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Demographic, Clinical and Polysomnographic Characteristics of Childhood- and Adult-Onset Sleepwalking in Adults

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Abstract
Background: Sleepwalking (SW) is found to affect children predominantly, but it can persist or appear de novo even among adults. In this study, we assessed the demographic, clinical and polysomnographic profile, trigger factors and associated comorbidities of adult-onset (AO-SW) and childhood-onset (CO-SW) adult sleepwalkers. ***Methods:*** In adult sleepwalkers, a structured clinical interview, a battery of questionnaires, video-polysomnography (v-PSG) and standard electroencephalography (EEG) were performed. ***Results:*** Among 63 sleepwalkers, 45% had ≥1 episodes/month, 54% had partial recall of the episodes and 36% reported trigger factors for SW. Almost all subjects reported co-occurring parasomnias. In v-PSG, 4% exhibited episodes of SW, 17% confusional arousals, 21% had an increased apnea-hypopnea-index and 6% exhibited features of an overlap parasomnia disorder. In our cohort, 73% reported CO-SW and 27% AO-SW. In subjects with AO-SW, positive family history for parasomnias was found in 33% (vs. 49% in CO-SW), neurological comorbidities in 44% (vs. 14%), psychiatric comorbidities in 25% (vs. 33%), EEG abnormalities in 50% (vs. 29%). Violence during SW episodes was more frequent in males and in subjects with CO-SW (45% for self-injury and 44% for violent behaviour vs. 33 and 29% respectively in the AO-SW group). ***Conclusions:*** Adult SW represents a complex and potentially dangerous condition. The characteristics of AO-SW often differ from those of CO-SW.

Introduction

Sleepwalking (SW) is considered to be a disorder of impaired arousal [1]. This sleep disorder is a non-rapid eye movement sleep parasomnia, which occurs predominantly out of slow wave sleep and is characterized by a state of dissociated consciousness, in which phenomena of the sleeping and waking states coexist [1, 2]. SW is commonly found in the general population and the lifetime prevalence is about 29%. It typically affects children reaching a peak at around 10–13 years [3], disappearing in about 75% of the affected during the adolescence [4, 5]. SW can also persist or appear de novo in adulthood.

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Among adult sleepwalkers, approximately 13% develop this sleep disturbance during adulthood [5]. The overall prevalence of SW in adulthood is about 4% [6].

Only a few studies in the past have assessed characteristics and comorbidities of SW. In the study by Lopez et al. [7], SW was associated with an altered quality of life and several symptoms including daytime sleepiness, fatigue, insomnia, depression and anxiety. In contrast, Labelle et al. [8] reported that there was no association between adult SW and clinically significant levels of depression or anxiety and even if present, these symptoms had little impact on the phenomenological features of SW. Commonly reported trigger factors for SW include sleep deprivation and stress [9]. In addition, subjects with a longer history of SW reported more frequent episodes of SW [9]. Lam et al. [10] showed a higher prevalence of AO-SW in a psychiatric outpatient cohort compared to the general population.

Data regarding differences between childhood-SW (CO-SW) and adult-onset SW (AO-SW) is limited. Lopez et al. [7] reported that subjects with late-onset (subjects older than 9 years) primary SW (subjects with comorbidities were excluded) had lower incidence of violent behaviours and were more prone to worsening of their SW over time compared to those with early-onset SW [7]. However, in another cohort, Bušková et al. [9] found no association between age at onset of SW with violent and injurious behaviour.

Most of the above-mentioned studies focused only on specific aspects of SW profiles (e.g., psychiatric comorbidities), reported results independent of the age at onset of SW (childhood- vs. adulthood-onset) or excluded secondary SW related to comorbidities. The current study aimed to describe demographic data, clinical and polysomnographic features, trigger factors and associated comorbidities of AO-SW and CO-SW adult sleepwalkers.

Patients and Methods

Data obtained as part of the clinical routine from 78 subjects who were referred, over a period of 12 years, to the sleep centres of the University Hospital Bern and the University Hospital Zürich and reported SW was retrospectively analyzed. The adult subjects were classified as CO-SW if the first episode of SW occurred during childhood (<18 years) and as AO-SW if it occurred during adulthood.

Fifteen subjects were excluded from analysis due to the high amount of missing data (including demographic, clinical data and objective assessments) and therefore, 63 subjects were included in the analysis. A standard video-polysomnography (v-PSG) has been performed in 52 of them as previously described [11]. The v-PSG consisted of 6 channel electroencephalography (EEG; F3/A2, F4/A1, C3/A2, C4/A1, O1/A2, O2/A1), left and right electrooculography, submental, left and right anterior tibialis, flexor carpi radialis and adductor digiti minimi electromyography, electrocardiography, respiratory flow and effort, and pulse-oximetry. Sleep stages and sleep-associated events were manually scored according to the American Academy of Sleep Medicine scoring manual [12]. In 43 subjects, a 10/20 routine EEG was also performed.

The clinical and epidemiological sleep-wake profile of the patients was assessed by a structured clinical interview based on the "Bern Sleep Questionnaire". This questionnaire contains questions regarding demographics, reasons for referral to sleep laboratory, general information about sleep-wake habits and sleep problems, breathing and circulation, parasomnias and potential trigger factors, dreaming, dream enactment behaviour, waking-up, daytime tiredness and sleepiness, cataplexy, hallucinations, stress, well-being, neurological, psychiatric and other comorbidities, family history and questions regarding pregnancy in female participants. In addition, patient's medical records were reviewed to obtain additional information regarding reasons for referral to sleep laboratory, neurological and psychiatric comorbidities and medication. The time that would be needed to complete the entire questionnaire was around 90 min.

Epworth sleepiness scale (ESS) [13] was also performed and excessive daytime sleepiness was defined as an ESS score ≥10 [14].

The study was approved by the institutional review board of the departments and patients had given their written informed consent for using their data for scientific purposes.

Statistics

Univariate and bivariate analyses: depending on categorical or continuous variable and the distribution of the data, chi-square test/Fisher's exact test and unpaired Student *t* test were performed. The SD was used in conjunction with the mean to summarize continuous data. The level of significance was 0.05 in all tests. All tests were calculated using statistical package for social sciences, version 18 (SPSS-18).

Results

Epidemiological, Clinical and Polysomnographic Profile of Sleepwalkers

Data from 63 adult sleepwalkers was collected (age 39.1 ± 15.3, range 18–80 years, 41 male subjects, 46 subjects with CO-SW, 17 subjects with AO-SW). Excessive daytime sleepiness (ESS ≥10) was present in 60% of the subjects. Mean ESS was 10.2 ± 5.2. Among the subjects, 14% reported alcohol consumption on a regular basis. Demographic characteristics in our cohort are presented in Table 1.

In almost half of the cases, SW was not the reason for being referred to the sleep centre. The most frequent reasons for referral are presented in Table 2. Most sleepwalkers in our cohort (45%) had ≥1 episode/month, 22% ≤1 episode/month, 29% had weekly episodes and only 4% reported very

Table 1. Demographic characteristics of adult sleepwalkers

Demographics	Mean ± SD
Age, years	39.1±15.3
Males	39.8±16.1
Females	38.2±14.4
Males, %	65.1
BMI	26.0±5.3
Males	25.8±5.3
Females	26.2±5.1
ESS	10.2±5.2
Males	10.3±4.0
Females	11.1±7.3

BMI, body mass index; ESS, Epworth Sleepiness Scale.

Table 2. Reasons for referral to the sleep laboratory

Referral	Percentage, %
Suspected sleepwalking	60
Suspected sleep apnea	12
Insomnia or hypersomnia	9
Suspected epilepsy	4
Other reasons	15

Table 3. Polysomnographic features of subjects with adult sleepwalking

PSG variables	Mean ± SD
AHI, *n*/h	8.2±13.1
Mean desaturation, %	4.3±8.9
Sleep latency, min	20.2±44.0
REM latency, min	125.2±79.5
Sleep efficiency[a]	81.1±17.3
REM sleep, %[a]	10.1±6.2
NREM1 sleep, %[a]	22.4±11.8
NREM2 sleep, %[a]	41.1±12.2
NREM3 sleep, %[a]	14.3±7.1
PLM-index	8.1±28.8

[a] Percentage of the total sleep time, $n = 52$

PSG, polysomnography; AHI, Apnoe-Hypopnea Index; REM, rapid eye movement; NREM, non-rapid eye movement; PLM, Periodic limb movements.

frequent episodes ≥2/week. More than half of the patients (54%) had partial recall of the episodes and 36% reported at least one trigger factor for SW. The most frequent trigger factors were stress (68%), full moon (25%), anxiety (21%), alcohol consumption and sleep deprivation (18%).

Almost all sleepwalkers (98%) reported co-occurring parasomnias. Sleep talking (91%), night terrors (69%), bruxismus (54%) and nocturnal eating behaviour (50%) were the most frequently occurring events. In addition, hallucinations (45%), sleep paralysis (35%) and enuresis (7%) were frequently reported.

Among 52 sleepwalkers who underwent a v-PSG, 27 subjects (52%) had a sleep latency less than 10 min and 7 subjects a REM latency less than 60 min, 24 subjects (46%) had a sleep efficiency below 85%, 11 subjects (21%) had an apnea-hypopnea-index higher than 10/h, and 11 subjects (21%) had a PLM (periodic limb movements)-index higher than 15/h. Sleep architecture was often characterized by an increased percentage of stage 1 sleep and decreased rapid eye movement (REM) sleep and slow wave sleep compared to elsewhere reported age-dependent normal values [15]. Table 3 presents the main polysomnographic features of subjects with adult SW.

During v-PSG, episodes of SW were observed in 2 subjects (4%) and confusional arousals in 9 subjects (17%). Notably, in 3 patients (6%), the criteria for the co-existence of a REM-parasomnia (increased phasic muscle activity, jerks and increased muscle tone or partial loss of REM atonia combined with signs of dream enactment) were fulfilled [16].

Childhood- and Adult-Onset Sleepwalking

Among 63 sleepwalkers, 46 subjects reported CO-SW and 17 subjects reported AO-SW. Our cohort included predominantly males (65%); however, regarding the age at onset of SW no male-female differences were found. Patients with CO-SW reported more often than those in the AO-SW group a positive family history for parasomnias (49 vs. 33%; $p = 0.04$). Neurological comorbidities were significantly more often in the AO-SW than in the CO-SW (44 vs. 14%; $p = 0.02$). The most frequent were traumatic brain injury, parkinsonism, stroke, alcohol-related encephalopathy and perinatal cerebral dysfunction. In the AO-SW group, there was a trend for more frequent occurrences of EEG abnormalities compared to the CO-SW group; however, the difference was not significant (50 vs. 29%; $p = 0.24$). Typical EEG abnormalities included slowing activity in basic rhythm and theta activity. No epileptic activity was reported.

In our cohort, 29% of the subjects had a psychiatric comorbidity, the most frequent one being depression (23%). In addition, 14% reported a history of alcohol abuse. No differences were observed in the frequency of psychiatric comorbidities or alcohol abuse between the 2 groups (25% in AO-SW vs. 33% in CO-SW; $p = 0.39$).

Table 4. Differences between AO- and CO-SW

	CO-SW, %	AO-SW, %	*p* value
Males	61	71	0.34
Positive family history for parasomnias	49	33	0.04
Neurological comorbidities	14	44	0.02
Psychiatric comorbidities	33	25	0.39
Abnormalities in EEG	29	50	0.24
Sleepwalking-related self-injuries	45	33	0.32
Violent behavior during sleepwalking	44	29	0.03

AO-SW, adult-onset sleepwalkers; CO-SW, childhood-onset sleepwalkers; EEG, electroencephalography.

In our cohort, 40% of the adult sleepwalkers reported violent behaviour during SW and 42% reported self-injuries. Among them 72 (62.5%) were males. In the AO-SW group, 45% of the patients reported episodes with self-injury and 44% episodes with violent behaviour. For the patients in the CO-SW group, these percentages were 33% ($p = 0.32$) and 29% ($p = 0.03$) for self-injury and violent behaviour respectively. The differences between CO- and AO-SW are presented in Table 4.

Discussion

In the current study, we assessed characteristics of adult sleepwalkers and differences between AO- and CO-SW.

The profile of subjects with AO-SW differs from that of those with CO-SW. We confirmed previous reports that nearly 40% of individuals with SW had a family history of such a disorder [6]. However, in the subgroup analysis, not surprisingly, familial occurrence was significantly more frequent in the CO-SW compared to the AO-SW group. Neurological comorbidities were present in 23% of the subjects and were twice more frequent in the AO-SW group compared to subjects with CO-SW. Consequently, more subjects in the AO-SW group exhibited EEG abnormalities. In our cohort, nearly one-third of the subjects reported a psychiatric comorbidity; however, we could not confirm previous reports that psychiatric comorbidities or alcohol abuse are more often in subjects with AO-SW. We confirmed previous reports that violent episodes during SW are more frequently reported by male sleepwalkers [17] which might, at least partially, explain the more frequent referral of male sleepwalkers to our sleep centres. Adults with CO-SW reported less self-injuries, and the episodes of SW were significantly less violent compared to those in adults with AO-SW.

Often the first therapeutic approach of SW is based on the treatment of comorbidities or the management of trigger factors. Therefore, we focused on the demographic, clinical and polysomnographic profile, trigger factors and associated comorbidities of adult sleepwalkers. The demographic characteristics of our cohort did not differ significantly from those reported from previous studies. Sleep walking was more frequently reported in the category ≥1 episode/month and less frequent in the category ≥2 episodes/week. Consistent with previous reports [7], one-third of the subjects reported at least one SW trigger factor. Stress was mentioned by almost two-thirds of them and sleep deprivation, anxiety and alcohol consumption were also frequently reported. Interestingly, full moon was reported by 25% of our patients as a trigger factor, suggesting a periodic occurrence of the episodes, whereas in previous studies, it was rarely mentioned [9] or not mentioned at all. In our cohort, as in previous studies [18, 19], there were more males among sleepwalkers. This does not necessarily reflect an association of SW with gender [6] but possibly differences in the referral rates, which are likely due to the fact that male sleepwalkers have more frequent violent episodes than female sleepwalkers.

During night polysomnography, sleep efficiency and frequency of confusional arousals or episodes of SW in our cohort were comparable to previous studies [9]. However, sleepiness was almost 4-times and sleep disordered breathing (SDB) almost twice more frequent than previously reported [9]. It still remains unclear if and why subjects with SDB become more susceptible to SW. Based on the hypothesis that sleep disruption due to SDB could increase arousability, which under specific conditions (e.g., trigger factors) could lead to SW [19], early studies suggested that obstructive sleep apnea syndrome is associated with SW and treatment of the SDB could reduce susceptibility to SW [19–21].

Comorbid parasomnias are very frequent among sleepwalkers. The frequency of comorbid sleep talking and night terrors in our cohort was similar to previous reports [7]. To our knowledge, this study is the first to report the prevalence of bruxism, nocturnal hallucinations, sleep paralysis and enuresis in a cohort of sleepwalkers. Interestingly, 6% of the patients also fulfilled the polysomnographic and clinical criteria of a REM parasomnia, suggesting the existence of an overlap parasomnia. The prevalence of REM sleep behaviour disorder (RBD) is about 0.5% in the general population and 2% in

the older adult population [22]. Our data supports previous reports of an increased prevalence of SW among patients with RBD [11, 23]. RBD is considered a preclinical marker for neurodegenerative disorders and therefore the prevalence of overlap parasomnia among sleepwalkers needs further investigation.

The comparison of unequal sample sizes is a limitation of the current study. However, considering the low percentage of AO-SW among adult sleepwalkers (e.g., 13% in Lopez et al. [7], 20% in Labelle et al. [8]), the formation of equal sample sizes would require a prospective approach.

Our data indicates that adult SW represents a complex and potentially dangerous condition and underpin the importance of a detailed history taking, clinical, and polysomnographic assessment of adult sleepwalkers. Psychiatric and neurological comorbidities (for the latest especially in subjects with AO-SW) but also comorbid sleep-related disorders (e.g., SDB, overlap parasomnia) should be assessed and if indicated should be treated. This, together with a comprehensive counseling regarding prognosis (e.g., increased risk of experiencing violent or even self-injurious behaviour especially for subjects with CO-SW) consists an essential initial step towards the successful management of SW.

Disclosure Statement

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