after the event, which is actually also needed for long-term epidemiological studies.

Probably due to these difficulties, evidence from large-scale epidemiological studies that have been carried out after technological disasters is rather scarce [66,67]. Furthermore, before-after comparisons are rare and only possible by chance in ongoing research projects, due to the unexpected nature of technological disasters [68-70]. Most of the studies that have been conducted so far have relied on ‘convenience samples’, which were mainly composed of those who were directly affected, such as victims and residents; were based on non-epidemiological study designs; and used group-level or retrospective, self-reported exposure data, which can be affected by recall and reporting bias [71-74].

ESADA APPROACH

The purpose of the ESADA is to assess long-term health effects of occupational exposure to the air disaster in Amsterdam on professional assistance workers. In view of the above-mentioned difficulties in epidemiological research on disasters, the ESADA has some strong methodological points.
With respect to the study population, we have been able to identify the complete cohort of exposed and non-exposed workers accurately, based on company records of employment at the time of the disaster.

Another strong point of the ESADA is that we included reference groups of colleagues, who had the same jobs and employers, but who were not occupationally exposed to the disaster. Hence, we are able to draw group-level conclusions on associations between health status and occupational exposure to the disaster.

With respect to exposure assessment, we were able to collect individual data on occupational exposure to the air disaster. Moreover, this consisted of multiple aspects of self-reported occupational exposure, including the duration and location of various disaster-related tasks and the experience of potentially stressful events during these tasks. Finally, we also included various assessments of long-term health, such as laboratory tests and self-reported symptoms and health-related quality of life, to obtain an integral evaluation of health status.

Notwithstanding these strong methodological qualities, some limitations of the ESADA design should also be mentioned. Firstly, although company records of employment were available, we still had to resolve a few difficulties regarding the definition of the study population. For the fire-fighters, this was due to the fact that almost the entire fire department of Amsterdam had been exposed to the disaster. Therefore, in order to achieve an adequate reference group, we decided to also include fire-fighters who joined this fire department after the disaster took place. With respect to the police officers, we were unable to trace those who had left the Amsterdam-Amstelland regional police force in the years after the disaster, due to administrative difficulties. Hence, it was necessary to restrict this group to those who were still working for this police force in 2000.

A second methodological issue concerns the self-report nature of occupational exposure status, and the average time-lag of 8.5 years between the disaster and the assessment. Due to administrative deficiencies in the historic registration of the exposure status, we used our detailed questionnaire data to define exposure status for all workers. Strictly speaking, the ESADA is therefore not a historic cohort study, but a cross-sectional one. The time-lag between the disaster and the exposure assessment may have led to recall bias, especially concerning certain details of exposure to the disaster, such as the duration of activities. However, it seems reasonable to assume that the workers did recollect whether or not they performed any as opposed to no disaster-related tasks, which was used to define occupational exposure status. It is therefore very unlikely that recall bias has resulted in (non-)differential misclassification of exposed and non-exposed workers. Nevertheless, recall bias should be kept in mind with respect to exposure-response relationships. We included multiple aspects of level of exposure, such as the duration and the potential psycho-traumatic character of disaster-related tasks, as it is unknown which aspect of occupational exposure to disasters is relevant for long-term health. However, we may still have missed other potentially relevant aspects, such as exposure to disaster-related media reports in the aftermath of the disaster [4,75].

Thirdly, we acknowledge the fact that, with the exception of the laboratory variables, we rely on self-reported health outcomes. However, most of the health questionnaires that we used have been validated and widely accepted, except for those used to assess the physical symptoms. Differential misclassification in self-report health measures could occur if exposed workers are more likely than non-exposed workers to interpret and report bodily sensations as symptoms. On the other hand, hypervigilance and hypochondria themselves could well be adverse health effects of (toxicological) disasters [76,77].

In conclusion, to increase our knowledge of potential health consequences of (technological) disasters, it is important to be prepared for epidemiological disaster research. Incorporating basic multi-disciplinary, epidemiological research protocols into disaster management plans will stimulate scientifically sound research on the health effects of disasters. The ESADA will provide additional scientific knowledge on the long-term health effects of technological disasters on professional workers.
REFERENCES


45. Leusden van HAIM: Diagnostisch Kompas: voorlichting over aanvullende diagnostiek [Diagnostic Compass: information on diagnostic tests], 3 edn. Amstelveen: College voor zorgverzekeringen (CVZ); 2003.


UTILITY OF THE IMPACT OF EVENT SCALE IN SCREENING FOR POSTTRAUMATIC STRESS DISORDER

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ABSTRACT

This study assesses the optimal cut-off point for the Impact of Event Scale and compares its screening properties with those of the Self-Rating Inventory for Posttraumatic Stress Disorder among war-related trauma victims. Seventy-four patients with war-related trauma were administered the Impact of Event Scale and the Self-Rating Inventory for Posttraumatic Stress Disorder, followed one week later by the Clinician Administered PTSD Scale. Receiver operating characteristic analysis indicated for the Impact of Event Scale a sensitivity of .77 and a specificity of .51 at a cut-off value of 36. For the Self-Rating Inventory for Posttraumatic Stress Disorder a sensitivity of .86 and a specificity of .69 were found at a cut-off value of 52. The authors conclude that careful use of the Impact of Event Scale as a screening measure for Posttraumatic Stress Disorder is warranted.
1 INTRODUCTION

Since the introduction of the diagnosis Posttraumatic Stress Disorder (PTSD) in the Diagnostic and Statistical Manual of Mental Disorders (DSM-III, [1]), many techniques have been developed to measure Posttraumatic Stress Disorder and its core symptoms. Structured interviews have been most reliable and valid in assessing PTSD, for instance the Clinician Administered PTSD Scale (CAPS) [2, 3]. However, the less time-consuming and easily administered self-report questionnaires are frequently and widely used to assess the prevalence of Posttraumatic Stress Disorder in large populations or in clinical practice as an early screening measure [4]. In this study the screening abilities of two self-report measures, frequently used in the Netherlands, will be assessed and compared.

A widely used self-report measure to assess symptoms of intrusion and avoidance in response to a specific traumatic event is the Impact of Event Scale [5]. The scale was published a year before the admission of the concept PTSD in the DSM-III. The Impact of Event Scale was one of the first self-rating scales for posttraumatic distress and has, subsequently, been translated into and validated in many languages. The Dutch version [6] has also been used in different studies of stress reactions in several samples, for example with cancer patients [7], partners of World War II victims [8], and burn patients [9]. The Dutch version has been proven to be a reliable and sensitive measure of assessing symptoms of intrusion and avoidance in traumatised victims [6].

The psychometric aspects of the Impact of Event Scale have been satisfactory (e.g. [10-14]). However, its validity has been subject to quite a debate (see [4, 15, 16]). The most important limitation of the Impact of Event Scale is that it does not measure hyperarousal symptoms and therefore does not assess all three criteria for PTSD as outlined by the DSM-III, DSM-III-R, and DSM-IV [1, 17, 18]. Recently, a revised version has been developed, in which six hyperarousal items and one intrusion item were added [14]. Although the application of the Impact of Event Scale -R is increasing, the original IES was still being used in recent studies (e.g. [19, 20]).

Recently, reliability and construct validity of the Dutch non-revised version have been examined by Van der Ploeg, Mooren, Kleber, Van der Velden, and Brom [21]. In this study, adequate reliability and support for the construct validity of the Dutch version was found. The two-factor model of Intrusion and Avoidance originally formulated by Horowitz, et al. [5] fit the data best across samples with a variety of trauma related to work, war, and disaster. Reliability and validity aspects of the Impact of Event Scale have also been addressed by its originator based on a review of studies that evaluated the psychometric properties of the Impact of Event Scale [22]. These authors concluded that the high correlation between IES intrusion and avoidance and PTSD diagnosis obtained in a number of studies validates the usage of the Impact of Event Scale as a screening measure of PTSD. However, they ignore the fact that to date there is little or conflicting data about the sensitivity and specificity of the Impact of Event Scale in detecting cases of PTSD (e.g., [11, 23-25]). For example, recently Wohlfarth, et al. [25] examined the validity of the Impact of Event Scale and the PTSD Symptom Scale Self-Report version [26]. The screening utility of these measures were compared against PTSD diagnoses derived from the Composite International Diagnostic Interview according to the International Classification of Diseases [27] and the DSM-IV among 79 crime victims. The authors concluded that using an Impact of Event Scale cut-off score of 19 with sensitivity and specificity values of respectively 1.00 and .78 is preferable whether using the DSM-IV or the ICD-10 criteria.

Another self-report measure increasingly used in the Netherlands is the Self-rating Inventory for PTSD [28]. Unlike the Impact of Event Scale, the measured symptoms follow the three DSM-IV symptom clusters and the symptoms are not anchored to a specific traumatic event. Criterion validity of the Self-rating Inventory for PTSD was previously assessed in two clinical samples of World War II survivors by Hovens, Van der Ploeg, Bramsen, Klaarenbeek, Schreuder & Rivero [28] with a well-documented trauma history (N = 76) yielding a cut-off score of 52 and sensitivity of .86 and specificity of .71 with the Clinician Administered PTSD Scale as external criterion. In a recent study of van Zelst, De Beurs, Beekman, Deeg, Bramsen, and Van Dyck [29] a cut-off value of 39 yielded optimal sensitivity of 74% and specificity of 81% in community sample of elderly (N=1,721) against the Composite International Diagnostic Interview as criterion standard (see also [30]).
Chapter 4

The present study attempts to assess sensitivity and specificity values for the Impact of Event Scale and the Self-rating Inventory for PTSD in a sample of 74 World War II survivors. In the current study the original version of the Impact of Event Scale was given, since data sampling in the current study took place before the revised version of the Impact of Event Scale by Weiss and Marmar [14] was even available, i.e., in 1991 by Hovens. Sensitivity and specificity values of the Self-rating Inventory for PTSD within this same sample have previously been assessed and published [28]. In this study, the Clinician-administered PTSD Scale was used as criterion standard for PTSD. Sensitivity and specificity values at different cut-off scores and receiver operating characteristic curves will be provided as well as positive and negative predictive values. Results of both measures as screening devices are discussed.

2 Method

2.1 Participants

For this study, data of subjects collected in 1991 by one of the authors for a related study [28] were analysed. Briefly, subjects were 74 patients with a well-documented war-related history of trauma such as: concentration camp experiences, hiding because of persecution, being put on a convoy, severe malnutrition during World War II, sexual abuse, rape, physical torture, being under fire, being a witness of killings, and having to kill. The sample consisted of 49 men and 25 women with a mean age of 60.2 yr. (SD = 11.5). More demographic data on the subjects have been reported earlier [28]. Recruitment of participants in the current study has been described extensively by Hovens [28]. A summary of the procedure is given here. Traumatized war victims from three treatment centers and one social rehabilitation center, respectively the Dutch National Institute for the psychotherapeutic and psychiatric treatment of resistance veterans and survivors of World War II (Centre ‘45), the Regional Institute for Psychiatric Outpatient Care in The Hague (RIAGG-Zuidhage), the Jewish Outpatient Mental Care Center (JAGGZ) and the BNMO Center of the Association for Dutch Military War and Service Victims, were informed about the purpose of the study and invited to participate. The 76 persons who agreed to participate in this study were mailed a set of questionnaires to be completed at home. Subsequently, an appointment was made for a structured interview one week later with a senior investigator or psychiatrist to confirm their willingness to continue with the study. After their agreement the Clinician-administered PTSD Scale was administered. Given incomplete data on the Impact of Event Scale, two subjects were omitted from the analysis in our study.

2.2 Measures

Impact of Event Scale [5].—This is a widely used self-administered, two dimensional inventory developed to measure intrusion and avoidance in response to a critical incident or trauma. The scale was constructed before the diagnosis of PTSD was entered in the DSM-III [1]. The Dutch version of the Impact of Event Scale was used in this study [6]. The scale has two subscales with seven items reflecting Intrusion and eight items reflecting Avoidance of the trauma. An IES total score can be calculated by summing the ratings on a 4-point scale (0 = not at all, 1 = seldom, 3 = sometimes, 5 = often) for all 15 items. Cronbach reliabilities were .71 for the total score, .72 for the subscale Intrusion and .66 for the subscale Avoidance [6]. Participants were asked to answer the Impact of Event Scale with respect to their own war experiences.

Self Rating Inventory for PTSD [28].—This is a self-report questionnaire with 22 items based on the DSM-IV criteria for PTSD. The 22 items of this questionnaire are phrased without special reference to a critical incident or traumatic event and are scored on a 4-point scale (1 = not at all, 4 = extremely). Subscale scores on Intrusion, Avoidance, and Hyperarousal, as well as a total score can be calculated. Psychometric properties, such as validity and reliability for assessing PTSD, have been good in different populations. In a large sample of veterans (N = 892) Cronbach reliabilities were .94 for the Total score, .87, .88, and .85 for the subscales Intrusion, Avoidance, and Hyperarousal, respectively [31].
Clinician-administered PTSD Scale [3].—This is a structured interview which assesses the severity and intensity of PTSD symptoms based on the 17 symptoms of the B, C and D criteria of the DSM-III-R [17] and eight symptoms associated with PTSD. In the present study, the measure was used as criterion standard for the diagnosis PTSD. The Clinician-administered PTSD Scale has been translated in Dutch and validated by Hovens, Van der Ploeg, Klaarenbeek, Bramsen, Schreuder, and Rivero [28] in a sample of 74 traumatized subjects. The same data from this sample of 74 traumatized subjects was also analyzed in the current study. In this sample of 74 traumatized subjects, overall agreement between the Clinician-administered PTSD Scale and clinical diagnosis was 79%. Concurrent validity and reliability of the Clinician-administered PTSD Scale with other measures was also established and the Clinician-administered PTSD Scale subscales correlated significantly with those of the Impact of Event Scale subscales. Cronbach reliabilities were .89 for the total score, .63 for the intrusive items, .78 for the avoidance and numbing items, and .79 for hyperarousal items [28]. Full details on psychometric properties have been reported previously [3] [2, 28].

2.3 Analysis

The diagnostic accuracy, i.e., sensitivity and specificity, of the Impact of Event Scale and the Self-rating Inventory for PTSD were assessed against the diagnosis of PTSD with the Clinician-administered PTSD Scale, which is frequently used as the established standard for PTSD measurement [32, 33]. The receiver operating curves show the relationship between the true-positive and false-positive rates for different cut-off points for both the Impact of Event Scale and the Self-rating Inventory for PTSD. Efficient screening instruments are indicated by receiver operating characteristic curves that have a high area under the curve. The area under the curve of both the Impact of Event Scale and the Self-rating Inventory for PTSD are given with the 95% confidence interval. The closer the receiver operating curve is to the diagonal reference line (of 0.5), the less information a test gives about discriminating between cases and non-cases. Sensitivity, i.e., the probability that someone with a Posttraumatic Stress Disorder diagnosis will have tested positive, and specificity, i.e., the probability that someone without a Posttraumatic Stress Disorder diagnosis will have tested negative, were calculated.

The positive predictive value and the negative predictive value were also calculated. The positive predictive value indicates which portion of the study population with a positive test does in fact have PTSD. The negative predictive value indicates which portion of the study population with a negative test does not have PTSD. These measures are sensitive to the prevalence rate of PTSD in the population studied.

3 RESULTS

Of the 74 participants, 35 received a Clinician-administered PTSD Scale diagnosis, giving a prevalence rate of 47%. The sensitivity and specificity for all possible cut-off points for the Impact of Event Scale and Self-rating Inventory for PTSD were calculated (see Fig. 1). The Impact of Event Scale performed moderately as a screening instrument for PTSD; the receiver operating curve is close to the diagonal reference line, the area under the curve is low (.71), and the confidence interval almost crosses the 0.5. The Self-rating Inventory for PTSD discriminates better between Posttraumatic Stress Disorder and non-Posttraumatic Stress Disorder cases than the IES; the receiver operating curve is further to the left than that of the Impact of Event Scale and the Self-rating Inventory for PTSD has a greater area under the curve (.84).

Table 1 gives selected diagnostic cut-off scores for the Impact of Event Scale with related sensitivity and specificity values. When sensitivity is preferred to specificity, a cut-off score of 36 yields sensitivity and specificity values of .77 and .51, respectively. Higher cut-off points offer only slightly more specificity, but at a cost of lower sensitivity. Table 1 also shows that there is no cut-off point which gives both a high positive and high negative predictive power. Of the participants 59% with a score of 36 or higher have PTSD, and 71% with a score lower than 36 do not have PTSD.
Figure 1. Receiver Operating Characteristic curves for IES and Self Rating Inventory for PTSD in 74 patients with war-related trauma against PTSD diagnoses obtained with the Clinician Administered PTSD Scale. Area under the curve for IES = 0.71 (95% confidence interval 0.59-0.83); Area under the Curve for Self Rating Inventory for PTSD = 0.84 (95% confidence interval 0.75-0.93).

Table 1 presents cut-off values for the Self-rating Inventory for PTSD with sensitivity and specificity values. At a cut-off value of 52 the sensitivity is .86, and specificity is .69. A higher cut-off score of 55 results in a lower sensitivity of .71 and a specificity of .77. A cut-off value of 52 also yields a
positive predictive value of .71 (meaning that 71% of the participants with a score of 52 or higher do have PTSD) and a negative predictive value of .84 (meaning that 84% of the participants with a score lower than 52 do not have PTSD).

### 4 Discussion

In this study the screening precision of two self-report questionnaires for Posttraumatic Stress Disorder was compared. The results of this study indicate that, compared to the Self-rating Inventory for PTSD, the Impact of Event Scale is a less sensitive and less specific screening measure for Posttraumatic Stress Disorder at least in a sample of older traumatized war veterans in the Netherlands. The results for the Impact of Event Scale indicate that a total score of 36 is the optimal cut-off point for detecting Posttraumatic Stress Disorder cases in a sample of 74 war-related trauma victims. The results concerning the Self Rating Inventory for PTSD confirm the earlier findings of Hovens, Van der Ploeg, Bramsen, Klaarenbeek, Schreuder, and Rivero [28].

Nevertheless, an Impact of Event Scale score of 36 cannot be considered optimal because specificity is as low as .51, meaning that only 51% of the subjects without PTSD will be correctly classified as not having PTSD. Higher or lower cut-off points would yield relatively more specificity at the cost of lower sensitivity, or vice versa. However, because it is better not to ‘miss’ PTSD cases (least false negatives) at the risk of including some ‘false’ positives, good sensitivity is preferred over specificity.

The results of the small number of studies investigating the criterion validity of the Impact of Event Scale do not concur with the results of the current study, especially with regard to sensitivity and specificity. First, in a study by Neal, et al. (1994, [24]) a cut-off score of 35 was found optimal with sensitivity and specificity of respectively .89 and .88. Although this cut-off score is close to the optimal cut-off score in the current study, it yielded obviously much better sensitivity and specificity. Second, in a recent Dutch study of Wohlfarth et al., a lower cut-off value of 19 with perfect sensitivity (1.00) and acceptable specificity (.78) in a sample of 79 crime victims was advised by the authors [25]. Nevertheless, since the determination of the optimal cut-off score is relatively arbitrary, a cut-off score of 35 with good sensitivity (.89) and specificity (.94) was advised in the Wohlfarth study as alternative cut-off value for the IES as well. Again, this cut-off score of 35 was close to the one identified in the current study although it yielded higher sensitivity and specificity values than those in the current study.

The better results in both studies (Wohlfarth, et al., and Neal, et al., [24, 25]) might be attributable to several procedural and sample differences. In the Neal study [24] and the Wohlfarth study [25] respectively, the Clinician Administered PTSD Scale-1 was administered during the same session in which the questionnaires were completed by the participants and the Composite International Diagnostic Interview was administered by telephone around the same time the participants received the questionnaire at home. These interviews might have reactivated symptoms related to the trauma and might have affected the response on the questionnaires, including the Impact of Event Scale. In

| TABLE 2. SELECTED CUT-OFF POINTS FOR THE SELF-RATING INVENTORY FOR PTSD WITH RELATED SENSITIVITY AND SPECIFICITY VALUES (N = 74 PATIENTS) |
|---------------------------------|-----------------|-----------------|-----------------|
| CUT-OFF POINT | SENSITIVITY | SPECIFICITY | PREDICTIVE VALUE |
|                 |               |               | POSITIVE | NEGATIVE |
| 35               | 1.00          | .26           | .55        | 1.00        |
| 39               | 1.00          | .41           | .60        | 1.00        |
| 46               | 1.00          | .59           | .69        | 1.00        |
| 48               | .97           | .62           | .69        | .96        |
| 51               | .89           | .67           | .70        | .87        |
| 52               | .86           | .69           | .71        | .84        |
| 55               | .71           | .77           | .74        | .75        |
| 60               | .60           | .82           | .75        | .70        |
| 65               | .43           | .85           | .71        | .62        |
| 70               | .29           | .92           | .77        | .59        |
| 80               | .06           | 1.00          | 1.00        | .54        |
our study however, the Impact of Event Scale was completed at home one week prior to the Clinician-administered PTSD Scale. Moreover, in both the Neal, et al. and Wohlfarth, et al. studies the participants were younger ($M = 31.5$ yr. and $M = 48$ yr., respectively) than in the current study ($M$ age $60.2$ yr., $SD = 11.5$), and their experienced traumas were more recent and different from the war-related traumas in this study sample [24, 25]. Taken together, there are procedural and sampling reasons to assume that participants in the studies of Neal, et al. and Wohlfarth, et al. might have related their symptoms to the specific trauma more easily than participants in this study, and therefore, high levels of symptoms on the Impact of Event Scale are more consistent with PTSD identification by the structured interviews in these studies [24, 25].

When the results of the study of Neal and colleagues (1995, [23]), conducted one year later than the previously described study of Neal, et al. (1994, [24]) are compared with the results of the current studies, it may be concluded that similar samples yield similar results. In the study of Neal, et al. (1995, [23]), a sensitivity of .67 and specificity of .57 was found for the Impact of Event Scale at a recommended cut-off score of 35 in a non-clinical sample of 30 former World War II prisoners with the Clinician-administered PTSD Scale-1 as external criterion. The samples of the current study and that of Neal, et al. (1995, [23]), are similar in several ways. First, Neal, et al.'s participants had a high mean age of 75.4 yr. A second important fact to note is the relatively high correlation (.73) between the IES intrusion subscale and the avoidance subscale. This correlation is in line with the .79 correlation of the IES subscales in our population [34]. These high correlations are in contrast with the moderate correlation (.49) in the Neal, et al. study (1994, [24]) with younger subjects which, in turn, is similar to that reported by others also in younger populations [5, 11]. This might imply that in studies with older samples (such as in our study and that of Neal, et al., 1995, [23]), participants rate the items almost identically on the two subscales. Moreover, the trauma experience of older participants might date back for decades, as was the case in the current study, and as a result of this it might be more difficult to comprehend the symptoms in relation to the specific trauma as opposed to the relatively shorter length of time between trauma and administration of the Impact of Event Scale in younger participants. Hence, in the case of chronic Posttraumatic Stress Disorder in, for instance, Holocaust survivors, previously neutral stimuli may come to serve as traumatic reminders over time, and avoidance may become more generalized as well [35].

The inconsistent findings across the recent study and the several studies previously discussed [23-25] are not merely attributable to sample differences or to different procedures followed. There appear to be similarities between, for instance, the study of Neal, et al. (1994, [24]) and the current study as well. Both samples comprise participants referred to a treatment center or hospital because of psychological problems after experiencing traumatic events, and both samples have comparable prevalences of PTSD determined with the Clinician-administered PTSD Scale (51% vs. 47% in our study).

Some measure characteristics that, at least partially, might clarify the results of this study have to be emphasized as well. First, the symptoms on the Impact of Event Scale have to be anchored to one or more specific traumatic events. For persons who were traumatized many years previously or who experienced more than one traumatic event, relating symptoms to a specific event may be difficult. Second, the symptoms measured with the Self-rating Inventory for PTSD do not have to be related to a specific traumatic event. Although this last mentioned characteristic of the Self-rating Inventory for PTSD is not in line with criterion A of the DSM-IV, the measure follows the symptom constellation of the DSM-IV much more closely than the Impact of Event Scale, e.g., no hyperarousal symptoms and time frame of seven days. Third, the relationship of the external criterion (i.e., the Clinician-administered PTSD Scale) with the screening instruments (i.e., the Self Rating Inventory for PTSD and the IES) was stronger for the Self-rating Inventory for PTSD than for the Impact of Event Scale in patients with war-related trauma ($N = 76$) and psychiatric outpatients ($N = 59$). Correlations between the Clinician-administered PTSD Scale and the Self-rating Inventory for PTSD and Impact of Event Scale were .75 and .61, respectively (see reference [28]).
There are some limitations of the present study that have to be considered. First, because we only examined participants in treatment for war-related trauma the findings should be replicated in a non-clinical community-based sample. Replication of these findings in samples with different sorts of trauma could possibly yield different results. Particularly when the experienced trauma is more recent, the relationship between the two questionnaires and the structured interview might be stronger. Second, the small sample size might also pose a limitation to the reliability of the findings in the current study. Third, the nonrevised version without hyperarousal symptoms was used in the current study. This might have lessened the sensitivity of the Impact of Event Scale to yield good criterion validity, i.e. specificity.

Summarizing, this study indicates that the Impact of Event Scale is less accurate in identifying PTSD cases than the Self-rating Inventory for PTSD. The optimal cut-off point of 36 for the Impact of Event Scale in this group of war-related trauma victims has acceptable sensitivity though relatively low specificity. Based on the current results, it might be concluded that the use of the Impact of Event Scale as screening measure for PTSD is questionable, but it is important to note that the use of the Impact of Event Scale to measure symptoms of intrusion and avoidance after a variety of critical incidents or traumatic events is still legitimate.
REFERENCES


DIMENSIONALITY OF THE POSTTRAUMATIC STRESS RESPONSE AMONG POLICE OFFICERS AND FIRE FIGHTERS: AN EVALUATION OF TWO SELF-REPORT SCALES

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Confirmatory factor analyses were done to assess the dimensionality of the stress-response in a sample of police officers and fire fighters ($n = 1168$) involved in the 1992 air disaster in Amsterdam. The confirmatory factor analyses were applied to the responses on two psychometrically different instruments, i.e., the Self-Rating Inventory for Posttraumatic Stress Disorder (SRIP) and the Impact of Event Scale (IES). The previously found distinction between (active) avoidance and numbing in samples highly affected by posttraumatic stress disorder, appears to be applicable to the stress response of a less affected sample. For the SRIP, a five-factor structure (i.e., intrusion, avoidance, hyperarousal, emotional numbing and sleep disturbances) appeared to fit slightly better than the four-factor structures from previous findings. For the IES, our results replicated findings of a four-dimensional structure (i.e., intrusion, avoidance, numbing and sleep disturbance) underlying the posttraumatic stress response. The factors of the best-fitting structure of both instruments proved reliable. Due to the psychometric properties of the two instruments, the relationship between similar factors in both instruments was only low to moderate. Compared with the IES, factors of the SRIP were, however, less discriminative from other symptoms of psychopathology. Replication in different traumatized or community samples is recommended.
1 INTRODUCTION

In the Diagnostic and Statistical Manual of Mental Disorders third edition (DSM-III) [1], posttraumatic stress disorder (PTSD) was first codified to describe a range of syndromal responses to extreme stressors. In the later (revised) editions of the DSM (DSM-III-R, DSM-IV, DSM-IV-TR, 1987, 1994, 2000) [1-3], the number of symptoms increased up to 17 grouped into three clusters: symptoms of intrusive memories and re-experiencing (Criterion B; e.g., intrusive thoughts of trauma), avoidance and emotional numbing (Criterion C; e.g., avoiding thoughts of trauma or difficulty expressing emotions), and hyperarousal (Criterion D; e.g., exaggerated startle response). Subsequently, a minimal number of symptoms in every cluster (i.e., at least one re-experiencing symptom, at least three avoidance and numbing symptoms, and at least two hyperarousal symptoms) were required to diagnose PTSD according to the DSM-IV. The decision rules according to the DSM-IV have been criticized for being too restrictive and for having a tendency to overlook traumatized persons with symptoms below the diagnostic threshold for PTSD. Some individuals develop the full-blown syndrome PTSD, while others exposed to the same trauma suffer from a range of symptoms, including subthreshold presentations of PTSD, or the more normal adjustment to trauma of oscillation of intrusions and avoidance that diminish over time [4]. Subthreshold presentations, however, are highly prevalent among several different traumatized or community samples, and may also cause clinically significant impairment in functioning and may have symptom patterns different from PTSD [5-7]. Data on the dimensional structure of stress responses after trauma comes primarily from studies of individuals with high PTSD symptom levels using instruments resembling the PTSD diagnosis in the DSM-IV.

Initially, researchers employed the largely descriptive and theory-generating technique of exploratory factor analysis (EFA) and revealed competing factor solutions [8-11]. Subsequently, the research tool to conduct structural inquiries shifted towards confirmatory factor analysis (CFA), in order to a priori specify one or more hypothetical factor structures and/or determine whether those hypothetical factor structures better fit the data than previously found structures. The first studies using CFA confirmed some of the factor structures as generated in studies using EFA, for instance Taylor et al.’s [10] two-factor structure of intrusions/avoidance and arousal/numbing [12, 13]. More recent studies generally support the position that active avoidance and emotional numbing are distinct symptom clusters in models with four-factor solutions [14-18]. The structural studies investigating PTSD also indicated that the symptom manifestation of traumatized persons comprises non-specific components that are a reflection of so-called negative affectivity or general distress also found in several other anxiety and depressive disorders, such as dysphoria [16]. It is, however, uncertain whether the dimensional findings of PTSD are generalizable to a more theoretically based stress-response syndrome with a range from adaptive to less or maladaptive responses to extreme stressors. To our knowledge only two CFA-based studies have explored less affected individuals not seeking treatment for their PTSD-symptoms. Asmundson et al. (2000) administered the PTSD Checklist-Civilian Version [19] to 349 referrals to a primary care medical clinic and reported a wide range of traumatic experiences, whereas relatively few were seriously affected by their trauma exposure (prevalence of PTSD was 13%) [15]. In a recent study of McWilliams et al. [17], individuals with a lifetime history of PTSD (n = 429) were selected from the National Comorbidity Survey to examine the factor structure of responses on the Diagnostic Interview Schedule's PTSD module based on the DSM-III-R. Both Asmundson et al. and McWilliams et al. revealed a four-factor solution (hierarchical and intercorrelated, respectively) of intrusion, avoidance, emotional numbing, and hyperarousal compared to several competing models. The structural findings in these samples of less symptomatic individuals appear to resemble the structural findings in more severely traumatized samples [14, 18].

However, because recent studies use similar instruments closely following the 17 DSM symptoms, i.e., DSM-based structured interviews [15, 16, 18] or validated DSM-derived questionnaires [17], it is uncertain whether the findings differ as a function of the psychometric properties of the instrument. Factor analytic studies on data assessed with instruments not completely reflecting the symptomatology as outlined in the DSM diagnosis of PTSD, yield somewhat different results. For instance, in a
CFA study of Anthony et al. [20] a three-factor model best fitted the symptom data assessed with the Frederick Reaction Index compared to nine alternative models including a four-factor model of intrusion, avoidance, numbing, and hyperarousal in 5,664 children and adolescent victims of a disaster (and subsamples thereof). Furthermore, studies on the factor structure of the widely used Impact of Event Scale (IES) [21] indicate that the best fitting model has a separate factor of sleep disturbance together with factors of intrusion, avoidance, and emotional numbing [22, 23].

Assessment of the (posttraumatic) stress response primarily relies on instruments that closely follow the DSM-defined multiple symptom clusters in highly symptomatic and/or selected samples exposed to a specific trauma. It remains, however, unclear whether the previous factor analytic results of PTSD are generalizable to a syndrome with a range of responses from low to high distress. Therefore, in the present study previously found factorial structures of PTSD were tested on a large sample of police officers and fire fighters with a range of distress levels due to one or more traumatic exposures. In addition, to evaluate differences in dimensional outcome as a function of the psychometric properties of the instrument, two instruments with different psychometric properties were used, i.e., the Self-Rating Inventory for PTSD (SRIP) [24] and the Dutch version of the IES [21, 25]. The SRIP has the property to capture symptoms of cluster B, C, and D resembling the DSM-IV irrespective of a specific trauma experience, and as such is suitable to assess posttraumatic stress symptoms in large samples of individuals exposed to multiple different stressors. The IES, although not a measure of PTSD as defined in the DSM-IV, overcomes this drawback by providing a detailed and accurate definition of posttrauma responses after a specific trauma, i.e., the air disaster in Amsterdam in 1992.

A wide range of previously reported models was included because generalizability of the previous factor structures of PTSD to a broader stress response to trauma is unclear. For the SRIP, six models with one up to four correlated symptom clusters, previously identified with primarily DSM-driven instruments, were tested (for model specifications see section 2.3). In addition, a hypothesized seventh model (with factors of intrusion, avoidance, numbing, hyperarousal and sleep disturbance) not previously tested, was specified. Specification of this latter model was based on the evidence that active avoidance and emotional numbing should be split, and on the notion that several hyperarousal symptoms should be split from their respective factor because they resemble PTSD-unspecific general distress or dysphoria [16]. In this five-factor model the two SRIP sleep disturbance symptoms were split (D1) from the other hyperarousal symptoms (D2-D5), as is consistent with previous exploratory findings on the SRIP [24]. For the IES, five first-order models with one up to four factors identified in previous studies with the IES, were tested. To decrease complexity of the large amount of analyses done in this study, only first-order correlated factor models and no higher-order factors (i.e., an overall general distress or PTSD factor that subsumes lower order-symptom clusters) were tested. As previous theoretical and empirical evidence on DSM-derived instruments and the SRIP and IES suggested specific factors to explain the relations among variables, CFA was preferred to EFA. CFA also provides a more definitive evaluation of factors by comparing goodness-of-fit indices for the resulting factor structures. The results from CFA were cross-validated in our samples of police officers and fire fighters to examine whether the structure was robust across the two samples. Furthermore, to assess convergent and discriminant validity, we calculated factor intercorrelations of the best-fitting models for the SRIP and the IES, as well as correlations between the best-fitting models and external measures of psychopathology (i.e., subscales of the Symptom Check List-90) and reliability of the identified factors.

2 Methods

2.1 Sample

For the present study we selected 834 police officers and 334 fire fighters who were involved in rescue work at the disaster site of the 1992 El Al Boeing 747-F cargo aircraft crash (resulting in 43 casualties), from the original group (n=2499) of involved and non-involved participants in the Epidemiological Study Air Disaster Amsterdam (ESADA) [26, 27]. Data on the police officers and fire
fighters were collected between January 2000 and March 2002 in an outpatients’ clinic in Amsterdam, on average 8.5 years after the disaster. Potential participants were informed about the study via announcements in staff magazines, after which they were approached via personal letters and eventually by telephone; 97% of the potential participants could be traced and 71% of the two fire fighter and police officer groups participated (involved and non-involved). All participants gave informed consent and the study protocol was approved by the local medical ethics advisory committee. Police officers and fire fighters filled out a questionnaire on professional exposure and involvement in tasks or events, including those that, according to five independent PTSD experts, most likely satisfy the criterion A1 of the PTSD diagnosis in the DSM-IV [28]. To gather information on the A2 criterion, participants were asked to indicate the personal impact of the Amsterdam air disaster and all its consequences. Table 1 gives data on sociodemographic and exposure characteristics, as well as data on (posttraumatic) stress symptoms on the SRIP and the IES.

2.2 Instruments

The SRIP is a self-report questionnaire with 22 items based on the DSM-IV [28] criteria for PTSD [24, 29]. Subscale scores and a total score of intrusion, avoidance and hyperarousal symptoms over the previous four weeks are assessed on a 4-point Likert scale (1 = not at all, 4 = extremely). The SRIP closely follows the symptoms of PTSD listed in the DSM-IV, except that it does not include a corresponding SRIP item of symptom B4 ("Intense psychological suffering due to exposure to stimuli related to the traumatic event"). Psychometric properties (e.g., validity and reliability for assessing PTSD) have proven to be good in different samples [24, 30]. A clinical cut-off value of 39, previously identified in a community sample, was used to indicate probable PTSD caseness [31]. Partial PTSD reflects the number of subjects who have a high score on one or two of the three subscales, i.e., scale ratings of 3 or 4 on at least one item of the intrusion subscale, at least three items of the avoidance scale, or at least two items on the hyperarousal scale.

The IES is a two-scale inventory developed to measure intrusion (7 items) and avoidance (8 items) of a specific traumatic event occurring during the preceding week [21]. A total IES score can be calculated by summing the ratings of all 15 items on a 4-point scale (0 = not at all, 1 = seldom, 3 = sometimes, 5 = often). The Dutch version of the IES was used in the current study [25]. Participants were asked to answer the IES with respect to experiences specifically related to the Amsterdam air disaster. A cut-off point of 25 was used as indicative of a moderate or severe impact of the air disaster [32].

The Dutch adaptation of the Symptom Check List-90-R (SCL-90) [33] is a 90-item widely used self-report checklist measuring various dimensions of psychopathology. The SCL-90 contains eight subscales. For the current study, we calculated only those scales with symptoms that we expected to be most important for convergent validity: anxiety (10 items), depression (16 items), somatic complaints (12 items), insufficiency of thought and behaviour (9 items e.g., “Difficulty concentrating”), and sleep disturbances (3 items). The total score was also calculated. A five-point scale (1 = not at all, 5 = very much) was used to measure the severity of the complaints that occurred in the preceding week.

| TABLE 1. DEMOGRAPHIC AND EXPOSURE CHARACTERISTICS, AND PTSD SYMPTOM LEVELS |
|-------------------------------------------------|-----------------|-----------------|-----------------|
|                                                  | TOTAL SAMPLE   | POLICE OFFICERS | FIRE FIGHTERS   |
| **Age: mean (S.D.)**                             | 46.2 (7.0)     | 44.0 (6.2)      | 51.4 (5.9)      |
| **Gender: n (%)**                                |                |                 |                 |
| Male                                             | 1072 (91.8)    | 738 (88.5)      | 334 (100.0)     |
| Female                                           | 96 (8.2)       | 96 (11.5)       | 0 (0.0)         |
| **Ethnicity, n (%)**                             |                |                 |                 |
| Non-Western                                      | 23 (2.0)       | 23 (2.8)        | 0 (0.0)         |
2.3 Factor models

We tested eight models on the SRIP-data using 22 symptoms consistent with the codification in the DSM-IV, i.e., symptoms B1 to D5 (with the exception of B4) and two, instead of one, items covering B1, B3, C2, C5, D1, and D2, respectively. Model 1 specifies a single-factor model, included to determine whether all PTSD symptoms can be subsumed under a single general factor [34]. Model 2 specifies two factors as originally identified by Taylor et al. [10] and replicated with CFA by Buckley et al. [13], with items B1 to C2 and D4-D5 loading on a dimension labeled as intrusion/avoidance, whereas items C3 to D3 loaded on a numbing/arousal dimension. We evaluated two three-factor models. Model 3a specifies three correlated factors of intrusion (items B1 to B5), avoidance (items C1 and C2), hyperarousal (items D1 to D5) and emotional numbing (C3 to C7) [14, 15]. Model 3b, previously hypothesized and tested against several competing models by Simms et al. (2002), loaded items B1 to B5 to load on a factor intrusion, items C3 to C7 on a numbing factor, and items D1-D5 on a hyperarousal factor, as is consistent with the study of Anthony et al. [20]. Three separate four-factor models were evaluated in this study. Model 4a is based on studies of Asmundson et al. (2000) and King et al. (1998) and specifies four correlated factors of intrusion (items B1 to B5), avoidance (items C1 to C7), hyperarousal (items D1 to D5) and emotional numbing (C3 to C7) [14, 15]. Model 4b, previously hypothesized and tested against several competing models by Simms et al. (2002), loaded items B1 to B5 to load on a factor intrusion, C1 and C2 on a factor avoidance, items C3 to D3 were all forced to load on a factor labeled as dysphoria, and items D4 and D5 on a Hyperarousal factor. In Model 4c, the items B1 to B3, D4, and the D2 item "Having bursts of anger" are expected to load on the factor intrusion, items B5 to C2 avoidance, the items C3 to C7, D3 and the D2 item "Feeling irritable" on a numbing factor, and the two D1 items (i.e., "Having problems staying asleep" and "Having problems falling asleep") on the factor sleep disturbance. This model was previously identified through a principal components factor
analysis of PTSD symptoms measured with the SRIP on a sample of 135 subjects with a well-documented trauma history (Hovens et al., 1994). In Model 5, we hypothesized a correlated five-factor model partially based on Model 4c as described above. Model 5 specifies the factors intrusion (B1 to B5), avoidance (C1 and C2), numbing (C3 to C7), hyperarousal (D2 to D5) and sleep disturbance (two items resembling D1).

The factor structure of stress symptoms measured with the IES was analyzed by evaluation of five (inter)correlated lower-order models. A one-factor model (Model 1) was included to determine whether the intrusion and avoidance symptoms can be subsumed under a single general factor consistent with the findings of Hendrix et al. [35]. Two separate two-factor models were tested. Model 2a is based on the original rationale behind the design of the IES [21], i.e., two clusters of intrusive/re-experiencing (items 1, 4, 5, 6, 10, 11, 14) and avoidance (items 2, 3, 7, 8, 9, 12, 13, 15). The additional two factor model (Model 2b) differs from Model 2a in that items 2 and 12 were forced to cross-load on both the Intrusion and Avoidance factors based on results of several studies [36-38]. Model 2b was found to be the best-fitting model in a study of Shevlin et al. [39]. The three-factor model (Model 3) is based on previous findings of Larsson [40], and specifies three intercorrelated factors of intrusion (items 1, 4, 5, 10, 11, 14), avoidance (items 2, 3, 7, 8, 9, 12, 13, 15), and sleep disturbance (item 6). Ultimately, a four-factor model (Model 4) was specified of intrusion (items 1, 4, 5, 10, 11, 14), avoidance (items 2, 3, 7, 13), sleep disturbance and numbing (items 8, 12, 15). Item 9 was dropped, as is consistent with the model of Amdur and Liberzon [23]. Recently, Andrews et al. [22] found best fit for a four-factor model similar to that of Amdur and Liberzon, although with the extension of a second-order of general distress and item 12 loaded on avoidance instead of the numbing factor. Due to the similarity and to the fact that we did not test any higher-order models, this model was not tested in the present study.

2.4 Data analysis

All models of posttraumatic stress symptoms described above were subjected to CFA using the Analysis of Moment Structures (AMOS) version 4 software package [41]. Evaluation of the adequacy of each competing model was done by evaluating a number of other goodness-of-fit statistics that are frequently used within the CFA and which reflect the fit between the hypothesized statistical model and the actual data set [42]. Although the overall model chi-square ($X^2$) was calculated, we were not able to statistically test the chi-square difference between models because not all the models are nested. Previous studies on PTSD symptom structure [16, 17] were also unable to statistically test the chi-square difference and the model fit was also studied by evaluation of goodness-of-fit statistics. These tests provide information on each model's ability to explain the pattern of associations between the various items of a test that are present in the actual data set, these being the root-mean-square error of approximation (RMSEA), the Bentler-Bonett normed fit index (NFI) [42], the Comparative Fit Index (CFI) [42] and the adjusted goodness-of-fit index (AGFI), as recommended by Hu and Bentler [43] in the case of maximum likelihood estimation methods. The stringent cut-off value for the RMSEA proposed by Hu and Bentler [43] was followed in the current study, i.e., values below 0.08 indicate an adequate fit and values above 0.10 indicate that the model fit is unsatisfactory. For the other fit indices (i.e., CFI, NFI, and AGFI) we used the conventional cut-off value of 0.90 and greater to indicate adequate fit [44].

Subsequently, the (three) models that (according to the several fit indices in the total sample) yielded better fit compared with the alternative models, were reanalyzed and cross-validated in the samples of police officers and fire fighters separately. Multiple group analyses were used to study whether the best-fitting models of the SRIP and IES data were equivalent across the police officer and fire fighter samples.

Finally, to examine the convergent and discriminant validity and reliability of the identified factor structures of the best-fitting models, subscales were constructed by calculating the scores of the subsamples of police officers and fire fighters on the items that represent the identified factors. Spearman's rho correlation coefficients were calculated due to non-normal distribution of the scores on both PTSD instruments and the SCL-90.
Inspection of the data revealed that on the SRIP and the IES less than 1% of the involved police officers and fire fighters had missing values. For those few participants who had less than two missing values on the SRIP or IES, we followed manual instructions of missing data imputations and, if instructions were not available (as was the case for the IES), we chose to impute the median based on all valid responses of the participant because of non-normality of the data. Two participants were excluded from the IES-analyses because they had more than two missing values.

3 RESULTS

3.1 Confirmatory factor analysis on the SRIP

Table 2 presents the fit-indices of the seven models tested on the SRIP data in the total sample. In the total sample, three models (i.e., the four-factor models 4a and 4b, and five-factor model 5) appeared to adequately fit the data according to the RMSEA (0.070, 0.067 and 0.061, respectively). The value of the chi-square statistic was, however, significant for all models, e.g., Model 5 ($X^2 = 1053.31$ (199), $P < 0.01$), which indicates that a significant proportion of the data remains unexplained by the model but a significant chi-square should not lead to rejection of the model as this can be an artifact of sample size and small variations in data [45]. Most other fit indices (NFI, CFI, and AGFI) of these three models indicated borderline fit (just below 0.90). The hypothesized five-factor model (Model 5) appeared to yield a somewhat better fit than the alternative two models in the total sample. The fit of the AGFI was (borderline) adequate for model 5 in the total sample (i.e., 0.90). This parsimony-of-fit index evaluates model fit after adjusting for the number of paths assessed in the model. In the five-factor model a greater number of paths is estimated and this will yield better model fit, but the AGFI adjusts for this.

The three models that fitted relatively better (i.e., Model 4a, Model 4c and Model 5) than other models, were subsequently tested separately in the samples of police officers and fire fighters. Again, the RMSEA of all three models showed adequate fit in the police officers and the other fit indices (i.e., CFI, NFI and AGFI) were close to the adequate fit (ranging from 0.87 to 0.89). The fit indices for the three models in the fire fighters were not in the adequate range. The RMSEA for Model 5 in the fire fighters yielded borderline fit (i.e., 0.083), which was better than the four-factor models. The unsatisfactory fit of the models in the fire fighters might be due to the smaller sample size (half that of the police officers), or to differences in symptom structure across samples. As a whole, the analyses indicate that our hypothesized five-factor model of intrusion, avoidance, numbing, hyperarousal, and sleep disturbance was the best-fitting model based on comparison of several fit indices with those of alternative models.

To test the degree of equivalence of the identified five-factor model across the fire fighters and police officers, multiple group analyses were performed. All loadings and covariances between factors were constrained and expected to be similar across the two samples in this restricted model (Model 5 (I)). Second, because the factor loadings (see Table 3) of items 18 and 5 (“Acting as if events from the past were happening again” and “Physical reactions with recalling past events”) differed significantly between the two samples (i.e., 0.47 vs. 0.62 and 0.63 vs. 0.44, respectively), these two items were free in Model 5 (II). Third, the correlation between the intrusion and avoidance factors of the five-factor model (Table 6) was higher in the police officers (0.57) than in the fire fighters (0.43). Therefore, we also tested Model 5 (III) in which the correlation between Intrusion and Avoidance was free. Finally, Model 5 (IV) was tested in which the correlation between Intrusion and Avoidance, as well as items 18 and 5 of the Intrusion factor were free. Differences between the most restricted model and the additional models were also assessed (Model 5 (I) versus Model 5 (II): $X^2_{\text{diff}} (2, n = 1,168) = 213.89$, $P < 0.001$, Model 5 (I) versus Model 5 (III): $X^2_{\text{diff}} (2, n = 1,168) = 35.44$, $P < 0.001$, Model 5 (I) versus Model 5 (IV): $X^2_{\text{diff}} (4, n = 1,168) = 249.95$, $P < 0.001$).

According to the significant differences, the Models 5 (II), (III), and (IV) showed better fit than the most restrictive Model 5 (I). On that basis it seems reasonable to assume that the best fit is somewhat different for both samples tested in this study.
Table 3 gives the standardized factor loadings for Model 5 in all three samples separately; factor loadings of symptom B4 are not presented because none of the SRIP items correspond with this item. Although most factor loadings were in the high range (i.e., > 0.60) and very similar across samples, it is important to note that some symptoms/items had consistently lower loadings on their designated factors than others (i.e., B2, C3, D2/item 16, D4, D5). Some even had factor loadings below or near the permissible minimum of 0.40, advocated in factor analysis literature [46]. Item C3 “Amnesia for events from the past” had low loadings on its designated factor Emotional Numbing. Item B2 “Having dreary dreams” also loaded relatively low/moderate on the factor Intrusion in the total sample and the police officers’ sample. Items D4 “Being vigilant” and D5 “Being easily frightened” loaded relatively low on the Hyperarousal factor.

Table 2. Fit indices for proposed models of the SRIP

<table>
<thead>
<tr>
<th>Model</th>
<th>DF</th>
<th>$X^2$</th>
<th>RMSEA</th>
<th>NFI</th>
<th>CFI</th>
<th>AGFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL SAMPLE (N = 1,168)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>209</td>
<td>2622.63</td>
<td>0.099</td>
<td>0.71</td>
<td>0.73</td>
<td>0.76</td>
</tr>
<tr>
<td>2</td>
<td>208</td>
<td>1933.04</td>
<td>0.084</td>
<td>0.79</td>
<td>0.81</td>
<td>0.83</td>
</tr>
<tr>
<td>3a</td>
<td>206</td>
<td>2034.47</td>
<td>0.087</td>
<td>0.78</td>
<td>0.79</td>
<td>0.82</td>
</tr>
<tr>
<td>3b</td>
<td>206</td>
<td>1834.97</td>
<td>0.083</td>
<td>0.80</td>
<td>0.82</td>
<td>0.84</td>
</tr>
<tr>
<td>4a</td>
<td>203</td>
<td>1368.49</td>
<td>0.070</td>
<td>0.85</td>
<td>0.87</td>
<td>0.88</td>
</tr>
<tr>
<td>4b</td>
<td>203</td>
<td>2232.50</td>
<td>0.093</td>
<td>0.76</td>
<td>0.77</td>
<td>0.80</td>
</tr>
<tr>
<td>4c</td>
<td>203</td>
<td>1276.20</td>
<td>0.067</td>
<td>0.86</td>
<td>0.88</td>
<td>0.89</td>
</tr>
<tr>
<td>5</td>
<td>199</td>
<td>1053.31</td>
<td>0.061</td>
<td>0.88</td>
<td>0.90</td>
<td>0.90</td>
</tr>
</tbody>
</table>

| POLICE OFFICERS (N = 834) |
| 4a | 203 | 1063.09 | 0.071 | 0.84 | 0.84 | 0.87 |
| 4c | 203 | 980.42  | 0.068 | 0.85 | 0.79 | 0.88 |
| 5  | 199 | 838.32  | 0.062 | 0.87 | 0.88 | 0.89 |

| FIRE FIGHTERS (N = 334) |
| 4a | 203 | 753.51  | 0.090 | 0.76 | 0.67 | 0.79 |
| 4c | 203 | 761.58  | 0.118 | 0.67 | 0.73 | 0.71 |
| 5  | 199 | 660.31  | 0.083 | 0.79 | 0.84 | 0.81 |

| MULTIGROUP |
| 5 (I) | 430 | 2148.38 | 0.059 | 0.78 | 0.81 | 0.85 |
| 5 (II)| 428 | 1934.49 | 0.055 | 0.80 | 0.84 | 0.85 |
| 5 (III)| 428 | 2112.99 | 0.058 | 0.78 | 0.82 | 0.85 |
| 5 (IV)| 426 | 1898.43 | 0.054 | 0.80 | 0.84 | 0.86 |

RMSEA = root-mean-squared error of approximation; NFI = Bentler-Bonett normed fit index; CFI = comparative fit index; AGFI = adjusted goodness of fit index.

Table 3. Standardized factor loadings for Model 5 of the SRIP

<table>
<thead>
<tr>
<th>DSM-IV PTSD</th>
<th>Item SRIP</th>
<th>Item</th>
<th>TOTAL SAMPLE (N = 1168)</th>
<th>POLICE OFFICERS (N = 834)</th>
<th>FIRE FIGHTERS (N = 334)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACTOR 1: INTRUSIONS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>Having recurrent unpleasant memories</td>
<td>9</td>
<td>0.80</td>
<td>0.77</td>
<td>0.84</td>
</tr>
<tr>
<td>B2</td>
<td>Having intrusive unpleasant memories</td>
<td>21</td>
<td>0.73</td>
<td>0.72</td>
<td>0.77</td>
</tr>
<tr>
<td>B3</td>
<td>Feeling that events from the past were happening again</td>
<td>10</td>
<td>0.68</td>
<td>0.66</td>
<td>0.74</td>
</tr>
<tr>
<td>B4</td>
<td>Acting as if events from the past were happening again</td>
<td>18</td>
<td>0.51</td>
<td>0.47</td>
<td>0.62</td>
</tr>
<tr>
<td>B5</td>
<td>Physical reactions with recalling past events</td>
<td>5</td>
<td>0.58</td>
<td>0.63</td>
<td>0.44</td>
</tr>
<tr>
<td>FACTOR 2: AVOIDANCE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>Trying to avoid thoughts about past events</td>
<td>2</td>
<td>0.75</td>
<td>0.74</td>
<td>0.79</td>
</tr>
<tr>
<td>C2</td>
<td>Trying to avoid situations that would recall past events</td>
<td>14</td>
<td>0.90</td>
<td>0.87</td>
<td>0.97</td>
</tr>
<tr>
<td>FACTOR 3: EMOTIONAL NUMBING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>Amnesia for events from the past</td>
<td>3</td>
<td>0.40</td>
<td>0.41</td>
<td>0.37</td>
</tr>
</tbody>
</table>
3.2 Confirmatory factor analysis on the IES

Table 4 shows fit indices for the tested models on the IES data. The four-factor model (Model 4), originally identified by Amdur and Liberzon (2001), yielded a better fit than all other models tested in the total sample. Models 2b and 3 fitted the data only slightly less. In the police officers and fire fighters samples, most values of the fit indices of the three models (i.e., Model 4, Model 3, and Model 2b) did not meet the criteria. The CFI of Model 4, however, met the criterion of 0.90 and the fit of the NFI value of Model 4 was borderline adequate in the police officers. The RMSEA and the AGFI values of all three best fitting models in the police officers were close to adequate fit. In the fire fighters, analyses did not yield an adequate fit for Model 2b, and Model 3 or for Model 4, in spite of indications of some better fit of Model 4.

Multiple group analyses were also done to test the equivalence across the two samples of the identified four-factor structure. First, the four-factor model with all loadings constrained was tested (Model 4 (I)). Second, according to the difference in correlation (Table 7) between the Intrusion and Avoidance factor across the police officers and fire fighters samples (0.49 and 0.61, respectively), this covariance was free in Model 4 (II). Third, item 6 (“I had dreams about it”) differing between the two samples (police: 0.51; fire fighters: 0.68), was free in Model 4 (III). Eventually, both item 6 and the correlation between Intrusion and Avoidance were free in Model 4 (IV). All three models yielded significantly better fit than the most restrictive Model (Model 4 (I) versus Model 4 (II): \(\chi^2\) diff (2, \(n = 1,165\) = 305.67, \(P < 0.001\), Model 4 (I) versus Model 4 (III): \(\chi^2\) diff (1, \(n = 1,166\) = 230.29, \(P < 0.001\), Model 4 (I) versus Model 4 (IV): \(\chi^2\) diff (3, \(n = 1,166\) = 308.82, \(P < 0.001\)). Again, the structure of the best fitting four-factor model of the IES differed slightly between the two samples.
Standardized factor loadings for Model 4 of IES symptoms are shown in Table 5. Most items loaded relatively high on their designated factors (range 0.51 to 0.89) across the total sample and the subsamples, indicating a strong relationship between the symptoms and their corresponding factors. IES item 8 (“I felt as if it hadn’t happened or it wasn’t real”) had low loadings on the factor numbing across (sub)samples (range 0.13 to 0.38). The item “I had dreams about it” loaded moderately on the sleep disturbance factor in the total sample and in police officers.

3.3 Convergent and discriminant validity

We examined the convergent and discriminant validity of each factor of the respective best-fitting models (i.e., Model 5 for the SRIP and Model 4 for the IES). For this purpose, subscales and total scores were calculated. Tables 6 and 7 present Spearman’s rho coefficients between scales. First, Spearman’s rho coefficients between SRIP factors and IES factors are low to moderate in both the police officers (range 0.15 to 0.38) and the fire fighters (range 0.09 to 0.40). Second, the SRIP factors correlate moderately to high with the SCL-90 scales. This is most prominent between the total score of the SRIP and the total score of the SCL-90 in the police officers sample. Correlations between the IES factor scales and the SCL-90 were lower.
Cronbach’s alpha’s were calculated to test reliability and were moderate to high for both PTSD scales (Tables 6 and 7). Lowest Cronbach’s alpha coefficients (around 0.60) were found for the numbing and sleep disturbance factors of the IES and the hyperarousal factor of the SRIP in both the police officers and fire fighters.

| Table 6. Intercorrelations and External Correlations of Factor Clusters Among Police Officers (N = 833) |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| **SUBSCALES**                   | **ITEMS** | **1**     | **2**     | **3**     | **4**     | **5**     | **6**     | **7**     | **8**     | **9**     | **10**    |
| Intrusion                       | 6         |          | (0.77)    |           |           |           |           |           |           |           |           |
| Avoidance                       | 3         | 0.57     | (0.79)    |           |           |           |           |           |           |           |           |
| Sleep disturbance               | 2         | 0.35     | 0.28      | (0.76)    |           |           |           |           |           |           |           |
| Numbing                         | 6         | 0.44     | 0.42      | 0.36      | (0.71)    |           |           |           |           |           |           |
| Hyperarousal                    | 5         | 0.44     | 0.39      | 0.46      | 0.55      | (0.60)    |           |           |           |           |           |
| SRIP Total                      | 22        | 0.66     | 0.61      | 0.66      | 0.75      | 0.83      | (0.88)    |           |           |           |           |
| **IES**                         |           |           |           |           |           |           |           |           |           |           |           |
| Intrusion                       | 5         | 0.35     | 0.27      | 0.24      | 0.26      | 0.28      | 0.37      | (0.84)    |           |           |           |
| Avoidance                       | 4         | 0.31     | 0.37      | 0.19      | 0.27      | 0.26      | 0.33      | 0.49      | (0.80)    |           |           |
| Sleep disturbance               | 3         | 0.30     | 0.22      | 0.15      | 0.16      | 0.23      | 0.34      | 0.34      | 0.59      |           |           |
| Numbing                         | 2         | 0.35     | 0.30      | 0.18      | 0.24      | 0.24      | 0.33      | 0.50      | 0.53      | 0.34      | (0.54)    |
| IES Total                       | 14        | 0.36     | 0.29      | 0.24      | 0.28      | 0.29      | 0.38      | 0.99      | 0.54      | 0.39      | 0.56      | (0.87)    |
| **SCL-90**                      |           |           |           |           |           |           |           |           |           |           |           |
| Anxiety                         | 10        | 0.46     | 0.39      | 0.40      | 0.48      | 0.51      | 0.60      | 0.24      | 0.18      | 0.18      | 0.21      | 0.25      |
| Depression                      | 16        | 0.51     | 0.46      | 0.43      | 0.58      | 0.63      | 0.72      | 0.26      | 0.24      | 0.24      | 0.18      | 0.25      | 0.27      |
| Somatic complaints              | 12        | 0.36     | 0.29      | 0.39      | 0.44      | 0.46      | 0.54      | 0.26      | 0.19      | 0.11      | 0.22      | 0.27      |
| Insufficiency                   | 9         | 0.43     | 0.38      | 0.44      | 0.63      | 0.64      | 0.70      | 0.24      | 0.21      | 0.18      | 0.21      | 0.25      |
| Sleep disturbance               | 3         | 0.33     | 0.27      | 0.82      | 0.35      | 0.42      | 0.60      | 0.24      | 0.23      | 0.14      | 0.17      | 0.24      |
| SCL total                       | 90        | 0.51     | 0.45      | 0.55      | 0.64      | 0.68      | 0.80      | 0.31      | 0.26      | 0.19      | 0.27      | 0.32      |

Coefficients presented along the top diagonals are Cronbach’s alpha coefficients.  \( P < 0.01 \), except for the non-significant correlation between IES Numbing and SRIP Sleep disturbance.

| Table 7. Intercorrelations and External Correlations of Factor Clusters Among Fire Fighters (N = 333) |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| **SUBSCALES**                   | **ITEMS** | **1**     | **2**     | **3**     | **4**     | **5**     | **6**     | **7**     | **8**     | **9**     | **10**    |
| Intrusion                       | 6         |          | (0.80)    |           |           |           |           |           |           |           |           |
| Avoidance                       | 3         | 0.43     | (0.87)    |           |           |           |           |           |           |           |           |
| Sleep disturbance               | 2         | 0.37     | 0.21      | (0.78)    |           |           |           |           |           |           |           |
| Numbing                         | 6         | 0.39     | 0.43      | 0.34      | (0.64)    |           |           |           |           |           |           |
| Hyperarousal                    | 5         | 0.38     | 0.30      | 0.41      | 0.54      | (0.61)    |           |           |           |           |           |
| SRIP Total                      | 22        | 0.63     | 0.56      | 0.63      | 0.76      | 0.78      | (0.88)    |           |           |           |           |
| **IES**                         |           |           |           |           |           |           |           |           |           |           |           |
| Intrusion                       | 5         | 0.38     | 0.32      | 0.16      | 0.25      | 0.30      | 0.38      | (0.87)    |           |           |           |
| Avoidance                       | 4         | 0.34     | 0.37      | 0.17      | 0.32      | 0.26      | 0.36      | 0.61      | (0.82)    |           |           |
| Sleep disturbance               | 3         | 0.33     | 0.21      | 0.26      | 0.16      | 0.28      | 0.29      | 0.44      | 0.43      | (0.61)    |           |
| Numbing                         | 2         | 0.29     | 0.29      | 0.09      | 0.27      | 0.27      | 0.29      | 0.51      | 0.50      | 0.39      | (0.57)    |
| IES Total                       | 14        | 0.39     | 0.33      | 0.17      | 0.27      | 0.33      | 0.40      | 0.98      | 0.67      | 0.45      | 0.59      | (0.90)    |
| **SCL-90**                      |           |           |           |           |           |           |           |           |           |           |           |
| Anxiety                         | 10        | 0.38     | 0.25      | 0.44      | 0.44      | 0.51      | 0.55      | 0.22      | 0.26      | 0.15      | 0.27      | 0.26      |
| Depression                      | 16        | 0.43     | 0.32      | 0.42      | 0.51      | 0.53      | 0.59      | 0.27      | 0.27      | 0.21      | 0.25      | 0.30      |
| Somatic complaints              | 12        | 0.32     | 0.23      | 0.38      | 0.42      | 0.49      | 0.51      | 0.18      | 0.25      | 0.14      | 0.21      | 0.22      |
| Insufficiency                   | 9         | 0.32     | 0.28      | 0.32      | 0.54      | 0.59      | 0.60      | 0.24      | 0.24      | 0.12      | 0.27      | 0.28      |
| Sleep disturbance               | 3         | 0.34     | 0.23      | 0.76      | 0.32      | 0.40      | 0.58      | 0.20      | 0.14      | 0.23      | 0.12      | 0.21      |
| SCL total                       | 90        | 0.47     | 0.34      | 0.53      | 0.57      | 0.65      | 0.73      | 0.30      | 0.30      | 0.19      | 0.29      | 0.33      |

Coefficients presented along the top diagonals are Cronbach’s alpha coefficients.  \( P < 0.01 \), except for the non-significant correlation between IES Numbing and SRIP Sleep disturbance.
4 DISCUSSION

Our study shows that the previously found distinction between (active) avoidance and emotional numbing found in samples highly affected by PTSD (see for a review Asmundson et al., [3]), appears to be applicable to the stress response of a less strongly affected sample. This dimensional finding was the same for responses on two psychometrically different instruments and appeared to be robust across the samples tested. Furthermore, the results indicated that in the current relatively healthy sample, some factor(s) were rather unspecific to the posttraumatic stress response and less discriminative from other symptoms of psychopathology.

We have shown that, considering the goodness-of-fit values of the various models tested on the SRIP symptom data, a five-factor structure of intrusion, avoidance, numbing, hyperarousal and sleep disturbance underlies the stress response of the current sample of police officers and fire fighters. In view of the nature of most factors of the five-factor model, it might be concluded that the stress response results are consistent with the reported results of the structure underlying PTSD [14, 15, 17]. However, because our results diverge from previous work with regard to the number of factors and the distinct mechanism of sleep disturbances, we need to critically evaluate our decision to prefer the five-factor model to the other (four) factor models. Determination of which model provides the best overall fit is a complex process involving not only consideration of multiple fit indices but also on the basis of parsimony. Hence, the fit indices of the four-factor model of intrusion, avoidance, numbing and hyperarousal cf. King et al., 1998, Asmundson et al., 2000, McWilliams et al., 2005 [14, 15, 17] and the four-factor model of intrusion, avoidance, numbing and sleep disturbance of Hovens et al. [24] were only marginally different from the five-factor model. The goodness-of-fit indices of the four-factor models did not, however, meet the criteria; but neither did all the indices of the five-factor model. In favour of the five-factor model are, however, the moderate intercorrelations between the factors and the moderate to high reliability for the separate factors in our samples. This indicates that the five-factor model offers distinctive reliable factors. As such, the five-factor structure might be preferred to the four-factor structures as best reflecting the underlying stress response assessed with the SRIP in a sample of relatively healthy individuals.

We note, however, that the marginally better fit of the five-factor structure might (in part) be a function of the psychometric properties of the SRIP. As previously described, the SRIP reflects most of the B, C and D criteria of the DSM-IV, but differs in that it assesses 22 instead of 17 items (with the exclusion of symptom B4). Sleep disturbance is split into two (instead of one in most other DSM-based instruments) highly intercorrelating and generally phrased items (i.e., "Having problems falling asleep" and "Having problems staying asleep"). Moreover, model specification (i.e., a fifth factor sleep disturbance) was based on previous results of the SRIP [24]. Nonetheless, in the present study, since the magnitude of the factor loading is also an important indicator of the reliability of the factor sleep disturbance, this factor seems reliable and robust across the two samples. Moreover, previous studies with DSM-based instruments also found relatively low factor loadings of this sleep disturbance item ("Problems falling and staying asleep") on their designated factors [13, 15, 16, 20]. This indicates that these sleep disturbances might well be split into a separate factor rather unspecific to PTSD.

The hyperarousal factor of the current five-factor model describing the SRIP also appeared to be somewhat unspecific to the stress-response in the total sample. This factor correlated highly with some of the SCL-90 scales (e.g., SCL-90 Depression). The lower loadings of D4 ("Being vigilant") and D5 ("Being easily frightened") on their designated Hyperarousal factor suggest that they are different from the other symptoms D2 ("Feeling irritable") and D3 ("Difficulty concentrating") within this same factor. Simms et al. (2002) hypothesized that D4 and D5 are the more prototypic manifestations of hyperarousal, whereas D2 and D3 represent nonspecific symptoms of general distress, i.e., dysphoria. Recently, McWilliams et al. [17] replicated this finding with an exploratory analysis on a community sample of individuals with a lifetime history of PTSD. Another item that had low loadings
on its respective factor (i.e., numbing) in the current study was “Amnesia for events from the past”, consistent with McWilliams et al. and King et al. [14, 17]. Additional research is needed to assess and conceptualize this symptom.

With regard to the factor structure of the stress response assessed with the IES, the intercorrelated four-factor model of intrusion, avoidance, numbing and sleep disturbance of Amdur and Liberzon [23] met all the goodness-of-fit criteria in the total sample of police officers and fire fighters, whereas a model of three intercorrelated factors of intrusion, avoidance/numbing, and sleep disturbance based on results of Larsson [40], yielded borderline fit in this same sample. On the basis of parsimony, one could also favour the three-factor model. Nonetheless, the fact that numbing and (active) avoidance represent distinct mechanisms of the stress response in several other psychometrically sound IES studies [22, 23], we prefer the four-factor model. Moreover, all factors of the four-factor model (as well as the entire scale) were found to be moderately to highly reliable (Cronbach’s alpha’s ranged from 0.54 to 0.90) in both the police officer and fire fighter subsamples. The results are largely in concurrence with Andrews et al. [22]; however these authors extended the intercorrelated four-factor model with an overarching second-order general distress factor, although no firm statistical grounds were present to prefer this model to the lower-order intercorrelated four-factor model. The high factor loadings of the IES items on their respective factors also support the four-factor model, despite the fact that item 8 (“I felt as if it hadn’t happened or it wasn’t real”) had lower loadings on its designated numbing factor (Items 8, 12, and 15) than the other two items within this factor. In previous studies item 8 was part of the factor avoidance but also had consistently low loadings on that factor [39, 40, 47]. Feelings of derealization are more prevalent when the trauma experience is more recent and item 8 might be difficult to comprehend when a relatively long time has passed since the event (i.e., 8.5 years). In concordance with Larsson [40] and Amdur and Liberzon [23], a separate sleep disturbance (items 4 and 6) factor with high factor loadings and reliability was also part of the best-fitting model of the IES. This sleep-disturbance factor, however, differs substantially from the sleep-disturbance factor of the five-factor model of the SRIP.

With respect to convergent validity of the factors of both models, low correlations between SRIP and IES factors in both the police officers (scale intercorrelations ranging from 0.15 to 0.38) and the fire fighters (scale intercorrelations ranging from 0.09 to 0.40) were found. Results on discriminant validity show that most of the SRIP factors are moderately to highly associated with several scales of the SCL-90, while the IES factors correlated only low to moderately with the SCL-90. The divergence between the results on convergent and discriminant validity of the SRIP and the IES, is probably best explained by specific psychometric properties combined with sample characteristics. The SRIP captured responses of police officers and fire fighters to a range of (possibly traumatic) events in the course of active duty, whereas the symptoms on the IES are specifically linked to the 1992 air disaster. The measurement aim of the SRIP is broader than the IES with respect to the A1 criterion of PTSD, though stricter in capturing symptoms reflecting the DSM-IV. The results indicate that the SRIP indeed captures the broader distress symptoms in response to any (traumatic) event in a sample less strongly affected with PTSD. The factors numbing, hyperarousal and sleep-disturbances correlated more highly with SCL-90 subscales and (as we suggested previously) appear relatively unspecific for PTSD. For instance, the SCL-90 sleep disturbances scale correlated highly with the SRIP factor sleep disturbance, whereas the correlation with the IES factor sleep disturbance was very low. Sleep disturbances on the IES are probably a reflection of specific disaster-related PTSD, whereas the sleep disturbances on the SRIP might reflect so-called general distress. As stated above, the item content of IES sleep disturbances (i.e., caused by “…pictures or thoughts about the traumatic event that come into mind” and/or be a result of “…dreams about the traumatic event”) differs considerably from that of the SRIP sleep disturbances which are more generally phrased. Moreover, the PTSD specific symptom “Having dreary dreams” was not part of the factor sleep disturbance but of the intrusion factor in the best fitting five-factor model of the SRIP.

The results indicated that the five-factor structure of the SRIP and the four-factor structure of the IES yielded best fit in the samples of police officers and fire fighters, although due to methodology aspects (e.g., differences in sample size) fit indices did not meet (all) the criteria. Multigroup
analyses indicated that the symptom structure for both the SRIP and the IES differed only slightly between the fire fighters and police officers. The replication of the previously suggested distinction between (active) avoidance and numbing and the poorer discriminant validity of some of the factors (and thus unspecific to PTSD) across the total sample and the subsamples, lends support for the suggestion that dimensionality underlying PTSD is, to a certain extent, also applicable to samples of individuals with less severe stress reactions. It is, however, important to know whether the findings, and specifically the separate sleep-disturbance factor, are sample specific or whether they are also generalizable to other (community) samples. Police officers report significantly worse sleep quality and less average sleep time than the corresponding control groups not-involved in this work and, although the traumatic aspects of police work were related to nightmares, the routine stressors of police service seem to most affect global sleep quality in these subjects [48]. Moreover, the fact that the four-factor model previously supported by Asmundson et al. (2000) [15] in a less symptomatic community sample was not the best fitting structure in the current study, might indicate that a separate sleep disturbance factor is more specific for police officers and fire fighters, or that differences in psychometric properties of the instrument account for this. The results of the IES in our sample of police officers and fire fighters, however, replicate the findings of the IES from more traumatized samples [23] as well as from similar samples including police officers and fire fighters [22].

The current findings appear to have implications for the theoretical foundations underlying the stress response. It might be important to know that sleep disturbances (“falling and/or staying asleep”) are highly unspecific to the (posttrauma) stress-response when they are not linked to thinking about a specific (traumatic) event and do not include unpleasant dreams or nightmares. The current results might also offer information concerning the diagnostic use of self-report questionnaires in research (or clinical) settings. Score information from self-report questionnaires is frequently summed in total scores or is based on the three-factorial DSM-IV structure, whereas the distinct contribution of several factors (such as avoidance and numbing) should be given full attention in the range of individual differences in the stress response.

The strengths of the present study are that a wide range of models have been used to test the posttraumatic stress response using two intrinsically different instruments in a large sample, and that the results have been cross-validated. The following limitations may hopefully be remedied in future studies. First, we did not test whether the four-factor and five-factor models would fit the data better had we included an overarching second-order general distress factor, whereas theoretically might be important to know whether the stress response to traumata is hierarchical in nature (i.e., a higher-order general distress factor and lower-order factors of components specific to a certain disorder such as PTSD), as current theoretical models of anxiety (and depression) suggest [49, 50]. Furthermore, because we did not statistically test the difference in fit between the models (i.e., via chi-square difference), this diminishes the value of our conclusion that the five-factor model fits better than the other four-factor models. Second, according to the symptom structure of the IES, the participants filled out the IES on average 8.5 years after the experienced trauma, whereas symptoms of intrusion, avoidance or numbing might differentiate over time. For instance, previously neutral stimuli may come to serve as traumatic reminders over time, and avoidance may also become more generalized [51]. Third, although we aimed to assess whether the exposure to the air disaster was traumatic in nature (A1 and A2 criteria of the DSM-IV), the retrospective self-report of the exposure is a limitation. Furthermore, police officers and fire fighters have probably been exposed to other potentially traumatic events in the time that elapsed since 1992. Fourth, the sample has fairly low symptom levels, and it is uncertain whether findings are replicable in other (e.g., community samples). Moreover, the borderline fit of the best-fitting models might be due to the fairly low levels of (traumatic) distress (i.e., a minor proportion of subjects fulfilled the criteria for PTSD or of partial PTSD) in the sample.

Some general conclusions can be drawn from the current study. The previously found distinction between (active) avoidance and numbing underlying the DSM-IV based PTSD diagnosis, is also applicable to a more continuous and less severe stress response to trauma. Nonetheless, divergence from current literature was found with respect to the number of factors underlying the stress
response measured with the SRIP, since rather unspecific factors resembling general distress were part of a best-fitting five-factor structure with factors of intrusion, avoidance, hyperarousal, emotional numbing and sleep disturbance. The results replicated recent findings of a four-dimensional structure of intrusion, avoidance, numbing and sleep disturbance underlying the posttrauma stress response of the IES in a less symptomatic sample. The factorial structure underlying the stress response as measured with the SRIP (and IES) should be replicated in other community samples.
REFERENCES


PSYCHOLOGICAL DISTRESS OF RESCUE WORKERS 8.5 YEARS AFTER PROFESSIONAL INVOLVEMENT IN THE AMSTERDAM AIR DISASTER

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**Abstract**

This study examined specific and general psychological distress 8.5 years following the 1992 cargo aircraft crash in Amsterdam in 334 occupationally exposed fire fighters and 834 occupationally exposed police officers compared with reference groups of 194 fire fighters and 634 police officers, who were employed at the same fire-, respectively, police departments though exposed to duty-related stressors other than the disaster. On the standardized instruments of psychological distress, exposed fire fighters reported more somatic complaints and fatigue, while exposed police officers reported higher psychological distress on all aspects. The degree and type of exposure at the disaster site and other background factors were associated with several outcomes of psychological distress levels of exposed rescue workers. The disasters’ aftermath of rumours about potential health consequences due to toxic exposure likely contributed to the long-lasting psychological distress of some of the rescue workers as well.
1 Introduction

Traumatic experiences and the associated psychological after-effects, such as posttraumatic stress disorder (PTSD), appear to be an occupational hazard for fire fighters and police officers. Varying prevalence rates of PTSD or posttraumatic distress among fire fighters and police officers who were called to assist in rescue work at the site of traumatic accident or disaster have been reported, e.g., ranging from 7%-10% [1, 2] up to 20% [3, 4]. Other post-trauma reactions in rescue workers are more general symptoms of distress (e.g., anxiety and (psycho)somatic symptoms) [4], increased alcohol consumption [5], or socio-economic problems [6]. Moreover, due to various occupational exposures, such as shift work, high physical demands, or exposure to (hazardous) materials, a relatively high number of musculoskeletal complaints and respiratory symptoms have been found among rescue workers, e.g., the World Trade Center cough in fire fighters and police officers in New York [7]. In general, however, fire fighters and police officers are reported to be relatively healthy (both mentally and physically) than other samples from the general population, probably because of selection (e.g., pre-employment physical, mental and medical screening), monitoring of fitness and training and their different role in disasters than direct survivors [8, 9].

Several personal and environmental factors have been found to be related to the level of post-disaster psychological distress among rescuers, e.g., single life status [10], older age [6, 11], female gender [6], ethnic-minority-group membership [12], negative life events [13], and lower level of education [14]. Protective against the severity of post-disaster distress are social support and so-called hardiness (i.e., the trait of being willing to undertake things that involve risk or danger) [15]. Degree of exposure and type of involvement in disaster rescue work, e.g., body handling, are also associated with mental health problems [16, 17].

The type of disaster (i.e., natural vs. technological disaster) is another factor that might affect the level of psychological distress of those involved. The impact of natural disasters is usually immediate and clearly visible, whereas technological disasters are caused by humans and more often have a slowly evolving, uncertain and not always readily perceptible impact. Norris et al., (2002) found a small though significantly higher aggregated severity rating of technological disasters (disasters with a human intent particularly) than natural disasters for developed countries [8]. For instance, a relatively high prevalence rate of PTSD (i.e., 13%) was found among fire fighters three years after professional involvement in the Oklahoma city bombing [18].

Another type of disaster that has a particularly long-lasting impact on the psychological well-being of those involved, are those with real or alleged exposure to hazardous chemicals with uncertainty about potential physical and mental health effects, e.g., the Exxon Valdez chemical spill [19], and the Chernobyl disaster [20]. In such disasters hazard perception, risk perception and sense of control, are important mediators between disaster exposure and psychological distress [21]. Although several studies report on the physical effects on rescue workers exposed to chemical fires or biochemical terrorist attacks (e.g., [22]), there’s a lack of studies that show higher levels of psychological distress among first responders after such disasters [23], probably because of the low frequency and, more particularly, the relatively low amount of direct casualties in such disasters.

The Amsterdam Air Disaster

On October 4th, 1992, a Boeing 747 cargo aircraft crashed into two apartment buildings in a suburb of Amsterdam killing 43 people and destroying 266 apartments. Rescue workers, e.g., fire fighters and police officers, were immediately called to the disaster to extinguish the fire, secure the surroundings, and to search for victims in the rubble. Rescue workers were, at the time of the disaster, not aware of a potential hazardous exposure and not instructed to wear a protective garment. Although fire fighters and police officers are quite familiar with traumatic incidents, a disaster like the Amsterdam air disaster is very unusual and stressful for them as well because of its large amount of casualties and gross destruction. In addition, the unusual long aftermath of speculations about the cause of the crash, the contents of the cargo, the potential hazardous materials, and its
health consequences may have affected rescue workers psychological (and physical) wellbeing [24]. The same may be true for the various chaotic and often contradictory actions of the government accompanied by extensive media coverage about unresolved issues [25, 26], such as the disappearance of the depleted uranium used as balance weight in the aircraft.

Most previous studies on post-disaster psychological distress of fire fighters and police officers after technological disasters have a relatively small sample size, lack a reference group, and have predominantly focused on the short-term aftermath of (primarily) the victims. In the current study with assessments on average 8.5 years after the air disaster, two hypotheses are tested: 1) exposed fire fighters and police officers report more symptoms of specific and non-specific psychological distress than non-exposed fire fighters and police officers exposed to duty-related stressors other than the disaster, and 2) factors indicated in previous studies to be risk factors (i.e., background factors and degree of exposure) will be associated with the level of psychological distress among exposed fire fighters and police officers. In addition, differences in type and degree of disaster-exposure between fire fighters and police officers are discussed and related to the findings on the above hypotheses. For instance, being confronted with helplessness during rescue work instead of being able to actively engage in rescue tasks might result in higher psychological distress.

2 Methods

2.1 Overview

The methods presented are part of a larger study, the design of which has been described elsewhere: the Epidemiological Study Air Disaster in Amsterdam (ESADA) that assessed the long-term health effects of occupational exposure to this disaster among professional assistance workers [27]. The study design was approved by the Medical Ethics Committees of the two medical facilities involved in this project: the VU University Medical Center (VUmc) and the ‘Onze Lieve Vrouwe Gasthuis’ (OLVG) in Amsterdam. Previous reports of the ESADA have already shown that exposed rescue workers reported more physical and psychological health complaints than non-exposed colleagues [28, 29]. No consistent significant differences between exposed and nonexposed workers were found with regard to several clinical parameters in urine and blood samples, such as blood cell counts, creatinine clearance, and autoantibody serology. A difference in auto-antibody prevalence, for example, could have indicated a systemic autoimmune disorder through exposure to the disaster.

2.2 Participants and procedure

In view of ongoing health concerns of fire fighters and police officers involved in rescue work at the site of the air disaster, employers of fire fighters and police officers in Amsterdam decided to start an independent assessment of the health status of professional workers involved in the disaster. Police officers, who were employed in the Amsterdam-Amstelland regional police force at the time of the disaster, were invited to participate in this epidemiological study. The same applied for fire fighters employed in the Amsterdam fire department, be it that fire fighters who started after the disaster were invited as well in order to get a large enough sample of non-exposed fire fighters. Participants were recruited via, respectively, announcements in staff magazines, letters and successively by telephone. Of the potential participants 97% (N = 2902) could be traced, and finally 71% of both groups participated in this study. Of all participants, a total of 52 fire fighters and police officers were excluded for reasons such as having lived or were living in the disaster area, or having too many missing data on the involvement/exposure questionnaire. Fire fighters (N = 528) and police officers (N =1468) were further subdivided into exposed and non-exposed groups, using a questionnaire about their possible involvement in disaster-related tasks. Participants were reassured confidentiality (i.e., identification numbers were unrelated to their names), joined the study voluntarily after its purpose was explained (i.e., to examine the health effects of the air disaster), and gave informed consent. Participants were permitted to go to the hospital during working hours and the exposed rescue workers were offered an individual medical examination. Between January 2000 and March
2.3 Measures

**Demographic Variables.** We devised several questionnaires to obtain demographic information on age, gender, level of education, current and previous chronic illnesses (e.g., diabetes, rheumatoid arthritis), marital status (single vs. married/living together), gender, ethnicity, alcohol use and smoking habits (see Table 2). Ethnicity was categorized into European (e.g., those who considered themselves Dutch, British, Spanish, Dutch/Chinese, Dutch/Indonesian) or as non-European (e.g., those who considered themselves Moroccan, Turkish, Surinamese). A detailed description was published recently [27].

**Occupational Exposure.** Participants were asked to fill in a questionnaire on professional exposure to the air disaster including items about several disaster-related tasks and events during the disaster and other psychosocial aspects in relation to the disaster. Involvement in at least one disaster-related task was defined as occupationally ‘exposed’ and no involvement in disaster-related tasks was defined as occupationally ‘non-exposed’.

The degree of exposure to the air disaster was linked to the type and number of disaster-related tasks and events. A list of items with tasks and events during the disaster was presented to five eminent PTSD researchers (most of which were also clinicians) to be scored on potentially traumatic impact, i.e., does the event or task satisfy the criterion A1 of the PTSD diagnosis in the DSM-IV [30] on a 4-point scale from 1 ‘very unlikely’ to 4 ‘very likely’. A modest inter-rater reliability was found among the five PTSD experts (i.e., Cronbach’s alpha of .64). We used an average item rating of 3.0 or higher to select items that most likely satisfied the A1 criterion. Tasks and events were consequently subdivided into ‘A1 tasks’ and ‘A1 events’ on the one hand and ‘Tasks’ and ‘Events’ on the other hand (Table 1).

**Symptom Checklist 90-Revised (SCL-90-R).** To measure a broad range of psychological reactions, the Dutch adaptation of the Symptom Check List-90-R was used [31, 32]. This is a validated and widely used scale of 90 items each rated on a 5-point scale ranging from 0= not at all to 4= extremely. For the purpose of the current study we selected the scales: anxiety (10 items), depression (range 16 items), somatic complaints (12 items), and sleep disturbances (3 items). Cronbach’s alpha coefficients for the anxiety, depression and somatic complaints scales were .77, .88, and .74, respectively, in the total police officers sample, and .82, .89, and .78, respectively, in the total fire fighters sample. For each scale we also used the “above average” cut-off scores for the general Dutch population according to the manual.

**General Health Questionnaire (GHQ-12).** To screen for possible mental disorders, the Dutch adaptation of the 12-item version of the General Health Questionnaire was used [33, 34]. Using the conventional binary GHQ scoring method, a total GHQ score 2 was defined as indicative of ‘psychiatric caseness’. Among exposed fire fighters and police officers Cronbach’s alphas of .87 and .86, respectively, were found for the total GHQ score.

**Self-Rating Inventory for Posttraumatic Stress Disorder (SRIP).** For the assessment of PTSD, the SRIP was used [35]. With this reliable and valid 22-item scale, symptoms of intrusion (6 items), avoidance (9 items) and hyperarousal (7 items) and a total score (range 0-88) of PTSD-symptoms experienced during the preceding four weeks are assessed on a 4-point scale. Items of the SRIP are based on the DSM-IV criteria for PTSD phrased without reference to a certain specific trauma. A correlation coefficient of .92 for test-retest reliability was found [35], and Cronbach’s alphas of .88 for the total score in both the exposed fire fighters and police officers were found [36]. A clinical cut-off value of 39, previously identified in a community sample, was used to indicate probable PTSD caseness [37].
Impact of Event Scale (IES). Psychological reactions to the air disaster were measured with the Dutch adaptation of the IES [38, 39]. Both subscales of intrusion (7 items) and avoidance (8 items) as well as a total score of all 15 items were calculated. A cut-off point of 25 was used as indicative of a moderate or severe impact of the air disaster [40]. Recently, reliability and validity of the Dutch adaptation of IES was examined among different samples including the participants of the current study [36]. Cronbach’s alphas of .90 and .87 were found for the total IES score among exposed fire fighters and police officers, respectively.

Checklist Individual Strength (CIS). Different aspects of fatigue were measured with the CIS [41]. In the present study the total CIS score (range 0-140) based on all 20 items of the scale was used. A cut-off value of > 76, previously determined in a working population, was used to indicate a debilitating level of fatigue [42]. Regarding the internal consistency of the CIS total score, Cronbach’s alphas of .94 and .95 for total groups of fire fighters and police officers, respectively, were found.

Negative life events. A 15-item negative life events questionnaire was used to measure negative life events that can occur in the life of every participant or in the lives of close relatives (e.g. divorce or break-up of a long-term relationship). All participants were required to indicate (‘yes’ or ‘no’) if an event had happened to them before and/or after the air disaster in Amsterdam in 1992. The last two questions were open-ended, and were screened on duplicity with responses to similar events on the list.

2.4 Data analysis

All data were analysed using the Statistical Package for the Social Sciences (version 11.0 for Windows XP). Demographic characteristics, pre- and post-disaster life events, and chronic illnesses were examined using t-tests for independent samples (for continuous variables) and chi-square tests (for dichotomous and categorical variables). To test our first hypothesis (i.e., exposed report more symptoms of specific and non-specific psychological distress than non-exposed) several linear regression analyses with SRIP (sub)scales, SCL-90-R subscales, GHQ-12 total score, CIS total score as dependent variables and exposure vs. non-exposure to the air disaster as main independent variable, were performed. In addition, logistic regression analyses with clinical cut-offs of the scores as dependent variables were also performed. The analyses were adjusted for the potentially confounding factors age, gender, education, ethnicity, pre-disaster life events, and chronic illness because these factors potentially differ between exposed and non-exposed rescue workers and, as several studies have shown, are related to levels of psychological distress. Smoking, alcohol use and post-disaster life events was not adjusted for because they might be an outcome of exposure to the disaster and correlate with other outcome measures of psychological distress. To test our second hypothesis (i.e., background-factors and exposure are associated with higher levels of psychological distress) several hierarchical multiple regression analyses for, respectively, the exposed fire fighters and exposed police officers were performed. In each analysis one of the dependent variables of psychological distress was entered, whereas the potential background and disaster-related variables were entered stepwise as independent variables. In each step (1: background characteristics; 2: disaster-related exposure variables; and 3: post-disaster life events) we examined the "effect" of variables entered, controlling for variables entered in previous steps.

Due to non-normality of most of the variables of psychological distress, (linear) regression analyses were performed on log-transformed data. Transformed regression coefficients [EXP(regression coefficient)] are reported. Due to the large number of statistical tests (i.e., 10 dependent variables), a Bonferroni-adjusted critical two-sided p-value < .005 was considered statistically significant for the analyses regarding the first hypothesis and the second hypothesis. A reliability analysis of the independent risk factors revealed that ‘A1 Events’ and ‘Events’ in the police officer sample, and pre- and post-disaster life events in both the fire fighter and the police officer samples were relatively highly (inter)correlated. Therefore, the variables ‘Events’ and ‘pre-disaster life events’ were excluded as determinants in the hierarchical regression analysis.
3 RESULTS

3.1 Exposure factors

In Table 1 the responses concerning the nature of exposure to the air disaster and occupational involvement in specific tasks are set out. Occupationally exposed fire fighters were significantly more often involved in potentially traumatic tasks and other tasks such as cleaning up the area and fire extinguishing than exposed police officers (p < .05). Police officers, on the other hand, reported significantly more often than fire fighters that they were involved in security tasks, providing first aid to victims or emergency personnel and witnessed injured or dead people more often (A1 event) (see Table 1). As can be seen in Table 1, a few non-exposed rescue workers reported to be exposed to disaster-related events as well, due to personal involvement. Personal involvement outside the professional role, however, occurred in the exposed rescue workers as well. Therefore it was decided to keep these few personally involved non-exposed rescue workers who had no occupational role in the disaster, in the sample.

| Table 1. Occupational exposure characteristics in the Amsterdam air disaster of exposed and non-exposed fire fighters and police officers |
|---|---|---|---|---|---|
| | EXP N = 334 | NON-EXP N = 194 | EXP N = 834 | NON-EXP N = 634 | X² DIFF EXPOSED |
| **A1 TASKS**: | | | | | |
| Identification, recovery of victims/transport or search for human remains | 50 (15%) | 0 (0%) | 68 (8%) | 0 (0%) | 12.8*** |
| Rescue people | 163 (49%) | 0 (0%) | 129 (16%) | 0 (0%) | 142.2*** |
| **TASKS**: | | | | | |
| Clean-up of the destroyed area | 180 (55%) | 0 (0%) | 40 (5%) | 0 (0%) | 380.0*** |
| Transport of injured victims | 14 (4%) | 0 (0%) | 35 (4%) | 0 (0%) | .0 |
| Fire extinguishing | 199 (61%) | 0 (0%) | 1 (0.1%) | 0 (0%) | 593.9*** |
| Security tasks (e.g., surveillance, keep bystanders from the area) | 11 (3%) | 0 (0%) | 655 (79%) | 0 (0%) | 515.0*** |
| Other tasks (including traffic management) | 83 (25%) | 0 (0%) | 318 (38%) | 0 (0%) | 18.9*** |
| Sort wreckage in the hangar | 1 (0.3%) | 0 (0%) | 16 (2%) | 0 (0%) | 4.4* |
| Other tasks in the hangar in the presence of the wreckage | 0 (0%) | 0 (0%) | 23 (3%) | 0 (0%) | 9.4** |
| Transport of wreckage | 29 (9%) | 0 (0%) | 55 (7%) | 0 (0%) | 1.6 |
| Burning of contaminated soil remnants | 8 (2%) | 0 (0%) | 5 (1%) | 0 (0%) | 7.0** |
| **A1 EVENTS**: | | | | | |
| Immediate family members died / in life-threatening danger / injured | 0 (0%) | 0 (0%) | 4 (0.5%) | 2 (0.3%) | 1.6 |
| Having been in life-threatening danger during the disaster | 4 (2%) | 0 (0%) | 10 (1%) | 1 (0.2%) | .01 |
| Personal injuries due to the disaster | 0 (0%) | 0 (0%) | 3 (0.4%) | 0 (0%) | 1.2 |
| Having witnessed dead or injured victims | 56 (32%) | 1 (0.5%) | 364 (45%) | 2 (0.3%) | 8.7** |
| In or near one of the destroyed buildings at the time of the disaster | 14 (4%) | 9 (4.6%) | 70 (8%) | 4 (0.6%) | 16.0*** |
| **EVENTS**: | | | | | |
| Saw the aircraft crash, or saw or heard the aircraft just before it crashed | 23 (7%) | 9 (5%) | 41 (5%) | 23 (4%) | 1.8 |
| Saw the fire | 170 (52%) | 14 (7%) | 556 (68%) | 16 (3%) | 27.8*** |
| Other family members in life-threatening danger / injured | 0 (0%) | 1 (0.5%) | 5 (1%) | 0 (0%) | 4.5 |
| Saw disaster site directly after crash, or when wreckage was still there | 246 (74%) | 21 (11%) | 624 (75%) | 8 (1%) | .17 |
| Friends or acquaintances died, injured or in life-threatening danger | 10 (3%) | 7 (4%) | 40 (5%) | 2 (0.3%) | 2.0 |
| Felt or heard the impact of the crash | 20 (6%) | 11 (6%) | 40 (5%) | 15 (2%) | .68 |
3.2 Background factors

All exposed ($N = 334$) and non-exposed ($N = 194$) fire fighters were male. The mean age of the exposed fire fighters was 12.6 years higher than that of the non-exposed group (Table 2). Moreover, the number of life events experienced before and after the disaster, percentage of individuals having one or more chronic illnesses, and degree of alcohol use were all significantly higher for exposed fire fighters compared to their non-exposed colleagues (Table 2). Non-exposed fire fighters more often had a high or middle level of education than those exposed, who in turn more often had a missing or low level of education. Table 2 also shows that exposed police officers ($N = 834$) were more often male, slightly younger, experienced more negative life events before and after the air disaster, and more often reported to be suffering from at least one chronic illness compared to non-exposed police officers ($N = 634$).

### Table 2. Descriptive characteristics of fire fighters and police officers exposed and non-exposed in the Amsterdam air disaster

<table>
<thead>
<tr>
<th></th>
<th>Exposed ($N = 334$)</th>
<th>Non-exposed ($N = 194$)</th>
<th>$p$</th>
<th>Exposed ($N = 834$)</th>
<th>Non-exposed ($N = 634$)</th>
<th>$\chi^2$ Diff Exposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years (Mean, SD)</td>
<td>51.4 (5.9)</td>
<td>38.8 (9.1)</td>
<td>0.001</td>
<td>44.0 (6.2)</td>
<td>44.8 (7.0)</td>
<td>0.05</td>
</tr>
<tr>
<td>Male gender %</td>
<td>100.0</td>
<td>100.0</td>
<td>-</td>
<td>88.5</td>
<td>84.9</td>
<td>0.05</td>
</tr>
<tr>
<td>Single status %</td>
<td>5.4</td>
<td>8.2</td>
<td>0.20</td>
<td>10.0</td>
<td>9.0</td>
<td>0.53</td>
</tr>
<tr>
<td>Education %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>6.3</td>
<td>10.3</td>
<td>0.05</td>
<td>20.9</td>
<td>23.3</td>
<td>0.72</td>
</tr>
<tr>
<td>Middle</td>
<td>27.5</td>
<td>35.1</td>
<td></td>
<td>52.5</td>
<td>51.5</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>58.7</td>
<td>50.5</td>
<td></td>
<td>20.7</td>
<td>19.7</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>7.5</td>
<td>4.1</td>
<td></td>
<td>5.9</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Non-European Ethnicity %</td>
<td>0.0</td>
<td>0.0</td>
<td>-</td>
<td>2.8</td>
<td>1.6</td>
<td>0.13</td>
</tr>
<tr>
<td>1 chronic illnesses %</td>
<td>60.8</td>
<td>25.3</td>
<td>0.001</td>
<td>52.2</td>
<td>42.6</td>
<td>0.001</td>
</tr>
<tr>
<td>Smoking habits %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non smoker</td>
<td>32.0</td>
<td>44.8</td>
<td>0.05</td>
<td>33.1</td>
<td>27.9</td>
<td>0.05</td>
</tr>
<tr>
<td>Ex smoker</td>
<td>35.0</td>
<td>29.4</td>
<td></td>
<td>31.7</td>
<td>38.0</td>
<td></td>
</tr>
<tr>
<td>Smoker</td>
<td>32.9</td>
<td>25.8</td>
<td></td>
<td>35.3</td>
<td>34.1</td>
<td></td>
</tr>
<tr>
<td>Alcohol use %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non alcohol use</td>
<td>4.2</td>
<td>12.4</td>
<td>0.001</td>
<td>11.4</td>
<td>8.2</td>
<td>0.10</td>
</tr>
<tr>
<td>Light-moderate use</td>
<td>72.8</td>
<td>70.6</td>
<td></td>
<td>74.3</td>
<td>75.7</td>
<td></td>
</tr>
<tr>
<td>Excessive use</td>
<td>23.1</td>
<td>17.0</td>
<td></td>
<td>14.3</td>
<td>16.1</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 6

Hypothesis one: psychological distress in exposed and non-exposed fire fighters

The several linear regression analyses with continuous variables of psychological distress as dependent variables and exposure (y/n) as independent variable revealed that somatic complaints and fatigue symptoms were reported significantly more often ($p < .005$) by exposed than by non-exposed fire fighters, after having adjusted for potential confounders (Table 3). For instance, a coefficient of 1.17 for the difference in fatigue for fire fighters means that the exposed fire fighters had a 17% higher score on fatigue compared to the reference group ($p = 0.001$). Logistic regression analyses revealed that the prevalence of a debilitating level of fatigue and somatic complaints among exposed was 12% and 18%, respectively, compared to 3% for both scales among non-exposed fire fighters ($p = .009$ and $p = .028$, respectively). On the IES, almost 3% ($N = 9$) of the exposed fire fighters reported a moderate to severe traumatic reaction to the air disaster. None of the occupationally non-exposed rescue workers reported a high traumatic stress reaction to the air disaster.

Hypothesis one: psychological distress in exposed and non-exposed police officers

Table 3 shows that exposed police officers reported significantly more symptoms of anxiety, depression, somatic complaints, sleep disturbances, PTSD (intrusion, avoidance and hyperarousal), symptoms on the GHQ-12 and fatigue than non-exposed police officers after having adjusted for potential confounders ($p < .005$). The logistic regression analyses showed that the prevalence rates of clinically high symptom levels of anxiety (12%, $N = 96$), somatic complaints (17%, $N = 138$), sleep disturbances (23%, $N = 193$), and fatigue (17%, $N = 136$) were significantly higher (i.e., $p < .005$) among exposed police officers than among non-exposed police officers (i.e., anxiety 5%, $N = 32$; somatic complaints 6%, $N = 40$; sleep disturbances 13%, $N = 81$; fatigue 9%, $N = 56$). As a consequence of our stringent alpha level of $p < .005$, the prevalence of a clinically high symptom level indicative of PTSD on the SRIP (i.e., 7%, $N = 54$ and 2%, $N = 20$, respectively) was not significantly higher among exposed police officers than among non-exposed police officer ($p = .010$). Two percent ($N = 20$) of the exposed police officers reported a moderate to severe traumatic reaction to the air disaster on the IES. One non-exposed police officer had a moderate to high level of symptoms on the IES but reported never any exposure to the air disaster on the several questionnaires.

### Table 2. Descriptive characteristics of fire fighters and police officers exposed and non-exposed in the Amsterdam air disaster

<table>
<thead>
<tr>
<th>Measure</th>
<th>Fire fighters</th>
<th>Police officers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed ($N = 334$)</td>
<td>Non-exposed ($N = 194$)</td>
</tr>
<tr>
<td>Life events before disaster (Mean, SD)</td>
<td>2.7 (1.9)</td>
<td>2.0 (1.9)</td>
</tr>
<tr>
<td>Life events after disaster (Mean, SD)</td>
<td>3.2 (2.0)</td>
<td>3.0 (1.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure</th>
<th>Median (IQR)</th>
<th>Median (IQR)</th>
<th>B*</th>
<th>CI</th>
<th>$p$</th>
<th>Median (IQR)</th>
<th>Median (IQR)</th>
<th>B*</th>
<th>CI</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCL-90-R Anxiety</td>
<td>10.0 (10.0-12.0)</td>
<td>10.0 (10.0-11.0)</td>
<td>1.03</td>
<td>0.99-1.07</td>
<td>.205</td>
<td>11.0 (10.0-12.0)</td>
<td>10.0 (10.0-11.0)</td>
<td>1.05</td>
<td>1.03-1.07</td>
<td>.000*</td>
</tr>
<tr>
<td>Depression</td>
<td>17.0 (16.0-20.0)</td>
<td>17.0 (16.0-17.0)</td>
<td>1.03</td>
<td>0.98-1.07</td>
<td>.241</td>
<td>17.0 (16.0-20.0)</td>
<td>17.0 (16.0-18.0)</td>
<td>1.05</td>
<td>1.02-1.06</td>
<td>.000*</td>
</tr>
<tr>
<td>Somatic complaints</td>
<td>14.0 (13.0-17.0)</td>
<td>13.0 (12.0-14.0)</td>
<td>1.09</td>
<td>1.04-1.14</td>
<td>.000*</td>
<td>14.0 (13.0-17.0)</td>
<td>13.0 (12.0-15.0)</td>
<td>1.06</td>
<td>1.04-1.09</td>
<td>.000*</td>
</tr>
</tbody>
</table>
Hypothesis two: (risk-) factors and psychological distress in exposed fire fighters

For each of the ten dependent variables and the IES total score, stepwise hierarchical linear regression analyses were performed with background factors, exposure factors and post-disaster negative life events as independent factors. A factor or correlate was considered to be significantly associated with the outcome of psychological distress when $p < .005$. The following factors were found significantly associated in exposed fire fighters ($N = 334$): age (per 5-year increase) with, respectively, SRIP total ($B = 1.03$), SRIP intrusion ($B = 1.03$), SRIP avoidance ($B = 1.03$), air-disaster related posttraumatic distress on the IES ($B = 1.17$); unmarried status with SRIP total ($B = 1.16$), SRIP intrusion ($B = 1.15$), SRIP avoidance ($B = 1.16$), SRIP hyperarousal ($B = 1.18$), total GHQ-12 score ($B = 1.86$), SCL-90-R depression ($B = 1.14$), respectively; chronic illness with CIS fatigue ($B = 1.25$) and SCL-90-R somatic complaints ($B = 1.17$), respectively; tasks performed at the disaster site with SRIP total ($B = 1.03$), SRIP hyperarousal ($B = 1.04$), IES-total ($B = 1.18$), GHQ-12 score ($B = 1.11$), SCL-90-R depression ($B = 1.03$), SCL-90-R anxiety ($B = 1.04$) and SCL-90-R somatic complaints ($B = 1.04$), respectively; number of post-disaster life events with all SRIP scales, SCL-90-R anxiety and SCL-90-R depression, respectively (all $B = 1.02$). Effects remained stable in subsequent steps. The following factors were not significantly associated with any of the psychological distress outcomes in fire fighters: (lower) education and traumatic exposure (A1 tasks, A1 events and other events) at the disaster site.

Because some exposure items (e.g., exposure to some A1 events) were not filled-out by part of the exposed fire fighters (see Table 1), a subgroup analysis was done on exposed fire fighters who filled-out all items. This had, however, no consequences on the outcomes.

Hypothesis two: (risk-) factors and psychological distress in exposed police officers

Among police officers ($N = 834$), the following factors were significantly associated ($P < .005$): male gender with SCL-90-R depression ($B = 0.93$) and SCL-90-R somatic complaints, respectively ($B = 0.91$); education (missing vs. high) with SRIP hyperarousal ($B = 1.14$), SCL-90-R depression ($B = 1.10$) and SCL-90-R anxiety ($B = 1.10$), respectively; chronic illness with SRIP hyperarousal ($B = 1.05$), SCL-90-R anxiety ($B = 1.04$), SCL-90-R depression ($B = 1.04$), SCL-90-R somatic complaints ($B = 1.12$), and CIS fatigue ($B = 1.24$), respectively; A1 events, A1 tasks and other tasks with disaster-related posttraumatic distress on the IES-total ($B = 1.38$; $B = 1.31$; $B = 1.13$); number of post-disaster life events with SRIP total score, SRIP intrusion, SRIP avoidance and SRIP hyperarousal, SCL-90-R anxiety, SCL-90-R depression, SCL-90-R somatic complaints ($B = 1.02$ for all SRIP and SCL-90-R scales), CIS total score of fatigue ($B = 1.04$), and IES total ($B = 1.09$), respectively. Not signif-
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Psychological distress of rescue workers were: age, marital status, and more tasks and A1 events at the disaster site was not associated with non-disaster related psychological distress.

4 Discussion

Exposure to critical incidents is part of the work of most fire fighters and police officers. Disasters, however, are experienced less frequent and can be overwhelming even to rescue workers. Most studies into the after-effects of disasters on rescue workers have focused on the psychological after-effects of exposure to a high number of dead bodies after disasters (e.g., [10, 17]). The present study was unique in several ways. Participants were exposed to a disaster that involved exposure not only to gross destruction and multiple dead bodies, but also to a long-term aftermath of rumours and uncertainty about potential health effects through real and/or alleged toxic exposure. Additionally, this epidemiological study had a large study population with good response rates, and included non-exposed fire fighters and police officers as reference groups.

Before discussing the implications of the present findings, some methodological considerations should be addressed. First, this is a cross-sectional study with retrospective self-reports of exposure to a disaster that occurred about 8.5 years previously, which makes it difficult to draw conclusions about cause and effect between background and exposure factors and psychological distress. Moreover, the validity of retrospective self-reports of exposure to trauma and that of (traumatic) events in the years afterwards, has been debated. Although reports of whether or not a certain event had actually occurred were found to be accurate [43], recall of details of the events appeared to be less accurate especially among subjects with PTSD [44]. Secondly, the exposed fire fighters in our sample were significantly older, had (expectedly) more years of service, more pre- and post-disaster negative life events, and lower education than the non-exposed fire fighters who joined the fire department after the air disaster. Although statistical adjustment for most of these factors was applied, other potential cohort effects cannot be ruled out. For instance, older fire fighters might be less inclined to talk about psychological distress than their much younger non-exposed counterparts.

The results of the current study show that, 8.5 years after the air disaster, exposed fire fighters reported significantly more symptoms of fatigue and somatic complaints than non-exposed fire fighters, whereas police officers reported significantly more symptoms of PTSD and general psychological distress compared to non-exposed police officers. Among exposed fire fighters and police officers several background and exposure factors were positively associated with psychological distress. The current results are in line with previous findings that showed higher levels of psychological distress among those involved in disasters with real or alleged exposure to hazardous materials [19, 20]. For instance, in the Chernobyl accident widespread psychological distress among clean-up workers was found, whereas it was difficult to determine whether these symptoms were stress-related or radiation-induced [20]. The same more or less applies to the Amsterdam air disaster: no differences were found in the prevalence of auto-antibodies nor were there any clinically relevant significant differences in hematological and biochemical laboratory values and urinalysis outcomes [28, 29], and a risk analysis revealed that it is unlikely that the missing uranium had indeed led to the health complaints reported [45].

Linking disaster exposure to the higher levels of general psychological distress among exposed fire fighters and police officers is complex. Some disaster-related exposure variables were related to higher levels of psychological distress, however, it is unclear whether the degree of exposure at the disaster site in 1992 or the exposure to the long-term aftermath is primarily responsible for the higher level of psychological distress. In exposed fire fighters performance of an increasing number of tasks at the disaster site was associated with (disaster-related and -unrelated) outcomes of psychological distress, whereas in police officers the degree of (traumatic) exposure at the disaster site was only significantly related to disaster-related posttraumatic stress symptoms and not to other more general psychological distress. Perhaps exposure to the disasters’ long-term aftermath is even more harmful for long-term psychological distress than the exposure to the disaster itself [21, 24-26]. However, very few studies have actually assessed factors, such as media exposure, in relation
to an increase of health problems [46]. Waxing and waning of concerns among exposed fire fighters and police officers inside the fire and police departments might have played an important role as well. Probably a complex interplay between these various types of exposures and other pre- and post-disaster factors resulted in a higher level of psychological distress among rescue workers exposed to the Amsterdam air disaster, even many years afterwards. Although not assessed in the current study, cognitive factors (such as risk perception and appraisal of the trauma) are also potential mediators between both types of exposures and psychological distress [21].

A potential bias introduced by investigating the health of rescue workers more than 8 years after a disaster may also play a role [47]. Because our participants were aware of the purpose of the study, their focus on health problems may have increased and/or might have evoked feelings of anxiety. Although the influence of this factor cannot be ruled out, we do not think this factor alone can explain the differences found. Nonetheless, in future studies it is recommended to assess the rescue workers on their exposure to a wider range of work-related events and to leave the participants uninformed about which particular event is expected to be most strongly related to the psychological distress.

Although not directly tested, police officers seemed more affected by the air disaster than exposed fire fighters. Differences in psychological distress between exposed and non-exposed were found on more outcome measures among police officers than among fire fighters. However, increased power due to large sample size in police officers most likely plays a role in this difference between fire fighters and police officers. Psychological distress of exposed fire fighters was consistently associated with the number of tasks they had performed at the disaster site, whereas among exposed police officers disaster-related posttraumatic distress was related to both the number of tasks performed and the number of traumatic tasks and events. This is somewhat surprising given the fact that exposed fire fighters were significantly more often involved in A1 tasks than exposed police officers. Police officers reported to have been exposed to injured and dead victims more often than fire fighters, probably because they were more often in an ‘audience position’ that might have increased feelings of helplessness and, subsequently, posttraumatic distress. An earlier study on some of the police officers involved in the 1992 disaster (N = 105), revealed that performing rescue operations was emotionally exhausting for some police officers, particularly for those who were involved for a long time in rescue operations and who were debriefed afterwards [48].

However, in the present study the rates of long-term disaster-related posttraumatic morbidity among fire fighters and police officers were quite similar (i.e., 3% and 2%, respectively), which is in line with results of Marmar et al., [2]. It seems that both occupationally exposed fire fighters and police officers (particularly those who performed more tasks) were negatively affected by the stressful aftermath of the 1992 disaster, but that police were also vulnerable to specific traumatic exposures at the disaster site, e.g. because they had less experience with this type of disaster work and/or have more pre-existing background factors known to be associated with psychological distress. Indeed, in our sample the exposed police officers were a more heterogeneous group regarding potential risk factors for posttraumatic distress (i.e., including females and non-European officers) than the more homogeneous group of fire fighters. In line with the literature and the current findings, these background factors were significantly associated with general and specific psychological distress, particularly among exposed police officers [1, 10, 13]. For example, police officers with a non-European ethnicity are mostly from ethnic-minority groups (e.g., Turkish, Moroccan) and may have encountered frequent discrimination during their (work)lives and/or the social circumstances of these groups may play a role in how they interpret trauma (e.g., [49]).

Exposed fire fighters and police officers had higher prevalence rates of clinically high levels of specific and general psychological distress than the non-exposed groups. However, prevalence rates of, for example, severe fatigue were lower among the currently studied rescue workers than the prevalence rate of 22% found in the general Dutch working population [50]. Current (past 4 weeks) PTSD rates of nearly 5% and 7% were found among exposed fire fighters and police officers, respectively, compared with 3% and 2%, respectively, among non-exposed colleagues. In community samples, lifetime PTSD rates of 8% and 9% have been found [51, 52]. Current PTSD rates fol-
lowing trauma in a community sample, however, have found to be lower (e.g., [53]). Among police officers current PTSD rates of 7% were found after responding to a critical incident or disaster [1, 6], whereas among fire fighters a high prevalence rate of 18% of current PTSD following trauma has been found [3]. Comparing prevalence rates across studies is difficult because of the differences in methodologies study populations. Overall, prevalence rates of PTSD in the present study are relatively low, specifically when frequent traumatic exposure might be expected. Relatively low exposure to duty-related traumatic incident in the months before assessment might play a role. No specific data on such exposures, however, were available. Other methodological factors, such as PTSD assessment with a questionnaire instead of a structured clinical interview, might also play a role.

In conclusion, the air disaster and its aftermath resulted in higher levels of psychological distress among rescue workers involved even 8.5 years afterwards. Some fire fighters and police officers still suffer from a moderate to high level of disaster-related posttraumatic distress. Several background and exposure factors were associated with levels of specific and general psychological distress. Fire fighters and police officers differed in exposure at the disaster site and its association with psychological distress. However, at the group level, police officers and particularly fire fighters appear to be in relatively good mental health. More studies (preferably with a prospective design and longitudinal monitoring of psychological distress) are needed. These should elucidate the underlying mechanisms and relationships with regard to what specific exposure factors (including an aftermath of exposure in the media and at the fire and police departments) and their mediators (e.g., risk perception) determine and predict psychological distress following disasters and incidents with an aftermath of real and/or alleged exposure to hazardous materials.
REFERENCES


47. van Dijk FJ: [The cares and anxiety of those involved in the Bijlmermeer aviation disaster did not diminish following the medical investigations]. *Ned Tijdschr Geneeskd* 2005, 149(23):1257-1260.


LONG-TERM HEALTH COMPLAINTS OF THE AMSTERDAM AIR DISASTER ON POLICE OFFICERS AND FIRE-FIGHTERS

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Chapter 7

ABSTRACT

Objectives On October 4th, 1992, a cargo aircraft crashed into apartment buildings in Amsterdam, the Netherlands. Fire-fighters and police officers assisted with the rescue work. The present study examined the long-term health effects on rescue workers exposed to a disaster.

Methods A historical cohort study was performed among police officers (n= 834) and fire-fighters (n=334) who performed at least one disaster-related task and reference groups of their non-exposed colleagues (n=634 and n=194, respectively). The main outcome measures included digestive, cardiovascular, musculoskeletal, nervous system, airway, skin, post-traumatic stress, fatigue and general mental health complaints; hematological and biochemical laboratory values, and urinalysis outcomes.

Results Police officers and fire-fighters who were professionally exposed to a disaster reported more physical and mental health complaints, compared to the reference groups. No clinically relevant statistically significant differences in laboratory outcomes were found.

Conclusions Our study is the first to examine long-term health effects of a large sample of rescue workers exposed to a disaster in comparison to reference groups of non-exposed colleagues. Our findings show that even in the long term, and in absence of laboratory abnormalities, rescue workers report more health complaints.
1 INTRODUCTION

On October 4th, 1992, a cargo aircraft crashed into two apartment buildings in a densely populated suburb of Amsterdam, the capital of the Netherlands. The Amsterdam Air Disaster resulted in 39 fatal injuries on the ground, killed all four occupants of the aircraft, and destroyed 266 apartments. Fire-fighters and police officers helped to rescue the victims of this disaster, to extinguish the fire and to clear away the debris.

Several years later, some of the police officers and fire-fighters who had been exposed to the disaster, and a number of inhabitants of the area were still worried about the content of the cargo of the aircraft. They reported a variety of health complaints, which they attributed to the disaster, and called for a study to investigate whether their health complaints were related to the disaster. In 1998, a parliamentary inquiry was held to investigate the cause of the crash and to gain insight into the content of the cargo of the aircraft. One of the recommendations was that an epidemiological study should be conducted to investigate the health status of the victims of the disaster and the rescue workers exposed to the disaster.

The Amsterdam Air Disaster is an example of a technological disaster with a sudden onset. Other studies have shown that such disasters may result in acute injuries (such as burns and fractures) and short-term symptoms (such as respiratory symptoms) [1]. However, the mere threat of exposure to hazardous material during such an event may also be a source of stress, associated with changes in mental health, physical health, and health-related behaviour [2]. Indeed, various symptoms, such as headache, fatigue, memory disorders, joint and muscle aches, bowel symptoms, dizziness, anxiety, depression, and Post-Traumatic Stress Disorder (PTSD) have sometimes been found to develop over time among affected populations after various disastrous events [3-6]. Moreover, the long aftermath of the Amsterdam Air Disaster and the confusing and ambiguous information in the media may have been an additional cause of distress to those involved. In fact, the disaster was followed by speculation regarding the content of the cargo of the plane, that might have included a toxic agent (such as depleted uranium, mycoplasma fermentans, sarin), rumours and conspiracy theories [7-8]. According to Vasterman et al. [7], two media hyps were reinforced, which concerned the presumed “cover-up” about an unknown toxic agent that may cause health symptoms. These media hyps were followed by new groups of people reporting to suffer from health problems which they attributed to the disaster [7].

Most of the previous studies have focused on the health status of inhabitants of the affected area of a disaster and reported short-term health effects only. Furthermore, very few studies included a reference group of people who were not exposed to the disaster, and information on disaster-related long-term health complaints of rescue workers is scarce. The present large-scale historical cohort study was designed to study the long-term health effects on police officers and fire-fighters exposed to a disaster.

Our aim was to investigate the physical and mental health status of police officers and fire-fighters 8.5 years after they had been exposed to the Amsterdam Air Disaster and to compare their health status with that of colleagues in reference groups.

2 METHODS

2.1 Participants

All police officers and fire-fighters who were on active duty at the time of the disaster and in the weeks afterwards, were invited to participate in the Epidemiological Study Air Disaster Amsterdam (ESADA) study. Due to administrative deficiencies and partial lack of historic registration of exposure status, we used detailed self-reported data to define exposure status for all workers. Therefore, our study can be regarded as a historic cohort study, with retrospective data on exposure.
Participants completed a questionnaire on professional exposure to the disaster, which included questions on disaster-related tasks such as “saving people’s lives”, “extinguishing the fires”, and “transporting the wounded”. Police officers and fire-fighters who performed at least one task, were defined as being ‘exposed’. Police officers were mostly involved in security tasks (surveillance, preventing burglary, keeping disaster area free of bystanders), a variety of other tasks (including traffic management), and assisting or providing first aid to injured victims or emergency personnel. The most prevalent tasks among fire-fighters were fire extinguishing, rescuing people, and clearing up of the destructed area. We have used a priori stratification by occupational group, because of fundamental differences between these occupational groups (i.e. police officers and fire-fighters) with respect to occupational exposure to the disaster, general health status, and socio-demographic variables.

Professional colleagues who did not perform any disaster-related task were also invited to participate in the study, in “non-exposed” reference groups, and were matched according to job title. The exclusion criteria were: having insufficient knowledge of the Dutch language and therefore not being able to fill in questionnaires, residing in the disaster area, and missing questionnaire data on disaster-related tasks.

All of the participants gave written informed consent and participated voluntarily. Data were collected in an outpatient clinic of the Onze Lieve Vrouwe Gasthuis (OLVG) in Amsterdam, which took place from January 2000 to March 2002, on average 8.5 years after the Amsterdam Air Disaster. Details of the history and the set-up of the study, including details about the outcome measures, have already been reported elsewhere [9].

2.2 Health outcomes

2.2.1 Perceived health complaints

All participants filled out questionnaires on their current health status at the time of the assessment. The International Classification of Primary Care (ICPC), as designated by the World Organization for Family Doctors (WONCA), was used to classify the symptoms reported by the participants [10]. The following somatic symptoms categories were used in the analysis: (1) general and non-specific, (2) digestive system, (3) cardiovascular system, (4) musculoskeletal system, (5) nervous system, (6) respiratory tract, and (7) skin. A dichotomized score was composed for each category of symptoms, (“0” = no symptom, “1” = at least one symptom in this category).

Post-traumatic stress symptoms were assessed using the Self-Rating Inventory for Post-traumatic Stress Disorder (SRIP), a 22-item questionnaire [11-13]. The items were based on symptoms of post-traumatic stress disorder as described in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) for psychiatric diagnoses [14]. A cut-off score of 39 was predetermined to define individuals who have problems due to involvement in a traumatic event [15].

Fatigue symptoms were measured with the Checklist Individual Strength (CIS), a 20-item scale, resulting in four subscales and a total score. For the present study, use was made of dichotomized scores on the ‘subjective fatigue’ sub-scale (cut-off score: 35) and the total score (cut-off score: 76) [16-17].

General mental health was assessed by means of the Symptom Checklist (SCL-90) [18]. This is a 90-item questionnaire, which consists of 8 sub-scales (somatic symptoms, depression, anxiety, obsessive-compulsive behavior, agoraphobia, interpersonal sensitivity, hostility, sleeping problems). Scores above the 65th percentile of the normal Dutch population were regarded as deviant [19].
2.3 Laboratory outcomes

All the laboratories involved in this study carried out their analyses according to the accredited (Dutch) standards. We used the clinical cut off values of these laboratories to define a deviant outcome [20]. The blood count included hemoglobin, leukocyte count, differential leukocyte count, and platelet count. Blood chemical values included potassium, creatinine, alanine aminotransferase, alkaline phosphatase, gamma-glutamyl transferase, creatine kinase, thyroid stimulating hormone, C-reactive protein and ferritin. Urinalysis included the dipstick test followed by microscopic evaluation of the urinary sediment if indicated by presence of protein.

2.4 Statistical analysis

Differences between the exposed police officers and fire-fighters and their reference groups were analysed with unconditional multiple logistic regression analyses. All analyses were adjusted for the following potential confounders: age, professional level, level of education, alcohol consumption, smoking habits and level of physical activity. For police officers only, gender and ethnicity were added as potential confounders. In addition, mental health outcomes were adjusted for the number of adverse pre-disaster life-events and the presence of chronic diseases. Odds ratios (ORs) and the 95% Confidence Intervals (95% CI) were estimated. The analyses were carried out in SPSS version 10.1, and p< .05 (two-sided) was used to determine statistical significance.

3 RESULTS

3.1 Response

The response from both the police officers and the fire-fighters was 70%. Of the 2112 police officers who were invited to participate, 1489 agreed. After the exclusion criteria had been applied, data from 834 exposed police officers and 634 non-exposed police officers were analysed. Of the 790 fire-fighters who were invited to participate, 559 agreed, and after the exclusion criteria had been applied, data from 334 exposed and 194 non-exposed fire-fighters were analysed. Details are shown in Figure 1. Table 1 presents background characteristics of the participants.

<table>
<thead>
<tr>
<th>TABLE 1. BACKGROUND CHARACTERISTICS OF THE PARTICIPANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>POLICE OFFICERS</td>
</tr>
<tr>
<td>EXPOSED</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>AGE IN YEARS (SD)</td>
</tr>
<tr>
<td>44.0 (6.2)</td>
</tr>
<tr>
<td>Level of educational (%)</td>
</tr>
<tr>
<td>Low Intermediate High</td>
</tr>
<tr>
<td>22.0</td>
</tr>
<tr>
<td>55.8</td>
</tr>
<tr>
<td>22.2</td>
</tr>
<tr>
<td>Alcohol consumption(^1) (%)</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Low to moderate Heavy</td>
</tr>
<tr>
<td>74.3</td>
</tr>
<tr>
<td>14.3</td>
</tr>
<tr>
<td>Heavy</td>
</tr>
<tr>
<td>11.4</td>
</tr>
<tr>
<td>31.7</td>
</tr>
<tr>
<td>35.3</td>
</tr>
<tr>
<td>Smoking habits (%)</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Former smoker</td>
</tr>
<tr>
<td>33.1</td>
</tr>
<tr>
<td>31.7</td>
</tr>
<tr>
<td>35.3</td>
</tr>
<tr>
<td>Male Gender (%)</td>
</tr>
<tr>
<td>84.9</td>
</tr>
</tbody>
</table>

\(\text{SD} = \text{standard deviation}; \ ^1 \text{Alcohol consumption was assessed according to the Garretsen index [45].}\)

A random sample of non-respondent fire-fighters (\(n=66 \) [29%] of \(n=231\)) were attempted to be contacted by telephone for a brief interview. Of this sample, 47 (71%) completed the interview. Only five were unwilling to participate, while 14 non-respondents could not be contacted, even after several attempts. Non-respondents and participants were compared with respect to socio-demographic variables (age, sex, level of education), and subjective health outcomes (general health;
physical symptoms; psychological symptoms; chronic skin, joint or respiratory diseases since 1992). For most of these variables, no statistically significant differences between non-respondents and participants were found. However, compared to their participating counterparts, non-respondent fire-fighters were slightly older, reported less often a low level of education, and more often had psychological complaints and chronic arthritis since the year of the disaster (1992).

Table 2 presents the results of the multiple logistic regression analyses with regard to the ICPC symptoms categories, adjusted for potential confounders. In general, the exposed police officers and the exposed fire-fighters reported health complaints significantly more often than the respective reference group.

Table 3 presents the results of the multiple logistic regression analyses with regard to mental health outcomes, adjusted for potential confounders. In general, again the exposed police officers reported symptoms significantly more often than the reference group, including PTSD, fatigue, and indices of psychopathology. The exposed fire-fighters reported significantly more fatigue and somatic symptoms than the reference group.

*only one female firefighter participated and was therefore excluded; 14 firefighters in the reference group were of non-Caucasian ethnicity, and could therefore not be compared to the involved group, which included only Caucasian firefighters.

**Figure 1. Flow-chart of the response**

### 3.2 Perceived health complaints

Table 2 presents the results of the multiple logistic regression analyses with regard to the ICPC symptoms categories, adjusted for potential confounders. In general, the exposed police officers and the exposed fire-fighters reported health complaints significantly more often than the respective reference group.

Table 3 presents the results of the multiple logistic regression analyses with regard to mental health outcomes, adjusted for potential confounders. In general, again the exposed police officers reported symptoms significantly more often than the reference group, including PTSD, fatigue, and indices of psychopathology. The exposed fire-fighters reported significantly more fatigue and somatic symptoms than the reference group.
3.3 Laboratory outcomes

The laboratory analyses showed no significant differences between exposed participants and their respective reference groups. There were two exceptions; in exposed fire-fighters the number of leukocytes was less frequently increased than in non-exposed fire-fighters. As an increase in the number of leukocytes could indicate disease in the reference group, this finding would be in favour of the exposed group. Furthermore, in exposed police officers a significant larger group of participants with a (slightly) increased percentage of monocytes was found. However, the increased percentage of monocytes did not exceed 15% of the differential count (data not shown).

### Table 2. Comparison between exposed police officers and fire-fighters and their reference groups with regard to health complaints, sub-divided into ICPC symptoms categories

<table>
<thead>
<tr>
<th>ICPC symptoms categories</th>
<th>Police officers</th>
<th>Fire-fighters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed</td>
<td>Reference</td>
</tr>
<tr>
<td>General/non-specific</td>
<td>40.4%</td>
<td>27.4%</td>
</tr>
<tr>
<td>Digestive</td>
<td>21.3%</td>
<td>15.1%</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>25.7%</td>
<td>16.7%</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>42.1%</td>
<td>29.2%</td>
</tr>
<tr>
<td>Nervous system</td>
<td>51.1%</td>
<td>39.7%</td>
</tr>
<tr>
<td>Airway</td>
<td>29.7%</td>
<td>19.7%</td>
</tr>
<tr>
<td>Skin</td>
<td>51.9%</td>
<td>28.4%</td>
</tr>
</tbody>
</table>

*p < .05; ICPC: International Classification of Primary Care; OR: Odds Ratio; CI: Confidence Interval; Ref: Reference group; The percentages reflect the relative number of participants who reported one or more symptom(s) in the relevant symptoms categories. Analyses are adjusted for age, gender, ethnicity, professional level, and level of education, alcohol consumption, smoking habits, and level of physical activity.

### Table 3. Comparison between exposed police officers and fire-fighters and their reference groups with regard to mental health complaints

<table>
<thead>
<tr>
<th></th>
<th>Police officers</th>
<th>Fire-fighters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed</td>
<td>Reference</td>
</tr>
<tr>
<td>PTSD (SRIP)</td>
<td>6.5%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Fatigue (CIS)</td>
<td>19.4%</td>
<td>9.9%</td>
</tr>
<tr>
<td>Subjective fatigue</td>
<td>16.7%</td>
<td>8.8%</td>
</tr>
<tr>
<td>Total score</td>
<td>11.7%</td>
<td>5.2%</td>
</tr>
<tr>
<td>SCL-90</td>
<td>8.3%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Agoraphobia</td>
<td>31.7%</td>
<td>18.9%</td>
</tr>
<tr>
<td>Anxiety</td>
<td>21.9%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Somatic symptoms</td>
<td>32.4%</td>
<td>17.0%</td>
</tr>
<tr>
<td>Obsessive-compulsive</td>
<td>26.9%</td>
<td>16.7%</td>
</tr>
<tr>
<td>Inter-personal sensitivity</td>
<td>12.0%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Hostility</td>
<td>42.7%</td>
<td>32.2%</td>
</tr>
<tr>
<td>Sleeping problems</td>
<td>48.3%</td>
<td>35.5%</td>
</tr>
</tbody>
</table>

*p < .05; OR = Odds Ratio; CI = Confidence Interval; PTSD = Post-Traumatic Stress Disorder; SRIP = Self-Rating Inventory for Posttraumatic Stress Disorder; CIS = Checklist Individual Strength; SCL-90 = Symptom Checklist-90. The reported prevalences reflect scores above the cut-off values for the questionnaires. Analyses are adjusted for age, gender, ethnicity, professional level, level of education, alcohol consumption, smoking habits, level of physical activity, number of adverse life-events, and chronic diseases.

### Table 4. Comparison between exposed police officers and fire-fighters and their reference groups with regard to laboratory outcomes

<table>
<thead>
<tr>
<th></th>
<th>Police officers</th>
<th>Fire-fighters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed</td>
<td>Reference</td>
</tr>
<tr>
<td>Blood count</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>14.5%</td>
<td>17.1%</td>
</tr>
</tbody>
</table>
### Table 4. Comparison between Exposed Police Officers and Fire-fighters and their Reference Groups with Regard to Laboratory Outcomes (Continued)

<table>
<thead>
<tr>
<th></th>
<th>Police Officers</th>
<th>Fire-fighters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed</td>
<td>Reference</td>
</tr>
<tr>
<td>Leukocytes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% increased</td>
<td>5.5%</td>
<td>4.9%</td>
</tr>
<tr>
<td>% decreased</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Neutrophils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% increased</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>% decreased</td>
<td>2.8%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% increased</td>
<td>15.0%</td>
<td>14.5%</td>
</tr>
<tr>
<td>% decreased</td>
<td>10.0%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Monocytes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% increased</td>
<td>9.7%</td>
<td>6.3%</td>
</tr>
<tr>
<td>% decreased</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Eosinophils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% increased</td>
<td>8.2%</td>
<td>7.0%</td>
</tr>
<tr>
<td>Basophils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% increased</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>% decreased</td>
<td>0.0%</td>
<td>0%</td>
</tr>
<tr>
<td>Platelet count</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% increased</td>
<td>0.7%</td>
<td>0.9%</td>
</tr>
<tr>
<td>% decreased</td>
<td>1.7%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Blood Chemical Values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>15.2%</td>
<td>18.5%</td>
</tr>
<tr>
<td>Alanine aminotransferase</td>
<td>10.8%</td>
<td>8.2%</td>
</tr>
<tr>
<td>Alkaline phosphatase</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Y-Glutamyl transferase</td>
<td>14.1%</td>
<td>13.6%</td>
</tr>
<tr>
<td>Creatine kinase</td>
<td>17.9%</td>
<td>17.9%</td>
</tr>
<tr>
<td>TSH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% increased</td>
<td>1.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>% decreased</td>
<td>1.0%</td>
<td>0.6%</td>
</tr>
<tr>
<td>C-Reactive protein</td>
<td>3.7%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Ferritin</td>
<td>12.5%</td>
<td>12.3%</td>
</tr>
</tbody>
</table>

**Notes:** *p < .05; --: analyses were not performed due to the very low number of cases (n<5). The reported prevalences reflect scores above (increased) or below (decreased) the cut-off values for parameters. Cut-off values: hemoglobin men < 8.7 mmol/L, women <7.5 mmol/L; leukocyte count < 3x10^9/L or > 10x10^9/L; differential leukocyte count: neutrophils <45% or >80%; lymphocytes <20% or >35%; monocytes <2% or > 10%; eosinophils > 5% and basophils >2%; platelet count <150x10^9/L or > 400x10^9/L; potassium < 3.6 mmol/L; creatinine men > 115 mol/L, women 95 mol/L; alanine aminotransferase > 45 U/L; alkaline phosphatase > 120 U/L; gamma-glutamyl transferase men > 50 U/L, women > 35 U/L; creatine kinase men > 190 U/L, women 170 U/L; TSH = thyroid stimulating hormone < 0.4 IU/L or > 4 IU/L; C-reactive protein > 10 mg/L; ferritin > 250 ng/ml; Urinalysis: Creatinine clearance: Cockroft equation (140- age)*body weight) / ((creatinine (serum))*0.86 (males) or *1.01 (females)) was used to estimate clearance of endogenous creatinine, cut-off: < 75 ml/min. Proteinuria with either sediment abnormality or increased serum creatinine, cut-off: protein not negative, erythrocytes > 5 per high power field, leukocytes > 10 per high power field, bacteria not negative. Analyses are adjusted for age, gender, ethnicity, professional level, level of education, alcohol consumption, smoking habits, and level of physical activity.

### 4 Discussion

Our study is the first to examine long-term health effects of rescue workers exposed to a disaster in comparison to reference groups of non-exposed colleagues. In this historical cohort study we had the unique opportunity to compare the health status of exposed police officers and fire-fighters with that of a reference group of non-exposed colleagues, 8.5 years after the Amsterdam Air Disaster.
Self-reported health complaints were compared, as well as routine laboratory analyses of urine and blood. The results showed that, even after 8.5 years, the police officers and fire-fighters who were professionally exposed to the disaster reported health complaints significantly more often than their colleagues in the reference groups. This difference concerned cardiovascular, musculoskeletal, nervous system, skin, and fatigue complaints for the exposed police officers as well as the exposed fire-fighters, and airway, digestive and general physical and mental health complaints for the exposed police officers only. Laboratory analyses showed no statistically significant or clinically relevant differences between the exposed participants and their reference groups. Thus, we found no indication that the excess in complaints in the exposed workers could be accounted for by any somatic disease, in particular haematological, chronic infectious or immunological diseases, kidney, liver or thyroid diseases. The only laboratory outcome that could have clinical relevance (more frequently an increased number of leukocytes in non-exposed fire-fighters) is not an indication for disease in the exposed group, but, on the contrary, it is in favour of the exposed group.

The results of this study are highly relevant for future research on health effects of disasters on rescue workers. For instance, recent studies have shown that rescue workers who were exposed to the World Trade Center disaster in New York reported symptoms of ill health in the short term [21-22]. In fact, most previous studies on the health effects of disasters have focused on shorter term effects on direct victims, e.g. the inhabitants of an area that was struck by a flood [23] or a bush fire [24-25]. In general, these studies reported an increase in various health problems in natural disaster victims, compared to controls. A higher frequency of relatively minor physical symptoms rather than clinically relevant pathology, was reported in most studies [26]. However, in these studies a broad range of methods was used to assess the physical consequences of the disaster, and they varied in the number of participants, and in the follow-up duration after the disaster. For instance, several studies were based on small samples, and covered only a short period of time after the disaster, which is likely to result in a high incidence of temporary morbidity. Two studies compared self-report data on health before and after a disaster, because the disaster took place between the assessment waves of ongoing panel studies [27-28], and found that exposure to a flood accounted for 2% to 12% of the change in physical health status across the measurement intervals, but was not related to the onset of clinically relevant disorders.

In addition to natural disasters, several chemical and radiation disasters have taken place since 1980, including the Chernobyl disaster, the Three Miles Island incident, and other, smaller incidents in which inhabitants and rescue workers were exposed to potential hazardous materials [29-31]. In some cases, exposure to the hazardous materials was reported to be a plausible cause for the negative health effects that were found, while in others it was suggested that the insecurity, loss of control, and risk perception may have accounted for the reported health effects [29, 32]. This may have played a role in the Amsterdam Air Disaster as well, since the crash was followed by a long aftermath, with increased risk perception, and confusing and ambiguous information about the cargo contents [7, 8]. Another explanation for our findings may be that exposed disaster workers were more likely to interpret certain physical sensations as symptoms of adverse health, which they attributed to the disaster. Media reports on individual cases with multiple symptoms may have enhanced this tendency. These media reports focused on all sorts of toxic agents that might have been present in the cargo of the crashed plane [7]. Such news can increase fear and anxiety among those involved in disasters [7,33], and may have increased the attribution of health complaints to exposure to the disaster. General practitioners, however, associated only a small proportion of the reported symptoms with the disaster in a sample of patients in Amsterdam [34]. The symptoms reported in the present study were all based on self-report, and could not be confirmed by laboratory measures. Perhaps, the phenomenon commonly described as "unexplained physical symptoms", i.e. physical symptoms without sufficient objective, demonstrable pathological abnormalities, is therefore applicable to our findings [35]. A recent review stated that these unexplained symptoms are common in survivors of disasters [35]. However, we cannot rule out the possibility that there is a biological marker for these complaints, albeit one that is not (yet) known. Fear of exposure may
have played a role as well in the self-reported complaints, because some researchers have suggested that insecurity, loss of control, and risk perception after exposure to hazardous materials may account for reported adverse health [29, 32, 36-40].

Only a few studies have specifically focused on the health status of rescue workers, such as police officers and fire-fighters. Although rescue workers are usually not direct victims of a disaster, their duties may include exposure to very stressful and traumatic events, such as the salvage and identification of bodies, rescue work under high risk conditions with fear for their physical integrity, and even for their own lives, and contacts with the bereaved families. Post-traumatic stress disorder (PTSD) could also play a role in the assessment of physical health effects of disaster exposure, as there is a large body of literature on the co-occurrence of PTSD and adverse physical health outcomes after traumatic events [39]. Several studies have shown that rescue workers are at risk for post-traumatic stress disorders [40-44]. Other mental health effects have also been found, including sleeping problems [45], and anxiety or depression [46-51]. In contrast, however, several studies have shown that rescue workers may be regarded as a highly resilient group of professionals with regard to the potentially harmful effects of stress [42, 48, 49].

A few limitations of the present study should be mentioned. First, there is a considerable time-lag between the disaster and the start of our study, i.e. on average 8.5 years. Therefore, we were not able to study the exact timing of onset of the reported complaints, nor were we able to analyze the course of the complaints during this period of time. Prospective longitudinal studies are needed to gain insight into the timing of onset and the course of complaints after a disaster. A further limitation of our study is the fact that non-exposed workers were younger than the exposed fire-fighters. Because almost the entire fire department was involved in the disaster related work, this was unavoidable. Therefore, non-exposed fire-fighters who joined this fire department after the disaster were included in the reference group. The applied statistical adjustments for age and other potentially related confounders may not have fully accounted for this systematic difference between exposed and non-exposed fire-fighters.

The results of the present study demonstrate that police officers and fire-fighters exposed to the Amsterdam Air Disaster reported a broad range of health complaints even more than 8 years after the disaster, similar to what is sometimes found for victims of natural or technological disasters [3-6]. However, the symptoms of our participants were all based on self-report, and could not be confirmed by routine laboratory tests. The outcomes of laboratory tests show no morbidity in relation to the disaster. In addition, no difference in absence at work due to illness was found between the exposed police officers and fire-fighters and the reference groups (data not shown). These findings suggest that there is no serious somatic pathological condition underlying the self-reported symptoms.
REFERENCES


LIFE EVENTS, POSTTRAUMATIC STRESS, SOMATIC COMPLAINTS AND FATIGUE IN POLICE OFFICERS FOLLOWING AN AIR DISASTER

AB Witteveen, P Slottje, JWR Twisk, I Bramsen, AC Huizink, T Smid, HM van der Ploeg

Submitted
In this study, the association of pre- and post disaster negative life events with posttraumatic stress, somatic complaints and fatigue was examined in a sample of police officers ($N = 834$) 8.5 years following exposure to the Amsterdam air disaster compared to non-exposed police officers ($N = 634$). Compared to non-exposed police officers, exposed police officers more often reported to have experienced negative life events in the pre-disaster period (odds ratios ranged from 1.4, $p < .05$ to 2.1, $p < .001$), and particularly negative life events experienced in the post-disaster period (odds ratios ranged from 1.3 to 1.4, $p < .05$ and from 1.7 to 2.3, $p < .001$). Exposed police officers also reported more often they had not dealt with these events, particularly events affecting their own health or socio-occupational functioning (odds ratios ranged from 8.9 to 11.5 with $p < .001$). Positive associations of post-disaster negative life events with posttraumatic stress, somatic complaints and fatigue were significantly stronger in exposed (betas of 1.14, 1.13 and 1.17, $p < .01$, respectively, for every increase in two life events) than in non-exposed police officers (betas of 1.08, 1.04 and 1.08, $p < .01$, respectively, for every increase in two life events). Due to the cross-sectional measurement of both the outcomes of psychological distress and the negative life events, correct interpretation of the relevance of the findings is rather difficult. Suffering from psychological or physical health problems can affect the way one deals with and interprets new events or stressors in the post-disaster period but may also facilitate socio-occupational and other health problems. This study indicates that occupational exposure to a disaster signals a higher risk for long-term post-disaster negative life events and psychological distress.
1 Introduction

Exposure to a traumatic event can have a tremendous impact on the psychological wellbeing of those involved. Posttraumatic stress disorder (PTSD) has been found in direct response to disasters [1]. In the long-term aftermath of disasters or war non-specific psychological and medically unexplained physical symptoms have been found as well [2-4]. Some individuals appear more resilient than others in response to such events. Those more vulnerable to the effects of a traumatic event seem to have less effective coping abilities, or posit personality styles that make coping with these events more difficult [5, 6]. Other risk factors for the development of psychological distress after traumatic events include degree of exposure at the disaster site and socio-demographic factors such as female gender and single life status [7, 8].

According to the stress vulnerability or sensitization hypothesis, a history of pre-trauma negative life events is another risk factor for the development of post-disaster psychological distress [9-11]. However, a beneficial effect of prior (“similar”) trauma exposure has also been reported [12]. For instance, among rescue workers of a major air disaster prior trauma that was “dissimilar” to the rescue work was associated with greater vulnerability to the crash-related distress, whereas pre-disaster trauma that was quite “similar” to the trauma experienced did not increase vulnerability for distress [13].

In addition, post-trauma or post-disaster life events appear to be associated with the development and/or severity of post-trauma psychological distress even more often than pre-trauma events [14-17]. A positive association between post-trauma life events (e.g., loss of job or income or serious illness or injury in the victims) and PTSD, has been found in several studies [18, 19].

In our previous study, we found that professionally involved rescue workers reported significantly more symptoms of posttraumatic stress, other psychological problems, somatic complaints and fatigue approximately 8.5 years after the air disaster Amsterdam in 1992 than not involved colleagues [20]. In line with other studies on rescue workers [9, 15, 16], we found that, among several other risk-factors, the number of post-disaster negative life events was significantly associated with all aspects of psychological distress. Further to our previous findings, we hypothesize in the current study that exposed police officers report more often post-disaster negative life events and will more often not have (completely) dealt with these post-disaster events than non-exposed police officers. Secondly, we hypothesize that the expected positive association between pre- and post-disaster life events and PTSD symptoms, somatic complaints and fatigue will be stronger for exposed than for non-exposed police officers (i.e., an interaction effect of negative life events and exposure in its relationship with psychological distress).

2 Method

2.1 Participants

The method and procedure presented are part of a larger study, the design of which has been published elsewhere [21]: i.e., the Epidemiological Study Air Disaster in Amsterdam (ESADA) that assesses the long-term health effects of occupational exposure to this disaster among professional assistance workers. The study design was approved by the Medical Ethics Committees of the two medical facilities involved in this project: the VU University Medical Center and the ‘Onze Lieve Vrouwe Gasthuis’ in Amsterdam.

The sample included police officers professionally involved in the Amsterdam air disaster in 1992 (n = 834) from the Amsterdam-Amstelland regional police force, and colleagues from this same department who were not involved in this disaster (n = 634). Police officers participating were employed in the Amsterdam-Amstelland regional police force on the date of the disaster (October 4th, 1992) and were still employed at the start of the ESADA.
2.2 Recruitment and procedure

Participants were recruited via, respectively, announcements in staff magazines, letters and successively by telephone. Of the potential participants from the police force 99.9% (n = 2112) could be traced and 71% (n = 1489) of them participated in this study. A total of 21 police officers were excluded for reasons such as having lived or are living in the disaster area, or having too many missing data on the involvement/exposure questionnaire. Police officers (n =1468) were subdivided into exposed and non-exposed groups, based on a questionnaire about their involvement in disaster-related tasks. All participating professionals gave informed consent and participated voluntarily after description of the study. Data were collected between January 2000 and March 2002 in an outpatient clinic in Amsterdam, on average 8.5 years after the disaster.

2.3 Measures

- **Socio-demographic variables.** Participants were presented with several questions and questionnaires concerning age, sex, ethnicity, marital status, and level of education (for a detailed description see Slottje et al., [21]). The presence and history of various chronic conditions considered to have a significant impact on wellbeing (e.g., diabetes), was assessed with one specific questionnaire.

- **PTSD Symptomatology.** PTSD symptomatology was measured with the Self-Rating Inventory for Posttraumatic Stress Disorder (SRIP). The SRIP is a validated 22-item measure of symptoms of intrusion (6 items), avoidance (9 items) and hyperarousal (7 items) during the preceding four weeks on a four-point scale ranging from 'not at all' to 'a lot'. Items are based on the DSM-IV criteria for PTSD phrased without reference to a certain specific trauma. The SRIP provides a total score (range 0-88) [22, 23].

- **Health complaints.** Somatic complaints were measured with a subscale of the Symptom Check List-90 (SCL-90-R). In this study, the Dutch adaptation of the Symptom Check List-90-R was used [24]. The Dutch adaptation of the SCL-90-R by Arrindell & Ettema [25] is a validated and widely used scale in the Netherlands to measure a broad range of psychological reactions, each rated on a 5-point scale ranging from 0 = not at all to 4 = extremely. The SCL-90 contains eight scales and a total score ('Psychoneuroticism') can be calculated. For the purpose of the current study, we used the scale containing somatic complaints (0-12 items).

- **Negative life events.** A 15-item life events questionnaire (based on the Social Readjustment Rating Scale of Holmes & Rahe [27]) was used to measure negative life events that can occur in the life of every participant or in the lives of close relatives. All subjects were required to indicate ('yes' or 'no') if an event had happened to them before the air disaster in Amsterdam in 1992 and, subsequently, whether or not this event had happened in the period after the air disaster. The last two questions were open-ended (i.e., 'Something else'), and were screened on duplicity with responses to similar events on the list. Furthermore, for every event they reported to have experienced pre- and/or post disaster, the participants also had to indicate whether they had dealt with this event on a four-point scale (i.e., 1 = completely; 2 = almost completely; 3 = a little bit; or 4 = not at all). In the current study, a dichotomous variable ('degree of dealing with the event') was calculated by adding responses 1 and 2 as well as the responses 3 and 4.

Subsequently, events were divided into pre-disaster events and post- disaster events. Police officers reporting they had experienced a certain event both in the pre- and in the post-disaster period were computed into both variables (pre- and post-disaster events). The total number of pre- or post-disaster negative life events was divided into three categories. Category A included events affecting one's own physical health and socio-occupational functioning, (i.e., events 1, 5,
Category B included events which affected the health or life of close relatives in the family and/or social network (i.e., events 2, 3, and 4). Category C included events which most likely satisfy criterion A1 of PTSD (American Psychiatric Association, 1994, [28]) (events 9, 10, 11, 12, and 13). Almost no police officers reported additional events (items 14 and 15) other than the previously scored thirteen items, nor did any of them reported to have experienced a prison sentence (item 8). Therefore, items 8, 13 and 14 were excluded from the analysis in the current study.

2.4 Analysis

The socio-demographic characteristics (age, gender, ethnicity and marital status), chronic illnesses, and mean number of negative life events experienced in the pre-disaster and/or post-disaster period of the exposed police officers were compared with non-exposed police officers using t-tests for independent samples (for continuous variables) and chi-square tests (for dichotomous and categorical variables). Differences between exposed and non-exposed police officers in the outcome variables PTSD symptoms, somatic complaints and fatigue, were examined by performing linear regression analyses with correction for potentially confounding factors (i.e., age, gender, marital status, education, ethnicity, and chronic illness). Natural log transformations were applied due to non-normal distribution of the outcome variables.

Differences between exposed and non-exposed police officers in prevalence of the negative life events and the degree of dealing with them, was examined with logistic regression analysis with correction for potentially confounding factors (hypothesis 1). In order to test our second hypothesis, we first performed several separate multiple regression analyses (so called ‘crude’ regression analyses) to examine associations between the number of pre- and post disaster negative life events (categories A, B, and C) with PTSD, somatic complaints and fatigue as outcome variables, after possible confounding socio-demographic variables and exposure (yes/no) was controlled for. Secondly, ‘adjusted’ multiple regression analyses were performed with all categories of pre-, respectively, post-disaster life events entered together in one multiple regression model in order to adjust for the effect of each category. Thirdly, to investigate potential interactions between the number of pre- and/or post-disaster events from category A, B, and C and exposure (yes/no), six interactions-terms were entered into the several (‘crude’ and ‘adjusted’) multiple regression analyses with, subsequently, PTSD symptoms, somatic complaints and fatigue as outcome variables. All data were double entered and checked for inconsistencies and were analyzed using the Statistical Package for the Social Sciences (version 11.0 for Windows XP). Due to missing values on the life events questionnaire and/or outcome measures the total number of exposed and non-exposed police officers differed somewhat (between 823-834, and between 619-634 for the exposed and non-exposed, respectively).

3 RESULTS

3.1 Background variables

Exposed police officers did not differ from non-exposed controls regarding marital status, ethnicity and education (Table 1). Exposed police officers were more often male, only slightly younger, and more often reported one or more chronic illnesses than non-exposed police officers. Exposed police officers reported more pre-disaster life events, particularly events with a potential traumatic character (cat. C). Exposed police officers reported significantly more post-disaster life events. After adjustment for potentially confounding variables, exposed police officers reported a significantly higher mean (log transformed) number of PTSD symptoms on the SRIP, somatic complaints on the SCL-90 and fatigue(-related) symptoms on the CIS than non-exposed colleagues.
### Table 1. Demographic Characteristics, Negative Life Events, Posttraumatic Stress, Somatic Complaints, and Fatigue Among Police Officers

<table>
<thead>
<tr>
<th></th>
<th>Exposed (N = 834)</th>
<th>Non-exposed (N = 634)</th>
<th>Test of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>44.0 (6.2)</td>
<td>44.8 (7.0)</td>
<td>t = -2.11, p = 0.35</td>
</tr>
<tr>
<td>Gender (% male)</td>
<td>88.5</td>
<td>84.9</td>
<td>χ² = 4.18, p = 0.04</td>
</tr>
<tr>
<td>Level of education (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>20.9</td>
<td>23.3</td>
<td>χ² = 1.34, p = 0.72</td>
</tr>
<tr>
<td>Middle</td>
<td>52.5</td>
<td>51.5</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>20.7</td>
<td>19.7</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>5.9</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Marital status (% single)</td>
<td>10</td>
<td>9.0</td>
<td>χ² = 0.39, p = 0.53</td>
</tr>
<tr>
<td>Ethnicity (% non-western)</td>
<td>2.8</td>
<td>1.6</td>
<td>χ² = 2.28, p = 0.13</td>
</tr>
<tr>
<td>≥1 chronic illnesses (%)</td>
<td>52.2</td>
<td>42.6</td>
<td>χ² = 13.22, p = 0.00</td>
</tr>
<tr>
<td>PTSD-symptoms SRIP total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>27.3 (6.1)</td>
<td>25.7 (4.4)</td>
<td>β³ = 1.05 (1.03-1.07)**</td>
</tr>
<tr>
<td>Somatic complaints SCL-90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>15.3 (3.9)</td>
<td>14.0 (2.6)</td>
<td>β³ = 1.05 (1.03-1.07)**</td>
</tr>
<tr>
<td>Fatigue CIS-total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>49.4 (24.4)</td>
<td>42.4 (20.4)</td>
<td>β³ = 1.08 (1.03-1.14)**</td>
</tr>
<tr>
<td>Mean no. of total NLE pre disaster (SD)</td>
<td>3.1 (2.1)</td>
<td>2.7 (2.2)</td>
<td>t = 3.36, p = 0.001</td>
</tr>
<tr>
<td>Category A (1, 5, 6, 7) (SD)</td>
<td>0.6 (0.8)</td>
<td>0.6 (0.8)</td>
<td>t = 0.69, p = 0.49</td>
</tr>
<tr>
<td>Category B (2, 3, 4) (SD)</td>
<td>0.95 (1.0)</td>
<td>0.93 (1.1)</td>
<td>t = 0.45, p = 0.66</td>
</tr>
<tr>
<td>Category C (9, 10, 11, 12, 13) (SD)</td>
<td>1.59 (1.3)</td>
<td>1.26 (1.2)</td>
<td>t = 4.9, p = 0.00</td>
</tr>
<tr>
<td>Mean no. of total NLE post disaster</td>
<td>4.3 (2.2)</td>
<td>3.3 (2.1)</td>
<td>t = 8.64, p = 0.00</td>
</tr>
<tr>
<td>Category A (1, 5, 6, 7) (SD)</td>
<td>1.33 (1.07)</td>
<td>0.90 (0.96)</td>
<td>t = 8.15, p = 0.00</td>
</tr>
<tr>
<td>Category B (2, 3, 4) (SD)</td>
<td>1.42 (1.06)</td>
<td>1.20 (1.03)</td>
<td>t = 3.93, p = 0.00</td>
</tr>
<tr>
<td>Category C (9, 10, 11, 12, 13) (SD)</td>
<td>1.53 (1.27)</td>
<td>1.19 (1.26)</td>
<td>t = 4.99, p = 0.00</td>
</tr>
</tbody>
</table>

* p < .05; ** p < .01; *** p < .001

a Transformed [EXP(regression coefficients)] regression coefficients are reported with 95% confidence intervals and are adjusted for age, gender, ethnicity, marital status, education and suffering from chronic illness.

### 3.2 Specific life events

Table 2 shows that the exposed police officers did not significantly differ in reporting specific events from category A and B in the pre-disaster period. Several pre-disaster traumatic negative life events from category C were, however, reported significantly more often by exposed police officers than by non-exposed colleagues. Post-disaster events from category A and B and two events from category C were significantly more often reported by exposed police officers as well. More specifically, exposed police officers reported approximately twice as often as non-exposed police officers to have experienced a 'Serious illness or injury or other significant changes in your own health', 'Serious problems and tension at home or at work', and 'Seeing that someone was badly injured or seeing somebody die' in the post-disaster period.
### 3.3 Dealing with negative life events

Exposed police officers more often reported to have not (completely) dealt with negative life events experienced in the pre- and post-disaster period (Table 2). Although the incidence of the items did not always allow us to statistically test differences in dealing with the events experienced in the pre-disaster period, the exposed police officers were found to have significantly more often not dealt with events such as ‘The death of your partner or child or other members of your immediate family or relatives’ and ‘Seeing that somebody was badly injured or seeing somebody die’. For most of the post-disaster events from category A, B, or C, around 8% of the exposed police officers had problems dealing with them versus approx 1% of the non-exposed police. Most pronounced was that 25% of the police officers who reported a post-disaster significant change in their own health, did not completely deal with this event 8.5 years after the air disaster.

<table>
<thead>
<tr>
<th></th>
<th>Pre disaster negative life events</th>
<th>Post disaster negative life events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reported experience</td>
<td>Dealt incompletely with event</td>
</tr>
<tr>
<td></td>
<td>EXP</td>
<td>NON-EXP</td>
</tr>
<tr>
<td>1. Serious illness or injury or other significant changes in your own health (A)</td>
<td>10.9%</td>
<td>11.8%</td>
</tr>
<tr>
<td></td>
<td>n = 90</td>
<td>n = 73</td>
</tr>
<tr>
<td>2. Serious illness or injury or other changes in health of family or relatives (B)</td>
<td>34.3%</td>
<td>33.2%</td>
</tr>
<tr>
<td></td>
<td>n = 282</td>
<td>n = 208</td>
</tr>
<tr>
<td>3. The death of your partner or child or other immediate family or relatives (B)</td>
<td>35.7%</td>
<td>34.8%</td>
</tr>
<tr>
<td></td>
<td>n = 293</td>
<td>n = 218</td>
</tr>
<tr>
<td>4. The death of a good friend or somebody else who meant a lot to you (B)</td>
<td>26.6%</td>
<td>25.6%</td>
</tr>
<tr>
<td></td>
<td>n = 217</td>
<td>n = 160</td>
</tr>
<tr>
<td>5. Divorce or separation or the break-up of a long-term relationship (A)</td>
<td>15.7%</td>
<td>13.9%</td>
</tr>
<tr>
<td></td>
<td>n = 129</td>
<td>n = 87</td>
</tr>
<tr>
<td>6. Serious problems and tension at home or at work (A)</td>
<td>18.5%</td>
<td>22.6%</td>
</tr>
<tr>
<td></td>
<td>n = 116</td>
<td>n = 186</td>
</tr>
<tr>
<td>7. Dismissal from your job or significant changes/reorganization at work (A)</td>
<td>9.5%</td>
<td>11.6%</td>
</tr>
<tr>
<td></td>
<td>n = 79</td>
<td>n = 73</td>
</tr>
<tr>
<td>8. Seeing that someone was badly injured or seeing somebody die (C)</td>
<td>82.2%</td>
<td>68.6%</td>
</tr>
<tr>
<td></td>
<td>n = 682</td>
<td>n = 431</td>
</tr>
<tr>
<td>9. Victim of a traffic accident (C)</td>
<td>28.9%</td>
<td>22.5%</td>
</tr>
<tr>
<td></td>
<td>n = 239</td>
<td>n = 142</td>
</tr>
<tr>
<td>10. Victim of a crime (C)</td>
<td>25.1%</td>
<td>19.4%</td>
</tr>
<tr>
<td></td>
<td>n = 208</td>
<td>n = 123</td>
</tr>
<tr>
<td>11. Victim of serious physical abuse or mental neglect/abuse (C)</td>
<td>15.7%</td>
<td>10.9%</td>
</tr>
<tr>
<td></td>
<td>n = 130</td>
<td>n = 69</td>
</tr>
<tr>
<td>12. Victim of incest or sexual abuse (C)</td>
<td>8.1%</td>
<td>5.4%</td>
</tr>
<tr>
<td></td>
<td>n = 67</td>
<td>n = 34</td>
</tr>
</tbody>
</table>

Note: * p < .05; ** p < .01; *** p < .001 adjusted for age, gender, ethnicity, marital status, education and suffering from chronic illness.

Table 2. Negative life events and psychological processing of negative life events experienced before and/or after the Amsterdam air disaster in 1992
3.4 Life events and PTSD, somatic complaints and fatigue

Table 3 shows that the number of pre- and post-disaster events from category A (i.e., life events affecting the own health or socio-occupational functioning) are significantly associated with PTSD symptoms, somatic complaints and fatigue, irrespective of exposure (yes/no). For instance, an almost 30% increase in fatigue for every two extra life events experienced, was found for post-disaster life events from category A. Although post-disaster events from category B and C were also positively and significantly associated with PTSD symptoms and somatic complaints (category C), the ‘adjusted’ analyses, in which all categories of life events were entered in one multiple regression model to adjust for the effects of one another, show that a higher number of post-disaster negative life events affecting one’s own health or socio-occupational functioning (category A) accounted for the significant increase of PTSD symptoms (12%), somatic complaints (10%), and fatigue (28%).

Further analyses showed that the total number of post-disaster negative life events from category A significantly and positively interacted with exposure in its relation with PTSD symptoms ($p = .001$), somatic complaints ($p < .001$), and fatigue ($p = .001$) (data not shown). The results indicate that the association between post-disaster negative life events from category A with PTSD symptoms, somatic complaints and fatigue was significantly stronger for exposed police officers than for non-exposed police officers. For example, for non-exposed police officers an effect of $B = 1.04$ ($p = .011$) for every two extra life events on somatic complaints was found, whereas for exposed police officers an effect of $B = 1.13$ ($p < .001$) for every two extra life events on somatic complaints was found.

Table 3. Multiple linear regression analyses of associations of negative life events with PTSD-symptoms, somatic complaints, and fatigue

<table>
<thead>
<tr>
<th></th>
<th>Posttraumatic stress symptoms</th>
<th>Somatic complaints</th>
<th>Fatigue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crude$^a$</td>
<td>Adjusted$^b$</td>
<td>Crude$^a$</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>P</td>
<td>B</td>
</tr>
<tr>
<td>NLE A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre</td>
<td>1.05***</td>
<td>.000</td>
<td>1.01</td>
</tr>
<tr>
<td>post</td>
<td>1.11***</td>
<td>.000</td>
<td>1.12***</td>
</tr>
<tr>
<td>NLE B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre</td>
<td>1.01</td>
<td>.179</td>
<td>0.99</td>
</tr>
<tr>
<td>post</td>
<td>1.02*</td>
<td>.012</td>
<td>1.01</td>
</tr>
<tr>
<td>NLE C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre</td>
<td>1.01</td>
<td>.145</td>
<td>0.98</td>
</tr>
<tr>
<td>post</td>
<td>1.02*</td>
<td>.007</td>
<td>1.02*</td>
</tr>
</tbody>
</table>

Note. * $p < .05$; ** $p < .01$; *** $p < .001$.

$^a$ Crude: main effects for number of pre- and post disaster negative life events categories A, B, and C separately without adjustment for effects of other categories. $^b$ Adjusted: main effects for number of pre- and post disaster negative life events categories A, B, and C with adjustment for effects of all other categories. $^c$ Transformed: [EXP(regression coefficients)] regression coefficients (B) are reported, potential confounders were controlled for.
4 DISCUSSION

This study supports our hypothesis that police officers exposed to an air disaster in Amsterdam in 1992, reported significantly more often to have experienced negative life events in the pre-disaster period and, most explicitly, in the period of 8.5 years after the disaster than non-exposed colleagues. The higher prevalence of post-disaster negative life events that affect one's own health and problems in the socio-occupational realm among exposed police officers is in line with a more pronounced occurrence of post-trauma adverse life events among directly injured victims who, as a consequence of their trauma, had to deal with socio-economic or health problems in the Maes et al. study [19].

The police officers involved in rescue work in the Amsterdam air disaster, however, were exposed through different and more indirect factors than the motor vehicle accident victims in the Maes et al., study [19]. More specifically, the long-term aftermath of the air disaster in 1992 was characterized by rumours about hazardous exposure due to the disaster and its potential health consequences, although health effects through toxic exposure were never confirmed [29-31]. A recent epidemiological study also confirmed that on average 8.5 years after the disaster, exposed rescue- and assistance workers reported significantly more physical and psychological symptoms than reference groups, although no significant or clinically meaningful differences in laboratory analyses of blood and urine were found [32]. As the results of the current study indicate, an aftermath like the one described might result in greater additional post-disaster life stressors, most specifically in the socio-occupational realm and health. More specifically, exposed police officers experienced two times more often a post-disaster change in their own health than non-exposed police officers and 25% of them did not completely deal with this event even 8.5 years after the disaster. Perhaps, not having a clear explanation or diagnosis for this negative change in health might have made it more difficult to cope with these somatic problems [33]. Hence, coping strategies or personality traits of those more affected in physical or psychological well-being after a disaster with alleged chemical exposure, may also be different from the ones less affected in well-being, as is supported by findings among fatigued and non-fatigued Gulf War veterans [34].

An interesting finding of the current study was that exposed police officers reported they had been exposed to traumatic events in the pre-disaster period more often than non-exposed police officers. It might be that the disaster reactivated thoughts about previous traumatic events. If this is the case, the results are in line with the reactivation hypothesis. For instance, Bramsen, Van der Ploeg, and Boers [35], found a reactivation of war-related re-experiencing and avoidance in WW II survivors after they experienced the Enschede fire work explosions in 2000 comparison to non-exposed controls. A finding that supports this ‘reactivation’ hypothesis, is that exposed police officers reported to have significantly more often not dealt with specifically traumatic events that had already happened before 1992 than non-exposed police officers.

A positive association between the number of pre- and particularly of post-disaster negative life events and psychological and physical distress after controlling for the effects of exposure and socio-demographic variables, is in line with other studies among rescue workers and police officers [9, 14-16]. The fact that the association of post-disaster negative life events affecting the own health or socio-occupational functioning with PTSD, somatic complaints and fatigue, was significantly more present among exposed than among non-exposed police officers, is in support of our second hypothesis that the disaster and its specific aftermath might have made exposed police officers with more psychological (and physical) problems also more vulnerable to subsequent stressful experiences. Hence, suffering from psychological or physical distress can make it more difficult to deal with certain new events (e.g., problems at home or at work, additional health problems) or these problems might, as a secondary result of the stress induced by the disaster, facilitate socio-occupational or health problems.

Although the prevalence of pre-disaster (traumatic) life events was relatively higher among exposed police officers, a significant association between number of pre-disaster events and PTSD symptoms was not stronger (or weaker) for exposed than for non-exposed police officers. Thus the findings do
not support the ‘vulnerability’ hypothesis [9, 15, 36] nor do they indicate a potential beneficial effect from pre-disaster traumata [12]. The fact that we found a significant association between post-disaster additional life events in the social realm and distress but not (statistically significant) for pre-disaster life events, is in line with the meta-analysis of Brewin et al. [14] who found that factors operating during or after the trauma (such as additional life stress) had stronger effect sizes in predicting PTSD than pre-trauma factors.

The frequently demonstrated findings of co-occurrence and comorbidity between PTSD symptoms and physical health problems (e.g., fatigue and somatic complaints) among traumatized victims such as war veterans who were exposed to real or alleged exposure to toxic agents [4, 37], was also found in the current study. Moreover, stress or emotional traumas themselves are considered risk factors for unexplained fatiguing illnesses [38].

This study incorporates several strengths. Most studies of pre- and post-disaster negative life events and their association with psychological distress did not include a control group of participants not exposed to the trauma. In the current study a large and, according to the socio-demographic background factors, highly comparable group of non-exposed police officers was used as reference group. The non-exposed police officers were employed at the same police department during the disaster and the overall response rate was good. Almost all of the exposed and non-exposed police officers could be traced in the year 2000, and of those invited 71% agreed to participate.

Some shortcomings should also be addressed. This study has a cross-sectional design and involves the examination of associations between current distress and retrospective reports of exposure to negative life events and to the disaster. Furthermore, there might be confounding of the outcome of somatic complaints and fatigue with the (number of) events in category A since it includes ‘Serious illness or injury or other significant changes in your own health’, whereas physical complaints were specifically more present among those exposed to the disaster [32]. Post-hoc analyses (data not shown) revealed, however, that not only the association between ‘Serious illness or injury or other significant changes in your own health’ and somatic complaints or fatigue was stronger among exposed than non-exposed police officers, but also the association between ‘Serious problems or tension at home or at work’ and somatic complaints and fatigue.

In conclusion, the results show that, compared to controls, police officers occupationally involved in rescue work at the air disaster site in 1992, reported more often various negative life events experienced pre-disaster, and particularly, in the 8.5 years after the disaster and had more often not (completely) dealt with these events. The number of post-disaster life events was positively associated with, respectively, PTSD symptoms, somatic complaints and fatigue and, in support of our hypothesis that exposure to the air disaster and its aftermath is associated with additional post-disaster negative life events, this association was significantly stronger among exposed police officers, specifically for events that affected one’s own health or socio-occupational functioning.

To further investigate the potential role of accumulative life events prior to or after a disaster or other trauma, it might be important to have not only retrospective accounts of life events and the degree one has come to terms with them, but also information gathered at several time points during the careers of rescue workers.
REFERENCES


POST-DISASTER PHYSICAL SYMPTOMS
OF FIREFIGHTERS AND POLICE
OFFICERS: ROLE OF TYPES OF
EXPOSURE AND POSTTRAUMATIC
STRESS SYMPTOMS

P Slottje, AB Witteveen, JWR Twisk, N Smidt, AC Huizink, W van Mechelen, T Smid

Submitted
ABSTRACT

Objective To examine relationships between occupational exposure to the air disaster in Amsterdam and multiple long-term physical symptoms of firefighters and police officers, and the role of posttraumatic stress symptoms herein.

Methods Historic cohort study, among professional firefighters (n=334) and police officers (n=834) who were occupationally exposed to the disaster (i.e. who reported at least one disaster-related task), and their nonexposed colleagues (n=194 and n=634, respectively). On average 8.5 years post-disaster, multiple questionnaires assessed occupational disaster exposure, current physical and posttraumatic stress symptoms, and background characteristics.

Results Exposed workers reported multiple physical symptoms significantly more often than nonexposed colleagues. Among exposed workers, multiple physical symptoms were significantly more often reported by firefighters who rescued people, and police officers who supported injured victims and workers, who were involved in the identification or recovery of or search for victims and human remains, who witnessed the immediate disaster scene, or had a close one affected by the disaster. Adding posttraumatic stress symptoms did not essentially change these effects of exposure status and types of exposure. No significant interactions between exposure status and posttraumatic stress symptoms were found.

Conclusions This study shows an excess in multiple long-term physical symptoms after the air disaster in Amsterdam among exposed professional firefighters and police officers, which could not substantially be attributed to posttraumatic stress symptoms. The finding that professional assistance workers are at risk for multiple long-term physical symptoms underlines the need for prospective research on risk factors and preventive measures.
1 INTRODUCTION

In 1992 a cargo aircraft crashed into apartment buildings in Amsterdam, killing 43 people and destroying 266 apartments [1]. An extensive aftermath followed, in which various potential disaster-related exposures and health effects were publicly discussed [1-3]. However, no public health risk was predicted in retrospective evaluations on exposures related to the destroyed apartment buildings, and the aircraft, including its cargo and balance weights of depleted uranium [4-5]. The air disaster in Amsterdam is an example of a man-made disaster, i.e. a sudden collective stressful experience due to technological failure. Previous major technological disasters around the world have caused mortality and morbidity [e.g. 6-8]. They also had psychiatric consequences, notably post-traumatic stress disorder [9-12]. It also becomes increasingly recognised that victims of disasters may develop physical symptoms without sufficient or apparent medical explanation [13]. These so-called, yet ill-defined, medically 'unexplained physical symptoms' have been described particularly in communities and military samples faced with stressful events involving (alleged) exposure to hazardous materials [14-20].

A recent literature review of unexplained physical symptoms in communities struck by disaster identified some consistent risk factors, such as a high degree of physical damage and female gender [13]. Furthermore, evidence was found suggesting that posttraumatic stress symptoms is a perpetuating factor, i.e. a post-disaster factor that maintains or exacerbates unexplained physical symptoms. A mediating role of posttraumatic stress symptoms between exposure to traumatic events and the development of unexplained physical symptoms has also been postulated [21]. In any case, co-occurrence of and associations between post traumatic stress symptoms and physical health problems have frequently been demonstrated [22-27].

Most of the evidence linking disaster to physical health effects is based on communities struck by disaster and military samples. Less is known about the physical health effects of disasters on professional assistance workers. The few published studies that have addressed this, suggested that these workers are also at risk for physical morbidity and physical symptoms [28-32]. Starting in 2000, the Epidemiological Study Air Disaster in Amsterdam (ESADA) aimed to assess long-term health effects in professional assistance workers who were occupationally exposed to this disaster [33]. Previously, elevated prevalence rates of self-reported physical and psychological symptoms were reported among exposed workers compared with nonexposed colleagues, without accompanying consistent differences in clinical laboratory outcomes in blood and urine [34] (Huizink et al. unpublished data). The present study is based on the ESADA and aims to assess the relationship between (types of) disaster exposure and the occurrence of multiple long-term physical symptoms among professional firefighters and police officers. In addition, the potential mediating or moderating role of posttraumatic stress symptoms in this relationship will be explored.

2 METHODS

This paper is based on data of the ESADA, of which the study design is described in detail elsewhere [33]. Briefly, the ESADA can be characterized as a historical cohort study, with self-reported exposure status.

2.1 Study population and data collection

The study population used in this paper comprised two occupational cohorts: (1) the professional firefighters who were employed in the Amsterdam fire department on the date of the disaster; and (2) the police officers who were employed in the Amsterdam-Amstelland regional police force on the date of the disaster and still were on January 1, 2000. In addition, firefighters who started working in the Amsterdam fire department after the disaster were also invited to participate, as almost the entire fire department had been exposed to the disaster.
The Medical Ethics Committees of both medical centres involved in the ESADA approved the study protocol. All participants signed informed consent and participated voluntarily. Data collection took place from January 1, 2000, to March 1, 2002, i.e. on average 8.5 years after the disaster.

2.2 Occupational disaster exposure

All workers were asked to complete a detailed questionnaire on occupational exposure to the disaster. Workers reporting at least one disaster-related task (including ‘other’ tasks) were defined as (occupationally) ‘exposed’; all others as ‘nonexposed’. In addition, type of exposure was characterised by the following aspects:

1) A series of disaster-related tasks: rescuing people, firefighting, identification and recovery of or search for victims and human remains, clean-up of the disaster site, security and surveillance of the disaster area, and supporting injured victims and workers;
2) Having witnessed the immediate disaster scene: having seen the disaster scene within the first hours after the crash or when the wreckage was still there;
3) Having a close one affected by the disaster: having a close or beloved one(s) (i.e. family members, relatives, friends or acquaintances) affected by the disaster in any way (i.e. in life-threatening danger, injured, destroyed apartment, died, or affected in another way);
4) Perceived severity of the disaster: the disaster and its aftermath was ‘not bad’, ‘quite bad’, ‘terrible’, or ‘the worst thing that ever happened to me’.

2.3 Multiple physical symptoms

Three questionnaire-based definitions were used for the concept of ‘multiple physical symptoms’, resulting in three outcome variables:

1) Multiple ‘somatic symptoms’: an above average score compared to the general Dutch norm population (i.e. \( \geq 19 \)) [35] on the somatic symptom subscale of the Dutch version of the 90-item Symptom Checklist-R (SCL90) [36]. This subscale encompasses the following symptoms in the past 7 days on a 5-point scale (from not at all to all the time): headaches, faintness or dizziness, pains in heart or chest, pains in lower back, nausea or upset stomach, soreness of muscles, trouble getting breath, hot or cold spells, numbness or tingling, a lump in throat, feeling weak, and heavy feelings in arms or legs.
2) Multiple ‘fatigue-related symptoms’: a total score on the Checklist Individual Strength (CIS) above 76 (i.e. a cutoff score proposed for working populations) [37], which encompasses 20 items on fatigue, lack of concentration, motivation, and physical activity in the past two weeks [38].
3) Multiple ‘physical symptom categories’: having symptoms in at least three different categories. For this variable a list of 34 physical symptoms (currently present versus absent) that was drawn up for the ESADA was divided into 8 symptom categories according to the International Classification of Primary Care (ICPC) [39]: General and non-specified (n=4, e.g. fatigue and nocturnal transpiration); Digestive (oral ulcers); Eye (sand feeling in eye); Cardiovascular (n=3, e.g. varicose veins or leg ulcers); Musculoskeletal (n=4, e.g. chronic joint and low back pain); Neurological (loss of strength); Respiratory (n=6, e.g. chronic cough and shortness of breath); and Skin (n=14, e.g. eczema, photosensitivity of skin, and ‘other’). Subsequently, the number of positive categories (i.e. with \( \geq 1 \) symptom) was counted, and an arbitrary cut-off of at least three was used to define having multiple physical symptom categories.

2.4 Posttraumatic stress symptoms

The Dutch version of the Self-Rating Inventory for Posttraumatic stress disorder (SRIP) was used to assess posttraumatic stress symptoms, i.e. symptoms of intrusion (six items), avoidance (nine items), and hyperarousal (seven items) during the preceding four weeks [40]. A total score of 39 or
higher has been shown to indicate that a person probably suffers from posttraumatic stress disorder and this cut-off was therefore used to define presence of (a high level of) ‘posttraumatic stress symptoms’ [41].

2.5 Background characteristics

The following background characteristics were also collected: age, sex, ethnicity, cigarette smoking, alcohol consumption, highest level of education completed, and executive function [33].

2.6 Statistical analysis

The background characteristics and posttraumatic stress symptoms of exposed and nonexposed workers were compared by means of t-tests for independent groups (age), Fisher’s exact test (posttraumatic stress symptoms), and Pearson’s tests (all others). Comparisons between exposed and nonexposed workers regarding multiple physical symptoms were analyzed with logistic regression models, both unadjusted and adjusted for background characteristics. To avoid excluding workers from the adjusted regression analyses due to missing values on background characteristics, a ‘missing’ category was added for those background characteristics with more than 5% missing values (level of education), and median values (stratified according to exposure status and occupation) were imputed for the background characteristics with less than 5% missing values (all others, except age and sex for which the data were complete). The potential mediating or modifying role of posttraumatic stress symptoms was explored by adding posttraumatic stress symptoms to the adjusted regression model, and, in a next step, the interaction between exposure status and posttraumatic stress symptoms.

For exposed workers, logistic regression was also used to analyze the association between multiple physical symptoms and the following types of exposure: individual disaster-related tasks, having witnessed the immediate disaster scene, having a close one affected by the disaster (all coded as yes versus no), and perceived severity of the disaster (categorical with “worst thing that ever happened to me” as the reference category). The types of exposure were first introduced in separate (‘univariate’) models, after which they were all introduced together and those types of exposure with P > 0.10 were removed in a step-wise backward manner. Thus, the resulting ‘multivariate’ model included only those types of exposure with P ≤ 0.10. Posttraumatic stress symptoms were subsequently added to this multivariate model, in order to establish their potential influence on these associations. These univariate and multivariate analyses were adjusted for age and sex. It was decided a priori that the analyses of types of exposure would be performed only if exposed workers had multiple physical symptoms significantly more often than nonexposed workers.

All analyses were performed with SPSS (version 10.1) and two-sided P-values of less than 0.05 were regarded as statistically significant.

3 Results

3.1 Response

Almost the complete historic cohort of firefighters and police officers (99% of n=2924) could be traced and invited to participate in the ESADA. Among those invited, the response rate was 71% for firefighters (n=559) and police officers (n=1489). Subsequently, 31 firefighters and 21 police officers were excluded from the statistical analyses because they lived in the disaster area at the time of the disaster (n=32), had missing data on exposure status (n=5), and/or because no comparison was possible between exposed and nonexposed workers (n=15), i.e. only one female firefighter participated, and all 14 firefighters who were of non-European ethnicity were nonexposed. Thus, 528 firefighters (63% exposed) and 1468 police officers (57% exposed) were included in the statistical analysis.
3.2 Background characteristics and posttraumatic stress symptoms

In general, exposed and nonexposed workers were comparable regarding background characteristics, although some statistically significant differences were found (Table 1). Moreover, exposed firefighters were, on average, more than 10 years older than nonexposed firefighters. The prevalence rate of posttraumatic stress symptoms was higher among exposed than nonexposed workers; but this difference was statistically significant for police officers only (Table 1).

### Table 1. Background Characteristics and Posttraumatic Stress Symptoms of Exposed and Nonexposed Workers

<table>
<thead>
<tr>
<th></th>
<th>Firefighters</th>
<th></th>
<th>Police Officers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed (N=334)</td>
<td>Nonexposed (N=194)</td>
<td>Exposed (N=834)</td>
<td>Nonexposed (N=634)</td>
</tr>
<tr>
<td>Age, mean (SD), years</td>
<td>51.4 (5.9)*</td>
<td>38.8 (9.1)</td>
<td>44.0 (6.2)*</td>
<td>44.8 (7.0)</td>
</tr>
<tr>
<td>Sex, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>100</td>
<td>100</td>
<td>*</td>
<td>88.5</td>
</tr>
<tr>
<td>Female</td>
<td>0</td>
<td>0</td>
<td>11.5</td>
<td>15.1</td>
</tr>
<tr>
<td>Level of education, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>58.7</td>
<td>50.5</td>
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<td>19.7</td>
</tr>
<tr>
<td>Medium</td>
<td>27.5</td>
<td>35.1</td>
<td>52.5</td>
<td>51.1</td>
</tr>
<tr>
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<td>6.3</td>
<td>10.3</td>
<td>20.9</td>
<td>23.3</td>
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<td>7.5</td>
<td>4.1</td>
<td>5.9</td>
<td>5.8</td>
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<tr>
<td>Alcohol consumption, %†</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>4.2</td>
<td>12.4</td>
<td>11.4</td>
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</tr>
<tr>
<td>Low to moderate</td>
<td>72.8</td>
<td>70.6</td>
<td>74.3</td>
<td>75.7</td>
</tr>
<tr>
<td>Excessive</td>
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<td>17.0</td>
<td>14.3</td>
<td>16.1</td>
</tr>
<tr>
<td>Cigarette smoking, %†</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>32.0</td>
<td>44.8</td>
<td>33.1</td>
<td>27.9</td>
</tr>
<tr>
<td>Formerly</td>
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<tr>
<td>Currently</td>
<td>32.9</td>
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<td>35.3</td>
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<tr>
<td>Ethnicity, %†</td>
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</tr>
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<td>European</td>
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<td>100</td>
<td>97.2</td>
<td>98.4</td>
</tr>
<tr>
<td>Other</td>
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<td>0</td>
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<td>1.6</td>
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<tr>
<td>Executive function, %†‡</td>
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<tr>
<td>No</td>
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<td>79.4</td>
<td>59.7</td>
<td>58.8</td>
</tr>
<tr>
<td>Yes</td>
<td>42.5*</td>
<td>20.6</td>
<td>40.3</td>
<td>41.2</td>
</tr>
<tr>
<td>Posttraumatic stress symptoms (SRIP ≥39), %</td>
<td>5.4</td>
<td>2.6</td>
<td>6.5*</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Abbreviations: SD= standard deviation; SRIP= Self-Rating Inventory for Posttraumatic stress disorder.

* P < 0.05, using t-test for independent groups (age), Fisher’s Exact test (posttraumatic stress symptoms), and Pearson $X^2$ (all others), with nonexposed as the reference group. † Missing values (<5%) replaced by median values within each sub-group. ‡ I.e. supervising one or more workers.

3.3 Multiple physical symptoms of exposed versus nonexposed workers

Exposed workers reported multiple physical symptoms significantly more often than their nonexposed colleagues, regarding each of the three outcome variables (i.e. somatic symptoms, fatigue-related symptoms, and ≥3 physical symptom categories) (Table 2). Adding posttraumatic stress symptoms to the regression models did not essentially change the effect of exposure status (Table 2). The percentage of change in the regression coefficient of exposure status among firefighters ranged from −16% (somatic symptoms) to −3% (≥3 physical symptom categories) compared to the analysis without posttraumatic stress symptoms. For police officers this ranged from +18% (fatigue-related symptoms) to +4% (≥3 physical symptom categories). Furthermore, no statistically significant interactions between exposure status and posttraumatic stress symptoms were found (the P-values of these interactions ranged from 0.21 to 0.98 among firefighters, and from 0.19 and 0.89 among police officers).
A closer look at the 34 categorised physical symptoms indicated that exposed workers reported many of them (rather than certain selected symptoms) more often than nonexposed workers. The difference in the prevalence rates of these symptoms between exposed and nonexposed was statistically significant for 12 and 27 of the 34 symptoms among firefighters and police officers, respectively, using adjusted logistic regression analysis (data not shown).

| TABLE 2. PREVALENCE OF MULTIPLE PHYSICAL SYMPTOMS AMONG EXPOSED VERSUS NONEXPOSED WORKERS |
|---------------------------------|---------------------------------|-----------------|-----------------|-----------------|
|                                | EXPOSED | NON-EXPOSED | UNADJUSTED | ADJUSTED † | ADJUSTED + PTSS‡ |
| Firefighters, n                | 334     | 194         |             |             |                 |
| Somatic symptoms (sub-scale SCL90 ≥19) | 18.0 %  | 3.1 %       | 6.9 (2.9-16.3)*** | 4.7 (1.8-12.4)** | 6.0 (2.0-18.2)** |
| Fatigue-related symptoms (CIS total >76) | 11.7 %  | 2.6 %       | 5.0 (1.9-12.9)** | 4.4 (1.4-13.7)** | 4.8 (1.4-15.7)* |
| Physical symptom categories (≥3) | 34.4 %  | 8.8 %       | 5.5 (3.2-9.4)** | 4.4 (2.3-8.5)** | 4.6 (2.3-9.1)** |
| Police officers, n             | 834     | 634         |             |             |                 |
| Somatic symptoms (sub-scale SCL90 ≥19) | 16.6 %  | 6.3 %       | 2.9 (2.0-4.3)** | 3.1 (2.1-4.5)** | 2.8 (1.9-4.1)** |
| Fatigue-related symptoms (CIS total >76) | 16.7 %  | 8.8 %       | 2.1 (1.5-2.9)** | 2.1 (1.5-2.9)** | 1.8 (1.3-2.6)** |
| Physical symptom categories (≥3) | 32.7 %  | 13.9 %      | 3.0 (2.3-3.9)** | 3.2 (2.5-4.2)** | 3.1 (2.3-4.1)** |

Abbreviations: CIS= Checklist Individual Strength; PTSS= posttraumatic stress symptoms, i.e. a score ≥39 on the Self-Rating Inventory for Posttraumatic stress disorder; SCL90: 90-item Symptom Checklist List.

†Adjusted for background characteristics, i.e. age, level of education, alcohol consumption, cigarette smoking, executive function, and for police officers only, sex and ethnicity.

‡Adjusted for the above-mentioned background characteristics and posttraumatic stress symptoms (i.e. total score ≥39 on the Self-Rating Inventory for Posttraumatic stress disorder).

* P < 0.05; ** P < 0.01; *** P < 0.001.

3.4 Multiple physical symptoms according to types of exposure

Tables 3 and 4 give the prevalence rates of the types of exposure for exposed firefighters and police officers, respectively. Most of the exposed firefighters reported two of these tasks. About a quarter (24.6%) of them reported the combination of firefighting, clean-up of the disaster site, and rescuing people. Most of the police officers reported one of these tasks. For about 64% of those reporting one task, this concerned security and surveillance.

Positive significant associations were found between multiple physical symptoms and types of exposure of exposed firefighters (Table 3) and police officers (Table 4). The types of exposure found to be univariately associated with multiple physical symptoms (P ≤ 0.10), were generally also retained in the multivariate model with comparable effect sizes. Adding posttraumatic stress symptoms to the resulting multivariate models did not essentially change the associations between multiple physical symptoms and types of exposure.

Among exposed firefighters, the multivariate analysis revealed that multiple physical symptoms (i.e. ≥3 physical symptom categories) were associated with four types of exposure (with odds ratios ranging from 1.6 to 2.0): rescuing people, clean-up of the disaster site, supporting injured victims and workers, and witnessing the immediate disaster scene (Table 3). Of these associations, only the one with rescuing people was significant. A similar effect size was also found between fatigue-related symptoms and clean-up of the disaster site (P ≤ 0.10). In contrast, those who performed security tasks (n=11) reported at least 3 categories of physical symptoms less often (P ≤ 0.10).

Among exposed police officers, multivariate analysis showed that multiple physical symptoms were reported significantly more often (with odds ratio’s ranging from 1.5 to 2.5) by those who supported injured victims and workers (somatic symptoms), who were identification or recovery of or search for victims and human remains (≥3 physical symptom categories) who had a close one affected by the disaster, who witnessed the immediate disaster scene (both regarding ≥3 physical symptom cat-
In addition, multiple physical symptoms were also non-significantly associated with two other types of exposure (with odds ratios ranging from 1.5 to 1.8): identification or recovery of or search for victims and human remains (fatigue-related symptoms), security and surveillance tasks (all three multiple physical symptom outcomes).

### Table 3. Associations between types of exposure and multiple physical symptoms among 334 exposed firefighters

<table>
<thead>
<tr>
<th>Exposure Category</th>
<th>Somatic Symptoms (SCL90 ≥19)</th>
<th>Fatigue Symptoms (CIS total &gt;76)</th>
<th>Physical Symptom Categories (≥3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rescuing People</td>
<td>Univariate analysis‡ 1.2 (0.66-2.0)</td>
<td>1.3 (0.66-2.6)</td>
<td>2.0 (1.3-3.3)**</td>
</tr>
<tr>
<td>Identification/Recovery/Search Victims/Human Remains</td>
<td>Multivariate analysis§ -</td>
<td>0.81 (0.30-2.2)</td>
<td>0.61 (0.31-1.2)</td>
</tr>
<tr>
<td>Fighting (n = 199, 61%)</td>
<td>Multivariate analysis§ -</td>
<td>1.7 (0.83-3.7)</td>
<td>1.7 (1.0-2.7)*</td>
</tr>
<tr>
<td>Clean-up the Disaster Site (n = 180, 55%)</td>
<td>Multivariate analysis§ -</td>
<td>2.0 (0.97-4.2)</td>
<td>1.6 (1.0-2.7)*</td>
</tr>
<tr>
<td>Security and Surveillance of Disaster Area (n = 11, 3.4%)</td>
<td>Multivariate analysis§ -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Support Injured Victims and Workers (n = 33, 10%)</td>
<td>Multivariate analysis§ + PTSS -</td>
<td>-</td>
<td>1.8 (0.86-3.9)</td>
</tr>
<tr>
<td>Witnessed Immediate Disaster Scene (n = 246, 74%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Close One Affected by Disaster ‘Not Bad’ (n = 13, 3.9%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Perceived Severity of Disaster ‘Quite Bad’ (n = 27, 8.1%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Perceived Severity of Disaster ‘Terrible’ (n = 219, 66%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Univariate analysis‡ includes age-adjusted odds ratios with (95% confidence intervals) for each dichotomous outcome variable of multiple physical symptoms, using the following reference categories: exposed workers not performing the specified task; not having seen the immediate disaster scene; not having some one close affected by the disaster; and perceiving the disaster as the worst thing that ever happened to them, respectively. Multivariate analysis§ includes age-adjusted odds ratios for each dichotomous outcome variable of multiple physical symptoms with posttraumatic stress symptoms (PTSS) added to the multivariate model. Abbreviations: CIS = Checklist Individual Strength; n.a. = not applicable; PTSS = posttraumatic stress symptoms, i.e. a score ≥39 on the Self-Rating Inventory for Posttraumatic stress disorder; SCL90 = 90-item Symptom Checklist. # Table gives age-adjusted odds ratios with (95% confidence intervals) for each dichotomous outcome variable of multiple physical symptoms, using the following reference categories: exposed workers not performing the specified task; not having seen the immediate disaster scene; not having some one close affected by the disaster; and perceiving the disaster as the worst thing that ever happened to them, respectively. § Univariate analysis (age adjusted): each type of exposure is entered in a separate logistic regression models. § Multivariate analysis (age adjusted): all types of exposure are entered at one, after which those with P > 0.10 are eliminated in a step-wise backward manner and only those with P ≤ 0.10 are retained and presented here; posttraumatic stress symptoms are subsequently added to this multivariate model (*Multivariate + PTSS*). * P < 0.05; ** P < 0.01.
### Table 4. Associations between types of exposure and multiple physical symptoms among 834 exposed police officers#

<table>
<thead>
<tr>
<th>Rescuing People (n=129, 16%)</th>
<th>Identification/Recovery/Search for Victims/Human Remains (n=68, 8.2%)</th>
<th>Clean-up the Disaster Site (n=40, 4.9%)</th>
<th>Security and Surveillance of Disaster Area (n=655, 79%)</th>
<th>Support Injured Victims and Workers (n=200, 24%)</th>
<th>Witnessed Immediate Disaster Scene (n=624, 75%)</th>
<th>Close One Affected by Disaster (n=53, 6.4%)</th>
<th>Perceived Severity of Disaster ‘Not Bad’ (n=57, 6.9%)</th>
<th>Perceived Severity of Disaster ‘Quite Bad’ (n=87, 11%)</th>
<th>Perceived Severity of Disaster ‘Terrible’ (n=515, 62%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOMATIC SYMPTOMS (SUB-SCALE SCL90 ≥19)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Univariate analysis‡</td>
<td>1.2 (0.76-2.1)</td>
<td>1.1 (0.57-2.2)</td>
<td>0.96 (0.39-2.4)</td>
<td>1.5 (0.93-2.6)</td>
<td>1.7 (1.1-2.5)*</td>
<td>1.4 (0.91-2.3)</td>
<td>1.5 (0.76-2.9)</td>
<td>0.42 (0.17-1.1)</td>
<td>0.66 (0.33-1.3)</td>
</tr>
<tr>
<td>Multivariate analysis§</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.6 (0.93-2.6)</td>
<td>1.7 (1.1-2.5)*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Multivariate analysis§ + PTSS</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.4 (0.83-2.4)</td>
<td>1.5 (0.95-2.3)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

| **FATIGUE SYMPTOMS (CIS TOTAL >76)** | | | | | | | | | | |
| Univariate analysis‡ | 1.3 (0.81-2.2) | 1.5 (0.83-2.8) | 0.58 (0.20-1.7) | 1.5 (0.92-2.5) | 1.4 (0.96-2.2) | 1.0 (0.67-1.6) | 1.2 (0.57-2.4) | 1.1 (0.51-2.5) | 0.71 (0.33-1.5) | 1.1 (0.69-1.8) |
| Multivariate analysis§ | - | 1.8 (0.95-3.4) | - | 1.6 (0.98-2.8) | - | - | - | - | - | - |
| Multivariate analysis§ + PTSS | - | 1.9 (0.96-3.8) | - | 1.5 (0.86-2.6) | - | - | - | - | - | - |

| **PHYSICAL SYMPTOM CATEGORIES (≥3)** | | | | | | | | | | |
| Univariate analysis‡ | 1.5 (1.0-2.2)* | 1.8 (1.1-3.0)* | 1.4 (0.70-2.6) | 1.4 (0.95-2.1) | 1.3 (0.96-1.9) | 1.6 (1.1-2.2)* | 2.2 (1.3-3.9)** | 0.55 (0.27-1.1) | 0.62 (0.47-1.5) | 1.0 (0.72-1.5) |
| Multivariate analysis§ | - | 2.3 (1.3-3.8)** | - | 1.5 (0.97-2.2) | - | 1.5 (1.0-2.1)* | 2.5 (1.4-4.4)** | - | - | - |
| Multivariate analysis§ + PTSS | - | 2.3 (1.3-3.9)** | - | 1.4 (0.91-2.1) | - | 1.5 (1.0-2.2)* | 2.3 (1.2-4.1)** | - | - | - |

### Abbreviations:
- **CIS**: Checklist Individual Strength
- **PTSS**: posttraumatic stress symptoms, i.e. a score ≥39 on the Self-Rating Inventory for Posttraumatic stress disorder
- **SCL90**: 90-item Symptom Checklist

#Table gives age-adjusted odds ratios with (95% confidence intervals) for each dichotomous definition of multiple physical symptoms, using the following reference categories: exposed workers not performing the specified task; not having seen the immediate disaster scene; not having some one. ‡Univariate analysis (age and sex adjusted): each exposure characteristic is entered in separate logistic regression models. §Multivariate analysis (age and sex adjusted): all exposure characteristics are entered at one, after which those with P > 0.10 are eliminated in a step-wise backward manner and only those with P ≤ 0.10 are retained and presented here; posttraumatic stress symptoms are subsequently added to this multivariate (Multivariate + PTSS). *P < 0.05. **P < 0.01. close affected by the disaster; and perceiving the disaster as the worst thing that ever happened to them, respectively.
4 Discussion

This epidemiologic study sought to examine associations between (types of) exposure to the air disaster in Amsterdam and multiple long-term physical symptoms among professional assistance workers, and to explore the potential role of posttraumatic stress symptoms in these associations. Exposed firefighters and police officers reported multiple physical symptoms significantly more often than their nonexposed colleagues. Furthermore, among exposed workers, multiple physical symptoms were reported significantly more often by firefighters who rescued people, and police officers who supported injured victims and workers, who were involved in the identification or recovery of or search for victims and human remains, who witnessed the immediate disaster scene, or had a close one affected by the disaster.

Posttraumatic stress disorder has previously been postulated to play a mediating [21] or a moderating [13] role in the relationship between mass trauma exposure and physical health problems. The results of the present study did not suggest a mediating role because addition of posttraumatic stress symptoms to the regression models did not essentially change the associations between (types of) disaster exposure and multiple physical symptoms. No indication was also found for an effect-modifying role, because no statistically significant interactions between exposure status and posttraumatic stress symptoms were found. Thus, our results provide further support for the hypothesis that posttraumatic stress symptoms are likely to explain only a small proportion of post-event physical health problems [27, 42-44]. The low prevalence of posttraumatic stress symptoms in our population (overall 4.6%), however, warrants cautious interpretation of these results. Furthermore, the cross-sectional design of this study precludes drawing inferences about causality and the direction of associations between disaster exposure, posttraumatic stress symptoms, and multiple physical symptoms. No data are available on the course of symptoms in the period between the disaster and the assessment after on average 8.5 years. It is possible, for example, that some exposed workers had already recovered from disaster-related posttraumatic stress symptoms. In that case, their previous posttraumatic stress symptoms might still have contributed to the development of multiple physical symptoms. Other psychological symptoms, such as anxiety and depression, may also have influenced the association between disaster exposure and multiple physical symptoms. However, the results were similar when anxiety or depression symptoms were entered in the analyses instead of posttraumatic stress symptoms, i.e. the association between (types of) exposure and multiple physical symptoms remained essentially the same after adjustment for anxiety and depression symptoms, and no significant interactions were found that would indicate that the effect of exposure status on multiple physical symptoms was stronger among those with anxiety or depression symptoms (data not shown).

An alternative explanation for the excess in multiple long-term physical symptoms among exposed workers could be direct effects of exposure to hazardous materials. This explanations, however, seems less plausible because previous ESADA studies showed no consistent significant differences between the exposed and nonexposed workers in various clinical parameters in blood and urine [34] (Huizink et al. unpublished data). Furthermore, no indications were found for a disaster-related cluster of certain types of physical symptoms. Rather, exposed workers reported the same type of physical symptoms, yet at a higher prevalence rate than their nonexposed workers. Taken together, these ESADA results, and the fact that no public health risk emerged from retrospective risk evaluations of disaster-related exposures [1,5], make specific noxious exposures a less plausible explanation for the elevated prevalence of multiple physical symptoms among exposed workers. Instead, our findings may indicate a phenomenon of "unexplained physical symptoms" resulting from the aggregate stressors of the disaster and its aftermath, similar to those seen in communities struck by disaster [13] and military personnel after war or peacekeeping service [18].

Such unexplained physical symptoms have been suggested to be particularly likely after (perceived) exposure to hazardous materials [15, 45-49]. The extended aftermath of the air disaster in Amsterdam was characterized by various rumours, public discussions, and extensive media coverage on alleged exposures to hazardous materials and on health consequences [1-3, 5]. Moreover, these
publicly discussed issues will also have been subject of debate among exposed assistance workers. This could have contributed to sustained uncertainty among these workers and other exposed colleagues, and could have affected their perception and reporting of physical symptoms.

One strength of the present study is that historic registers were available to identify the complete historic cohort of professional firefighters and police officers who were employed at the time of the disaster. Moreover, almost all of the exposed and nonexposed workers could be traced in the year 2000, and 71% of those invited participated. Therefore selection bias was limited. In addition, a concise non-response analysis among firefighters revealed no significant differences between nonrespondents and participants regarding current physical health complaints and general health perception (data not shown).

The impact of occupational disaster exposure on multiple physical symptoms was assessed in two ways, i.e. a comparison of exposed and nonexposed workers, and associations with types of exposure. The types of exposure could partly overlap, e.g. rescuers most probably also witnessed the immediate disaster scene. However, in general, the associations between types of exposure and multiple physical symptoms that were found univariately remained essentially the same in multivariate analysis, thus indicating independent effects of these types of exposure on multiple physical symptoms.

Multiple instruments were used to assess physical symptoms: two validated questionnaires, and a list of other physical symptoms drawn up for the ESADA. Published external criteria were used to define high levels of (i.e. multiple) somatic symptoms [35] and fatigue-related symptoms [37]. However, for the ESADA questionnaire an arbitrary cut-off score (≥3) was used to define multiple physical symptom categories. A sensitivity analysis using a less (≥2) and a more (≥4) stringent cut-off score showed that the results across these cut-off values were similar regarding the comparison of exposed and nonexposed workers (data not shown). However, the results of the multivariate associations with types of exposure depended to some extent on the cut-off value used. These results should therefore be considered with caution. Among police officers, for example, the effect sizes tended to be somewhat higher when using ≥3 compared to the other two cut-off values.

One limitation of the present study is that retrospective, self-reported exposure status was used. However, (differential) misclassification with respect to the dichotomy of exposed versus nonexposed workers seems unlikely, because workers were presumably able to recollect whether they performed any as opposed to no disaster-related tasks. It should be borne in mind though, that recall and reporting bias might have influenced the associations between the self-reported types of disaster exposure and multiple physical symptoms.

A final drawback concerns the fact that the exposed firefighters were on average more than 10 years older than the nonexposed firefighters. This was unavoidable because almost the entire Amsterdam fire department was exposed to the disaster and firefighters who joined this department after the disaster had to be included in the reference group. The applied statistical adjustments for age may not have fully accounted for this systematic difference between exposed and nonexposed firefighters.

In conclusion, this epidemiological study demonstrates that professional assistance workers are at risk for multiple physical symptoms even after several years after a disaster, and irrespective of long-term posttraumatic stress symptoms. These findings are in line with those found among community members struck by disaster and military personnel after war or peace-keeping service. Further longitudinal studies on professional assistance workers are needed to address risk factors, improve aftercare, and prevent multiple long-term physical symptoms.
REFERENCES


SALIVARY CORTISOL AND POSTTRAUMATIC STRESS SYMPTOMS IN FIRE FIGHTERS AND POLICE OFFICERS 8.5 YEARS AFTER THE AIR DISASTER IN AMSTERDAM

AB Witteveen, AC Huizink, P Slottje, I Bramsen, T Smid, HM Van der Ploeg

Submitted
ABSTRACT

Posttraumatic stress disorder (PTSD) after traumatic exposure is known to be related to alterations in the hypothalamic-pituitary-adrenal axis, as reflected by low (basal) cortisol levels. In this study cortisol levels from saliva collected in the early morning, noon, or the late afternoon of 334 fire fighters and 834 police officers 8.5 years involved in the 1992 Amsterdam air disaster were compared with, respectively, 194 and 634 non-exposed colleagues. Mean basal salivary cortisol (measured around noon) was significantly different (i.e., higher) only between exposed and non-exposed fire fighters and was associated with a clinically high score on the Self-rating Inventory for Posttraumatic Stress Disorder (SRIP) among exposed fire fighters. In contrast, lower mean cortisol levels of exposed police officers around noon were associated with intrusive symptom(s) on the SRIP and a moderate to severe level of disaster-related posttraumatic distress on the Impact of Event Scale. The authors conclude that more carefully controlled studies in PTSD and trauma research are needed to further investigate the role of cortisol in PTSD.
1 INTRODUCTION

Posttraumatic Stress Disorder (PTSD) is an anxiety disorder that might occur in persons who experience a highly traumatic event, such as a large-scale disaster. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) [1], exposure to a traumatic event includes a direct experience of an event that involves a threat to one’s own or another person’s life or physical integrity, and a subjective response of fear, helplessness or horror. Clinical features of PTSD are persistent intrusive memories, active and passive avoidance and symptoms of increased arousal.

In addition to these clinical features, two neuroendocrine stress response systems are related to (traumatic) stress reactions. The first is the immediate biological reaction to a traumatic event that involves an increased blood flow, heart rate, blood pressure and glucose availability to muscles in order to cope with (“flight or fight”) the threatening situation, as originally described by Walter Cannon (1914) [2]. In addition, within a few minutes, the hypothalamic-pituitary-adrenal (HPA) system reacts through the release of the corticotropin-releasing factor from the hypothalamus that stimulates the pituitary to release and produce the corticotropic hormone which in turn stimulates the adrenal cortex to produce cortisol that can be measured in saliva approximately 20-30 min after the stressor took place. Catecholamines, such as the corticotropic hormone, increase the availability of energy to vital organs, whereas cortisol is needed to dampen the stress response by suppressing the HPA axis through a negative feedback mechanism on the pituitary, hippocampus, hypothalamus and amygdala. Hormone levels should generally be back to basal levels within a few hours [3] [4].

In several psychiatric conditions, however, alterations in the basal activity of the HPA axis are known to occur. For instance, higher basal cortisol levels have been found in depressed subjects compared to healthy controls [5-7], whereas in studies of persons with PTSD, lower basal cortisol levels and greater suppression of cortisol in response to the administration of dexamethasone compared to (healthy) controls, have been reported [5, 8]. In contrast to these findings some studies found no differences [9], or found elevated cortisol levels among PTSD patients when compared to healthy (matched) controls [10, 11]. Most of these studies assessed cortisol in highly traumatized PTSD subjects, whereas only a few studies have investigated the relationship between basal cortisol levels and PTSD symptoms over a wide continuum of symptom severity. These latter studies assessed the relationship of salivary cortisol with cumulative critical incident exposure and PTSD symptoms among a sample of relatively healthy still functioning samples who are often exposed to traumatic events as part of their occupations, such as police officers and rescue workers [12, 13]. Neylan et al. (2005) found that greater levels of PTSD symptoms were associated with lower levels of pre-dexamethasone cortisol levels on awakening [12]. In the study of Aardal-Eriksson et al. (1999) none of the rescue workers from the local rescue service crossed the clinical cut-off point for PTSD; however, positive correlations between symptoms on the anxiety scale and the total score of a psychiatric health questionnaire (i.e., the General Health Questionnaire-28) and salivary cortisol at 8 AM and at 10 PM were found [13]. It appears that in studies of severely traumatized PTSD victims and in studies of relatively healthy rescue workers, the associations between (salivary) cortisol levels and adverse mental health are inconsistent. The discrepancies across studies might be due, for instance, to differences in the methods used (e.g., specific PTSD outcome or more general psychiatric health, time elapsed since trauma), comorbidity of PTSD with other psychiatric states (e.g., depression), or time of assessment.

In the present study basal cortisol levels from saliva in fire fighters and police officers 8.5 years after exposure to the Amsterdam air disaster in 1992 are assessed and compared with the cortisol levels of non-exposed colleagues. Since significantly higher PTSD symptom levels were reported among rescue workers 8.5 years after exposure to the air disaster in Amsterdam compared to those non-exposed [14], we expected to find a significant difference in mean cortisol level between exposed and non-exposed rescue workers. For instance, approximately 7% of the exposed police officers reported a high level of symptoms probably indicative for PTSD, compared to 3% among the non-exposed police officers. Although previous results on the association between trauma and PTSD show discrepant findings, lower cortisol levels are expected to be found among the exposed fire
fighters and police officers. In addition, this study also investigated associations between salivary cortisol concentrations and PTSD symptoms related to the disaster, and PTSD symptoms without specific reference to a traumatic event, using two screenings instruments. We expected that higher levels of PTSD symptom severity on a self-report questionnaire would be associated with lower levels of cortisol among exposed fire fighters and police officers.

2 Method

2.1 Participants

For the purpose of this study, 334 fire fighters and 834 police officers from the Epidemiological Study Air Disaster in Amsterdam (ESADA) who were involved in rescue and clean-up work at the site of the El Al cargo aircraft crash in Amsterdam in 1992 that killed 43 victims and destroyed 266 apartments, were selected. Non-involved fire fighters (n = 194) and police officers (n = 634), were selected as well. Details about recruitment of participants and study design have been described in detail elsewhere [15]. Summarized, participants were recruited via announcements in staff magazines and letters, and successively by telephone. Data were collected at the Prinsengracht outpatient clinic of the 'Onze Lieve Vrouwe Gasthuis' from January 2000 to March 2002, i.e. on average 8.5 years after the disaster. The study design was approved by the Medical Ethics Committees of the two medical facilities in Amsterdam involved in this project: the VU University Medical Center and the 'Onze Lieve Vrouwe Gasthuis'. All participants signed informed consent and participated voluntarily.

Twelve police officers were excluded because they reported that they were being treated with prednisone or prednisolone and this might lead to an artificially high level of cortisol. A total of 27 fire fighters and 70 police officers could not be included because their cortisol level could not be assessed from the saliva due, for instance, to a shortage of saliva.

The four groups in this study finally consisted of 316 exposed fire fighters and 185 non-exposed fire fighters and 775 exposed police officers and 607 non-exposed police officers. All exposed and non-exposed fire fighters were male. Exposed fire fighters were significantly older (M age = 51.6 years, SD = 5.9) than non-exposed fire fighters (M age = 38.9 years, SD = 9.3; p = .000). Exposed fire fighters reported significantly more often a moderate to excessive use of alcohol and less often no use of alcohol (p < .01) and were more often cigarette users than non-exposed fire fighters (p < .01). Exposed police officers were significantly more often male (90%) than non-exposed police officers (85%) (p < .05). Exposed police officers were slightly younger (M age = 44.0 years, SD = 6.1) than non-exposed police officers (M age = 44.8 years, SD = 10.0; p <.05).

2.2 Measures

Saliva sampling.— Salivary samples of each subject were obtained at one of three time points, i.e., Time point 1 = between 8.30 and 9.30 AM, Time point 2 = between 12.00 AM and 1.00 PM, or Time point 3 = between 3.30 and 4.30 PM. A cortisol concentration obtained with saliva collection is a well-validated and unobtrusive method that accurately reflects the level of serum cortisol [16]. Cortisol levels in saliva follow the normal diurnal rhythm also found in serum, with higher cortisol levels in the (early) morning (shortly after awakening) and steadily decreasing values thereafter. Saliva samples were collected at the hospital within the time frame of two hours that were needed to fill out a set of questionnaires. Saliva was collected with Salivettes (Sarstedt, Inc., Numbrecht, Germany), a plastic tube containing a cotton-wool swab on which the individuals were instructed to chew lightly. Afterwards it was replaced into the insert. After receipt in the laboratory of the VU University Medical Center, the saliva samples were centrifuged and frozen at −20° C. With competitive immunoassay, i.e., the Spectria Cortisol Coated Tube Radioimmunoassay reagens kit (Orion Diagnostica, Espoo, Finland), and a gammacounter (Gammacounter Wizard 1470, Perkin Elmer) the concentrations of cortisol in saliva were computed.
Self-rating Inventory for PTSD [17].---This is a self-report questionnaire including 22 items based on the DSM-IV B, C, and D criteria for PTSD. The items are phrased without specific reference to a critical incident or traumatic event and are scored on a 4-point scale from ‘not at all’ to ‘extremely’. A total score as well as subscales of intrusion (6 items), avoidance (9 items) and hyperarousal (7 items) can be calculated. Psychometric properties, such as validity and reliability for assessing PTSD, have been proven good in different populations [18]. For the purpose of the current study, a clinical cut-off value of 39 (previously identified in a community sample) was used to indicate (probable) PTSD-caseness [19]. Subsequently, having scale ratings of 3 and 4 on at least one item of the intrusion subscale, on at least three items of the avoidance subscale, or on at least two items of the hyperarousal scale are used as clinical cut-off points for the three subscales.

Impact of Event Scale [20].---This is a widely used questionnaire to assess psychological reactions to critical (traumatic) events. It consists of 15 items which reflect intrusion (7 items, e.g., “I had waves of strong feelings about it”) and avoidance (8 items, e.g., “I tried not to talk about it”) of the trauma. The Dutch version of the Impact of Event Scale (IES) [21] was used in this study. All items are scored on a 4-point scale (0 = not at all, 1 = rarely, 3 = sometimes, 5 = often). For the purpose of the current study, in addition to a continuous measure of disaster-related posttraumatic stress symptoms (IES total score), a clinical cut-off value of 25 was used as indicative of a moderate or severe impact of the air disaster [22].

Demographic variables:--- In this study a selection of several potentially relevant confounders were included. Using several questionnaires, demographic information on age, gender, current and previous chronic illnesses (e.g., diabetes, stroke, rheumatoid; dichotomized into none vs. one or more of 13), alcohol use and smoking habits was obtained. A more detailed description of these questionnaires is available from the recently published online article about the study design [15].

2.3 Analysis

To normalize distributions as required for statistical procedures, natural log transformations were applied to cortisol and to total PTSD score and subscores. Because of the skewed distributions of the raw cortisol data, medians and minimum and maximum are presented for each group according to the time point at which they were tested. For the rating scores of the various psychological variables the means and standard deviations and percentages above clinical cut-offs are given. Chi-square and t-tests were applied to study differences in the selected demographic variables age, gender, suffering from chronic illness, alcohol use and smoking. Group differences in basal cortisol levels (exposed versus non-exposed) and the association between PTSD symptoms and cortisol levels were analyzed using multiple linear regression analysis with adjustment for selected possible confounders (i.e. age, gender, chronic illness, smoking and alcohol use). Statistical tests were performed with SPSS 11.0, using two-tailed significance tests, with 

3 Results

Tables 1a and 1b present data on the salivary cortisol levels among the groups of exposed and non-exposed fire fighters and police officers at the three different time points. As can be seen, median cortisol levels reflect the normal diurnal cortisol pattern with higher median cortisol levels in the early morning, and lower levels at noon or in the late afternoon. Table 1b also shows that mean (log transformed) salivary cortisol levels of exposed police officers were not significantly lower or different from those of the non-exposed police officers after adjustment for potential confounders (i.e., age, gender, chronic illness, smoking and alcohol use). Among fire fighters, however, exposed fire fighters whose cortisol levels were collected around noon, had significantly higher cortisol levels than non-exposed fire fighters after adjustment for possible confounders (p = .04).
Table 2 gives descriptive information on mean PTSD levels and subscales of intrusion, avoidance and hyperarousal at the three time points. Prevalence of probable PTSD on the SRIP among exposed fire fighters and police officers is around 5-7% for time point 1 (8.30 to 9.30 AM) and 2 (around noon). None of the fire fighters whose salivary cortisol was collected between 3.30 and 4.30 PM reported a high level of PTSD symptoms on the SRIP or a clinically high level of disaster-related PTSD symptoms. Among police officers, clinically high levels of PTSD symptoms were less prevalent at time point 3 than on time point 1 or 2 (i.e., around 2-5%).
Table 3 shows that there were statistically significant associations among exposed fire fighters and exposed police officers between cortisol levels and posttraumatic stress for cortisol collected around noon. Probable PTSD (39 or higher on SRIP total) was significantly (p < .05) associated with higher cortisol levels at time point 2 (i.e., around noon) among exposed fire fighters after correction for potential confounders (i.e., age, chronic illness, smoking and alcohol use). The SRIP intrusion clinical cut-off (according to the DSM-IV) and a high level of disaster-related intrusions and avoidance symptoms (IES-clinical cut-off) were significantly associated with lower cortisol levels at time point 2 (i.e., around noon) among exposed police officers. There were no significant associations between the continuous posttraumatic stress-levels and cortisol at time points 1, 2 and 3 among exposed fire fighters or among exposed police officers.

Table 2. Descriptive information on posttraumatic stress symptoms among fire fighters and police officers exposed to the 1992 air disaster in Amsterdam.

<table>
<thead>
<tr>
<th></th>
<th>Time 1 (8.30 - 9.30 AM)</th>
<th>Time 2 (12.00 AM-1.00 PM)</th>
<th>Time 3 (3.30-4.30 PM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed fire fighters</td>
<td>Exposed police officers</td>
<td>Exposed fire fighters</td>
</tr>
<tr>
<td></td>
<td>(N = 153)</td>
<td>(N = 336)</td>
<td>(N = 135)</td>
</tr>
<tr>
<td>SRIP total score</td>
<td>26.8 (5.7)</td>
<td>27.6 (5.8)</td>
<td>27.0 (6.2)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>5.2%</td>
<td>6.8%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Intrusion score</td>
<td>6.8 (1.7)</td>
<td>6.8 (1.5)</td>
<td>6.8 (1.8)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>8.5%</td>
<td>6.3%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Avoidance score</td>
<td>10.8 (2.6)</td>
<td>11.0 (2.5)</td>
<td>11.1 (2.8)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>3.3%</td>
<td>0.3%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Hyperarousal score</td>
<td>9.3 (2.4)</td>
<td>9.8 (2.7)</td>
<td>9.2 (2.8)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>12.4%</td>
<td>11.3%</td>
<td>11.1%</td>
</tr>
<tr>
<td>IES total</td>
<td>3.0 (6.8)</td>
<td>3.7 (7.0)</td>
<td>3.4 (7.6)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>3.3%</td>
<td>2.4%</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

Table 3. Associations between (log transformed) salivary cortisol and continuous and dichotomous posttraumatic stress levels among fire fighters and police officers exposed to the 1992 air disaster in Amsterdam.

<table>
<thead>
<tr>
<th></th>
<th>Time 1 (8.30 - 9.30 AM)</th>
<th>Time 2 (12.00-1.00 PM)</th>
<th>Time 3 (3.30-4.30 PM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed fire fighters</td>
<td>Exposed police officers</td>
<td>Exposed fire fighters</td>
</tr>
<tr>
<td></td>
<td>(N = 153)</td>
<td>(N = 336)</td>
<td>(N = 135)</td>
</tr>
<tr>
<td>SRIP total score</td>
<td>1.12 (0.70-1.78)</td>
<td>1.00 (0.77-1.30)</td>
<td>1.14 (0.75-1.73)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>0.65 (0.66-1.38)</td>
<td>0.89 (0.73-1.08)</td>
<td>1.46 (1.05-2.01)*</td>
</tr>
<tr>
<td>SRIP Intrusion score</td>
<td>0.97 (0.63-1.51)</td>
<td>0.91 (0.70-1.19)</td>
<td>1.08 (0.71-1.64)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>0.93 (0.68-1.26)</td>
<td>0.85 (0.69-1.04)</td>
<td>1.14 (0.80-1.62)</td>
</tr>
<tr>
<td>SRIP Avoidance score</td>
<td>1.05 (0.69-1.58)</td>
<td>0.99 (0.78-1.27)</td>
<td>1.05 (0.72-1.54)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>1.00 (0.63-1.60)</td>
<td>1.07 (0.84-2.62)</td>
<td>0.98 (0.63-1.52)</td>
</tr>
<tr>
<td>SRIP Hyperarousal score</td>
<td>1.18 (0.82-1.69)</td>
<td>1.04 (0.86-1.27)</td>
<td>1.14 (0.83-1.57)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>1.14 (0.88-1.46)</td>
<td>0.97 (0.83-1.13)</td>
<td>1.20 (0.92-1.57)</td>
</tr>
<tr>
<td>IES total score</td>
<td>0.96 (0.89-1.04)</td>
<td>1.00 (0.95-1.05)</td>
<td>0.97 (0.89-1.05)</td>
</tr>
<tr>
<td>Clinical cut-off</td>
<td>0.85 (0.53-1.35)</td>
<td>1.04 (0.76-1.43)</td>
<td>0.85 (0.82-2.14)</td>
</tr>
</tbody>
</table>

* p < .05, ** p < .01, *** p < .001

Betas are adjusted for potential confounders age, chronic illness, smoking, alcohol use, and gender (only among police officers).
4 Discussion

In this study, the relationship of a well-known stress marker, i.e., cortisol level, with exposure to a traumatic air disaster experienced 8.5 years prior and PTSD symptom levels was examined among fire fighters and police officers. The only significant difference between exposed and non-exposed professionals was found for fire fighters whose cortisol was collected between 12.00 AM and 1.00 PM, i.e., the exposed fire fighters had higher (transformed) mean cortisol levels than the non-exposed fire fighters. In relation to our second hypothesis, cortisol was not significantly associated with continuous posttraumatic stress levels nor with clinically high levels of posttraumatic stress among exposed fire fighters and police officers whose cortisol was collected at time point 1 (between 8.30 and 9.30 AM) or at time-point 3 (between 3.30 and 4.30 PM). The only (few) significant associations between clinically high levels of PTSD symptoms and cortisol levels were found among exposed fire fighters and police officers who were assessed at time point 2 (between 12.00 AM and 1.00 PM). More specifically, a clinically high level of PTSD symptoms on the SRIP was significantly associated with higher mean cortisol levels among exposed fire fighters, whereas among exposed police officers intrusion (category B of the DSM-IV diagnosis of PTSD) and a moderate to severe posttraumatic stress reaction to the disaster on the IES were significantly associated with lower mean cortisol levels.

Although the results indicate that 8.5 years afterwards there were virtually no differences between fire fighters and police officers exposed to the air disaster in Amsterdam and non-exposed fire fighters and police officers, the higher mean cortisol level among exposed fire fighters (with cortisol assessment around noon) and its association with a high level of posttraumatic stress is, to some extent, in agreement with the few studies that also found higher salivary cortisol in rescue workers [13, 23]. Aardal-Eriksson and co-authors found higher salivary cortisol levels among rescue workers with a high level of distress and a higher level of PTSD scores [13]. A higher cortisol level in association with a high level of posttraumatic stress was also found in a recent case-matched control study of 12 police officers with PTSD and 12 traumatized police officers without a lifetime PTSD [23]. An important difference between these two studies and ours is that an association between posttraumatic stress and higher cortisol was not found in the (early) morning cortisol assessment of the current study. This might, however, be due to the fact that high levels of posttraumatic stress were less prevalent among fire fighters and police officers assessed between 8.30 and 9.30 AM (or between 3.30 and 4.30 PM) than between 12.00 AM and 1.00 PM.

The current results among the exposed fire fighters are, however, in contrast with the several studies that indicate that basal cortisol levels are decreased after trauma and in PTSD patients [5, 8]. It has been speculated that PTSD might be initially associated with higher cortisol levels, eventually resulting in lower cortisol levels after a period of dysregulation of the HPA axis. Moreover, PTSD patients may have normal or low baseline cortisol levels in response to chronic suppression of responsiveness and psychological avoidance, while new stressors may result in exaggerated cortisol responses [24]. For instance, among two rescue workers in the Aardal-Eriksson et al. study [13], a significant rise in salivary cortisol was present because they were exposed to a duty-related traumatic event (death of a child in a traffic accident) during that study. In the current study a high level of PTSD symptoms on the SRIP was relatively more prevalent among exposed than non-exposed fire fighters (5% vs. 3%, respectively [14]), and might be linked to any traumatic event experienced more recently or in the past, including the 1992 air disaster. Although specific information on more recent or current duty-related traumatic exposure was not available, exposed fire fighters were much longer employed in the fire department than the younger non-exposed fire fighters who started working in this fire department after the disaster (and who had to be included because almost the entire fire department had been exposed to the disaster). It might be speculated that the exposed fire fighters had more previous and current (during the measurement period) traumatic exposure than the less experienced non-exposed fire fighters, resulting in higher cortisol levels among the exposed. Due to a longer history of frequent exposure to traumatic events, the HPA axis of the exposed fire fighters might have become more sensitive and reacts with a larger increase of cortisol to subsequent and current stressors than the HPA axis of younger and relatively less experi-
enced fire fighters. Advanced age in the exposed fire fighters might play an important role as well, since higher age is known to be related to higher basal cortisol levels [25] and the applied statistical adjustment for age (and other socio-demographic variables) might not have fully accounted for this difference between exposed and non-exposed fire fighters.

Not only did we find a higher cortisol level (between 12.00 AM and 1.00 PM) among exposed fire fighters compared to non-exposed colleagues, the higher cortisol level among exposed fire fighters was also associated with a high level of posttraumatic stress. Post hoc analyses revealed that the age of exposed fire fighters (M age = 57 years, SD = 2.9) with a high level of posttraumatic stress and whose cortisol was collected around noon, was significantly higher (p < .001) than the age of exposed fire fighters without this high level of posttraumatic stress (M age = 52 years, SD = 6.0). Not only might the higher age explain the association between a clinically high level of posttraumatic stress and elevated cortisol among the exposed fire fighters, but comorbidity of the SRIP total PTSD score with depression might also play a role [26]. Depression is known to be associated with higher cortisol levels [5-7]. For instance, elevated cortisol in PTSD was found comorbid with lifetime major depressive disorder [9]. However, in the current study an even higher correlation between posttraumatic stress on the SRIP and depression was found among exposed police officers (r = .72) than among exposed fire fighters (r = .59) [26]. It might also be speculated that an interplay between age and the correlation between depression and posttraumatic stress might explain the difference in findings across fire fighters and police officers. For instance, in a study of Sher, Oquendo, Galfalvy, Cooper, and Mann [27] cortisol levels appeared to increase with age in depressed patients without PTSD but not in depressed patients with comorbid PTSD or in healthy volunteers.

In contrast with the fire fighters, no difference was found between exposed and non-exposed police officers at the several time points, and a lower cortisol level was associated with a high level of disaster-related posttraumatic stress among exposed police officers. Important is the fact that the exposed and non-exposed police officers are much more comparable on several socio-demographic variables (including age) than the exposed and non-exposed fire fighters. Both exposed and non-exposed police officers were (according to the company records) employed in the Amsterdam-Amstelland regional police force on the date of the disaster, and were still employed at the start of measurement [14, 15]. Among exposed police officers, a moderate to severe level of air disaster-related posttraumatic stress symptoms was associated with lower cortisol levels between 12.00 AM and 1.00 PM. This result is, to some extent, in agreement with a study of Goenjian, Yehuda, Pynoos, Steinberg, Tashjian, Yang, Najarian, and Fairbanks [28], in which adolescents who were closer to the epicentre of the Armenian earthquake in 1988 had significantly lower cortisol levels 5 years afterwards than adolescents much further away from the epicentre. The adolescents in the latter study were experiencing more severe earthquake related PTSD symptoms than the adolescents from the control city, and a significant association was found between intrusion and lower salivary cortisol in the early morning. In the current study the PTSD symptom category B (one or more severe intrusions) and disaster-related intrusions and avoidance symptoms were significantly associated with lower basal cortisol levels (between 12.00 AM and 1.00 PM). However, in the current study a significant association between cortisol levels and posttraumatic stress could not be established in the early morning but only among police officers assessed around noon. In contrast with the exposed fire fighters, post-hoc analyses revealed that age of exposed police officers with a high level of disaster-related posttraumatic stress and/or a clinical high level of intrusion was not significantly different from the age of exposed police officers not suffering from these high levels of posttraumatic stress.

The present study has several limitations. The most important one is the fact that only one a single saliva sample was collected for every individual. Saliva collection should preferably involve collecting different samples during the day, with at least one collection in the early morning [29]. Ideally, saliva collection should also include reference to the individual’s usual time of awakening rather than a fixed clock time because early morning cortisol levels can be a reliable biological marker for the individual’s adrenocortical activity when measured repeatedly with strict reference to the time of awakening [30]. Due to the epidemiological setting (with large groups including almost all police officers
and fire fighters from the Amsterdam-Amstelland police department and the fire department) we were not able to collect saliva samples at several different time-points during the day to obtain a normal diurnal pattern for each individual.

A second limitation might be that the saliva sampling around noon (between 12.00 AM and 1.00 PM) produced the only significant associations, whereas the magnitude of the cortisol response at noon is in part dependent upon the composition of the lunchtime meal (e.g., carbohydrates elevate cortisol levels) which complicates the noon measurement. Third, the unstable sleep-wake schedule of fire fighters and police officers could not be controlled for. Fourth, in this cross-sectional study more recent or current traumatic exposure was not investigated and the presence of PTSD was not obtained with a standardized questionnaire.

In sum, virtually no differences in cortisol level 8.5 years after exposure to the air disaster in Amsterdam were found between exposed and non-exposed fire fighters and police officers. The fact that we found only few and contrasting results among both groups of rescue workers (i.e., fire fighters and police officers) in the association between cortisol and trauma (exposure to the air disaster) and posttraumatic stress, is to a certain extent in line with the lack of clarity in the literature on this topic, or might be due to chance. Further research is needed to elucidate the relationship between cortisol and PTSD, since it appears to play a role in memory function and dysfunction and might serve to improve the successful treatment of PTSD [23, 31]. A pilot study by Aerni, Traber, Hock, Roozendaal, Schelling, Papassotiropoulos, Nitsch et al. [32], indicated that low-dose cortisol treatment reduces the cardinal symptoms of PTSD and they speculated that cortisol administration reduced avoidance by reducing reexperiencing symptoms. Because fire fighters and police officers are at high risk to experience traumatic events (and might subsequently suffer from PTSD), further investigation into the relationship between cortisol levels and PTSD symptoms among these populations is recommended.
References


This chapter presents the main findings of this thesis and discusses the methodological considerations with regard to the ESADA. Section 11.1 presents the main findings of the three research questions. In section 11.2 the methodological considerations are described in order to ultimately address the legitimacy of the findings. Section 11.3 addresses the meaning and relevance of the findings of this thesis and discusses them in relation to the international literature. Section 11.4 further discusses the implications of the findings of the current thesis for clinical practice and makes suggestions for future research. Finally, section 11.5 presents some general conclusions of the thesis.

1 Main findings

This section addresses the five research questions posed in the Introduction (Chapter 1).

Do occupationally exposed rescue workers (i.e., fire fighters and police officers) differ from non-exposed colleagues regarding psychological distress, i.e., (symptoms of) PTSD and other (general) psychological distress (e.g., anxiety, somatic complaints and fatigue) 8.5 years after the air disaster? Which background-related and exposure-related (risk) factors are associated with the potential long-term psychological distress among exposed rescue workers?

The results regarding the first research question show that exposed fire fighters reported more somatic complaints and fatigue than occupationally non-exposed fire fighters (see Chapter 6). Compared to non-exposed police officers, exposed police officers reported more symptoms on all outcome measures of psychological distress. In addition, prevalence rates of a relatively high level of anxiety, somatic complaints, sleep disturbances, and fatigue in exposed police officers were higher than the respective prevalence rates in non-exposed police officers. A moderate to high level of disaster-related posttraumatic distress was found in 3% and 2% of the exposed fire fighters and police officers, respectively. The results also indicated that disaster exposure was associated with psychological distress. Exposed fire fighters who had performed more tasks at the disaster site reported more psychological distress, whereas exposed police officers who performed more tasks in general or who were exposed to tasks and events with a potential traumatic character reported more disaster-related posttraumatic distress. As expected, several socio-demographic factors were associated with psychological distress as well (e.g., ethnicity, age).

Do occupationally exposed rescue workers differ from non-exposed rescue workers regarding self-reported health and laboratory outcomes 8.5 years after the air disaster?

Findings regarding the second research question revealed that, compared to non-exposed colleagues, exposed fire fighters and police officers reported more (physical and mental) health complaints (see Chapter 7). The results regarding laboratory analyses, however, showed no statistically significant or clinically relevant differences between the exposed fire fighters and police officers and their non-exposed colleagues.

Do occupationally exposed fire fighters and police officers differ from non-exposed colleagues regarding self reported negative life events experienced in the pre- and particularly in the post-disaster period? Is the number and nature of pre- and/or post-disaster negative life events associated with psychological distress, and is this association significantly stronger for exposed than for non-exposed police officers?

The results regarding the third research question show that exposed police officers more frequently reported to have experienced negative life events in the pre- and, particularly, the post-disaster period. Exposed police officers also reported more often that they had not dealt with these events, particularly events affecting their own health or socio-occupational functioning, compared to non-exposed police officers (see Chapter 8). The findings also revealed positive associations between the number and type of negative life events and psychological distress among police officers. This particularly concerned the associations of events affecting the police officers’ own health or socio-
Are potential differences between occupationally exposed rescue workers in self-reported physical health linked to the nature and extent of the psychological distress of exposed rescue workers?

Findings indicated that, compared to non-exposed colleagues, exposed fire fighters and police officers significantly more often reported multiple physical symptoms (see Chapter 9). Multiple physical symptoms were related to the degree and type of exposure. Posttraumatic stress symptoms did not substantially account for the multiple physical symptoms seen in exposed fire fighters and police officers.

Do occupationally exposed rescue workers (i.e., fire fighters and police officers) differ from non-exposed colleagues regarding the level of the stress hormone cortisol? Is the level of the stress hormone cortisol associated with (symptoms of) PTSD among exposed rescue workers?

Comparisons of differences in salivary cortisol levels between exposed fire fighters and police officers and non-exposed colleagues revealed that only the mean basal salivary cortisol level measured around the noon time point was significantly higher in exposed fire fighters compared to non-exposed fire fighters (see Chapter 10). Salivary cortisol levels measured at the noon time point were associated with PTSD in general and specific disaster-related posttraumatic distress; however, the directions of the associations differed between exposed fire fighters and police officers. Higher levels of salivary cortisol in exposed fire fighters were associated with a clinically high PTSD score, whereas lower levels of salivary cortisol were associated with a high level of disaster-related posttraumatic distress in exposed police officers.

In conclusion, the findings of this thesis show that exposure to the air disaster affected the long-term psychological wellbeing of rescue workers, i.e., PTSD, other outcomes of psychological distress (e.g., symptoms of depression or fatigue), the experience of post-disaster negative life events, and psychobiological correlates of trauma exposure and PTSD. Self-reported physical health was lower in both exposed fire fighters and police officers compared to non-exposed colleagues, although the symptoms of PTSD could not account for the high number of physical health symptoms. More specifically, on average 8.5 years after the disaster, nearly 3% of the exposed rescue workers still suffered from disaster-related intrusions and avoidance symptoms. Psychological distress of exposed rescue workers was, to a certain extent, associated with the type and degree of exposure at the disaster site, while other background characteristics also played a role in psychological distress.

2 Methodological Considerations

In order to conclude whether the findings of this thesis, as summarized above, are valid and generalizable, several methodological factors that might have influenced the findings need to be discussed.

2.1 Participants

Participant selection should focus on the inclusion of a representative sample of the population for whom one wishes to generalize. Because a number of factors might have affected the representativeness of our sample (i.e., the exposed and the non-exposed reference groups), some shortcomings of the ESADA do exist.

First, with regard to the fire fighters, a selection bias may have taken place because fire fighters who joined the fire department after the disaster took place had to be included in the reference group (Chapter 3). This was, however, inevitable since almost the entire fire department was exposed to the disaster. As a consequence, the exposed fire fighters were significantly older (i.e., on average ten
years) than the non-exposed fire fighters. Although we adjusted for the large difference in age and other potential socio-demographic confounders between exposed and non-exposed fire fighters, other cohort effects (such as job experience, and changes in selection criteria and training procedures over the years) might have affected the results. It is not unlikely that the level of job experience (which includes previous trauma exposure and probably previous disaster exposure, more training and the probability of past PTSD) differed significantly between exposed and non-exposed fire fighters. On the other hand, age can be regarded as a proxy for job experience because most of the fire fighters have a lifetime career at the fire department. Moreover, the findings regarding job experience and previous disaster and trauma exposure, and subsequent risk for PTSD and psychological distress, differ across studies and it is unclear whether longer job experience sensitizes employees against the risk of psychological distress following disasters and other trauma (Chapter 2).

Second, significant differences in psychological distress were less often found among exposed and non-exposed fire fighters than among police officers (Table 3, Chapter 6). The smaller sample size of the exposed and non-exposed fire fighter samples, and the fact that several adjustments (particularly age) in the regression analyses of the fire fighters had to be made, might have decreased the ability to demonstrate statistically significant differences in psychological distress among fire fighters. This lack of significance does, however, not mean that there are no relevant associations between exposure and distress at all, but statistical proof of this association was lacking. More specifically, a trend of higher symptom levels on several outcomes of psychological distress for exposed fire fighters compared to non-exposed colleagues was noticed. Here the concept of power of a study must be discussed. One has to take into account that some study samples may be too small to identify important significant differences, whereas studies with large sample sizes identify significant differences that are not clinically relevant. It is therefore important for future studies to consider the magnitude of the differences between the exposed and non-exposed groups in combination with the power of the study.

Third, although exposed and non-exposed police officers were generally highly comparable, one factor might have introduced selection bias among this cohort. Because it was not possible to trace police officers who had left the department before the investigations of the ESADA started, only those police officers that were still working at the police department at the start of the ESADA could be invited to participate (Chapter 3). A selection bias might have been introduced when leaving the department (e.g., due to dismissal, illness or on own initiative) was related to psychological distress and physical symptoms and exposure to the air disaster.

In contrast to these potential shortcomings, several important strengths of the study population can be mentioned. First, a complete cohort of fire fighters and police officers who were exposed and non-exposed to the air disaster could be identified from company records. More specifically, large groups of fire fighters and police officers exposed to the air disaster and non-exposed reference groups of colleagues who had the same jobs and who were from the same departments but exposed to duty-related stressors other than the disaster, were included in order to assess associations between disaster exposure and self-reported psychological distress, physical symptoms and health status (Chapters 6 and 7). Large sample sizes reduce the probability of errors, maximize the accuracy of population estimates, and increase the generalizability of the results. On the other hand, a type I error might be incorporated in studies with large sample sizes when multiple relationships are tested. Therefore, a Bonferroni alpha correction was applied to the results on psychological distress (Chapter 6). As shown in Chapter 2, many previous studies on the psychological distress of rescue workers following disasters include only small sample sizes and/or lack a comparable reference group, and reported on relatively short-term psychological distress.

Second, the samples included in the current study yielded good response rates: almost the entire study population could be traced and invited to participate (97%), and 71% of the fire fighters and police officers participated in this study. In the ESADA a non-response analysis of the fire fighters was included [1]. Although this analysis revealed some significant differences between participating fire fighters and non-responding fire fighters (i.e., non-responders more often reported psychological
problems and chronic arthritis since the disaster), exposure played no role in these differences between non-responding and participating fire fighters. Unfortunately, a non-response analysis of the police officers cohort was not possible because no data on non-responding police officers was available. Many previous studies on rescue workers following disasters had problems in defining and contacting the population of interest and in composing and selecting a relevant reference group (section 4.1.1., Chapter 2). Taken together, it may be concluded that in the ESADA there is a negligible chance of the findings not being representative for the entire cohort of fire fighters and police officers.

In conclusion, the selection of the participants, to a certain extent, has affected the findings of this thesis. This influence is, however, minimized in view of the clear strengths regarding the selection of the participants.

2.2 Design

The influence of study design on the findings also needs to be discussed. Detailed self-report data of the exposure questionnaire filled out 8.5 years after the air disaster was used to define exposed versus non-exposed groups. With one assessment point approximately 8.5 years after the air disaster, the design of the ESADA is thus, strictly speaking, a cross-sectional one. The original design of the ESADA was a historical cohort study with historic registration of the exposure status. However, due to administrative deficiencies the registrations were not completely reliable and we had to rely on self-reports of exposure. The ability to determine the direction of the associations between outcomes of psychological distress, and correlates or risk factors, is difficult in a study with a cross-sectional design. Cross-sectional (retrospective) designs have also been criticized because they can result in recall bias. In the case of the ESADA this might have affected measurement of exposure to the disaster and pre- and post-disaster negative life events. Recall bias will be further discussed in section 11.2.3.

Another bias in epidemiological studies with large sample sizes that are more often heterogeneous regarding several (risk) factors, is confounding bias. For instance, if we would fail to adjust for the effect of one or more variables that are related to both the exposure factor and the outcome of psychological distress, and they are not distributed equally between the groups (exposed and non-exposed rescue workers), a systematic error might occur. This may create the appearance of a cause-effect between disaster exposure and psychological distress that actually does not exist. In the ESADA adjustments were made regarding several important factors (e.g., age, gender, and ethnicity) that have a potential to distort the relation between exposure to the disaster and outcomes of psychological distress and physical health. A potential confounder that we were not able to adjust for is, for instance, job experience (including duty-related exposure to other events or disaster(s)).

Notwithstanding these potential biases regarding the design of the ESADA, the findings of this thesis are based on an epidemiological design. Sound epidemiological designs are rarely used and difficult to realize in disaster research. In the ESADA, the exposed groups of rescue workers could be compared to highly similar reference groups of non-exposed rescue workers from the same departments, and adjustments for several confounders were made to minimize confounding.

2.3 Measurement

Incorrect measurement of determinant, exposure or outcome may result in information bias (and misclassification) and, in turn, affect the findings. Several factors that may lead to such information bias are discussed in the following sections.

2.3.1 Exposure

Occupational exposure to the air disaster was assessed using a detailed questionnaire including items on several disaster-related tasks and events during the disaster. Involvement in at least one disaster-related task was defined as occupationally ‘exposed’ and no involvement in disaster-related
tasks was defined as occupationally ‘non-exposed’. The fact that we had to use self-reports of exposure instead of the historic registration of exposure status may have led to recall bias. It has been found, for instance, that recall of details of events appeared to be less accurate, especially among subjects with PTSD [2]. This might have affected the relationship found between degree of exposure and psychological distress (Chapter 6) and (multiple) physical health symptoms (Chapter 9). For instance, fire fighters and police officers who more often had high levels of psychological distress (e.g., PTSD) or (multiple) physical health complaints, may overestimate their involvement in tasks and their exposure to traumatic events at the disaster site.

On the other hand, reports of whether or not a certain event had actually occurred are known to be relatively accurate [3] and it is thus unlikely that misclassification of exposed and non-exposed occurred because of recall bias, i.e., one will probably remember fairly accurately whether or not one was occupationally involved in one (or more) events or tasks with a potential traumatic character. Besides, we performed a post hoc analysis of the main outcomes of psychological distress, as presented in Chapter 6, based on agreement between self report exposure status and exposure status provided by the employers of the fire fighters and police officers (i.e., definitely exposed vs. definitely non-exposed). Although the sample size decreased a little bit, particularly in the non-exposed fire fighters group, the results of the comparison between exposed and non-exposed rescue workers regarding the main outcome measures of psychological distress differed, in general, not from the results based on self-report exposure status.

Determination of what events and tasks were potentially traumatic was based on an author-constructed list of events and tasks which was presented to five eminent PTSD researchers to be scored on potentially traumatic impact, i.e., does the event or task satisfy the criterion A1 of the PTSD diagnosis in the DSM-IV [4]. Although there is no information on construct and content validity of this author-constructed exposure list, a fairly modest inter-rater reliability among the PTSD experts was found (Chapter 6). Although the duration of disaster exposure has been found to be associated with post-disaster psychological distress in rescue workers [5, 6], recall bias is more problematic when assessment of the duration of exposure is included (Chapters 6 and 9). In the ESADA, reports of exposure duration were therefore excluded from the analyses.

2.3.2 Psychological distress

Measurement of psychological distress in the current thesis was performed with validated and widely accepted self-report instruments of PTSD, post-traumatic distress, (general) psychological distress (e.g., anxiety, depression) and fatigue. A disadvantage of self-reports may be that participants overreport symptoms if they think that this could result in some sort of (financial) compensation. Structured face-to-face interviews might, to a certain extent, have prevented this potential report bias. In line with the prior potential report bias, bias might also have occurred due to the fact that the purpose of the investigation was made clear to the participants. For instance, knowing that the aim of the investigation was to measure the health effects of the air disaster might have made the exposed rescue workers more vigilant and aware of their psychological (and physical) problems. Structured interviews are the measurement instrument of first choice whenever a diagnosis is to be made regarding the presence or absence of PTSD. However, these interviews are relatively time consuming, especially in a study with an epidemiological design.

In the current thesis the posttraumatic stress response and prevalence of current PTSD was assessed with the Self-rating Inventory for PTSD (SRIP) which is a reliable and valid self-report instrument that closely follows the B, C, and D criteria of PTSD [7, 8]. The fact that the SRIP was specifically designed to assess current symptoms of PTSD without making reference to a specific trauma might be a drawback, because it is unclear whether fire fighters and police officers suffered from (symptoms of) PTSD as a consequence of their exposure to the air disaster in 1992 and/or other duty-related or personal traumas. On the other hand, if rescue workers needed to link their PTSD symptoms to one or more specific traumata, the generalizability of the data would decrease [9], and the ability to compare PTSD among exposed and non-exposed rescue workers would no longer be possible.
An additional instrument was used in order to specifically link PTSD symptoms with the disaster, i.e., the Impact of Event Scale (IES). However, as shown in Chapter 4, the IES appears to be less accurate in identifying PTSD cases than the SRIP, at least in samples of war-related trauma victims. This is not surprising since the IES was designed to assess intrusion and avoidance and was not designed to assess PTSD as conceptualized in the DSM. Although the results of Chapter 4 indicated a cut-off value of 52 for the SRIP and a cut-off value of 36 for the IES in order to diagnose PTSD with relatively high sensitivity, the specificity rates were relatively low, especially for the IES. If these cut-off values were retained in assessing cases of PTSD and (high) disaster-related posttraumatic distress in Chapter 6 and Chapter 7, several cases would probably be missed, particularly in this relatively healthy sample of rescue workers. Therefore, it was decided to use somewhat lower clinical cut-off values previously identified to have relatively good sensitivity and specificity values, i.e., 39 for the SRIP and of 25/26 for the IES [10, 11].

In addition to these clinical cut-offs, the findings of this thesis were also based on a continuous posttraumatic stress response of the fire fighters and police officers. The advantage of this approach is that it includes the posttraumatic stress response of rescue workers who suffer from a range of PTSD symptoms that might also interfere with functioning [12, 13]. The results of Chapter 5 showed that both instruments of posttraumatic stress (i.e., the SRIP and the IES) elicited specific dimensions of PTSD defined by the DSM, albeit with two additional rather non-specific dimensions Numbing and Sleep Disorder. In addition, the results indicated that the identified factors of both the SRIP and the IES are reliable, albeit only low to moderately related to each other, perhaps because of the difference in linking the symptoms to criterion A. In Chapter 5 results on discriminant validity show that the SRIP dimensions (specifically the non-PTSD specific dimensions) correlate moderately to highly with several scales of the SCL-90. The results of Chapter 5 underscore the suggestion that the response to traumatic events is broader than the three PTSD dimensions postulated in the DSM and that, in addition to PTSD, other psychological problems following trauma should also be assessed (e.g., sleep disturbance, depression).

Retrospective measurement of negative life events experienced in the pre- and post-disaster is rather complex. First, confounding might have occurred when exposed rescue workers more often experienced negative life events pre- and post-disaster than non-exposed rescue workers, and when these negative life events are related to self-reported psychological distress. However, it has been found that these types of life events (e.g., a significant change in one’s own health, and other socio-economic problems) are most likely an outcome of exposure to a trauma (like a disaster) and if adjustments had been made for post-disaster negative life events a non-differential error would occur. Therefore the analyses of psychological distress were only adjusted for pre-disaster negative life events (Chapter 6).

Second, the unvalidated nature of the list is problematic since no information on construct and content validity is available, whereas the kinds of inferences and generalizations that can be made are determined by the decisions made in constructing the life events list [14]. Although most events on the list could potentially have fallen into the criterion A category, depending on its suddenness (unexpected nature) and severity and the response of the exposed individual (i.e., criterion A2), it was decided to divide the events into three separate categories, including physical and socio-occupational functioning, events occurring to close others, and criterion A1 events, in order to draw more substantiated inferences. Unfortunately, it remained unclear what negative life events were duty related and which were not.

Third, the cross-sectional design and the retrospective assessment of negative life events and outcomes made it difficult to unravel the exact (causal) mechanism and mediators behind the positive association between post-disaster negative life events and psychological distress (i.e., PTSD symptoms, somatic complaints and fatigue). First, exposure to the disaster and its aftermath might have caused more negative life events, perhaps by leading the exposed to be less vigilant and less effective in managing situations and events. Second, the exposed may have become more negative in their reporting in general. A third explanation for the findings in Chapter 8 may be that exposed police officers were more vulnerable to negative life events even before the disaster (i.e., some pre-
disaster negative life events were also more often reported by exposed police officers), for instance because of differences in coping and personality. On the other hand, this is highly improbable since exposed and non-exposed police officers were very similar regarding other background factors and no significant interaction effect between pre-disaster negative life events and psychological distress was found.

Assessment of psychobiological parameters in PTSD and after exposure to trauma (e.g., in fire fighters and police officers) is increasing [15-17]. The assessment of salivary cortisol in the current thesis had (Chapter 10), however, some methodological shortcomings that might have influenced the validity of the findings. The most important one is the fact that only a single saliva sample was collected for every individual. Other factors that may have affected the validity of the findings is the fact that only significant findings regarding saliva sampling were only found in the less reliable noon time point (between 12.00 am and 1.00 pm), and the fact that the potential unstable sleep-wake schedule of fire fighters and police officers could not be controlled for. On the other hand, the thesis is unique in its attempt and its ability to assess the relationship between disaster and PTSD and a psychobiological parameter in an epidemiological study with large samples.

2.4 Conclusions regarding methodology

After taking into account the several methodological considerations of the ESADA, it might be concluded that the findings of the current thesis are based on a study in which the population of interest was accurately defined, confounding bias was controlled for, and the stringent criteria regarding response rates, and sample size were satisfied. In addition, valid and reliable measures of psychological distress were used, and assessment of exposure to the air disaster was optimized in order to accurately assess the degree of exposure and to decrease potential (recall) bias. To prevent report bias, it is recommended in future research to leave (whenever possible) participants uninformed about which particular event is expected to be most strongly related to the psychological distress.

3 RELEVANCE OF FINDINGS

Several parallels with the findings of the current thesis and those of previous studies on psychological distress in rescue workers (i.e., fire fighters and police officers) following (air) disasters can be acknowledged (Chapter 2).

First, psychological distress in rescue workers following exposure to a disaster is relatively well-documented (e.g. [18-22]). PTSD prevalence rates across studies of rescue workers occupationally involved in airplane crashes, however, vary considerably, predominantly concern the more short-term aftermath of disasters, and are not based on comparisons with non-exposed rescue workers [18]. The fact that outcomes of psychological distress (e.g., symptoms of depression and anxiety) other than PTSD were affected by exposure to the air disaster and co-occurred with PTSD-specific dimensions in the current thesis, is also in agreement with previous research (e.g. [18, 23]).

Second, although the effects of exposure to a disaster with an aftermath of real and/or alleged toxic exposure have very rarely been studied in rescue workers, findings of long-term elevated psychological distress are in agreement with similar studies (e.g. [24, 25]). It appears from these latter studies that if spontaneous recovery of symptoms does not occur in the first months after the disaster, psychological distress persists for many years with hardly any reduction of symptoms over time. The results of the effects study on the air disaster in Amsterdam show no spontaneous reduction of health complaints in individuals (e.g., rescue workers) exposed to that disaster [26], despite the individual medical examination and the epidemiological investigations of the ESADA.

Third, the associations between the degree and type of exposure and socio-demographic factors and psychological distress are also generally in line with the literature on air disasters and fire fighters and police officers [18, 20, 22]. For instance, increased experience of stressful negative life events in
the years following disaster exposure and associations between pre- and post-disaster negative life events and psychological distress, have previously been reported in fire fighters and police officers in the aftermath of disasters [22, 23].

Fourth, the fact that associations between salivary cortisol and PTSD and posttraumatic distress in fire fighters and police officers could be found in the current thesis, is in agreement with other (however scarce) studies of fire fighters and police officers following trauma [16, 17]. However, similar to the findings of the current thesis, the direction of the associations between salivary cortisol and PTSD differed across studies and samples.

Despite the above-mentioned concurrence between the findings of the current thesis and the literature, our work offers several distinctive and unique findings that add important new information to the disaster literature. First, findings of previous disaster research are predominantly based on non-epidemiological studies that lack large samples of accurately defined exposed and non-exposed rescue workers. More specifically, this is the first epidemiological study on psychological distress of rescue workers long-term after exposure to a disaster with an aftermath of real of alleged exposure to hazardous materials.

Second, the current thesis is unique in the sense that it aimed to assess psychological distress of rescue workers in its broadest sense, including assessments of PTSD unrelated to the disaster, specific air-disaster related posttraumatic distress, other symptoms of psychological distress, and psychobiological correlates of PTSD and posttraumatic distress. Moreover, previous studies predominantly focused on psychological distress in rescue workers following disaster, whereas in the current thesis both psychological distress and physical symptoms were assessed. Previous studies on self-reported physical health problems after alleged or real exposure and its associations with PTSD were assessed in, for instance, Gulf war veterans [27-29]. However, ours is the first epidemiological study of rescue workers that examined the mediating role of posttraumatic stress between (types of) disaster exposure and multiple physical symptoms in rescue workers. Although a mediating role of posttraumatic distress could not be confirmed, it might be speculated that certain dynamic interactions between psychological distress and physical health symptoms were present. For instance, exposure to the disaster in 1992 and its aftermath might have led to anxiety and uncertainty among rescue workers about their health (in the future). The perceived threat to oneself and others due to exposure to the disaster itself and horrifying information in the aftermath can result in symptoms of hyperarousal and intrusions of future consequences of the disaster leading to increased awareness of bodily sensations and, potentially, to the interpretation of these sensations as symptoms of disease (e.g., [30, 31]). Moreover, in the absence of a medical explanation for physical health symptoms psychological distress develops or continues. In such a state psychobiological alterations may also occur (e.g., [32]). The paradox in PTSD whereby individuals feel anxious about the future even though the trauma lies in the past, has also been given attention in the cognitive model of Ehlers and Clark [33]. More specifically, their model suggests that ongoing intrusions, avoidance and hyperarousal in response to trauma may arise when individuals process the trauma information in a way that produces a sense of current threat. Negative (cognitive) appraisal of the trauma and its sequelae is, in addition to the nature of the trauma memory itself, one of the two major mechanisms that produce this effect [34].

Third, fire fighters and police officers were analyzed separately in the current thesis, whereas previous studies primarily assessed a heterogeneous group of rescue workers including both fire fighters and police officers (Chapter 2). In the current thesis it was therefore possible to acknowledge certain differences regarding, for instance, the nature of the association between exposure and psychological distress (Chapter 6). This difference is probably due to several factors, a) both groups have been involved in different tasks and events at the disaster site, b) groups might differ in the amount of experience they had in the type of tasks they had to perform and the (disaster) events they were exposed to, and c) selection and training might differ between both groups that, subsequently, might lead to differences in communication about psychological problems at the department, and differences across both groups regarding the representation of certain personality types (e.g., hardiness).
Although a consistent elevation of long-term symptoms of psychological distress was found in the current thesis, the majority of the fire fighters and police officers did not present a clinically high level of psychological distress. With regard to PTSD, the prevalence rates of exposed fire fighters and police officers (i.e., 5% and 7%, respectively) are somewhat lower than PTSD rates found after responding to critical incidents or disaster [5, 35, 36]. Exact comparison across studies of rescue workers exposed to a specific disaster is, however, difficult because of the heterogeneity of methodology and disaster characteristics. For instance, it is important to note whether reported prevalence rates are based on baseline assessments of PTSD or following a trauma or other critical incidents, and whether or not PTSD or posttraumatic distress is specifically linked to this specific traumatic event or disaster.

4 SUGGESTIONS FOR FUTURE RESEARCH AND CLINICAL IMPLICATIONS

Having discussed the methodological strengths and weaknesses of the ESADA and this thesis and having addressed the value of the findings presented in the current thesis, several issues related to future research should be mentioned.

First, prospective epidemiological designs with multiple assessments in the years after disasters should be incorporated in future disaster research to further delineate risk and protective factors for long-term post-disaster psychological distress. In disaster research it is rather difficult to obtain pre-disaster baseline data in order to compare pre- and post-disaster psychological distress of survivors due to the sudden and unexpected nature of disasters. Up till now there are very few studies which had this opportunity and used electronic recordings of, for instance, general practitioners (e.g., [19, 37]). Nonetheless, the populations most at risk to encounter a disaster during their lives are rescue workers and thus they offer a unique opportunity to gain accurate data obtained from structural screenings of rescue workers’ mental and physical health during the course of their careers. Pre-disaster data on health might then be available whenever a disaster (or other duty-related incidents) strikes.

Second, even more important in future research might be the implementation of systematic and accurate recordings of exposure during the course of a disaster and directly afterwards. For instance, a scale that has a primary focus on criterion A (including A2) should be included. This might increase the ability to assess disaster-related PTSD and enable disaster management to focus on those rescue workers at higher risk for post-disaster adjustment problems. That peri-traumatic factors may affect the way a trauma is processed and stored into memory and subsequently leads to PTSD, has been given full attention in the recent psychological theory of Ehlers and Clark [33]. Their theory involves the assumption that conceptual processing at the time of a trauma facilitates integration of the trauma memory with the autobiographical database, whereas data-driven processing at the time of the trauma (i.e., focusing on the sensory impressions) leads to strong perceptual priming and memory disorganization. According to their theory the latter data-driven way of processing, results in intrusive memories and PTSD. Unfortunately, assessment of on scene cognitive data-driven processing versus conceptual processing is rather difficult, especially because it has to be based on retrospective self-report items that may be influenced by the extent of, for instance, reexperiencing [38]. Nonetheless, it might be important to have information on cognitive processing during trauma since several studies confirm that it is related to the development of PTSD symptoms [39, 40]. In addition to assessment of peri-traumatic cognitive factors, a scale assessing pre-traumatic exposure to a variety of traumatic events, including critical incidents other than the disaster, should be used as well. According to one of the early psychological theories of PTSD, i.e., the theory of shattered assumptions [41], people with the most positive experiences in life and therefore most positive beliefs or assumptions, are the ones most affected by traumatic events. Although this theory has been important in, for instance, the possibility of positive reframing of the trauma, empirical evidence does not support the theory on this point because previous trauma has been found a major risk factor for PTSD [42]. In the review in Chapter 2, however, it remained ambiguous whether previous disaster- and trauma exposure is a risk factor for psychological distress following disasters and other trauma in rescue workers. Furthermore, post-trauma factors such as the degree and type
of exposure to the aftermath of rumours about potential health effects due to toxic exposure was not assessed in the ESADA, while it has frequently been suggested that exposure to disasters’ long-term aftermath is even more harmful for long-term psychological distress than the exposure to the disaster itself [43-46]. Therefore, in future research, risk of toxic exposure should be examined immediately after disasters and the reactions and perceptions of health risks in rescue workers should also be assessed.

Third, the current thesis also included a biological factor that has been found to be associated with PTSD (and depression). If assessment of biological changes in PTSD, for instance neurohormonal changes (e.g., salivary cortisol) or pathophysiological changes in the brain (e.g., hippocampal volume), is included in future epidemiological research, researchers have to take into account that these assessments can be complex and require accurate methodology in order to yield valid results. For instance, salivary cortisol should ideally be measured in the early morning and at several other time points during the day, and records of night shifts should be included. In epidemiological designs with large sample sizes such assessments are costly; therefore, randomly selected subsamples of exposed and non-exposed rescue workers could be assessed for psychobiological changes.

Fourth, in the current thesis social and cognitive factors, such as coping strategies and social support, were not included. In a recent meta-analysis of several risk-factors for PTSD (including trauma severity and gender), however, social support had the strongest effect size [42]. For instance, in a study of Fullerton et al., [47] stress after rescue work in fire fighters was found to be mediated by availability of social support among other factors such as type of leadership. Cognitive coping strategies such as cognitive reconstructing (i.e., translating what is an unpleasant task into valuable and meaningful one) are also known to be helpful [37], whereas coping strategies such as rumination and avoidance and thought suppression are known to increase the risk of PTSD and are related to slower recovery from PTSD [38, 48].

Finally, information on the type and number of treatments that rescue workers received for their disaster-related health problems should be included in future research. In the ESADA, exposed rescue workers were offered an individual medical examination and, subsequently, could be advised to get treatment for their PTSD symptoms or physically unexplained symptoms. Exact data on the number and type of treatments for disaster-related health problems were, however, lacking in the current thesis.

Because the results of the current thesis show that exposure to a disaster can result in long-lasting symptoms of psychological distress (i.e., 3% had a high level of disaster-related posttraumatic distress), some clinical implications need to be provided. First, organizations of fire fighters and police officers should be aware of the long-term negative consequences of disaster exposure on psychological wellbeing. Certainly, debriefing after disasters and other critical incidents has already been implemented in these organizations, e.g., following the air disaster Amsterdam. Studies of the effects of debriefing, however, did not show short-term and long-term preventive effects on posttraumatic distress [49, 50]. The fact that debriefing is, primarily, provided once-only within 78 hours after the traumatic incident or disaster, might play a role in this. Adequate aftercare for psychological distress should therefore be provided even long-time after a disaster. Second, organizations should also be aware of the risk factors for development of psychological distress in the aftermath of disasters [35, 51]. For instance, the fact that post-disaster negative life events in the occupational realm interacted with exposure to the disaster in its relation to posttraumatic stress, fatigue and somatic complaints indicates that more chronic job stressors, that imply dissatisfaction with organizational aspects of the rescue work rather than dissatisfaction with the job itself, may result in fatigue and burnout. This suggestion is supported by the fact that in previous research in ambulance workers and forensic doctors, acute stressors such as critical incidents and traumatic events were found to be interrelated with chronic job stressors, that in turn were directly related to burnout, fatigue and posttraumatic stress reactions [52, 53]. Specific chronic job stressors that may play an important role in the mental and physical health of fire fighters and police officers (such as burnout) are lack of group cohesion, sleep disturbance due to shift work, and discrimination [54, 55]. Although unfortunately chronic job stressors and burnout were not accurately assessed in the current study, it is rec-
ommended for organizations of fire fighters and police officers to have their employees engaged in decision making, to facilitate good group relationships and to provide the ability to talk to colleagues after a traumatic incident like a disaster, in order to give the employees some sense of control and to prevent PTSD and other health problems [37].

5 Conclusions

The current thesis shows that the effects of a disaster on psychological distress of rescue workers can be long lasting. Compared to non-exposed reference groups, exposed fire fighters reported more somatic complaints and fatigue, and exposed police officers reported more symptoms of PTSD and other outcomes of psychological distress, reported to have experienced more negative life events (particularly in the 8.5 years post disaster) and more often had difficulty coming to terms with them. Nearly 3% of the exposed rescue workers still suffers from disaster-related intrusions and avoidance symptoms on average 8.5 years after the disaster. Symptoms of PTSD could not entirely account for the excess (multiple) physical health symptoms of exposed fire fighters and police officers. Disaster-related posttraumatic distress and other symptoms of psychological distress were, to some extent, associated with the type and degree of exposure at the disaster site, while other background characteristics also played a role in the psychological distress.

On the other hand, the results also show that the vast majority of fire fighters and police officers does not suffer from clinically high levels of psychological distress. It can thus also be concluded that psychological wellbeing of professional fire fighters and police officers is not substantially affected by frequent exposure to (duty-related) trauma including an air disaster with a long-term adverse aftermath compared to other groups of survivors of disaster. Hence, most fire fighters and police officers and other care providing professions such as ambulance workers, are capable of recovering from the consequences of trauma or critical incidents by themselves or with support from closely related others [56]. For instance, fire fighters and police officers may attribute a positive meaning to their work by thinking of the positive aspects of the work and the trauma. As such, trauma does not only give rise to psychological morbidity but may also lead to personal growth [52, 57]. In this respect, the healthy worker effect needs to be mentioned as well; this refers to the effects of accurate pre-selection, regular assessments of psychological and physical health, and training on health of fire fighters and police officers.

Taken together, this thesis shows that although fire fighters and police officers are in relatively good mental health, it is not unusual for rescue workers to experience a certain degree of long-term psychological distress following an event like an air disaster with a stressful aftermath.
REFERENCES


The long-term aftermath of the Amsterdam air disaster: psychological wellbeing of professionally involved rescue workers
1 BACKGROUND

On Sunday evening of the fourth of October 1992, an El Al Boeing 747 cargo aircraft crashed into apartment blocks of the suburb “the Bijlmermeer” in Amsterdam. The air disaster in Amsterdam killed 39 inhabitants of the Bijlmermeer and all four crewmembers of the aircraft. In addition, 266 apartments were destroyed and many persons lost their homes. After the crash rescue workers were immediately called into action. Fire fighters tried to extinguish the fire, searched for and rescued people and cleaned up the area and police officers secured the surroundings of the disaster, brought survivors into safety and provided first aid. In the years after the air disaster a chaotic and complex aftermath arose.

In the first couple of years most attention was paid to the psychological aftercare. Some individuals involved in the disaster appeared to suffer from psychological distress such as posttraumatic stress disorder (PTSD) due to the air disaster. PTSD is an anxiety disorder that may develop after having experienced an event that involved an actual or threatened death or serious injury, or a threat to the physical integrity of self or others. Individuals generally respond to this event with intense fear, helplessness or horror. Symptoms of PTSD are generally subdivided into three main clusters: 1) persistent reexperiencing of the trauma, 2) avoidance of stimuli associated with the traumatic event and numbing of general responsiveness, and 3) persistent symptoms of hyperarousal such as problems concentrating and exaggerated startle responses. These symptoms persist more than a month and cause clinically significant distress or impairment in social, occupational or other important areas of functioning. PTSD may co-occur with other disorders such as depression, additional anxiety disorders, and socio-occupational problems. PTSD may also alter stress systems in the body and may cause persistent stress reactions. For instance, an alteration of the level of the stress hormone cortisol is noticed during stressful situations, and in PTSD the release of cortisol may be chronically disturbed.

In addition to psychological distress, the aftermath of the Amsterdam air disaster was characterized by a gradual increase in rumors and suspicions about potential effects on the health of those exposed to the disaster. Residents of the Bijlmermeer and involved rescue workers were worried about their health, and some linked their physical symptoms to their involvement and exposure at the site of the air disaster. Until now there is, however, very little scientific data on the long-term physical health effects of disasters on professionally exposed rescue workers.

Disasters (like the air disaster in Amsterdam) are sudden unusual events with a potential risk for those involved to develop mental and physical health problems. Research on the effects of disasters has primarily focused on the immediate survivors of disaster. Over the past two decades there is, however, increasing focus on the psychological wellbeing of rescue workers who have a high risk of exposure to critical incidents, and as a consequence, a potential risk of developing psychological distress. On the other hand, rescue workers are known to be relatively resilient due to, for instance, pre-employment screening and self-selection and in general do not suffer from major psychological distress. Disasters, however, are unique in the lifetime careers of most fire fighters and police officers, and might have adverse effects on psychological wellbeing and physical health.

Between 2000 and 2002, i.e. on average 8.5 years after air disaster, the Institute for Research in Extramural Medicine (EMGO Institute) carried out an epidemiological study to assess the health status of rescue and assistance workers involved in the air disaster: the Epidemiological Study Air Disaster Amsterdam (ESADA). This study forms the basis of the current thesis. In this epidemiological study a complete cohort of fire fighters and police officers who were involved in the air disaster, and their colleagues from the same departments who were not exposed to the disaster (i.e., the reference groups), were identified based on company records of employment during the disaster. More specifically, all professional fire fighters who were employed in the Amsterdam fire department at the time of the air disaster and police officers who were employed in the Amsterdam–Amstelland regional police force at the time of the disaster and who were still in employed in 2000, were invited to participate. Because almost the entire fire department had been exposed to the disaster, fire fighters who started working in the fire department after the disaster had taken place, had to be
included in the reference group. Almost the entire study population could be traced and invited to participate (i.e., 97%) and eventually 71% of the fire fighters and police officers participated in this study. Hangar workers who were involved in cleaning up the wreckage of the aircraft were also included in the epidemiological study but were not included in the work presented in this thesis. This epidemiological study was also designed to assess the psychological and physical health status of residents of the Bijlmermeer; unfortunately, however, this part of the investigation had to be canceled due to low response rates.

In order to assess the relationship between occupational exposure to the disaster and psychological distress, fire fighters and police officers were subdivided into ‘exposed’ and ‘non-exposed’ based on a detailed questionnaire regarding their occupational exposure to the disaster. Eventually, the data of 334 exposed fire fighters and 194 non-exposed fire fighters, and 834 exposed police officers and 634 non-exposed police officers, were analyzed. More specifically, differences in psychological distress between exposed and non-exposed fire fighters and police officers were assessed separately. Associations between psychological distress and several correlates and (risk) factors, such as type and degree of exposure at the air disaster site and background factors, among exposed fire fighters and police officers were also assessed. Assessment of outcomes of psychological distress and its correlates and (risk) factors was based on data collected with, mainly, validated and widely used self-report questionnaires and laboratory analyses of saliva samples.

2 RESEARCH QUESTIONS AND RESULTS

Do occupationally exposed rescue workers (i.e., fire fighters and police officers) differ from non-exposed colleagues regarding psychological distress, i.e., (symptoms of) PTSD and other (general) psychological distress (e.g., anxiety, somatic complaints and fatigue) 8.5 years after the air disaster? Which background-related and exposure-related (risk) factors are associated with the potential long-term psychological distress among exposed rescue workers?

In chapter 6 differences regarding specific and more general psychological distress 8.5 years after the air disaster between exposed and non-exposed fire fighters and police officers are reported and discussed. The findings show that exposed fire fighters reported more somatic complaints and fatigue than occupationally non-exposed fire fighters. Compared to non-exposed police officers, exposed police officers reported more symptoms on all outcome measures (i.e., PTSD symptoms of intrusion, avoidance, and hyperarousal, and anxiety, depression, somatic complaints, sleep disturbances, fatigue and general psychological distress). In addition, prevalence rates of a moderate to high level of anxiety, somatic complaints, sleep disturbances, and fatigue in exposed police officers were significantly higher than the respective prevalence rates in non-exposed police officers. A moderate to high level of disaster-related posttraumatic distress (i.e., intrusions and avoidance) was found in 3% and 2% of the exposed fire fighters and police officers, respectively.

With regard to the second part of the first research question, the results of chapter 6 indicated that disaster exposure was significantly associated with psychological distress. Exposed fire fighters who had performed more tasks at the disaster site reported more psychological distress (i.e., PTSD symptoms in general, and hyperarousal specifically, disaster-related posttraumatic distress, general psychological distress, depression, anxiety and somatic complaints), whereas exposed police officers who performed more tasks in general and police officers who were exposed to tasks and events with a potential traumatic character reported more disaster-related posttraumatic distress (i.e., intrusions and avoidance). As expected, several socio-demographic factors were associated with psychological distress (e.g., ethnicity, age).
Do occupationally exposed rescue workers differ from non-exposed rescue workers regarding self-reported health and laboratory outcomes 8.5 years after the air disaster?

In chapter 7 the following outcomes were examined: (a) physical complaints, (b) mental health problems, (c) laboratory analysis (haematological and biochemical values and urinalysis outcomes). Findings with respect to the second research question reveal that, compared to non-exposed colleagues, exposed fire fighters and police officers reported more physical health complaints and general mental health problems 8.5 years after occupational exposure to the air disaster. Laboratory analyses showed no statistically significant or clinically relevant differences between the exposed fire fighters and police officers and their non-exposed colleagues.

Do occupationally exposed police officers differ from non-exposed colleagues regarding self-reported negative life events experienced in the pre- and, particularly, the post-disaster period? Is the number and nature of pre- and/or post-disaster negative life events associated with psychological distress, and is this association significantly stronger for exposed than for non-exposed police officers?

In chapter 8 the prevalence of post-disaster negative life events in exposed police officers compared with non-exposed police officers was examined. Exposed police officers more frequently reported to have experienced negative life events in the pre- and, particularly, the post-disaster period, and more often had not dealt with these events, particularly with events affecting their own health or socio-occupational functioning. The findings of chapter 8 also revealed positive associations between the number and type of negative life events and psychological distress among police officers. This particularly concerned the associations of events affecting the police officers’ own health or socio-occupational functioning experienced in the 8.5 years after the air disaster, with PTSD, somatic complaints and fatigue. These associations were significantly stronger among exposed police officers than non-exposed police officers.

Are potential differences between occupationally exposed rescue workers in self-reported physical health linked to the nature and extent of the psychological distress of exposed rescue workers?

The results of chapter 9 show that exposed fire fighters and police officers significantly more often reported multiple physical symptoms compared to non-exposed colleagues. Multiple physical symptoms were related to the degree and type of exposure (i.e., traumatic events and tasks). A high level of posttraumatic stress symptoms did not substantially account for the multiple physical symptoms seen in exposed fire fighters and police officers.

Do occupationally exposed rescue workers (i.e., fire fighters and police officers) differ from non-exposed colleagues regarding the level of the stress hormone cortisol? Is the level of the stress hormone cortisol associated with (symptoms of) PTSD among exposed rescue workers?

In chapter 10 the salivary cortisol levels (as a psychobiological correlate of PTSD) were compared between exposed fire fighters and police officers and non-exposed colleagues. The results revealed that only the mean basal salivary cortisol level measured around the noon time point was significantly higher in exposed fire fighters compared to non-exposed fire fighters. The results of chapter 10 also indicated that salivary cortisol levels measured at the noon time point were associated with PTSD in general and specific disaster-related posttraumatic distress. However, the directions of the associations differed between exposed fire fighters and police officers. Higher levels of salivary cortisol in exposed fire fighters were associated with a clinically high PTSD score, whereas lower levels of salivary cortisol were associated with a high level of disaster-related posttraumatic distress in exposed police officers.
3 Relevance of Findings

In chapter 11 the main findings of this thesis are summarized and discussed with respect to methodological considerations based on chapter 3, chapter 4 and chapter 5. The relevance of the current findings is further discussed by drawing parallels with the literature in chapter 2. Suggestions for future research and clinical implications are also provided in chapter 11.

In chapter 3 several advantages of the design of the ESADA are mentioned. First, with regard to the study population, a complete cohort of exposed and non-exposed rescue workers could be accurately identified based on company records of employment at the time of the disaster. Second, reference groups of fire fighters and police officers who were not occupationally exposed to the disaster were included in order to assess associations between disaster exposure and self-reported psychological distress, physical symptoms and health status. Third, the samples included in the current study yielded good response rates and adjustments for several confounders were made to minimize confounding.

Several potential biases of the ESADA design are also mentioned in chapter 3 and further discussed in chapter 11. For instance, selection bias might have occurred because fire fighters who started working in the fire department after the disaster had taken place, had to be included in the reference group, and among the cohort of police officers only those still working at the police department at the start of the ESADA in 2000 could be invited to participate. Furthermore, the ESADA has a cross-sectional design with some features of a historical cohort study. The cross-sectional assessment of exposure and outcomes of psychological distress made it difficult to determine the direction of associations between exposure and other correlates or (risk) factors and psychological distress. In addition, with regard to self-reports of disaster exposure 8.5 years after the disaster, potential recall bias and misclassification of exposed and non-exposed groups were discussed. It was concluded, however, that one will probably accurately remember whenever one was exposed to one or more disaster-related tasks or events. Besides, the results of a posthoc analysis of the main outcomes of psychological distress based on agreement between self-report exposure status and exposure status provided by the employers of the fire fighters and police officers (i.e., definitely exposed vs. definitely non-exposed) did, in general, not differ from the results based on self-report exposure status.

Assessment of psychological distress was primarily based on reliable and valid measurement instruments of PTSD and other scales of (general) psychological distress. With regard to the assessment of PTSD and posttraumatic distress, the psychometric properties of two self-report instruments were analyzed in more detail in chapter 4 and chapter 5. In chapter 4 the optimal cut-off point of the Impact of Event Scale (IES) is assessed and its screening properties are compared with the screening properties of the Self-Rating Inventory for Posttraumatic Stress Disorder (SRIP) in a sample of war-related trauma victims. A validated structured interview was used as criterion standard for PTSD. Results indicated that the IES is less accurate in identifying PTSD cases than the SRIP. We concluded that careful use of the IES as a screening measure for PTSD is warranted. The findings of this thesis were also based on a more continuous measure of the posttraumatic stress response of exposed fire fighters and police officers. In chapter 5 the dimensionality of this stress response was assessed by means of confirmatory factor analyses on the SRIP and the IES. The results indicated that the previously reported distinction between (active) avoidance and numbing in samples highly affected by PTSD appears to be applicable to the stress response of less affected samples of fire fighters and police officers. More specifically, for the SRIP and the IES, a separate dimension ‘sleep disturbances’ appears to be underlying the posttraumatic stress response in addition to the core PTSD dimensions (intrusions, avoidance and arousal). However, due to the psychometric properties of the two instruments, the relationship between similar dimensions in both instruments was only low to moderate. Dimensions elicited with the SRIP were less discriminative from other symptoms of psychopathology than those of the IES. The results of chapter 5 underscore the suggestion that the response to traumatic events is broader than the three core PTSD dimensions and that, in addition to PTSD, other psychological problems following trauma should be assessed as well.
Chapter 2 presents a review of 37 studies on psychological distress among rescue workers following exposure to a disaster. The review indicates that prevalence rates of PTSD and other psychological distress ranged from 5% to 20%, with a few rare peaks of 40%. Risk factors such as degree of exposure, single life status, comorbid psychiatric disorders and pre- and post-disaster negative life events were consistently related to higher levels of post-disaster psychiatric morbidity. After careful examination of the several studies, it was concluded that methodological issues and disaster characteristics predominantly clarify the differences across studies regarding post-disaster morbidity and risk factors in rescue workers. In chapter 11, the findings of the current thesis are related to what is generally known about psychological distress in rescue workers (i.e., fire fighters and police officers) following (air-) disasters based on the findings of chapter 2. It is concluded that the findings of this thesis are, to a certain extent, in agreement with the literature. However, several distinctive and unique findings of the current thesis that add important new information to the disaster literature were also mentioned. First, the current findings are based on large samples of accurately defined exposed and non-exposed rescue workers, while sound epidemiological designs are scarce in disaster research, particularly in rescue workers. Second, there are no previous findings of psychological distress of rescue workers following exposure to a disaster that happened 8.5 years earlier. Third, psychological distress was assessed in its broadest sense, including assessments of PTSD unrelated to the disaster, specific air-disaster related posttraumatic distress, other symptoms of psychological distress and psychobiological correlates of PTSD and posttraumatic distress. In addition, we were able to examine the potential mediating role of PTSD symptoms between (types of) disaster exposure and multiple physical symptoms in rescue workers.

4 Conclusions

The current thesis shows that the effects of a disaster on psychological distress can be long lasting in fire fighters and police officers occupationally involved in a variety of events and tasks at the disaster site. Compared to non-exposed reference groups, exposed fire fighters reported significantly more somatic complaints and fatigue, and exposed police officers reported more symptoms of PTSD and other outcomes of psychological distress, more negative life events (particularly in the 8.5 years post disaster) and more often had difficulty coming to terms with these events. Among exposed rescue workers outcomes of psychological distress were associated with several correlates and (risk) factors, and with regard to the excess of physical health complaints among exposed fire fighters and police officers, symptoms of PTSD could not entirely account for this. The results also show that the vast majority of fire fighters and police officers does not suffer from clinically high levels of psychological distress. On the other hand, nearly 3% of the exposed rescue workers report a moderate to high level of disaster-related intrusions and avoidance symptoms even 8.5 years after the air disaster.

In chapter 11 we recommended that future studies of rescue workers’ mental health following disasters should ideally include: a) prospective epidemiological designs with multiple assessments in the years after the disasters, and accurate documentation of information obtained from structural screenings of rescue workers’ mental and physical health, b) systematic and accurate recordings of exposure during the course of a disaster and directly afterwards, including assessments of emotional reactions, cognitive processing and perceptions of health risks in rescue workers, c) accurate assessments of psychobiological correlates of PTSD (e.g., salivary cortisol), d) assessment of other (risk) factors for post-disaster psychological distress, including job experience and social factors, and e) information on the type and number of treatments that rescue workers received for their disaster-related health problems. We recommended organizations of fire fighters and police officers to be aware of potential long-term adverse effects of disaster exposure on psychological wellbeing and its risk factors, and recommended to provide access to adequate aftercare even many years after occupational involvement in such a unique event like an air disaster. Furthermore, it is important for organizations to be aware of additional chronic job stressors and negative life events because they appear to interact with acute job stressors (such as involvement in a disaster) in relation to posttraumatic stress symptoms and other health complaints such as fatigue. Taken together, this thesis
show that apart from the relatively good psychological wellbeing of fire fighters and police officers, it is not unusual for rescue workers to experience a certain degree of long-term psychological distress following an event like an air disaster with a stressful aftermath.
SAMENVATTING

De lange termijn nasleep van de Vliegramp Bijlmermeer: psychisch welbevinden van beroepsmatig betrokken hulpverleners
SAMENVATTING

1 ACHTERGROND


In de eerste jaren na de ramp ging de meeste aandacht uit naar psychologische nazorg omdat sommige betrokkenen last hadden van psychische klachten zoals posttraumatische stress stoornis (PTSS). PTSS is een angststoornis die zich kan ontwikkelen nadat iemand een gebeurtenis heeft meegemaakt waarbij sprake is geweest van een feitelijke of dreigende dood of ernstige verwonding of een bedreiging van de fysieke integriteit van zichzelf of anderen. Men reageert in het algemeen met intense angst, hulpeloosheid en afgrijzen op een dergelijke gebeurtenis. Symptomen van PTSS worden veelal onderverdeeld in drie clusters: 1) voortdurende herbelevingen van de traumatische gebeurtenis, 2) actieve en passieve vermijding van prikkels die geassocieerd zijn met de gebeurtenis en afstomping van de algemene reactiviteit en 3) aanhoudende symptomen van prikkelbaarheid die zich manifesteren in o.a. concentratieproblemen en overdreven schrikreacties. Voordat gesproken kan worden van PTSS moeten deze klachten gedurende tenminste een maand bestaan en aanzienlijk lijden of beperkingen veroorzaken in sociale, beroepsmatige en andere belangrijke levensgebieden. Naast PTSS kan men ook aan andere stoornissen, zoals depressie of andere angststoornissen, lijden. PTSS kan ook tot veranderingen in stresssystemen in het lichaam leiden waardoor stressreacties lang aan kunnen bleven. Tijdens stressvolle situaties vindt er bijvoorbeeld een verandering in het niveau van het stresshormoon cortisol plaats en er zijn aanwijzingen dat de cortisol uitscheiding vaak chronisch verstoord is bij mensen met PTSS.

Naast bovenbeschreven psychische klachten, ontstond er in de jaren na de Vliegramp Bijlmermeer een toenemende stroom van geruchten en verdachtmakingen over mogelijke gezondheidseffecten van de ramp op de betrokken. Zo waren o.a. bewoners van de Bijlmermeer en betrokken hulpverleners bezorgd over hun gezondheid en sommigen van hen schreven hun lichamelijke klachten toe aan blootstelling aan de rampplek. Er is echter nog weinig bekend over de lichamelijke gezondheidsgevolgen van rampen voor beroepsmatig betrokken hulpverleners.

Rampen zoals de vliegramp Bijlmermeer zijn gebeurtenissen die onverwacht en zeer zelden voorkomen, maar als ze voorkomen dan vormen ze een risico voor betrokkenen om psychische en lichamelijke gezondheidsklachten te ontwikkelen. Onderzoek naar de gezondheidseffecten van rampen richtte zich lange tijd vooral op directe slachtoffers en overlevenden. De afgelopen paar decennia is er een toenemende aandacht voor het psychisch welzijn van reddingswerkers en hulpverleners. Reddingswerkers en hulpverleners hebben een hoog risico om ernstige en traumatische gebeurtenissen mee te maken en hebben daarmee ook een potentieel risico hebben om psychische klachten zoals PTSS te ontwikkelen. Daar staat tegenover dat reddingswerkers en hulpverleners bekend staan om hun aanzienlijke veerkracht. Onder andere door uitgebreide screening voor zij in dienst treden, zelfselectie en frequent geplaatste gezondheids Tests, is het een groep die in zijn algemeenheid niet aan uitgebreide psychische klachten of stoornissen lijdt ondanks de frequentie confrontatie met ernstige gebeurtenissen. Rampen zoals de vliegramp Bijlmermeer zijn echter bijzondere gebeurtenissen in de meestal lange carrières van brandweerman en politiemedewerkers en blootstelling hieraan kan leiden tot negatieve gevolgen voor psychisch welzijn en lichamelijke gezondheid.

Tussen 2000 en 2002, gemiddeld 8,5 jaar na de ramp, is een epidemiologisch onderzoek uitgevoerd door het Instituut voor Extramuraal Geneeskundig Onderzoek (EMGO) om de gezondheid van reddingswerkers en hulpverleners betrokken bij de vliegramp Bijlmermeer te onderzoeken: het Medisch Onderzoek Vliegramp Bijlmermeer–Epidemiologie (MOVB-E). Dit onderzoek vormt de basis voor het huidige proefschrift. In dit epidemiologisch onderzoek is een compleet cohort van brandweer-
medewerkers en politiemedewerkers die betrokken waren bij de vliegramp Bijlmermeer en collega’s van dezelfde brandweer- en politiekorpsen die niet betrokken waren bij de ramp (de referentiegroepen) geïdentificeerd op basis van bedrijfsverslagen van gedraaide diensten. Alle professionele brandweermedewerkers die in dienst waren van het Amsterdamse brandweerkorps gedurende de ramp en politiemedewerkers die in dienst waren van het regionale politiekorps Amsterdam-Amsteland gedurende de ramp en die nog steeds in dienst waren in 2000, zijn uitgenodigd deel te nemen aan het onderzoek. Omdat bijna het gehele brandweerkorps betrokken was bij de ramp, is het noodzakelijk gebleken om in de referentiegroep ook brandweermedewerkers mee te nemen die pas nadat de ramp had plaatsgevonden in dienst zijn getreden van het brandweerkorps. Bijna de gehele geïdentificeerde onderzoeksgruppe (97%) kon worden gelokaliseerd en uitgenodigd om deel te nemen aan het onderzoek en uiteindelijk nam 71% van de brandweermedewerkers en politiemedewerkers deel aan het onderzoek. Medewerkers die in contact waren geweest met wrakstukken van het vliegtuig in hangar 8 op Schiphol, werden ook betrokken in het epidemiologische onderzoek maar zijn niet meegenomen in de verschillende hoofdstukken van dit proefschrift. Deze epidemiologische studie is aanvankelijk ook opgezet om de gezondheid van de getroffen bewoners te onderzoeken. Helaas moest dit gedeelte van het onderzoek worden gestaakt omdat er een te lage deelname was.

In het kader van dit proefschrift is de relatie tussen beroepsmatige blootstelling en betrokkenheid bij de ramp en psychische klachten bij de ramp onderzocht. Hiertoever, is van een getailleerde vragenlijst over beroepsmatige betrokkenheid en blootstelling, brandweermedewerkers en politiemedewerkers onderscheid in ‘betrokken’ en ‘niet-betrokken’. Uitgebreid zijn de data van 334 betrokken brandweermedewerkers en 194 niet-betrokken brandweermedewerkers en 834 betrokken politiemedewerkers en 634 niet-betrokken politiemedewerkers vergeleken. De verschillen in psychische klachten tussen betrokken en niet-betrokken brandweermedewerkers en politiemedewerkers zijn apart geanalyseerd. De eventuele samenhang tussen psychische klachten en diverse mogelijk correlerende (risico)factoren, zoals het type en de mate van blootstelling aan en betrokkenheid bij de ramp en achtergrond factoren, is ook onderzocht. Gegevensverzameling in dit proefschrift betreffende betrokkenheid, psychische klachten en potentieel correlerende en/of (risico)factoren, zijn verzameld met in beginsel gevalideerde en veelvuldig gebruikte zelfrapportage vragenlijsten en met betrekking tot cortisolwaarden in speeksel door laboratoriumonderzoek.

**2 Ondersoeksvragen en resultaten**

In het kader van dit proefschrift zijn de volgende vragen bestudeerd:

Verschillen beroepsmatig betrokken brandweermedewerkers en politiemedewerkers van niet-betrokken collega’s ten aanzien van psychisch (on)welbevinden 8.5 jaar na de ramp? Welke achtergrond- en blootstellingsgerelateerde (risico)factoren hangen samen met potentieel psychisch (on)welbevinden op de lange termijn bij betrokken hulpverleners?

In hoofdstuk 6 worden de verschillen tussen betrokken en niet-betrokken brandweermedewerkers en politiemedewerkers wat betreft specifieke en meer algemene psychische klachten 8.5 jaar na de vliegramp besproken. Betrokken brandweermedewerkers hebben significant meer lichamelijke klachten en vermoeidheid gerapporteerd dan niet-betrokken collega’s, terwijl betrokken politiemedewerkers op alle gemeten aspecten (PTSS-klachten als herbeleving, vermijding, en prikelbaarheid, en angst, depressie, lichamelijke klachten, slaapproblemen, vermoeidheid en algemene vermindering van psychisch welbevinden) meer psychische klachten hebben gerapporteerd. Daarnaast is gebleken dat de prevalentie van een bovengemiddeld tot hoog niveau van angst, lichamelijke klachten, slaapproblemen en vermoeidheid bij betrokken politiemedewerkers significant hoger is dan bij niet-betrokken politiemedewerkers. Respectievelijk 3% en 2% van de betrokken brandweermedewerkers en politiemedewerkers heeft een gemiddeld tot hoog niveau van rampgerelateerde posttraumatische stress (herbelevingen en vermijding) gerapporteerd.
Ten aanzien van het tweede deel van de eerste onderzoeksvraag blijkt uit de resultaten dat de mate van en soort betrokkenheid op de rampplek geassocieerd is met verschillende psychische klachten. Zo blijken betrokken brandweermedewerkers die aangaven meer taken te hebben verricht op de rampplek meer psychische klachten gerapporteerd te hebben op verschillende uitkomstmatten, terwijl betrokken politiedienstmedewerkers die meer taken uitgevoerd hebben op de rampplek en politiedienstmedewerkers die meer betrokken zijn geweest bij taken en gebeurtenissen op de rampplek met een mogelijk traumatisch karakter, alleen meer specifieke rampgerelateerde posttraumatische stressklachten (herbelevingen en vermijding) hebben gerapporteerd. Zoals verwacht, blijken diverse socio-demografische achtergrondfactoren (bijvoorbeeld vrijgezelle levensstatus en hogere leeftijd) significant samen te hangen met een hoger aantal psychische klachten op verschillende uitkomstmatten.

Verschillen beroepsmatig betrokken brandweermedewerkers en politiedienstmedewerkers van niet-betrokken collega’s ten aanzien van zelfgerapporteerde gezondheid en laboratorium uitslagen 8,5 jaar na de vliegramp?

In hoofdstuk 7 zijn de gevonden verschillen tussen betrokken brandweermedewerkers en politiedienstmedewerkers ten aanzien van: a) zelfgerapporteerde lichamelijke gezondheid, b) zelfgerapporteerde psychische gezondheid o.a. PTSS, en c) laboratorium analyses (o.a. hematologische en chemische bloedwaarden en urine uitslagen) beschreven. De resultaten tonen aan dat 8,5 jaar na de vliegramp beroepsmatig betrokken brandweermedewerkers en politiedienstmedewerkers meer lichamelijke en psychische gezondheidsklachten hebben gerapporteerd dan niet bij de ramp betrokken collega’s. Resultaten van de laboratorium analyses tonen echter aan dat er geen statistisch significante of klinisch relevante verschillen zijn tussen betrokken brandweermedewerkers en politiedienstmedewerkers en hun niet-betrokken collega’s 8,5 jaar na de ramp.

Verschillen beroepsmatig betrokken politiedienstmedewerkers van niet-betrokken collega’s ten aanzien van zelfgerapporteerde negatieve levensgebeurtenissen die zij hebben meegemaakt voor de ramp en gebeurtenissen die zij hebben meegemaakt na de ramp? Hangen het aantal en het type voor- en/of na de ramp meegemaakte negatieve levensgebeurtenissen samen met psychisch (on)welbevinden, en is deze samenhang sterker onder betrokken politiedienstmedewerkers dan onder niet-betrokken politiedienstmedewerkers?

In hoofdstuk 8 is de prevalentie van negatieve levensgebeurtenissen onder betrokken en niet-betrokken politiedienstmedewerkers bestudeerd. Vergeleken met niet-betrokken politiedienstmedewerkers, hebben bij de ramp betrokken politiedienstmedewerkers gerapporteerd dat zij vaker en meer negatieve levensgebeurtenissen hebben meegemaakt niet alleen vóór de ramp, maar ook en in sterkere mate na de ramp. Betrokken politiedienstmedewerkers geven ook vaker aan deze gebeurtenissen, zoals een significante verandering van de eigen gezondheid en/of sociaal-maatschappelijke gebeurtenissen zoals problemen op het werk, niet geheel verwerkt te hebben. De resultaten uit hoofdstuk 8 impliceren ook dat er een positieve samenhang is tussen het aantal en het soort negatieve levensgebeurtenissen en psychische klachten onder politiedienstmedewerkers. Dit betreft eveneens voornamelijk de samenhang tussen gebeurtenissen zoals een verandering van de eigen gezondheid en/of sociaal-maatschappelijke gebeurtenissen in de privé-sfeer of op het werk meegemaakt in de 8,5 jaar na de ramp, en psychische klachten zoals PTSS-klachten, lichamelijke klachten en vermoeidheid. Deze samenhang is significant sterker gebleken onder betrokken politiedienstmedewerkers dan onder niet-betrokken politiedienstmedewerkers.
Zijn eventuele verschillen tussen beroepsmatig betrokken en niet-betrokken brandweermedewerkers en politiemedewerkers ten aanzien van de zelfgerapporteerde fysieke gezondheid 8,5 jaar na de ramp gerelateerd aan het soort en de mate van psychisch (on)welbevinden onder betrokken hulpverleners?

In hoofdstuk 9 zijn de resultaten ten aanzien van verschillen tussen betrokken en niet-betrokken hulpverleners in zelfgerapporteerde lichamelijke klachten besproken. Vergeleken met niet-betrokken collega’s, hebben betrokken brandweermedewerkers en politiemedewerkers significant vaker meerdere lichamelijke klachten gerapporteerd. Deze meerdere lichamelijke klachten zijn op hun beurt gerelateerd aan de mate en het soort betrokkenheid (zoals potentieel traumatische gebeurtenissen en taken op de rampplek). Een hoog niveau van posttraumatische stress klachten blijkt de meerdere lichamelijke klachten onder betrokken brandweermedewerkers en politiemedewerkers niet significant te kunnen verklaren.

Verschillen beroepsmatig betrokken brandweermedewerkers en politiemedewerkers van niet-betrokken collega’s ten aanzien van de concentratie van het stresshormoon cortisol? Hangt de concentratie van het stresshormoon cortisol samen met PTSS en PTSS-klachten onder betrokken brandweermedewerkers en politiemedewerkers?

In hoofdstuk 10 is de cortisol concentratie in speeksel als psychobiologische correlaat van PTSS vergeleken tussen bij de ramp betrokken brandweermedewerkers en politiemedewerkers en niet-betrokken collega’s. Uit de analyses blijkt dat alleen de gemiddelde basale cortisol concentratie op het meetpunt tussen de middag significant hoger was onder betrokken brandweermedewerkers vergeleken met niet-betrokken brandweermedewerkers. Uit de resultaten van hoofdstuk 10 blijkt dat de cortisol concentratie in speeksel gemeten rond het middaguur samenhangt met PTSS-klachten. Echter, de richting en het type samenhang verschilt tussen betrokken brandweermedewerkers en politiemedewerkers. Zo hangt een gemiddeld hogere cortisol concentratie samen met het hebben van PTSS onder betrokken brandweermedewerkers vergeleken met niet-betrokken collega’s, terwijl een gemiddeld lagere cortisol concentratie significant samenhangt met een hoog niveau van specifieke rampgerelateerde posttraumatische stress onder betrokken politiemedewerkers.

3 RELEVANTIE VAN DE RESULTATEN

In hoofdstuk 11 zijn de belangrijkste bevindingen van dit proefschrift samengevat en besproken met betrekking tot methodologische eigenschappen die zijn beschreven in hoofdstuk 3, hoofdstuk 4 en hoofdstuk 5. De bevindingen van dit proefschrift zijn vergeleken met de bevindingen uit de literatuur zoals onder andere beschreven in hoofdstuk 2. Suggesties voor toekomstig onderzoek en klinische implicaties zijn ook besproken in hoofdstuk 11.

In hoofdstuk 3 worden de verschillende voordelen van het MOVB-E design genoemd. Ten eerste is met betrekking tot de onderzoeksbedrijf een compleet cohort van bij de ramp betrokken en niet-betrokken reddingswerkers en hulpverleners accuraat geïdentificeerd op basis van historische bedrijfsverslagen van gedraaide diensten op het moment van de ramp. Ten tweede zijn referentiegroepen van brandweermedewerkers en politiemedewerkers die niet betrokken zijn geweest bij de ramp meegenomen om zo de samenhang tussen betrokkenheid bij de ramp en zelfgerapporteerde psychische en lichamelijke klachten en gezondheidsstatus vast te stellen. Ten derde is er een hoge mate van respons gerealiseerd en is confounding geminimaliseerd door in de analyses te corrigeren voor diverse factoren zoals leeftijd en etniciteit.

Verschillende vormen van potentiële bias in het MOVB-E design zijn ook genoemd in hoofdstuk 3 en zijn verder besproken in hoofdstuk 11. Selectiebias zou bijvoorbeeld plaats hebben kunnen vinden omdat brandweermedewerkers die pas na de Bijlmerramp in dienst zijn getreden van het
Amsterdamse brandweerkorps zijn meegenomen in de referentiegroep en, wat betreft het cohort politiemedewerkers, zijn alleen die agenten uitgenodigd die bij de start van het MOVB-E nog in dienst waren.

Hoewel het MOVB-E design ook enige kenmerken van een historisch cohort onderzoek heeft, zijn zowel betrokkenheid bij de ramp als de diverse uitkomstmaten cross-sectioneel vastgesteld. Een cross-sectioneel design kan het bepalen van de richting in de eventuele samenhang tussen betrokkenheid en andere correlerende (risico)factoren en psychische klachten bemoeilijken. Daarbij zou, met betrekking tot zelfrapportage van betrokkenheid bij de ramp 8,5 jaar later, mogelijk sprake kunnen zijn geweest van informatiebias en misclassificatie. We hebben echter geconcludeerd dat het onwaarschijnlijk is dat er sprake is geweest van misclassificatie omdat betrokkenen zich doorgaans wel weten te herinneren of ze bij één of meerdere rampgerelateerde taken of gebeurtenissen betrokken zijn geweest. Bovendien volgt uit de resultaten van een posthoc analyse dat ten aanzien van de psychische klachten, er over het algemeen geen verschillen zijn in uitkomsten wanneer de betrokkenheids-status op zelfrapportage gebaseerd is of wanneer de betrokkenheids-status gebaseerd is op gegevens van de werkgevers van de brandweer- en politiemedewerkers.

Het meten van psychische klachten is primair gebaseerd op betrouwbare en gevalideerde meetinstrumenten van PTSS en andere vragenlijsten van psychisch welbevinden en psychische klachten. Met betrekking tot het meten van PTSS en posttraumatische stress zijn de psychometrische eigenschappen van twee zelfrapportage vragenlijsten in detail geanalyseerd in hoofdstuk 4 en hoofdstuk 5. In hoofdstuk 4 is het optimale afkappunt van de Schokverwerkingslijst (SVL) bepaald en de screeningscapaciteit van dit meetinstrument vergeleken met de screeningscapaciteit van de Zelfinventarisatielijst voor posttraumatische stressstoornis (ZIL) in een groep oorlogsgeregerelateerde trauma slachtoffers. Een gevalideerd gestructureerd interview is gebruikt als gouden standaard voor PTSS. Uit de resultaten blijkt dat de SVL minder accuraat is in het identificeren van PTSS dan de ZIL in deze groep van traumaslachtoffers. We hebben geconcludeerd dat een weloverwogen gebruik van de SVL als screeningsinstrument voor PTSS van belang is. De bevindingen in dit proefschrift zijn ook gebaseerd op een continue maat (lage tot hoge scores) van de posttraumatische stress reactie. In hoofdstuk 5 is de dimensionaliteit van deze continue posttraumatische stress reactie bij betrokken brandweermedewerkers en politiemedewerkers onderzocht door middel van confirmatieve factor analyse op de ZIL en de SVL. De resultaten laten zien dat het eerder gerapporteerde onderscheid in enerzijds een dimensie ‘(actieve) vermijding’ en anderzijds een dimensie ‘afstomping van de algemene reaktiviteit’ in groepen met een hoog aantal PTSS patiënten ook van toepassing is op groepen die minder last hebben van PTSS. Daarnaast is gebleken, voor zowel de ZIL als de SVL, dat ‘slaapstoornissen’ een aparte dimensie van de posttraumatische stress reactie is naast de welbekende PTSS kerndimensionen (herbeleving, vermijding, hyperarousal). Als gevolg van verschillende psychometrische eigenschappen van de twee instrumenten is gebleken dat vergelijkbare dimensies van beide instrumenten slechts beperkt met elkaar samenhangen. De resultaten in hoofdstuk 5 laten duidelijk zien dat de posttraumatische stress reactie breder is dan de drie kerndimensionen van PTSS en dat na een trauma naast PTSS ook andere psychische klachten en stoornissen onderzocht dienen te worden.

In hoofdstuk 2 is een overzicht van 37 studies naar psychisch (on)welbevinden van reddingswerkers en hulpverleners na een ramp gepresenteerd. Dit overzicht toont aan dat de prevalentie van PTSS en andere psychische klachten varieerde van 5% tot 20%, met een paar uitschieters richting de 40%. Risicofactoren, zoals de mate van blootstelling aan de ramp, vrijgezelle levensstatus, comorbide psychiatrische stoornissen en voor en na de ramp meegemaakte negatieve levensgebeurtenissen, waren frequent en consistent gerelateerd aan meer psychische klachten na een ramp. Verschillen ten aanzien van psychisch (on)welbevinden en risico factoren tussen de studies zijn na zorgvuldige bestudering van de verschillende studies toegerekend aan de methodologische eigenschappen en eigenschappen van de ramp zelf.

In hoofdstuk 11 zijn de bevindingen van dit proefschrift gerelateerd aan wat er in algemene zin bekend is over psychisch (on)welbevinden van reddingswerkers en hulpverleners na rampen zoals beschreven in hoofdstuk 2. Onze conclusie is dat de bevindingen van dit proefschrift, tot op zekere
hoogte, overeenstemmen met de literatuur. Desalniettemin draagt dit proefschrift met een aantal uitgesproken en unieke bevindingen op een belangrijke wijze bij aan de stand van de huidige literatuur. In de eerste plaats zijn de huidige bevindingen gebaseerd op nauwkeurig gedefinieerde grote onderzoeksgruppen van bij de ramp betrokken reddingswerkers en hulpverleners en hun niet-betrokken collega’s, terwijl zuivere epidemiologische studie designs zelden zijn toegepast in onderzoek naar hulpverleners bij rampen. In de tweede plaats zijn er geen eerdere studies naar rampen gedaan ten aanzien psychisch (on)welbevinden van reddingswerkers en hulpverleners op een (zeer) lange termijn. In de derde plaats is in de studie die ten grondslag ligt aan dit proefschrift op een relatief uitgebreide wijze psychisch (on)welbevinden vastgesteld. Zo is niet alleen PTSS in het algemeen vastgesteld, maar ook specifiek aan de ramp gerelateerde posttraumatische stressklachten, andere (algemene) psychische klachten, en psychobiologische correlaten van PTSS. Daarnaast hebben we in dit onderzoek de potentieel mediërende rol van PTSS klachten tussen (mate en soort) betrokkenheid bij de ramp en een hoog aantal lichamelijke klachten onderzocht.

4 Conclusies

Dit proefschrift toont aan dat de effecten van rampen op psychisch welbevinden van bij de ramp betrokken reddingswerkers en hulpverleners langdurig kunnen zijn. In vergelijking met niet-betrokken referentiegroepen, hebben betrokken brandweermedewerkers meer lichamelijke klachten en vermoeidheid gerapporteerd, en betrokken politiemedewerkers hebben meer PTSS-klachten, andere psychische en lichamelijke klachten, en negatieve levensgebeurtenissen meegemaakt in de jaren na de ramp gerapporteerd. Betrokken politiemedewerkers hebben deze negatieve levensgebeurtenissen minder vaak verwerkt dan niet-betrokken politiemedewerkers. Psychische klachten onder betrokken reddingswerkers en hulpverleners bleken geassocieerd met verschillende (risico) factoren, waaronder mate en soort betrokkenheid bij de ramp, sociaaldemografische factoren, en het stresshormoon cortisol. Posttraumatische stress biedt geen verklaring voor de hogere mate van lichamelijke klachten onder betrokken brandweer en politie. De resultaten geven ook aan dat het grootste deel van de brandweer- en politiemedewerkers geen klinisch hoge niveaus van psychische klachten vertoont. Toch heeft zelfs 8,5 jaar na de ramp bijna 3% van de betrokken reddingswerkers en hulpverleners een vrij hoge mate van aan de ramp gerelateerde herbelevings- en vermijdingsklachten gerapporteerd. In hoofdstuk 11 zijn verschillende aspecten genoemd die idealiter meegenomen zouden moeten worden in toekomstig onderzoek naar reddingswerkers en hulpverleners die betrokken zijn geweest bij rampen, te weten: a) prospectieve epidemiologische designs met meerdere meetmomenten in de jaren na een ramp en nauwkeurige documentatie van informatie uit structurele screenings van mentale en fysieke gezondheid, b) systematische en nauwkeurige vastlegging van betrokkenheid en blootstelling aan de ramp direct nadat de ramp heeft plaatsgevonden, inclusief meting van emotionele reacties, cognitieve verwerking tijdens en direct na de ramp en perceptie van gezondheidsrisico’s, c) nauwkeurige meting van psychobiologische correlaten van PTSS zoals cortisol, d) meting van risicofactoren voor psychische klachten na rampen inclusief werkervaring en sociale factoren; en e) informatie over het soort en aantal behandelingen dat reddingswerkers en hulpverleners ontvangen voor hun ramp gerelateerde gezondheidsklachten. Brandweer en politieorganisaties wordt aanbevolen om alert te zijn op mogelijke negatieve psychische gezondheidseffecten op de lange termijn na een ramp en de risicofactoren voor verminderd psychisch welbevinden. We hebben de suggestie gedaan dat passende nazorg voor handen moet zijn, zelfs vele jaren na de ramp. Daarnaast hebben we de aanbeveling gedaan om ook aandacht te schenken aan meer chronische stressoren binnen het werk en ten tijde van de nasleep van bepaalde traumatische gebeurtenissen zoals een ramp. Deze stressoren ofwel negatieve levensgebeurtenissen blijken namelijk te interacteren met betrokkenheid bij de Bijlmerramp in relatie met gezondheidsklachten zoals vermoeidheid en posttraumatische stressklachten. Samengevat toont dit proefschrift aan dat ondanks het relatief goede psychisch welbevinden van brandweer- en politiemedewerkers, het niet ongebruikelijk is voor reddingswerkers en hulpverleners dat zij jaren na een gebeurtenis als een ramp met een stressvolle nasleep nog een zekere mate van psychische klachten ervaren.
De lange termijn neisleep van de Fleenramp Bijlmermeer: psychisch wolwèzen van beropsmjittich betrutsen helpferlieners

In komplekse en gaoatyske neisleep krige syn beslach yn de jierren nei de ramp. Yn de earste jierren nei de ramp kryeg de psychologyske neisoarch it measte omtinken, om’t guon minsken dy’t der by betrutsen wiene, lêst hiene fan psychyske klachten sa as posttraumatsyske stres fersteuring (PTSS). PTSS is in eangstfersteuring dat ûntwikkelje kin nei’t inmen in barren meimakke hat dêrt’ sprake fan in feitlike of driigjende dea of earnstige ferwûning west hat of in bedrîg fan de fysike yntegriteit fan jinsels oaren. Der wurdt oer it generaal reagearre mei yntinse eangst, helpleazens en ôfgriis op sa’n foarfal. Symptomen fan PTSS wurde meastrings ûnderferdield yn trije klusters: 1) hietylwd welerliblijn fan it traumatsyske barren, 2) aktive en passive tefoaren kommen fan prikkels dy’t assosjearre binne mei it foarfal en ûnderstoring fan de algemiene reaktiviteit en 3) oanhâldende symptomen fan nityelgens dy’t uterje yn û.o. ko nsintraasjeproblemen en oor anhâldende symp-
tomen fan nityelgens fan in vây ni hûs troch kwyt en oer anhâldende symp-
tomen fan nityelgens dy’t uterje yn û.o. kontraasjeproblemen en oerdreaun skrikreaksjes.

Foar’t praat wurde moatte dy klachten op syn minst in moanne lang oanwêzich wêze en foar gâns lijen en beheiningen soargje yn sosjale, beropsmjittige en oare wichtige libbensgebieten. Neist PTSS kinne hja ek mei oare fersteuringen, sa as depresje of oare eangstfersteuringen te krijen. PTSS kin ek ta feroaringen yn stressystemen yn it lichem liede wêrtroch stresreaksjes lang oanhâlden kinne. By stresfolle omstannichheden fynt der bygelyks in feroaring yn it nivo fan it stre-
shormoan kortisol plak en der binne aanwizings dat de kortisol útskieding by minsken mei PTSS faak groansysk fersteurd is.

Neist boppebeskreuna psychyske klachten, ûntstie der yn de jierren nei de Fleanramp Bijlmermeer aanboazjend praat en fertochtmakkings oer mooglike sûnenseffekten fan de ramp op de betrut-
senen. Sa wiene û.o. bewenners fan de Bijlmermeer en betrutsen helpferlieners besoarge oer de sûnens en guon skreaunen harren lichaamlike klachten ta oan it oanwêzich wêzen. Der is lykwols noch mar in bytsje bekend oer de gefolgen fan de lichaamlike sûnens by it oanwêzich wêzen by rampen fan foarfal, beropsmjittige en oare belangrike libbensgebieten.

Rampen sa as de fleanramp Bijlmermeer binne barrens dy’t net ferwachte en komselden foar komme mar as se foar komme dan foarmje se in risiko foar betrutsen oer psychyske en lichaam-
lijk sûnensklaarten te ûntwikkeljen. Undersyk nei de sûnenseffekten fan rampen rjocht him lange tiid foaral op de slachtoffers en oerlibbben. De ôfrûne peer desennia is der in tanimmende oandacht foar it psychysk wolwêzen fan rëdingswurkers en helpferlieners. Rëdingswurkers en helpferlieners hawwe in heech risiko om earnstige en traumatsyske barrens mei te meitsjen en hawwe dêrtroch ek in gruttere kâns om psychyske klachten sa as PTSS te krijen. Dêr stiet wer tsjinoer dat rëdingswurkers en helpferlieners bekend steane om harren grutte fearkrêft. Under oaren troch in degelik undersyk foar’t hja yn tsjinst komme, selsseleksje en herhelle sûnenstesten, is it in groep dy’t oer it generaal net lêst hat fan grutte psychyske klachten oer fersteuringen nettsjinstande dat hja faak te meitsjen hawwe mei earsteef hjelpe. Rampen sa as de fleanramp Bijlmermeer binne lykwols bysûndere barrens yn de meastal lange karriêres fan brânwachtmannen en polysje-
meiwurkers en bleatstelling dêroan kin liede ta negative gefolgen foar psychysk wolwêzen en lichaamlike sûnens.

Tusken 2000 en 2002, trochstrings 8,5 jier nei de ramp, is in epidemiologysk undersyk útfierd troch it “Instituut voor Extramuraal Geneeskundig Onderzoek” (EMGO) om de sûnens fan rëdingswurkers en helpferlieners betrutsen en helpferlieners vetuwen dien de fleanramp Bijlmermeer te undersykjen: It “Medisch Onderzoek Vliegramp Bijlmermeer-Epidemiologie” (MOV-B-E). Dat undersyk foarmet de grûnslach foar it hjoed-
deestijns proefskrift. Yn dat epidemiologysk undersyk is in kompleet koart fan brânwachtmeiwurkers en polysjemiensken dy’t betrutsen wiene yn de fleanramp Bijlmermeer en kollega’s fan dyselde
brânwacht- en polysjekorpsen dy’t net betrutschen wiene by de ramp (de referinsjegroepen) op grûn fan bedriuwsferslaggen fan draaide tsjinsten identifisearre. Alle personele brânwachtmeiwurkers dy’t yn tsjinst wiene fan it Amsterdam’s brânwachtkorps mei de ramp en polysjemeiwurkers dy’t yn tsjinst wiene fan it polysjekorps út de omkriten fan Amsterdam-Amstelland yn ’e tiid fan de ramp en dy’t noch altyd yn tsjinst binne yn 2000, binne útnoege mei te dwaan oan it ûndersyk. Om’t hast it hiele brânwachtkorps betrutschen wie by de ramp, die blicken dat it needsaaklik wie om yn de referins-sjegroep ek brânwachtmeiwurkers mei te nimmen dy’t pas neidat de ramp plak fûn hie yn tsjinst kamen fan it brânwachtkorps. Hast de hiele identifisearre ûndersyksgrûp (97%) ko ko lokalisearre wurde en útnoege om diel te nimmen an it ûndersyk en uiteinlik die 71% fan de brânwachtmeiu-

mers en polysjemeiwurkers mei it oan it ûndersyk. Meiwurkers dy’t yn kontakt west hien mei wrakstikken fan it fleantúch yn hangaar 8 op Skiphol, waarden ek betrutschen yn it epidemiologysk ûndersyk mar binne net opnommen yn de ferskille brânwachtmeiwurkers, wylst polysjemeiwurkers op alle mjitten (PTSS-klachten as werbelibjen, tefoar en kommen, en niteligens, en eangst, depresje, lichaamlike klachten, sliepproblemen, wurgens en algemien weromrinnten fan psychysch wolwêzen) mear psychyske klachten rapportearre hawwe. Dêrnei st hat bliken dien dat de prevalinsje fan in boppegemiddeld oant hiech nivo fan eangst, lichaamlike klachten, sliepproblemen en wurgens by betrutschen polysjemeiwurkers sinjifikant heger is as by net-betrutschen polysjemeiwurkers. Respektive-lik 3% en 2% fan de betrutschen brânwachtmeiwurkers en polysjemeiwurkers hat in gemiddeld heger nivo fan ramprelatearre posttraumatyske stres (werbelibjen en tefoar kommen) rapportearre.

Oangeande it twadde part fan de earste ûndersykfraach docht bliken út de resultaten dat de mijtje fan en soort betrutschenens op it plak fan de ramp assoosjeearre is mei ferskille brânwachtmeiwurkers. Sa doch bliken dat betrutschen brânwachtmeiwurkers dy’t oanjoegen mear taken dien te hawwen op it plak fan de ramp mei psychyske klachten rapportearre te hawwen op ferskille ûtkomstmojten, wylst polysjemeiwurkers dy’t mear taken op it plak fan de ramp útfierd hawwen en polysjemi-

2 UNDERSYKFRAGEN EN RESULTATEN

Yn it ramt fan dit proefskrift binne úndersteande fragen bestudearre:

Ferskille beropsmjittich betrutschen brânwachtmeiwurkers en polysjemeiwurkers fan net betrutschen kollega’s oangeande psychysch (net)wolwêzen 8,5 jier nei de ramp? Hokker aftegrûn- en bleatstellingsrelatearre (risiko)faktoaren hingje gear mei potinsjeel psychysch (net)wolwêzen op de lange termyn by betrutschen helpferlieners?

Yn haadstik 6 wurde de ferskille tunsen betrutschen en net-betrutschen brânwachtmeiwurkers en polysjemeiwurkers oangeande specifieke en meer algemene psychyske klachten 8,5 jier nei de flean-ramp besprutsen. Betrutschen brânwachtmeiwurkers hawwe sinjifikant mear lichaamlike klachten en wurgens rapportearre dan net-betrutschen kollega’s, wylst betrutschen polysjemeiwurkers on alle mjitten aspektens (PTSS-klachten as werbelibjen, tefoaren kommen, en niteligens, en eangst, sliepproblemen, wurgens en algemien weromrinnten fan psychysch wolwêzen) meer psychyske klachten rapportearre hawwe. Dérneist hat bliken dien dat de prevalinsje fan it mear vâlangse rôf fan it ramp rekapemiddeld oant heech nivo fan eangst, lichaamlike klachten, sliepproblemen en wurgens by betrutschen polysjemeiwurkers sinjifikant heger is as by net-betrutschen polysjemeiwurkers. Respektive-lik 3% en 2% fan de betrutschen brânwachtmeiwurkers en polysjemeiwurkers hat in gemiddeld heger nivo fan ramprelatearre posttraumatyske stres (werbelibjen en tefoaren kommen) rapportearre.

Oangeande it twadde part fan de earste ûndersykfraach docht bliken út de resultaten dat de mijtje fan en soort betrutschenens on it plak fan de ramp assoosjeearre is mei ferskille psychyske klachten. Sa doch bliken dat betrutschen brânwachtmeiwurkers dy’t oanjoegen mear taken dien te hawwen op it plak fan de ramp mei psychyske klachten rapportearre te hawwen op ferskille ûtkomstmojten, wylst polysjemeiwurkers dy’t mear taken op it plak fan de ramp útfierd hawwen en polysjemi-
Ferskille beropsmjittich betrutsen brânwachtmeiwurkers en polysjemeiwurkers fan net-betrutsen kollega’s oangeande selsrapportearre sûnens en laboratoarium útslaggen 8,5 jier nei de fleanramp?

Yn haadstik 7 binne de fûne ferskille tusken betrutsen brânwachtmeiwurkers en polysjemeiwurkers oangeande: a) selsrapportearre lichaamlike sûnens, b) selsrapportearre psychyske sûnens û.o. PTSS, en c) laboratoarium analyzes (û.o. hematologyske en gemyske bloedwearden en urine útslaggen) beskreau. De resultaten litte sjen dat 8,5 jier nei de fleanramp beropsmjittich betrutsen brânwachtmeiwurkers en polysjemeiwurkers meer lichaamlike en psychyske sûnensklachten rapportearre hawwe as net by de ramp betrutsen kollega’s. Resultaten fan de laboratoarium analyzes litte lykwols sjen dat der gijn statistysk sinjifikante of klinsky relevante ferskillet binne tusken betrutsen brânwachtmeiwurkers en polysjemeiwurkers en har net-betrutsen kollega’s 8,5 jier nei de ramp.

Ferskille beropsmjittich betrutsen polysjemeiwurkers fan net-betrutsen kollega’s oangeande selsrapportearre negative libbensbarrens dy’t hja meimakke hawwe foar de ramp en barrens dy’t hja meimakke hawwe nei de ramp? Hingje it tal en it soart foar- en/of nei de ramp meimakke negative libbensbarrens gær mei psychysk (net)wolwêzen, en is dy gearhing sterker ûnder betrutsen polysjemeiwurkers as ûnder net-betrutsen polysjemeiwurkers?

Yn haadstik 8 is de prevalinsje fan negative libbensbarrens ûnder betrutsen en net-betrutsen polysjemeiwurkers bestudearre. Yn ferliking mei net-betrutsen polysjemeiwurkers, hawwe by de ramp betrutsen polysjemeiwurkers rapportearre dat hja faker en meardere lichaamlike sûnens meimakke hawwe nei allinne foar de ramp mar ek en yn sterkere mjitte nei de ramp. Betrutsen polysjemeiwurkers jouwe ek faker oan dy barrens, sa as in sinjifikante feroaring fan de eigen sûnens en/of sosjaal-maatskiplike barrens sa as problemen op it wurk, net allhiel ferwurke te hawwen. De resultaten út haadstik 8 hâlde ek yn dat der in positive gearhing is tusken it tal en it soart negative libbensbarrens en psychyske klachten ûnder polysjemeiwurkers. Dat belanget ek yn dat grutte mjitte die gearhing tusken barrens sa as in feroaring fan de eigen sûnens en/of sosjaal-maatskiplike barrens yn de privee-sfear op it wurk meimakke yn de 8,5 jier nei de ramp, en psychyske klachten sa as PTSS-klachten, lichaamlike klachten en wurgens. Dy gearhing is sinjifikant sterker ûnder betrutsen polysjemeiwurkers as ûnder net-betrutsen polysjemeiwurkers.

Binne mooglike ferskillet tusken beropsmjittich betrutsen en net-betrutsen brânwachtmeiwurkers en polysjemeiwurkers oangeande de selsrapportearre fysike sûnens 8,5 jier nei de ramp relateearre on it soart en de mjitte fan psychysk (net)wolwêzen ûnder betrutsen helpferlieners?

Yn haadstik 9 binne de resultaten oangeande de ferskillet tusken betutsen en net-betrutsen helpferlieners yn selsrapportearre lichaamlike klachten besprutsen. Ferlike mei net-betrutsen kollega’s, hawwe betrutsen brânwachtmeiwurkers en polysjemeiwurkers sinjifikant faker en meardere lichaamlike klachten rapportearre. Dy meardere lichaamlike klachten binne op syn beurt relateearre oan de mjitte en it soart betrutsenens (sa as potinsjeel traumatyske barrens en taken op it plak fan de ramp). In heech nivo fan posttraumatyske stres klachten lit sjen dat de meardere lichaamlike klachten ûnder betrutsen brânwachtmeiwurkers en polysjemeiwurkers net sinjifikant ferklearre wurde kinne.
Ferskille beropsmjittich betrutsen brânwachtmeiwurkers en polysjemeiwurkers fan net-betrutsen kollega’s oangeande de konsintraasje fan it streshormoan kortisol? Hinet de konsintraasje fan it streshormoan kortisol gear mei PTSS en PTSS-klachten ûnder betrutsen brânwachtmeiwurkers en polysjemeiwurkers?

Yn haadstik 10 is de kortisol konsintraasje yn flibe as psychobiologysk korrelaat fan PTSS ferlike tusken by de ramp betrutsen brânwachtmeiwurkers en polysjemeiwurkers en net betrutsen kollega’s. Ut de analyzes docht blikken dat allinne de gemiddelde basale kortisol konsintraasje op it mijtpunt tusken de middei sinjifikant heger wie ûnder betrutsen brânwachtmeiwurkers ferlike mei net-betrutsen brânwachtmeiwurkers. Ut de resultaten fan haadstik 10 docht blikken dat de kortisol konsintraasje yn flibe mjitten tusken de middei gear hinget mei PTSS-klachten. Lykwols, de rjochting en it type gearhing ferskilt tusken betrutsen brânwachtmeiwurkers en polysjemeiwurkers. Sa hinget in gemiddeld hegere kortisol konsintraasje gear mei it hawwen fan PTSS ûnder betrutsen brânwachtmeiwurkers ferlike mei net-betrutsen kollega’s, wylst in gemiddeld legere kortisol konsintraasje sinjifikant gearhinget mei in heger nivo fan spesifike ramprelatearre posttraumatske stres ûnder betrutsen polysjemeiwurkers.

3 RELEVÂNSJE FAN DE RESULTATEN

Yn haadstik 11 binne de wichtichste befiningen fan dit proefskrift gearfetten en besprutsen mei betrutsenen ta metodologyse eigenskippen dy’t beskreau binne yn haadstik 3, haadstik 4 en haadstik 5. De befiningen fan dit proefskrift binne ferlike mei de befiningen út de literatuur sa as ûnder oaren beskreau yn haadstik 2. Suggestjes foar takomstich ûndersyk en klinyske ymplikaasjes binne ek besprutsen yn haadstik 11.

Yn haadstik 3 wurde de ferskillende foardielen fan it MOVB-E ûntwerp neamd. Op it foarste plak is oangeande de ûndersykgroep in kompleet kohort fan by de ramp betrutsen en net-betrutsen rëdingswurkers en helpferlieners akkuraat identifisearre op grûn fan histoaryske bedriuwsferslaggen fan draaide tsjinsten op it stuit fan de ramp. Op it twadde plak binne referinsjegroepen fan brânwachtmeiwurkers en polysjemeiwurkers dy’t net betrutsen west hawwe by de ramp meinommen om sa de gearhing tusken betrutsenen tusken de ramp en selsrapporteearre psychyske en lichaamlike klachten en sûnensstatus fêst te stellen. Op it tredde plak is der in hege mjitte fan respons realisearre en is kon founding minimalisearre troch yn de analyzes te ferbetterjen foar ferskate faktoaren sa as leeftyd en etnisiteit.

Ferskate foarmen fan potinsjele bias yn it MVOB-E ûntwerp binne ek neamd yn haadstik 3 en binne dêrnei besprutsen yn haadstik 11. Seleksjebias soe bygelyks plak fûn hawwe kinne om’t brânwachtmeiwurkers dy’t pas nei de Bijlmer ramp yn tsjinst kommen binne fan it Amsterdamse brânwachtkorps meinommen yn de referinsjegroep en, wat it kortohol polysjemeiwurkers oanbelanget, binne allinne dy polysjes útnoege dy’t by de start fan it MOVB-E noch yn tsjinst wiene. Hoewol’t it MOVB-E ûntwerp ek inkele skaaimerken fan in histoarysk kohort ûndersyk hat, binne sawol betrutsen tusken de ramp as de ferskate útkomstmjitten kros-seksjoneel fêststelt. In kross-seksjoneel ûntwerp kin it bepalen fan in rjochting yn de mooglike gearhing tusken betrutsenen en oare korrelearjende (risiko)faktoaren en psychyske klachten dreger meitsje. Dêrbey soe, oangeande selsrapporteazje fan betrutsenens by de ramp 8,5 jier letter, mooglik sprake west hawwe kinne fan ynformaasjesjebias en misklassifikasaasje. Wy hawwe lykwols konkludearre dat it ûnwierskynlik is dat der sprake west hat fan misklassifikasaasje om’t betrutsenens harren trochstrings wol yn it sin bringe kinne oft hja by ien of meardere ramprelatearre taken of barrens betrutsen west hawwe. Boppedat folget ût de resultaten fan in posthok analyze dat oangeande de psychyske klachten, der trochstrings gijn ferskillen binne yn útkomsten wanneer’t de betrutsenens-status op selsrapporteazje grûne is of wannear’t de betrutsenens-status grûne is op gegevens fan de wurkjouwers fan de brânwacht- en polysjemeiwurkers.
It mijten fan psychyske klachten is yn it foarste plak basearre op betroubere en falidearre mjitynstruminten fan PTSS en oare fragelisten fan psychyske wolwêzen en psychyske klachten. Oangeande it mijten fan PTSS en posttraumatiske stres binne de psychometryske eigenskippen fan twa selsrapportaazje fragelisten yn details analysee ren na haadstik 4 en haadstik 5. Yn haadstik 4 is it optimale ôfkappunt fan de Skokferwurkingslis (SVL) bepaald en de screeningskapasiteit fan dat mjitynstrumint ferlike mei de screeningkapasiteit fan de Selsynfintarisaasjelist foar posttraumatiske stres steurmis (ZIL) yn in groep aanlochsrelateearre trauma slachtoffers. In falidearre structurearre fraachpetear is brûkt as goudin standert fan de SVL as screeningsynstrumint foar PTSS fan belang is. De befiningen yn dit proefschrift binne ek grûne op trochgeande mijtte (lege oant hege skoares) fan posttraumatiske stres reaksje. Yn haadstik 5 is de dyminsjonaliteit fan psy chysk (net)wolwêzen by betrutsen rêdingsmeiwurkers en polysj emeiwurkers undersocht troch konforme faktor analyze op de ZIL en de SVL. De resultaten litte sjen dat it earder rapportearre underskied yn oo oan ‘e iene kant in dyminsje ‘(akteve) tefoaren kommen’ en oan de oare kant in dyminsje ‘ôfstomping fan de algemiene reaktiviteit’ yn groepen mei in heech tal PTSS pasjinten ek fan tapassing is op groepen dy’t minder lêst hawwe fan PTSS. Dêrneist hat blikken dien, foar sawol de ZIL as de SVL, dat ‘sliepsteurnissen’ in aparte dyminsje fan de posttraumatiske stres reaksje is neist de wolbekende PTSS kearndiminsjes (werbelibje, tefoaren komme, hyperarousal). As gefolch fan ferskillende psychometryske eigenskippen fan de twa ynstruminten hat blikken dien dat ferlykbere dyminsjes fan beide ynstruminten mar beheind mei elkoar gearhingje. De resultaten yn haadstik 5 litte dúdlik sjen dat de posttraumatiske stres reaksje breder is as de trije kearndiminsjes fan PTSS en dat nei in trauma neist PTSS ek oare psychyske klachten en steurnissen undersocht wurde moatte.

Yn haadstik 2 is in oersicht fan 37 stúdzjes nei psychysk (net)wolwêzen fan rêdingsmeiwurkers en helpferlieners nei in ramp aanbean. Dat oersicht lit sjen dat de prevalinsje fan PTSS en oare psychyske klachten skommelje fan 5% oant 20%, mei in pear útsjitters rjochting de 40%. Risikofaktoaren, sa as de hichte fan bleatstelling oan de ramp, frijeselle libbensstatus, komorbide psychyske steurnissen en foar nei de ramp meimakke negative barrens yn it libben, wiene frekwint en konsistint relateearre oan mear psychyske klachten nei in ramp. Ferskilen oangeande psychysk (net)wolwêzen en risiko faktoaren tusken de stúdzjes binne nei soarchfâldige bestudearring fan de ferskate stúdzjes tarekkene oan de metodologyske eigenskippen en eigenskippen fan de ramp sels.

Yn haadstik 11 binne de befiningen fan dit proefschrift relateearre oan wat der yn algemiene sin bekend is oer psychysk (net)wolwêzen fan rêdingsmeiwurkers en helpferlieners nei rampen sa as beskreaun yn haadstik 2. Us konklúzie is dat de befiningen fan dit proefschrift, oan in bepaalde hichte ta, oerimissje mei de literaturaire. Lykwols draacht dit proefschrift mei in tal ûtsprutsen en unike befiningen op in wichtige wize by oan de stân fan de hjoeddeistigere literaturaire. Yn it foarste plak binne de hjoeddeistigere befiningen basearre op seker definiearre grutte undersyk groepen fan by de ramp betrutsen rêdingsmeiwurkers en helpferlieners en harren net betrutsen kollega’s, wylst suvere epidemiologyske stúdzje ûntwerpen konseldan tapast binne yn undersyk nei helpferlieners by rampen. Op it twadde plak binne de grij iene eardere stúdzjes nei rampen dien oangeande psychysk (net)wolwêzen fan rêdingsmeiwurkers en helpferlieners op in (tige) lange termyn. Yn it trede plak is yn de stúdzje dy’t de grûnschach foarmet oan dit proefschrift op in relatif wiidfiemjende wize psychysk (net)wolwêzen fêststeld. Sa is net allinne PTSS yn it algemien fêststeld, mar ek spesifik oan de ramp relateearre posttraumatiske stres klachten, oare (algemiene) psychyske klachten, en psychobiologyske korrelaten fan PTSS. Dêrneist hawwe we yn dit undersyk de potinsjele medyeaarjende rol fan PTSS klachten tusken (mjitte en soart) betrutsenens by de ramp en in heech tal lichaamlie klachten undersocht.
4 Konklusjes

Dit proefskrift lit sjen dat de effekten fan rampen op psychysk wolwêzen fan by de ramp betrusen rêdingswurkers en helpferlieners in lange tiid duorje kinne. Neffens net-betrutsen referinsjegroepen, hawwe betrusen brânwachtmeiwurkers mear lichaamlike klachten en wurgens rapportearre, en betrusen polysjemeyeuwurkers hawwe meir PTSS-klachten, oare psychyske en lichaamlike klachten, en negative libbensbarrens meimakke yn de jierren nei de ramp rapportearre. Betrusen polysjemeyeuwurkers hawwe dy negative libbensbarrens minder faak ferwurke as net-betrutsen polysjemeyeuwurkers. Psychyske klachten ûnder betrusen rêdingsmeiwurkers en helpferlieners skine assosjeearre te wêzen mei ferskillende (risiko) faktoaren, wêrûnder mjitte en soart betrusenenens by de ramp, sosjaal-demografyske faktoaren, en it streshormoan kortisol. Posttraumatyske stres biedt gijn ferkle-arraing foar de hegere mjitte fan lichaamlike klachten ûnder betrusen brânwacht en polysje. De resultaten jouwe ek oan dat it grutste part fan de brânwacht- en polysjemeyeuwurkers gijn klinysk hege nivo’s fan psychyske klachten sjen litte. Dochs hat 8,5 jier nei de ramp hast 3% fan de betrusen rêdingsmeiwurkers en helpferlieners in frij hege mjitte fan de ramp relatearre klachten fan werbelibbing en tefoaren kommen rapportearre. Yn haadstik 11 binne fersskillende aspekten neamd dy’t idealiter meinommen wurde moatte soenen yn takomstich ûndersyk nei rêdingswurkers en helpferlieners dy’t betrusen west hawwe by rampen, te witten: a) prospektive epidemiologyske ûntwerpen mei meardere mjitmominten yn de jierren nei de ramp en sekuere dokumintaasje fan ynformaasje út strukturele screenings fan mentale en fysike sûnens, b) systematsyk en krekte fêst-izzing fan betrusetenens en bleatstelling aan de ramp daliks nei’t de ramp plak fûn hat, ynklusyf mjitting fan emosjonale reaksjes, kognitive ferwurki ng by en daliks nei de ramp en persepsje fan mjitting fan psychobiologyske korrelaten fan PTSS sa as kortisol, d) mjitting fan risikofaktoaren foar psychyske klachten nei rampen ynklusyf wurkerfaring en sosjaal faktoaren; en e) ynformaasje oer it soart en tal behannelings dy’t rêdingswurkers en helpferlieners krije foar aan de ramp relatearre sûnensklachten. Brânwacht en polysje-organisaasjes wurde oanrekomman-dearre om wach te wêzen op mooglike negative psychyske sûnenseffekten op de lange termyn nei in ramp en de riskofaktoaren foar fermindere psychysk wolwêzen. Wy hawwe de suggestje dien dat passende neisoarch foar hannen wêze moat, ek hiel wat jierren nei de ramp. Dêrneist hawwe wy de oanbefeeling dien om ek oandacht te skinken oan meir groanske stressoaren binnen it wurk en by de neisleep fan bepaalde traumatyske barrens sa as in ramp. Dy stressoaren of te wol negative libbensbarrens skine namentlik te unteraktearjen mei betrusenenens by de Bijlerramp yn relaasje ta sûnensklachten sa as wurgens en posttraumatyske streksklachten. Gearfetsjend lit dit proefskrift sjen dat brânwacht- en polysjemeyeuwurkers net tsjinstande harren relatyf goede psychysk wolwêzen jierren nei in ramp mei in stresfolle neisleep noch psychyske klachten erfare kinne.
DANKWOORD
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CURRICULUM VITAE
Anke Boukje Witteveen was born in Bolsward on June 6 1977. She completed her pre-university education at the Titus Brandsma College in Bolsward. After having followed training at the Youth Theatre School in Leeuwarden and the Institute for Preparatory Theatre Training in Groningen during her pre-university education, she performed and worked fulltime in the production group of the institute in 1995 and 1996. In 1997, she completed her propaedeutic degree in Theatre-, Film, and Television Sciences at the University of Utrecht. Between 1997 and 2001, she studied psychology at the Rijksuniversiteit Groningen where she completed her masters degree cum laude in April 2001 in the major Clinical Psychology and the minors Neuro/Bio psychology and Health psychology. She started working on the epidemiological study of the air disaster in Amsterdam at the Department of Medical Psychology of the VU University Medical Center in Amsterdam in September 2001. She was co-writer of two reports on the air disaster and worked on the present doctoral thesis. In 2004, she combined scientific research with clinical healthcare activities at the VU Medical Center as part of the postdoctoral education to become healthcare psychologist. Mid 2006, both this doctoral thesis and the postdoctoral education were completed.