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Frequency of use and preferences for information and communication technologies in patients with sleep apnea: A multicenter, multinational, observational cross-sectional survey study

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ABSTRACT

Background: Obstructive sleep apnea (OSA) is a condition characterized by repeated episodes of partial or complete obstruction of the upper airway during sleep. An accessible method to facilitate self-management education is through information and communication technologies (ICTs).
Purpose: To assess the frequency of and preferences for ICT use in patients with sleep apnea.
Methods: A multicenter, multinational, observational cross-sectional survey study was conducted between 2018 and 2019 in sleep units in different countries of Latin America, including patients of both genders older than 18 years with a diagnosis of sleep apnea. Participants were asked to complete 20 questions in a self-administered survey about the frequency of use of ICTs and their preferences for receiving disease-related information.
Results: A total of 435 patients participated in the study, with a mean age of 59.1 ± 14.0; 62.5% (n = 272) were males. Most patients had access to cellphones (92.4%, n = 402), smartphone (83.0%, n = 361) and an internet connection (82.3%, n = 358). One-to-one ICTs were regarded as the most frequently used ICT type, as 75.4% (n = 328) of participants reported using them daily ($\chi 2(4) = 848.207$, p =.000). With respect to categories of interest, one-to-one ICTs were also the best rated ICT type to receive (59.1%, n = 257; $\chi 2(2) = 137.710$, p =.000)

Abbreviations: ICTs, Information and Communication Technologies; WHO, World Health Organization; OSA, Obstructive sleep apnea; CPAP, Continuous positive airway pressure; SME, Self-management education; PSG, Polysomnography; HST, Home sleep test; AHI, Apnea-hypopnea index; SMS, Short message service; COPD, Chronic obstructive pulmonary disease.

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and ask physicians (57.0%, n = 248; $\chi 2(2) = 129.145$, p =.000) information about OSA. Finally, older adults and those with lower educational levels were found to be less likely to use and be interested in ICTs.
Conclusion: Most patients have access to different ICTs and often use them to seek and receive medical information. The preferred ICTs include those in the one-to-one category (WhatsApp, email) and the one-to-many category (web browsers) for general health and OSA-related information.

1. Introduction

Obstructive sleep apnea (OSA) is a condition characterized by repeated episodes of partial or complete obstruction of the upper airway during sleep [1]. The current literature demonstrates that OSA is a highly prevalent disorder [2–6]. Continuous positive airway pressure (CPAP) is the first-line therapy for moderate to severe OSA and involves the use of a small motorized unit that delivers pressurized air through a mask, stabilizing the upper airway during sleep [7]. However, treatment success depends on CPAP adherence, which is highly variable [8,9].

Self-management education (SME) is a recommended strategy in chronic diseases, as it can help in achieving a successful treatment and alleviating depression and anxiety [10,11]. The use of the internet is increasing progressively, and most patients with chronic disorders use the internet to obtain information about their conditions [12]. An accessible method to facilitate SME is through information and communication technologies (ICTs). ICTs are broadly defined as technologies used to communicate, manipulate and store data by electronic means. They include e-mail, SMS text messaging, video chat (i.e., Skype), and online social media (i.e., Facebook or Twitter) as well as all the different computing and mobile-type devices (smartphones and tablets) that perform a wide range of communication and information functions [13]. Compared to face-to-face communication, the use of ICTs reduce the challenges associated with cultural diversity and decision making. Therefore, the selection and implementation of particular ICTs could facilitate global virtual communication and decision making [14].

We hypothesized that patients with sleep apnea would have a high use of ICTs, especially those that offer the opportunity to share health behaviors and coping experiences, social support, or recommendations for living with sleep apnea. This study aimed to assess the frequency of and preferences for ICT use in patients with sleep apnea.

2. Methods

2.1. Study design

This was a multicenter, multinational, observational cross-sectional survey study conducted between 2018 and 2019 in sleep units in different countries of Latin America, including 2 centers in Argentina (Buenos Aires), 4 centers in México (México City), 1 center in Perú (Lima) and 1 center in Colombia (Bogotá). Adult patients with sleep apnea were recruited and completed a self-administered survey under supervision by trained staff [15].

2.2. Ethical considerations

This study was approved by the ethics committee *"Comité de ética e Investigación en Seres Humanos (CEISH)"*, Guayaquil-Ecuador (#HCK-CEISH-18-0060), and subsequently reviewed by a committee for each participating center. All study procedures were performed in accordance with the ethical standards described in the 1964 Declaration of Helsinki and its later amendments. All patients gave their written informed consent to participate in the study, and confidentiality of their data was guaranteed. Finally, it is worth mentioning that privacy regulations in the surveyed countries would allow for the type of public information exchange and use of the studied ICTs.

2.3. Participants and eligibility criteria

Patients of both genders were included if they agreed to participate in the study, were older than 18 years, and had a diagnosis of sleep apnea established by a sleep test, polysomnography (PSG) or home sleep test (HST) performed in a sleep laboratory or at home. A diagnosis of sleep apnea was considered when the apnea-hypopnea index (AHI) was $\geq$ 5/hour [16].

We excluded patients who had other sleep disturbance diseases (insomnia, restless leg syndrome, parasomnia, narcolepsy), who had intellectual disabilities that presented difficulties for understanding and participating in the study, or who opted to not participate.

2.4. Sample size

Sample size was calculated using G*Power Version 3.1.9.4. In this study, we set the parameters for the test with the highest sample size requirement, which was an X2 test. By considering a small effect size (w = 0.2), a power of 0.80, an α error probability of 0.05 and 4 degrees of freedom, the calculated sample size was 299 participants. Moreover, adjusting our calculation to an anticipated non-response rate of 20% resulted in a final sample size for our study of 374. As a final step, the sample size was expanded to 435 patients to overcome potential type II errors (missing data, unbalanced groups, etc.). This resulted in a power of 0.93. Participants were recruited through convenience sampling.

The questionnaire assessed the frequency of use of social media and technology by patients and their preferred ICTs for receiving disease-related information. It also collected demographic information (age, gender, education level, occupation, marital status) and information on their time with the disease (OSA patients were asked about the use of social digital networks for all purposes and specifically related to searching for information on health and diseases, as well as their preference when receiving or requesting information from their doctors).

2.5. Questionnaire

We applied a survey designed for similar previous studies in populations of urticaria, COPD, and asthma patients [15,17,18]. A committee of sleep experts developed an adapted version for patients with sleep apnea. Participants were asked to complete the 20-question self-administered survey during their stay in each sleeping unit, supervised by trained staff. The survey asked if participants had access to cellphones, smartphones and internet in a dichotomic fashion (yes or no). Then, the questionnaire inquired about the frequency of use of each technology (SMS, Facebook, Twitter, LinkedIn, Email, web browser, WhatsApp, YouTube, Instagram, Skype and Blogs) which participants answered by selecting one of the following options: daily, not daily but at least once a week, not weekly but at least once a month, not monthly but at least once a year and never. The survey also assessed the patients' interest in both, receiving and asking physicians for information regarding obstructive sleep apnea through each of the ICTs, by asking them to quantify it as follows: not interested, slightly interested, moderately interested, very interested and extremely interested.

For data analysis, the variable age was categorized into: "*young adults*" (18–40 years old), "*average adults*" (41–65 years old) and "*elderly adults*" (>65 years old), while education level was classified as: "*no education/primary education*", "*secondary education*" and "*tertiary education*" (undergraduate, graduate and postgraduate). Furthermore, ICTs

were arranged into one of the following three types: "*one-to-one*" (dialogic): SMS, WhatsApp, Skype, and email; "*one-to-many*" (informative): YouTube, web browsers and blogs or forums; and "*many-to-many*" (social): Instagram, Twitter, Facebook, and LinkedIn. In addition, frequency of use was dichotomized as "*at least once a week*" (daily and not daily but at least once a week) and "*less than once a week*" (not weekly but at least once a month, not monthly but at least once a year and never). Finally, the categories of interest in receiving and asking physicians for information about OSA were rearranged to describe participants as being either "*very-to-extremely interested*" (very interested and extremely interested) or "*not very-to-extremely interested*" (not interested, slightly interested and moderately interested).

2.6. Risk of bias

Data collectors were trained on the content of the survey by the researchers. They were able to satisfy the doubts of participants during the study execution. The analysis was carried out by independent researchers.

2.7. Statistical analysis

Continuous variables are reported as the mean ± standard deviation (SD) or median with interquartile range. Nominal variables are reported as numbers and percentages. Differences between nominal variables were tested using the $\chi 2$. Specifically, a chi-square goodness of fit test was performed to determine if the observed distribution of the categories of ICT use frequency by technology type and categories of interest to receive and ask physicians about OSA information differed from the expected distribution. Afterwards, a chi-square test of independence was run to determine if there was an association between the categorical independent variables age and education level and the dependent dichotomic variables cellphone access, smartphone access, internet access, frequency of use of each specific ICT and interest in receiving and asking physicians about OSA information. A Fisher's exact text was applied in case an assumption was violated. All tests were two-tailed, and p values < 0.05 were considered statistically significant. All statistical analyses were carried out using SPSS V.24 software (SPSS Inc., Chicago, IL, USA).

3. Results

The analytical sample included 435 patients whose mean age was 59.1 ± 14.0; 62.5% (n = 272) were males. Approximately, half of the participants had tertiary education (48.0%, n = 209) and most were urban residents (96.3%, n = 419). Regarding clinical information, the average time of obstructive sleep apnea diagnosis was 2.7 ± 3.8 years which had been mostly managed with CPAP (79.1%, n = 344). The most common comorbid conditions were hypertension (35.4%, n = 154) and diabetes (18.6%, n = 81). A better description of the surveyed population's demographics and clinical characteristics is presented in Table 1.

In general, most of the sample had access to a cellphone (92.4%, n = 402), smartphone (83.0%, n = 361) and an internet connection (82.3%, n = 358). One-to-one ICTs were regarded as the most frequently used ICT type, as 75.4% (n = 328) participants reported using them daily ($\chi^2(4) = 848.207$, $p = .000$) (Fig. 1). In terms of specific ICTs, WhatsApp (71.7%, n = 312), web browsers (48.7%, n = 212) and e-mail (43.7%, n = 190) were the highest rated for daily use (Fig. 2). With respect to categories of interest, one-to-one ICTs were also the best rated ICT type to receive (59.1%, n = 257; $\chi^2(2) = 137.710$, $p = .000$) and ask physicians (57.0%, n = 248; $\chi^2(2) = 129.145$, $p = .000$) information about OSA (Fig. 3). Whilst e-mail (54.7%, n = 238) was the preferred ICT among patients to receive information about OSA, it was WhatsApp (55.2%, n = 240) the best ranked technology to ask physicians about their condition.

Table 1
Characterization and demographics of the sample by countries ($n = 435$).

	Country				
	Argentina	Colombia	Mexico	Peru	Total
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Cases (*n*, %)	91 (20.9)	31 (7.1)	211 (48.5)	102 (23.4)	435 (100)
Age (mean, SD)	65.8 (12.7)	67.4 (11.1)	59.0 (13.1)	51.0 (13.2)	59.1 (14.0)
Gender					
Male	53(58.3)	25 (81.4)	114 (54.1)	83 (81.4)	272 (62.5)
Female	38 (41.7)	6 (18.6)	97 (45.9)	19 (18.6)	163 (37.5)
Education level					
No education/ Primary education	32 (35.2)	1 (3.2)	55 (26.1)	1 (1.0)	89 (20.5)
Secondary education	47 (51.6)	14 (45.2)	64 (30.3)	12 (11.7)	137 (31.5)
Tertiary education	12 (13.2)	16 (51.6)	92 (43.6)	89 (87.3)	209 (48.0)
Employment status					
Active worker	17 (18.7)	11 (35.5)	91 (43.1)	91 (89.2)	210 (48.3)
Unemployed/ retired/disabled	69 (75.8)	13 (41.9)	69 (32.7)	4 (3.9)	155 (35.6)
Student/ homemaker	5 (5.5)	7 (22.6)	51 (24.2)	7 (6.9)	70 (16.1)
Years since OSA diagnosis (mean, SD)	2.8 (2.5)	6.6 (3.3)	2.9 (4.1)	1.1 (3.5)	2.7 (3.8)
Treatment					
CPAP	84 (92.3)	24 (77.4)	160 (75.8)	75 (73.5)	344 (79.1)
BPAP	0 (0.0)	3 (9.7)	9 (4.3)	0 (0.0)	12 (2.7)
DAM	2 (2.2)	0 (0.0)	2 (0.9)	9 (8.8)	12 (2.7)
Positional	0 (0.0)	0 (0.0)	0 (0.0)	4 (3.9)	4 (0.9)
No treatment	5 (5.5)	4 (12.9)	40 (18.9)	14 (13.7)	63 (14.5)
Comorbidities					
Hypertension	18 (19.8)	10 (32.3)	91 (43.1)	18 (17.6)	154 (35.4)
Diabetes	14 (15.4)	4 (12.9)	51 (24.2)	8 (7.8)	81 (18.6)
Other	35 (38.5)	11 (35.5)	35 (16.6)	28 (27.5)	88 (20.2)
No comorbidities	24 (26.3)	6 (19.3)	34 (16.1)	48 (47.1)	112 (25.7)

With respect to age groups, elderly adults reported the lowest proportion of cellphone (68.3%, n = 112; $\chi^2(2) = 42.334$, $p = .000$), smartphone (67.7%, n = 111; $\chi^2(2) = 40.983$, $p = .000$) and internet access (85.4%, n = 140; $\chi^2(2) = 19.347$, $p = .000$). There were statistically significant differences in the frequency of use in all ICTs, except for SMS messaging, across the age categories. WhatsApp was the most used ICT by the three age groups ($\chi^2(2) = 45.011$, $p = .000$); however, the proportion of use was lower in older adults (57.9%, n = 95). Furthermore, it was systematically observed that the proportion of those interested in using different ICTs to either receive and ask physicians information about OSA was lowest in elderly adults and highest, for nearly all associations, in young adults. Associations considering age groups as an independent variable versus the outcomes of interest are best reported in Table 2.

On the other hand, analyses considering education level as the independent variable resulted in patients with primary or no education presenting the lowest proportions of mobile (55.1%, n = 49; $\chi^2(2) = 77.525$, $p = .000$) and smartphone (52.8%, n = 47; $\chi^2(2) = 79.025$, $p = .000$) ownership as well as of internet access (74.2%, n = 66; $\chi^2(2) = 53.913$, $p = .000$). WhatsApp was the most used ICT by the three education groups ($\chi^2(2) = 71.889$, $p = .000$); however, the percentage of use

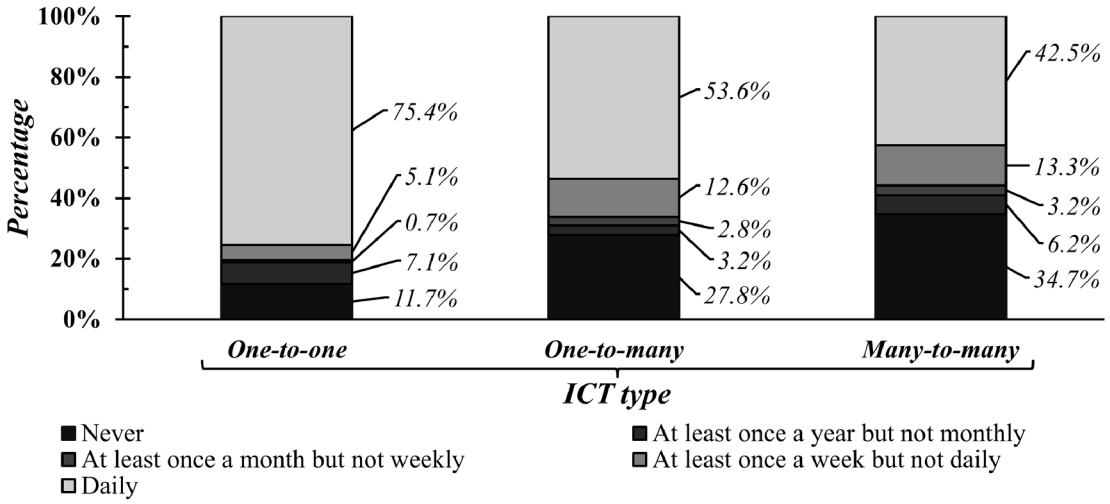

Fig. 1. Frequency of use of each ICT type in the surveyed population.

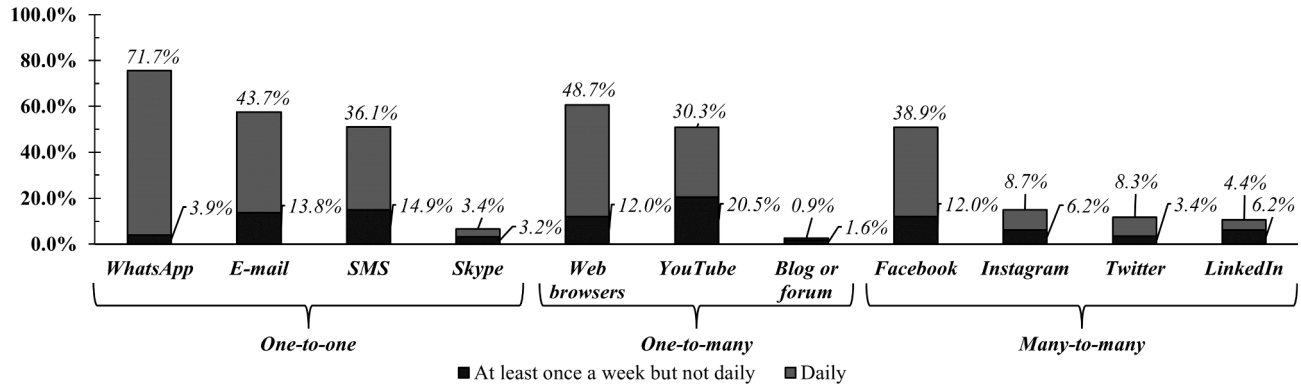

Fig. 2. Frequency of use of each individual ICT in the surveyed population.

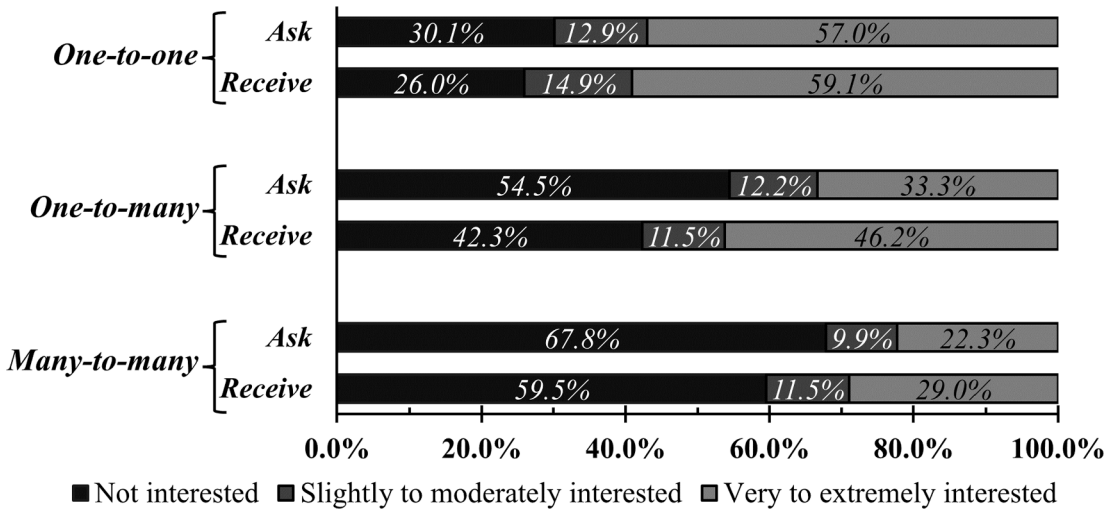

Fig. 3. Interest in receiving and asking physicians information about OSA trough each ICT type.

was lower in those with primary or no education (47.2%, n = 42). It was observed that the proportion of interest for receiving and asking physicians information about OSA through ICTs was lowest for every technology in patients with primary or no education. Statistically significant differences between education groups and the outcomes of interest are best reported in Table 3.

4. Discussion

This study is the first to demonstrate the ICT usage habits of patients with OSA in patients from Latin America, and our results indicate that almost all patients use ICT platforms. To obtain general health and OSA-related information, ICTs in the one-to-one (WhatsApp, email) and one-

Table 2
Frequency of use and interests in ICT according to age range.

	AGE									
	Young adults		Average adults		Elderly adults		Chi-square[a]	*p* value	Total	
	n	%	*n*	%	*n*	%			*n*	%
Internet	38	100.0%	224	96.1%	140	85.4%	19.347	0.000	402	92.4%
Cellphone	38	100.0%	211	90.6%	112	68.3%	42.334	0.000	361	83.0%
Smartphone	38	100.0%	209	89.7%	111	67.7%	40.983	0.000	358	82.3%
Using ICTs at least once a week										
SMS	18	47.4%	125	53.6%	78	47.6%	1.624	0.444	221	50.8%
Facebook	32	84.2%	136	58.4%	53	32.3%	44.729	0.000	221	50.8%
Twitter	6	15.8%	38	16.3%	7	4.3%	14.148	0.001	51	11.7%
LinkedIn	9	23.7%	32	13.7%	5	3.0%	19.188	0.000	46	10.6%
E-mail	30	78.9%	158	67.8%	62	37.8%	43.314	0.000	250	57.5%
Web browsers	33	86.8%	163	70.0%	68	41.5%	44.692	0.000	264	60.7%
WhatsApp	34	89.5%	200	85.8%	95	57.9%	45.011	0.000	329	75.6%
YouTube	32	84.2%	147	63.1%	42	25.6%	72.690	0.000	221	50.8%
Instagram	16	42.1%	41	17.6%	8	4.9%	36.421	0.000	65	14.9%
Skype	7	18.4%	17	7.3%	5	3.0%	12.036	0.002	29	6.7%
Blog or forum	4	10.5%	6	2.6%	1	0.6%	12.313	0.002	11	2.5%
At least some interest in receiving information through ICTs										
SMS	14	36.8%	74	31.8%	52	31.7%	0.414	0.813	140	32.2%
Facebook	21	55.3%	90	38.6%	33	20.1%	24.116	0.000	144	33.1%
Twitter	6	15.8%	24	10.3%	7	4.3%	7.367	0.025	37	8.5%
LinkedIn	5	13.2%	21	9.0%	4	2.4%	9.020	0.011	30	6.9%
E-mail	29	76.3%	151	64.8%	58	35.4%	41.513	0.000	238	54.7%
Web browsers	28	73.7%	125	53.6%	50	30.5%	32.955	0.040	203	46.7%
WhatsApp	23	60.5%	129	55.4%	72	43.9%	6.423	0.040	224	51.5%
YouTube	22	57.9%	96	41.2%	31	18.9%	31.587	0.000	149	34.3%
Instagram	10	26.3%	26	11.2%	6	3.7%	19.457	0.000	42	9.7%
Skype	4	10.5%	19	8.2%	6	3.7%	4.124	0.127	29	6.7%
Blog or forum	3	7.9%	20	8.6%	4	2.4%	6.446	0.040	27	6.2%
At least some interest in asking physicians information through ICTs										
SMS	13	34.2%	82	35.2%	44	26.8%	3.194	0.202	139	32.0%
Facebook	19	50.0%	89	38.2%	23	14.0%	34.766	0.000	131	30.1%
Twitter	6	15.8%	24	10.3%	5	3.0%	10.216	0.006	35	8.0%
LinkedIn	3	7.9%	18	7.7%	3	1.8%	6.870	0.032	24	5.5%
E-mail	27	71.1%	149	63.9%	51	31.1%	47.570	0.000	227	52.2%
Web browsers	21	55.3%	110	47.2%	48	29.3%	16.220	0.000	179	41.1%
WhatsApp	23	60.5%	149	63.9%	68	41.5%	20.158	0.000	240	55.2%
YouTube	15	39.5%	66	28.3%	29	17.7%	10.206	0.006	110	25.3%
Instagram	5	13.2%	24	10.3%	5	3.0%	8.674	0.013	34	7.8%
Skype	6	15.8%	22	9.4%	6	3.7%	8.142	0.017	34	7.8%
Blog or forum	3	7.9%	22	9.4%	6	3.7%	4.902	0.086	31	7.1%

[a] Chi-square test results are significant at the 0.05 significant level.

to-many (web browsers) categories are preferred, with older adults and those with a lower educational level using ICTs the least in general.

The characteristics of this population were similar to those described in previous studies carried out in Latin America in terms of age, gender, marital status, education level, CPAP treatment and prevalence of comorbidities [5,19–24]. In this study, more than eighty percent of patients had used ICTs via mobile devices, smartphones, or the internet. A similar result was observed in a study carried out in Ecuador with patients with hypertension [25]. Regarding the frequency of use, in all categories (daily, more than once a week and once a week), the most used ICTs were those in the one-to-one category, specifically WhatsApp and email, followed by those in the one-to-many category, where web browsers were the most prevalent. Maurer et al., evaluating the use of ICTs in individuals with urticaria, found the same distribution, with the difference being that email was used more than WhatsApp. Regarding the use of many-to-many ICTs, Facebook was the most commonly used, again coinciding with previous studies.

Calderon et al. evaluated the use of technologies in patients with asthma from five Latin American countries and observed that SMS messaging was used by all ages, while Facebook, WhatsApp and Twitter were more frequently used in young and adult patients. As we observed in our sample, patients with higher educational levels tended to be more interested in using ICTs. Another study, also in Latin America [18], analyzed the use of ICTs in people with COPD and showed that SMS messaging and email were useful for developing future strategies to improve COPD outcomes. On the other hand, more recent social media, such as Facebook and WhatsApp, would be useful for younger COPD patients.

In our study, the percentage of participants who used ICTs to receive medical information or to ask questions to their physicians was lower in individuals with up to elementary education levels and older adults. Our results are similar to those of previous studies carried out with patients with respiratory disorders [17,18]. Our study yields important results by showing that a high proportion of older adults use ICTs, even those with the lowest percentages of use.

Arrua et al. conducted a three-month randomized study to assess ICT-based out-of-hospital management of OSA compared to inpatient management [26]. The study focused on the cost-effectiveness approach in terms of telemedicine-based ICT. The patients were randomized into an ICT group or a classical in-hospital group with respiratory polygraphy, polysomnography, or home respiratory polygraphy, CPAP titration, and treatment with hospital follow-up. The trial results suggested

Table 3
Frequency of use and interests in ICT according to education level.

	EDUCATION LEVEL									
	No education/ Primary education		Secondary education		Tertiary education		Chi-square[a]	*p* value	Total	
	n	%	*n*	%	*n*	%			*n*	%
Internet	66	74.2%	131	95.6%	205	98.1%	53.913	0.000	402	92.4%
Cellphone	49	55.1%	110	80.3%	202	96.7%	77.525	0.000	361	83.0%
Smartphone	47	52.8%	111	81.0%	200	95.7%	79.025	0.000	358	82.3%
Using ICTs at least once a week										
SMS	27	30.3%	66	48.2%	128	61.2%	24.410	0.000	221	50.8%
Facebook	25	28.1%	64	46.7%	132	63.2%	32.050	0.000	221	50.8%
Twitter	2	2.2%	11	8.0%	38	18.2%	17.952	0.000	51	11.7%
LinkedIn	0	0.0%	4	2.9%	42	20.1%	39.049	0.000	46	10.6%
E-mail	13	14.6%	65	47.4%	172	82.3%	125.238	0.000	250	57.5%
Web browsers	20	22.5%	69	50.4%	175	83.7%	107.123	0.000	264	60.7%
WhatsApp	42	47.2%	95	69.3%	192	91.9%	71.889	0.000	329	75.6%
YouTube	18	20.2%	59	43.1%	144	68.9%	63.962	0.000	221	50.8%
Instagram	3	3.4%	15	10.9%	47	22.5%	20.458	0.000	65	14.9%
Skype	1	1.1%	4	2.9%	24	11.5%	15.279	0.000	29	6.7%
Blog or forum	0	0.0%	4	2.9%	7	3.3%	2.965	0.227	11	2.5%
At least some interest in receiving information through ICTs										
SMS	23	25.8%	43	31.4%	74	35.4%	2.674	0.263	140	32.2%
Facebook	17	19.1%	43	31.4%	84	40.2%	12.803	0.002	144	33.1%
Twitter	1	1.1%	8	5.8%	28	13.4%	14.019	0.001	37	8.5%
LinkedIn	1	1.1%	4	2.9%	25	12.0%	16.345	0.000	30	6.9%
E-mail	13	14.6%	63	46.0%	162	77.5%	105.832	0.000	238	54.7%
Web browsers	13	14.6%	61	44.5%	129	61.7%	56.042	0.000	203	46.7%
WhatsApp	29	32.6%	72	52.6%	123	58.9%	17.333	0.000	224	51.5%
YouTube	14	15.7%	44	32.1%	91	43.5%	21.842	0.000	149	34.3%
Instagram	1	1.1%	14	10.2%	27	12.9%	10.028	0.007	42	9.7%
Skype	2	2.2%	6	4.4%	21	10.0%	7.786	0.020	29	6.7%
Blog or forum	3	3.4%	7	5.1%	17	8.1%	2.846	0.241	27	6.2%
At least some interest in asking physicians information through ICTs										
SMS	19	21.3%	47	34.3%	73	34.9%	5.803	0.055	139	32.0%
Facebook	16	18.0%	42	30.7%	73	34.9%	8.689	0.013	131	30.1%
Twitter	2	2.2%	8	5.8%	25	12.0%	9.278	0.010	35	8.0%
LinkedIn	2	2.2%	5	3.6%	17	8.1%	5.488	0.064	24	5.5%
E-mail	15	16.9%	60	43.8%	152	72.7%	83.734	0.000	227	52.2%
Web browsers	12	13.5%	53	38.7%	114	54.5%	43.961	0.000	179	41.1%
WhatsApp	26	29.2%	73	53.3%	141	67.5%	37.214	0.000	240	55.2%
YouTube	13	14.6%	36	26.3%	61	29.2%	7.127	0.028	110	25.3%
Instagram	2	2.2%	9	6.6%	23	11.0%	7.076	0.029	34	7.8%
Skype	3	3.4%	8	5.8%	23	11.0%	6.133	0.047	34	7.8%
Blog or forum	4	4.5%	5	3.6%	22	10.5%	7.084	0.029	31	7.1%

[a] Chi-square test results are significant at the 0.05 significant level.

that the satisfaction and feasibility of the patients/physicians in the first 17 patients were good; however, one of the 9 ICT patients dropped out at follow-up. Overall, the trial found that ICT strategies can lead to cost-effective OSA management procedures and can improve physician and patient satisfaction [26].

Salvemini et al. conducted a systematic review to assess the effects of ICTs on patient care with sleep issues [27]. The systematic review included a total of 11 articles with three categories identified in the results. These included 1) virtual coaches, 2) internet-delivered cognitive behavioral therapy for insomnia, and 3) sleep technologies. Considering that the mean age of the participants in our study was approximately 59 years, the findings by Salvemini et al. support the notion that technological applications can rehabilitate elderly people with sleep issues while reducing caregiver burden, improving the quality of life for families and finally reducing healthcare costs by reducing the need for premature institutional care [27]. Large-scale studies (i.e., rigorous clinical trials) using similar frameworks as our study are required to truly understand the role of ICTs and advanced technologies across a spectrum of disorders not limited to sleep apnea.

4.1. Limitations and recommendations

Our study has some limitations. First, this is a cross-sectional study; therefore, cause-and-effect relationships cannot be made. Second, the study was not conducted in all Latin American countries, and the preferred use of social media in other countries could differ significantly. Additionally, the study population included patients accessing the public health system. It is well known that the rate of poverty in this region is high, and in this social stratum, access to health care and ICTs could be potentially worse. The accessibility of ICTs differs between centers from different countries, which could have directly affected the results. Also, the definition applied to web browsers could also have led to overlap with other ICT, as well as conflating interactive technologies with others that are more straightforward and informational in nature. Finally, although the survey has not been validated, we built it based on previous studies with the same objective. Thus, we leave the interpretation of the results to the reader's discretion.

On the other hand, this study has some strengths. First, we recruited a broad sample of adult OSA patients with an adequate sample size, including participants of different age, sex, and educational level. Moreover, this is the first study that relates OSA patients to the use of

ICTs. It must be noted that we carried out research in before the COVID-19 pandemic. A survey carried out during or after the pandemic would be interesting to evaluate the evolution of these indicators. An increase in the use of ICTs could reasonably be expected.

Future studies should investigate how to develop and promote more effective social media-based resources to engage OSA patients in self-management, especially in persons with up to elementary education levels and older adults. It may be possible to develop applications in response to the specific requirements of each patient in different countries. However, it is indisputable that the widespread use of social networks opens new possibilities for the relationship between physicians and patients and improves communication in both directions.

5. Conclusion

In this study, we found that the majority of OSA patients used ICTs to search for, request or receive medical information, with older adults and those with lower educational levels showing lower percentages of use. ICTs in the one-to-one (WhatsApp, email) and one-to-many (web browsers) categories were preferred. Further studies are needed to assess if ICT related strategies can improve coping mechanisms, positive health behaviors, and more social inclusion for patients with OSA.

Ethics approval and consent to participate: We received ethical committee approval from Comité de ética e Investigación en Seres Humanos (CEISH), Guayaquil-Ecuador (#HCK-CEISH-18-0060). All study procedures were performed in accordance with the ethical standards described in the 1964 Declaration of Helsinki and its later amendments. All patients gave their written informed consent to participate in the study, and confidentiality of their data was guaranteed.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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CRediT authorship contribution statement

Veronica R. Jaritos: Conceptualization, Methodology, Supervision, Resources. **Emanuel Vanegas:** . **Juan Facundo Nogueira:** Data curation, Methodology, Visualization, Resources. **Sebastian Leiva Agüero:** Data curation, Methodology, Visualization, Resources. **Vanina Giovini:** Data curation, Methodology, Visualization, Resources. **Jorge Rey de Castro:** Data curation, Methodology, Visualization, Resources. **Yadira Rodríguez Reyes:** Data curation, Methodology, Visualization, Resources. **José Luis Carrillo Alduenda:** Data curation, Methodology, Visualization, Resources. **Pammela Torres Gittaim:** Data curation, Methodology, Visualization, Resources. **Zaira Romero:** Data curation, Methodology, Visualization, Resources. **Guadalupe Terán Pérez:** Data curation, Methodology, Visualization, Resources. **María Angélica Bazurto:** Data curation, Methodology, Visualization, Resources. **Azza Sarfraz:** Writing – original draft, Writing – review & editing, Investigation, Methodology. **Zouina Sarfraz:** Writing – original draft, Writing – review & editing, Investigation, Methodology. **María José Farfán Bajaña:** Writing – original draft, Writing – review & editing, Investigation, Methodology. **Hans Mautong:** Writing – original draft, Writing – review & editing, Investigation, Methodology. **Miguel Felix:** Writing – original draft, Writing – review & editing, Investigation, Methodology. **Ivan Cherrez- Ojeda:** Conceptualization, Methodology, Supervision, Resources, Writing – original draft, Writing – review & editing, Investigation, Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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