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Original article

Factors related to positive airway pressure adherence in patients with obstructive sleep apnea at King Chulalongkorn Memorial Hospital

Piraya Pithathitikul[a], Decha Lalitanantponga[a], Krittapas Thienwiwatnukul[b], Puntarik Srisawart[a,b,*]

[a]Department of Psychiatry, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand
[b]The Excellence Center for Sleep Disorders, King Chulalongkorn Memorial Hospital, Bangkok, Thailand

Background: Positive airway pressure (PAPs) is a standard and efficacious treatment for obstructive sleep apnea (OSA). Poor adherence could lead to impaired daytime performance, increasing risk of traffic accidents, hypertension, cardiovascular events, and neuropsychological disturbances. Previous studies reported rates and factors influencing PAPs adherence, but the data in Thailand was still lacking.

Objectives: To investigate the rate of PAPs adherence, the prevalence of depressive and anxiety symptoms, and the factors associated with PAPs adherence among patients with OSA.

Methods: This is a cross-sectional descriptive study that was conducted during June 2021 to September 2022. The data was collected from patients with ages ≥ 18 years old who were diagnosed with OSA, suggested by physician to use PAPs for treatment, and currently being followed-up at King Chulalongkorn Memorial Hospital (KCMH). The questionnaires developed by the investigator were used to assess demographic and clinical data, factors associated with PAPs adherence and rate of PAPs adherence. Thai Hospital Anxiety and Depression Scale (HADS) was used to assess the prevalence of depressive and anxiety symptoms.

Results: A total of 115 patients consented to participate in this study. Forty-eigth of the subjects (41.7%) met the adherence criteria in this study. The prevalence of depressive and anxiety symptoms was 1.7% and 3.5%, respectively. The mean depressive scores in the adherence group were statistically less than those in the non-adherence group ($P = 0.046$), but there were no significant different in mean anxiety scores between the two groups ($P = 0.308$). Significant associated factors related to PAPs adherence were income, improving of daytime sleepiness, usage of OSA impacted medication, number of OSA impacted medication using, and feeling difficulty to breath while using the PAPs machine. Multivariate analysis demonstrated a significant association between lower income (less than 30,000 Thai baht per month) and the feeling of difficulty to breath while using the PAPs machine with the non-adherence to PAPs using while other covariate factors were controlled.

Conclusion: The prevalence of depression and anxiety was lower than other previous studies. Income, improving of daytime sleepiness, usage of and number of OSA impacted medications, and feeling difficulty to breath while using the PAPs machine were significant factors associated with PAPs adherence. Income less than 30,000 Baht per month and reported difficulty to breath during PAPs treatment could predict future non-adherence to PAPs treatment.

Keyword: Adherence, obstructive sleep apnea, positive airway pressure.

Obstructive sleep apnea (OSA) is one of the most common chronic respiratory disorders worldwide[1], with a 14.0 - 55.0% increase from the early 1990s to the late 2000s. Untreated OSA is associated with long-term health consequences, including atrial fibrillation, congestive heart failure, stroke, hypertension, coronary artery disease, and diabetes mellitus.[2] In addition, cognitive dysfunction, impaired workplace productivity, and increased risk of motor vehicle accidents are associated with untreated OSA.[3] Other consequences of OSA include impaired vigilance, daytime somnolence, performance deficits, morning headaches, mood disturbances, neurobehavioral impairments, and general malaise. Additionally, the economic impact of OSA on the health system is

*Correspondence to: Puntarik Srisawart, Department of Psychiatry, Faculty of Medicine, Chulalongkorn University, Bongkok 10330, Thailand.
E-mail: ps.taew@gmail.com
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substantial due to the high prevalence of associated morbidities and complications, which can represent a significant financial burden to healthcare services.[4 - 5]

A systematic review and meta - analysis reported the prevalence of depressive and anxious symptoms in OSA patients as 35.0% (95% CI, 28.0 - 41.0%) and 32.0% (95% CI, 22.0 - 42.0%), respectively.[4] The recent cross sectional descriptive study in Thai populations show the prevalence of depression in OSA patient is 29.7% (mild, moderate and severe OSA is 11.8%, 26.1% and 47.2% respectively) and found the correlation between severity of OSA and depression with statistical significant. [5] Several studies confirm that co-morbid OSA could worsen the symptoms of affective disorders. Although, it has been well established that depression is also related to the occurrence and worsening of severe medical conditions such as metabolic and cardiovascular diseases[6] and is a major contributing factor to no-compliance with OSA treatment.[7]

Positive airway pressure (PAPs) delivered in continuous (CPAP), bilevel (BiPAP), and auto titrating (APAP) modes is a standard therapy for moderate (The apnea-hypopnea index (AHI) 15 - 30) to severe (AHI > 30) OSA and an optional therapy for mild (AHI 5 - 15) OSA. Although it is a highly effective treatment, adherence to therapy remains a difficult issue. Poor adherence could lower the efficacy of treatment or even result in treatment failure.[8] PAPs adherence rates are variable, the recent studies reported CPAP adherence rates of 37.3 - 87.5% in Western populations and 38.0 - 90.0% in Asian populations.[9] Factors influencing CPAP adherence include disease and patient characteristics, treatment titration procedures, device factors, psychological and social factors. Barriers to CPAP acceptance include cost, inconvenience, discomfort, treatment uncertainty and the choice of alternative therapies.[10, 11]

In addition. medications could have a potential impact on OSA included medications that could worsen OSA, such as opioids, benzodiazepines, baclofen, testosterone, and medications inducing weight gain such as neuroleptics, tricyclic antidepressants, monoamine oxidase inhibitors, paroxetine, mirtazapine, anticonvulsants, insulin, sulfonylureas, thiazolidinediones, cyproheptadine, propranolol, doxazosin, contraceptives, glucocorticoids, progestational steroids.[12] Therefore, the aim of this study was to investigate the rate of PAPs adherence, the prevalence of depressive and anxiety symptoms, and the factors associated with PAPs adherence among patients with OSA.

Materials and methods

Research design

This is a cross-sectional descriptive study conducted during June 2021 to September 2022 at King Chulalongkorn Memorial Hospital (KCMH) Bangkok, Thailand. The study has been approved by The Human Research Ethics Committee, Faculty of Medicine, Chulalongkorn university (IRB no.510/64).

Population and sample

The inclusion criteria were patients with ages ³ 18 years old who were diagnosed with OSA (AHI ³ 5), suggested by physician to use PAPs for treatment, currently being followed-up at The Excellence Center for Sleep Disorders of KCMH, able to communicate fluently in Thai, and willing to participate in the study. The patients and/or their surrogate decision makers were approached after their routine follow-up with the attending physician and gave their consent to participate in the study.

The exclusion criteria were patients who had impaired ability to communicate (for example; visual, speech, or hearing impairment), had an emergency condition, were currently admitted as an inpatient, and had been diagnosed with dementia or other sleep-related conditions, for example, narcolepsy, parasomnia, central sleep apnea, mixed sleep apnea, restless leg syndrome, periodic limb movement disorder, and obesity hypoventilation syndrome. We used the method described by Lwanga SK. and Lemeshow S.[13] to estimate the sample size. The calculated sample size for this study was 105 subjects; 10.0% was added to compensate for potential nonresponses (refusals or losses). Thus, at the end of the data collection, 115 patients had participated in the study.

Data collection

After the data screening, the attending physicians informed the patients about the study information. The patients who met the inclusion criteria and were willing to participate were asked to complete the consent form. The subjects would later be interviewed by the investigator using the research questionnaire and the Thai Hospital Anxiety and Depression Scale (HADS) which took approximately 15 - 20 minutes. subjects whose scores indicated they were at risk of developing either anxiety or depressive disorders were scheduled for a more comprehensive evaluation of psychiatric conditions later. The investigator also collected data from the hospital database and the data which were downloaded from the currently using PAPs machine's memory card. (Figure 1).

Measurements

Independent variable measurement

The primary independent variables were general demographic information (e.g. age, gender, educational level), clinical information (e.g. body mass index (BMI), underlying disease, current medication that have a potential impact on OSA (included medications which may worsen OSA such as opioids, benzodiazepines, baclofen, testosterone, and medications inducing weight gain such as neuroleptics,

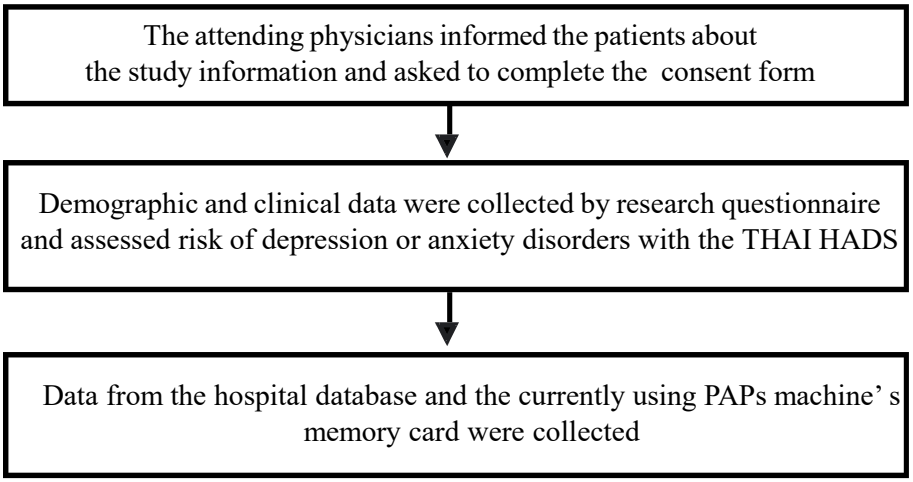

Figure 1. Study flow chart.

tricyclic, antidepressants, monoamine oxidase inhibitors, paroxetine, mirtazapine, anticonvulsants, insulin, sulfonylureas, thiazolidinediones, cyproheptadine, propranolol, doxazosin, contraceptives, glucocorticoids, progestational steroids), PAPs usage information (e.g. hours per night, % use of night, type of PAPs machine, leakage) and depressive and anxiety symptom.

Outcomes measurement

The primary outcome of this study was the rate of positive airway pressure adherence, which was defined as > 4 hours of PAPs use per night and > 70.0% of nights; the secondary outcome was the prevalence of depressive and anxiety symptoms, which were graded on a scale of 0 - 3 for items number 2, 4, 6, 8, 10, 12, 14 for depression and items number 1, 3, 5, 7, 9, 11, 13 for anxiety in the Thai HADS. Those who score ≥ 11 were at risk of having disorders within the depressive spectrum and anxiety disorders.; and the tertiary outcome was the factors associated with positive airway pressure adherence among patients with obstructive sleep apnea.

Statistical analysis

Frequency and percentages were used to describe categorical variables such as gender, educational level, occupation, income, and underlying disease. Mean with standard deviation (SD) were used to represent continuous variables such as age, number of medications uses, and AHI. Median with Interquartile range (IQR) were used to measure variability in skewed distributions.

An unpaired *t* - test was used to compare the mean difference of a continuous variable between two categorical groups, such as age and PAPs adherence. The Mann-Whitney U test was used to compare two independent samples when the dependent variable was not normally distributed. Pearson's Chi-square test and Fisher exact test were used to compare categorical variables between two groups, such as gender and PAPs adherence. Finally, the association between certain such factors and PAPs adherence was tested by logistic regression. The statistical significance was set at a *P* - value less than 0.05. All statistical analyses were performed using SPSS version 22.0.

Results

A total of 115 patients consented to participate in this study. Baseline demographic and clinical data comparing patients with and without adherence to PAPs use were shown in Table 1 and 2. Most subjects were male (63.5%). Factors that were statistically different between the two groups of patients were income,improving daytime sleepiness, usage of OSA impacted medication, number of OSA impacted medication, and feeling difficulty to breath while using the PAPs machine. PAPs adherence patients were found to have higher income ($P = 0.005$), more improvement of daytime sleepiness feeling ($P = 0.035$), not using OSA impacted medication ($P = 0.045$), less OSA impacted medication using ($P = 0.039$) and less breathing difficulty to breath while using the PAPs machine ($P = 0.026$). Other factors were not significantly different between the two groups.

Table 1. Demographic and clinical data comparing between patients with and without adherence for PAPs use.

Variable	Total = 115 n (%)	Adherence = 48 n (%)	Non-adherence = 67 n (%)	*P* - value
Gender				0.166
Male	73 (63.5)	34 (70.8)	39 (58.2)	
Female	42 (36.5)	14 (29.2)	28 (41.8)	
Body mass index (BMI)				0.563
BMI < 23 kg/m^2	28 (24.3)	13 (27.1)	15 (22.4)	
BMI ≥ 23 kg/m^2	87 (75.7)	35 (72.9)	52 (77.6)	
Educational level				0.996
Compulsory education	12 (10.4)	5 (10.4)	7 (9.0)	
Higher than compulsory education	103 (89.6)	43 (89.6)	60 (91.0)	
Income per month				0.005*
< 30,000 Baht	61 (53.0)	18 (37.5)	43 (64.2)	
≥ 30,000 Baht	54 (47.0)	30 (62.5)	24 (35.8)	
Medical welfare for PAPs treatment				0.812
Self-pay	47 (40.9)	19 (39.6)	28 (41.8)	
Copayment from medical welfares	68 (59.1)	29 (60.4)	39 (58.2)	
Occupation				0.245
Retirement/Not working	48 (41.7)	17 (35.4)	31 (46.3)	
Have a job	67 (58.3)	31 (64.6)	36 (53.7)	
Co-morbidities				
Hypertension	57 (49.6)	19 (39.6)	38 (56.7)	0.070
Dyslipidemia	45 (39.1)	19 (39.6)	26 (38.8)	0.933
Rhinosinusitis	39 (33.9)	16 (33.3)	23 (34.3)	0.911
Diabetes mellitus	31 (27.0)	10 (20.8)	21 (31.3)	0.210
Cardiovascular disease	18 (15.7)	9 (18.8)	9 (13.4)	0.439
Neuropsychiatric disorder	14 (12.2)	4 (8.3)	10 (14.9)	0.286
Cerebrovascular disease	7 (6.1)	4 (8.3)	3 (4.5)	0.449[a]
Baseline OSA severity				0.067
Mild (AHI 5 - 14.9)	8 (7.0)	6 (12.5)	2 (3.0)	
Moderate (AHI 15 - 29.9)	31 (27.0)	15 (31.3)	16 (23.9)	
Severe (AHI ≥ 30)	76 (66.0)	27 (56.3)	49 (73.1)	
Current OSA severity				0.147
Normal (AHI < 5)	102 (88.7)	45 (93.7)	57 (85.0)	
Mild (AHI 5 14.9)	13 (11.3)	3 (6.3)	10 (15.0)	
Type of PAPs				0.890
CPAP	87 (75.7)	36 (75.0)	51 (76.1)	
APAP BiPAP	28 (24.3)	12 (25.0)	16 (23.9)	
Type of mask				0.968
Nasal mask	100 (87.0)	42 (87.5)	58 (86.5)	
Nasal pillow	8 (7.0)	3 (6.3)	5 (7.5)	
Full - face mask	7 (6.0)	3 (6.3)	4 (5.9)	
Chin strap	30 (26.1)	10 (20.8)	20 (29.9)	0.277
Humidifier	54 (47.0)	21 43.8)	33 (49.2)	0.560
OSA impacted medication				0.045*
Non use	69 (60.0)	34 (70.3)	35 (52.2)	
Use at least one medication	46 (40.0)	14 (29.2)	32 (47.8)	
Duration of PAP use				0.145
< 6 months	27 (23.5)	8 (16.7)	19 (28.3)	
≥ 6 months	88 (76.5)	40 (83.3)	48 (71.6)	

Table 1. (Cont.) Demographic and clinical data comparing between patients with and without adherence for PAPs use.

Variable	Total = 115 n (%)	Adherence = 48 n (%)	Non-adherence = 67 n (%)	*P* - value
Factors associated to experience of PAPs use				
Improving daytime sleepiness	84 (73.0)	40 (83.3)	44 (65.7)	0.035*
Uncomfortable feelings due to the device	32 (27.8)	9 (18.7)	23 (34.3)	0.066
Nasal congestion	32 (27.8)	13 (27.1)	19 (28.3)	0.880
Dry nose	29 (60.4)	11 (22.9)	18 (26.9)	0.631
Air leakage (> 20 LPM)	28 (58.3)	8 (16.7)	20 (29.9)	0.104
Get out of bed often	26 (22.6)	10 (20.8)	16 (23.9)	0.700
Feeling difficulty to breath	14 (12.2)	2 (4.2)	12 (17.9)	0.026*,[a]
Skin irritation	11 (9.6)	2 (4.2)	9 (13.4)	0.118[a]
Inappropriate pressure	11 (9.6)	6 (12.5)	5 (7.5)	0.522[a]
No benefit was seen	7 (6.1)	1 (2.1)	6 (9.0)	0.236[a]
Unfit mask	6 (5.2)	1 (2.1)	5 (7.5)	0.398[a]

*$P < 0.05$, [a]Fisher's Exact Test, [b]Nonparametric test (Mann-Whitney U test)

Table 2. Clinical data comparing between patients with and without adherence for PAPs use.

Variable	Total (mean, SD) or median (IQR)	Adherence (mean, SD) median (IQR)	Non-adherence (mean, SD) or or median (IQR)	Mean difference, 95% CI	*P* - value
Age, year	57.8 (15.2)	58.5 (13.3)	57.2 (16.5)	1.333 (-4.2, 6.9)	0.633
BMI, kg / m^2	27.9 (7.4)	26.8 (5.6)	28.8 (8.5)	-2.077 (-4.7, 0.5)	0.166
Number of Co - morbidities	2.0 (1.0, 3.0)	1.7 (1.0, 2.0)	1.9 (1.0,3.0)	-0.252 (-0.8, 0.3)	0.414[b]
Number of OSA impacted medication	0.0 (0, 1.0)	0.4 (0, 1.0)	0.6 (0,1.0)	-0.245 (-0.5, 0)	0.039*,[b]
Initial AHI	40.6 (26.0, 69.7)	46.5 (24.9, 69.8)	51.5 (28.3,69.7)	-5.001 (-16.0, 6.1)	0.186[b]
Current AHI	1.5 (0.7, 3.0)	1.9 (0.70, 2.6)	2.5 (0.8, 3.4)	-0.609 (-1.4, 0.2)	0.568[b]
Thai-HADs					
Mean depressive scores	3.2 (3.0)	2.5 (2.5)	3.7 (3.2)	-1.1 (-2.2, -0)	0.046*
Mean anxiety scores	3.8 (3.1)	3.5 (2.8)	4.1 (3.3)	-0.6 (-1.8, 0.6)	0.308

*$P < 0.05$, [a]Fisher's Exact Test, [b]Nonparametric test (Mann-Whitney U test)

Table 3. Logistic regression model of the associations between non-adherence for PAPs use and associated factors.

Associated factors[a]	Odds ratio	95% CI	*P* - value
(Constant)	0.126		0.062
Income less than 30,000 per month	2.957	(1.271 - 6.881)	0.012*
Feeling difficulty to breath	5.260	(1.021 - 27.108)	0.047*
Moderate-severe OSA	6.539	(0.935 - 45.747)	0.059
Use at least one OSA impacted medication	2.307	(0.960 - 5.545)	0.062
Improving of daytime sleepiness	0.459	(0.170 - 1.236)	0.123
Female	1.801	(0.740 - 4.381)	0.195

* $P < 0.05$

The definition of PAP adherence was using of PAPs > 4 hours per night and > 70.0% of nights, 48 patients (41.7%) met the adherence criteria.

The prevalence of depressive symptoms among the patients evaluated by Thai HADS was 1.7%; 50.0% were female, and all of these patients showed non-adherence to PAPs. While the prevalence of anxiety symoptoms is 3.5%; 75.0% were female, and most of them (75.0%) showed non-adherence to PAPs.

The mean depressive scores in the adherence group were 2.54, which was statistically less than the non-adherence group ($P = 0.046$, mean difference-1.115, 95% CI-2.212 to 0.017). The mean anxiety scores in the adherence group were 3.47, which was not statistically different between the two groups with the mean difference of - 0.595 ($P = 0.308$, 95% CI - 1.746 to 0.555) (Table 2).

Using the logistic regression model, with controlling of other factors, patients who had an income less than 30,000 baht per month and reported difficulty to breath during PAPs use were more likely to be non-adherence (ORs = 2.957, *P* - value 0.012, and ORs = 5.260, $P = 0.047$, respectively). There was no association between non-adherence for PAPs use and other factors (improving of daytime sleepiness, hypertension, female gender, use at least one OSA impacted medication, depressive score, anxiety score, and moderate-severe OSA) (Table 3).

Discussion

The aim of this study was to investigate the rate of positive airway pressure adherence, the prevalence of depressive and anxiety symptoms, and the factors associated with positive airway pressure adherence among patients with obstructive sleep apnea. 48 of 115 subjects (41.7%) met the adherence criteria in this study. The prevalence of depressive and anxiety symptoms among subjects were 1.7% and 3.5%, respectively. The mean depressive scores in the adherence group were statistically less than those in the non-adherence group, there were no statistically significance between the two groups in the mean anxiety scores. Factors that were significantly associated with positive airway pressure adherence were income, improvement of daytime sleepiness, usage of OSA impacted medication, number of OSA impacted medication using, and feeling difficulty to breath while using the PAPs machine. By using the multivariate analysis with logistic regression model, the investigators found significant association between lower income (less than 30,000 Baht per month) and the feeling of difficulty to breath while using the PAPs machine with the non-adherence to PAPs use when other covariate factors were controlled.

The positive airway pressure adherence rate from previous studies in the USA and Western countries were 35.3 - 87.5% [14 - 19], and the adherence rate was reported from studies in Asian populations at 38.0 - 89.8%. [9, 20 - 26] The adherence rate found in this study was 41.7%, which was comparable to previous studies. Most studies in USA and Western countries investigated adherence rate in moderate to severe or even only in severe OSA, only one study in Denmark by Jacobsen AR, *et al*. [14] that investigated adherence rate in all severity of OSA and found the adherence rate 78.5%. In Asia, Tan B, *et al*.[9], Hussain JL, et al. [27], Yang MC, *et al*. [22] and Tanahashi T, *et al*. [24] investigated all severity level of OSA and found an adherence rate 38.0 - 78.5%. The studies by Tanahashi T, *et al*.[24] in Japan found the adherence was 38.0%, which was resembled to this study. When compare to the recent studies, There were several differences that may affected the results of this study: 1) The classification and definition of PAPs adherence group that were different between studies, such as the Japan study was classified PAPs adherence groups into 3 groups (non-adherence: not begun or had quit CPAP therapy within 6 months, poor adherence: average CPAP duration < 4 h/night, and good adherence: average CPAP duration > 4 h/night), but this study was classified into 2 groups (non-adherence, and adherence); 2) Time to evaluate PAPs adherence and factors which related to adherence may affected rate of adherence, moreover the associated factors that could be changed overtime. This study investigated the adherence rate in different time after PAPs using, whereas previous studies evaluated at time point after PAPs therapy, such as 6 months. The patients with long term PAPs usage may had adjusted pressure and other factors that affected to

the PAPs use before participating this study. Besides, researchers studied factors which related to adherence at the same time of evaluating the adherence rate, whereas some of previous studies evaluated before undergoing overnight polysomnography for CPAP titration and initiating use of a treatment device.

A previous large cohort study [29], which was retrospective, cross - sectional, and used ICD-9-CM codes to review comorbid psychiatric condition showed the prevalence of comorbid depression and anxiety for Veterans Health Administration beneficiaries with sleep apnea were 21.8% and 16.7%, respectively. Previous systematic review and meta-analysis [4] reported the pooled prevalence of depressive and anxious symptoms in OSA patients as 35.0% and 32.0%, respectively. In this study, the prevalence of depression and anxiety were lower (1.7% and 3.5%, respectively), which could be explained by: 1) This was a cross-sectional study that investigated OSA patients who currently follow-up at PAPs clinic, KCMH. In this group of patients, they tended to have good adherence, moreover the patients were satisfied with PAPs use or experienced better results from the treatment; 2) The apnea hypopnea index of these patients were currently in the normal range (AHI < 5) after PAPs treatment. Means and colleagues [28] reported that treatment of OSA with CPAP reduced depressive symptoms. Furthermore, a systematic review of randomized trials of CPAP therapy in OSA had shown mood improvement after the treatment [29]; 3) Previous studies investigated depression and anxiety using different questionnaires. The studies in the systematic review and meta-analysis [4] used the Beck Depression Inventory (BDI; BDI - II) (31.5%), the Center for Epidemiologic Studies Depression Scale (CES-D) and the Zung Self - Rating Depression Scale (SDS) (9.6% each), the Minnesota Multiphasic Personality Inventory-2 (MMPI - 2), and the Hospital Anxiety and Depression Scale (HADS) (8.2%), while this study used only the Thai - HADS to screen depressive and anxiety symptoms; 4) The major problem of patients who follow-up in PAPs clinic was sleep related disorders, whereas the patients who had major psychiatric disorder tend to evaluate and follow-up at psychiatric clinic; and 5) Because of women are likely to have lifetime prevalence of depression and anxiety disorder more than men (2 : 1; depression and 1.5 : 1; anxiety disorder), and 2/3 of all subjects in this study were male (2/3 of all subjects). [30] So, the different research designs, populations, questionnaires, and time to assessment may cause different outcomes.

Recent studies identified various associated factors with positive airway pressure adherence among patients with OSA, including a systematic review of CPAP adherence across age groups [31], which reported factors that influence adherence to CPAP include disease and patient characteristics, treatment titration procedures, technological device factors and side effects, psychological and social factors. These influential factors have guided the development of interventions to promote CPAP adherence, including educational, technological, psychosocial, pharmacological, and multi-dimensional approaches. Palm A, *et al*. [32] identified risk factors of discontinuation CPAP treatment in patients with OSA. They found that female and coexisting hypertension were the risk factors of discontinuation of CPAP, and the failure of adherence to CPAP was associated with increased mortality rate. A prospective cohort study in Saudi patients [33] identified reasons for patients with obstructive sleep apnea abandoning CPAP use, the most common reason was dislike to CPAP (48.1%), and side effects of CPAP use among patients who were using CPAP at 1, 4, and 10 months. The common side effects in this prospective cohort study were mask discomfort (39.0 - 42.0%), nasal / mouth dryness (35.0 - 36.0%), removing CPAP unknowingly during sleep (15.0 - 17.0%), and mask leak / air leak (16.0%). A cross-sectional study [21] reported that compliance with CPAP therapy was associated with a higher BMI, a higher Epworth sleepiness scale score, a history of witnessed apnea, and a reduction in daytime sleepiness with CPAP therapy. OSA severity assessed by AHI did not affect compliance with CPAP therapy. Use of anti-depressants and CPAP-induced sleep disturbances were associated with poor compliance with CPAP therapy. Several factors that statistically different between adherence and non-adherence groups of patients were found in this study. PAPs adherence patients were found to have higher income, better feeling of daytime sleepiness improvement, OSA impacted medication was not used, less OSA impacted medication use, and less feeling difficulty to breath while using the PAPs machine.

Using multivariate analysis, our study found an association between patients who had income less than 30,000 baht per month and reported difficulty to breath during PAPs use and non-adherence behavior among OSA patients. Patients who had incomes less than 30,000 baht per month had a risk of non-adherence behavior that was approximately three times higher compared to those who had income more than 30,000 baht per month. In the same direction, patients who reported difficulty to breath during PAPs use had a higher risk of non-adherence behavior approximately seven times compared to those who did not report this feeling. Having a low income can affect the decision to buy PAPs machine and other equipment, or even the quality of the products that they can afford. In addition, a low income may also affect the ability to replace products or buy new ones when they were broken after use. The feeling of difficulty to breath during PAPs use is usually sensorial such as the complaint of shortness of breath, difficulty exhaling or not getting enough air, which were one of the most common PAPs machine side effects that may involve in the PAPs use and adherence.

There were many limitations in our study. First, there was small sample size that may not be large enough to explore the association between the associated factors and PAPs adherence. The most important reason was this study conducted under the COVID-19 situation in specific out-patient clinic in single center, which reduced the number of patients in each visit for social distancing policy. Second, this was a cross-sectional study which was able to demonstrate only the correlation between depressive, anxiety symptoms or other factors and PAPs adherence, but unable to show the causality. Third, this study collected data from one visit of each patient, so the adherence rate or even factors that impacted adherence behavior may change over time. Forth, the OSA patients who currently follow-up tended to have good adherence and satisfied with PAPs use or had experienced better results from the treatment. Patients who loss follow-up might have no problem about PAPs use or even who was already abundant to PAPs use. So, the adherence rate found in this study may not represent the real-world data. Fifth, the AHI in participated patients were currently normal (AHI < 5) after PAPs treatment regardless of good adherence or not, and the previous studies had been showed that the treatment of OSA with CPAP improved depression after PAPs treatment. Sixth, patients who had a pre-existing psychiatric disorder and were using psychotropic medication were enrolled in this study. That could confound the result of PAPs adherence and prevalence of depression and anxiety. Seventh, the evaluation using Thai HADS was limited to 1 week prior to that visit, so it was hard to tell whether the subjects' depression and anxiety were temporary or chronic, which could have a different impact on PAPs adherence and could contributed to the low prevalence rate of depression and anxiety in this study. Finally, the factors associated with non-adherence to PAPs use could differ from studies in other countries because of social, cultural, healthcare service, and economic differences.

Conclusion

This is a cross-sectional study of OSA patients currently using PAPs treatment. The adherence rate was 41.7%, and the prevalence of depression and anxiety was lower than in other studies (1.7% and 3.5%, respectively). Associated factors which significantly related to PAPs adherence were income, improving of daytime sleepiness, usage of OSA impacted medication, number of OSA impacted medication, and feeling difficulty to breath while using the PAPs machine. The predictor factors of non-adherence to PAPs treatment were income less than 30,000 baht per month and reported difficulty to breath while using the PAPs machine. Future prospective studies with a larger sample size are suggested to confirm the results of this study and may focus on the socioeconomic burden of starting and continuing to use PAPs without financial support. Adequate educational and supported programs, closed supervision and encouragement by the sleep specialist and other health care providers could improve adherence to PAPs treatment and leading to better outcome. Moreover, adding modern technology to usual care such as active patient engagement (APE) technology can facilitate OSA patient engagement leading to important improvements in adherence to PAPs therapy. [34]

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Conflicts of interest statement

Each of the authors has completed an ICMJE disclosure form. None of the authors declare any potential or actual relationship, activity, or interest related to the content of this article.

Data sharing statement

The present review is based on the references cited. Further details, opinions, and interpretation are available from the corresponding authors on reasonable request

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