



NREM parasomnia-related behaviors and adverse childhood experiences

Vivian M. Correa^{a,*}, Mengesha S. Biresaw^a, József Vitrai^b, Anna Szűcs^c

^a Mental Health Sciences Doctoral School, Semmelweis University, Hungary

^b Department of Preventive Health Science, Széchenyi University of Győr, Hungary

^c Institute of Behavioral Sciences, Semmelweis University, Budapest, Hungary

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ABSTRACT

Purpose: To assess the prevalence, types, sociodemographic factors, and reported dangerous activities of sleep-related behaviors likely representing NREM parasomnia episodes, as well as their association with adverse childhood experiences in Hungary.

Methods: Cross-sectional survey of 1000 adults (aged ≥ 18 years) representing the Hungarian population, using a non-probability quota sampling with a random walk method and a structured face-to-face interview. A multi-criterion weighting procedure was applied to correct bias along the main sociodemographic variables to the data available. Binary logistic regression estimated the odds of NREM parasomnia-related behaviors associated with sociodemographic factors and adverse childhood experiences.

Results: The prevalence of NREM parasomnia-related behaviors was 2.7 %, and self-reported sleep-eating was 0.1 % of the population (4.6 % of parasomnia-like activities). For middle-aged adults, the odds of sleep ambulation were significantly lower than for younger adults (OR 0.3; $P = 0.03$). A participant's family occurrence of reported parasomnia-like activity increased their odds of having it by more than 7 times (OR 7.1; $P < 0.001$). Nine participants out of those 27 people reporting NREM parasomnia-related behavior episodes, reported childhood adverse experiences, increasing the odds of parasomnia-related behavior by more than six times (OR 6.2; $P < 0.001$) compared to those not reporting it.

Conclusion: This is the first population survey in Hungary on adult sleep-related behaviors likely representing NREM parasomnia episodes and the potential association with childhood traumatic events preceding them. The related dangerous behaviors call for safety measures and prevention. The significant association between adverse childhood events and NREM parasomnia-related behaviors needs further analysis.

1. Introduction

Although there is abundant literature on NREM parasomnias also termed disorders of arousal (DOA) [1], the mechanism and prevalence of different types and risky behaviors remain unclear [2]. NREM parasomnias include sleepwalking, sleep terrors, sleep-related eating disorders, confusional arousal, and sexsomnia based on the classification of the third edition of the International Classification of Sleep Disorders (ICSD-3) [3,4].

DOAs have been evidenced to be underlain by NREM sleep dissociation – a part of the brain sleeping and another circumscribed part fully or partially awake; as well as increased arousal in sleep; shown by sleep fragmentation [4].

Sleepwalking is characterized by ambulation in a partially sleeping

and partially awake state. It may be associated with dangerous behaviors [5]. The affected person may slowly speak and even respond to questions in a reduced capacity [6]. Simple behaviors, such as sitting up or walking around, or complex ones, such as packing, leaving home, cooking, or driving, occur [7]. The prevalence tends to decrease from childhood to adulthood and older age, showing a descending “age-slope” [8].

Sleep terrors are characterized by sudden and short episodes of behaviors reflecting intense fear, panic, or agitation evolving from NREM sleep [9]. The affected persons have no memory of the episode upon awakening [10]. These episodes typically occur during deep sleep and involve a sudden partial arousal [11].

During confusional arousals the awakening person remains half-sleeping for a variable duration of time from minutes to hours;

* Corresponding author. Vivian Miranda Correa Institute of Behavioral Sciences, Doctoral School of Mental Health Semmelweis University, 28 Dob Street, Budapest, Hungary.

E-mail address: vivian.miranda@phd.semmelweis.hu (V.M. Correa).

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resulting in disorientation and confusion; usually followed by partial amnesia [10]. Such episodes may be facilitated by forced awakenings, particularly in individuals lacking sufficient sleep [12].

Sleep-related eating disorder (SRED) involves eating in a half-sleeping state [8]. Patients may consume odd or prohibited foods and non-edible materials such as raw meat, deep-frozen stuff, soap, and even poisonous substances [13].

Performing different sexual activities, from masturbation to full sexual intercourse during NREM sleep, is called *sexsomnia*. It is usually followed by complete amnesia in the episode and can evoke forensic consequences [14–16].

Sleep talking, or *somniloquy* is considered by ICSD-3 as a standard variant or isolated symptom that may be associated with both DOA and REM parasomnias [4,10]. It may include uttering simple sounds, mumbles, or complex, coherent speech [17].

The family accumulation of DOAs is well-known [18]. While external factors can precipitate these events, an underlying genetic predisposition is likely [19]. One gene linked to sleepwalking on chromosome 20q12-q13.12 [20] has been identified, and the association of DOA with HLA DQB1*05:01 has been shown [21]. Additionally, NREM parasomnias are genetically and clinically connected to nocturnal frontal lobe epilepsy; both groups of conditions are likely related to hypersensitivity of the acetylcholine-related arousal system [22].

Lifestyle issues, alcohol, medicines, and different psycho-active substances may have priming or triggering roles in NREM parasomnias [19,23] and the etiologic role of personality traits, psychological factors, trauma as well as adverse childhood experiences (ACEs) have been raised [24]. ACEs, such as emotional and physical (including sexual) abuse and/or dysfunctional household conditions (parental divorce, orphanage, etc.) [25], have been linked with other sleep disorders such as sleep apnea, sleep paralysis, nightmares, and psychiatric distress as well [26]. In an Indonesian study on sleep-disordered children, NREM parasomnias were found to be linked to low socioeconomic status and disrupted families [15]. Data in the literature on sex differences of NREM parasomnias are contradictory, and prevalence data on sleep-related eating disorders and *sexsomnia* are lacking or sparse [13].

There are important definition-related and diagnostic issues [12], different types of studied populations (sleep lab, population survey, sleep clinic, etc.), and methodological differences underlying the inconsistencies of data. In addition, to our knowledge, no population survey of NREM parasomnias has been performed in Hungary.

These facts have led us to perform this study. We aimed to assess the prevalence, types, sociodemographic factors, risks, and injurious consequences of different NREM parasomnias and explore their potential association with ACEs in Hungary, a country with a population of 9 800,000 (5 070,000 females at the beginning of 2023) [27]. We aimed to learn the followings.

1. The prevalence of sleep-related behaviors likely representing NREM parasomnia episodes and their sub-types in Hungary;
2. The influence of sociodemographic factors on the occurrence of sleep-related behaviors likely representing NREM parasomnia episodes;
3. The prevalence of potentially dangerous activities during sleep-related behaviors likely representing NREM parasomnia episodes;
4. If there is a statistical link between sleep-related behaviors likely representing NREM parasomnia episodes and ACEs.

2. Methods

2.1. Data collection

We hired a professional pollster company, the Zavecz Research Group, to conduct a cross-sectional community-based survey of adults (aged ≥ 18 years) between 28th February and March 8, 2023. A personal interviewing method using a laptop or tablet computer was performed

by trained data-collectors. A random walk method selected 1000 respondents in a non-probability quota sample. The quotas of gender (M/F), age, residence (urban dwellers: people living in towns with $\geq 100,000$ inhabitants; rural dwellers: those living in smaller towns, villages, and farms), education (primary, secondary, or graduated), employment status (active or inactive), and family status (living alone or partnership/marriage) were determined for regional strata based on the last census to ensure the representativeness of the studied population. Participants signed an informed consent form to be interviewed.

2.2. The questionnaire

After recording sociodemographic data, the participants were interviewed about their sleep-related behaviors likely representing parasomnia episodes, and related dangerous activities, family accumulation, and ACEs using the following questions.

1. Have you ever sleepwalked or did some activity during sleep? (Yes/No/I do not know)
2. Please describe the behaviors you performed during sleep.
3. Have you performed any potentially injurious or dangerous activity during sleep? (e.g., leaving the house, climbing or jumping through the window, driving, handling electricity or sharp objects, etc.) (Yes/No/I do not know)
4. Have any of your family members experienced any sleep-related behaviors? (Yes/No/I do not know)
5. Have you experienced any severe physical or mental trauma in your childhood? (Yes/No/I do not know)
6. If yes, what was it?

The authors (V.C. and A.S.) coded the answers to questions 2 and 6. The sleep-related activity types were classified as sleepwalking, sleep terrors, sleep talking/shouting, sleep eating, and *sexsomnia*. The answers to question 6 were classified as physical or mental/emotional distress.

2.3. Statistical analysis

Pairwise marginal distributions of the main sociodemographic variables were used for the weighting procedure to adjust for sample bias. We used descriptive statistics, including the mean $\pm$ standard deviation for the quantitative variables and percentages for the qualitative variables. We have used a conservative estimation with "I don't know" answers categorized as "No". Due to the participants' registration with the professional pollster company that performed the survey, there was no missing data in the sociodemographic responses. Associations between sociodemographic characteristics and "Yes/No" responses were analyzed by logistic regression. The independent explanatory variables were gender, age group (18–30, 31–49, or ≥ 50), education, and residence (urban or rural). The odds ratio (OR), its significance (P-value), and 95 % confidence interval (CI 95 %) were calculated. Computations were performed using the STATA statistical package (StataCorp. 2019. Stata Statistical Software: College Station, TX: StataCorp LLC).

3. Results

Out of the initially selected 1140 people, 12.3 % refused to participate in the survey. The sociodemographic characteristics of the 1000 participants are shown in Table 1.

We found the prevalence of NREM parasomnia-related behaviors at 2.7 % (CI 95 % 1.9–3.9), sleep-eating at 0.1 % of the total population, and 4.6 % of parasomnia-like activities. Five participants refused to answer the question about the types of their activities in sleep. Therefore, we calculated the prevalence of different sleep-related behavior types likely representing NREM parasomnia based on 22 responses (Table 2). We could reach a satisfactory level of agreement in the coding

Table 1
Sociodemographic characteristics of the 1000 participants in the NREM parasomnia-related behavior episodes survey in Hungary.

Sociodemographic feature	Total (%) 1000 (100)
Gender	
Men	469 (47)
Women	531 (53)
Age	
18–30	181 (18)
31–49	356 (36)
≥50	463 (46)
Education	
Primary	508 (51)
Secondary	315 (32)
Graduated	177 (18)
Residence	
Urban	695 (70)
Rural	305 (30)

of questions 2 and 6 (free text): 0.57 Cohen’s Kappa coefficient at 0.29 to 0.81 (95 % CI), SE 0.12.

No participant reported sleep sex or occurrences raising the possibility of confusional arousals, or sleep terrors. The possibility of REM sleep behavior disorder (RBD) could be suspected in the case of one person aged more than 50 years, who reported “arguing and shouting” in sleep.

Regarding the results of the ACEs question, 139 (13.9 %) persons of the whole sample answered “not knowing” if they had or had not had any ACE episodes; and 92 participants (9.2 %) out of the whole population reported having had ACE, also identifying its type (Table 3).

Out of the 27 persons who self-reported NREM parasomnia-related behaviors, 9 participants (33 %) reported having experienced an ACE: physical abuse - 6 persons; severe mental distress in childhood - 3 persons. Our method has not allowed a better characterization of the types, duration, numbers of ACEs, or follow-up of those cases. The reported ACEs were associated with a remarkable six times higher (OR 6.2; $P < 0.001$) probability of sleep-related behaviors likely representing NREM parasomnia episodes compared to those not reporting ACEs.

We found about one-fifth less middle-aged than young people experiencing NREM parasomnia-related behaviors (OR 0.3; $P = 0.029$). Those participants reporting sleep-related activities of their family members had a 7-times probability (OR 7.1; $P < 0.001$) of having reported parasomnia-like occurrence(s) compared to non-family cases (Table 4).

4. Discussion

We found the prevalence of self-reported NREM parasomnia-related behaviors at 2.7 %. Our result was similar to Great Britain’s population data on DOAs, at 2.5 % [28], while this ratio in France has been estimated to be around 1.7 % [29], 3.9 in Brazil [7], and 1.7 % in a Norwegian research [29]. NREM parasomnias’ prevalence was higher in a study on psychiatric patients (SRED 9.9 % and sleepwalking 8.5 %) [30].

Some people may have had multiple types of behaviors in a reported sleep episode, unfortunately, our interviewing method did not allow us

Table 3
The main types of self-reported adverse childhood experiences reported by 92 participants out of the whole population.

Childhood trauma	N (%)
Emotional and physical abuse (including sexual)	57 (62)
Dysfunctional household conditions (parental loss/divorce, orphanage, etc.)	35 (37)

to scrutinize this.

Eighteen percent of those with self-reported NREM parasomnia-related behaviors in our study claimed to have performed potentially dangerous sleep-related behaviors during their episodes. In comparison with other studies reporting on 4.3 % of self-injuries and 0.9 % of injuring others [31]; our finding signals a very high hazard. In addition, 4.6 % of DOA persons reported sleep eating (similar to a US study) [32], which may be considered another type of hazard. These data call for safety and prevention measures.

We did not find a biological sex difference, unlike some other studies [33,34]. Younger adults had a significantly ($P < 0.026$) higher prevalence of sleepwalking than the middle-aged, in agreement with the literature on DOA’s age distribution.

Thirty-three percent of those reporting sleep-related behaviors likely representing NREM parasomnia had also reported ACE, raising the possibility of ACE’s etiologic role; childhood traumatic experiences participating in-, or causing permanent psychological or psycho-somatic changes leading to parasomnias [35]. Our single interview by non-clinical staff did not allow us to follow up or have further analysis of those experiences, however, this finding may call attention to ACEs’ role as also raised and discussed in the literature [25,30,35].

Hundred-thirty-nine participants “did not know” (DNK) of having or having not experienced ACEs. Remaining on the conservative side and not exaggerating numbers in our calculations, we considered the DNK answers ‘no’ to the ACE question; however, such responses might well reflect a refusal to communicate painful and sensitive childhood memories. Thus, the proportion of those with ACEs in the general population may be much higher than 9.2 %, needing further analysis as well.

The form of ACEs in our study was emotional abuse at 62 %, which is higher than in the last research documented in Hungary in 2019, in a population of 756 adolescents who self-reported it at 32.1 % [36]. Dysfunctional household/loss of a close relative was found at 37 % (71.2 % in the above Hungarian study) [30].

While the family accumulation and genetic background of parasomnias have been evidenced [9,21], a link between ACEs and parasomnias has been raised as well [37–39]. There are studies in the literature on the impact of adverse childhood experiences (ACEs) on NREM parasomnias in adults [35,40], but the picture is far from being clear. Patients who suffered sexual abuse in childhood appear to have a greater risk of somnambulism, nightmares, bruxism, and pavor nocturnus in adulthood [24].

In our study, reported ACE was six times more frequent in people with parasomnias compared to those not reporting it. Several studies have delved into the relationships between ACEs and sleep-related behaviors, revealing potential connections [25], however, we could not

Table 2
Prevalence of NREM parasomnia-related behaviors during sleep, N:22.

Activities during sleep	N (%)	[95 % Conf. Interval]
Ambulation	13 (59)	35.67–78.94
Talking, arguing, shouting	5 (22.8)	1.97–38.84
Non-dangerous activities during SW (e.g., getting dressed, turning on the lights, packing ...)	1 (4.4)	0.51–29.08
Eating	1 (4.6)	0.54–30.52
Dangerous activities during SW (e.g., leaving the house, touching electrical equipment)	2 (9.3)	1.92–33.57

Table 4
Results of logistic regression analysis to assess the associations of NREM parasomnia-related behaviors with age, family accumulation, and adverse childhood experiences (ACEs), (N:27; reference categories: 18–30 years (young adults), and sleep-related behaviors).

Comparison group	OR	95%CI	Std. Err.	P-value	Result
Age: 31-49	0.3	0.10–0.80	0.16	0.029 *	Association with the age 18-30
Age: ≥50 y	0.5	0.18–1.30	0.24	0.152	
ACEs	6.2	2.5–14.96	2.8	0.001*	Association with sleep-related behaviors
Family accumulation	7.1	2.7–18.72	3.5	0.001*	

Significant findings are marked as *.

find data for a comparison of the effect size of the relationship between ACEs and NREM parasomnias. Further research on this association may provide important information on the mechanism of NREM parasomnias. At the same time, our study might give an idea about the strength of this link-to be confirmed.

4.1. Limitations

The small sample size of people with parasomnias is our major limitation. The data came from self-reports without medical diagnoses, collateral data, test results, or follow-up interviews; and a recall bias may decrease the validity of responses as well. The personal interviewing method could be another source of bias, potentially causing less frequent reports on sensitive data, including violence, sex, or painful childhood data.

5. Conclusion

In this first survey in Hungary, the prevalence of self-reported adult parasomnias was slightly different compared to other countries. The high occurrence of potentially dangerous behaviors indicates the importance of prevention measures. We found an association between ACEs and NREM parasomnias pointing to the complexity of potential contributory factors – supporting the significance of childhood adverse events also in this respect.

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Ethics committee

The Ethical Committee of Semmelweis University consented to the study (1/2024). Informed consent was obtained from all participants.

CRedit authorship contribution statement

Vivian M. Correa: Writing – original draft, Methodology, Investigation. **Mengesha S. Biresaw:** Writing – review & editing. **József Vitrai:** Formal analysis, Methodology, Writing – review & editing. **Anna Szűcs:** Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:
Vivian Miranda Correa reports Semmelweis University provided financial support. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abbreviations

CI	Confidence Interval
NREM	non-rapid eye movement
REM	rapid eye movement
DOA	disorder of arousal
SW	sleepwalking
SRED	sleep-related eating disorder
ACEs	adverse childhood experiences
DNK	did not know

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