Injury, Int. J. Care Injured 47 (2016) 250–256

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

The risk of PTSD and depression after an airplane crash and its potential association with physical injury: A longitudinal study

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ARTICLE INFO

Article history:
Accepted 1 July 2015

Keywords:
Post-traumatic stress disorder (PTSD)
Depression
Injury severity
Hospitalisation
Airplane crash
Longitudinal study

ABSTRACT

In 2009, a commercial airplane crashed near Amsterdam. This longitudinal study aims to investigate (1) the proportion of survivors of the airplane crash showing a probable posttraumatic stress disorders (PTSD) or depressive disorder, and (2) whether symptoms of PTSD and depression were predicted by trauma characteristics. Identifying these trauma characteristics is crucial for early detection and treatment. Of the 121 adult survivors, 82 participated in this study 2 months after the crash and 76 participated 9 months after the crash. Risk for PTSD and depression was measured with the self-report instruments Trauma Screening Questionnaire and Patient Health Questionnaire-2. Trauma characteristics assessed were Injury Severity Score (ISS), hospitalisation, length of hospital stay, and seating position in the plane. Two months after the crash, 32 participants (of $N = 70$, 46%) were at risk for PTSD and 28 (of $N = 80$, 32%) were at risk for depression. Nine months after the crash, 35 participants (of $N = 75$, 47%) were at risk for PTSD and 24 (of $N = 76$, 35%) were at risk for depression. There was a moderate correlation between length of hospital stay and symptoms of PTSD and depression 9 months after the crash ($r = .33$ and $r = .45$, respectively). There were no differences in seating position between participants at high risk vs. participants at low risk for PTSD or depression. Mixed design ANOVAs showed also no association between the course of symptoms of PTSD and depression 2 and 9 months after the crash and ISS or hospitalisation. This suggests that health care providers need to be aware that survivors may be at risk for PTSD or depression, regardless of the objective severity of their physical injuries.

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Introduction

On 25 February 2009, a Boeing 737-800 crashed near Schiphol airport, Amsterdam. Most occupants (93%) survived the crash. Ninety-five percent of survivors were injured [1]. Following such an event, survivors are at risk for developing posttraumatic mental disorders, particularly Posttraumatic Stress Disorder (PTSD), major depression and other anxiety disorders, that may cause significant suffering and functional impairment [2,3]. Studies on PTSD and depression among air crash survivors are rare. In 1995, Gregg et al. [4] found PTSD prevalence of 40% and depression prevalence of 33%. PTSD is characterised by involuntary intrusive thoughts of the event, avoidance, negative alterations in cognition and mood and heightened arousal [5]. Acute PTSD may be diagnosed one month after the traumatic event; chronic PTSD is diagnosed when symptoms persist for over 3 months. Depression may be diagnosed when symptoms of depressed mood and/or loss of interest in life activities last longer than 2 weeks [5].

Early identification of symptoms of PTSD and depression is important to prevent a chronic course of PTSD; acute PTSD may be treated effectively with brief psychotherapy [6]. Identifying the risk factors in the acute phase following trauma that predict PTSD

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http://dx.doi.org/10.1016/j.injury.2015.07.005
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and depression is crucial to facilitating early identification. Characteristics of the traumatic event may affect the development of symptoms of PTSD and depression following trauma [7,8]. For instance, trauma severity and proximity to the stressor are associated with an increased risk for symptoms [7,8]. Both concepts refer to the degree to which someone is directly exposed to the traumatic event, for instance by measuring perceived life threat or physical danger. Physical injury is often also considered a possible risk factor [7], however, research on the relationship between physical injury and mental health problems following trauma demonstrates conflicting results. Most studies carried out in injured trauma patients investigated survivors of motor vehicle accidents and the majority of these studies report no significant relationship between injury severity and incidence of PTSD and/or depression [9–11]. However, since most of these studies were conducted in severely injured trauma patients, it remains possible that patients with severe injuries may be at higher risk for PTSD than patients with no or very mild injuries.

This study examined two research questions: (1) what was the proportion of survivors of the February 2009 airplane crash showing a probable posttraumatic stress disorder (PTSD) or depressive disorder 2 months and 9 months after the crash? and (2) to what extent were symptoms of PTSD and depression associated with trauma characteristics (injury severity, hospitalisation, length of stay in hospital and seating position) among survivors of this airplane crash?

The study population offered several advantages for research into this relationship. The population was homogeneous with respect to the type of trauma, as the index trauma was shared by all participants, and the survivors varied in terms of severity of injury – from not injured to severely injured – and length of stay in a hospital after the crash. Also, we were able to include medical and psychological data of victims.

The Medical Research Ethics Committee (MREC) of the Academic Medical Centre Amsterdam and the regional MREC of Noord Holland gave approval for this study.

Methods

Study population

On 25 February 2009, a commercial airplane crashed near Amsterdam in the Netherlands. Of the 135 occupants (passengers and crew) of 12 different nationalities, 9 were fatally wounded [1]. All 126 survivors (including 5 children) were screened and treated for injuries at the emergency departments of several hospitals. Demographic data (age, gender and nationality) and extensive medical data on all survivors were gathered. The regional Community Health Service (CHS) conducted a survey to identify symptoms of PTSD and depression 2 and 9 months after the crash using self-report instruments, administered by telephone. Survivors were invited to participate by letter or phone call. Interviews were conducted in Turkish, Dutch or English.

Fig. 1 provides a flow diagram showing survivors of the crash and the participants of this study. The inclusion criterion was age above 14 years. Response rates were 68% at timepoint 1 (at 2 months; $n = 82$, total adult survivors $N = 121$) and 63% at timepoint 2 (at 9 months; $n = 76$). The main reasons given for refusal to participate were that the individual had moved on with his or her life, had already received psychological treatment or did not want to talk about their complaints. These reasons also explain why, especially at timepoint 1, some participants chose to complete only a brief part of the study protocol that consisted of 2 items (PHQ-2).

Outcome measures

To address our first research question, symptoms of PTSD and depression were measured. Symptoms of PTSD were measured using the Trauma Screening Questionnaire (TSQ), a ten-item questionnaire developed to enable early identification of individuals at risk for PTSD [12,13]. The TSQ uses a yes/no response format and asks about symptoms during the past week. It consists of five items about re-experiencing and five items about arousal taken from the DSM IV (Diagnostic and Statistical Manual of Mental Disorders, 4th ed.) PTSD criteria [14]; scores range from 0 (asymptomatic) to 10. A score $\geq$6 was considered to indicate that the individual was at risk for PTSD [15]. The TSQ is considered to identify accurately individuals at risk for a PTSD diagnosis using this threshold, when compared with a "gold standard", clinician-administered interview; sensitivities of .76–.86 and specificities of .93–.97 have been reported [12].

Symptoms of depression were measured by the Patient Health Questionnaire 2 (PHQ-2), a two-item measure that inquires about the frequency of depressed mood and anhedonia over the past two weeks [16,17]. The PHQ-2 uses a four-option response format (not at all; several days; more than half the days; nearly every day).

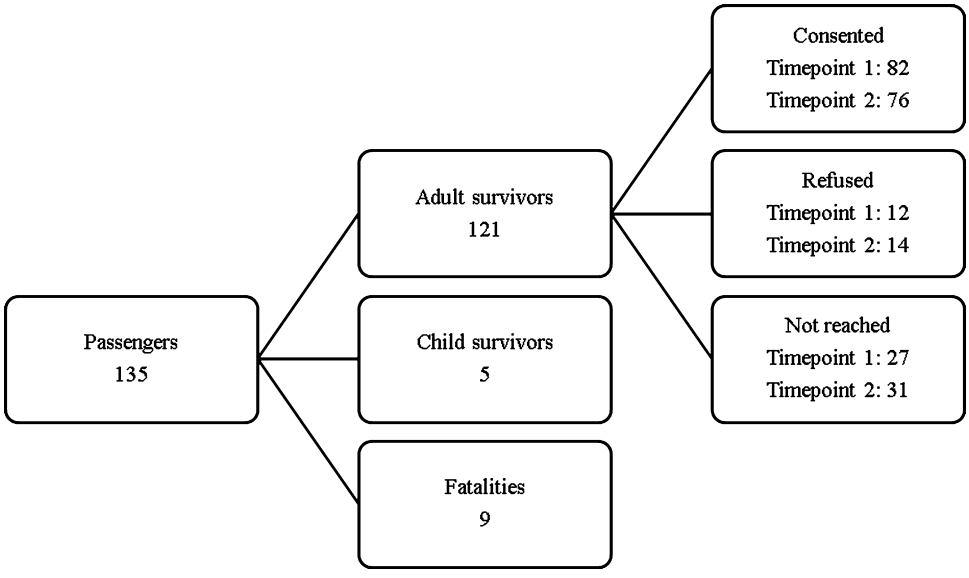

Fig. 1. Flow diagram of survivors and participants.

Total score ranges from 0 to 6. A cut-off score of 3 was used to identify those at risk for depression [18]. The PHQ-2 score ≥3 has been found to agree well with formal diagnosis, sensitivities of .83–.87 and specificities of .78–.92 have been reported [16,18].

To address our second research question, hospitalisation, length of stay in hospital (LOS), Injury Severity Score (ISS) and seating position in the airplane were measured. Hospitalisation was measured dichotomously and indicated whether a participant had been admitted to a hospital after being treated in the emergency department. Sixty-four victims were hospitalised. LOS was measured in days.

The ISS is based on the Abbreviated Injury Score (AIS) and has been arguably the most used injury severity measure since its development in 1974 [19,20]. The ISS is calculated as the sum of the squares of the highest AIS scores for the three most injured body regions (head or neck, face, chest, abdominal or pelvic contents, extremities or pelvic girdle, and external). The ISS scale ranges from 1 to 75. To compare survivors with no or minor injuries and moderate to severe injuries, we used a threshold of ISS scores greater than 8 [21]. Higher thresholds may exclude a substantial number of participants with severe trauma [22].

Information about seating position in the plane was provided by the Dutch Safety Board. We used seating position as a means to gauge the degree of difficulty for victims to reach safety after the crash, calculated by the distance to the nearest exit. Number of seats and rows survivors had to pass before reaching the nearest exit were counted. Survivors used the following exits (Fig. 2): two emergency exits above the right wing, one emergency exit above

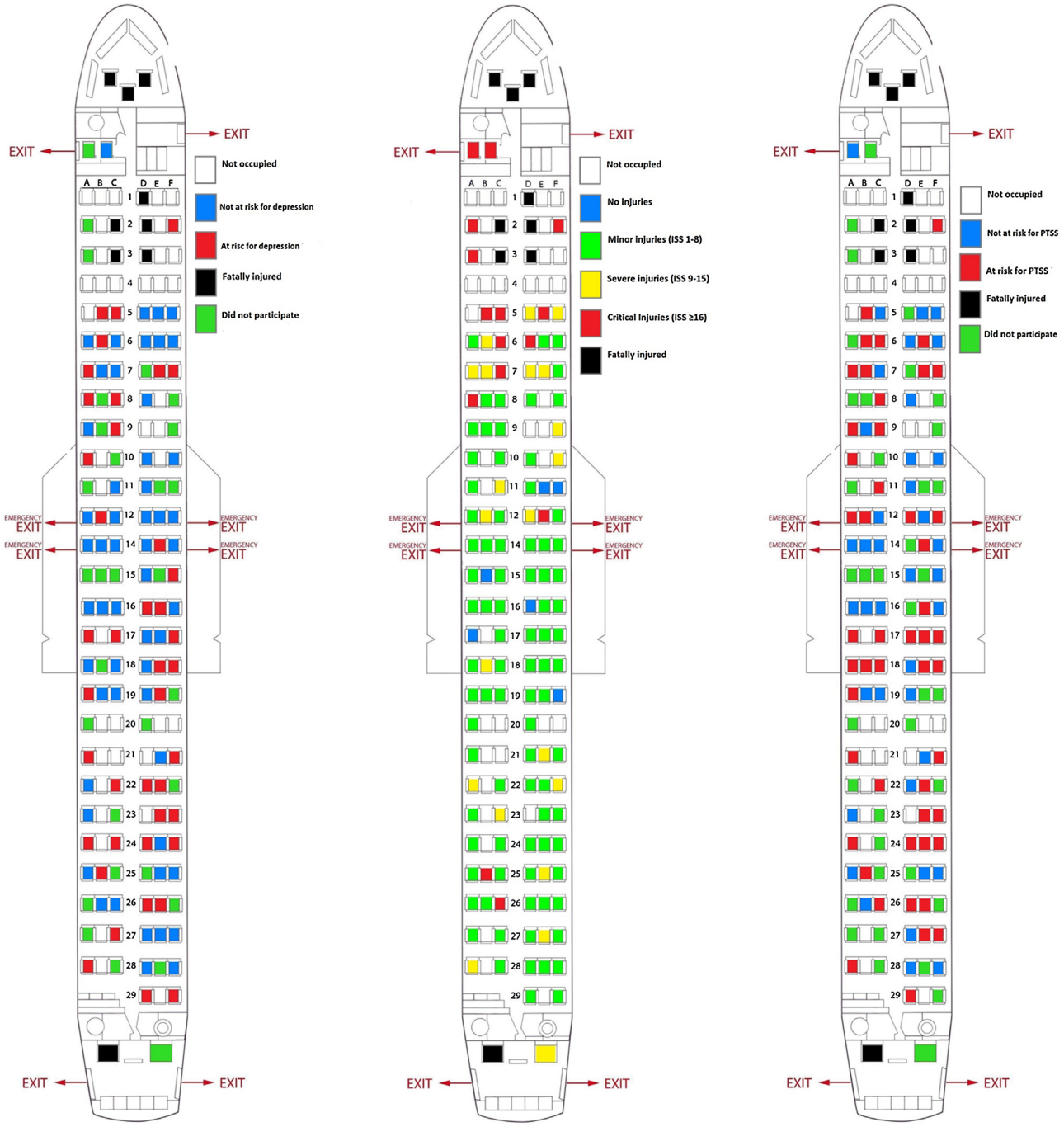

Fig. 2. Seating position with respect to injury severity, risk for depression and risk for PTSD. The left figure shows risk for depression at timepoint 1 or 2. The right figure shows risk for PTSD at timepoint 1 or 2. The middle figure shows injury severity directly after the crash.

the left wing, tear on the right sight between rows 7 and 8 (caused by the crash), and an opening at the rear after row 28. The rear section of the plane (from row 29) had broken off and become separated from the main fuselage during impact, thereby creating an additional means of escape for passengers. A score of 1 was given to each seat a survivor had to pass in his/her row, and to each additional row he/she had to pass before reaching the exit. These scores were then tallied and ranged from 0 (next to exit) to 10.

Analysis

Statistics were computed in SPSS Statistics 20, with *p*-levels of $<.05$ taken to indicate statistical significance. To examine the characteristics of the participants and investigate our first research question, we conducted descriptive statistics, independent *t*-tests and Chi-square tests. To test our second research question, bivariate correlations (Pearson), mixed design ANOVAs and independent *t*-tests were conducted. Bivariate correlations were computed to examine the association between demographic variables (age, gender), trauma characteristics (ISS as continuous variables, LOS, hospitalisation) and symptoms of PTSD and depression. This was done separately for timepoint 1 (2 months after the crash) and timepoint 2 (9 months after the crash). Among those participants who completed the TSQ or PHQ-2 at both timepoints, mixed design ANOVAs were conducted to examine whether ISS and hospitalisation (as dichotomous, between-subjects factors) were related to the course of PTSD symptoms and depressive symptoms at 2 and 9 months after the crash (within-subject factor with two levels). Independent *t*-tests were conducted to examine whether number of seats to nearest exit differed between participants at high risk of PTSD or depression vs. participants at low risk.

Results

Characteristics of participants

Table 1 presents demographic data (gender, age, nationality) for adult survivors and participants who completed the TSQ and/or PHQ-2. There were no significant differences in the distribution of gender, age and nationality between the participants who completed the study protocol and non-responders.

Table 1 includes ISS, hospitalisation and LOS for the population of adult survivors and the samples at timepoints 1 and 2. At timepoint 1 ($N = 82$) and timepoint 2 ($N = 76$) there was no difference between the study sample and non-responders in terms of mean scores on ISS and LOS and group distributions on ISS and hospitalisation. After the crash 3 adult survivors were not injured (ISS = 0) and 118 were injured (ISS > 0). Of the 121 adult survivors, 45% ($n = 54$) had an ISS score of 1 (e.g. bruises, lacerations) and 30% ($n = 36$) were moderately to severely injured e.g. fractures, multiple trauma (ISS score > 8). Of those hospitalised ($n = 64$), 21 stayed at the hospital for longer than 1 week and 3 participants stayed more than 1 month.

Research question 1: Participants showing a probable PTSD or depressive disorder

At timepoints 1 and 2, respectively, 32 (of $N = 70$) and 35 (of $N = 75$) participants were considered to be at risk for PTSD (indicated by a score of ≥ 6). Mean TSQ scores were 5.2 at timepoint 1 (SD = 3.5) and 4.8 at timepoint 2 (SD = 3.5). Of those participants who completed the TSQ at both timepoints ($N = 64$), 21 showed a probable PTSD at both moments in time. Furthermore, 28 (of $N = 80$) participants at timepoint 1 and 24 participants (of $N = 76$) at timepoint 2 were at risk for depression (indicated by a PHQ-2 score of ≥ 3). Mean PHQ-2 scores were 2.1 at timepoint 1 (SD = 2.0) and 1.8 at timepoint 2 (SD = 1.9). A minority of 9 participants (of $N = 66$) showed a probable depression at both timepoints.

Risk for PTSD and depression co-occurred: 18 participants (of $N = 68$) showed both a probable PTSD and probable depression at timepoint 1. At timepoint 2 this was the case for 22 participants (of $N = 75$).

Research question 2: Association of PTSD and depression with trauma characteristics

ISS, hospitalisation (being hospitalised or not), age and gender were not associated with PTSD or depression at either timepoint. At timepoint 2, among those hospitalised, longer LOS correlated with a higher score on PTSD symptoms ($n = 40$, $r = .33$, $p = .04$) and depressive symptoms ($n = 41$, $r = .45$, $p = .001$). At timepoint 1, LOS did not significantly correlate with PTSD symptoms ($n = 36$, $r = .12$, $p = .48$) or depressive symptoms ($n = 41$, $r = .14$, $p = .39$).

Tables 2 and 3 show mean TSQ and PHQ-2 scores for participants grouped by injury severity and hospitalisation. Regarding TSQ score and PHQ-2 score there was no significant interaction between time and ISS ($F(1, 62) = 1.14$, $p = .29$ and $F(1, 64) = .47$, $p = .50$, respectively), indicating that the course of PTSD symptoms and depressive symptoms did not differ significantly between participants with high and low injury severity. We

Table 1
Demographics and physical injury of the participants.

	Adult survivors ($N = 121$)		Timepoint 1 ($N = 82$)		Non-responders timepoint 1 ($N = 39$)		Timepoint 2 ($N = 76$)		Non-responders timepoint 2 ($N = 45$)	
	N (%)	*M* (SD)	*N* (%)	*M* (SD)	*N* (%)	*M* (SD)	*N* (%)	*M* (SD)	*N* (%)	*M* (SD)
Male	85 (70)		55 (67)		29 (74)		49 (65)		35 (78)	
Female	36 (30)		27 (33)		10 (26)		27 (35)		10 (22)	
Age		40.2 (13.2)		40.4 (13.7)		39.7 (12.4)		41.7 (14.1)		37.6 (11.4)
Dutch	60 (50)		47 (57)		13 (33)		45 (59)		15 (33)	
Turkish[a]	46 (38)		28 (34)		18 (46)		26 (34)		20 (45)	
Other[b]	15 (12)		7 (9)		8 (21)		5 (7)		10 (22)	
ISS 0–8	85 (70)		60 (73)		25 (64)		53 (70)		32 (71)	
ISS > 8	36 (30)		22 (27)		14 (36)		23 (30)		13 (29)	
ISS		6.6 (9.3)		5.4 (6.5)		9.0 (13.1)		6.1 (7.0)		7.4 (12.2)
Hospitalised	64 (53)		42 (50)		22 (56)		41 (54)		23 (51)	
LOS		9.9 (15.7)		8.1 (9.8)		13.2 (23.0)		8.3 (9.9)		12.6 (22.6)
Distance to nearest exit		4.7 (2.5)		4.6 (2.5)		4.7 (2.7)		4.6 (2.4)		4.7 (2.8)

[a] We compared the distribution of Turkish and Dutch participants vs. non-responders. For other nationalities, groups were too small for chi square analysis.
[b] Other nationalities were mostly Iranian, American, English and Syrian.

Table 2
Mean TSQ score with respect to ISS and hospitalisation.

	N (64)[a]	TSQ Timepoint 1 M (SD)	TSQ Timepoint 2 M (SD)
ISS = 0–8	46	5.0 (3.4)	4.3 (3.5)
ISS ≥ 9	18	5.7 (3.7)	5.8 (3.5)
Not hospitalised	30	5.0 (3.3)	3.7 (3.5)
Hospitalised	34	5.4 (3.6)	5.5 (3.3)

[a] Number of participants that completed the TSQ at both timepoints.

Table 3
Mean PHQ-2 score with respect to ISS and hospitalisation.

	N (66)[a]	PHQ-2 Timepoint 1 M (SD)	PHQ-2 Timepoint 2 M (SD)
ISS = 0–8	47	1.8 (2.0)	1.6 (1.8)
ISS ≥ 9	19	2.1 (1.6)	2.2 (2.0)
Not hospitalised	31	1.7 (2.0)	1.3 (1.6)
Hospitalised	35	2.1 (1.8)	2.1 (2.0)

[a] Number of participants that completed the PHQ-2 at both timepoints.

also found no significant main effect of time on PTSD symptoms ($F(1, 62) = .64$, $p = .43$) or depressive symptoms ($F(1, 64) = .09$, $p = .76$), indicating that participants' symptoms of PTSD and depression did not change between 2 and 9 months after the crash. We also found no significant main effect of low and high injury severity groups on PTSD symptoms ($F(1, 62) = 1.53$, $p = .22$) or depressive symptoms ($F(1, 64) = .94$, $p = .34$), which means that participants with low and high injury severity did not differ in their level of PTSD symptoms and depressive symptoms.

In case of hospitalisation as an independent (between group) variable, there was no significant interaction effect between time and hospitalisation regarding TSQ and PHQ-2 score ($F(1, 62) = 3.83$, $p = .06$ and $F(1, 64) = .21$, $p = .65$, respectively). This means that the course of PTSD symptoms and depressive symptoms did not differ between hospitalised participants and not-hospitalised participants. There was also no significant main effect of time on PTSD symptoms ($F(1, 62) = 2.43$, $p = .12$) or depressive symptoms ($F(1, 64) = .47$, $p = .50$), and no significant main effect of hospitalisation on PTSD symptoms ($F(1, 62) = 2.14$, $p = .15$) or depressive symptoms ($F(1, 64) = 2.34$, $p = .13$), indicating that both time and hospitalisation had no effect on the symptom level of PTSD and depression.

The seating distribution of participants at risk for PTSD or depression is shown in Fig. 2 and Table 1. Visual inspection of Fig. 2 suggests no relationship between seating position and later being at risk for PTSD or depression at both timepoints. Survivors later assessed as at risk were spread throughout the plane. With respect to the number of seats and rows survivors had to pass before reaching the nearest exit, independent t-tests showed no difference at both timepoints between participants at high risk vs. participants at low risk for PTSD (timepoint 1: $t(68) = -1.02$, $p = .31$; timepoint 2: $t(73) = -1.40$, $p = .17$) or depression (timepoint 1: $t(78) = -1.74$, $p = .09$; timepoint 2: $t(74) = -.73$, $p = .47$).

Discussion

The first research question focused on the proportion of survivors of a commercial airplane crash near Amsterdam, in the Netherlands, showing a probable PTSD or depressive disorder. We found that 2 months after the crash 32 survivors (46%) were at risk for PTSD and 28 (32%) for depression. Nine months after the crash, still 35 survivors (47%) were at risk for PTSD and 24 (35%) for depression. Risk for PTSD and depression also co-occurred: 18 (27%) participants showed both a probable PTSD and depression 2 months after the crash. This was the case for 22 (29%) participants 9 months after the crash. These rates are relatively high, compared to previously reported prevalence of 10% [2,23]. Possible explanations are that, firstly, all survivors were in close proximity to the event and were unable to escape; proximity is an important risk factor for mental health problems [7,24]. Although close proximity varies between events, it is common in accidents such as an airplane crash. Close proximity might explain why Gregg at al. [5] also found prevalence rates of 40% for PTSD and 33% for major depression among survivors of an air crash in England (in which 47 people died and most of the 79 survivors were injured) in the year after the crash. In 1988 Sloan [25] followed up 32 survivors of a non-fatal charter flight crash and also found initially intense stress that subsided over the following months. However, results of other types of accidents, such as motor vehicle accidents, contradict this explanation: although some studies find a high risk of mental health problems [26–29], other do not find elevated rates [30,31].

A second explanation for the rather high percentage of participants showing a probable PTSD or depression relates to the use of self-report screening instruments. These are known to overestimate mental health problems compared to structured clinical interviews [32]. This explanation cannot in itself explain the higher prevalence, as many studies of mental health problems in disaster survivors have used self-report questionnaires and reported lower prevalence [3,33,34]. It is important to note that the TSQ and PHQ-2 questionnaires are considered accurate for the early identification of PTSD and depression.

A third explanation relates to cultural differences. Drogendijk et al. [35,36] found that Turkish migrant victims of a disaster scored considerably higher than native Dutch victims on instruments assessing mental health problems and posttraumatic stress. To test this explanation we compared Turkish and Dutch participants in our sample, but found no group differences in either TSQ or PHQ-2 score.

A fourth explanation might be that some survivors have not received the mental health care they needed. Survivors can be dissatisfied with the support provided after an airplane crash [37]. The CHS actively sought to identify all survivors with mental health problems to help them find local psychosocial care. Nevertheless, this explanation cannot be ruled out.

The second research question focused on whether symptoms of PTSD and depression were associated with trauma characteristics. Injury severity and hospitalisation were not associated with the course of symptoms of PTSD and depression. Previous studies also did not find any relations between physical injuries and mental problems [9–11]. A possible explanation is that the subjective experience of the severity of an event may be more important than objective indicators of trauma severity (such as ISS or hospitalisation) [9,29,38]. Interestingly, seating position seemed also not related. Those showing a probable PTSD or depression were not nearer to an exit, where they might have been exposed to the crash for a shorter period of time or might have been less afraid of not being able to exit. Evidently, they were also not overly represented at the front of the plane, where the severe and critical injuries occurred.

Among those hospitalised, length of stay in a hospital was significantly correlated with symptoms of PTSD and symptoms of depression 9 months after the crash. This result is consistent with the findings of Sijbrandij et al. [9], who reported that injury tends to be associated with late-onset symptoms rather than early symptoms. In the long term survivors may become functionally impaired and have work or relationship difficulties that may contribute to symptoms of depression and PTSD [39]. They suggest that survivors may focus on physical recovery first and become aware of psychological distress later.

Limitations

This study has a number of limitations. Obviously, sample size was limited, which reduced the statistical power of the study. The TSQ and PHQ-2 do not measure the whole spectrum of symptoms of PTSD and depression (e.g. the TSQ specifically does not address avoidance symptoms). This could have resulted in misclassification of individuals in our sample with undetected symptoms of PTSD or depression. Although the PHQ-2 has proven to accurately detect and monitor depression over time [18], the TSQ has mainly proven accurate for the early identification of PTSD and more research is needed to assess its accuracy months after the event. There was no information available on pre-existing symptoms of PTSD and depression in the population under study, so one cannot assume that PTSD and depression symptoms are 'new'. Because we started measuring symptoms at 2 months after the crash, we could not identify survivors who suffered from symptoms within the first 2 months but recovered naturally before the study started. There were also no longer term (>2 years) measurements in order to investigate delayed onset PTSD and/or depression. Finally, note that there are many other possible predictors of PTSD and depression that were not tested in this study (e.g. history of mental illness, childhood trauma, sense of death threat, social support) [7,8].

Given these limitations we strongly recommend future research to confirm our findings, using different and larger samples with varying severity of physical injury, to improve our understanding of the relationship between proximity to a stressor and subjective and objective injury, and the possible influence of length of hospital stay on mental health.

Conclusions

Mental health risks of airplane accidents have rarely been studied. This study showed a risk for PTSD and depression among survivors of an airplane crash. Objectively measured physical injuries and hospitalisation had no association with course of the symptoms of either PTSD or depression. Raising awareness of these results among health care providers is important. Victims' need for mental health care cannot be related to their often much more visible physical needs, so monitoring mental health needs is particularly important, not only during the first days after an incident, but also over the following weeks and months. Survivors without severe injuries may nevertheless suffer from mental health problems; communication and cooperation between the medical health care system and community health services is therefore essential to deliver optimal long term care.

Conflict of interest

There a no conflicts of interest.

Acknowledgements

This study was made possible by a collaboration between Academic Medical Centre in Amsterdam (on behalf of the Medical Research Group Turkish Airlines Crash), VU University Amsterdam, EMGO Institute for Health and Care Research, Utrecht University and Impact – National Knowledge and Advice Centre for Psychosocial Care Concerning Critical Incidents. We would like to thank the participants, who made this research possible. We would also like to thank Jolanda ten Brinke and Ietje Boele of the regional public health service of Kennemerland and the interviewers for their great work regarding acquisition of data and care about the participants. We also thank Niels van der Aa for his advice about methods and statistical analyses.

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