Determinants of adherence to continuous positive airway pressure therapy in adults with obstructive sleep apnea

Determinantes de adherencia a presión positiva continua de la vía aérea en adultos con apnea del sueño

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ASBTRACT

Objectives Adherence to continuous positive airway pressure (CPAP) devices in patients with obstructive sleep apnea (OSA) determines the effectiveness of the treatment. Likewise, the assessment of the control of the disease must consider the information referred by the patient, among other value-based health measures related to the satisfaction of the intervention. The objectives of this study were a) Determine the factors related to adherence to CPAP devices in subjects with OSA affiliated to an insurance company of the healthcare system in Colombia. b) Assess symptom control associated to the disease from the individual´s perspective and his/her satisfaction with the treatment received.

Materials and Methods 1,501 subjects with OSA were surveyed by telephone to explore: sociodemographic factors, habits and lifestyles, use of CPAP and its adverse events, control of the disease, comorbidities, access to care and therapy satisfaction. Using multilevel logistic regression techniques, the influence of the various factors on adherence to CPAP was analyzed, using Stata 13 software.

Results Adherence to CPAP therapy was of 58% and the control of symptoms was of 41.7%. The factors that determined the use of CPAP were knowledge on how the device operates, and the disturbances during sleep due to the mask or nasal pad. Therapy satisfaction was predominantly very good or good.

Conclusion Even with moderate adherence values and a good experience with CPAP therapy, symptomatic control of the disease is poor. Many of the factors that affect the use of CPAP are modifiable with a proper approach by the devices´ service provider.

Key Words: Sleep apnea syndromes; continuous positive airway pressure; disorders of excessive somnolence; patient compliance; patient satisfaction (*source: MeSH, NLM*).

RESUMEN

Objetivos La adherencia a los dispositivos de presión positiva continua de la vía aérea (CPAP) en pacientes con síndrome de apnea obstructiva del sueño (SAOS) define la efectividad del tratamiento. Los objetivos de este estudio fueron: a) Determinar los factores relacionados con la adherencia al CPAP en pacientes con SAOS de una aseguradora del Sistema General de Seguridad Social en Salud colombiano y b) evaluar el control de los síntomas de la enfermedad desde la perspectiva del individuo y su satisfacción con la terapia.

Materiales y Métodos Mediante encuesta telefónica a 1 501 pacientes con SAOS se exploraron factores sociodemográficos, hábitos y estilos de vida, uso del CPAP y eventos adversos relacionados, control de la enfermedad, comorbilidad, acceso a la atención y satisfacción con la terapia. Utilizando técnicas de regresión logística multinivel, se analizó la influencia de los distintos factores sobre la adherencia al CPAP mediante el software Stata 13.

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Resultados La adherencia al CPAP fue del 58% y el control de los síntomas del 41,7%. Los factores que determinaron el uso del CPAP fueron el conocimiento del funcionamiento del equipo y la dificultad para dormir debida a la mascarilla o la almohadilla nasal. La satisfacción con la terapia fue buena o muy buena predominantemente.

Conclusiones Aún con valores de adherencia moderados y una buena experiencia con la terapia CPAP, el control sintomático de la enfermedad es pobre, pues varios de los factores afectan el uso del CPAP. Dichos factores se pueden intervenir con un adecuado abordaje por parte del prestador de servicios del dispositivo.

Palabras Clave: Síndromes de la apnea del sueño; presión de las vías aéreas positiva contínua; trastornos de somnolencia excesiva; cooperación del paciente; satisfacción del paciente (*fuente: DeCS, BIREME*).

Obstructive sleep apnea (OSA) is a disorder that affects the quality of life of people that suffer from it, in addition to being an important cardiovascular risk factor (1). The objective of CPAP therapy, as treatment pillar, is to improve the symptoms associated with OSA, such as daytime sleepiness and disturbances in attentions span (2).

The insurance companies of the Colombian Healthcare System have within their roles the comprehensive health risk management of the population insured (3). In EPS Sanitas, an insurance company, there is a growing trend, evident in recent years, of the incidence of OSA along with a poor adherence to CPAP devices and an increase in costs derived from care.

The adherence to CPAP therapy varies between 28 to 83%, with an average long-term adherence rate of 50% (4). Among the factors that determine adherence, the following stand out: age, smoking, OSA severity, modality of the device and tolerance to it. Thus, the study of the determinants of adherence arises as an approach to identify the modifiable factors to guide the design of new health interventions that increase the value in health provided.

The value in Health of the CPAP therapy is measured by the combination of the degree of symptom control achieved and the presentation of secondary adverse events (5). Our hypothesis is that several of the complications associated with the use of CPAP affect the subjects´ adherence to these devices and thus symptom control of the disease.

MATERIALS AND METHODS

Context and population

An observational and prospective cross-sectional study was conducted in adults diagnosed with OSA affiliated to EPS Sanitas and treated with continuous positive airway pressure devices during 2018. In this year, the CPAP user population represented 12,000 cases distributed in the insured population of the country (around 2.5 million people).

In the study population, subjects with clinical suspicion of OSA (increased risk of OSA is indicated by the presence of excessive daytime sleepiness and at least two of the following three criteria: habitual loud snoring; witnessed apnea, gasping, or choking; or diagnosis of hypertension) were evaluated by a polysomnography (PSG) which defines the diagnostic classification and severity of the disease. CPAP therapies were prescribed by a sleep medicine physician, with expertise in the diagnosis and management of adults with OSA, in patients with predominantly moderate to severe OSA [AHI (apnea-hypopnea index) cutoff of ≥15 events/h]. Only subjects with use of CPAP device for at least six months were considered eligible for this study. After the diagnosis, patients were followed up by four different ventilation device providers, all had the same follow up schedule (at first month and subsequently every six months during the first year and annually from the second year on) and the same patient education schemes.

Exclusion criteria were defined by the concomitant presence of other sleep-related disorders, such as central sleep apnea syndromes, sleep-related hypoventilation disorders and sleep-related hypoxemia disorders, restrictive lung diseases, restrictive pathology of the chest, severe heart failure, severe arrhythmias, severe cardiomyopathy, personal history of mental illness, and major cognitive disorders. Patients with severe cardiopulmonary diseases usually are managed in specialized clinics for OSA and they do not represent the vast majority of patients in our insured population requiring CPAP.

Sampling frame

Probabilistic sampling was performed in the defined population based on an estimated sample size for a multivariable logistic regression model. In the calculation a probability of adherence was assumed of 0.35 and an OR of 2.7, for those who do not know how to use the positive pressure device, taking into account an alpha error of 0.05, a power of 0.95 and a r square of 0.1 in a two-tailed test, obtaining an estimate of 230 subjects. This calculation was made using the G*Power 3.1 program of the University of Düsseldorf (6-7).

Collection of data and variables

All participants in the study were asked for their verbal informed consent prior to the completion of the telephone

survey, only those who agreed to participate were included for data analysis. Each of the eligible subjects was reached by telephone by a respiratory therapist who reviewed the last reading of the electronic cards of the CPAP devices. Adherence was considered when the device was used for at least four hours each day for five days of the week (adherent-use threshold).

In the telephone interview a standardized questionnaire was formulated for the collection of sociodemographic characteristics, habits and healthy lifestyles (alcohol, AUDIT-C questionnaire), important medical history, symptoms of the disease (Epworth Sleepiness Scale), adverse events secondary to the use of the CPAP device, knowledge of the device, use of healthcare services in the last year and the degree of satisfaction with the service.

Data analysis

The study variables were described considering their qualitative or quantitative nature. For the first variables, absolute and relative frequencies were calculated; while for the latter, measures of central tendency and dispersion were calculated. To determine the distribution of each of the characteristics according to the level of adherence to the CPAP devices, the chi-square test was used when the variables were categorical; while for the numerical ones the Student t test or Mann-Whitney U test were used, according to the statistical normality of the data.

The possible associations between sociodemographic variables, habits and healthy lifestyles, clinical characteristics, information related to the device and its adverse events and access to services with the level of adherence to CPAP were explored, adjusting a multilevel logistic regression model whose dependent variable was the threshold of adherent use. The model used as independent variables all those characteristics with statistical significance in the bivariable analysis.

As a term of random effects or level variable, the positive pressure device provider was used. To estimate the level effect of the provider, the intraclass correlation coefficient was calculated in order to know the percentage of variation of the response due to the level. The data analysis was carried out through the statistical program Stata 13.

This work has been approved by the Research Ethics Committee of the Fundación Universitaria Sanitas and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All persons gave their verbal informed consent (phone interview) prior to their inclusion in the study.

RESULTS

Between August and December 2018, 1,501 subjects with OSA affiliated to the insurance company nationwide were interviewed. The interviewee, in 5% of the cases, was the main caregiver. Male participants were 53.6% of the sample and average age of all patients was 64.7 years (SD: 13.0 years).

Table 1 shows the characterization of the study population, with a predominance of subjects from the Bogotá Regional of the insurance company. More than half of the subjects were inactive workwise, and only 7% alternated between day and night shifts due to their occupation. The group of single, separated or widowed subjects accounted for a third of the total sample.

In terms of habits and healthy lifestyles, 58% of subjects slept accompanied and 52.2% performed at least 150 minutes of moderate aerobic physical activity per week. The recommended consumption of fruits and vegetables per day was barely seen in one third of the subjects, although the prevalence of tobacco consumption and alcohol risk consumption did not represent more than 5% each (Table 1).

In regards to the use of CPAP, almost a third of respondents were unaware of when the device was functioning properly. Symptoms such as difficulty sleeping due to the mask, nasal or throat discomfort and dry mouth represented the most frequent adverse events due to its use (Table 1). However, the satisfaction with the device reported by the subjects was good or very good in 82% of cases, regular (13%) and bad or very bad (5%).

The level of control of OSA, assessed by the absence of sleepiness referred by the subjects through the Epworth Scale, was observed in 41.7% of respondents. In respect to the associated comorbidity, 79% of subjects were overweight or obese at the time of the interview. Likewise, the first three conditions apart from overweight and obesity accompanying OSA were, in order of frequency, hypertension, upper respiratory tract conditions (recurrent rhinitis, sinusitis or laryngitis) and hypothyroidism (Table 1).

The evaluation of access to healthcare services revealed that 75% of subjects had a visit to the specialist for the management of their disease in the last six months, while 71% of them denied having been seen by respiratory therapy during the last year (Table 1). The level of satisfaction referred of the overall experience with the attention received for the management of OSA was good or very good in 75% of respondents, neutral (14%) and bad or very bad (11%).

Table 1. Characterization of the population with OSA. N=1501

Variable		n (%)
Sociodemographic characteristics		
Regionals (within Colombia)	· Bogotá	1164 (77.5)
	· Barranquilla	33 (2.2)
	· Bucaramanga	27 (1.8)
	· Cali	102 (6.8)
	· Mid-East	64 (4.3)
	· Medellin	111 (7.4)
Ethnicity	· Afro-descendent	9 (0.6)
	· Indigenous	4 (0.3)
	· ROM (Romani)	2 (0.1)
	· Other	1486 (99.0)
Work-shift	· Dayshift	570 (38.0)
	· Nightshift	4 (0.3)
	· Mixed-shift	105 (7.0)
	· Not employed	822 (54.7)
Education	· None/primary education	233 (15.5)
	· Secondary education	408 (27.2)
	· Technical/university	860 (57.3)
Social class/ socioeconomic stratum†	· Stratum 1	25 (1.7)
	· Stratum 2	211 (14.1)
	· Stratum 3	550 (36.6)
	· Stratum 4	423 (28.2)
	· Stratum 5	189 (12.6)
	· Stratum 6	103 (6.8)
Marital status	· Married	850 (56.6)
	· Separated	128 (8.5)
	· Single	200 (13.3)
	· Civil union	139 (9.3)
	· Widower	184 (12.3)
Healthy habits and lifestyles		
Smoke (any consumption)	· No	1427 (95.1)
	· Yes	74 (4.9)
Alcohol	· No	1421 (94.7)
	· Yes	80 (5.3)
Ventilation device		
Provider	· Provider 1	413 (27.5)
	· Provider 2	251 (16.7)
	· Provider 3	517 (34.5)
	· Provider 4	320 (21.3)
Knows how to start/ operate de device	· No	82 (5.5)
	· Yes	1419 (94.5)
Knows how to connect the mask/ nasal pad to the device	· No	84 (5.6)
	· Yes	1417 (94.4)
Knows how to adjust the mask/nasal pad to the face	· No	88 (5.9)
	· Yes	1413 (94.1)
Knows when the device is not working properly	· No	469 (31.2)
	· Yes	1032 (68.8)
Use of vibrating positional device	· No	1494 (99.5)
	· Yes	7 (0.5)
Use of mandibular advancement device	· No	1491 (99.3)
	· Yes	10 (0.7)
Satisfaction with the positive pressure device		
Adverse events related to the device		
Difficulty sleeping due to the mask/ nasal pad	· No	913 (60.8)
	· Yes	588 (39.2)
Excessive noise that prevents sleep	· No	1248 (83.1)
	· Yes	253 (18.9)
Nasal/throat symptoms	· No	908 (60.5)
	· Yes	593 (39.5)
Dry mouth	· No	970 (64.6)
	· Yes	531 (35.4)
Skin events	· No	1263 (84.1)
	· Yes	238 (15.9)
Ocular symptoms	· No	1222 (81.4)
	· Yes	279 (18.6)
Abdominal distension	· No	1179 (78.6)
	· Yes	322 (21.4)
Chest or sinus discomfort or difficulty exhaling	· No	1267 (84.4)
	· Yes	234 (15.6)
The partner complains about the use of the device	· No	637 (42.4)
	· Yes	247 (16.5)
	· Sleeps alone	617 (41.1)

Variable		n (%)
Sociodemographic characteristics		
Comorbidities		
Body Mass Index	· Under weight	4 (0.3)
	· Normal	310 (20.7)
	· Overweight	697 (46.4)
	· Obesity	490 (32.6)
Arterial hypertension	· No	671 (44.7)
	· Yes	830 (55.3)
Diabetes mellitus	· No	1189 (79.2)
	· Yes	312 (20.8)
Cerebrovascular disease	· No	1427 (95.1)
	· Yes	74 (4.9)
Recurrent rhinitis, sinusitis or laryngitis	· No	1005 (67.0)
	· Yes	496 (33.0)
Asthma	· No	1400 (93.3)
	· Yes	101 (6.7)
COPD (Chronic Obstructive Pulmonary Disease)	· No	1237 (82.4)
	· Yes	264 (17.6)
Hypothyroidism	· No	1035 (68.9)
	· Yes	466 (31.1)
Use of sedatives or tranquilizers	· No	1231 (82.0)
	· Yes	270 (18.0)
Access		
Respiratory therapy consultation	· 3 months ago	283 (18.9)
	· 6 months ago	59 (3.9)
	· A year ago	42 (2.8)
	· More than a year ago	47 (3.1)
	· None	1070 (71.3)
General medicine consultation	· 3 months ago	182 (12.1)
	· 6 months ago	26 (1.7)
	· A year ago	11 (0.7)
	· More than a year ago	12 (0.8)
	· None	1270 (84.6)
Specialized medicine consultation	· 3 months ago	769 (51.2)
	· 6 months ago	361 (24.1)
	· A year ago	178 (11.8)
	· More than a year ago	139 (9.3)
	· None	54 (3.6)
Have you attended an OSA management education workshop?	· 3 months ago	93 (6.2)
	· 6 months ago	51 (3.4)
	· A year ago	59 (3.9)
	· More than a year ago	233 (15.5)
	· None	1065 (71.0)
Do you attend a cardiovascular risk program?	· 3 months ago	188 (12.5)
	· 6 months ago	19 (1.3)
	· A year ago	12 (0.8)
	· More than a year ago	50 (3.3)
	· None	1232 (82.1)

†A socioeconomic stratum equal to six is an indicator of the maximum level of income of a family in Colombia, while stratum one reflects the worst socioeconomic condition.

In 670 (44.6%) subjects, information about the level of adherence was obtained by the registered reading of the electronic CPAP card. From these records, 57.9% of the sample population used the device for at least four hours in 70% or more of the previous 90 nights. While 79.5% of respondents reported, in the telephone interview, using CPAP for at least four hours, 5 days or more per week. The type of device most used was CPAP (82.7%), followed by Auto CPAP (8.6%), bilevel positive airway pressure (BPAP) (6.1%), and others (2.6%).

Table 2 provides the bivariable analysis resulting from the relationship between each of the factors studied and the adherence to the CPAP devices determined by the electronic record of the device. Age was the only demographic factor significantly associated with adherence to

CPAP, the proportion of subjects over 45 years was higher in the adherent groups. On the other hand, habits such as the consumption of fruits and vegetables, exercise and use of tobacco and alcohol were not associated with a greater or worse adherence to positive pressure devices.

Regarding the variables related to the CPAP, the device provider and the ability to operate the equipment were significantly associated with their adherence; meanwhile knowledge on how to adjust the mask to the face lingered at borderline of statistical significance (Table 2).

Three of the adverse events studied in relation to the use of CPAP devices showed a statistically significant association with the adherence to the device therapy. Thus, the proportion of subjects with difficulty sleeping due to the mask or nasal pad was higher in the non-adherent group, compared to the adherent group. Likewise, the non-adherent group referred ocular, chest and sinus discomforts or difficulty exhaling in higher frequency (Table 2).

None of the variables related to comorbidity showed a significant association with subjects' adherence to CPAP. However, in terms of access to services for the care of OSA, the specialized medicine visit in the last six months was a factor associated with adherence to the device. The proportion of subjects with a recent visit to the specialist was higher in the group of adherent subjects compared with non-adherent. The other variables of the care model studied were not associated with adherence to CPAP (Table 2).

Table 2. Bivariate analysis between the analyzed factors and CPAP adherence

Variable	Non-adherent n (%)	Adherent n (%)	P value
Sociodemographic characteristics	n=282	n=388	
Sex			
· Male	138 (48.9)	209 (53.9)	0.207
· Female	144 (51.1)	179 (46.1)	
Age			
· 18-44 years	27 (9.6)	21 (5.4)	0.039
· ≥45 years	255 (90.4)	367 (94.6)	
Regional (within Colombia)			
· Bogotá	225 (79.8)	322 (83.0)	
· Barranquilla	6 (2.1)	5 (1.3)	
· Bucaramanga	3 (1.1)	4 (1.0)	0.797
· Cali	18 (6.4)	24 (6.2)	
· Mid-East	11 (3.9)	9 (2.3)	
· Medellin	19 (6.7)	24 (6.2)	
Ethnicity			
· Afro/indigenous/ROM	3 (1.1)	3 (0.8)	0.693
· Other	279 (98.9)	385 (99.2)	
Workshift			
· Dayshift	111 (39.4)	127 (32.7)	
· Night/Mixed-shift	23 (8.2)	27 (7.0)	0.129
· Not employed	148 (52.4)	234 (60.3)	
Education			
· None/primary education	45 (16.0)	61 (15.7)	
· Secondary education	72 (25.5)	117 (30.2)	0.406
· Technical/university	165 (58.5)	210 (54.1)	
Social class/socioeconomic stratum			
· Stratum 1 y 2	44 (15.6)	62 (16.0)	
· Stratum 3	99 (35.1)	136 (35.0)	0.976
· Stratum 4	86 (30.5)	113 (29.1)	
· Stratum 5 y 6	53 (18.8)	77 (19.9)	
Marital status			
· Married	159 (56.4)	223 (57.5)	
· Separated	25 (8.9)	37 (9.6)	
· Single	38 (13.4)	51 (13.1)	0.979
· Civil union	23 (8.2)	32 (8.2)	
· Widower	37 (13.1)	45 (11.6)	
Healthy habits and lifestyles			
Sleeps accompanied			
· No	130 (46.1)	178 (45.9)	0.954
· Yes	152 (53.9)	210 (54.1)	
Exercise			
· <150 min/week	138 (48.9)	185 (47.7)	0.748
· ≥150 min/week	144 (51.1)	203 (52.3)	
Nutrition			
· <5 servings of fruits and vegetables/day	198 (70.2)	264 (68.0)	0.549
· ≥5 servings of fruits and vegetables/day	84 (29.8)	124 (32.0)	
Smoke (any consumption), n (%)			
· No	270 (95.7)	364 (93.8)	0.274
· Yes	12 (4.3)	24 (6.2)	
Alcohol			
· No	198 (70.2)	264 (68.0)	0.549
· Yes	84 (29.8)	124 (32.0)	

Variable	Non-adherent n (%)	Adherent n (%)	P value
Sociodemographic characteristics	n=282	n=388	
Ventilation device			
Provider			
· Provider 1	54 (19.1)	81 (20.9)	0.011
· Provider 2	59 (20.9)	79 (20.4)	
· Provider 3	93 (33.0)	162 (41.7)	
· Provider 4	76 (27.0)	66 (17.0)	
Knows how to start/operate the device			
· No	20 (7.1)	11 (2.8)	0.010
· Yes	262 (92.9)	377 (97.2)	
Knows how to connect the mask/nasal pad to the device			
· No	17 (6.0)	16 (4.1)	0.261
· Yes	265 (94.0)	372 (95.9)	
Knows how to adjust the mask/nasal pad to the face			
· No	20 (7.1)	15 (3.9)	0.064
· Yes	262 (92.9)	373 (96.1)	
Knows when the device is not working properly			
· No	96 (34.0)	116 (29.9)	0.255
· Yes	186 (66.0)	272 (70.1)	
Use of vibrating positional device			
· No	280 (99.3)	386 (99.5)	0.748
· Yes	2 (0.7)	2 (0.5)	
Use of mandibular advancement device			
· No	280 (99.3)	385 (99.2)	0.924
· Yes	2 (0.7)	3 (0.7)	
Adverse events related to the device			
Difficulty sleeping due to the mask/nasal pad			
· No	150 (53.2)	260 (67.0)	<0.001
· Yes	132 (46.8)	128 (33.0)	
Excessive noise prevents sleep			
· No	234 (83.0)	333 (85.8)	0.313
· Yes	48 (17.0)	55 (14.2)	
Nasal/throat symptoms			
· No	165 (58.5)	238 (61.3)	0.460
· Yes	117 (41.5)	150 (28.7)	
Dry mouth			
· No	171 (60.6)	245 (63.1)	0.509
· Yes	111 (39.4)	143 (36.9)	
Skin events			
· No	229 (81.2)	324 (83.5)	0.439
· Yes	53 (18.8)	64 (16.5)	
Ocular symptoms			
· No	213 (75.5)	320 (82.5)	0.028
· Yes	69 (24.5)	68 (17.5)	
Abdominal distention			
· No	214 (75.9)	315 (81.2)	0.097
· Yes	68 (24.1)	73 (18.8)	
Chest or sinus discomfort or difficulty exhaling			
· No	228 (80.8)	343 (88.4)	0.007
· Yes	54 (19.2)	45 (11.6)	
The partner complains about the use of the device			
· No/sleeps alone	239 (84.8)	321 (82.7)	0.486
· Yes	43 (15.2)	67 (17.3)	
Comorbidities			
Body Mass Index			
· Under weight	2 (0.7)	1 (0.3)	0.684
· Normal	56 (19.9)	76 (19.6)	
· Overweight/obesity	224 (79.4)	311 (80.1)	
Arterial hypertension			
· No	128 (45.4)	159 (41.0)	0.255
· Yes	154 (54.6)	229 (59.0)	
Diabetes mellitus			
· No	226 (80.1)	299 (77.1)	0.339
· Yes	56 (19.9)	89 (22.9)	
Cerebrovascular Disease			
· No	268 (95.0)	370 (95.4)	0.845
· Yes	14 (5.0)	18 (4.6)	
Recurrent rhinitis, sinusitis or laryngitis			
· No	179 (63.5)	268 (69.1)	0.129
· Yes	103 (36.5)	120 (30.9)	
Asthma			
· No	263 (93.3)	366 (94.3)	0.569
· Yes	19 (6.7)	22 (5.7)	
COPD			
· No	231 (81.9)	308 (79.4)	0.414
· Yes	51 (18.1)	80 (20.6)	
Hypothyroidism			
· No	182 (64.5)	256 (66.0)	0.699
· Yes	100 (35.5)	132 (34.0)	
Use of sedatives or tranquilizers			
· No	225 (79.8)	326 (84.0)	0.157
· Sí	57 (20.2)	62 (16.0)	

Variable	Non-adherent n (%)	Adherent n (%)	P value
Sociodemographic characteristics	n=282	n=388	
Access			
Respiratory therapy consultation · <6 months · >6 months/never	76 (26.9) 206 (73.1)	110 (28.3) 278 (71.7)	0.760
General medicine consultation · <6 months · >6 months/never	52 (18.4) 230 (81.6)	62 (16.0) 326 (64.0)	0.403
Specialized medicine consultation · <6 months · >6 months/never	216 (76.6) 66 (23.4)	322 (83.0) 66 (17.0)	0.040
Have you attended an OSA management education workshop? · <6 months · >6 months/never	37 (13.1) 245 (86.9)	41 (10.6) 347 (89.4)	0.309
Did you attend a cardiovascular risk program? · <6 months · >6 months/never	29 (10.3) 253 (89.7)	56 (14.4) 332 (85.6)	0.111

The multivariable analysis of the data was based on a maximum model containing the variables of: age, sex, ability to operate the equipment, ability to adjust the mask/nasal pad to the face, difficulty sleeping due to the mask/nasal pad, ocular symptoms, abdominal distension, chest or paranasal sinuses discomforts or difficulty exhaling, and specialized medicine consultation; considering as a level variable the CPAP service provider.

Only two of the factors of the maximum model were significantly related to subject's adherence to positive pressure devices, and two of them remained at borderline of statistical significance (Table 3). The ability to operate the equipment almost tripled the adherence odds (OR: 2.90; 95% CI: 1.32 to 6.38) compared to those who did not know how to operate it; while those that referred difficulty sleeping due to the mask/nasal pad reduced adhesion odds by 41%, compared to those that did not present this discomfort (Table 3).

On the other hand, being 45 years of age or older increased the odds of adherence to CPAP by 70%, compared with subjects 18 to 44 years of age, and presenting chest or sinus discomfort or difficulty exhaling decreased adhesion odds by 36%; although these effects were barely kept at borderline of statistical significance (Table 3).

Table 3. Multivariate analysis of the determinants of adherence to CPAP. N=670

Variable	Adherence OR (IC 95%)	P value
Sex · Male · Female	10.80 (0.58 a 1.11)	0.182
Age · 18-44 years · ≥45 years	11.79 (0.97 a 3.31)	0.063
Knows how to start/operate the device · No · Yes	12.90 (1.32 a 6.38)	0.008
Difficulty sleeping due to the mask/nasal pad · No · Yes	10.59 (0.42 a 0.82)	0.002
Chest or sinus discomfort or difficulty exhaling · No · Yes	10.64 (0.41 a 1.02)	0.061

The final model described was adjusted by the CPAP service provider as a level variable with a statistically significant residual intraclass correlation of 2.08% (95% CI 0.30 to 12.76). That is, the CPAP provider explains around 2% of the variability in the level of adherence.

DISCUSSION

Among the most relevant findings of this study, 58% of subjects with OSA used the CPAP device for at least 4 horas, 70% or more of the nights, reaching a control of daytime sleepiness of 41.7% of the sample analyzed. The factors associated with the adherence to these devices were the ability to operate the equipment and the difficulty sleeping due to the mask or nasal pad.

Likewise, the observed prevalence of overweight and obesity, arterial hypertension and diabetes mellitus concomitant with OSA itself as cardiovascular risk factors in the study population stand out. However, subjects referred low involvement in cardiovascular risk programs as well as education workshops for OSA management.

Similarly, the use of complementary forms of intervention to CPAP therapy, such as mandibular advancement devices were reported by less than 1% of the study population. However, the perceived satisfaction of the care received and the CPAP therapy itself was valued as good or very good primarily.

There are several reasons that can explain the level of adherence observed. Adverse events secondary to the use of the positive pressure devices affected a significant proportion of subjects in this study, which may not have been intervened successfully by the device provider during the subject´s adaptation process. However, the level of adherence found is within the limits published by other authors in the literature, which range between 41.6% and 78%(8-10).

As in our work, authors such as Baratta et al.(8) and Bazurto et al. (11) have also assessed the main discomforts derived from the use of CPAP involved in discontinuation of therapy. These authors found that the complaints most

frequently referred by subjects were upper airway symptoms (e.g. nasal) and those related to the facial mask (e.g. pressure). The latter closely linked to low adherence in our study. Unlike the findings of this work, several previously published studies have identified that cardiovascular risk factors, such as hypertension(12), history of myocardial infarction and cerebrovascular events8 and smoking (8-9) constitute independent risk factors for poor adherence to CPAP.

In regards to the health value provided by CPAP therapy in subjects with OSA, the published results on the control of daytime sleepiness, measured using the Epworth Sleepiness Scale, show a frequency of symptomatic sleepiness of up to 58% of cases in subjects with different severity levels of the disease (13-14). In our work, severe excessive daytime sleepiness affected 46% of adults with OSA, similar to that observed by Bostokeky et al. (13) after one to six months of treatment with CPAP in adults with severe disease.

The level of satisfaction with CPAP therapy has also been a subject of study in different publications. A survey of more than 3,000 users of these devices in France revealed that overall satisfaction was good or excellent in 90% of subjects (15). Likewise, in a clinical trial in Sweden in which two follow-up alternatives were compared in subjects with OSA, satisfaction with CPAP reached 99% in both groups (16). Although these values are higher than those observed in this study, the results of our work show a great consistency between the overall satisfaction with the CPAP and the one referred with the attention received for the management of OSA.

Although several of the adverse events secondary to the use of CPAP have been described in this study, other factors that determine adherence such as the knowledge of the risk derived from the disease and the perceptions and expectations regarding the therapy were not addressed by the interviews. Future analyzes of this nature, especially of a qualitative nature, could reveal other direct causes that explain poor adherence in certain groups of subjects.

In the Broström et al. (17) study some of the barriers identified in CPAP users consisted of negative attitudes prior to and during the therapy, based on feelings of doubt regarding the certainty of the diagnosis and the need for CPAP therapy. Some subjects experienced shame at the need for treatment with CPAP and its use in the presence of other people.

The accessibility of information from the automatic readings of the electronic cards of the devices leads to the question of whether the subjects from which no information on the use of CPAP was obtained, the levels of adherence and their associated factors were the same as those found in the analyzed sample. However, in terms of the sample estimate made, the n studied was sufficient for the proposed objectives.

Considering the low involvement in cardiovascular programs in the study population, as well as the low participation of educational activities for the management of OSA, some questions are proposed that can be addressed by practice and research: Is the program offer, in health education and prevention aimed at patients with OSA, sufficient? Is the population with the disease aware of the value of treating their condition? Do patients with OSA know the risk of unwanted cardiovascular events or death? and finally, are the causes of non-compliance to available therapies by patients known and addressed by healthcare services?

It is well known how mandibular advancement devices an alternative to CPAP in subjects with mild and moderate OSA are, helping to prevent snoring and excessive daytime sleepiness (18-19). Even these devices are as effective as CPAP in terms of the benefit on quality of life (sleepiness and functional and cognitive outcomes), according to a recent meta-analysis of randomized controlled clinical trials; effect attributed to a lower adherence of subjects to CPAP devices (20).

Despite the above, in our study the use of mandibular advancement devices referred by subjects was very low, setting a favorable scenario for the inclusion of this technology to achieve cost-effective results in the population with OSA.

In conclusion, even with moderate adherence values and a good experience with CPAP therapy, the symptomatic control of the disease remains poor. The main factors associated with adherence were the subjects´ ability to operate the equipment and the adverse effects due to the mask or nasal pad; both factors modifiable with a proper approach by the devices´ service provider (e.g., reading the level of adherence, education about the use of CPAP or adjusting the face mask) ♣

Conflicts of interest: None.

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