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Unique sleep disorders profile of a population-based sample of 747 Hmong immigrants in Wisconsin

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Abstract

Concerns regarding sleep disorders in Hmong immigrants in the US emerged when an astonishingly high mortality rate of Sudden Unexplained Nocturnal Death Syndrome (SUNDS) was documented in Hmong men. Stress, genetics, and cardiac abnormalities interacting with disordered sleep were hypothesized as contributing factors to SUNDS. Most recently, sleep apnea has been implicated in nighttime deaths of Brugada Syndrome. This syndrome is thought to comprise a spectrum of sudden cardiac death disorders, including SUNDS. However, little research since has placed SUNDS in its context of Hmong cultural beliefs, health, or the prevalence of other sleep disorders. Because the epidemiology of sleep disorders and terrifying nighttime experiences in Hmong is poorly documented, we investigated the prevalence and correlates of sleep apnea, rapid eye movement (REM) sleep stage related disorders, and insomnia in 3 population-based samples (collected from 1996 to 2001) comprising 747 Hmong immigrants in Wisconsin. Participants were questioned on sleep problems, cultural beliefs, health, and other factors. A random subsample ($n = 37$) underwent in-home polysomnography to investigate sleep apnea prevalence. Self-report and laboratory findings were compared with similarly collected data from the Wisconsin Sleep Cohort (WSC) study ($n = 1170$), a population-based longitudinal study of sleep. The results inform a unique Hmong sleep disorder profile of a high prevalence of sleep apnea, sleep paralysis, and other REM-related sleep abnormalities as well the interaction of culturally related nighttime stressors with these sleep problems. For example, experiences of dab tsog (frightening night spirit pressing on chest) was prevalent and related to sleep apnea indicators, sleep paralysis, nightmares, hypnagogic hallucinations, and insomnia. Understanding the role of sleep disorders and the cultural mechanisms that may trigger or condition response to them could ultimately provide a basis for screening and intervention to reduce the adverse health and emotional consequences of these conditions in Hmong.

Keywords

USA; Sleep disorders; Sleep paralysis; Hmong health; SUNDS; Sleep apnea; Cultural stress; Brugada syndrome

Introduction

Sudden Unexplained Nocturnal Death Syndrome (SUNDS)

In 1981, an unusual new condition came to the attention of the medical community: based on mortality reports first appearing in 1977, the Centers for Disease Control (CDC) issued an international note that Southeast Asian refugees, primarily Hmong, to the US were dying in their sleep (Centers for Disease Control, 1981). What made this occurrence unusual was,

not only the circumstances of the nocturnal deaths, but the fact that the victims were young men, previously in good health. Reports of these cases increased over the following six years; a mortality rate of 92/100,000 showed these Hmong men were dying at a rate equivalent to the leading five causes of death for American-born men of the same age range (Munger, 1987). CDC researchers noted that non-traumatic sudden death among previously healthy young men with no definitive underlying cause was rare (Centers for Disease Control, 1981). Furthermore, the shared features of the victims, including time of death, signs of respiratory distress preceding death, ethnicity, young age, and rapid transition from apparent health to death, suggested a distinct syndrome; this was subsequently termed “Sudden Unexpected Nocturnal Death Syndrome” (SUNDS) (Holtan, Carlson, Egbert, Mielke, & Thao, 1984).

Family interviews, case investigations, and small case-control studies, (Baron & Kirschner, 1983; Baron et al., 1983; Kirschner, Eckner, & Baron, 1986; Munger, 1987; Tatsanavivat et al., 1992) revealed no promising candidate risk factors. Post mortem exams revealed no evidence of prior pathophysiology, but suggested that the immediate cause of death was ventricular fibrillation leading to cardiac arrest (Munger, 1987; Munger et al., 1991; Otto et al., 1984). Based on reports of family members and those who attempted rescue, the fatal episode is now commonly summarized as having onset during sleep, with clear signs of agonal respiration, with including shallow, irregular breathing interrupted by pauses, choking, gasping, and otherwise labored respiration. The victims appeared to be unconscious and did not respond to attempts to awaken them (Holtan et al., 1984; Munger, 1987; Verrier & Josephson, 2011). Victims who were revived reported sensations of airway obstruction, chest discomfort or pressure, and weak or numb limbs (Verrier & Josephson, 2011).

Since the identification of SUNDS three decades ago, etiological research has been sparse and few hypotheses have been tested. Independent of a focus on SUNDS, in 1992 cardiovascular researchers identified Brugada syndrome, a cardiac abnormality characterized by a distinct ECG pattern and irregular heart rhythm (Brugada & Brugada, 1992). The syndrome is associated with sudden death, with most deaths occurring during the night, (Matsuo et al., 1999) and has been linked to genetic mutations, primarily of the SCNSA gene (Rook et al., 1999). Analyses of several large data bases of genotyped Brugada patients and healthy controls revealed mutation in SCNSA in approximately 21% of Brugada patients compared with 2–5% in healthy controls, supporting a genetic basis for this sudden cardiac death syndrome (Kapplinger et al., 2010). In a study of SCNSA gene mutations in 10 surviving SUNDS patients and their families, the mutation was found in 3 families (Vatta, Dumaine, Varghese et al., 2002). The authors concluded that SUNDS and Brugada syndrome were phenotypically, genetically and functionally the same disorder. Similarities to other conditions of sudden death in otherwise healthy persons indicate that Brugada syndrome may encompass other disorders such as Sudden Infant Death in addition to SUNDS (Fowler & Priori, 2009).

As is true of many other potentially fatal genetic disorders, not all those with the Brugada gene mutation suffer from its expression. Other exposures or triggers appear necessary to initiate the genetic-pathophysiologic mechanism. Recently, the role of sleep apnea and other sleep abnormalities in triggering the unique irregular heart rhythm of Brugada Syndrome has gained support as a possible etiological mechanism (Gami & Somers, 2008; Macedo et al., 2011; Verrier & Josephson, 2009).

Sleep apnea is characterized by repeated episodes of momentary airway closures (apnea, complete closure and pause in breathing; hypopnea, partial closure) as a result of reduced airway tone and collapse during sleep. The resulting breathing pauses have acute effects of

hypoxia and cardiopulmonary instabilities and cause brief arousals to the wake state, which resumes airway tone but results in disrupted sleep patterns (Henry, 2013). In their overnight polysomnography study of 20 Brugada patients and 11 healthy controls, Macedo et al. (2011) found a 2-fold higher prevalence of sleep apnea in the Brugada patients (63%) compared to controls (27%). The authors concluded that the higher incidence of nocturnal death in patients with Brugada syndrome may be a result of co-morbidity with sleep apnea, whereby the apneic events and instability of sleep states associated with transitions between REM and non-REM sleep exacerbate significant cardiac rhythm abnormalities, (Macedo et al., 2011). Thus, some type of adverse sleep-related trigger interacting with a genetic susceptibility to fatal cardiac arrhythmias (i.e., Brugada syndrome) may explain SUNDS etiology.

Dab tsog, sleep paralysis, and other sleep disorder symptoms: prevalent conditions in Hmong as well as SUNDS triggers?

In contrast to the novelty of SUNDS to Western science in 1981, Hmong and other South-East Asian populations have long feared the personal experience epitomized by SUNDS. Culture-specific names have been given to this experience; Hmong refer to the terrifying nighttime occurrence of the crushing spirit on their chest as dab tsog (Adler, 1995; Bliatout, 1982; Fukuda, Miyasity, Inugami, & Ishihara, 1987; Holtan et al., 1984). Victims of visits from this spirit report that dab tsog sat on their chest with crushing force, making it impossible to move and “took their breath”. Although parallels are drawn between SUNDS and the dab tsog experience, the high fatality of the medical syndrome of SUNDS differs from that of dab tsog: historical and ethnographic reports indicate that the experience of dab tsog is not rare or fatal, and is often experienced repeatedly by the victims (Adler, 1995, 2011). Thus, the cultural pattern, collective knowledge and universal description of dab tsog suggest a prevalent bio-psychosocial condition of which only a limited number of cases results in a SUNDS fatality. In a study of 118 Hmong in California, 58% reported at least one experience of the dab tsog visit; in-depth interviews clearly indicated widespread fear, stress, and dread of sleep abnormalities in the Hmong population (Adler, 1994).

The physical experience of both SUNDS survivors and victims of dab tsog is strongly suggestive of several sleep disorder symptoms, including sleep apnea, sleep paralysis, hypnogogic hallucinations and nightmares. Sleep paralysis is caused by the intrusion of wakefulness during a period of Rapid Eye Movement (REM) sleep during which the skeletal muscles are paralyzed (American Academy of Sleep Medicine, 2005, pp. 148–170). During this terrifying event, consciousness is retained, but the ability to speak or activate any voluntary muscle activity (such as moving the limbs or head) is absent (American Academy of Sleep Medicine, 2005, pp. 148–170).

Biomedical research has tended to focus on acute physiological mechanisms as the underlying cause of death by SUNDS. However, considering the wealth of historical and ethnographic reports which demonstrate widespread knowledge and experience of dab tsog that closely parallel sleep paralysis, sleep apnea, and other sleep disorders, it is clear that the cultural context of SUNDS is critical to inform the larger picture of the health and psychosocial burden of severe sleep problems and related stress in Hmong.

Sleep disorders may be triggers for SUNDS, but more importantly, may be under-recognized, highly significant Hmong health issues. Interviews of several Hmong communities indicate that a high proportion of Hmong, apart from SUNDS survivors, report sleep episodes characterized by pressure on their chest and the restricted ability to breath, indicating the possibility of breathing pauses of sleep apnea and REM-like disorders such as sleep paralysis, hallucinations, and/or severe nightmares (Adler, 2011).

Additionally, terrifying encounters with nocturnal spirits, whether as part of the traditional belief structure or exacerbated by conflict or loss of that structure (e.g., due to culture dislocation as part of the refugee experience) have been hypothesized as causes of severe psychological stress that may act as a trigger for SUNDS (Adler, 1994, 1995, 2011; Bliatout, 1982; Holtan et al., 1984).

However, regardless of whether severe or unique sleep disorders increase the risk of SUNDS, Hmong clearly, by their historical report, suffer from terrifying sleep experiences. If culture specific sleep terror (i.e., dab tsog), REM related disorders, and sleep apnea, are highly prevalent among Hmong, this would significantly increase Hmong general morbidity and mortality risk (including hypertension, stroke, depression, diminished quality of life), beyond any possible SUNDS risk (American Academy of Sleep Medicine, 2005, pp. 148–170; Institute of Medicine, 2006).

At present, the prevalence of sleep disorders in Hmong is unknown. There are no systematically collected sleep disorders data on a population sample of Hmong to determine whether this ethnic group, compared to the US population in general, is indeed at higher risk of sleep disorders. Furthermore, data on the relationship of cultural beliefs and culture-related stress with these sleep disorders is sparse. As a first step in understanding the epidemiology of sleep disorders of Hmong, we investigated the prevalence and risk factors for sleep apnea symptoms, sleep paralysis and other REM-related disorders, and insomnia in a sample of 747 Hmong who had immigrated to Wisconsin. Similar data from a Wisconsin population cohort ($n = 1170$) (Young, 2009; Young et al., 1993) were used for comparison to determine if Hmong have a unique sleep disorders profile. In addition we investigated the correlation of personal characteristics, health, traditional practices, acculturation, and the experience of dab tsog, with the occurrence of sleep apnea, sleep paralysis and other disorders.

Methods

Sample construction

The total sample which we refer to heretofore as the Hmong Combined Sample ($n = 747$) comprises participants of three consecutive studies to survey sleep and cultural experiences of Hmong immigrants in Wisconsin conducted from 1996 to 2001. Ethical approval for this research was given by the Internal Review Board, University of Wisconsin. The three population-based samples of Hmong men and women ages 18 years and older were recruited from the following sources:

1. LaCrosse Sample: attendees at a New Year's Celebration in LaCrosse, WI ($n = 134$)
2. Madison Sample: telephone directory listing of Hmong clan names in Greater Madison area, WI ($n = 83$)
3. 3) Statewide Hmong Census Sample: a probability sample of listings in a commercial Midwest Census Directory of Hmong residents in Wisconsin ($n = 530$).

In all studies, participants were asked to complete a questionnaire on sleep habits and problems. The questionnaires all contained a set of standard sleep questions and socio-demographic questions, but additional questions on traditional beliefs and experiences (detailed below) were added to the last two survey instruments for the Madison and Statewide Census Samples.

The questionnaires for all three Hmong studies were developed with input from several Hmong community advisors, to re-phrase questions for improved comprehension and to

incorporate questions that were compatible with Hmong-specific sleep problems, cultural experiences and habits. Questionnaires were designed in both Hmong and English language. Both versions were back translated to help insure comparability and pilot tested on three groups of Hmong volunteers.

With the exception that the average age of the LaCrosse Sample was slightly lower, the three sample groups were not significantly different on variables for other demographics, sleep, or culture, based on univariate comparisons and statistical models with a term for sample source. Consequently, the three groups were combined for further analysis.

Participants were recruited from several areas of Wisconsin for the Statewide Hmong Census Sample. Consequently, this introduced the potential for duplicate recruitment of Hmong already in the Madison and LaCrosse samples. Because of the lack of variation in Hmong surnames and residential mobility over the study years, it was not possible to rule out any potential duplication of participants. However, results from analyses conducted on only the Statewide Hmong Census Sample did not differ from that of all three samples combined. Therefore, it is unlikely that duplication of participants was significant or biased the findings.

A limitation of the Combined Hmong Sample is the potential lack of generalizability of Hmong living in WI to those residing in MN or CA (the other two major Hmong settlement areas in the US), other areas of the US, or in other countries. It is likely that economics, lifestyle, acculturation, and other factors do indeed differ, particularly for Hmong living in large metropolitan vs rural areas. Although traditional beliefs and reports of sleep disturbances appear similar according to reports from MN and CA (Adler, 1995; Holtan et al., 1984), unknown societal differences may limit the generalizability of our findings, particularly those related to acculturation.

Sample details

LaCrosse Sample (n = 134)—Hmong adults were recruited at the 1996 Hmong New Year's festival in LaCrosse, Wisconsin, a highly anticipated event throughout the year. Most of the community comes out to watch athletic events, a cultural show and to visit the booths selling everything from clothes to medicine. Two interviewers, one fluent in the Hmong language, were present (S Xiong, E Young) to interact enthusiastically with attendees and invite them to fill out a questionnaire or be interviewed. Participants who could not read or write were interviewed in the Hmong language. An incentive to participate was a certificate for a free beverage. Out of an estimated 250 attendees, a total of 146 surveys were completed from the LaCrosse recruitment. To restrict the study to adults (18 years of age or older), we excluded 16 participants, yielding the final sample of 134.

Madison Sample (n = 83)—From the Ameritech 1997–1998 Greater Madison WI Area telephone directory, Hmong adults (age 18 or older) were recruited based on clan name (last name). Hmong have less than 20 clan names. Therefore all the 18 last names (Cha/Chang, Cheng, Chue, Fang, Hang, Her/Her, Kha/Khang, Kong, Kue/Keu, Lee/Ly, Lo/Lor, Moua, Pha, Thao, Vang, Vue, Xiong/Siong, Yang) including variations on spelling were identified from the phone directory. All identified Hmong households were phoned at random times (until a connection was established) and asked a series of questions to ascertain that the household was Hmong and identify an adult resident (age 18 years or older). The study was explained, and potential participants were requested to complete a mailed survey in Hmong, English, or both. Of the 152 surveys sent out to Hmong adults in the greater Madison community, 83 completed surveys were returned, with a response rate of 55%.

A subsample ($n = 37$) of the Madison Sample also participated in an in-home polysomnography study and interview. For this, the first wave of respondents ($n = 50$) were invited to participate in this additional protocol. The in-home protocol was conducted by a researcher (S Xiong) and an assistant, both Hmong and fluent in the language. As part of the interview, participants were asked their opinion of what might be the causes of SUNDS, and about their own experiences with dab tsog. Overnight sleep and breathing were recorded using portable polysomnography (PSG).

Statewide Hmong Census Sample ($n = 530$)—A probability sample of Hmong residents in Wisconsin was obtained in 2001 from the publishers of the commercially available Hmong Social Services Census Directory (C&W Communications, Minneapolis, MN). While the census directory included Hmong residing in both Wisconsin and Minnesota, we selected only Wisconsin residents ($n = 3000$). Questionnaires on sleep habits, problems, adherence to traditional religious beliefs, and other factors (in English and Hmong) were sent to the sample of names and addresses selected. The questions were identical to the LaCrosse and Madison questionnaires, but included additional questions about cultural beliefs and practices. Unknown to us, the census directory sample we acquired had not been updated yearly as was described by the publisher. Due to out of date addresses, approximately half of the surveys were returned undelivered; we received 530 completed surveys and estimate a minimal response rate of 33%.

Comparison sample: Wisconsin Sleep Cohort (WSC) study ($n = 1170$)—To determine if the prevalence and risk factors of sleep disorders reported by the Hmong participants were unique, we used survey data from the WSC, an ongoing, longitudinal population based study of sleep disorders for comparison. The WSC sample, described previously (Young, 2009; Young et al., 1993) is based on a probability sample of WI state employees, and has low ethnic diversity, with 96% Caucasian and no Hmong participants. In the WSC study, data are collected by self-report (survey and interview), and by an examination that comprises a wide range of measurements, including in-laboratory polysomnography comprising an 18 channel recording of sleep, breathing, heart rate, movement and other functions throughout the night (Grass Instruments, Quincy, MA), as well as other tests (Young et al., 1993). Overnight recordings were scored for AHI using standard definitions (American Academy of Sleep Medicine Task Force, 1999). Although participants have been studied repeatedly (at approximately 4 year intervals), to insure conformity for this investigation, we selected the WSC data nearest in time to the date of the Hmong sample data collection.

Data collection

Questionnaire—Questions were focused on frequency of sleep problems, socio-demographic factors, indicators of acculturation, cultural practices and beliefs, and health.

1. Sleep problems. Information on the occurrence and frequency of several sleep problems, including indicators of sleep apnea (snoring, breathing pauses), REM-related disorders including sleep paralysis at sleep onset, waking, and mid-sleep, hypnagogic hallucinations, nightmares, cataplexy-like symptom of “weak knees” when laughing or excited, insomnia, and excessive daytime sleepiness (EDS). A semi-qualitative scale was used for response frequencies as follows: Never; Rarely (1–2 nights a year); Sometimes (a few nights a month), Often (a few nights per week) and Very often (every night or almost every night).
2. Socio-demographics. Questions were asked regarding sex, age, and number of children and adults in household.

3. Acculturation. To estimate degree of acculturation, questions were included on type of diet (Hmong vs Western), years lived in America, and religious practices (Shamanism, Christianity or “other”).
4. Traditional beliefs and experiences. Questions were asked regarding knowledge and personal experience of the nightmare visit by a spirit (dab tsog) which sits on the chest and is said to steal one’s breath, knowledge of SUNDS deaths in relatives or acquaintances, and feeling affected in some way, including stress, by experience with the Vietnam War. A list of possible experiences with the Vietnam War was provided, along with the choice of “no experience”. Any of the following was coded as affirmative for as a stressful experience with the Vietnam War: I was in the army; I was exposed to chemical warfare; I lost family, close relatives or friends; I had other stressful experiences due to the war.
5. Health. Participants were asked to report their height and weight, and if they experienced: heart disease, hypertension, diabetes, chronic pain.

Polysomnography—Sleep and breathing of 37 Hmong participants were recorded using in-home portable polysomnography, comprising EEG to determine sleep stage, oximetry for oxygen saturation, thermisters for airflow and respiration plethysmography for respiratory excursions (Compumedics, Abbotsford, Victoria, AU). The overnight records were scored for sleep stage and apnea and hypopnea events using the same standard definitions as were used in the WSC (American Academy of Sleep Medicine Task Force, 1999) to determine the average number of apnea and hypopnea events during EEG indicated sleep (apnea–hypopnea index, AHI). AHI was determined for overall sleep time and for REM-stage time (REM AHI).

Statistical methods

The data collected in this study were analyzed using SAS (9.2) software modules for descriptive statistics, contingency tables, and multiple logistic regression. We grouped variables into socio-demographics (age, sex); frequencies of sleep disorder symptoms (snoring, breathing pauses, EDS, sleep paralysis nightmares, hypnagogic hallucinations, cataplexy-like symptom, difficulty falling to sleep, and restless sleep); culturally relevant variables (adherence to Shamanistic spiritual beliefs, Hmong diet, number of people in household, years living in the United States, experience with the Vietnam War, knowledge of relative or acquaintance who die of SUNDS, and personal experience of dab tsog); and health (body mass index, heart disorders, hypertension, diabetes, chronic pain).

We compared the sleep disordered symptom prevalences from the Hmong survey data and the Wisconsin Sleep Cohort Study data ($n=1170$) using contingency tables with Chi-sq test for statistical significance of difference between groups. We then examined potential risk factors (sociodemographic, cultural, and health) for the sleep disorder symptoms (as dependent variables) using multiple logistic regression modeling. First, age and sex were examined in the basic model and then were used as covariates with each of the cultural variables in individual models. Statistical significance of logistic regression coefficients was assessed by Wald Chi-square tests. Estimated beta coefficients and standard errors were used to calculate odds ratios and 95% confidence intervals.

For those who underwent polysomnography, we compared the prevalence of sleep disordered breathing using the AHI (based on both REM stage sleep time and overall sleep time) at two cutpoints (5 and 15) between the Hmong and WSC participants. Logistic regression models for the AHI variables were adjusted for age, sex, and body mass index. A variable was created to represent the sample source (Hmong or WSC). Odds ratios were

estimated from the beta coefficient of this variable to determine the risk of sleep apnea indicated by AHI (in REM and total sleep time) severity levels in Hmong, with WSC as the reference group. In all analyses, results with a p -value of less than 0.05 were considered statistically significant.

Results

Descriptive characteristics of the Hmong Combined Sample (n = 747)

Table 1 shows that most participants practiced Shamanistic religion, adhered to a Hmong diet and on average lived in fairly large households. Twenty-nine percent knew a relative or acquaintance who had died of SUNDs. Although the participants had been in the US for several years on average, it appears that most adhered closely to the Hmong culture. A high prevalence of chronic pain was reported.

Frequency of experiencing sleep disorder symptoms

Table 2 displays the reported frequency of sleep symptoms and disorders including snoring, breathing pauses, and excessive daytime sleepiness (EDS), insomnia, sleep paralysis, nightmares and other REM-related sleep abnormalities, and the culture-specific sleep disruption of dab tsog. Hmong reported high frequencies (e.g., at least a few nights per month to “always”) of several sleep disorder symptoms, particularly those of REM-related disorders, including sleep paralysis, cataplexy-like symptom of weak knees when excited, and nightmares. Thirty-one percent reported experiencing dab tsog, a visit from the chest pressing spirit, with 17% having this occur at least a few nights each month or more often (i.e., sometimes; often; very often).

Prevalence of sleep disorder symptoms

To determine if the sleep symptom prevalences were significantly different in the Hmong sample, we dichotomized the sleep frequency variables according to commonly used cutpoints (indicated by shading in Table 2). After adjusting for age, sex, and BMI, we compared the prevalence of these sleep problems with those in the WSC.

As seen in Fig. 1, although prevalence for breathing pauses were similar for both groups, prevalence of snoring was lower in Hmong. Most striking was the statistically significant higher prevalence of sleep paralysis in Hmong compared to the WSC (30% vs 3%). Higher prevalences were also found for cataplexy-like symptoms of weak knees when excited or laughing, nightmares, and insomnia.

Risk factors for sleep disorder symptoms in Hmong

To investigate the role of cultural beliefs and unique sleep-related experiences (such as dab tsog) in Hmong sleep problems, we examined the association of demographic and cultural variables with the sleep disorder symptoms. Table 3a shows associations, indicated by odds ratios (adjusted for age and sex) for the risk of reporting sleep apnea symptoms (snoring, breathing pauses, and EDS), given the occurrence of the cultural factors. Table 3b shows the risk of experiencing frequent sleep paralysis and other REM-related sleep abnormalities and insomnia with the culture-specific variables.

Correlates of self-reported sleep apnea symptoms

As shown in Table 3a, Snoring frequency was significantly associated with being male and increasing age (both established risk factors for sleep apnea), but was not related to cultural-specific stress such as dab tsog. In contrast, frequency of breathing pauses was strongly associated with dab tsog (OR = 4.2, $p < 0.001$). This discrepancy is potentially important as

snoring is typically reported with breathing pauses in both population and clinic samples. Furthermore, in contrast to the WSC sample, the prevalence of snoring, but not breathing pauses, was lower for Hmong. Thus, our data indicate that the questions for frequency of snoring and breathing pauses may elicit different content for Hmong. The strong correlation of breathing pauses with dab tsog suggests the reporting of breathing pauses is not based on a bed partner's account of the subject's breathing pauses, but rather the subject's own feeling of awakening with the lack of breathing. While this may be an apneic event, it may be part of the constellation of symptoms of experiencing dab tsog. Other culture-specific variables were not consistently related to the sleep apnea markers.

Correlates of sleep paralysis and other REM-like sleep disorder symptoms

Odds ratios ranging from 2 to 4, with $p < 0.0001$, are shown in Table 3b for the REM-related sleep symptoms of sleep paralysis, nightmares, hypnagogic hallucinations, cataplexy-like experiences, and insomnia with cultural-specific risk factors that include: experiences of dab tsog, knowledge of SUNDS deaths in relatives and friends, Vietnam War stress, acculturation, and chronic pain. Other variables to reflect acculturation (practicing Shamanism, adherence to Hmong diet, years living in the USA) were not consistently related to these sleep problems. In addition, diabetes, heart problems and hypertension were not significantly related to any of the sleep outcomes (not shown). However, chronic pain was consistently related to all of the REM-related sleep disorders given in Table 3b.

Personal accounts of culture-relevant sleep problems and experiences

Madison Sample participants who participated in the in-home protocol for polysomnography (Madison Hmong Subsample, $n = 37$) were also asked open-ended questions about knowledge of SUNDS, if they knew someone who died from SUNDS, what they felt caused SUNDS, and any personal experiences of dab tsog. Of the total sample of 37, ten participants declined to provide answers, resulting in 27 completed interviews. The responses are summarized below, highlighted with some personal accounts. Of the 27 who provided detailed responses:

- 25 were familiar with SUNDS.
- 16 responded they did not know a cause.
- 3 knew of deaths in a relative or close acquaintance. One woman responded that her husband had died of SUNDS in Thailand. She said he husband had not been sick but prior to his death she heard him snoring, snorting and making "hard to breath" sounds.
- 2 participants replied they knew of "lots" of SUNDS deaths. One woman knew a man in Thailand who "couldn't cough and died of SUNDS.
- 3 gave fairly objective responses, stating that they believe the cause of SUNDS was due to airflow obstruction or disease. One said, "I do not believe in superstitions. I believe SUNDS is caused by abnormal sleeping patterns which obstruct regular airflow and result in death." Another said the cause was "clogged arteries or veins".
- 3 reported it was due to stress. It is interesting to note that all these participants also had great fear of SUNDS, possibly indicating that fear of SUNDS in itself may cause stress. One of the participants said they, "worry a lot about things and it's hard to fall asleep."
- 6 reported having the experience of dab tsog ($6/27 = 45\%$). One participant reported that "Something on chest has=happened a lot". Another complained of having nightmares 2–3 times a year in which they cannot move or breathe with pressure on

their chest, leading to them stating that they “worry about having nightmares and being unable to breathe.”

- 4 reported it was something on their chest that stopped movement and breathing. In a similar account another participant described a deep sleep nightmare in which they, “cannot breath and feel something on chest like a cat.”

- 1 believed the cause was spiritually related. The participant stated that SUNDS is, “due to worry and not following God.”

Polysomnography

Table 4 compares the polysomnography results for sleep apnea (indicated by the average number of apneas and hypopneas per hour of sleep) from the Hmong Madison Subsample vs WSC participants. Hmong had a higher risk of mild (AHI > 5) or worse (AHI > 15) sleep apnea. The higher prevalence of sleep apnea for Hmong was seen in both total sleep time and REM sleep. When compared with WSC data, using logistic regression Hmong had an 8.8–10 fold risk of having mild or worse sleep apnea, and a 6.7–7.2 fold risk of having moderate to severe sleep apnea in both REM and total sleep. Differences were statistically significant with $p < 0.001$.

Discussion

Our findings, based on the largest Hmong population sample studied thus far, show important ethnic differences in the profile of sleep disorders in Hmong immigrants in Wisconsin. Most notably, prevalences of sleep paralysis and other REM-like disorders, objectively measured sleep apnea (all hypothesized triggers for SUNDS), were significantly higher compared to those in non-Hmong. Furthermore, several variables for culture-specific stress, including frequent experience of dab tsog, knowing relatives who died of SUNDS, and traumatic Vietnam War experiences, were strikingly correlated with the REM-related sleep symptoms of sleep paralysis, nightmares, hypnogogic hallucinations, cataplexy-like experiences, and insomnia.

The objective of this study was to examine the epidemiology, including the prevalence and cultural correlates of sleep disorder symptoms in Hmong, prompted by the high risk of SUNDS and its unusual sleep symptoms. Sleep apnea and REM-related abnormalities have been suggested as triggers for SUNDS in those with a genetic vulnerability to arrhythmias as seen in Brugada syndrome (Gami & Somers, 2008; Macedo et al., 2011). In addition, cultural stress, either due to strong beliefs in harmful spirits and/or conflict due to difficulties adhering to these spiritual beliefs have been supported as a trigger for SUNDS by the extensive work of Adler (1994, 1995). In particular, Adler discusses the role of forced cultural isolation due to the traumatic events of the Vietnam War, subsequent relocation and isolation from traditional lifestyle (Adler, 2011).

Our findings of high prevalences of sleep disorders and correlation with dab tsog and other culture-relevant variables support the above hypotheses and speak to the broader health problems of severely disturbed sleep in Hmong. Based on our population sample, traditional beliefs and stresses are inter-twined with significant sleep disorders, particularly those with SUNDS-like symptoms of dab tsog, sleep paralysis, obstructed breathing, and hallucinations.

Prevalences of experiencing frequent REM-related symptoms and polysomnographically determined sleep apnea were notably higher for Hmong compared with WSC participants. Isolated sleep paralysis is reported to occur rarely (at least once in a lifetime) by 40–50% of the general population, but only 3–6% report this as a chronic complaint (American

Academy of Sleep Medicine, 2005, pp. 148–170; Buzzi & Cirignotta, 2000). In contrast, 31% of our Hmong sample reported a frequent (at least weekly) occurrence of sleep paralysis. Prevalence of very frequent (several nights per week or every night) nightmares (15%) and insomnia (20%) were also statistically significantly higher in the Hmong compared to the WSC.

Sleep apnea is a suspected trigger of SUNDS (Gami & Somers, 2008; Macedo et al., 2011). Although the prevalence for Hmong of reported snoring (the most common indicator of sleep apnea) was not high, polysomnography assessment of sleep apnea in our Madison Hmong Subsample ($n = 37$) revealed high prevalences of mild to severe sleep apnea. Comparison with WSC prevalences suggests that Hmong may be at 6–10 times the odds ($p < 0.001$) of having mild or worse sleep apnea, based on polysomnographically-estimated AHI in both REM stage sleep and total sleep time.

The discrepancy between subjective snoring frequency and the objective polysomnography findings may indicate that the snoring question was misunderstood or under-reported due to a lack of bed-partner's or other informant's complaints on the subject's snoring. Other cultural variables may have influenced the reporting of snoring. For example, do Hmong typically sleep in the same bed together? Is there a social stigma related to snoring contributing to its under-reporting? There are no data concerning the validity of self reported snoring in Hmong. Regardless, the data from these 37 PSG recordings represent the only non-selected population-based objectively measured data on apnea and hypopnea events during sleep in Hmong. Thus, In spite of limitations, the findings provide a first estimate of high sleep apnea prevalence in Hmong and suggest that usual clinical assessment of snoring history may not be appropriate for sleep apnea screening in Hmong.

Fear and stress due to traumatic experiences or traditional beliefs in malevolent forces are known to have profound effects of all aspects of physical and mental health (Cohen & Herbert, 1996). There is considerable research supporting severe sleep disruption as an etiologic or comorbid factor in post traumatic stress syndrome (Fukuda et al., 1987; Hinton, Pich, Chhean, Pollack, & McNally, 2005; Spanos, McNulty, DuBreuil, & Pires, 1995). More broadly, Integrative and behavioral medicine has brought the importance of the mind and body connection in informing the etiology of adverse health states. When SUNDS is considered in the perspective of traditional Hmong culture as well as other Southeast Asian cultures (Fukuda et al., 1987; de Jong, 2005), it appears that SUNDS may be but one negative outcome of culture-specific stress that affects sleep pathophysiology to result in significant negative health outcomes.

The link between sleep paralysis, dab tsog, and traditional beliefs in harmful spirits is underscored in our findings that the odds of sleep paralysis is 2–4 times higher in Hmong reporting dab tsog, personal experience with SUNDS, or stressful Vietnam War experiences. In addition to the inherent psychobiological trauma, resulting adverse health outcomes are suggested in our data by strong associations of sleep paralysis and other REM-like sleep disorders with chronic pain. In a recent study of Chinese–Taiwanese patients (Hsieh, Lai, Liu, Lan, & Hsu, 2010), sleep paralysis (called ghost oppression by Chinese) was associated with several measures of health-related quality of life. The authors note that sleep paralysis is not only a terrible experience during sleep but also considered a bad omen with psychosocial consequences (Hsieh et al., 2010).

It is possible that the cultural-related stress, fears and beliefs have a causal role in the experience of dab tsog, which in turn influences the report of breathing pauses and the REM-like disorders, particularly sleep paralysis. Alternatively, the sleep disorder symptoms may be interpreted as the experience of dab tsog. Dab tsog was very strongly associated with

significant sleep problems including sleep paralysis, other REM-like disorders, insomnia, breathing pauses and daytime sleepiness, and with chronic pain. With 17% of our sample reporting the dab tsog experience to occur on multiple nights per week or every night and many fearing the occurrence, this condition, comprises a significant trauma and health burden for the Hmong.

Conclusions

Our data provide strong support for a high prevalence of sleep abnormalities and a high level of specific cultural stress regarding awareness of SUNDS victims and experiencing dab tsog. From our study of 747 Hmong men and women in Wisconsin, we conclude that Hmong are at high risk for the hypothesized nighttime triggers for SUNDS, including sleep apnea, sleep paralysis and other REM-like symptoms, and culture-specific stressful experiences (including personal knowledge of SUNDS victims and experience of dab tsog). Furthermore, the culture specific stressful experiences were significantly associated with most sleep disorder symptoms, particularly REM-related disorders, suggesting a bio-psychological connection.

Regardless of whether these sleep abnormalities are involved in the etiology of SUNDS, they represent a significant mental and physical health burden with quality of life repercussions that warrants attention. Health care providers and traditional Hmong healers need to be aware of the high risk of sleep disorders and culture-related stress that negatively affect sleep in Hmong, implement sensitive measures for case-finding, and make proper referrals for sleep evaluation and other care.

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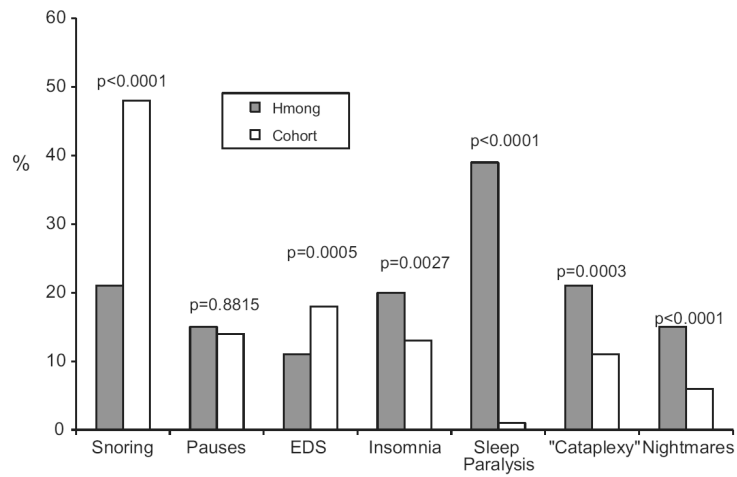


Fig. 1. Comparison of sleep problems prevalence in Hmong Combined Sample ($n = 747$) and Wisconsin Sleep Cohort samples ($n = 1170$); p -value indicates statistical significance of difference between groups.

Table 1Description of Hmong Combined Sample, $n = 747$.

Characteristic	Value
Age, years, mean (sd) range	40 (13) 18–86
Sex, % male	62%
Body mass index, mean (sd)	26 (4)
Number of years in US, mean (sd) range	15 (6) 0.1–30
Practice shaman religion, % yes	66%
Knowledge of nocturnal sudden death in relative or friend, % yes	29% ^a
Affected in some way by Vietnam War, % yes	74%
Diabetes, % yes	7% ^a
High blood pressure, % yes	11% ^a
Heart problems, % yes	3% ^a
Pain most of the time, % yes	34% ^a
Hmong diet, % yes	80% ^a
Number of people in household, mean (sd) range	7 (3) 1–21

^aWisconsin statewide and LaCrosse surveys ($n = 664$).

Table 2Percent experiencing sleep disorder symptom by frequency category (Hmong Combined Sample, $n = 747$).

Sleep disorder symptom	Frequency, nights per week				
	Never, %	Rarely, %	Sometimes, %	Often, %	Very often, %
Snoring	40	11	28	9	12
EDS	44	19	25	8	3
Breathing pauses during sleep	74	12	11	2	2
Insomnia	34	15	31	11	9
Nightmares	22	21	42	9	6
“Paralysis” falling asleep or waking	60	8	23	5	3
Cataplexy-like symptom of “weak knees” when excited	79	8	10	2	1
Spirit on chest experience during sleep (dab tsog)	69	14	13	2	2

Shading indicates binary category of frequency used to estimate prevalence in Fig. 1.

Table 3a

Association of cultural variables with sleep apnea symptoms estimated by logistic regression (Hmong Combined Sample, $n = 747$).

Models Independent variables	Odds ratios (p -values) for sleep apnea symptoms		
	Snoring	Breathing pauses	Excessive daytime sleepiness
Sex, male	2.2 ^{**}	–	–
Age, 1 yr	1.03 ^{**}	–	–
Models below all adjusted for age and sex:			
Average number living in household (reference category, <5)			
5–9	–	–	–
10	–	–	–
Practice Shamanism, yes	–	–	–
Hmong diet, yes	–	–	–
Years living in USA (reference category <10)			
10–20	1.84 [*]	–	–
10	2.77 ^{**}	–	–
Any experience in Vietnam War, yes vs no	0.52 [*]	–	–
Any SUNDS among relatives, friends, yes vs no	–	–	–
Experience of dab tsog, rarely or more vs less	–	4.17 ^{***}	3.18 ^{***}
Chronic pain	–	2.34 ^{***}	–

–Indicates $p > 0.05$.

*
 $p < 0.05$.

**
 $p < 0.01$.

 $p < 0.001$.

Table 3b

Association of cultural variables with REM related sleep disorders estimated by logistic regression models.

Models Independent variables	Odds ratios (<i>p</i> -values) for sleep disorder symptoms							
	Sleep paralysis			Hypnagogic hallucinations	Night-mares	Difficulty getting to sleep	Restless sleep	“Weak knees” (cataplexy-like symptom)
	Going to sleep	During sleep	During wake					
Sex, male	1.61**	–	–	–	–	1.67**	1.58**	–
Age, 1 yr	–	–	–	–	1.03**	–	1.01*	–
Models below all adjusted for age and sex:								
Average number living in household (ref <5)								
5–9	–	–	–	–	–	–	–	–
10	–	–	–	–	2.25*	–	–	–
Practice Shamanism, yes	–	–	–	1.56*	–	–	–	–
Hmong diet, yes	–	–	–	–	–	–	–	–
Years living in USA (ref <10)								
10–20	–	–	–	–	–	–	–	–
10	–	–	–	–	0.47*	–	–	–
Any experience in Vietnam War, yes	1.69*	1.80*	–	–	–	–	1.91*	–
Any SUNDS among relatives, friends, yes	–	1.68*	2.18**	1.80**	1.81*	–	–	2.02**
Experience of dab tsog, rarely or more	2.41***	3.01***	2.00***	3.69***	4.07***	1.86**	1.49*	3.33***
Chronic pain	1.66*	1.80**	1.72*	2.17**	2.66**	2.72***	3.31***	1.97**

* $p < 0.05$,** $p < 0.01$,*** $p < 0.001$.

Table 4

Prevalence (%) and adjusted^a odds ratios (95% confidence intervals) of REM–AHI and AHI severity for Hmong vs WSC.

Sample group	AHI > 5		REMAHI > 5		AHI > 15		REMAHI > 15	
	Prevalence (%)	Adjusted OR (95% CI)	Prevalence (%)	Adjusted OR (95% CI)	Prevalence (%)	Adjusted OR (95% CI)	Prevalence (%)	Adjusted OR (95% CI)
Cohort	22%	Reference	33%	Reference	8%	Reference	16%	Reference
Hmong	57%	10.2* (4.5, 23.2)	71%	8.8* (3.7, 21.0)	27%	6.7* (2.2, 19.9)	48%	7.2* (3.1, 16.5)

* $p < 0.001$.

^a Adjusted for age, sex, and body mass index.