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Impairment in sleep health in young adults with chronic pain: a modifiable risk factor

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Abstract

Background Impairments in sleep health are associated with the development or worsening of chronic pain. Further, chronic pain can cause sleep health disruption by impacting sleep onset, sleep maintenance, sleep quality, and causing daytime somnolence. However, the association between chronic pain and sleep disturbances in the young adult population is unclear.

Aim We describe our initial experience in establishing and running a clinic for managing sleep health and chronic pain in young adults. We also describe the prevalence and the pattern of sleep disruption as well as its relationship with self-efficacy in pain management, depression, and quality of life in this cohort.

Methods After approval from the Institutional Review Ethics board, chart review and data extraction were conducted for patients who presented at the Young Adult Clinic (YAC) at Women's College Hospital from March 1, 2018 to April 30, 2019.

Results Medical charts of 55 patients were reviewed with the majority being females (71%). Chronic widespread pain was the most common pain syndrome diagnosed in our patients. Insomnia was the most common sleep-health related diagnosis in our patients. Patients with disorders of sleep were more likely to report lower self-efficacy for managing pain as compared to those with no sleep disorders ($p=0.023$) but there was no significant difference between these two groups as regards risk for pain-related catastrophizing.

Conclusion Impairments in sleep health may be an important modifiable risk factor for alleviating pain in young adults with chronic pain. Sleep disorders should be evaluated and addressed in this population.

Keywords Sleep health, Young adults, Chronic pain

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Introduction

Background

Every fifth Canadian child and adolescent has chronic pain and 5–8% of this cohort have pain affecting their quality of life (King et al. 2011). Childhood chronic pain may continue into adulthood or result in the development of new onset chronic pain after a period of remission (King et al. 2011; Rapley and Davidson 2010). Transition programs for graduating pediatric chronic pain patients to adult healthcare system are scarce, and data on sleep health disruption is lacking in the context of young adults (17 to 25 years of age) with chronic pain.

The prevalence of coexisting chronic pain and sleep disorders has been widely studied in the older adult and pediatric populations. However, there is a paucity of these data in the young adult chronic pain population. The Toronto Academic Pain Medicine Institute (TAPMI) Young Adult Clinic (YAC) based at Women's College Hospital, Toronto, Ontario was developed in 2018 to help fill a gap in pain care in the Greater Toronto Area, and to offer services with the goal of optimizing outcomes for clients aged 17 to 25 years who had chronic pain.

The conceptual model of sleep health includes sleep quality (the subjective assessment of good or poor sleep, waking up unrefreshed), alertness (the ability to maintain attentive wakefulness), sleep timing (the placement of sleep within the 24-h clock), sleep efficiency (the ease of falling asleep and resuming sleep) and sleep duration (the total amount of sleep obtained per 24 h) (Buysse 2014) (Fig. 1). In adolescence, there is a change in sleep habits as compared to their earlier childhood years, and an increase in problems with sleep maintenance with 30% of adolescents experiencing at least one sleep problem (Ohayon et al. 2000). Some studies report that up to 16% of young adults have clinically significant insomnia (Morrison et al. 1992; Ohayon et al. 1998; Roberts et al. 2004). This in turn affects their ability to manage pain. Long-term sleep disruption has been associated with increased pain sensitivity (Bigatti et al. 2008; Nicassio et al. 2002), prolonged duration of pain (Copperman et al. 1934), and it also predicts chronic pain in adult patients (Finan et al. 2013). Moreover, the degree of pain relief can directly impact the quality of sleep. Studies indicate that disrupted sleep due to chronic pain causes reduced social functioning, poorer quality of life, higher levels of disability and depression (Long et al. 2008; Palermo et al. 2008), poor self-efficacy, and increased pain-related catastrophizing in chronic pain patients (Gerhart et al. 2017; Buenaver et al. 2012).

In a recent study (Oreper et al. 2022), we highlighted the need for a collaborative and individualized approach for the successful transition of young adults

Fig. 1 Sleep health domains—sleep health includes sleep quality (the subjective assessment of good or poor sleep, waking up unrefreshed), alertness (the ability to maintain attentive wakefulness), sleep timing (the placement of sleep within 24 h), sleep efficiency (the ease of falling asleep and returning to sleep) and sleep duration (the total amount of sleep obtained per 24 h)

across the continuum of chronic pain care by building relationships with young adults that facilitate choice and autonomy while enhancing skill-building and education on available resources. Here, we describe our initial experience using a multi-disciplinary model, and multi-modal approach to optimal sleep health, and management of chronic pain in the YAC population. The primary objective of this retrospective, observational study was to report our initial experience in creating this multidisciplinary clinic and in delivering care. The secondary objective was to identify the prevalence and the pattern of sleep disruption in the TAPMI YAC population and to describe the relationships between sleep health disruption and validated measures of self-efficacy, depression, and quality of life.

Materials and methods

This retrospective, observational study was carried out after approval from the Women's College Hospital Research Ethics Board (2019-0091-E). This study included patients who attended the TAPMI YAC from March 1, 2018, to April 30, 2019. Inclusion criteria were patients aging 17–25 years old, with chronic pain problems.

The Strengthening The Reporting of OBservational studies in Epidemiology (STROBE) checklist was used to prepare this manuscript (Elm et al. 2007).

Study site and population

The TAPMI YAC at Women's College Hospital was developed in 2018 to help fill a gap in care for young adults with chronic pain in Toronto, and to offer transition services (from pediatric/adolescent to adult care) for clients aged 17 to 25 years with persistent pain. It was developed by TAPMI in consultation with the Pediatric Chronic Pain Clinic and Pediatric Transition Program at The Hospital for Sick Children, Toronto, Ontario. The healthcare providers at YAC include a Pain Medicine physician, a Sleep Medicine physician, and an occupational therapist. The YAC team includes a Sleep Medicine specialist because of the high prevalence of sleep disorders in young adults with pain (Fig. 2). All patients at this clinic are assessed by the three healthcare providers and case conferences are conducted for every patient in real time. Pharmacological, mental health, and physical therapies

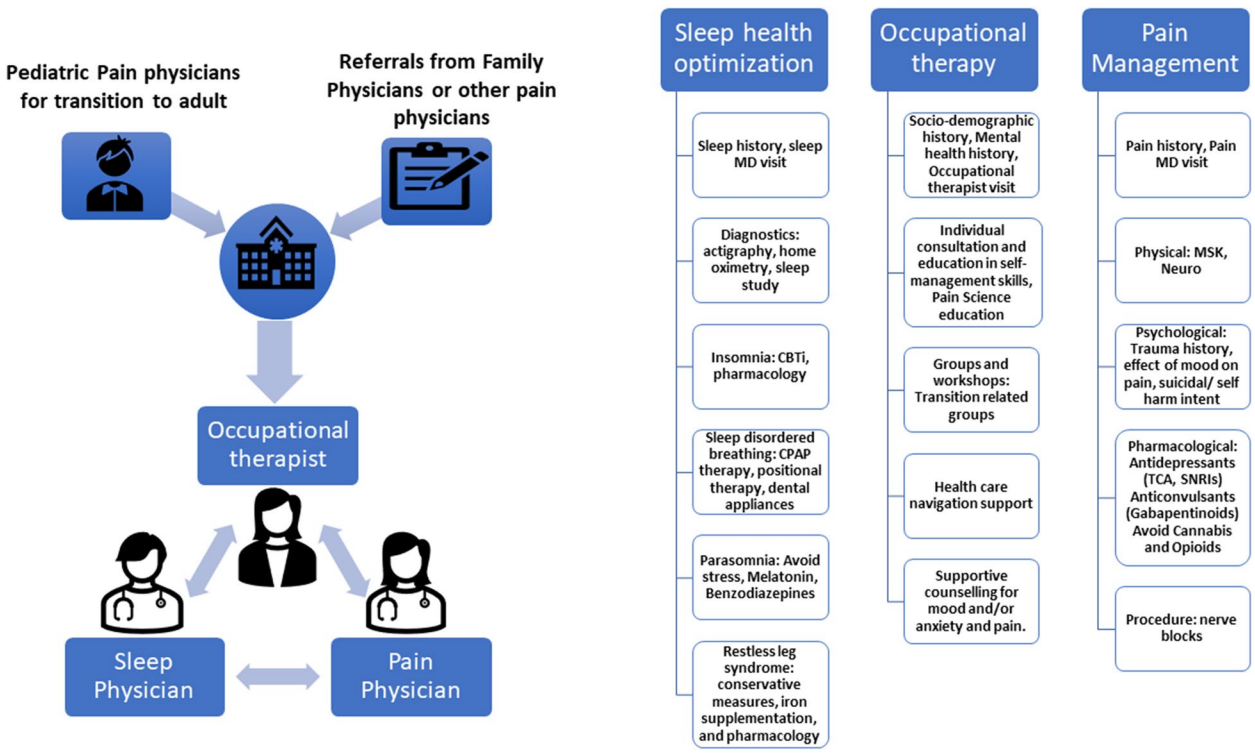

Fig. 2 Patient journey through the Young Adult Clinic. Referrals from pediatric pain physician for transition into adult healthcare, or referrals from family physicians or other pain physicians. Triage done to enroll the patients into YAC. The clinic is housed at the TAPMI hub location at Women's College Hospital, Toronto, Canada, and has a multi-disciplinary team: Pain Medicine Physician, Sleep Medicine Physician, and an Occupational Therapist. Assessments by each of the three providers are conducted and then a case conference is held to reach a diagnosis and a therapeutic plan. The plan is then discussed with the patient and a letter is sent to the referral physician with the care plan

to improve pain management are offered to patients as appropriate.

The YAC also offers various programs and workshops for these patients that include education regarding healthcare navigation and self-management strategies for managing pain. Other programs that are offered to the YAC patients include the TAPMI Pain Education Workshop, Acceptance and Commitment Therapy (ACT) group sessions, Physiotherapy group sessions, Cannabis education workshop, and online educational modules including those for improving sleep health (Pain U Online, Toronto Academic Pain Medicine Institute) (2021). This uniquely-positioned clinic also allows young adults with pain to be internally referred to other specialists with expertise in interventional pain management, neuromodulation, neurology and physiatry within the TAPMI partnership, as well as allied health services such as pharmacy.

Data collection

Each patient at the YAC clinic completes an assessment package on their first visit. The health care workers document their assessments in the hospital electronic charting system, which was the data source for this study. Data collected includes demographics (age, gender, body mass index (BMI), medications), pain-related information (location, onset, possible causes, intensity, character, aggravating and relieving factors), validated patient-reported sleep health domains including sleep quality (the subjective assessment of good or poor sleep), alertness (the ability to maintain attentive wakefulness, captured on Epworth Sleepiness scale (ESS) (Johns 1991), sleep timing (the placement of sleep within the 24 h cycle), subjective, reported sleep efficiency (the ease of falling asleep and returning to sleep) and sleep duration (the total amount of sleep obtained in a 24 h epoch) (Johns 1991). In addition, sleep disorders such as insomnia, sleep related breathing disorders, sleep related movement disorders, circadian rhythm sleep–wake disorders, parasomnias or central disorders of hypersomnolence were diagnosed based on semi-structured interviews conducted by qualified sleep physician according to the International Classification of Sleep Disorders, 3rd edition (ICSD -3) (American Academy of Sleep Medicine (AASM) 2014). Validated questionnaires employed in this clinic include Pain Self Efficacy Questionnaire (PSEQ, 10-item questionnaire, to assess self-efficacy in chronic pain patients) (Nicholas 2007), Patient Health Questionnaire – 9 (PHQ-9, 9 items questionnaires used for screening and measuring the severity of depression) (Kroenke et al. 2001; Kroenke and Spitzer 2002), Pain Catastrophizing Scale (PCS, measures rumination, magnification, and helplessness related to pain) (Sullivan et al. 1995), and Transition-Q (developed for transition in youth and young adults to measure and track the development of skills needed to manage their health and health care on their own) (Klassen et al. 2015) (Table 1).

Data analysis

Data were extracted into an Excel spread sheet. Missing data points were identified. No imputation was done unless more than 5% data were missing. Descriptive characteristics are reported as frequency (percent), means with standard deviation (SD), or median with interquartile

Table 1 Questionnaires used in the Young Adult Clinic

Questionnaire	Outcome	Score	Significance
Epworth Sleepiness Scale (ESS)	Day time sleepiness	Range from 0–24	11–14 mild symptoms 15–17 moderate symptoms 18–24 severe symptoms
Pain Self Efficacy Questionnaire (PSEQ-10)	Self efficacy	Range from 0–60	$\leq$ 30/60 indicates low self efficacy and predicts less sustainable functional gains $\geq$ 40/60 indicates higher self efficacy and are associated with clinically significant functional levels
Patient Health Questionnaire-9 (PHQ-9)	Depression symptom screening	Range from 0–27	0–4 minimal – depression treatment not required 5–9 mild symptoms 10–14 moderate symptoms 15–19 moderately severe symptoms 20–27 severe symptoms
Pain Catastrophizing Scale (PCS)	Catastrophizing thoughts related to pain	Range from 0–52	Score $\geq$ 30/52 suggests clinically relevant level of catastrophizing
Transition-Q	Measure and track the development of skills adolescents need to acquire to manage their health and healthcare	Range from 0–28	Higher scores indicate more readiness for transition into adult health care

range [IQR] (if non-normally distributed). Pair-wise comparisons were made based on sex, and those with or without sleep health disruptive symptoms. Univariable analyses were conducted using two-sample independent t-test for data with normal distribution, Mann–Whitney U test for data with non-normal distribution, or χ^2-test for categorical data. Comparisons were made also based on sex (Tables 2, 3), and the presence or absence of symptoms of disorders of sleep (Table 5). The *p*-values are two-tailed, with statistical significance defined as $p < 0.05$.

Results

The TAPMI YAC received a total of 58 referrals in the study period. Eighteen of these referrals were for transition of care from pediatric pain physicians at the Hospital for Sick Children in Toronto. Other referrals were from family physicians and pain clinics within the Greater Toronto Area. Fifty-five patients were seen with the majority of them being female (39; 71%) and the mean age for this cohort was 20.3 ± 2.4 years with male patients were statistically significant older (21.38 ± 2.6 vs. 19.88 ± 2.2, *p* value 0.045). As regards BMI, mean BMI was 24.15 ± 5.90 with female patients were found to be with statistically significant higher BMI as shown in Table 2 and Fig. 3.

Pain-related domains

Nineteen (35%) of the patients had chronic widespread pain or fibromyalgia (nociplastic pain (Kosek et al. 2016)). Chronic widespread pain was associated with

Table 2 Demographics characteristics and pain-related data in the YAC cohort. Data are mean ± SD or number (%)

Variable	Total (*n* = 55)[a]	Males (*n* = 15)	Females (*n* = 39)	*P* value
Age *(years)*	20.29 ± 2.9	21.38 ± 2.6	19.88 ± 2.2	0.045
BMI[b] *(kg/m²)*	24.15 ± 5.90	19.87 ± 2.8	25.41 ± 6.1	0.040
Pain duration (years)	8.18 ± 5.35	6.17 ± 3.40	8.13 ± 5.56	0.569
Pain syndrome				
Chronic Widespread Pain/Fibromyalgia	19 (34.5%)	4 (26.7%)	14 (35.9%)	ns
Chronic Widespread Pain: secondary	10 (18.2%)	1 (6.7%)	9 (23.1%)	
Musculoskeletal pain	6 (10.9%)	2 (13.3%)	4 (10.3%)	
Back Pain	8 (14.5%)	3 (20%)	4 (10.3%)	
Neuropathic Pain Syndromes	5 (9%)	1 (6.7%)	4 (10.3%)	
Headache and craniofacial pain	4 (7%)	1 (6.7%)	3 (7.7%)	
Pelvic pain	3 (5.5%)	1 (6.7%)	2 (5.1%)	
Pain medications				
Anticonvulsants	33 (60%)	7 (46.7%)	24 (61.5%)	ns
NSAIDS[c]	25 (45.5%)	5 (33.3%)	20 (51.30%)	
Acetaminophen	22 (40%)	5 (33.3%)	17 (43.6%)	
Cannabinoids	20 (36.4%)	7 (46.7%)	13 (33.3%)	
Opioids	16 (29%)	7 (46.7%)	9 (23.1%)	
TCA[d]	14 (25.5%)	3 (20%)	10 (25.6%)	
SNRI[e]	13 (23.6%)	3 (20%)	10 (25.6%)	
SSRI[f]	12 (21.8%)	3 (20%)	8 (20.5%)	
Muscle relaxants	6 (10.9%)	3 (20%)	3 (7.7%)	
Melatonin	5 (9.1%)	1 (6.7%)	3 (7.7%)	
Antipsychotics	5 (9.1%)	0 (0%)	4 (10.3%)	
Benzodiazepine	4 (7.3%)	3 (20%)	1 (2.6%)	
Zopiclone	4 (7.3%)	1 (6.7%)	3 (7.7%)	
Triptans	4 (7.3%)	1 (6.7%)	3 (7.7%)	
Steroids	3 (5.5%)	0 (0%)	3 (7.7%)	
Bupropion	2 (3.6%)	0 (0%)	2 (5.1%)	
SARIs[g]	1 (1.8%)	1 (6.7%)	0 (0%)	
DMARD[h]	1 (1.8%)	0 (0%)	1 (2.6%)	
Dopamine agonist	1 (1.8%)	0 (0%)	1 (2.6%)	

[a] One patient was nonbinary, [b]*BMI* Body mass index, [c]*NSAIDs* Nonsteroidal anti-inflammatory drugs, [d]*TCAs* Tricyclic anti-depressants, [e]*SNRI* Serotonin and norepinephrine reuptake inhibitors, [f]*SSRI* Selective serotonin reuptake inhibitors, [g]*SARI* Serotonin antagonist and reuptake inhibitors, [h]*DMARD* Disease modifying antirheumatic drug

Table 3 Sleep related parameters in the YAC cohort. Data are mean ± SD or number (%)

Variable	Total ($n=47$)[a]	Males ($n=10$)	Females ($n=36$)	*P* value
Sleep disorder symptom in nighttime	39 (82.98%)	7 (70%)	31 (86.11%)	0.439
Wake up unrefreshed	25 (53.19%)	3 (30%)	21 (58.33%)	0.181
Poor sleep quality	11 (23.4%)	3 (30%)	7 (19.44%)	0.336
Sleep related movement disorder (*Restless legs*)	7 (14.89%)	0 (0%)	6 (16.67%)	0.130
Sleep related breathing disorders	12 (25.53%)	1 (10%)	11 (30.56%)	0.190
Snoring	3	0	3	
Suspected OSA[b]	7	1	6	
OSA not on treatment	1	0	1	
OSA on CPAP/BIPAP	1	0	1	
Circadian rhythm disorders	14 (30.4%)	4/10 (40%)	10/36 (27.8%)	0.457
Delayed sleep wake phase disorder	8 (17.02%)	3/10 (30%)	5/36 (13.89%)	0.393
Irregular sleep wake rhythm disorder	6 (12.77%)	1/10 (10%)	5/36 (13.89%)	0.406
Parasomnias	1 (2.13%)	0/10	1/36 (2.78%)	0.594
Insomnia	32 (68.09%)	7 (70%)	24/36 (66.67%)	0.842
Initiation	12/32 (37.5%)	5/7 (71.43%)	7/24 (29.17%)	0.124
Maintenance	8/32 (25%)	1/7 (14.29%)	6/24 (25%)	
Both	12/32 (37.5%)	1/7 (14.29%)	11/24 (45.83%)	
Mean sleep latency time mean in mins	41.39 ± 46.4	42.00 ± 22.2	41.79 ± 51.9	0.825
Daytime fatigue *(ESS*[d] *> 10)*	9/32 (28.13%)	1/6 (16.7%)	8/25 (32%)	0.627
Daytime sleepiness				
Normal (ESS < 11)	23/32 (71.88%)	5/6 (83.3%)	17/25 (68%)	0.044
Mild sleepiness (ESS 11–14)	8/32 (25%)	0/6 (0%)	8/25 (32%)	
Moderate sleepiness (ESS 15–17)	0/32 (0%)	0/6 (0%)	0/25 (0%)	
Severe sleepiness (ESS 18–24)	1/32 (3.13%)	1/6 (16.67%)	0/25 (0%)	
PCS[c] risk of catastrophizing				
Low risk (< 50th percentile; < 20/52)	14 (30.4%)	3 (27.3%)	10 (30.3%)	0.740
Moderate risk (50th-75th percentile; < 30/52)	15 (32.6%)	5 (45.5%)	10 (30.3%)	
High risk (> 75th percentile: ≥ 30/52)	17 (37%)	3 (27.3%)	13 (27.3%)	
Pain Self-Efficacy Questionnaire (PSEQ) score	27.68 ± 14.8	22.46 ± 15.1	29.88 ± 14.6	0.140
Patient Health Questionnaire (PHQ)-9 score	13.98 ± 7.4	14.67 ± 9.0	13.71 ± 6.8	0.701

[a] One patient was nonbinary, [b]*OSA* Obstructive Sleep Apnea, [c]*PCS* Pain Catastrophizing Scale, [d]*ESS* Epworth sleepiness Scale

Ehler Danlos Syndrome, cerebral palsy, sickle cell disorder, Charcot-Marie-Tooth disease, and congenital heart disease in 10 (18.2%) of the patients. A diagnosis of musculoskeletal limb pain was made in 6 (11%), back pain in 8 (14.5%), neuropathic pain syndromes in 5 (9%), headache and craniofacial pain in 4 (7%), and pelvic pain in 3 (5.5%) of the patients (Table 2) (Fig. 4).

The duration of pain ranged from 1—21 years, with a mean of 8.18 ± 5.35 years, with no statistically significant difference between males and females, *p* value 0.569 (Table 2). Most frequently used medications by YAC patients were gabapentinoids by 33 (60%) patients, non-steroidal anti-inflammatory medications (NSAIDs) by 25 (45.5%) patients, and acetaminophen by 22 (40%) patients. Cannabinoids and opioids were used by 20 (36.4%) and 16 (29%) of the patients, respectively. Other medications used by patients were tricyclic antidepressants (TCA), serotonin noradrenaline reuptake inhibitors (SNRI), selective serotonin reuptake inhibitors (SSRI), muscle relaxants, melatonin, antipsychotics, benzodiazepine, zopiclone, triptans, oral steroids, bupropion, serotonin antagonists and reuptake inhibitors (SARI), Disease Modifying AntiRheumatic drugs (DMARDs), and dopamine agonists as shown in Table 2 and Fig. 5.

Sleep health and sleep disorders

Prior to the addition of a sleep medicine specialist to the team, patients in YAC (1st 21 patients) were seen by a pain physician and an occupational therapist. However, 13 out of these 21 patients self-reported sleep problems or being unsatisfied with their sleep and a basic sleep assessment involving a semi-structured interview about sleep habits, problems, and quality was performed by the pain physician and the occupational therapist for

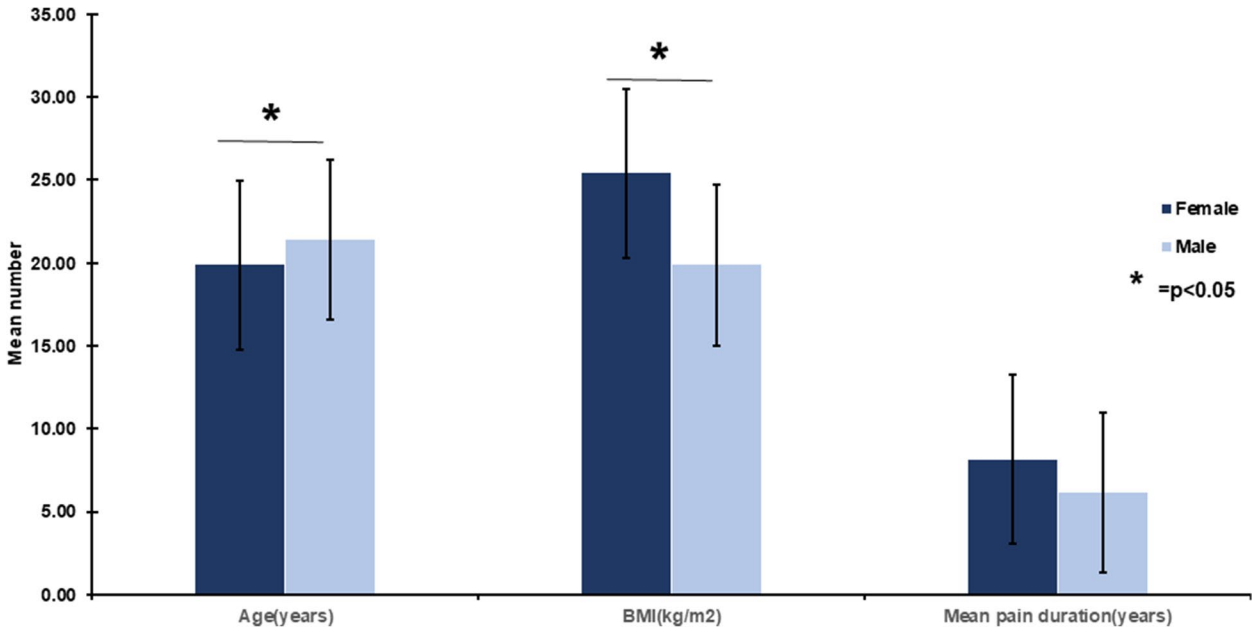

Fig. 3 Demographic characteristics in YAC patients

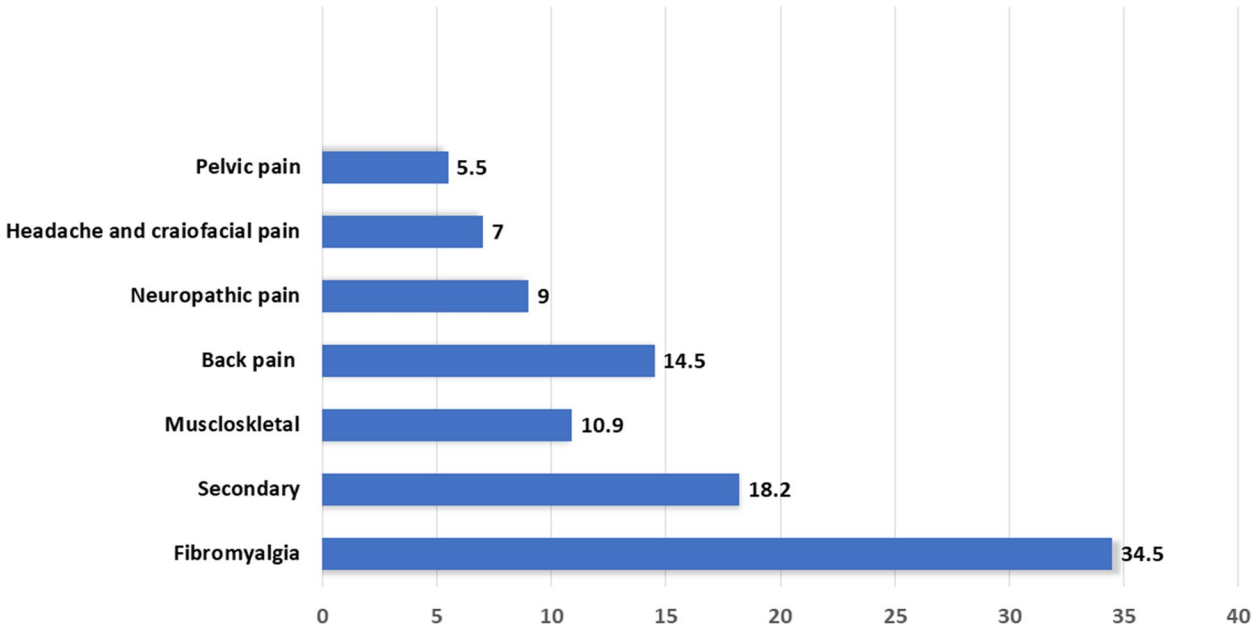

Fig. 4 Causes of chronic pain in patients presenting to YAC

these 13 patients. The need for increased assessment and intervention by a sleep medicine physician was clearly identified and a sleep medicine physician was brought onto the team three months after the initiation of the clinic. Since then, sleep health has been assessed using a standardized questionnaire for all patients presenting at the YAC supplemented by a comprehensive clinical interview. Patients who have a history suggestive of sleep disorders are referred for a sleep study. Data related to sleep health were available for 47 of the 55 patients. Out of these, 39 (82.98%) patients had symptoms of disorders of sleep including insomnia in 32 (68.1%) patients, sleep disordered breathing in 12 (25.5%) patients, sleep-related movement disorder in 7 (14.9%) patients,

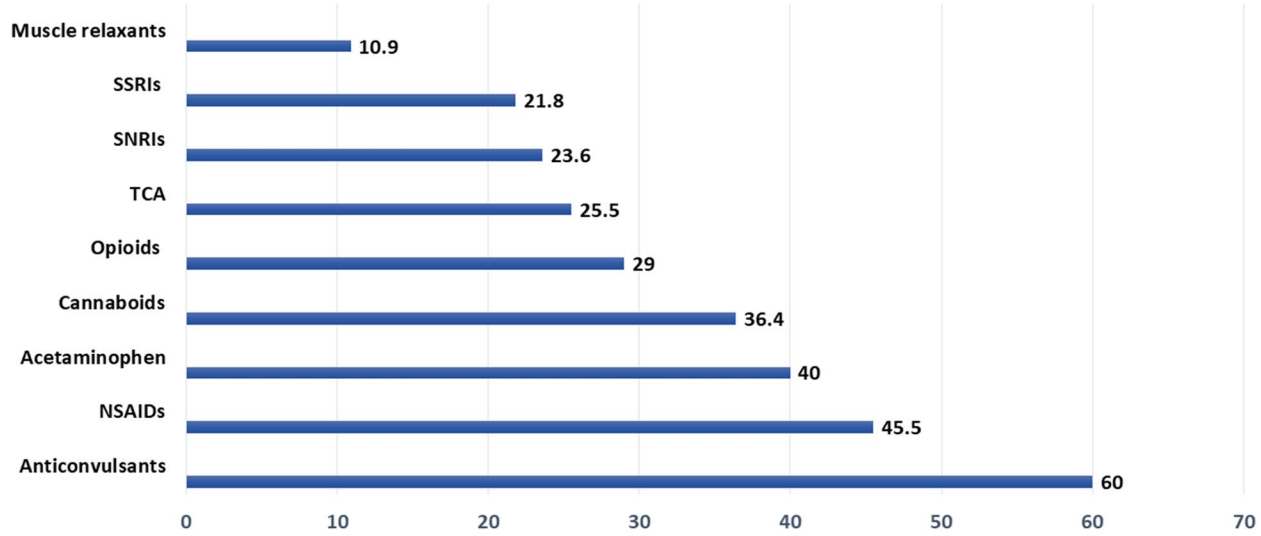

Fig. 5 Pain medications used by patients presenting to YAC

circadian rhythm disorder in 14 (30%) patients, and parasomnia in 1 (2.13%) patient. Twenty-five (53%) of the patients complained of waking up unrefreshed and 11 (23.4%) had poor sleep quality. Mean sleep duration was 8 ± 1.9 h. The ESS scores (Johns 1991) were available for 32 patients with 8 (25%) of the patients indicating mild daytime sleepiness, all of them were females with statistically significant p value of 0.044 and 1 (3%) patient with severe daytime sleepiness who was a male patient (Table 3). Only 8 patients were referred for a sleep study, 2 patients were diagnosed with sleep apnea; one was mild and offered APAP (Automatic positive airway pressure) therapy (subject 7 in Table 4), while the other was already on CPAP (continuous positive airway pressure) therapy (Subject 6 in Table 4). Both patients tolerated well and were compliant during their follow ups.

Depression, self-efficacy, and pain-related catastrophizing

The PSEQ and PHQ-9 score values were available for 48 patients and PCS data was available for 46 patients. Seventeen (37%) patients had significant pain-related catastrophizing (PCS score 30/52 or greater). The mean PSEQ score of the cohort was 27.68 ± 14.8. PSEQ scores lower than 30 suggest a low level of confidence for patients who have ongoing pain. The mean PHQ-9 score was 13.98 ± 7.4 indicating a moderate severity of depression in this cohort. We compared the mean values for male and female patients in our cohort but there were no significant differences with respect to these measures (Table 3).

We also compared demographic, clinical, and polysomnographic characteristics of patients who had symptoms of disorders of sleep at night (39/55) with the cohort that did not have evidence of these disorders (16/55) (Table 5). No significant differences were seen in age, or gender between the two cohorts. Patients with symptoms of disorders of sleep at night were more likely to report low pain self-efficacy with mean PSEQ scores of 24.90 ± 13.2 compared to a mean score of 34.43 ± 16.9 in those with no symptoms ($p = 0.041$). Prevalence of low pain self-efficacy was 57.6% in those with symptoms of sleep disorders compared to 21.4% in those without symptoms ($p = 0.023$). There was no significant difference between both groups as regards risk for pain-related catastrophizing as measured by PCS and self-management skills as assessed by Transition Q.

Discussion

In this retrospective observational study, we summarize our initial experience in creating a multidisciplinary clinic and in delivering care for young adults with chronic pain and sleep health impairments. We report notable sleep disturbances in this cohort that had females in the majority (71%). The most encountered pain diagnosis in this cohort was chronic widespread pain or fibromyalgia, present in 35% of the patients. Sleep data were available in 47 patients and majority (83%) had symptoms of disorders of sleep.

Several studies have shown that young adults with chronic pain report greater sleep disturbances and poorer sleep quality compared to their healthy counterparts (Allen et al. 2016; Valrie et al. 2013; Lewin and Dahl 1999; Palermo et al. 2011a; Roehrs and Roth 2005; Brown et al. 2021; Larche et al. 2021). Here, we evaluated the

Table 4 Sleep studies

Subject	Total sleep time (min)	Sleep onset latency (min)	REM[a] sleep onset latency (min)	Sleep efficiency (%)	WASO[b] (min)	Sleep stages (N1, N2, N3, REM, %)	Sleep stages (N1, N2, N3, REM, ↑/↓/-)	Arousal index (events/hr)	PLM[c] index (events /hr)	Index (events/hr)	AHI[i] (events / hr)	ODI[j] (events/hr)	Min SaO2[k] during sleep (%)	Mean SaO2 TST (%)	
Subject 1	361	15.8	156	91.4	18.3	N1: 4.3 N2: 63.3 N3: 16.2 REM: 16.2	N1: - N2: ↑ N3: - REM: ↓	18.9	-	CAI[d]: 0.2 OAI[e]: 0 MAI[f]: 0 AI[g]: 0.2 HI[h]: 1.3	1.5	0.3	91.0	96.5	
Subject 2	245.5	40.9	N/A	52.5	180.8	N1: 29.9 N2: 49.3 N3: 20.8 REM: 0.0	N1: ↑ N2: - N3: - REM: ↓	16.9	0.0	CAI: 0 OAI: 0 MAI: 0 AI: 0 HI: 0	0	0.7	91.0	94.0	
Subject 3	473	14.4	53.5	92.5	23.9	N1: 2.9 N2: 61.9 N3: 14.0 REM:21.2	N1: - N2: ↑ N3: ↓ REM: -	7.2	0.0	CAI: 0 OAI: 0 MAI: 0 AI: 0 HI: 0.4	0.4	1.9	88.0	95.0	
Subject 4	439	25.3	54	92.9	8.3	N1: 3.4 N2: 75.6 N3: 6.2 REM: 14.8	N1: - N2: ↑ N3: ↓ REM: ↓	7.2	0.0	CAI: 0 OAI: 0 MAI: 0 AI: 0 HI: 4.4	4.4	3.8	93.0	96.5	
Subject 5	251.5	33.2	N/A	61.3	125.4	N1: 26.8 N2: 48.9 N3: 24.3 REM: 0	N1: ↑ N2: - N3: - REM: ↓	8.8	9.1	CAI: 0 OAI: 0 MAI: 0 AI: 0 HI: 0.2	0.2	2.4	92.0	95.0	
Subject 6	342.5	6.3	209	77.2	94.6	N1: 7.7 N2: 68.8 N3: 16.4 REM: 7.2	N1: - N2: ↑ N3: - REM: ↓	8.1	34.5	CAI: 0 OAI: 0 MAI: 0 AI: 0 HI: 3.6	3.6	6.5	90.0	96.5	CPAP[l] titration study at 9 cm H2O*
Subject 7	372.5	47	225	83.4	27.0	N1: 4.6 N2: 57.6 N3: 24.3 REM: 13.6	N1: - N2: - N3: - REM: ↓	9.5	0.8	CAI: 0 OAI: 0 MAI: 0 AI: 0 HI: 11.8	11.8	10.0	89.0	94.0	

Table 4 (continued)

Subject	Total sleep time (min)	Sleep onset latency (min)	REM[a] sleep onset latency (min)	Sleep efficiency (%)	WASO[b] (min)	Sleep stages (N1, N2, N3, REM, %)	Sleep stages (N1, N2, N3, REM, ↑/↓/-)	Arousal index (events/hr)	PLM[c] index (events /hr)	Index (events/hr)	AHI[i] (events / hr)	ODI[j] (events/hr)	Min SaO2[k] during sleep (%)	Mean SaO2 TST (%)
Subject 8	386.5	15.2	146.5	94.6	6.8	N1: 3.0 N2: 61.1 N3: 18.6 REM: 17.3	N1: - N2: ↑ N3: - REM: ↓	4.2	0.0	CAI: 0 OAI: 0 MAI: 0 AI: 0 HI: 0.8	0.8	0.0	93.0	97.0

[a] *REM* Rapid eye movement, [b]*WASO* wakefulness after sleep onset, [c]*PLM* Periodic Limb Movement, [d]*CAI* central apnea index, [e]*OAI* obstructive apnea index, [f]*MAI* mixed apnea index, [g]*AI* apnea index, [h]*HI* hypopnea index, [i]*AHI* Apnea hyponea index, [j]*ODI* Oxygen desaturation index, [k]*SaO2* oxygen saturation, [l]*CPAP* continuous positive airway pressure, ↑/↓: Increased/ Decreased compared to age-matched controls, Hypopnea criteria: The peak signal excursion drop by > 30% of pre-event baseline, duration of > 30% drop in signal excursion is > 10 s and there is a > 3% oxygen desaturation from pre-event baseline or event associated with an arousal

[m] The criteria used for scoring are those recommended in The 2015 AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications, Version 2.3) (Berry et al. 2015)

[n] The normal data come from a data set collected at the University of Florida, published in Electroencephalography of human sleep: Clinical application. John Wiley and Sons New York, Ny 1974. Pages 26–68; mentioned in the Clinical Practice Parameters and Standards – Sleep Medicine 4th Edition, October 2016; Page 69 to 70 (The Principles and Practice of Sleep Medicine 2006)

Table 5 Sleep disruption related parameters in the YAC cohort. Data are mean ± SD or number (%)

Variable	Nocturnal symptoms present ($n=39$)	No Nocturnal symptoms ($n=16$)	*P* value
Age	20.59 ± 2.6	19.56 ± 1.8	0.149
Gender M:F	7:31 (17.9%:79.5%)	6:9 (37.5%:56.2%)	0.212
PSEQ[a] score (0–60)	24.90 ± 13.2	34.43 ± 16.9	0.041
Low Pain self efficacy (PSEQ < 30/60)	19/34 (57.6%)	3/14 (21.4%)	0.023
PHQ-9[b] (0–27)	14.09 ± 6.7	13.71 ± 9.1	0.053
Total depressed (> 5/27)	31/34 (91.2%)	13/14 (92.9%)	0.915
Mild (5–9)	9/34 (27.3%)	6/14 (42.9%)	0.442
Moderate (10–19)	14/34 (42.4%)	3/14 (21.4%)	
Severe (20–27)	8/34 (24.2%)	4/14 (28.6%)	
PCS[c]			
Low risk	7/32 (21.9%)	7/14 (50%)	0.139
Moderate risk	11/32 (34.4%)	4/14 (28.6%)	
Severe risk	14/32 (43.8%)	3/14 (21.4%)	
Transition-Q score	21.75 ± 6.1	21.86 ± 4.1	0.953

[a] *PSEQ* Pain Self-Efficacy Questionnaire, [b] *PHQ-9* Patient Health Questionnaire – 9 items for depression, [c] *PCS* Pain Catastrophizing Scale

impact of pain on sleep health by assessing major sleep health domains—sleep efficacy, sleep timing, alertness, sleep quality, and sleep duration. Although mean sleep duration in our cohort was 7.9 ± 4.8 h in patients with symptoms of disorders of sleep at night and 9.3 ± 8.0 h in those with no symptoms implying that sleep duration is minimally affected by the experience of pain. However, the assumed refreshing effect of sleep in these patients was questionable because 25 (53%) of the patients complained of waking up unrefreshed and 9/32 (28.13%) had increased daytime sleepiness as per their ESS scores (i.e., ESS score more than 10/24). Previous studies have also suggested that although youth with chronic pain demonstrate similar sleep latency, sleep efficiency, and sleep duration when compared to those without chronic pain, they still report greater insomnia symptoms and spend more time sleeping during the day (Palermo et al. 2011a; Palermo et al. 2012; Haim et al. 2004; Law et al. 2012; Lewandowski et al. 2010; Meltzer et al. 2005; Palermo et al. 2011b; Tsai et al. 2008).

Systematic reviews on children and young adults with chronic pain found high rates of sleep impairment among these patients (Valrie et al. 2013). While previous studies have reported sleep deficiency in more than 50% of youth with chronic pain, here we found symptoms of disorders of sleep in ~ 83% of our sample (Allen et al. 2016; Palermo 2000). We found heterogenicity in sleep disorders among these patients including insomnia (68.1%), sleep-related movement disorder (14.9%), circadian rhythm disorder (30.4%), parasomnia (2.13%), and sleep disordered breathing disorders (25.5%). Our study sample (71% female) is also consistent with previously published studies that show chronic pain disorders have a higher prevalence in females (King et al. 2011; Brown et al. 2021; Keilani et al. 2018), with female patients reporting poorer sleep quality than males (Karaman et al. 2014). This high proportion of patients with symptoms of disorders of sleep in our sample highlights the need for sleep assessment and outcomes to be integrated in comprehensive pain management. Despite the prevalence of poor sleep health in young adults with chronic pain, sleep health is often overlooked during chronic pain assessments and care plan. This is exemplified by a recent systematic review that included 75 studies with 78,364 young adults with chronic pain, in which only five studies reported assessing the association between sleep problems and chronic pain (Brown et al. 2021).

Several studies report that sleep and pain interact in a bidirectional manner in adolescents with chronic pain (Valrie et al. 2013; Palermo et al. 2012). Furthermore, the effect of sleep deficiency on pain may be stronger than the effect of pain on sleep (Ocay et al. 2022). Recent evidence suggests that sleep deficits may result in the development of new-onset chronic pain or worsen pain and disability in individuals with pre-existing pain (Allen et al. 2016; Valrie et al. 2013; Palermo et al. 2012; Palermo 2000; Bonvanie et al. 2016). Collectively these findings again highlight the need for sleep health assessment and clinical follow up in order to support chronic pain management and potentially the prevention of new-onset pain in young adults with chronic pain. While the current study does not address the directionality or timing of chronic pain and symptoms of disorders of sleep, we do find that young adults with symptoms of sleep disorder have lower pain self-efficacy. Future studies that evaluate the impact of clinical sleep interventions on

this population are required to determine whether early intervention can improve pain and mitigate the onset of new pain or worsening disability.

The impact of various medications used for chronic pain management on sleep should also be considered. Most commonly used medication by patients in our cohort were anticonvulsants such as gabapentin and pregabalin that improved sleep disturbance in patients with chronic pain syndromes (Roth et al. 2010; Straube et al. 2010) but also contributed to increased daytime somnolence, a dose-dependent adverse effect (Bohra et al. 2014). Given the relationship between sleep health and chronic pain symptoms and prognosis, the impact of medications on both pain and sleep outcomes should be carefully considered.

It is recognized that poor coping (low pain self-efficacy scores, high catastrophizing) and mental health conditions such as depression can adversely impact sleep health and quality of life. In our study, there was a trend toward increased PHQ-9 score in patients with symptoms of disorders of sleep at night compared to those without these symptoms. A study by Gregory and O'Connor (Gregory and O'Connor 2002) reported that increase in depressive symptoms was associated with sleep impairments in youth. MacGregor et al. also demonstrated that Item 3 of the PHQ-9 ("Trouble falling or staying asleep, or sleeping too much") shows promise as a screener for sleep problems in primary care (MacGregor et al. 2012). However, our study showed no difference in the incidence of depression in those with no symptoms of disorders of sleep (93%) compared to those with symptoms of disorders of sleep (91%). Seventeen (37%) of the patients in our cohort were at a high risk of pain-related catastrophizing as indicated by their PCS scores. However, there was no significant difference between those with sleep disorders and those with no sleep disorders. There was a higher prevalence of low pain self-efficacy in patients with symptoms of disorders of sleep at night compared to those with no symptoms, with mean PSEQ scores of 24.90 ± 13.2 and 34.43 ± 16.9 ($p = 0.041$) and prevalence of 57.6% and 21.4% ($p = 0.023$), respectively. Self-efficacy beliefs play an important role in functioning and coping with chronic pain. It is an important determinant of disability and is strongly related to treatment outcome (Gatchel et al. 2007; Woby et al. 2008). Additionally, pain catastrophizing thoughts are more often associated with patients suffering greater sleep disturbance as suggested by Buenaver et al. in their study for patients with myofascial temporomandibular disorder (Buenaver et al. 2012). These findings suggest that problems related to sleep are not necessarily a secondary issue and deserve more attention to identify other effective ways to improve sleep quality and reduce pain in young people.

Our study has a few limitations including a small sample size and its retrospective nature. Our sample is not representative of the general population of all young adults suffering from chronic pain and the results should be interpreted with caution. We could only demonstrate that sleep disturbances are commonly found in young adults with chronic pain and we have elaborated on the nature of sleep problems. Any causality or any other association cannot be established by our study. Further, not all young adult patients with pain were seen by the sleep specialist. We also do not have data on the intensity of pain and the daily opioid doses for patients who were on this group of medications.

Conclusion

We found that sleep health impairments co-exist in young adult patients presenting with chronic pain, with insomnia being the most common sleep disorder. These sleep impairments also co-exist with mental health problems including depression, poor self-efficacy, and pain catastrophizing. Larger prospective studies are needed in young adults with chronic pain to evaluate interventions targeting insomnia. Outcomes that must be assessed include associations between enhanced sleep health and improved pain management, pain self-efficacy, mental health, and overall quality of life in this vulnerable patient population.

In our YAC program, patient feedback and preferences are incorporated, as we attempt to integrate systematic evaluation of sleep health with assessment of pain, by identifying specific domains of sleep health disruption, and targeting treatment strategies in a coordinated fashion between the Pain Medicine physician, Sleep Medicine physician and the Occupational Therapist. Our goal is to of improve overall health and quality of life of this vulnerable patient population.

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Authors' contributions

ME and SB contributed to the manuscript equally. They reviewed the literature, designed the protocol, managed the data, performed statistical analyses, and wrote the manuscript. RB designed the protocol, managed the data, performed statistical analyses, and wrote the manuscript. MS reviewed the literature, designed the protocol, performed overview of data collection, data analysis, and wrote the manuscript. YL reviewed the literature, helped with data collection, and wrote the manuscript. KPS performed the statistical analysis. DT, AB, SS, JS, FC, SB and MM reviewed the literature, and wrote the manuscript. All authors had a significant role in reviewing and formatting the manuscript. The author(s) read and approved the final manuscript.

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Availability of data and materials
The data used in this case report are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was carried out after approval from the Women's College Hospital Research Ethics Board (2019-0091-E). All participants provided informed written consent to participate in this project prior to the start of this study.

Consent for publication
Not applicable.

Competing interests
ME does not have any conflicts of interest. AB does not have any conflicts of interest. SB does not have any conflicts of interest. TD does not have any conflicts of interest. MM does not have any conflicts of interest. JS does not have any conflicts of interest. FC does not have any conflicts of interest. SB does not have any conflicts of interest. SS does not have any conflicts of interest. YL does not have any conflicts of interest. KS does not have any conflicts of interest. RB does not have any conflicts of interest. MS serves on the medical advisory board of the Hypersomnia Foundation on a voluntary basis.

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