Brace for impact! A thesis on medical care following an airplane crash
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Chapter 11

The risk of PTSD and depression after an airplane crash: Potential association with physical injury

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Based on
The risk of PTSD and depression after an airplane crash: potential association with physical injury
Submitted
Abstract

Background
After experiencing a potentially traumatic event, a small percentage of people develop post-traumatic stress disorder (PTSD) and/or depression. This study aims to investigate 1. the risk of PTSD and depression after an airplane crash, and 2. whether this risk is predicted by trauma characteristics. Identifying these risk factors is crucial for early detection and treatment.

Methods
Of the 126 survivors of a commercial airplane crash near Amsterdam in 2009, 82 adults were included in this study. Risk for PTSD and depression was measured with the self-report instruments Trauma Screening Questionnaire and Patient Health Questionnaire-2, 2 and 9 months after the crash. Trauma characteristics assessed were Injury Severity Score (ISS), number of days in hospital and seating position in the airplane. Descriptive statistics and mixed design ANOVAs were computed to measure risk for PTSD and depression and its association with physical injury.

Results
Forty seven percent of participants showed an increased risk of PTSD, at both 2 and 9 months after the crash. The risk of depression was 34% at 2 months and 32% at 9 months. There was a small but significant correlation between length of stay in hospital and symptoms of PTSD and depression 9 months after the crash (r=.27 and r=.34 respectively). Mixed design ANOVAs showed no association between the course of symptoms of PTSD and depression 2 and 9 months after the crash and ISS or hospitalisation.

Conclusion
Survivors of an airplane crash are at risk for PTSD and depression, but physical injuries and hospitalisation have no effect on the course of these symptoms; health care providers need to be aware that survivors may be at risk of PTSD or depression, regardless of the objective severity of their physical injuries.
Background

On 25 February 2009, a Boeing 737-800 crashed near Amsterdam Airport Schiphol. Most occupants (93%) survived the crash. Ninety five percent of survivors were injured. (1) Following such an event, survivors are at risk of developing mental disorders that may cause significant suffering and functional impairment, particularly Posttraumatic Stress Disorder (PTSD), major depression and other anxiety disorders. (2; 3) PTSD is characterised by involuntary intrusive thoughts of the event, avoidance, negative alterations in cognition and mood and heightened arousal. (4) 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. (4) Studies on PTSD and depression among airplane crash survivors are rare. In 1995, Gregg et al. found PTSD prevalence rates of 40% and depression rates of 33%. (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 and depression is crucial for facilitating early treatment. First of all, characteristics of the traumatic event may affect the development of symptoms of PTSD and depression following trauma. (7; 8) For instance, proximity to the stressor is associated with an increased risk of symptoms. (8) Physical injury is also often considered a possible risk factor. (7) However, research studying the relationship between physical injury and mental health problems following a trauma, has yielded conflicting results. Most studies carried out on injured trauma patients, investigated survivors of motor vehicle accidents (MVA) and the majority of these studies report no significant relationship between injury severity and incidence of PTSD and/or depression. (9; 10; 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 of PTSD than patients with no or very mild injuries.

This study examined the risk of PTSD and depression in survivors of the February 2009 airplane crash and its relationship to characteristics of the event. The study population offered several advantages for research into this relationship. Firstly, it was homogeneous with respect to the type of event, as all participants were occupants of the airplane during the crash; secondly, 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. By combining data from two unrelated studies, we were able to include medical and psychological data of victims.

The study addressed two research questions: 1) what was the risk of PTSD and depression in survivors of the February 2009 airplane crash? and 2) to what extent were symptoms of PTSD and depression associated with trauma characteristics (injury severity, length of stay in hospital and event characteristics such as seating position) in survivors of this airplane crash?

**Figure 1:** Flow diagram of survivors and participants

### Methods

#### Study population

On 25 February 2009, a commercial airplane crashed near Amsterdam in the Netherlands. Of the 135 occupants (passengers and crew) from 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. All interviewers received
appropriate training and interviews were conducted in Turkish, Dutch or English. Figure 1 provides a flow diagram showing survivors of the crash and the participants of this study. Response rates were 68% at time point 1 (at 2 months; n = 82, total adult survivors N = 121) and 63% at time point 2 (at 9 months; n = 76). The main reason given for refusal to participate was that the individual had moved on with his or her life. Some had already received psychological treatment and some did not want to talk about their complaints.

The Regional Medical Ethical Committee and the Medical Ethical Board of the Academic Medical Centre Amsterdam gave approval for this study. Anonymised medical records were made available for this study, and the requirement to obtain consent for the use of these data was waived by the Medical Ethical board. All participants gave oral informed consent for participation in the CHS study; the parents of adolescents (15-18 years at time of the crash) also gave consent for their participation. The inclusion criterion was age above 14 years.

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 of 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; scores range from 0 (asymptomatic) to 10 (14) A score ≥6 was considered to indicate that the individual was at risk of PTSD. (15) The TSQ is considered to accurately identify individuals at risk of a PTSD diagnosis using this threshold, when compared with a “gold standard”, clinician-administered interview; sensitivities of 0.76-0.86 and specificities of 0.93-0.97 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). Total score ranges from 0 to 6. A cut-off score of 3 was used to identify those at risk of depression. (16) The PHQ-2 score ≥3 has been found to correspond well with formal diagnosis; sensitivities of 0.83-0.87 and specificities of 0.78-0.92 have been reported. (16; 18) To address our second research question, Injury Severity Score (ISS) length of stay...
in hospital (LOS) and seating position in the airplane were measured. (17) Sixty four victims were admitted to a hospital for 1 or more days. Information about seating position in the airplane was provided by the Dutch Safety Board. We used seating position as a proxy for the difficulty of victims to get to safety after the crash, as measured by the distance to the nearest escape. Number of seats and rows, survivors had to pass before reaching the nearest exit were counted. Scores ranged from 0 (next to exit) to 10.

Table 1. Demographics and physical injury of the participants

<table>
<thead>
<tr>
<th></th>
<th>Adult Survivors (N=121)</th>
<th>Round 1 (N=82)</th>
<th>Round 2 (N=76)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%) M (SD)</td>
<td>N (%) M (SD)</td>
<td>Sig N M (SD)</td>
<td>Sig N M (SD)</td>
</tr>
<tr>
<td>Male</td>
<td>85 (70) 55 (67)</td>
<td>49 (65)</td>
<td>42 (66)</td>
</tr>
<tr>
<td>Female</td>
<td>36 (30) 27 (33)</td>
<td>27 (35)</td>
<td>27 (35)</td>
</tr>
<tr>
<td>Dutch</td>
<td>60 (50) 47 (57)</td>
<td>45 (59)</td>
<td>45 (60)</td>
</tr>
<tr>
<td>Turkish</td>
<td>46 (38) 28 (34)</td>
<td>26 (34)</td>
<td>25 (35)</td>
</tr>
<tr>
<td>Other**</td>
<td>15 (12) 7 (9)</td>
<td>5 (7)</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Age*</td>
<td>40.2 (13.2)</td>
<td>40.4 (13.7)</td>
<td>41.7 (14.1)</td>
</tr>
<tr>
<td>ISS</td>
<td>6.6 (9.3)</td>
<td>5.4 (6.5)</td>
<td>6.1 (7.0)</td>
</tr>
<tr>
<td>ISS 0-8</td>
<td>85 (70) 60 (73)</td>
<td>53 (70)</td>
<td>53 (70)</td>
</tr>
<tr>
<td>ISS &gt;8</td>
<td>36 (30) 22 (27)</td>
<td>23 (30)</td>
<td>23 (30)</td>
</tr>
<tr>
<td>LOS</td>
<td>5.2 (12.4)</td>
<td>4.2 (8.1)</td>
<td>4.5 (8.3)</td>
</tr>
<tr>
<td>Days at hospital</td>
<td>64 (53) 42 (50)</td>
<td>41 (54)</td>
<td>41 (54)</td>
</tr>
</tbody>
</table>

*In 2009. **Other nationalities were mostly Iranian, American, English and Syrian. ***We tested whether the deviation of Turkish and Dutch survivors differed from the participants at round 1 and round 2. For other nationalities, groups were too small for Chi Square analysis.

Analysis

To examine the characteristics of the participants and investigate our first research question, descriptive statistics, independent t-tests and chi-square tests were conducted. To test our second research question, bivariate correlations (Pearson), mixed design ANOVAs and independent t-tests were conducted. Bivariate correlations were used to examine the association between demographic variables (age, gender), trauma characteristics (ISS, LOS as continuous variables) and symptoms of PTSD and depression at 2 and 9 months after the crash. Mixed design ANOVAs were conducted to examine if ISS and hospitalisation (as dichotomous
variables) were related to the course of PTSD symptoms and depressive symptoms between 2 and 9 months after the crash. We used an ISS threshold of 8, and compared survivors with no or minor injuries (ISS = 0-8) and moderate to severe injuries (ISS ≥ 9). (18) Participants who were admitted to hospital for 1 or more days were compared with participants who were not hospitalised. With independent t-tests we examined whether the number of seats and rows survivors had to pass before reaching the nearest exit differed between participants at high risk of PTSD or depression compared participants at low risk.

Statistics were computed in SPSS® Statistics 20, with p-levels of < 0.05 taken to indicate statistical significance.

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 at both time points. There were no significant differences in the distribution of gender, age and nationality between the total population of survivors of the crash and participants who completed the study protocol.

After the crash 3 were not injured (ISS = 0) and 118 survivors were injured (ISS > 0). Many of the survivors (45%, n = 54) had an ISS score of 1 (e.g. bruises, lacerations). Thirty percent (n = 36) were moderately to severely injured e.g. fractures, multiple trauma (ISS score > 8). Fifty-three percent of survivors (n = 64) were admitted to a hospital after being treated in the emergency department. Of those hospitalized, 33% (n = 21) stayed in hospital for longer than 1 week and 3 participants were hospitalized for more than 1 month.

Table 1 includes the ISS and LOS for the population of adult survivors and the samples at time points 1 and 2. There was no difference between the study sample and the population of adult survivors in terms of mean scores on the ISS and LOS. Table 1 also shows that the group distribution of the survivor population and the study sample did not differ with respect to injury severity and hospitalisation.

Research question 1: High-risk groups of PTSD and depression
At time points 1 and 2, 47% of the participants (n = 33 and n = 35 respectively) were considered to be at risk of PTSD (a score of ≥ 6). Mean TSQ scores were 5.23 at time
point 1 (SD = 3.45, N = 70) and 4.79 at time point 2 (SD = 3.47, N = 75). Furthermore, 34% (n = 27) of participants at time point 1 and 32% (n = 24) of participants at time point 2 were at risk of depression (a score of ≥ 3). Mean PHQ-2 scores were 2.09 at time point 1 (SD = 1.99, N = 80) and 1.84 at time point 2 (SD = 1.84, N = 76).

Table 2. Mean TSQ score related to ISS and hospitalisation.

<table>
<thead>
<tr>
<th>ISS</th>
<th>TSQ Round 1</th>
<th>TSQ Round 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-8</td>
<td>N (64)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>ISS</td>
<td>46</td>
<td>5.0 (3.4)</td>
</tr>
<tr>
<td>ISS≥9</td>
<td>18</td>
<td>5.7 (3.7)</td>
</tr>
<tr>
<td>Not hospitalised</td>
<td>30</td>
<td>5.0 (3.3)</td>
</tr>
<tr>
<td>Hospitalised</td>
<td>34</td>
<td>5.4 (3.6)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>ISS</th>
<th>PHQ-2 Round 1</th>
<th>PHQ-2 Round 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-8</td>
<td>N (66)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>ISS</td>
<td>47</td>
<td>1.8 (2.0)</td>
</tr>
<tr>
<td>ISS≥9</td>
<td>19</td>
<td>2.1 (1.6)</td>
</tr>
<tr>
<td>Not hospitalised</td>
<td>31</td>
<td>1.7 (2.0)</td>
</tr>
<tr>
<td>Hospitalised</td>
<td>35</td>
<td>2.1 (1.8)</td>
</tr>
</tbody>
</table>

Research question 2: Relation between symptoms of PTSD, depression and physical injury

At time point 2, longer LOS correlated with a higher TSQ score (r = 0.27, p < 0.05) and PHQ-2 score (r = 0.34, p < 0.05). At time point 1 there was no such correlation. ISS was not associated with TSQ or PHQ-2 score at either time point. Age and gender were not associated with TSQ and PHQ-2 scores.

Tables 2 and 3 show mean TSQ and PHQ-2 scores for participants grouped by injury severity and hospitalisation. There was no interaction between TSQ score and ISS (p =0.29) or between PHQ-2 score and ISS (p = 0.50), indicating that the course of PTSD symptoms and depressive symptoms did not differ significantly between high and low ISS participants. In addition no main effect of time on the course of PTSD symptoms (p =0.43) or depressive symptoms (p =0.76) were found, indicating that there was no significant decrease in TSQ and PHQ-2 scores between 2 and 9 months after the crash.

There was also no significant interaction between hospitalization and TSQ score (p = 0.055) and between hospitalisation and PHQ-2 score (p = 0.65), indicating that the course of PTSD symptoms and depressive symptoms was not different for
hospitalized participants and non-hospitalized participants. In addition, there was no significant main effect of time on the course of PTSD symptoms ($p = 0.12$) and depressive symptoms ($p = 0.50$), indicating that there was no significant decrease in TSQ and PHQ-2 scores between 2 and 9 months after the crash.

The seating distribution of participants at risk of PTSD or depression at time point 1 and/or 2 in the airplane is shown in Figure 2. Visual inspection of this figure suggests no relationship between seating position and later being at risk of PTSD or depression. It shows that survivors later assessed as at risk were spread throughout the airplane. Independent t-tests showed no difference between participants at high risk compared to participants at low risk of PTSD or depression at time points 1 and 2 with respect to the number of seats and rows survivors had to pass before reaching the nearest exit.

Discussion

The first research question focused on the risk of developing PTSD and depression in 82 survivors of a commercial airplane crash near Amsterdam, in the Netherlands. We found that 47% of survivors were at risk of PTSD 2 months after the crash, the same percentage were at risk for PTSD 9 months after the crash. The prevalence of risk of depression was 34% 2 months after the crash and 32% 9 months after the crash. These rates are relatively high, compared to previously reported prevalence of 10%. (2; 19) There are a number of possible reasons for this. First, 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; 20) Proximity varies between events, but is generally high in accidents. This explanation is supported by the findings from two previous studies on PTSD and depression after an airplane crash. In 1988 Sloan assessed 32 survivors of a non-fatal charter flight crash and found initially intense stress that subsided over the following months. (21) In line with our results, Gregg at al. found that 40% of survivors of an airplane crash in England in which 47 people died and most of the 79 survivors were injured had a PTSD diagnosis and 33% had a diagnosis of major depression in the year after the crash. (5) There is also a high risk of mental health problems after motor vehicle accidents, although some studies have produced contradictory results. (22-25) (26; 27) A second explanation for the rather high PTSD and depression rates relates to the use of self-report screening instruments. These are known to over-estimate mental health problems compared
to structured clinical interviews. (28) This explanation alone 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; 29; 30) 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 for the high rates relates to cultural differences. Drogendijk et al. found that Turkish migrant victims of a disaster scored considerably higher than native Dutch victims on instruments assessing mental health problems and posttraumatic stress. (31; 32) 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 relates to the mental health care survivors received after the incident. Some survivors may not have received the mental health care they needed, and this is more than likely, given that occupants of the airplane originated from several countries. Survivors can be dissatisfied with the support provided after an airplane crash, however in this case the CHS actively sought to identify all survivors with mental health problems and to help them find appropriate, local psycho-social care. (33) Nonetheless 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, hospitalisation and distance to an exit were not associated with the course of symptoms of PTSD and depression. Those at risk of PTSD or depression were also not overly represented at the front of the airplane, where the severe and critical injuries occurred. This result is in line with previous studies that did not find any relationship between physical injuries and mental problems. (9-11) It also confirms previous findings that subjective experience of the severity of an event may be more important than objective indicators of trauma severity (such as ISS, hospitalization or seating position). (9; 25; 34) Although stringent ANOVA analyses found no association, length of stay in a hospital has a significant correlation with symptoms of PTSD and symptoms of depression 9 months after the crash. This is consistent with the findings of Sijbrandij et al. who reported that injury tends to be associated with late onset symptoms rather than early symptoms. (9) This may be because survivors focus on physical recovery first and become aware of psychological distress later. In the long term, survivors may become functionally impaired and have work or relationship difficulties that may contribute to symptoms of depression and PTSD. (35)
Figure 2 Seating arrangement for those at risk of PTSD and depression
Limitations

This study has a number of limitations. Obviously sample size was limited, which reduced the statistical power of the study. The TSQ does not measure the whole spectrum of PTSD symptoms; specifically it does not address avoidance symptoms. This could have resulted in misclassification of individuals in our sample with undetected symptoms of PTSD. Finally, because this study 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.

Given these limitations, we strongly recommend future research to confirm our findings, using different and larger samples with varying severity of physical injury. This would improve the understanding of differences in the relationship between proximity to a stressor and subjective and objective injury.

Conclusions

Almost half the survivors of the airplane crash are at risk of PTSD and a third of depression. Objectively measured physical injuries and hospitalisation had no association with the 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 physical 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.
References


Chapter 11


