



Original Research

Post-traumatic stress disorder prevalence and sleep quality in fire victims and rescue workers in southern Brazil: a cross-sectional study[☆]



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ARTICLE INFO

Article history:

Received 30 July 2021

Received in revised form

17 March 2022

Accepted 8 May 2022

Available online 21 June 2022

Keywords:

PTSD

Sleep quality

Post-traumatic stress

Nightclub fire

Victims

Rescue workers

ABSTRACT

Objectives: This survey was conducted to evaluate the prevalence of post-traumatic stress disorder (PTSD) and the sleep quality in victims and rescue team of the third deadliest nightclub fire in the world. **Study design:** A cross-sectional study.

Methods: Participants were victims and rescue workers exposed to a fire at a nightclub, which occurred in January 2013 in Southern Brazil. The Pittsburgh Sleep Quality Index (PSQI), composed of seven subjective sleep variables (including daytime dysfunction), and PTSD Checklist – Civilian version (PCL-C) were applied to all people who sought medical attention at the local reference center in the first year after the event. Comprehensive information was obtained concerning sociodemographic factors, health status, and sleep complaints.

Results: A total of 370 individuals, 190 victims and 180 rescue workers, were included. Participants were 70% male, with an average age of 29 years. The prevalence of PTSD was 31.9%, ranging from 24.4% for rescue workers to 38.9% for victims. The prevalence of poor sleep quality was 65.9%, ranging from 56.1% for rescue workers to 75.3% for victims. Most of the participants with PTSD (91.5%) had PSQI scores >5 (poor sleepers), against 54.0% of the non-PTSD individuals. All seven PSQI subscores showed significant differences between PTSD and non-PTSD individuals, especially daytime dysfunction. Sex, shift work, previous psychiatric disease, and sleep quality remained associated with PTSD in adjusted models, with a prevalence ratio (95% CI) of 1.76 (1.28–2.43) in females, 1.73 (1.17–2.55) in shift workers, 1.36 (1.03–1.80) in individuals with psychiatric disease history, and 5.42 (2.55–11.52) in poor sleepers.

Conclusions: The presence of daytime dysfunction increased by at least tenfold the prevalence of PTSD in this sample. Considering that daytime dysfunction was shown to be strongly associated with PTSD, sleep-related issues should be addressed in the assessment of individuals exposed to traumatic events, both victims and rescuers. Factors like shift work and female sex were also associated with PTSD, especially among victims.

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[☆] This work was carried out at Hospital Universitário de Santa Maria and Hospital de Clínicas de Porto Alegre, Brazil.

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Introduction

The Kiss nightclub fire erupted on 27 January 2013 in Santa Maria, a city located in Southern Brazil, killing 242 people and leaving hundreds injured. Most of the victims were university students aged between 18 and 30 years. It is ranked as the third deadliest nightclub fire in the world, topped only by the fire in Luoyang (China) in December 2000, which killed 309 people, and the Coconut Grove fire (Boston, USA) in November 1942, which killed 491 people. In addition to being an emotionally traumatic

event to all survivors, a part of them also experienced physical injuries, such as skin burns and airway damage.

Exposure to traumatic events is a common experience worldwide. According to epidemiologic studies, more than 70% of adults worldwide will experience a traumatic event at some point in their lives, and 30.5% will experience four or more events.^{1,2} One of the most prevalent psychiatric consequences of exposure to traumatic events is post-traumatic stress disorder (PTSD). The lifetime prevalence of PTSD depends on social background and country of residence, ranging from 1.0 to 14.0%, with a 1-year prevalence of 0.2 to 3.8%.^{2–7} Important PTSD-related symptoms include changes or even disturbances in sleep patterns. Recurrent nightmares and insomnia are the most common distressing sleep symptoms, although other sleep disturbances have been associated with PTSD, including periodic limb movement disorder, rapid-eye-movement sleep behavior disorder, and obstructive sleep apnea.^{8,9} Approximately 70% of individuals with PTSD report difficulty in initiating and maintaining sleep.^{7,8,10} The prevalence rate of nightmares in PTSD varies because of differences in methodology, ranging from 50 to 96%, the latter in patients with current comorbid panic disorder.^{10,11} Nightmares may also predict the subsequent development of PTSD and other psychiatric disorders.^{7,10,12–15}

Many factors have been associated with increased susceptibility to PTSD, such as female sex, fewer years of schooling, prior mental disorders, exposure to four or more traumatic events, age at trauma, race, and type of trauma.^{2,16,17} The prevalence of PTSD in the first year after a disaster has been documented to range from approximately 25 to 60% among direct victims^{18–20} and from 5 to 40% among rescue workers,^{21–26} suggesting a higher prevalence of PTSD in direct survivors of disasters than in rescue workers. However, a few studies have compared samples of rescue workers and survivors of a major disaster, allowing direct comparison between the two groups. An example is the study carried out after the 1995 Oklahoma City bombing, where the prevalence of PTSD related to the bombing was significantly lower in rescue workers (13%) than in primary victims (23%).²⁷

Studies conducted after traumatic events with countless victims are unique in that they allow researchers to evaluate the emotional response to a traumatic exposure in different groups of individuals, such as rescue workers, survivors, children, and health workers, among others. Thus, the present study was conducted to evaluate the prevalence of PTSD symptoms and sleep quality in individuals exposed to a large nightclub fire that occurred in Southern Brazil. In addition, it was analyzed which subjective sleep data were most related to the presence of PTSD symptoms. The assessments were carried out during the first year after the tragedy and the composition of the sample allowed us to compare the results between victims and rescue/recovery workers. And finally, potential factors associated with PTSD symptoms were identified.

Methods

Study design, setting, and participants

We conducted a cross-sectional survey of individuals (directly or indirectly) exposed to a fire at a nightclub, which occurred in January 2013 in Southern Brazil, as part of a cohort study initiated in 2013. For the present study, only the first evaluations performed during the first year (from February 2013 to January 2014) were considered. The research protocol and the questionnaires — Pittsburgh Sleep Quality Index (PSQI) and PTSD Checklist — Civilian version (PCL-C) — were applied to all individuals who underwent a clinical evaluation at the Pulmonology Service of Hospital Universitário de Santa Maria (HUSM), Brazil. The individuals were referred from the Accident Victims Service Center (CIAVA), a

multidisciplinary center specially created at HUSM to care for those involved in the fire. Individuals who could not understand the questions or who had inadequately completed the questionnaires were excluded from the study.

Comprehensive information was obtained concerning socio-demographic factors, general health status, and sleep complaints. For each participant, the following data were recorded: age (on the date of the event), sex, race (self-reported), marital status, level of education, elapsed time of the event, occupational category, smoking status, previous psychiatric disease, groups, type of exposure, and use of psychiatric medications. Data on shift work were collected in later evaluations or by telephone contact. The type of exposure was classified as follows: (a) individuals who were inside the nightclub when the fire started; (b) those who later entered the nightclub; (c) individuals who stood in front of the nightclub; and (d) those who were not at the site of the fire. The aforementioned classification was carried out irrespective of the grouping (victims or rescue workers), and according to the different places of exposure to the event.

Research tools

Sleep quality was estimated based on the validated Brazilian Portuguese version of the PSQI.²⁸ The PSQI assesses sleep quality over a 1-month period. The questionnaire consists of 19 self-rated questions, categorized into seven components, graded on a score that ranges from 0 to 3. The PSQI components are as follows: subjective sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), sleep disturbances (C5), use of sleep medication (C6), and daytime dysfunction (C7). The sum of the scores for the seven components yields a global score, which ranges from 0 to 21, where higher scores indicate worse sleep quality. Using a cut-off score of 5, the sensitivity and specificity are 89.6% and 86.5%, respectively, for identifying cases with sleep disorder.²⁹ Thus, participants were considered 'poor sleepers' if the global PSQI score was >5 and 'good sleepers' if ≤5.

PTSD symptoms were scored using the validated Brazilian Portuguese version of the PCL-C self-report questionnaire.³⁰ The 17 items of the PCL-C incorporate the PTSD symptom clusters delineated in the DSM-IV.^{31,32} The first five items refer to re-experience symptoms (criterion B), the next seven items refer to emotional avoidance/numbing (criterion C), and the last five items address hyperarousal (criterion D). For this study, we chose the global score to categorize the participants into probable PTSD and non-PTSD. The global PCL-C score ranges from 17 to 85. Participants with a score ≥44 were considered to have probable PTSD. Using a cut-off score of 44, the sensitivity and specificity are 94.4% and 86.4%, respectively.³¹

Statistical analysis

Quantitative variables were expressed as mean (SD) or as median (interquartile range [IQR]) when the Kolmogorov–Smirnov test showed asymmetry, and qualitative variables were expressed as percentage values. Two-tailed *P*-values of 0.05 or less were regarded as statistically significant, and 95% confidence intervals (CI) were calculated for the results.

For comparisons between groups, the Chi-squared test or Fisher's exact test was used for qualitative variables, and the Mann–Whitney U test or *t*-test for quantitative variables. A *P*-value <0.05 was considered to be statistically significant.

Poisson regression models with robust variance were used to analyze the adjusted associations among the variables. The following criteria were considered to include covariates in the adjusted regression models: (a) characteristics associated with the

outcome in the univariate analysis; (b) if there was not multicollinearity; and (c) if there was enough frequency in the categories. The predictors of PTSD symptoms in the total study sample were analyzed using the following covariates: sex, group, type of exposure, previous psychiatric disease, shift work, and sleep quality. Predictors of PTSD in victims and rescue workers were also evaluated separately.

The associations between the subjective sleep variables and PTSD were assessed separately, using PTSD as dependent variable. Afterwards, we did an analysis adjusted for PSQI subscores to identify the subjective sleep variables most associated with PTSD.

All analyses were performed by using SPSS for Windows, version 23.0 (SPSS Inc., Chicago, IL).

Ethical aspects

The study protocol was approved by the Research Ethics Committee of Universidade Federal de Santa Maria (UFSM) and subsequently by the Graduate Research Program of Hospital de Clínicas de Porto Alegre (HCPA). All patients signed an informed consent form before their inclusion in the study.

Results

Characteristics of the groups

A total of 370 individuals, 190 victims and 180 rescue workers, directly or indirectly exposed to the fire, underwent a clinical evaluation, properly completed the questionnaires, and signed the

informed consent form, being included in the study (Fig. 1). The sociodemographic characteristics of the participants are shown in Table 1.

PSQI and PCL-C scores

Most of the individuals with PTSD (91.5%) had PSQI scores >5 (poor sleepers), against 54.0% of the non-PTSD individuals. The association between subjective sleep data, expressed by the PSQI subscores, and PTSD are shown in Table 2. All seven PSQI subscores showed significant differences between PTSD and non-PTSD individuals. The adjusted prevalence ratio of these sleep parameters according to PTSD status identified daytime dysfunction as the subjective sleep parameter most closely associated with PTSD (Table 2).

The PCL-C and PSQI scores were also analyzed in 31 individuals (8.4%) who had burns, but no significant difference was found when compared to those who did not have burns ($P = 0.226$ and $P = 0.516$, respectively). Similar results were observed in 92 individuals (24.9%) who were hospitalized ($P = 0.331$ and $P = 0.283$, respectively) vs nonhospitalized individuals, and in 56 individuals (15.1%) who lost consciousness at the scene of the fire ($P = 0.274$ and $P = 0.411$, respectively) vs those who did not lose consciousness.

Factors associated with PTSD

The following factors were associated with PTSD: female sex, being a victim, previous history of psychiatric disease, and being inside the nightclub during the fire (Table 3). However, when

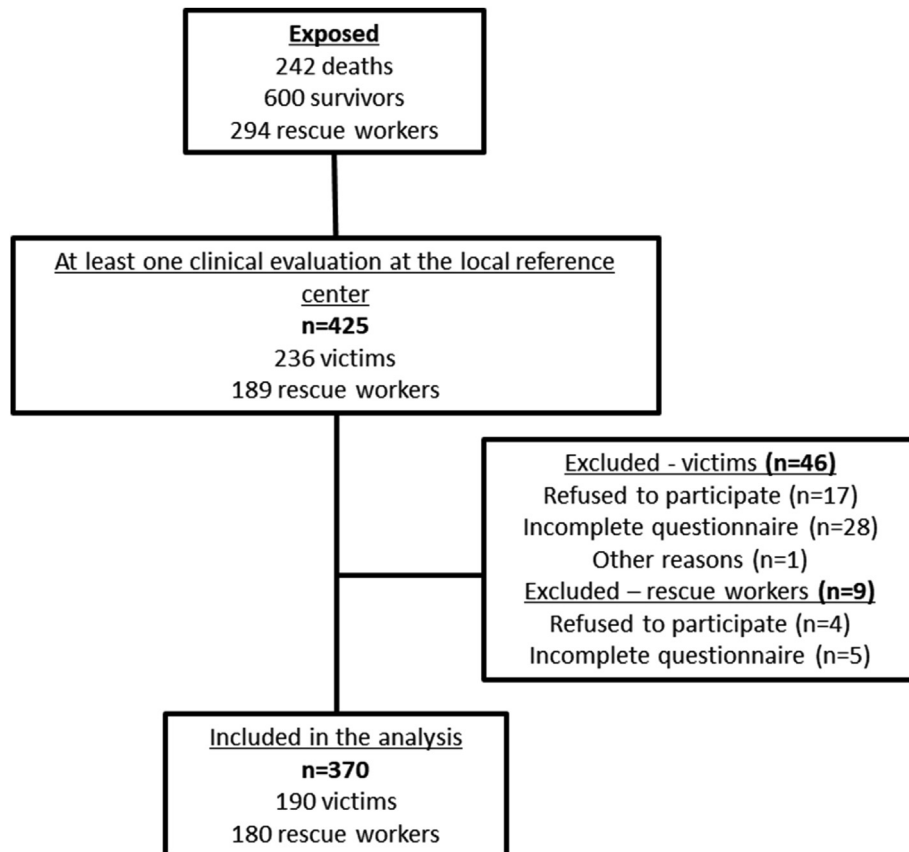


Fig. 1. Flowchart of inclusion and exclusion of patients.

Table 1
Sociodemographic characteristics, presence of PTSD, and sleep quality in victims and rescue workers.

| Variable | Total | Victims | Rescue workers | P-value ^a |
|--|--------------|-------------------------|-------------------------|----------------------|
| Number of individuals, n (%) | 370 | 190 (51.4) | 180 (48.6) | – |
| Male sex, n (%) | 261 (70.5) | 103 (54.2) | 158 (87.8) | <0.001 |
| Age (years), mean (SD) | 29.46 (9.59) | 24.79 (7.98) | 34.39 (8.65) | <0.001 |
| Time elapsed since event, n (%) | | | | |
| 0–6 months | 299 (80.8) | 144 (75.8) | 155 (86.1) ^b | 0.017 |
| 7–12 months | 71 (19.2) | 46 (24.2) ^b | 25 (13.9) | |
| Race, n (%) | | | | |
| White | 343 (92.7) | 169 (88.9) | 174 (96.7) ^b | 0.012 |
| Black | 6 (1.6) | 5 (2.6) | 1 (0.6) | |
| Other | 21 (5.7) | 16 (8.4) ^b | 5 (2.8) | |
| Marital status, n (%) | | | | |
| Never married | 202 (54.6) | 165 (86.8) ^b | 37 (20.6) | <0.001 |
| Married or cohabiting | 145 (39.2) | 17 (8.9) | 128 (71.1) ^b | |
| Divorced/Widowed | 23 (6.2) | 8 (4.2) | 15 (8.3) | |
| Level of education, ^c n (%) | | | | |
| Up to 8 years | 13 (3.5) | 10 (5.3) | 3 (1.7) | <0.001 |
| 9–11 years | 165 (44.6) | 55 (28.9) | 110 (61.1) ^b | |
| >11 years | 192 (51.9) | 125 (65.8) ^b | 67 (37.2) | |
| Occupational category, n (%) | | | | |
| Student | 105 (28.4) | 105 (55.3) ^b | – | <0.001 |
| Military police officer ^d | 175 (47.3) | – | 175 (97.2) ^b | |
| Security guard/watchman/Civil police officer/prison guard/military | 21 (5.7) | 16 (8.4) ^b | 5 (2.8) | |
| Associate's degree ^e | 24 (6.5) | 24 (12.4) ^b | – | |
| Professional degree ^f | 32 (8.6) | 32 (16.8) ^b | – | |
| Other ^g | 13 (3.5) | 13 (6.8) ^b | – | |
| Shift work, ^h n (%) | 124 (40.0) | 21 (11.1) | 103 (85.1) | <0.001 |
| Smoking status, n (%) | | | | |
| Current smoker | 36 (9.7) | 23 (12.1) | 13 (7.2) | 0.007 |
| Never smoked | 309 (83.5) | 161 (84.7) | 148 (82.2) | |
| Ex-smoker | 25 (6.8) | 6 (3.2) | 19 (10.6) ^b | |
| Previous psychiatric disease, n (%) | 52 (14.1) | 39 (20.5) | 13 (7.2) | <0.001 |
| Type of exposure, n (%) | | | | |
| Far from the nightclub | 54 (14.6) | – | 54 (30.0) ^b | <0.001 |
| In front of the nightclub | 44 (11.9) | 17 (8.9) | 27 (15.0) | |
| Later entered the nightclub | 99 (26.8) | – | 99 (55.0) ^b | |
| Inside the nightclub | 173 (46.8) | 173 (91.1) ^b | – | |
| Use of psychiatric medications, ⁱ n (%) | 70 (21.7) | 53 (27.9) | 17 (12.8) | 0.002 |
| PSQI, n (%) | | | | |
| Good sleeper (≤ 5) | 126 (34.1) | 47 (24.7) | 79 (43.9) | <0.001 |
| Poor sleeper (>5) | 244 (65.9) | 143 (75.3) | 101 (56.1) | |
| Stress (PCL-C), n (%) | | | | |
| PTSD | 118 (31.9) | 74 (38.9) | 44 (24.4) | 0.004 |
| Non-PTSD | 252 (68.1) | 116 (61.1) | 136 (75.6) | |

PCL-C = PTSD Checklist – Civilian version; PSQI = Pittsburgh Sleep Quality Index; PTSD = post-traumatic stress disorder; SD = standard deviation.

^a Qualitative variables were analyzed by the Chi-squared test or Fisher's exact test, whereas quantitative variables were analyzed by the Mann–Whitney U test or t-test.

^b Adjusted residuals >1.96.

^c The level of education was classified according to years of schooling in Brazil, where the first level corresponds to the period of elementary school, the second level to high school, and the third from college to postgraduation.

^d Twenty-eight firefighters are included in this category.

^e An associate's degree includes: agricultural technician, clinical analysis technician, accounting technician, administrative technician, real estate agent, secretary, nursing technician, trade representative, receptionist, and telecommunications technician.

^f A professional degree includes: administrator, dentist, tourismologist, medical doctor, pharmacist, designer, architect, professor, teacher, civil engineer, veterinarian, physiotherapist, accountant, physical educator, psychologist, environmental engineer, and journalist.

^g 'Other' includes: cook's assistant, deliveryman, waitress, manicurist, taxi driver, locksmith, agriculturalist, and bricklayer.

^h Missing = 60; seven staff members of the nightclub who were shift workers are included in the victim group.

ⁱ Psychiatric medications included antidepressants, antipsychotics, sleep inducers (benzodiazepines and non-benzodiazepines), mood stabilizers, and anticonvulsants. Missing = 47 (all from the rescue worker group).

the values were adjusted, there was an increased PTSD prevalence in shift workers, individuals with previous psychiatric disease, women, and individuals with poor sleep quality. As shown in Table 3, the crude prevalence ratio (95% CI) of 0.95 (0.69–1.32) in shift work was not statistically significant. Shift work was associated with PTSD symptoms only after adjustment, with a prevalence ratio (95% CI) of 1.70 (1.14–2.54) when adjusted for group, 2.06 (1.34–3.17) if adjusted for group and sex, and 1.73 (1.17–2.55) when adjusted for group, sex, type of exposure, previous psychiatric disease, and sleep quality. It is worth noting that most shift workers were men, where a lower prevalence of PTSD was observed in relation to women, and

rescue workers, also with a lower prevalence of PTSD when compared to victims.

Differences between victims and rescue workers

In the victim group, the prevalence of PTSD was higher in shift workers (68.2%) than in nonshift workers (35.1%) ($P = 0.006$). This result remained after adjustment for sex, age, marital status, previous psychiatric disease, sleep quality, and shift work, with a prevalence ratio of 1.90 (95% CI, 1.34–2.71). Also, a higher prevalence remained in women, older individuals, and poor sleepers ($P < 0.001$, $P = 0.035$, and $P = 0.004$, respectively).

Table 2
Sleep parameters according to post-traumatic stress disorder (PTSD) status.

| Variable | Total | Non-PTSD | PTSD | P-value ^a | Crude PR | Adjusted PR ^f |
|---|-----------------|-------------------------|------------------------|----------------------|-----------------------|--------------------------|
| Number of individuals | 370 | 252 (68.1) | 118 (31.9) | — | — | |
| PSQI global ^e (median/interquartile range) | 7.00/4.00–10.25 | 6.00/4.00–8.75 | 11.00/8.00–14.00 | <0.001 | 1.16 (1.14–1.19) | |
| Subscore 1 – PSQI | | | | | | |
| Subjective sleep quality, n (%) | | | | | | |
| ‘Very good’ | 37 (10.0) | 34 (13.5) ^b | 3 (2.5) | <0.001 | 1 (REF.) | 1 (REF.) |
| ‘Fairly good’ | 211 (57.0) | 170 (67.5) ^b | 41 (34.7) | | 2.40 (0.78–7.34) | 0.98 (0.36–2.62) |
| ‘Fairly bad’ | 98 (26.5) | 47 (18.7) | 51 (43.2) ^b | | 6.42 (2.13–19.30) | 1.39 (0.52–3.75) |
| ‘Very bad’ | 24 (6.5) | 1 (0.4) | 23 (19.5) ^b | | 11.82 (3.98–35.08) | 2.23 (0.82–6.06) |
| Subscore 2 – PSQI | | | | | | |
| Sleep latency, n (%) | | | | | | |
| ‘No difficulty’ | 63 (17.0) | 58 (23.0) ^b | 5 (4.2) | <0.001 | 1 (REF.) | 1 (REF.) |
| ‘Mild difficulty’ | 98 (26.5) | 82 (32.5) ^b | 16 (13.6) | | 2.06 (0.79–5.34) | 1.32 (0.56–3.14) |
| ‘Moderate difficulty’ | 128 (34.6) | 79 (31.3) | 49 (41.5) | | 4.82 (2.02–11.50) | 1.96 (0.83–4.62) |
| ‘Severe difficulty’ | 81 (21.9) | 33 (13.1) | 48 (40.7) ^b | | 7.47 (3.16–17.65) | 2.30 (0.97–5.45) |
| Subscore 3 – PSQI | | | | | | |
| Sleep duration, n (%) | | | | | | |
| >7 h | 168 (45.4) | 131 (52.0) ^b | 37 (31.4) | <0.001 | 1 (REF.) | 1 (REF.) |
| 6–7 h | 108 (29.2) | 78 (31.0) | 30 (25.4) | | 1.26 (0.83–1.91) | 0.77 (0.54–1.10) |
| 5–6 h | 66 (17.8) | 32 (12.7) | 34 (28.8) ^b | | 2.34 (1.62–3.38) | 1.12 (0.78–1.61) |
| <5 h | 28 (7.6) | 11 (4.4) | 17 (14.4) ^b | | 2.76 (1.83–4.16) | 0.74 (0.47–1.17) |
| Subscore 4 – PSQI | | | | | | |
| Habitual sleep efficiency, n (%) | | | | | | |
| >85% | 202 (54.6) | 157 (62.3) ^b | 45 (38.1) | <0.001 | 1 (REF.) | 1 (REF.) |
| 75–84% | 91 (24.6) | 58 (23.0) | 33 (28.0) | | 1.63 (1.12–2.37) | 1.21 (0.87–1.69) |
| 65–74% | 39 (10.5) | 23 (9.1) | 16 (13.6) | | 1.84 (1.17–2.90) | 1.11 (0.73–1.69) |
| <65% | 38 (10.3) | 14 (5.6) | 24 (20.3) ^b | | 2.84 (1.99–4.04) | 1.04 (0.69–1.59) |
| Subscore 5 – PSQI | | | | | | |
| Sleep disturbances, n (%) | | | | | | |
| ‘No difficulty’ | 16 (4.3) | 16 (6.3) ^b | — | <0.001 | 1 (REF.) ^g | 1 (REF.) ^g |
| ‘Mild difficulty’ | 169 (45.7) | 141 (56.0) ^b | 28 (23.7) | | | |
| ‘Moderate difficulty’ | 158 (42.7) | 90 (35.7) | 68 (57.6) ^b | | 2.84 (1.93–4.18) | 1.17 (0.78–1.77) |
| ‘Severe difficulty’ | 27 (7.3) | 5 (2.0) | 22 (18.6) ^b | | 5.38 (3.66–7.92) | 1.30 (0.81–2.07) |
| Subscore 6 – PSQI | | | | | | |
| Use of sleep medication, n (%) | | | | | | |
| Not during the past month | 265 (71.6) | 199 (79.0) ^b | 66 (55.9) | <0.001 | 1 (REF.) | 1 (REF.) |
| Less than once a week | 26 (7.0) | 17 (6.7) | 9 (7.6) | | 1.39 (0.79–2.45) | 0.85 (0.49–1.49) |
| Once or twice a week | 28 (7.6) | 16 (6.3) | 12 (10.2) | | 1.72 (1.07–2.77) | 0.82 (0.55–1.22) |
| Three or more times a week | 51 (13.8) | 20 (7.9) | 31 (26.3) ^b | | 2.44 (1.80–3.31) | 1.00 (0.74–1.35) |
| Subscore 7 – PSQI | | | | | | |
| Daytime dysfunction, n (%) | | | | | | |
| ‘No difficulty’ | 102 (27.6) | 100 (39.7) ^b | 2 (1.7) | <0.001 | 1 (REF.) | 1 (REF.) |
| ‘Mild difficulty’ | 136 (36.8) | 97 (38.5) | 39 (33.1) | | 14.63 (3.62–59.17) | 10.78 (2.59–44.91) |
| ‘Moderate difficulty’ | 92 (24.9) | 44 (17.5) | 48 (40.7) ^b | | 26.61 (6.65–106.42) | 17.09 (4.17–70.06) |
| ‘Severe difficulty’ | 40 (10.8) | 11 (4.4) | 29 (24.6) ^b | | 36.98 (9.25–147.78) | 17.04 (4.18–69.54) |
| PSQI 10^c | | | | | | |
| ‘Do you have a bed partner or roommate?’, n (%) | | | | | | |
| No | 128 (34.8) | 89 (35.5) | 39 (33.3) | 0.351 | 1 (REF.) | |
| In other room | 30 (8.2) | 18 (7.2) | 12 (10.3) | | 1.31 (0.79–2.19) | |
| In same room, but not same bed | 22 (6.0) | 12 (4.8) | 10 (8.5) | | 1.49 (0.88–2.53) | |
| In same bed | 188 (51.1) | 132 (52.6) | 56 (47.9) | | 0.98 (0.70–1.38) | |
| PSQI 10a^d | | | | | | |
| Loud snoring, n (%) | | | | | | |
| Not during the past month | 113 (47.5) | 84 (52.5) ^b | 29 (37.2) | 0.005 | 1 (REF.) | |
| Less than once a week | 39 (16.4) | 29 (18.1) | 10 (12.8) | | 1.00 (0.54–1.86) | |
| Once or twice a week | 37 (15.5) | 24 (15.0) | 13 (16.7) | | 1.37 (0.80–2.35) | |
| Three or more times a week | 49 (20.6) | 23 (14.4) | 26 (33.3) ^b | | 2.07 (1.37–3.11) | |
| PSQI 10b^d | | | | | | |
| Long pauses between breaths while asleep, n (%) | | | | | | |
| Not during the past month | 202 (84.9) | 147 (91.9) ^b | 55 (70.5) | 0.001 | 1 (REF.) | |
| Less than once a week | 13 (5.5) | 6 (3.8) | 7 (9.0) | | 1.98 (1.14–3.43) | |
| Once or twice a week | 10 (4.2) | 3 (1.9) | 7 (9.0) ^b | | 2.57 (1.62–4.09) | |
| Three or more times a week | 13 (5.5) | 4 (2.5) | 9 (11.5) ^b | | 2.54 (1.66–3.90) | |
| PSQI 10c^d | | | | | | |
| Legs twitching or jerking while you sleep, n (%) | | | | | | |
| Not during the past month | 142 (59.7) | 113 (70.6) ^b | 29 (37.2) | <0.001 | 1 (REF.) | |
| Less than once a week | 32 (13.4) | 22 (13.8) | 10 (12.8) | | 1.53 (0.83–2.81) | |
| Once or twice a week | 35 (14.7) | 17 (10.6) | 18 (23.1) ^b | | 2.52 (1.59–3.98) | |
| Three or more times a week | 29 (12.2) | 8 (5.0) | 21 (26.9) ^b | | 3.55 (2.39–5.26) | |
| PSQI 10d^d | | | | | | |

Table 2 (continued)

| Variable | Total | Non-PTSD | PTSD | P-value ^a | Crude PR | Adjusted PR ^f |
|---|------------|-------------------------|------------------------|----------------------|------------------|--------------------------|
| Episodes of disorientation or confusion during sleep, n (%) | | | | | | |
| Not during the past month | 166 (69.7) | 130 (81.3) ^b | 36 (46.2) | <0.001 | 1 (REF.) | |
| Less than once a week | 34 (14.3) | 21 (13.1) | 13 (16.7) | | 1.76 (1.05–2.95) | |
| Once or twice a week | 23 (9.7) | 5 (3.1) | 18 (23.1) ^b | | 3.61 (2.52–5.18) | |
| Three or more times a week | 15 (6.3) | 4 (2.5) | 11 (14.1) ^b | | 3.38 (2.22–5.15) | |

PR = prevalence ratio; PCL-C = PTSD Checklist – Civilian; PSQI = Pittsburgh Sleep Quality Index.

^a Qualitative variables were analyzed by the Chi-squared test or Fisher's exact test, whereas quantitative variables were analyzed by the Mann–Whitney U test.

^b Adjusted residuals >1.96.

^c Missing = 2.

^d Only individuals who had a bed partner or roommate were included in questions 10a to 10d; Does not apply = 128; Missing = 2.

^e Asymmetric by the Kolmogorov–Smirnov test ($P < 0.001$).

^f Adjusted for PSQI Subscore 1, Subscore 2, Subscore 3, Subscore 4, Subscore 5, Subscore 6, and Subscore 7.

^g The sum of the first and second scores ('no difficulty' and 'mild difficulty') was used as a reference.

Table 3

Predictors of PTSD among the total study sample.

| Variable | N | PTSD, n% | Crude PR ^a | Adjusted PR ^{a,b} |
|--|-----|------------|-----------------------|----------------------------|
| Number of individuals, n (%) | 370 | 118 (31.9) | – | – |
| Sex | | | | |
| Male | 261 | 66 (25.3) | 1 (REF.) | 1 (REF.) |
| Female | 109 | 52 (47.7) | 1.89 (1.42–2.51) | 1.76 (1.28–2.43) |
| Age (in years at event) | | | | |
| Elapsed time after event (months) | | | | |
| 0–6 | 299 | 90 (30.1) | 1 (REF.) | |
| 7–12 | 71 | 28 (39.4) | 1.31 (0.94–1.83) | |
| Race | | | | |
| White | 343 | 109 (31.8) | 1 (REF.) | |
| Black | 6 | 2 (33.3) | 1.05 (0.34–3.29) | |
| Other | 21 | 7 (33.3) | 1.05 (0.56–1.96) | |
| Marital status | | | | |
| Never married | 202 | 69 (34.2) | 1 (REF.) | |
| Married or cohabiting | 145 | 39 (26.9) | 0.79 (0.57–1.10) | |
| Divorced/Widowed | 23 | 10 (43.5) | 1.27 (0.77–2.11) | |
| Level of education | | | | |
| >11 years | 192 | 61 (31.8) | 1 (REF.) | |
| 9–11 years | 165 | 50 (30.3) | 0.95 (0.67–1.30) | |
| Up to 8 years | 13 | 7 (53.8) | 1.70 (0.98–2.92) | |
| Occupational category | | | | |
| Student | 105 | 34 (32.4) | 1 (REF.) | |
| Military police officer | 175 | 42 (24.0) | 0.74 (0.51–1.09) | |
| Security guard/watchman/Civil police officer/prison guard/military | 21 | 10 (47.6) | 1.47 (0.87–2.49) | |
| Associate's degree | 24 | 9 (37.5) | 1.16 (0.65–2.08) | |
| Professional degree | 32 | 14 (43.8) | 1.35 (0.84–2.18) | |
| Other | 13 | 9 (69.2) | 2.14 (1.36–3.37) | |
| Groups | | | | |
| Victims | 190 | 74 (38.9) | 1 (REF.) | 1 (REF.) |
| Rescue workers | 180 | 44 (24.4) | 0.63 (0.46–0.86) | 1.03 (0.50–2.12) |
| Shift work ^c | | | | |
| No | 186 | 63 (33.9) | 1 (REF.) | 1 (REF.) |
| Yes | 124 | 40 (32.3) | 0.95 (0.69–1.32) | 1.73 (1.17–2.55) |
| Smoking status | | | | |
| Current smoker | 36 | 13 (36.1) | 1 (REF.) | |
| Never smoked | 309 | 93 (30.1) | 0.83 (0.52–1.33) | |
| Ex-smoker | 25 | 12 (48.0) | 1.33 (0.73–2.41) | |
| Previous psychiatric disease | | | | |
| No | 318 | 92 (28.9) | 1 (REF.) | 1 (REF.) |
| Yes | 52 | 26 (50.0) | 1.73 (1.25–2.38) | 1.36 (1.03–1.80) |
| Type of exposure | | | | |
| Far from the nightclub | 54 | 10 (18.5) | 1 (REF.) | 1 (REF.) |
| Later entered the nightclub | 99 | 26 (26.3) | 1.42 (0.74–2.72) | 0.92 (0.42–2.01) |
| In front of the nightclub | 44 | 15 (34.1) | 1.84 (0.92–3.69) | 1.47 (0.63–3.41) |
| Inside the nightclub | 173 | 67 (38.7) | 2.09 (1.16–3.77) | 1.55 (0.59–4.04) |
| PSQI | | | | |
| Good sleeper (≤ 5) | 126 | 10 (7.9) | 1 (REF.) | 1 (REF.) |
| Poor sleeper (> 5) | 244 | 108 (44.3) | 5.58 (3.03–10.28) | 5.42 (2.55–11.52) |

PTSD = post-traumatic stress disorder; PR = prevalence ratio; PSQI = Pittsburgh Sleep Quality Index.

^a Values in parenthesis indicate 95% confidence intervals.

^b Adjusted for sex, group, type of exposure, previous psychiatric disease, shift work, and sleep quality.

^c Missing = 60.

In the rescue worker group, a higher prevalence of PTSD was found in poor sleepers and ex-smokers, the latter in comparison with those who never smoked ($P < 0.001$ and $P = 0.034$, respectively). However, only sleep quality remained significant after adjustment for sex, age, shift work, previous psychiatric disease, smoking status, and sleep quality.

The prevalence ratio of PTSD in poor sleepers was 3.45 (95% CI, 1.48–8.02) for victims and 10.59 (95% CI, 2.54–44.20) for rescue workers when adjusted for sex, age, shift work, previous psychiatric disease, and sleep quality. There was no difference in sleep quality between victims and rescue workers in the presence of PTSD. Among non-PTSD individuals, sleep quality was worse in victims than in rescue workers ($P = 0.006$).

Discussion

This study was unique in that it allowed us to assess different groups of individuals, victims and rescue team, with traumatic exposure to one of the deadliest nightclub fires in world history.

Of all exposed individuals, 65.9% were poor sleepers and 31.9% had probable PTSD in the first year after the event, rates similar to those described in the literature for this population.^{23,33,34} Most individuals with PTSD were also poor sleepers, which is consistent with the results of a previous study that found sleep disturbances in 70% of the PTSD subjects from an urban general population.⁷ However, even in the non-PTSD group, more than 50% had PSQI scores >5 (poor sleepers), a still high rate that may be explained by the possible presence of other psychiatric disorders, such as mood or anxiety disorders, the use of psychiatric medications or even by sleep disturbances associated with stressful life events or occupational stress exposure.^{7,35,36}

Sleep disruption following a traumatic event may constitute a specific mechanism involved in the pathophysiology of chronic PTSD and poor clinical outcomes.^{37,38} Extant research provides evidence for an association between subjective sleep disturbance and PTSD across diverse trauma samples, including veterans, natural disaster survivors, and mixed trauma samples.^{39–44} Individuals with PTSD report more sleep disturbance than both trauma-exposed and healthy controls. Moreover, Lind et al.⁴⁵ demonstrated that sleep phenotypes, particularly insomnia symptoms and extremes of sleep duration, have shared genetic etiology with PTSD, indicating potential shared pathophysiology. Although sleep disturbance is typically considered a symptom of PTSD, recent findings suggest that sleep disturbance may predict PTSD symptoms over time. Cox et al.⁴⁴ describe two potential roles for sleep disturbance in the development of PTSD: sleep disturbance before a traumatic event may confer vulnerability to developing PTSD; and sleep disturbance following a traumatic event may amplify or prolong typical stress responses and increase the likelihood of the development of PTSD. Furthermore, sleep disturbances in adults with PTSD independently contribute to poor daytime functioning, being a frequent residual complaint after PTSD treatment. Our study showed that daytime dysfunction was the result most closely correlated with PTSD. According to some authors, treatment focusing on sleep can alleviate both sleep disturbances and PTSD symptom severity,^{37,46} whereas standard PTSD treatments may conclude with residual sleep disturbance. Pigeon and Gallegos⁴⁷ described that nightmares are quite specific to PTSD and tend to ameliorate following standard treatments for PTSD, whereas insomnia is more prevalent and tends to persist if not directly treated. Finally, recent results suggest that intervening on sleep disturbance following trauma exposure could reduce the likelihood of developing PTSD and/or could buffer PTSD symptom severity.⁴⁴

In our study, the factors associated with PTSD were female sex, shift work, poor sleep quality, and previous psychiatric disease after adjustments. Findings on predictors of PTSD clearly point up the heterogeneity of the disorder in different settings. A meta-analysis of risk factors for PTSD in adults demonstrated that sex, age at trauma, and race predicted PTSD in some populations but not in others, whereas education, previous trauma, and general childhood adversity predicted PTSD more consistently.¹⁶ Previous epidemiological studies have demonstrated that PTSD is more likely to occur in women than in men.^{4,48–51} Women have been shown to be less likely to experience traumatic events than men, but more likely to experience certain types of trauma that are disproportionately likely to lead to PTSD, such as sexual assault and child sexual abuse.⁵² However, even when controlling for sex differences in trauma exposure, women are more vulnerable than men to developing PTSD.^{6,51,53} It is not clear whether that is related to differences in the perception of the trauma, in social support, in preexisting depression or anxiety disorders, more common in women, or in other factors that might mediate vulnerability to the trauma.^{49,51}

The presence of burns, hospitalization, and loss of consciousness at the scene of the fire were not associated with PTSD in our study. Previous studies have reported that survivors sustaining burn injuries from the fire are not more likely to experience post-traumatic stress symptoms or depressive symptoms than those without burn injuries,⁵⁴ suggesting that nonphysical trauma is the primary determinant of these outcomes.⁵⁵

PTSD symptoms were seemingly more frequent in victims than in rescue workers. However, the adjusted prevalence ratio between these groups was not statistically significant. This finding could be partly explained by the differences between groups, such as sex, a factor strongly associated with PTSD. Several studies conducted in the first year after disasters have suggested a higher prevalence of PTSD in direct survivors than in rescue workers.^{18–20,22,24–27} Perrin et al.²⁶ reported that police screening procedures could result in the selection of a more psychologically resilient workforce, supporting other studies that related low levels of resilience to PTSD.^{27,56–58} Another possible explanation is that police officers could be more likely to underreport symptoms of psychological distress due to fear of being judged as unable to perform their job responsibilities. However, there are studies demonstrating differences in PTSD prevalence even among disaster workers.^{27,59–61} Some factors were associated with increased PTSD prevalence in disaster workers, such as performing tasks outside their training, bereavement and self-identification with the victims, lack of access to mental health services, lack of recognition, and the duration of work at the disaster site.^{26,62–65} In the present study, many of the rescue workers performed several different tasks during the event and there was repeated exposure to the scene of the fire by some police officers who were responsible for patrolling the perimeter for several months.

Shift work was associated with PTSD in the present study after adjustment. Shift work has been described to lead to a disruption of circadian rhythm, which in turn can lead to internal de-synchronization,⁶⁶ causing significant alterations in sleep and biological functions. Several physical and psychiatric problems that reduce quality of life may occur.^{66–71} Existing evidence supports the idea that the circadian clock is vulnerable and/or disturbed in a variety of mental illnesses, including PTSD.⁷² Thus, Hasler et al.⁷³ demonstrated that chronotype is associated with lifetime post-traumatic stress symptoms in combat-exposed military veterans.

Some methodological limitations of this study should be mentioned. One limitation is the cross-sectional design: individuals completed the questionnaires at different time points during the

first year; therefore, the time of onset of symptoms cannot be determined. However, many studies assessing postdisaster PTSD have used a cross-sectional design, despite variations in statistical analysis.²³ Also, we have studied only a convenience sample from a single event that occurred in Brazil and, consequently, our results cannot be generalized to other populations. In addition, data were obtained directly from the participants by self-report questionnaires, potentially introducing a reporting bias. Nevertheless, most of the studies that have demonstrated an association between PTSD and sleep disturbances are based on questionnaires, structured interviews, and self-reported symptoms,^{74–77} possibly to facilitate the standardization of data and to simplify data collection. Furthermore, because of the retrospective nature of the analysis, we were unable to measure factors possibly related to PTSD and sleep quality, such as depressive symptoms, substance abuse, previous trauma exposure, and number of trauma exposures, as suggested in the literature.^{63,78} Finally, we did not perform objective assessments of sleep in the participants, which would have yielded more specific data on sleep disturbances. Although polysomnography is widely used for objective sleep assessments, it has produced controversial results in PTSD patients.³⁸

In conclusion, a high prevalence of PTSD symptoms and poor sleep quality was found during the first year in individuals exposed to a large nightclub fire. The present study provided important information regarding factors associated with PTSD symptoms and their differences between victims and rescue workers, which makes the paper unique. Special attention should be paid to women, individuals with a previous history of psychiatric problems, victims who work in shifts, and present sleep complaints, considering especially the predictive factors of PTSD found in the present study. Daytime dysfunction was the subjective sleep parameter most associated with PTSD. So, sleep-related issues should be addressed in the assessment of individuals exposed to traumatic events, both victims and rescuers. Long-term studies are needed to better understand the relationship between sleep disorders and PTSD, allowing for more effective strategies to screen for PTSD and to determine if early recognition and treatment of sleep disturbances can prevent future PTSD symptoms.

Author statements

Acknowledgments

The authors thank Daniela Benzano Bumaguin for providing statistical support. The authors are also grateful to the CIAVA team members, undergraduate students, and the Pulmonology Service health professionals for their assistance in data collection.

Ethical approval

The study protocol was approved by the Research Ethics Committee of Universidade Federal de Santa Maria (UFSM) and subsequently by the Graduate Research Program of Hospital de Clínicas de Porto Alegre (HCPA), in accordance with international and national guidelines. All patients signed an informed consent form before their inclusion in the study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interests

None declared.

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