DOI: http://dx.doi.org/10.18502/cjn.v21i2.10489

Current Journal of Neurology

Original Paper

Curr J Neurol 2022; 21(2): 66-73

Sleep status in multiple sclerosis: Role of vitamin D and body mass index

Received: 28 Nov. 2021
Accepted: 02 Feb. 2022

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Keywords
Sleep; Multiple Sclerosis; Vitamin D; Body Mass Index; Insomnia; Obstructive Sleep Apnea

Abstract

Background: Sleep disorders are major but neglected symptoms in patients with multiple sclerosis (MS). This study aimed to describe the sleep status in patients with MS.

Methods: We selected mildly-disabled [Expanded Disability Status Scale (EDSS) score < 4] patients with relapsing-remitting MS (RRMS). After determining the level of vitamin D in a blood sample of the patients, the validated Persian versions of Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), and snoring, tiredness, observed apnea, high blood pressure, body mass index (BMI), age, neck circumference, and gender (STOP-Bang) questionnaires were filled and the sleep condition was described. Besides, the impact of age, sex, disease duration, and EDSS on sleep status was determined.

Results: 37.87% of 103 included patients with MS had poor sleep quality. 21.35% rate of subthreshold, 10.67% rate of moderate, and 1.94% rate of severe insomnia were also observed. Only 1.94% of patients had a high risk of obstructive sleep apnea (OSA). There was a significant relation between Beck Depression Inventory (BDI) score with ISI ($r = 0.45$, $P < 0.01$), PSQI ($r = 0.53$, $P < 0.01$), and STOP ($r = 0.20$, $P = 0.03$). A significant correlation between STOP with BMI ($r = 0.24$, $P = 0.01$) and age ($r = 0.21$, $P = 0.03$) was also observed. Sleep status was not significantly different in groups of the patients based on vitamin D, overweight, or sex.

Conclusion: Poor sleep quality is a common finding among mildly-disabled patients with MS. There is also a 33.99% rate of subthreshold or clinical insomnia in different severities. Quality of sleep and insomnia is not significantly correlated to BMI, level of vitamin D, and sex in patients with MS.

Introduction

Multiple sclerosis (MS) is a chronic inflammatory disease of the central nervous system (CNS). MS has affected approximately 2.8 million individuals worldwide, which makes it the most common cause of non-traumatic neurological disability in young adults.[1-4]

How to cite this article: Yazdchi M, Khanalizadeh R, Nasiri E, Naseri A, Talebi M, Talebi M. Sleep status in multiple sclerosis: Role of vitamin D and body mass index. Curr J Neurol 2022; 21(2): 66-73.

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Although the exact cause of MS is still not fully understood, it seems that MS pathogenesis is a consequence of an interaction between genetic and environmental factors.[5,6] Since MS can affect each region in CNS, it can cause various symptoms ranging from sensory disturbance and cognitive impairment to fatigue and motor symptoms.[7,8]

Sleep disorders are common symptoms in patients with MS, and include insomnia, sleep-disordered breathing (SDB), narcolepsy, and restless legs syndrome (RLS).[9] 58.1% rate of sleep apnea, based on polysomnography (PSG)[10] and 42% rate of high risk of obstructive sleep apnea (OSA) based on questionnaire[11] have been reported in patients with MS. A systematic review and meta-analysis of incidence and prevalence of sleep disorders in patients with MS confirms a high rate of sleep disorders in these patients and also suggests a need for more studies on this topic.[12]

One of the associated factors with sleep conditions is the level of vitamin D.[13] Recent systematic reviews found a significant association between vitamin D deficiency and a higher risk of sleep disorders in the general population.[14,15] Body mass index (BMI) and psychiatric condition are the other factors that could be associated with quality of sleep.[16] Previous studies found a significant relationship between vitamin D and obesity with the risk of MS incidence,[17,18] but to the best of our knowledge, there is limited evidence regarding the role of these factors in the sleep condition of patients with MS.

In this study, at first, we described the status of sleep quality, insomnia, and risk of OSA in patients with MS; afterward, intending to recognize the possible risk factors, we investigated the role of vitamin D, BMI, and sex, as three major risk factors associated with sleep disorders in the general population. For removing the other possible confounding factors like pain and bladder and motor dysfunctions, we collected data from a sample of mildly-disabled patients with relapsing-remitting MS (RRMS) in the early stages of the disease.

Materials and Methods

This cross-sectional observational study was conducted in the Department of Neurology, Tabriz University of Medical Sciences Hospital, Tabriz, Iran. The study protocol was reviewed and approved by the Ethics Committee of Tabriz University of Medical Sciences, according to the Declaration of Helsinki.[19] This study did not impose a financial burden on patients, and a written informed consent form was taken from each patient, before participating in the study (Ethics Code: IR.TBZMED.REC.1398.533).

Adult patients (aged above 17) with a definite diagnosis of RRMS according to McDonald diagnostic criteria (2017 revision) and the Expanded Disability Status Scale (EDSS) score < 4 (mildly-disabled patients with MS)[20] were included in this study. The exclusion criteria were pregnancy, history of alcohol abuse, receiving of corticosteroid pulse or MS relapse within 12 weeks before assessment, systemic or infection diseases, severe disability, diagnosed respiratory disorders, discopathy, other neurological disorders, and using of sedatives or muscle relaxants. Patients with progressive forms of the disease [secondary progressive MS (SPMS) and primary progressive MS (PPMS)] and the clinically isolated syndrome (CIS) were also excluded.

Before filling the sleep questionnaires, a blood sample of patients was taken and the level of serum vitamin D (in form of 25-hydroxy vitamin D) was determined. Moreover, a trained examiner measured the height and weight of patients and calculated the BMI. The status of depression was determined based on the Persian version of the Beck Depression Inventory (BDI) questionnaire. Besides, before the study session, an experienced neurologist visited the patients and checked out the EDSS score.

For determining the sleep condition, the validated Persian versions of three different questionnaires, including the Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), and snoring, tiredness, observed apnea, high blood pressure, BMI, age, neck circumference, and gender (STOP-Bang) were utilized in this study.[21-26] PSQI is a self-rated instrument that assesses sleep quality and disturbances in the last month. The questionnaire includes 19 items and the global score of PSQI is the sum of scores for seven components, that can distinguish good and poor sleepers with a cut-off score of 5.[24] ISI is a brief screening measure of insomnia, based on a 7-item self-report questionnaire assessing the nature, severity, and impact of insomnia in the last month. The overall score of the ISI questionnaire is a number ranging from 0 to 28 and it is interpreted as follows: absence of insomnia (0-7), subthreshold insomnia (8-14), moderate insomnia (15-21), and severe insomnia (22-28).[25,27] Finally, the STOP-Bang is an assessment tool for evaluating the risk of OSA. STOP-Bang is an abbreviation of the words "Snoring", "Tired" for measuring daytime fatigue, "Observe" for observing

the patients choking or stopped breathing during sleep, "Pressure" for diagnosed hypertension (HTN), "BMI" so that index over 35 kg/m² is considered as a positive risk factor, "Age" older than 50, "Neck" size larger than 40 cm, and male "Gender". Positive answer for 0-2 question means that there is a low risk of OSA, for 3-4 questions means intermediate risk, and for 5-8 questions presents a high risk of OSA. In addition, some special cases of high risk of OSA are mentioned in the scoring guideline.[28] We also considered only the STOP section of the STOP-Bang tool. Printed questionnaires were filled by each patient or a trained colleague, based on the instruction of each one, and in case of disability in reading or filling, mentioned researcher helped the patients.

Based on 50 ng/ml cut-off for vitamin D, 25 kg/m² cut-off for BMI, and sex, patients were divided into 2 groups and the findings of the assessments were compared between the groups. The cut-off for vitamin D was retrieved based on the recommended levels for patients with MS.[29]

Statistical analysis was conducted using the SPSS software (version 26.0, IBM Corporation, Armonk, NY, USA) with a 0.05 level of significance for P-value and 95% confidence interval (CI). Values were given as mean ± standard deviation (SD) cut to two decimal places and statistics including the independent samples t-test, chi-square test, and Pearson correlation were used to evaluate the data.

Results

103 patients including 72 (69.90%) women and 31 (30.10%) men with a mean age of 34.29 ± 8.98 years were involved in this study. The detailed characteristics of the patients are presented in table 1. The mean EDSS of the patients was 1.11 ± 1.08 that ranged from 0 to 3.5. The mean BMI of the patients was 24.98 ± 3.78 kg/m², so that in 48 patients (46.60%), BMI was under 25 kg/m², which is considered normal and the rest 55 (54.39%) were overweight. In terms of vitamin D, the mean level of vitamin D was 41.70 ± 19.04 ng/ml, so that 70 patients (67.96%) had a low level of vitamin D based on the recommended cut-off for patients with MS. The mean BDI score of patients was 13.66 ± 11.46, so that the depressive condition was normal in 48.54% of our sample.

Based on the PSQI questionnaire, 64 patients (62.13%) had good sleep quality. The mean score of the ISI questionnaire was 6.69 ± 5.78, so that 66.01% of the patients had no insomnia. In the rest of the patients, most of them (21.35%) had subthreshold insomnia and severe clinical insomnia was observed in 2 patients (1.94%) in our sample. Finally, based on the STOP-Bang questionnaire, 93 patients (90.29%) had a low risk of OSA.

Table 1. Descriptive statistics

Characteristics	Value
Age (year)	34.29 ± 8.98
Sex	
Women	72 (69.90)
Men	31 (30.10)
Disease duration (year)	7.33 ± 6.08
EDSS	1.11 ± 1.08
Disease modifying drugs	
HDHF	33 (32.03)
LDLF	10 (9.70)
Oral medications	41 (39.80)
Infusion therapies	19 (18.44)
BMI (kg/m²)	24.98 ± 3.78
< 25	48 (46.60)
≥ 25	55 (54.39)
Vitamin D (ng/ml)	41.70 ± 19.04
< 50 ng/ml	70 (67.96)
≥ 50 ng/ml	33 (32.03)
BDI score	13.66 ± 11.46
Normal	50 (48.54)
Mild mood disturbances	16 (15.53)
Borderline clinical depression	8 (7.76)
Moderate depression	20 (19.41)
Severe depression	5 (4.85)
Extreme depression	4 (3.88)
PSQI	5.31 ± 4.10
Good sleep quality	64 (62.13)
Poor sleep quality	39 (37.87)
ISI	6.69 ± 5.78
No insomnia	68 (66.01)
Subthreshold insomnia	22 (21.35)
Moderate clinical insomnia	11 (10.67)
Severe clinical insomnia	2 (1.94)
STOP-Bang	
STOP	0.66 ± 0.65
Low risk of OSA	93 (90.29)
Intermediate risk of OSA	8 (7.76)
High risk of OSA	2 (1.94)

Data are presented as mean ± standard deviation (SD) or number and percentage

EDSS: Expanded Disability Status Scale; MS: Multiple sclerosis; STOP-Bang: Snoring, tiredness, observed apnea, high blood pressure, body mass index (BMI), age, neck circumference, gender; STOP: Snoring, tiredness, observed apnea, high blood pressure; HDHF: High-dose high-frequency; LDLF: Low-dose low-frequency; BDI: Beck Depression Inventory; BMI: Body mass index; PSQI: Pittsburgh Sleep Quality Index; ISI: Insomnia Severity Index; OSA: Obstructive sleep apnea

Tables 2 and 3 are a summary of investigating the effects of BMI, vitamin D, and sex on different factors of the study.

Table 2. Comparison of the demographic characteristics of the patients in the groups of the study based on vitamin D, body mass index (BMI) and sex

Characteristics	Value		P	Value		P	Value		P
	Vitamin D < 50 (n = 70)	Vitamin D ≥ 50 (n = 33)		BMI < 25 (n = 48)	BMI ≥ 25 (n = 55)		Men (n = 31)	Women (n = 72)	
Age (year)	34.27 ± 9.55	34.33 ± 7.78	0.97	32.08 ± 7.24	35.57 ± 9.57	0.04*	32.45 ± 10.70	34.94 ± 8.12	0.19
Sex									
Women	48 (68.57)	24 (72.72)	0.66	33 (71.73)	38 (70.37)	0.88	-	-	-
Men	22 (31.42)	9 (27.27)		13 (28.26)	16 (29.62)		-	-	
Disease duration (year)	6.76 ± 5.74	8.57 ± 6.69	0.16	6.66 ± 5.87	7.77 ± 6.21	0.36	7.55 ± 6.49	7.25 ± 5.92	0.81
EDSS	1.20 ± 1.08	0.93 ± 1.07	0.24	1.04 ± 1.06	1.18 ± 1.12	0.53	1.16 ± 1.23	1.09 ± 1.02	0.77
Disease modifying drugs									
HDHF	21 (30.00)	12 (36.36)	0.80	19 (39.58)	14 (25.45)	0.21	6 (19.35)	27 (37.50)	0.18
LDLF	6 (8.57)	4 (12.12)		3 (6.25)	7 (12.72)		3 (9.67)	7 (9.72)	
Oral medications	29 (41.42)	12 (36.36)		20 (41.66)	21 (38.18)		17 (54.83)	24 (33.33)	
Infusion therapies	14 (20.00)	5 (15.15)		6 (12.50)	13 (23.63)		5 (16.12)	14 (19.44)	
BMI (kg/m^2)	25.45 ± 4.16	24.05 ± 2.93	0.05	21.56 ± 2.17	27.90 ± 2.16	< 0.01*	24.57 ± 3.59	25.14 ± 3.87	0.48
< 25	29 (43.28)	17 (51.51)	0.43	-	-	-	14 (45.16)	34 (47.22)	0.87
≥ 25	38 (56.71)	16 (48.48)		-	-		17 (54.83)	38 (52.77)	
Vitamin D (ng/ml)	31.00 ± 8.85	64.40 ± 14.34	< 0.01*	43.30 ± 22.12	39.95 ± 15.33	0.15	40.26 ± 20.94	42.33 ± 18.28	0.61
< 50	-	-	-	31 (64.58)	39 (70.90)	0.49	22 (70.96)	48 (66.66)	0.66
≥ 50	-	-		17 (35.41)	16 (29.09)		9 (29.03)	24 (33.33)	
BDI score	14.42 ± 12.31	12.06 ± 9.36	0.33	13.77 ± 11.58	13.58 ± 11.45	0.93	13.35 ± 12.72	13.80 ± 10.96	0.85
Normal	34 (48.57)	16 (48.48)	0.02*	24 (50.50)	26 (43.27)	0.30	19 (61.29)	31 (43.05)	0.04*
Mild mood disturbances	13 (18.57)	3 (9.09)		5 (10.41)	11 (20.00)		1 (3.22)	15 (20.83)	
Borderline clinical depression	2 (2.85)	6 (18.18)		3 (6.25)	5 (9.09)		0 (0)	8 (11.11)	
Moderate depression	12 (17.14)	8 (24.24)		13 (27.08)	7 (12.72)		8 (25.80)	12 (16.66)	
Severe depression	5 (7.14)	0 (0)		1 (2.08)	4 (7.27)		1 (3.22)	4 (5.55)	
Extreme depression	4 (5.71)	0 (0)		2 (4.16)	2 (3.63)		2 (6.45)	2 (2.77)	

*P < 0.05

Data are presented as mean ± standard deviation (SD) or number and percentage

EDSS: Expanded Disability Status Scale; HDHF: High-dose high-frequency; LDLF: Low-dose low-frequency; BDI: Beck Depression Inventory; BMI: Body mass Index

Table 3. The role of vitamin D, body mass index (BMI), and sex in the sleep indices

Characteristics	Value		P	Value		P	Value		P
	Vitamin D < 50 (n = 70)	Vitamin D ≥ 50 (n = 33)		BMI < 25 (n = 48)	BMI ≥ 25 (n = 55)		Men (n = 31)	Women (n = 72)	
PSQI	5.20 ± 3.84	5.56 ± 4.68	0.68	4.97 ± 3.70	5.70 ± 4.49	0.38	5.38 ± 5.40	5.83 ± 5.55	0.70
Good sleep quality	44 (62.85)	20 (60.60)	0.82	31 (64.58)	33 (60.00)	0.63	21 (67.74)	43 (59.72)	0.44
Poor sleep quality	26 (37.14)	13 (39.39)		17 (35.41)	22 (40.00)		10 (32.25)	29 (40.37)	
ISI	6.15 ± 5.29	7.81 ± 6.65	0.17	7.13 ± 5.83	6.62 ± 5.79	0.66	5.38 ± 4.59	7.30 ± 6.14	0.12
No insomnia	47 (67.14)	21 (63.63)	0.10	28 (58.33)	40 (72.72)	0.33	23 (74.19)	45 (62.50)	0.30
Subthreshold insomnia	17 (24.28)	5 (15.15)		14 (29.16)	8 (14.54)		7 (22.58)	15 (20.83)	
Moderate clinical insomnia	6 (8.57)	5 (15.15)		5 (10.41)	6 (10.90)		1 (3.22)	10 (13.88)	
Severe clinical insomnia	0 (0)	2 (6.06)		1 (2.08)	1 (1.81)		0 (0)	2 (2.77)	
STOP-Bang									
STOP	0.67 ± 0.67	0.63 ± 0.60	0.37	0.54 ± 0.54	0.76 ± 0.71	0.11	0.64 ± 0.70	0.66 ± 0.62	0.28
Low risk of OSA	62 (88.57)	31 (93.93)	0.55	45 (93.75)	48 (87.27)	0.44	25 (80.64)	68 (94.44)	0.03*
Intermediate risk of OSA	6 (8.57)	2 (6.06)		2 (4.16)	6 (10.90)		4 (12.90)	4 (5.55)	
High risk of OSA	2 (2.85)	0 (0)		1 (2.08)	1 (1.81)		2 (6.45)	0 (0)	

*P < 0.05

Data are presented as mean ± standard deviation (SD) or number and percentage

PSQI: Pittsburgh Sleep Quality Index; ISI: Insomnia Severity Index; STOP-Bang: Snoring, tiredness, observed apnea, high blood pressure, body mass index (BMI), age, neck circumference, gender; STOP: Snoring, tiredness, observed apnea, high blood pressure; OSA: Obstructive sleep apnea; BMI: Body mass index

There was no significant association between vitamin D and BMI with sleep indices in our study. As expected, male patients had a higher level of risk of OSA (P = 0.03). As a secondary outcome, there was a significant difference between two groups of the patients based on vitamin D and the level of depression based on BDI score (P = 0.02), so that according to our assessment, the patients with a lower level of vitamin D were more likely to have depression. All of the nine patients with severe or extreme depression in our sample had a level of vitamin D below the recommended cut-off for patients with MS. Moreover, there was a significant difference between male and female patients in depression status (P = 0.04).

Table 4 is the summary of correlations between different numeric factors of the study. As shown, there were not any considerable relations between BMI, age, disease duration, EDSS, vitamin D, BDI score, and overall scores of PSQI and ISI questionnaires. STOP score was significantly correlated to age (P = 0.03), BMI (P = 0.01), and BDI score (P = 0.03). The other significant relationship in our sample was between BDI score with PSQI and ISI (P < 0.01 for both), which suggested poorer sleep quality and a higher level of insomnia in patients with higher BDI scores.

Discussion

This study was designed and conducted to investigate the quality of sleep, rate of insomnia, and risk of OSA in a sample of mildly-disabled patients with MS. According to our assessment, 37.87% of patients with MS had poor sleep quality based on the PSQI questionnaire. Furthermore, 10.67% rate of clinical insomnia with moderate severity and 1.94% rate of severe insomnia were observed in our sample. Only, 1.94% of our sample had a high risk of OSA. In terms of the risk factors, we could not detect a considerable association between vitamin D and overweight with sleep indices in our sample. There was a significant relation between BDI score and ISI, PSQI, and STOP scores, but EDSS, disease duration, and vitamin D did not affect any of the sleep indices in our sample. BMI and age were also significantly correlated to STOP scores.

Sleep disorders have become an epidemic problem in recent years.[30,31] One of the hypotheses states that vitamin D could play a crucial role in this regard.[32] The mechanism of the role of vitamin D in sleep conditions is mostly associated with regulating the sleep-wake cycle.[13] There is a limited number of studies considering the effects of vitamin D level and sleep abnormalities in patients with MS.

Despite the higher prevalence of sleep disorders in patients with MS, most of the time, it gets neglected by the clinicians.[33,34] Healthy sleep leads to the maintenance of physical and psychological health, and it is a crucial factor in patients' quality of life (QOL). Especially, regarding patients with MS, sleep disorders can be presented by fatigue, which is a more categorized and debilitating symptom of MS.[33,35] Therefore, as one of the important causes of fatigue in patients with MS, sleep disorders should be considered and followed up strictly by neurologists.[9] In addition, referral to a sleep medicine specialist should be considered, in case of severe problems and lack of enough response to first-line treatments.[36]

A study on 120 Italian patients with MS found that 47.5% of patients with a mean 2.7 ± 1.4 EDSS were poor sleepers based on PSQI.[37] In this study, the quality of sleep was associated with EDSS and the comorbidities of the patients. In another study in China, the rate of poor sleep quality in patients with MS was 64.9%.[38] The rate of poor sleep conditions in our sample was 37.87%. This lower rate of sleep abnormalities could be because of selecting only mildly-disabled patients with MS (EDSS < 4) in our study, which was similar to the Italian study, but the age and duration of disease were higher in the mentioned article.

In terms of the risk of insomnia, multiple studies reported about a 40% prevalence of insomnia in patients with MS, which usually was presented with waking up too early in the morning.[39,40]

Table 4. Correlations between sleep indices with demographic factors, body mass index (BMI), and vitamin D

Characteristic		BMI	Age	Disease duration	EDSS	Vitamin D	BDI score
PSQI	R	0.12	0.17	-0.05	0.08	0.01	0.53
	P	0.22	0.08	0.58	0.40	0.90	< 0.01*
ISI	R	0.00	0.05	-0.10	0.02	0.08	0.45
	P	0.94	0.58	0.31	0.79	0.38	< 0.01*
STOP	R	0.24	0.21	-0.11	0.12	-0.12	0.20
	P	0.01*	0.03*	0.25	0.22	0.19	0.03*

*P < 0.05

EDSS: Expanded Disability Status Scale; BDI: Beck Depression Inventory; BMI: Body mass index; PSQI: Pittsburgh Sleep Quality Index; ISI: Insomnia Severity Index; STOP: Snoring, tiredness, observed apnea, high blood pressure

In terms of the risk of insomnia, multiple studies reported about a 40% prevalence of insomnia in patients with MS, which usually was presented with waking up too early in the morning.[39,40] A 7.2% rate of severe insomnia and also 24.4% rate of moderate insomnia have been reported in previous studies in patients with MS.[41] The mentioned studies did not report the EDSS of patients in their articles. In our sample, about 34% of patients had subthreshold or clinical insomnia in different stages. Lower mean age, duration, and EDSS could be the reasons for this difference between our study and previous studies.

Respiratory disorders during sleep can have both central and peripheral bases in patients with MS.[42] Demyelinating lesions in the brainstem circuits, usage of painkillers or antispasmodic drugs, or inactivity leading to obesity are some of the suggested explanations.[40] There are a limited number of studies in terms of OSA risk in patients with MS. Based on previous studies, the prevalence of high risk of OSA based on the STOP-Bang questionnaire was 42% in a sample of patients with MS in the United States (US). This study found STOP-Bang an efficient and objective tool for detecting the risk of OSA in patients with MS.[11] In another study in the US, a high risk of OSA was observed in 37.8% of patients with MS with higher duration, age, and diversity in BMI.[41] In another study of 124 patients with MS with moderate disease severity in Egypt, the prevalence of high risk of OSA was 46.8%.[43] This study did not report the mean BMI of their sample. In our sample, the high risk of OSA was only seen in 1.94% of patients. BMI > 35 kg/m^2 is one of the risk factors of OSA in the STOP-Bang questionnaire, but with a 25 kg/m^2 cut-off, it could not affect the risk of OSA condition in our sample. Considering the findings of other studies, it is concluded that although OSA is a common finding in patients with MS,[44] in the first stages of the disease, the prevalence is not considerable, and still there is a need for more studies to solve the existing controversy.

In terms of sex differences in sleep conditions of patients with MS, although our study could not detect a significant difference between male and female patients, a study on the Chinese MS population found female gender as a risk factor for poor sleep quality.[38] OSA has been considered a male-related condition for a long time.[45] Moreover, as male sex is one of the risk factors of the STOP-Bang questionnaire, the difference between female and male patients in terms of OSA risk was expectable.

Based on the guidelines for the treatment of chronic insomnia in adults, the therapy should not be limited to prescribing sleep medicines. Instead, it should be cured with a special emphasis on the underlying causes. Besides, non-pharmacological therapies such as lifestyle changes, relaxation training, biofeedback, or cognitive behavioral therapy (CBT) are recommended.[39] Particularly in patients with MS, because of higher prevalence, independent diagnosis and treatment of each condition can be more points of interest.[46] Although our study could not detect a significant role for vitamin D in sleep disorders, there is evidence of the beneficial effects of vitamin D supplementation in boosting the sleep condition.[15]

Conclusion

There is about a 34% rate of subthreshold or clinical insomnia with different severities in the first stages of MS. Poor sleep quality is a common finding among mildly-disabled patients with MS (37.87%). 90.29% of patients with MS have a low risk of OSA. Although the level of vitamin D is one of the well-known associated factors with sleep conditions in the general population, there is no significant correlation in patients with MS, based on the recommended level of vitamin D for them. Furthermore, there is no significant difference between normal and overweight patients, and also female and male patients, in terms of sleep condition, but depressive status can affect the quality of sleep and insomnia. The limited sample size of this study highlighted a need for future studies in this topic to reach a more reliable conclusion, but considering the effects of sleep on fatigue, the sleep status of patients with MS should be followed up strictly by the clinicians and in case of severe problems, referral to a sleep medicine specialist can help boost patients' QOL.

Conflict of Interests

The authors declare no conflict of interest in this study.

Acknowledgments

The research protocol was approved and supported by the Neurosciences Research Center, Tabriz University of Medical Sciences (grant number: 62917).

The Ethics Committee of Tabriz University of Medical Sciences reviewed and approved the study protocol, according to the Declaration of Helsinki (Ethics Code: IR.TBZMED.REC.1398.533).

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