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Nightmares, Insomnia, and Sleep-Disordered Breathing in Fire Evacuees Seeking Treatment for Posttraumatic Sleep Disturbance

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Eight months after the Cerro Grande Fire, 78 evacuees seeking treatment for posttraumatic sleep disturbances were assessed for chronic nightmares, psychophysiological insomnia, and sleep-disordered breathing symptoms. Within this sample, 50% of participants were tested objectively for sleep-disordered breathing; 95% of those tested screened positive for sleep-disordered breathing. Multiple regression analyses demonstrated that these three sleep disorders accounted for 37% of the variance in posttraumatic stress symptoms, and each sleep disorder was significantly and independently associated with posttraumatic stress symptoms severity. The only systematic variable associated with posttraumatic stress symptoms of avoidance was sleep-disordered breathing. The findings suggest that three common sleep disorders relate to posttraumatic stress symptoms in a more complex manner than explained by the prevailing psychiatric paradigm, which conceptualizes sleep disturbances in PTSD merely as secondary symptoms of psychiatric distress.

KEY WORDS: PTSD; sleep; nightmares; insomnia; sleep-disordered breathing; obstructive sleep apnea; upper airway resistance.

Sleep disturbances such as insomnia are some of the most common complaints among trauma patients with posttraumatic stress symptoms (Kilpatrick et al., 1998). They are generally described in psychiatric nosology as "sleep disorders or insomnia related to another mental disorder" (American Psychiatric Association [APA], 2000, pp. 597–661) or more succinctly as "psychiatric insomnia" (Nowell et al., 1997). Nightmares, the second most common posttraumatic sleep disturbance, are also described as "related to another mental disorder" (APA, 2000). This paradigm conveys the impression that posttraumatic sleep disturbances are *not* distinctly treatable sleep disorders unless they are "sufficiently severe to warrant independent clinical attention" (APA, 2000, p. 648). Even then, sleep disturbances are deemed to be symptomatic or secondary processes to posttraumatic stress, because "pathophysiological mechanisms responsible for the mental disorder also affect sleep-wake regulation" (APA, 2000, p. 597). This paradigm further implies that an efficacious treatment

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for posttraumatic stress symptoms (e.g., exposure therapy) targeting symptoms other than sleep or dream complaints would ameliorate insomnia and nightmares as well (Ballenger et al., 2000).

This perspective appears entrenched in the psychiatric and trauma literature (APA, 2000; Ballenger et al., 2000; Davidson, 2001; Kilpatrick et al., 1998; Nowell et al., 1997), yet few studies have assessed posttraumatic sleep disturbances with state-of-the art, objective sleep technology (Pillar, Malhotra, & Lavie, 2000). Moreover, the psychiatric paradigm has neither incorporated current nosological constructs from the field of sleep disorders medicine (American Academy of Sleep Medicine, 1997, 1999; Krakow, Melendrez, Johnston, Warner, et al., 2002), nor addressed the potential for posttraumatic sleep problems to manifest as diagnosable, intrinsic sleep disorders (Krakow, Melendrez, Pedersen, et al., 2001; Krakow, Melendrez, Warner, et al., 2002) that require evidence-based sleep medicine assessments and therapies (Kryger, Roth, & Dement, 2000), distinct from psychiatric evaluations and interventions. In sum, the current psychiatric paradigm designates posttraumatic sleep disturbances exclusively within the category of posttraumatic stress symptoms. From a sleep medicine perspective (summarized below), limited evidence supports this prevailing psychiatric model.

Recent studies investigating chronic nightmare disorder, psychophysiological insomnia, and sleep-disordered breathing among trauma survivors provide some evidence to support the theory that these three disorders function as independent sleep complaints, not just secondary posttraumatic stress symptoms. Treatment studies using Imagery Rehearsal Therapy, a nonexposure based treatment for nightmares in trauma survivors, and cognitive behavioral therapy techniques for insomnia (e.g., stimulus control, sleep restriction, sleep hygiene) have demonstrated marked improvements in sleep quality and reductions in disturbing dreams and moderate to marked decreases in posttraumatic stress symptoms in three studies involving about 250 trauma patients (Krakow, Hollifield, et al., 2000, 2001; Krakow, Johnston, et al., 2001; Krakow, Melendrez, Johnston, Clark, et al., 2002). Although none of these studies used a therapist-delivered inert treatment as a control group comparison, the decrease in posttraumatic stress symptoms following these sleep-medicine treatments suggests that chronic nightmare disorder and psychophysiological insomnia in trauma survivors may function as independent sleep disorders that are highly responsive to brief, sleep medicine-oriented therapies, which, in general, do not incorporate standard posttraumatic stress disorder (PTSD) psychotherapeutic approaches. That is, chronic nightmare disorder and psychophysiological insomnia appear to be integral components of PTSD pathophysiology and are associated with greater posttraumatic stress symptoms severity (Krakow, Melendrez, Warner, et al., 2002). And, we theorize this relationship may develop when nightmares and insomnia become learned behaviors in trauma survivors (Krakow, Hollifield, et al., 2000, 2001; Krakow, Johnston, et al., 2001; Krakow, Melendrez, Johnston, Clark, et al., 2002).

In addition to insomnia and nightmares, some studies have found that patients with posttraumatic stress symptoms often experience symptoms of sleep-disordered breathing, a physiological disorder that fragments sleep and often produces oxygen desaturations (Krakow, Artar, et al., 2000; Krakow, Germain, et al., 2000, 2001; Krakow, Melendrez, Johnston, Warner, et al., 2002). In a study using objective sleep testing (polysomnography) on a representative subsample of patients, 93% of 187 sexual assault survivors who sought treatment for nightmares and insomnia were likely to suffer from sleep-disordered breathing (Krakow, Melendrez, Johnston, Warner, et al., 2002); the 168 probable sleep-disordered breathing cases demonstrated markedly worse posttraumatic stress symptoms, anxiety, depression, and quality of life impairment than the 19 patients without sleep-disordered breathing. In a study using polysomnography with advanced respiratory assessment technology (nasal cannula pressure transducer), 40 of 44 consecutive adult crime victims seeking treatment for insomnia and nightmares were diagnosed with sleep-disordered breathing (Krakow, Melendrez, Pedersen, et al., 2001). Many of these patients suffered predominantly from a subtle form of sleep-disordered breathing known as upper airway resistance syndrome (Guilleminault, Polombini, & Poyares, 1995). Scant research however has examined the relationship between sleep-disordered breathing and posttraumatic stress symptoms.

In sum, the prevalence and typology of intrinsic sleep disorders in trauma survivors remains unknown. Such information would provide a clearer indication of the sleep medicine resources needed to aid trauma survivors with posttraumatic stress symptoms. This study was designed to examine intrinsic sleep disorders in a sample of patients who had sleep complaints following a natural disaster. Our objectives were to identify potential intrinsic sleep disorders (i.e., chronic nightmare disorder, psychophysiological insomnia, and sleep disordered breathing) based on sleep medicine nosology (American Academy of Sleep Medicine, 1997, 1999) in a sample of fire evacuees presenting with sleep complaints and to analyze the relationships between sleep and distress in these trauma patients. We hypothesized that: (1) a large portion of the presenting sleep complaints would meet minimum diagnostic criteria for chronic nightmare disorder, psycho-physiological

insomnia, and sleep-disordered breathing; (2) most such patients tested with an objective sleep monitor would screen positive for a sleep-disordered breathing diagnosis; (3) positive relationships would be demonstrated between sleep dysfunction and posttraumatic stress symptoms; and, (4) chronic nightmare disorder, psychophysiological insomnia, and sleep-disordered breathing each would be independently associated with posttraumatic stress symptoms severity. Given the cross-sectional design, we were unable to exclude sleep-disordered breathing or chronic nightmare disorder as potential causes for psychophysiological insomnia (Hypothesis 1). Therefore, correlation analyses were used to measure the overall variability in posttraumatic stress symptoms accounted for by measures of chronic nightmare disorder, psycho-physiological insomnia, and sleep-disordered breathing (Hypothesis 3), as well as to calculate the unique variance of posttraumatic stress symptoms severity associated with each of the three sleep disorders (Hypothesis 4).

Method

Natural Disaster

In May 2000, a controlled burn was initiated in the Cerro Grande National Forest, which surrounds Los Alamos and White Rock, New Mexico. Control of the fire was lost and resulted in a rapidly spreading fire that at one point was predicted to destroy 60% of the city. An evacuation of approximately 18,000 residents of both towns was undertaken during the next two days and was accomplished without serious injury. Subsequently, the fire destroyed 235 structures and displaced 403 families. Evacuees stayed in various shelters and homes for approximately 1 week. As the evacuation was underway, we contacted the National Institute of Mental Health (NIMH) about a proposal to assess and treat sleep disturbances in those affected by the firestorm; the program was funded through the Rapid Assessment Post-Impact Disaster (RAPID) mechanism (National Institute of Mental Health [NIMH], 1995).

Recruitment, Sample, and Evacuation Screening

The study was approved by the University of New Mexico Health Sciences Center Human Research and Review Committee (IRB). A community-wide recruitment was initiated from October 2000 to January 2001, including regular media coverage through local newspaper stories and announcements, radio and television interviews, presentations to groups (notably the city and county fire survivors associations), posting of flyers, e-mail announcements to various local agencies and institutions, and regular coordination with Project Recovery staff, who had been involved in numerous aspects of assisting those in the community needing shelter, counseling, medical assistance, and other resources. Several private therapists as well as therapists affiliated with the Los Alamos Family Council and Los Alamos National Laboratory referred patients to the program as well. Referral and recruitment efforts consisted of requests for participants with insomnia or nightmares caused by the fire or insomnia or nightmares worsened by the fire. After a complete description of the study was provided to participants, informed written and oral consent was obtained.

Inclusion criteria comprised adults who, in the aftermath of the fire, reported the onset of insomnia and/or nightmares that were allegedly caused in part or wholly by the fire, evacuation or related events. If these sleep problems were preexisting, then individuals were eligible if the fire allegedly exacerbated them. Exclusion criteria included: age less than 18, acutely psychotic or suicidal, or acutely intoxicated or in withdrawal from alcohol or substances. Past history or current diagnosis of psychiatric disorders or usage of psychotropic medication were not exclusion criteria. Of the 104 individuals who contacted us, eight were ineligible because of sleep complaints other than insomnia or nightmares, and three suffered from acute sleep or psychiatric distress requiring urgent treatment. Of the remaining 93, all met inclusion criteria and received an intake packet of questionnaires. Eighty individuals returned the packet, but two records were not usable because of omissions. Thus, 84% ($n = 78$) of eligible participants completed enrollment in the study.

Fifty women and 28 men participated. They were an average of 51.5 years old ($SD = 13.0$). Ethnicity included primarily 78% non-Hispanic White and 17% Hispanic individuals. Sixty-seven percent of participants were married, and 77% averaged an annual household income greater than $50,000. College and more advanced degrees were held by 67% of the sample, of which 63% held graduate degrees. Occupational status was primarily employed (76%) and retired (17%). The body mass index of the group was near normal at $M = 25.6$ ($SD = 4.1$; normal $M = 25.0$), which amounted to an average of 2 to 3 pounds above normal weight. Five-point Likert rating scales (1 = *no stress*, 5 = *extremely stressful*) were used to evaluate the following perceived effects of the evacuation in a screening interview, including: severity of evacuation stress; concerns about safety; perceived threat to life; degree of physical injury; proximity to fire; loss of personal property; and disruption to home life, social life, and work life.

Table 1. Diagnostic Criteria for Intrinsic Sleep Disorders

Intrinsic sleep disorder	Minimum criteria
Chronic nightmare disorder[a]	A. At least one episode of sudden awakening from sleep with intense fear, anxiety, and feeling of impending harm. B. Immediate recall of frightening dream content. C. Alertness is full immediately upon awakening, with little confusion or disorientation. D. Associated features include at least one of the following: 1. Return to sleep after the episode is delayed and not rapid; 2. The episode occurs during the latter half of the habitual sleep period.
Psychophysiological insomnia[a]	A. Complaint of insomnia combined with complaint of decreased daytime functioning. B. Indications of learned sleep-preventing associations are found: 1. Trying too hard to sleep, suggested by an inability to fall asleep when desired, but ease of falling asleep during relatively monotonous pursuits, e.g., watching television or reading; 2. Conditioned arousal to bedroom or sleep-related activities, indicated by sleeping poorly at home, but sleeping better away from home or when not carrying out bedtime routines.
Sleep-disordered breathing[b]	A. Excessive daytime sleepiness that is not better explained by other factors; or B. Two or more of the following that are not better explained by other factors: • Choking or gasping during sleep; • Recurrent awakenings from sleep; • Unrefreshing sleep. • Daytime fatigue; • Impaired concentration; and C. Overnight monitoring demonstrates >5 obstructed breathing events per hour during sleep.

[a] American Academy of Sleep Medicine, 1997.
[b] American Academy of Sleep Medicine, 1999.

Sleep Measurements

The Sleep Medicine History (Krakow, Melendrez, Ferreira, et al., 2001) is organized as modules according to standard nosology or guidelines of the American Academy of Sleep Medicine (1997, 1999; see Table 1) to acquire information on sleep quality, insomnia and sleep habits, sleep medications, sleep breathing, peripheral sleep-disordered breathing symptoms (nocturia, dry mouth upon awakening, morning headache), previously diagnosed sleep problems, and other medical events occurring during the previous month. The Sleep Medicine History acquires sleep indices, including: sleep onset latency; total sleep time; time in bed; sleep efficiency (total sleep time divided by time in bed and expressed as a percent); wake time after sleep onset; and an 8-point Sleep Quality Rating ranging from "extremely good" to "extremely poor" sleep quality. The Sleep Medicine History was also used to presumptively diagnose chronic nightmare disorder, psychophysiological insomnia, and sleep-disordered breathing. Severity levels for each of these disorders were determined by the following validated psychometric scales.

Nightmares

The Disturbing Dream and Nightmare Severity Index, revised version of Nightmare Frequency Questionnaire (Krakow, Schrader, et al., 2002), uses five self-report items to measure the following indices: nights with nightmares per week (0–7 nights); number of nightmares per week (0–14); awakenings due to nightmares (0 = *never* to 4 = *always*); severity of nightmare problem (0 = *no problem* to 6 = *extremely severe*); and, nightmare intensity (0 = *not intense* to 6 = *extremely severe intensity*). The five items are summed to yield an index of nightmare severity (range = 0–37; Cronbach's α = .91). Scores >10 were most consistent with problematic chronic nightmares.

Insomnia

The Insomnia Severity Index (Bastien, Vallieres, & Morin, 2001) is a reliable and valid instrument that quantifies perceived insomnia severity. It is useful both as a screening device and as an outcome measure in insomnia treatment research for both primary and psychiatric insomnia. The scale consists of seven items measuring severity of difficulties with sleep onset, sleep maintenance, early morning awakenings, sleep problem interference with daily functioning, indications to others of impairment due to sleep problems, degree of concern about current sleep problem, and satisfaction/dissatisfaction with current sleep pattern. Each item is scored from 0 = *essentially no problems* to 4 = *very severe problems*, and yields a composite score ranging from 0 to 28. Scores >10 indicate clinical insomnia. Cronbach's α averaged .76 in two studies. Concurrent validity has been established with prospective sleep diary recording (r range = .32–.91).

Sleep-Disordered Breathing

The Functional Outcomes of Sleep Questionnaire (Weaver et al., 1997) is a self-reported measure designed to assess the impact of disorders of excessive sleepiness on multiple activities of daily functioning. This measure was validated with patients who suffer from moderate to severe sleep-disordered breathing. The Functional Outcomes of Sleep Questionnaire assesses the impact of "fatigue and sleepiness" with 30 items (on a 4-point Likert scale; 4 = *no difficulty* to 1 = *yes, extreme difficulty*) that generate five subscale scores: activity level, vigilance (not to be confused with hypervigilance), intimacy and sexual relationships, general productivity, and social outcome. A global score is calculated by taking the mean of the subscales and multiplying by 5. The global score ranges from 5 to 20, and lower scores indicate greater impairment on daily functioning. Cronbach's α ranged from .70 to .92 for the subscales and is .96 for the global score. The test–retest reliability of the Functional Outcomes of Sleep Questionnaire yields coefficients averaging from $r = .81$ for the five subscales to $r = .91$ for the global score. For this sample, Cronbach's $\alpha = .85$. The Functional Outcomes of Sleep Questionnaire global score successfully discriminates between normal participants and those seeking medical attention for a sleep problem. In validation studies, patients with severe sleep apnea averaged a global *M* (*SD*) score of 14.45 (3.57), whereas healthy controls had a mean score of 17.87 (*SD* = 3.03).

Although the Functional Outcomes of Sleep Questionnaire employs the word "fatigue" on the instrument, it defines this term by equating it with sleepiness, not tiredness. As such, Functional Outcomes of Sleep Questionnaire scores are most representative of sleep-disordered breathing, although other disorders of sleepiness, such as narcolepsy, could produce similar scores (Weaver et al., 1997). Disorders such as nightmares or insomnia would be expected to contribute much less to sleepiness than sleep-disordered breathing (Moul et al., 2002).

Sleep-Disordered Breathing Diagnostic Criteria

The American Academy of Sleep Medicine (1999) research guidelines for the presumptive diagnosis of sleep-disordered breathing were established to provide a means for assessing typical (Criterion A: sleepiness) and atypical presentations (Criterion B) when sleepiness symptoms might be absent. Criterion B lists five symptoms (Table 1) of which the patient need only report two to meet minimum criteria for a preliminary sleep-disordered breathing diagnosis "unless these symptoms are otherwise explained." Four of these symptoms (unrefreshing sleep, daytime fatigue, recurrent awakenings, impaired concentration) describe an insomnia-type pattern, which accurately reflects how some sleep-disordered breathing patients present (Krakow, Melendrez, Pedersen, et al., 2001). This symptom cluster also conforms to the kind of sleep complaints reported by psychiatric patients (Kupfer & Reynolds, 1997; Nowell et al., 1997), and, therefore, provides a means for assessing atypical sleep-disordered breathing presentations that might be more common among psychiatric patients (Ford & Kamerow, 1989; Reite, 1998). To confirm a sleep-disordered breathing diagnosis, Criterion C requires objective evidence (Table 1); this criterion was revised in response to advances in respiratory monitoring technology demonstrating that subtle breathing disruptions, known as respiratory-effort-related arousals, must be assessed and counted along with standard apneas and hypopneas in calculating a respiratory disturbance index (>5 total events/hr; American Academy of Sleep Medicine, 1999). This change is relevant to PTSD research because most previous studies on sleep and PTSD (Pillar et al., 2000) have not assessed subtle sleep breathing disruption.

Sleep Breathing Tests

All potential sleep-disordered breathing patients in the sample were offered the opportunity for objective screening for a sleep breathing disorder. Patients hooked themselves up to an Autoset Portable II Plus (ResMed Ltd., North Ryde, Australia) that includes a built-in nasal cannula pressure transducer and yields a sensitive and accurate measure of airflow. The Autoset has been evaluated against the gold standard of polysomnography (Gugger, 1997) and is useful and valid for obstructive sleep apnea diagnoses. The device provides two measurements. The standard apnea–hypopnea index (events/hour) assesses obstructive sleep apnea based on apneas and hypopneas. The flattening index assesses upper airway resistance (Krakow, Melendrez, Pedersen, et al., 2001) by analyzing the inspiratory flow-time curve (Hosselet, Norman, Ayappa, & Rapoport, 1998). Previous studies have demonstrated agreement between the flattening index and sleep-disordered breathing (e.g., Hosselet, Norman, Ayappa, & Rapoport, 1998; Krakow, Melendrez, Pederson, et al., 2001). For instance, a flattening index ≥20% has proven consistent with upper airway resistance syndrome, as tested by polysomnography, when the apnea–hypopnea index <5 (Krakow, Melendrez, Pederson, et al., 2001). Autoset results were reviewed by a board certified sleep specialist (BK), who was not blinded to the study or sample,

albeit the device automatically calculates apnea–hypopnea index and flattening index. To date, no studies have tested the correlation between the flattening index and respiratory-effort-related arousals; therefore, the presumptive diagnosis of obstructive sleep apnea was diagnosed based on conservative criteria excluding respiratory-effort-related arousals (apnea–hypopnea index >5). Presumptive upper airway resistance syndrome diagnoses were assigned based on the following criteria: apnea–hypopnea index <5, flattening index >20%; whereas, no sleep-disordered breathing was determined by an apnea–hypopnea index <5, flattening index <20%. All patients were asked to maintain current use or lack of use of psychotropic medication for the test.

Distress Measures

The Posttraumatic Stress Diagnostic Scale (PDS; Foa, 1995) is valid for diagnosing PTSD according to *DSM-IV* criteria. It consists of 17 items that evaluate the severity of symptoms experienced by the patient in the preceding 2-weeks. The PDS contains three symptom subscales: intrusion (reexperiencing), avoidance, and arousal. Severity of each symptom is rated on a four-point scale (0 = *not at all* to 3 = *very much*). The sum of all ratings gives a global score ranging from 0 to 51, with mild from 0 to 10, moderate from 11 to 20, moderately severe from 21 to 35, and severe from 36 to 51. Cronbach's $\alpha = .85$ for the overall scale. Alpha coefficients for the symptom subscales were as follows: intrusion = .69, avoidance = .65, and arousal = .71. The PDS also contains a brief historical accounting form to check off past traumatic events and a scoring sheet to determine if the patients meet Criteria A–F for a PTSD diagnosis. In this study, the PDS was used to measure posttraumatic stress symptoms from whatever cause the patient designated. Sixty-seven percent of participants reported the fire as the Criterion A event ($n = 52$). The remaining 33% endorsed the fire as a major traumatic event but "not currently the worst experience related to my PTSD." The following information was collected through completion of a general mental health and medication questionnaire: current medications for insomnia, nightmares, anxiety, depression and PTSD; self-reported past and current psychiatric diagnoses; and current psychotherapy.

Results

Preliminary Analyses

Screening data from the rating scales revealed that stress related to the evacuation received scores that averaged within the moderate to severe range ($M = 3.63$; $SD = 1.06$). Concerns about safety averaged mild ($M = 2.05$; $SD = 1.04$), and perceived threats to one's life were nearly absent ($M = 1.33$; $SD = .57$). Only a handful of people reported incurring minor injuries related to the fire or evacuation activities ($n = 5$). Average proximity to the fire was less than 1-mile, yet participants reported only mild smoke irritation ($M = 2.21$; $SD = 1.27$). Substantial loss of personal property—"lost everything," "lost home," or "home was severely damaged such that you had to live elsewhere"—was reported by 50% of the sample. "Current disruption to home life" averaged within the moderate to severe range ($M = 3.50$; $SD = 1.37$), and "current disruption to social and work life" averaged moderately severe ($M = 2.99$; $SD = 1.34$).

Forty-two patients reported preexisting insomnia, and 13 patients reported preexisting nightmares. Only 14% of patients reported ever having used a psychotropic medication before the fire, whereas 47% reported taking medication soon after the fire for current problems with anxiety, depression, PTSD, insomnia or nightmares, McNemar's Test, $\chi^2(1, N = 78) = 18.75, p < .001$. Only 18% reported ever having seen a therapist prior to the fire, whereas 39% reported seeing a therapist soon after the fire for these same five conditions, McNemar's Test, $\chi^2(1, N = 78) = 26.29, p < .01$.

Posttraumatic stress symptoms were reported by 96% of participants with *M* (*SD*) PDS score of 18.03 (10.61), which is within the moderate range of distress. Using *DSM-IV* diagnostic criteria (APA, 1994), 59% of the sample received a presumptive PTSD diagnosis.

Main Analyses

As predicted, these fire evacuees suffered from high rates of psychophysiological insomnia ($n = 77$, with no exclusion for presumptive sleep-disordered breathing or chronic nightmare disorder), presumptive sleep-disordered breathing ($n = 74$), and a relatively lower rate of chronic nightmare disorder ($n = 26$; see Table 2). As compared to normal sleep parameters established in the field of sleep medicine, severity levels for the Disturbing Dream and Nightmare Severity Index, Insomnia Severity Index, and Functional Outcomes of Sleep Questionnaire were in the moderate range, although the insomnia profile had some features in the moderate to severe range (see Table 2). Average sleep quality ratings were fair to poor (insomnia section in Table 2). In addition, at least one physiological peripheral symptom of sleep-disordered breathing (nocturia, morning dry mouth, morning headache) was reported by 92% of the total sample

Table 2. Posttraumatic Sleep Disturbance Profile in 78 Disaster Survivors

Diagnosis/measures	*N* (%)	*M* (*SD*)
Chronic nightmare disorder	26 (33)	
Disturbing dreams and nightmare severity index		17.03 (4.92)
Psychophysiological insomnia	77 (99)	
Insomnia severity index		16.00 (4.77)
Sleep onset latency (min), SMH		38.01 (34.96)
Total sleep time (h), SMH		5.87 (1.34)
Wake after sleep onset (min), SMH		72.94 (60.50)
Sleep efficiency (%), SMH		77.00 (17)
Sleep-disordered breathing	74 (95)	
Functional outcomes of sleep questionnaire		16.22 (2.66)
Peripheral sleep-disordered breathing symptoms	72 (92)[a]	
Nocturia, SMH	67 (86)	
Dry mouth upon awakening, SMH	40 (51)	
Morning headache, SMH	23 (29)	
Predominantly obstructive sleep apnea[b]	16 (41)	
Apnea/hyponea index, Autoset[b]		20.25 (10.56)
Flattening index, Autoset[b]		21.85 (12.58)
Predominantly upper airway resistance[b]	21 (54)	
Apnea/hyponea index, Autoset[b]		7.19 (3.84)
Flattening index, Autoset[b]		38.00 (11.88)

Note. SMH = Sleep medicine history.
[a]N (%) reporting at least one physiological peripheral symptom of sleep-disordered breathing (nocturia, dry mouth, or morning headache).
[b]$n = 39$ who underwent objective testing with the Autoset Portable II Plus.

(sleep-disordered breathing section in Table 2). In clinical terms, the average patient suffered from mild difficulties falling asleep, moderately severe decreased total sleep time, moderately decreased sleep efficiency, moderate sleep maintenance difficulties, and a moderate degree of sleepiness-related impairment.

All except four patients reported symptoms that suggested sleep-disordered breathing. Twenty-three patients (31%) presented with classic snoring and sleepiness symptoms of obstructive sleep apnea, and 69% presented with atypical symptoms (i.e., Criteria B described in Table 1). Of the 74 potential cases, 39 underwent testing on the Autoset. In a comparison of the two groups, the tested versus nontested participants revealed no systematic differences on 20 primary and secondary variables measured at intake. One statistically significant difference between the two groups indicated that those tested were more likely to have reported insomnia prior to the fire; 29 participants in the tested group had prior insomnia compared to 10 participants in the untested group, $\chi^2(1, n = 78) = 13.21$, $p < .001$. Test results showed that 37 of 39 participants (95%) screened positive for sleep-disordered breathing by Autoset (see bottom of Table 2). Most patients had documented episodes of apnea, hypopnea, and flattening events (upper airway resistance) resulting in 21 predominantly upper airway resistance syndrome cases (Functional Outcomes of Sleep Questionnaire $M = 15.95$; $SD = 2.54$), 16 predominantly obstructive sleep apnea cases (Functional Outcomes of Sleep Questionnaire $M = 15.54$; $SD = 2.58$), and 2 cases with no sleep-disordered breathing.

Correlations were significant between sleep disorder symptoms (Disturbing Dream and Nightmare Severity Index, Insomnia Severity Index, Functional Outcomes of Sleep Questionnaire) and posttraumatic stress symptoms (PDS overall and subscale scores; see Table 3). Greater posttraumatic stress symptoms severity was significantly associated with greater insomnia severity, nightmare severity, and impairment from sleep-disordered breathing. The mean (*SD*) correlation between sleep disorders and posttraumatic stress symptoms was .43 (.07). The correlation between the Insomnia Severity Index and PDS total was the largest ($r = .53$); the correlation between the Functional Outcomes of Sleep Questionnaire and PDS intrusion was the smallest ($r = -.29$; see Table 3). To examine potential associations between the PDS and sleep measures due to item overlap, analyses were repeated without sleep items on the PDS (items #2 and #13). The same pattern of results emerged.

Multiple linear regression was used to examine the relative contribution of nightmares (Disturbing Dream and Nightmare Severity Index), insomnia (Insomnia Severity Index), and sleep-disordered breathing (Functional Outcomes of Sleep Questionnaire) to total posttraumatic stress symptoms, as well as intrusion, avoidance, and arousal posttraumatic stress symptoms. In a single regression model that simultaneously tested the main effects for

Table 3. Correlations Among Sleep Measures and the Posttraumatic Stress Diagnostic Scale ($N = 78$)

Variables	1	2	3	4	5	6	7
1 PDS total	—						
2 PDS intrusion	.82***	—					
3 PDS avoidance	.91***	.62***	—				
4 PDS arousal	.88***	.63***	.71***	—			
5 DDNSI	.42***	.41***	.31**	.37***	—		
6 ISI	.53***	.48***	.42***	.52***	.27*	—	
7 FOSQ[a]	.46***	.29*	.43***	.46***	.20	.53***	—

Note. PDS = Posttraumatic Diagnostic Scale; DDNSI = Disturbing Dream and Nightmare Severity Index; ISI = Insomnia Severity Index; FOSQ = Functional Outcomes of Sleep Questionnaire.
[a] Correlations on the FOSQ have an inverse relationship; the lower the score the greater the impairment.
*$p < .05$. **$p < .01$. ***$p < .001$.

Disturbing Dream and Nightmare Severity Index, Insomnia Severity Index, and Functional Outcomes of Sleep Questionnaire as predictors, sleep-disordered breathing ($p < .05$), nightmares ($p < .01$), and insomnia ($p < .01$) each uniquely accounted for a significant portion of the variance in total posttraumatic stress symptoms severity, adjusted $R^2 = .37$, $F(3, 74) = 16.03$, $p < .001$ (see Table 4). Sleep-disordered breathing (Functional Outcomes of Sleep Questionnaire) contributed approximately 4% of the unique variance in posttraumatic stress symptoms severity, $\Delta R^2 = .04$, $\Delta F(3, 74) = 4.34$, $p < .05$. Findings did not differ with the exclusion of sleep-related items on the PDS.

The impact of relevant moderator variables that might qualify the relationship between sleep-disordered breathing and posttraumatic stress symptoms were tested by including both main effects and centered interaction terms (Moderator variable × Functional Outcomes of Sleep Questionnaire global score) for the following nine potential moderating variables analyzed in nine separate regressions: age, sex, high degree (≥3 events) of past traumatic exposure, current use of psychotropic medications or psychotherapy, severity of evacuation stress, home destroyed or compromised by fire, history of insomnia prior to firestorm, insomnia severity, and nightmare severity. No interactions were significant.

Table 4. Summary of Multiple Regression Analysis for Sleep Measures Predicting PDS Scores ($N = 78$)

Sleep variables	*B*	*SE B*	β
PDS total score, Adj $R^2 = .37$**			
ISI	.74	.24	.33**
DDNSI	.40	.13	.28**
FOSQ global	−.89	.43	−.22*
PDS intrusion subscale, Adj $R^2 = .28$**			
ISI	.27	.08	.38**
DDNSI	.14	.04	.30**
FOSQ global	−.03	.15	−.03
PDS avoidance subscale, Adj $R^2 = .24$**			
ISI	.25	.13	.22
DDNSI	.14	.07	.19
FOSQ global	−.55	.24	−.27*
PDS arousal subscale, Adj $R^2 = .34$**			
ISI	.23	.08	.33**
DDNSI	.10	.04	.24*
FOSQ global	−.30	.14	−.24*

Note. PDS = Posttraumatic Diagnostic Scale; ISI = Insomnia Severity Index; DDNSI = Disturbing Dream and Nightmare Severity Index; FOSQ = Functional Outcomes of Sleep Questionnaire.
*$p < .05$. **$p < .01$.

Follow-up analyses were then conducted with PDS subscales (see Table 4). Nightmares and insomnia were uniquely associated with posttraumatic stress symptoms of intrusion; the main effects only model with all three independent variables accounted for 28% of the overall variance, $F(3, 74) = 11.17$, $p < .001$. With the exclusion of PDS sleep-related items, the pattern of results remained the same, although the Disturbing Dream and Nightmare Severity Index became nonsignificant, $\beta = .20$, $t(78) = 1.87$, $p = .07$. Only sleep-disordered breathing was associated with posttraumatic stress symptoms of avoidance, adjusted R^2 for full model = .24, $F(3, 74) = 9.02$, $p < .001$. This finding did not differ with the exclusion of PDS sleep-related items. Insomnia, nightmares, and sleep-disordered breathing all accounted for significant portions of the variability ($p < .05$) associated with posttraumatic stress symptoms of arousal, adjusted R^2 for full model = .34, $F(3, 74) = 14.27$, $p < .001$. With the exclusion of PDS sleep-related items, the pattern of results remained the same, although the Insomnia Severity Index became nonsignificant, $\beta = .21$, $t(78) = 1.79$, $p = .08$.

Discussion

This study was designed to examine sleep disorders in a sample of patients who have sleep complaints following a natural disaster. Our overall objectives were (1) to diagnose intrinsic sleep disorders (i.e., chronic nightmare disorder, psychophysiological insomnia, and sleep

disordered breathing) based on sleep medicine nosology and research criteria (American Academy of Sleep Medicine, 1997, 1999) in a sample of fire evacuees presenting with sleep complaints and (2) to analyze relationships between sleep and distress in these trauma patients. The results provided support for each of the proposed hypotheses.

In support of our first hypothesis, we found that a large portion of those individuals with presenting sleep complaints met minimum diagnostic criteria for chronic nightmare disorder, psychophysiological insomnia, and sleep-disordered breathing. Posttraumatic sleep disturbances in treatment-seeking fire evacuees were characterized by a profile that matched the conventional diagnosis of "psychiatric insomnia." Closer inspection of sleep symptoms and objective sleep parameters, however, suggested a complex pattern consisting of primary (intrinsic) sleep disorders. Prior polysomnography studies in trauma patients are consistent with these findings in that insomnia, nightmares, and other chronic posttraumatic stress symptoms have been found to severely fragment sleep (Mellman, David, Kulick-Bell, Hebding, & Nolan 1995; Woodward, Friedman, & Bliwise, 1996).

Beyond expected symptoms of delayed sleep onset, prolonged wake time interspersed with the sleep period, decreased total sleep time, and reduced sleep efficiency, the patients in this study also reported symptoms of sleep-disordered breathing, including breathing difficulties, sleepiness, and peripheral symptoms (nocturia, headache, dry mouth). These self-report, breathing-related symptoms correlated with results from an objective sleep-breathing monitor demonstrating airway instability in 95% of those tested. A high rate of sleep-disordered breathing in this sample provides one objective explanation for nocturnal awakenings and difficulties returning to sleep (American Academy of Sleep Medicine, 1997, 1999; Guilleminault et al., 1995; Weaver et al., 1997) frequently reported by PTSD patients (Kilpatrick et al., 1998). Sleep-disordered breathing produces hundreds of awakenings, arousals or microarousals, that result in severe sleep fragmentation known to influence psychiatric symptoms (Edell-Gustaffson, 2002; Moore, Bardwell, Ancoli-Israel, & Dimsdale, 2001).

In our final hypotheses, we predicted the presence of statistically significant positive relationships between sleep variables and posttraumatic stress symptoms. Moderate posttraumatic stress symptoms severity correlated with nightmares, insomnia, and sleep-disordered breathing; and, each of these three sleep disorders were significantly associated with global posttraumatic stress symptom severity in a simultaneous regression model. Symptoms of all three sleep disorders were associated with arousal; symptoms of chronic nightmare disorder and psychophysiological insomnia were associated with intrusion; and sleep-disordered breathing was the only variable associated with avoidance.

One possible explanation for these findings is that symptoms overlap between sleep disorders and PTSD. Obvious areas of overlap are nightmares and PTSD intrusions and insomnia and PTSD hyper-arousal. Although neither fatigue nor sleepiness is among the 17 symptom categories listed as the primary elements of PTSD in the *DSM-TR-IV*, six of these symptoms (memory deficits, diminished interest or participation in activities, insomnia, irritability, social isolation, impaired concentration) are reported regularly by individuals suffering from fatigue or sleepiness due to sleep-disordered breathing (American Academy of Sleep Medicine, 1997, 1999). In addition, avoidance behaviors among sleep-disordered breathing patients share similar features with certain behaviors in PTSD patients. In general, sleep-disordered breathing patients report exhaustion that severely restricts lifestyle and markedly diminishes quality of life (Guilleminault et al., 1995). From a sleep medicine perspective, the relationship between avoidance and sleep-disordered breathing can be explained as being too tired, too sleepy or both to cope with the demands of daily functioning and other stressful experiences. Thus, avoidance is a plausible outcome, and sleep-disordered breathing can magnify this behavior through physiological sleepiness or outright exhaustion.

Another explanation for our findings, consistent with a sleep fragmentation model, may be that sleep-disordered breathing serves as a risk factor for posttraumatic stress symptoms, or sleep-disordered breathing might develop after trauma exposure depending upon psychophysiological vulnerabilities (Krakow, Melendrez, Warner, et al., 2002). In experimental research in normal sleepers, sleep fragmentation caused physiological destabilization of the upper airway (Meurice, Marc, & Series, 1996; Series, Roy, & Marc, 1994), which increased upper airway resistance and collapsibility. In a different controlled study, a statistically significant increase in apneas and hypopneas followed a single night of experimentally induced sleep fragmentation in normal sleepers (Series et al., 1994). Thus, greater vulnerability to the incursion of sleep-disordered breathing events might arise in susceptible trauma survivors, whose sleep is fragmented chronically by insomnia, nightmares, or by the trauma itself. Once entrenched, sleep-disordered breathing may further aggravate posttraumatic stress symptoms (Krakow, Melendrez, Warner, et al., 2002), including other sleep symptoms such as nightmares and insomnia. In support of this theory, some researchers have found an association between nightmares and snoring and obstructive sleep apnea (De Groen et al.,

1993; Thoman, 1997), and there is a growing body of literature linking insomnia with sleep-disordered breathing (Guilleminault, Palombini, & Poyares, 2002; Krakow, Melendrez, Warner, et al., 2002).

In interpreting the results from this study, a number of issues must be considered. First, this study is limited by a lack of a normative control group, and the prevalence of sleep complaints may not be representative of other PTSD samples, especially given that individuals in this sample were treatment-seeking for sleep problems. In addition, this sample may not reflect a traditional PTSD outpatient sample, as only 59% of the sample received a presumptive PTSD diagnosis. Also, 33% of the sample did not rate the fire or evacuation as the event in Criterion A. For these individuals, the fire exacerbated preexisting posttraumatic stress symptoms. The relatively small sample size in combination with a number of independent variables limits the stability of findings. Thus, our results need to be replicated using a larger sample size. Also, we used retrospective reports from our participants to gauge their sleep disturbances prior to the fire; therefore, the results may be partially influenced by retrospective memory bias. Furthermore, the cross-sectional design prohibits the ability to determine if their sleep disorders were caused or exacerbated by the stress related to the fire and evacuation. Our data could only reveal associations between posttraumatic stress symptoms and intrinsic sleep disorders. The precise role that each sleep disorder might play in the development, maintenance, or exacerbation of posttraumatic sleep disturbance must still be determined by longitudinal studies.

An additional, potential limitation in the study may arise from symptom overlap between sleep-disordered breathing, psychophysiological insomnia, chronic nightmare disorder, and PTSD. Item overlap between sleep and the PDS may be partially responsible for our results on subjective self-report questionnaires. At the same time, post hoc analyses without sleep-related items on the PDS did not significantly change the pattern of results; thus, the influence of item overlap is likely to be minimal. Future research could benefit from the development of posttraumatic stress symptoms scales that partial out sleep-related complaints so that the unique effects of disrupted sleep on psychiatric distress (attributed to the trauma) can be determined. Also, the use of objective testing for sleep-disordered breathing in conjunction with psychiatric measures of distress may assist in identifying overlap between the two disorders. Although this study did use objective testing, sleep and respiratory-effort-related-arousals were not measured. Future studies would benefit from more comprehensive objective testing techniques and measurements.

Within sleep medicine, no validated self-report instrument has been developed that clearly denotes the likelihood of an objective finding of obstructive sleep apnea; none have been used to assess subtler forms of sleep-disordered breathing such as upper airway resistance syndrome. The American Academy of Sleep Medicine research criteria are purposely broader and therefore create a much lower threshold for which to develop a suspicion for sleep-disordered breathing, in all its forms. Speculatively, there is likely to be much greater agreement between self-reported symptoms of sleep-disordered breathing and objective documentation of sleep-disordered breathing, when the full spectrum of sleep-disordered breathing and its diverse symptoms are considered. The results from our Autoset testing support this claim; and, the objective recording of sleep-disordered breathing utilized by half the sample corroborated the potential value of various self-report, sleep symptoms. Continued research on the efficacy of the Autoset or other autodiagnostic devices in testing for obstructive sleep apnea and upper airway resistance syndrome by American Academy of Sleep Medicine nosology should be a research priority, as should the efficacy of using self-report measures to diagnose milder forms of sleep-disordered breathing, particularly so in trauma survivors because they might be reluctant initially to be tested in a sleep laboratory if they were to perceive this environment as unfriendly or threatening.

Despite these limitations, this sample is likely to represent a natural subpopulation of treatment-seeking individuals exposed to traumatic stress. Furthermore, this study is one of the first using subjective and objective sleep measures to test the typology of sleep complaints in posttraumatic stress symptoms from a sleep medicine perspective. Prior studies that have used objective testing have utilized thermal sensors, a device that consistently underestimates physiological sleep breathing abnormalities (Hosselet et al., 1998). Conceivably, the prevalence of sleep-disordered breathing has been underestimated in posttraumatic stress research. New studies must employ advanced respiratory monitoring techniques (Hosselet et al., 1998) and possibly spectral analysis measurements (Black, Guilleminault, Colrain, & Carrillo, 2000) to accurately test this hypothesis.

Using American Academy of Sleep Medicine nosology to define sleep disorders will facilitate efforts to understand relationships between sleep and posttraumatic stress symptoms. Sleep medicine is a newer specialty that may be perceived by many healthcare professionals as tangential to their practices. Nevertheless, nosologically defined sleep disorders in these patients appeared to be of a clinical import not fully explained by the prevailing paradigm "relating [sleep disorders] to another mental disorder" (APA,

2000). New PTSD paradigms should consider the potential impact of intrinsic sleep disorders on posttraumatic sleep disturbances, particularly on arousal mechanisms during sleep in trauma survivors. If intrinsic sleep disorders, including sleep-disordered breathing, were shown to be highly prevalent in other samples of trauma survivors, then research must reexamine the theory that most EEG arousal activity during sleep in PTSD patients is caused by unknown central pathophysiological mechanisms that are associated with distress (Mellman, 1997; Woodward et al., 1996).

In conclusion, we speculate that a comorbid relationship between sleep disorders and psychiatric distress might produce a more compelling pathophysiological explanation for many who suffer from posttraumatic sleep disturbances. Potentially, inadequate treatment of intrinsic sleep disorders in trauma patients may prevent effective management of posttraumatic sleep disturbances, which in turn may retard the trauma recovery process. Collaboration between mental health and sleep medicine practitioners would likely benefit trauma patients with sleep disorders.

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