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ORIGINAL RESEARCH

Adherence to Inhalation Devices in Patients with Chronic Obstructive Pulmonary Disease

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Purpose: Chronic obstructive pulmonary disease (COPD) affects millions of people around the world. Poor adherence to treatment contributes to increased severity of symptoms, morbidity, and mortality. The objective of this study was to establish the adherence of patients diagnosed with COPD by their devices for inhalation in a group of patients, Colombia.

Patients and Methods: This was a cross-sectional study of patients treated in the Colombian health system. Adherence to inhalation devices was evaluated with the TAI-10 instrument (Inhaler Adherence Test). A score of 50 points was considered good adherence.

Results: A total of 500 patients from 84 cities were identified, with a median age of 79.0 years, and 59.2% were women. A total of 45% had GOLD B COPD, and 56.6% had good adherence. Average adherence was 47.4±5.3 points, and no significant differences were found according to inhalation devices (p=0.949). Training performed by specialist physicians (OR: 1.75; 95% CI: 1.17–2.62), use of an inhaler for less than 1 year (OR: 1.59; 95% CI: 1.04–2.43), use of short-acting β2-adrenergic agonists (OR: 1.58; 95% CI: 1.05–2.38) and increased satisfaction with the inhalation device (OR: 1.09; 95% CI: 1.04–1.14) were associated with good adherence, while those from the central region (OR: 0.55; 95% CI: 0.36–0.83), who had a COPD evolution time of less than 5 years (OR: 0.57; 95% CI: 0.37–0.98) and had diabetes mellitus (OR: 0.60; 95% CI: 0.37–0.98) had lower adherence.

Conclusion: Adherence to treatment with inhaled bronchodilators and glucocorticoids were not very high, with no significant differences by type of inhalation device. Satisfaction and training by specialists increased adherence.

Keywords: pulmonary disease, chronic obstructive, medication adherence, bronchodilator agents, devices, inhalation, pharmacoepidemiology

Introduction

Chronic obstructive pulmonary disease (COPD) include a group of progressive diseases that are characterized by the obstruction of airflow and that leads to the appearance of chronic respiratory symptoms such as cough and dyspnea.[1] It is a common disease and the worldwide prevalence is 10.3%, which corresponds to more than 390 million people.[2] In Latin America, the prevalence is 8.9%.[3] Currently, this pathology is among the main causes of death in the world,[1,4] and most of these deaths occur in low- and middle-income countries.[1] Furthermore, it ranks fifth in terms of disease burden.[4]

COPD management involves different therapeutic groups, highlighting inhaled therapy using β_2-adrenergic agonists, antimuscarinics, and, to a lesser extent, glucocorticoids.[1,4] These therapies have been shown to control chronic symptoms, reduce exacerbations and hospitalizations, improve quality of life and exercise tolerance.[1,4,5] Different types of inhalation devices are available, including the pressurized metered dose inhaler, single-dose dry powder inhaler, multidose dry powder inhaler and the soft mist inhalers.[6,7] Inhalation devices allow the drug to reach the lower respiratory tract.[6,7] However, an adequate inhalation technique is required to have a good therapeutic response.[8]

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Thus, adherence to bronchodilator drugs or inhaled glucocorticoids is very important in patients with COPD, because lack of adherence is related to worsening symptoms, increased risk of exacerbations and hospitalizations, and impaired quality of life and higher mortality.[9] The World Health Organization (WHO) has identified that poor adherence to the treatment of chronic non-communicable diseases constitutes a barrier that prevents achieving better health results and increases the costs of the health system.[10] Various factors affect the degree of adherence, such as sociodemographic factors (eg, age, level of education, income), clinical factors (eg, duration of the disease, severity, comorbidities, quantity of medications) and psychological factors (eg, depression, negative beliefs, satisfaction with treatment).[9,11] Specific adherence to inhalers can be evaluated using the Test of the Adherence to Inhalers (TAI).[12] The tool contains 10 items scored on a five-point Likert scale, which classifies patient adherence to treatment as good (50 points), intermediate (46–49 points) or poor (≤ 45 points), and is validated in Spanish.[12]

The Colombian Health System has a health benefits plan that provides universal coverage to all people through two regimes (contributory and subsidized). The contributory regime is paid between people with a labor contract and their employers, independent workers with the ability to pay and pensioners (private). While the subsidized regime is paid by the State (free). The health benefits plan is the same for both regimens and includes a significant number of drugs for the treatment of COPD, and with different inhalation devices. However, the pharmacoepidemiological information that addresses this pathology in the country is limited,[13] and the factors that may influence the adherence to treatment of these patients are unknown. Therefore, the objective of this study was to establish the adherence of patients diagnosed with COPD by their devices for inhalation in a group of patients, Colombia.

Methods

Study Design and Patients

An observational cross-sectional study was conducted on adherence to inhalation devices used by patients with a diagnosis of COPD who were being managed with inhaled bronchodilators or glucocorticoids. The patients were identified from a drug dispensing database that collects information from approximately 9.2 million people affiliated with the Colombian Health System who were insured by four health insurance companies. These patients constituted approximately 25.3% of the population affiliated with the contributory insurance scheme and 13.1% of the state-subsidized scheme. Together, these patients comprised 18.8% of the Colombian population.

From this population, cases in pharmacological management with at least one bronchodilator or inhaled glucocorticoid were identified between March 1 and 31, 2023. Those with a diagnosis of COPD were selected using the codes of the International Classification of Diseases, version 10 (ICD-10): J410, J411, J418, J420, J431, J432, J438-J441, J448, and J449. Individuals were eligible for the study if they were age 40 or older, of either sex and any city of residence. Subjects with a concomitant or previous diagnosis (in the past year) of bronchial asthma and those who were being treated only with oral pharmaceuticals were excluded.

During the study period, a total of 19,851 people who met the previously established criteria were identified. For the characterization of the inhalation devices, all patients were considered. To evaluate adherence, satisfaction and other sociodemographic, clinical and pharmacological variables phone calls were made. The number of 500 patients was determined at convenience, but their selection was carried out randomly. The participants were assigned to one of five strata according to type of inhalation device (metered-dose inhalers with short-acting bronchodilators, metered-dose inhalers with long-acting bronchodilators, single-dose dry powder inhaler, multidose dry powder inhaler and soft mist inhaler). The patients were selected using the Epidat 4.2 program, which conducted stratified randomized sampling and assigned an equal number for each stratum. The decision to have equal strata was made in order to avoid very small subgroups. Participants had provided informed consent and were notified by phone about their selection.

Variables

With the information obtained from the patient and the medications dispensed by the company Audifarma SA, a database was designed that allowed the following groups of variables to be collected:

1. Sociodemographic variables: sex, age, education, occupation, health system scheme (contributory or subsidized) and city of residence. The place of residence was categorized by departments according to the regions of Colombia, considering the classification of the National Administrative Department of Statistics (DANE) of Colombia, as follows: Caribbean region, Central region, Bogotá-Cundinamarca region, Pacific region and Eastern-Orinoquia-Amazon region.
2. Clinical variables:
   - Chronic obstructive pulmonary disease: current/former smoker, time of evolution of the disease, degree of dyspnea (mMRC-modified Medical Research Council-: <2 or ≥2 points), number of complications and hospitalizations in the past year and classification (GOLD-Global Initiative for Chronic Obstructive Lung Disease-: A, B or E).
   - Comorbidities: Conditions were identified from the main and secondary diagnoses reported by the ICD-10 in the selected patients.
3. Pharmacological variables:
   - Classification of devices: Pressurized metered-dose inhalers, single-dose or multidose dry powder inhalers, and soft mist inhalers.
   - Therapeutic group: short-acting (salbutamol, fenoterol) and long-acting β_2 adrenergic agonists (formoterol, salmeterol, vilanterol, indacaterol, olodaterol), short-acting (ipratropium) and long-acting muscarinic antagonists (tiotropium, glycopyrronium, umeclidinium), and glucocorticoids (beclomethasone, budesonide, fluticasone).
   - Training methods: demonstration, video, verbal instructions for use, information leaflet, others.
   - Training given by general practitioner, specialist physician (pulmonologist, internist, geriatrician, family member), others (nurse, respiratory therapist, pharmacist) or any health professional.
   - Device adherence: The Test of the Adherence to Inhalers (TAI)-10 instrument was used. Supplementary Table 1 shows the questions contained in the instrument.[12] A TAI-10 of 50 points was considered good adherence, a TAI-10 of 46–49 points was considered intermediate adherence, and a TAI-10 ≤45 points was considered poor adherence.[12]
   - Device satisfaction: This was determined by the Test of the Adherence to Inhalers (FSI) instrument −10. Supplementary Table 2 shows the questions contained in the instrument.[14] An FSI-10 ≥44 points was considered high satisfaction.[15,16]
   - Comedications: They were grouped into the following categories: a) antidiabetic drugs (oral and subcutaneous), b) antihypertensive and diuretic drugs, c) lipid-lowering drugs, d) antiulcer drugs, e) antidepressants, f) anxiolytics and hypnotics, g) thyroid hormone, h) antipsychotics, i) antiepileptics, j) antithrombotics, and k) analgesics and anti-inflammatories, among others.

Ethical Statement

The protocol was approved by the Bioethics Committee of the Technological University of Pereira in the category of research without risk (Endorsement code: 01–100220). The ethical principles established by the Declaration of Helsinki were respected. Oral informed consent was obtained from selected patients prior to the interviews.

Statistical Analysis

The data were analyzed with the statistical package SPSS Statistics, version 26.0 for Windows (IBM, USA). A descriptive analysis was performed with frequencies and proportions for the qualitative variables and measures of central tendency and dispersion for the quantitative variables, using means (standard deviation) and medians (interquartile range). The comparison of quantitative variables was performed using Student's *t*-tests or ANOVA and χ^2 or Fisher's exact test for categorical variables. A multivariate binary logistic regression model was developed that included the associated variables in the bivariate analyses, as well as those with sufficient plausibility or reported association to identify those that could be related to good adherence (TAI-10 of 50 points) (if/no). The Hosmer–Lemeshow test was performed to describe the goodness of fit. The predictive capacity of the model was determined according to the area under the curve (AUC). A level of statistical significance was established at $p<0.05$.

Results

Inhalation Device Use Pattern

Of the 19,851 patients with COPD, the majority used metered-dose inhalers (n=11,692; 58.9%), followed by multidose dry powder inhalers (n=7231; 36.4%), single dose dry powder inhalers (n=4515; 22.7%) and soft mist inhalers (n=3346, 16.9%).

Sociodemographics

In total, calls were made to 1545 patients to reach the sample of 500 participants. Those patients who did not answer the phone call or refused to participate in the study were excluded. The 500 patients who were selected came from 84 cities. The majority were women, and the median age was 79.0 years (range: 40.0–104.0 years). A total of 10.6% (n=53) were ages 40–64, 29.0% (n=145) were ages 65–74, 31% (n=155) were ages 75–84 and 29.0% (n=147) were age 85 or older. Most of the patients came from the central region (n=177, 35.4%), followed by the Bogotá-Cundinamarca region (n=160, 32.0%), the Pacific region (n=95, 19.0%), the Caribbean region (n=49; 9.8%) and the Eastern-Orinoquía-Amazon region (n=19; 3.8%). The education of most of the patients was primary (n=242; 48.4%) or secondary (n=106; 21.2%), and their main occupation was household activities (n=122; 24.4%). Most of the patients were affiliated with the contributory regime, and only 22.2% (n=111) were affiliated with the subsidized regime of the Colombian health system (Table 1).

Chronic Obstructive Pulmonary Disease and Comorbidities

The evolution time of COPD was 8.0 years (range:0–45 years). A total of 76.2% of the patients had dyspnea mMRC ≥2 points, and 45.8% (n=229) had presented exacerbations of their pathology in the past year. The average number of exacerbations that did not require hospitalization was 0.8±1.3 (range: 0–5), and the average number of hospitalizations was 0.3±0.7 (range: 0–4). Most of the patients were classified as COPD GOLD B, followed by GOLD E. A total of 62.2% (n=311) had a history of smoking. A total of 33.6% (n=168) were home oxygen users. The main comorbidities that were identified were hypertension (n=371, 74.2%), followed by diabetes mellitus (n=97, 19.4%), hypothyroidism (n=50, 10.0%), osteoarthritis (n=47; 9.4%) and anxiety disorders (n=44; 8.8%).

Therapy for Chronic Obstructive Pulmonary Disease and Comedications

The patients were being managed mainly with long-acting β_2 adrenergic agonists (n=263; 52.6%), followed by long-acting muscarinic antagonists (n=236; 47.2%), β_2 adrenergic agonists of short-acting (n=194, 38.8%), short-acting muscarinic antagonists (n=182, 36.4%) and inhaled glucocorticoids (n=172, 34.4%). The most frequently used comedications in the previous three months were antihypertensives and diuretics (n=351, 70.2%), analgesics or anti-inflammatories (n=299, 59.8%), lipid-lowering drugs (n=269, 53.8%), antiulcer (n=253; 50.6%) and antithrombotic medications (n=199; 39.8%).

Inhalation Devices

A total of 95.6% (n=478) of the patients stated that they received training to learn how to use the inhalation device, mainly through demonstration (n=361; 72.2%) and oral instructions for use (n=175; 35.0%), by pulmonologists (n=178; 35.6%), general practitioners (n=172; 34.4%) or internists (n=104; 20.8%) (Table 1). A total of 41.0% (n=205) had been using their inhalation devices for less than 1 year, 31.8% (n=159) 1 to 4 years, and 26.4% (n=132) for 5 or more years.

Adherence and Satisfaction

According to the TAI-10 questionnaire, 56.6% (n=283) of the patients had good adherence. The average adherence score was 47.4±5.3, and no significant differences were found between the different inhalation devices (p=0.949). Table 2 shows the score obtained for each item by type of inhalation device. Responses to the FSI-10 questionnaire indicated that 84.2% (n=421) of the patients were highly satisfied with their devices (≥44 points), and there were no significant differences between inhalation devices (p=0.759). Table 3 shows the score obtained for each item of the FSI-10 instrument by type of inhalation device.

Table 1 Comparison of the Type of Inhaler with Some Sociodemographic, Clinical and Pharmacological Variables, in Patients Diagnosed with Chronic Obstructive Pulmonary Disease, Colombia

Variables	Total		Metered Dose Inhalers[a]		Metered Dose Inhalers[b]		Multi-Dose Dry Powder Inhalers		Single-Dose Dry Powder Inhalers		Soft Mist Inhaler	
	n=500	%	n=100	%	n=100	%	n=100	%	n=100	%	n=100	%
Sociodemographic	–	–	–	–	–	–	–	–	–	–	–	–
Woman	281	59.2	63	63.0	60	60.0	54	54.0	44	44.0	60	60.0
Age; median (IQR)[c]	79.0 (70.0–86.0)		78.5 (70.0–86.8)		78.0 (69.0–85.0)		77.5 (70.0–84.0)		79.0 (71.0–85.0)		81.0 (70.3–88.0)	
Primary education	242	48.4	51	51.0	44	44.0	55	55.0	50	50.0	42	42.0
Active occupation	217	43.4	41	41.0	38	38.0	50	50.0	42	42.0	46	46.0
Contributory regime	389	77.8	77	77.0	75	75.0	81	81.0	79	79.0	77	77.0
Clinic	–	–	–	–	–	–	–	–	–	–	–	–
Diagnostic time (years); median (IQR)	8.0 (4.0–11.0)		8.0 (4.0–12.8)		7.5 (3.0–10.8)		8.0 (4.0–11.0)		7.5 (4.0–11.0)		8.0 (3.0–13.0)	
mMRC[d] ≥2 points	381	76.2	78	78.0	77	77.0	78	78.0	74	74.0	74	74.0
Exacerbations in the past year	186	37.2	35	35.0	40	40.0	42	42.0	29	29.0	40	40.0
Hospitalizations in the last year	114	22.8	21	21.0	24	24.0	27	27.0	19	19.0	23	23.0
GOLD[e] classification	–	–	–	–	–	–	–	–	–	–	–	–
A	94	18.8	17	17.0	20	20.0	13	13.0	20	20.0	24	24.0
B	225	45.0	49	49.0	48	48.0	44	44.0	46	46.0	38	38.0
E	181	39.2	34	34.0	32	32.0	43	43.0	34	34.0	38	38.0
Use of home oxygen	168	33.6	27	27.0	33	33.0	42	42.0	32	32.0	34	34.0
Comorbidities	–	–	–	–	–	–	–	–	–	–	–	–
Cardiovascular	376	75.2	83	83.0	74	74.0	74	74.0	72	72.0	73	73.0
Endocrine	181	36.2	37	37.0	41	41.0	35	35.0	28	28.0	40	40.0
Rheumatologic	88	17.6	12	12.0	20	20.0	23	23.0	15	15.0	18	18.0

(*Continued*)

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Table 1 (Continued).

Variables	Total		Metered Dose Inhalers[a]		Metered Dose Inhalers[b]		Multi-Dose Dry Powder Inhalers		Single-Dose Dry Powder Inhalers		Soft Mist Inhaler	
	n=500	%	n=100	%	n=100	%	n=100	%	n=100	%	n=100	%
Pharmacological	–	–	–	–	–	–	–	–	–	–	–	–
Type of training received	–	–	–	–	–	–	–	–	–	–	–	–
Demonstration	361	72.2	76	76.0	70	70.0	70	70.0	68	68.0	77	77.0
Verbal instructions for use	175	35.0	34	34.0	34	34.0	36	36.0	42	42.0	29	29.0
Information leaflet	25	5.0	7	7.0	6	6.0	5	5.0	0	0.0	7	7.0
Video	11	2.2	2	2.0	3	3.0	2	2.0	3	3.0	1	1.0
Professional who carried out the training	–	–	–	–	–	–	–	–	–	–	–	–
Medical specialist	281	56.2	58	58.0	52	52.0	49	49.0	56	56.0	66	66.0
General practitioner	172	34.4	37	37.0	42	42.0	38	38.0	33	33.0	22	22.0
Others	71	14.2	14	14.0	11	11.0	14	14.0	16	16.0	16	16.0
Usage time with the device (years); median (IQR)	2.0 (1.0–5.0)		2.0 (0.6–5.0)		3.0 (1.0–5.0)		2.0 (1.0–5.0)		2.0 (1.0–4.8)		2.0 (1.0–4.0)	

Notes: [a]Short-acting bronchodilators; [b]Long-acting bronchodilators/corticosteroids. [c]IQR: Interquartile range; [d]mMRC: modified Medical Research Council; [e]GOLD: Global Initiative for Chronic Obstructive Lung Disease.

Table 2 Comparison of the Type of Inhaler with the Score Obtained in Each Question of TAI-10 Questionnaire (Test of the Adherence to Inhalers), in Patients with a Diagnosis of Chronic Obstructive Pulmonary Disease, Colombia

TAI-10[a] Questionnaire Variables	Total (n=500)	Metered Dose Inhalers[b]	Metered Dose Inhalers[c]	Multi-Dose Dry Powder Inhalers	Single-Dose Dry Powder Inhalers	Soft Mist Inhaler
	Mean (SD)[d]	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
During the last 7 days, how many times did you forget to take your usual inhalers?	4.7 ± 0.7	4.7 ± 0.7	4.8 ± 0.6	4.7 ± 0.8	4.8 ± 0.6	4.7 ± 0.8
Do you forget to take inhalers?	4.6 ± 0.7	4.6 ± 0.7	4.7 ± 0.6	4.6 ± 0.7	4.6 ± 0.7	4.6 ± 0.8
When you feel good about your illness, do you stop taking your inhalers?	4.5 ± 1.1	4.5 ± 1.1	4.5 ± 1.1	4.3 ± 1.2	4.4 ± 1.1	4.6 ± 1.1
When you are on vacation or weekend, do you stop taking your inhalers?	4.7 ± 0.7	4.8 ± 0.6	4.7 ± 0.7	4.7 ± 0.8	4.7 ± 0.7	4.7 ± 0.9
When you are nervous or sad, do you stop taking your inhalers?	4.8 ± 0.6	4.9 ± 0.5	4.8 ± 0.6	4.8 ± 0.6	4.8 ± 0.6	4.8 ± 0.7
Do you stop taking your inhalers because of fear of side effects?	4.8 ± 0.6	4.9 ± 0.6	4.9 ± 0.5	4.9 ± 0.5	4.8 ± 0.6	4.8 ± 0.8
Do you stop taking your inhalers because of considering they are useless to treat your condition?	4.9 ± 0.5	4.9 ± 0.5	4.9 ± 0.4	4.9 ± 0.4	4.8 ± 0.6	4.9 ± 0.6
Do you take fewer inhalations than those prescribed by your doctor?	4.7 ± 0.8	4.7 ± 0.8	4.8 ± 0.5	4.6 ± 0.9	4.7 ± 0.8	4.8 ± 0.8
Do you stop taking your inhalers because you believe they interfere with your everyday or working life?	4.9 ± 0.4	4.9 ± 0.4	4.9 ± 0.3	4.9 ± 0.4	4.9 ± 0.4	4.9 ± 0.7
Do you stop taking your inhalers because you have difficulties to pay them?	4.7 ± 0.6	4.8 ± 0.5	4.8 ± 0.5	4.8 ± 0.6	4.8 ± 0.5	4.7 ± 0.9
Total	47.4 ± 5.3	47.6 ± 4.8	47.7 ± 4.6	47.2 ± 4.8	47.3 ± 5.0	47.4 ± 6.8
Good adherence (50 points); (n /%)	283 (56.6)	58 (58.0)	60 (60.0)	54 (54.0)	48 (48.0)	63 (63.0)
Intermediate adherence (46–49 points); (n /%)	127 (25.4)	24 (24.0)	23 (23.0)	24 (24.0)	35 (35.0)	21 (21.0)
Poor adherence (≤45 points); (n /%)	90 (18.0)	18 (18.0)	17 (17.0)	22 (22.0)	17 (17.0)	16 (16.0)

Notes: [a]TAI: Test of the Adherence to Inhalers; [b]Short-acting bronchodilators; [c]Long-acting bronchodilators/corticosteroids; [d]SD: Standard deviation. Adapted from Plaza V, Fernández-Rodríguez C, Melero C, et al. Validation of the 'Test of the Adherence to Inhalers' (TAI) for asthma and COPD patients. *J Aerosol Med Pulm Drug Deliv.* 2016;29(2):142–152. Creative Commons.[12]

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Table 3 Comparison of the Type of Inhaler with the Score Obtained in Each Question of FSI-10 Questionnaire (Feeling of Satisfaction with Inhaler), in Patients with a Diagnosis of Chronic Obstructive Pulmonary Disease, Colombia

FSI-10 Questionnaire Variables	Total (n=500)	Metered Dose Inhalers[a]	Metered Dose Inhalers[b]	Multi-Dose Dry Powder Inhalers	Single-Dose Dry Powder Inhalers	Soft Mist Inhaler
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Was it easy for you to learn to operate this inhalation device?	4.7 ± 0.6	4.8 ± 0.5	4.8 ± 0.6	4.8 ± 0.6	4.7 ± 0.7	4.7 ± 0.8
Was it easy for you to prepare this inhalation device for inhalation?	4.8 ± 0.6	4.8 ± 0.5	4.8 ± 0.4	4.8 ± 0.5	4.7 ± 0.6	4.7 ± 0.8
Was this inhalation device easy for you to use?	4.7 ± 0.7	4.7 ± 0.7	4.8 ± 0.6	4.8 ± 0.5	4.7 ± 0.8	4.7 ± 0.9
Has it been easy for you to keep the inhalation device in good working order and hygiene?	4.8 ± 0.6	4.8 ± 0.4	4.8 ± 0.5	4.8 ± 0.5	4.8 ± 0.4	4.7 ± 0.8
Was it easy for you to continue your normal activities using this inhalation device?	4.8 ± 0.6	4.8 ± 0.5	4.8 ± 0.6	4.8 ± 0.4	4.8 ± 0.6	4.7 ± 0.8
Was it comfortable for you to adapt the inhalation device to your lips?	4.8 ± 0.6	4.8 ± 0.5	4.8 ± 0.5	4.8 ± 0.4	4.7 ± 0.8	4.7 ± 0.8
Was the inhalation device comfortable for you in terms of weight and size?	4.8 ± 0.5	4.8 ± 0.5	4.8 ± 0.5	4.8 ± 0.5	4.8 ± 0.5	4.8 ± 0.8
Was the inhalation device comfortable for you to carry (transport) with you?	4.8 ± 0.5	4.8 ± 0.5	4.9 ± 0.4	4.8 ± 0.5	4.9 ± 0.4	4.8 ± 0.8
When you inhale, are you left with the feeling that you have used the inhalation device correctly?	4.7 ± 0.7	4.7 ± 0.7	4.7 ± 0.6	4.8 ± 0.5	4.7 ± 0.7	4.7 ± 0.8
Overall, taking all of the above into account, are you satisfied with the inhalation device?	4.7 ± 0.6	4.8 ± 0.5	4.7 ± 0.6	4.8 ± 0.5	4.7 ± 0.7	4.7 ± 0.8
Total	47.6 ± 5.4	47.9 ± 4.5	47.8 ± 4.4	47.9 ± 4.3	47.5 ± 5.3	47.1 ± 7.7
High satisfaction ≥44 points (n /%)	421 (84.2)	85 (85.0)	86 (86)	83 (83)	82 (82)	85 (85)

Notes: [a]Short-acting bronchodilators; [b]Long-acting bronchodilators/corticosteroids.
Abbreviations: FSI, Feeling of Satisfaction with Inhaler; SD, Standard deviation.

Table 4 Binary Logistic Regression on the Variables Associated with Good Adherence to Inhalation Devices, in Patients with a Diagnosis of Chronic Obstructive Pulmonary Disease, Colombia

Variables	Sig.	OR	95% CI	
			Lower	Upper
Women	0.065	1.446	0.978	2.140
Age (continuous)	0.835	1.002	0.983	1.022
Origin Central Region	0.005	0.556	0.368	0.839
High school or college	0.540	1.143	0.746	1.750
Active occupation	0.930	1.018	0.685	1.512
Cardiovascular comorbidities	0.761	0.930	0.585	1.481
Diabetes mellitus	0.043	0.608	0.376	0.984
COPD evolution time less than 5 years	0.010	0.570	0.372	0.873
Hospitalizations for COPD in the last year	0.605	0.878	0.536	1.438
Use of home oxygen	0.134	1.407	0.900	2.197
Training carried out by a specialist doctor	0.006	1.756	1.173	2.628
Use of the inhalation device less than one year	0.029	1.596	1.049	2.430
Use soft mist inhaler	0.149	1.439	0.878	2.359
Use of short-acting β2-agonists	0.026	1.587	1.056	2.385
Satisfaction FSI-10 questionnaire (continuous)	<0.001	1.094	1.048	1.142

Abbreviations: Sig, Statistical significance; OR, Odds Ratio; CI, Confidence interval; COPD, Chronic Obstructive Pulmonary Disease; FSI, Feeling of Satisfaction with Inhaler.

Multivariate Analysis

Binary logistic regression found that patients who received training by specialist physicians, had been using the inhalation device for less than a year, received short-acting β_2 adrenergic agonists and had the highest level of satisfaction were associated with good adherence. Those who came from the central region, had a COPD evolution time of less than 5 years and had diabetes mellitus had lower adherence (Hosmer–Lemeshow test p=0.941 and AUC=0.702) (Table 4).

Discussion

This analysis made it possible to characterize the types of inhalation devices most used, the level of adherence and the factors related to adherence in a group of patients with COPD from the different geographic regions of Colombia. The opinions, preferences and satisfaction that patients have with inhalation devices may be useful to health care, academic and scientific personnel in their decision-making and efforts to improve patients' adherence to pharmacological management and control of the disease. In this way, these findings may contribute to reducing exacerbations and hospitalizations, as well as improving the quality of life for these patients.[9]

A significant proportion of patients presented dyspnea mMRC ≥2 points and had exacerbations in the past year, which is consistent with what has been described in other studies carried out in Latin America,[5] Europe[17–19] and Asia.[20–23] According to the clinical classification of COPD, the majority were in the GOLD B category, which is in line with statistics reported in other studies (45.0% vs 34.3–44.6%).[17,18,21] Similarly, patients usually had other diseases, such as cardiovascular and endocrine comorbidities, which is consistent with what was found in the literature.[17,18,24]

A total of 58.9% of COPD patients used metered-dose inhalers, which is in line with previous reports of subjects with asthma in Colombia (73.0%).[16] In Europe and Asia, dry powder inhalers are the predominant devices (61.1–88.9%).[18,22,25,26] According to a systematic review and meta-analysis, COPD patients prefer inhalation devices that are small, durable, easy to use, and quick to administer the drug.[27] The preferences of the patient must be considered when establishing the treatment plan and thus improve the use of bronchodilators.[27] In addition, education and training to use

the inhalation device is crucial. The vast majority of patients were trained on how to use the inhalation device, consistent with findings in Korea (95.4%)[20] and Colombia (93.9%)[16] and higher than that documented in Spain (80.5%).[28]

A total of 56.6% of the patients had good adherence. This finding is consistent with that documented in a study carried out in seven Latin American countries, in which the TAI-10 questionnaire was also used, and it was found that 54.1% of patients with COPD had good adherence.[5] Furthermore, adherence was much better than that found by Świątoniowska et al in a systematic review of 25 studies involving 29 countries on 5 continents (46.3%).[9] In this report, no significant differences were found in adherence between the different inhalation devices. In Turkey, Gemicioglu et al evaluated adherence to inhalation devices in patients with COPD or asthma using the Morisky-Green-Levine test and found that those who used metered-dose inhalers had greater adherence.[25] Likewise, in Spain, Darbà et al documented that metered-dose inhaler users were more likely to adhere to therapy.[18]

Some variables were found that were related to increasing the probability of having good adherence. The patients who showed greater satisfaction with their inhalation device were more adherent to their treatment. Thus, in Egypt, Galal et al found this correlation but in patients with asthma.[29] In a study that involved different countries in the Americas, Europe and Asia, the authors documented that patients who had lower satisfaction with health care providers had poorer adherence.[30] Additionally, patients who received short-acting β_2 adrenergic agonists were also more adherent, which is consistent with a study conducted in the United States by Le et al, in which patients who used short-acting bronchodilators had a 36% probability of having good adherence.[31] Patients who received training or education on the use of their inhalation device by specialist physicians were more adherent. This is in line with two publications in which the authors found that patients treated by pulmonologists were more adherent to bronchodilator treatment.[24,29]

However, other conditions decreased the probability of having good adherence. Patients who had COPD with an evolution of the disease of less than 5 years were less adherent to its management, which is in line with what was previously reported in China.[23] This is probably due to the low awareness and knowledge that people have about the pathologies they suffer, especially in the first years following diagnosis.[32,33] Similarly, patients with diabetes mellitus as a comorbidity did not have good adherence, which is consistent with what was found by Di Martino et al in Italy[24] but contrasts with other studies where this association was not found.[11,17,31] However, different associations with other comorbidities have been found in the literature.[11,22,24,31] Finally, the place of care of the patient also influenced the degree of adherence. This finding is consistent with what was found in the cohort of patients with COPD in Italy, where adherence varied according to the type of hospital in which the patient was managed.[24] These differences may be due to the academic training of prescribers, the training given to use inhalation devices, the availability of medications and devices, and patient preferences.[16]

Some limitations should be considered when interpreting the results. The data were obtained from a group of patients with Colombian health system insurance, so the findings may not be extrapolated to patients without insurance. In addition, there was no data from paraclinical studies about spirometry, chest X-rays or blood counts, among others. However, the study included a significant number of patients distributed across the nation's geographic regions and involved cases with different degrees of severity in pathology, which were affiliated with both the contributory and subsidized insurance plans of the Colombian health system.

Conclusions

With these findings, it is concluded that metered dose inhalers are the most widely used devices among COPD patients in Colombia. Adherence to bronchodilator treatment and inhaled glucocorticoids was not very high, and there were no significant differences by type of inhalation device, but there were significant differences in some sociodemographic, clinical and pharmacological variables. It was possible to identify that the patients who presented greater satisfaction with their inhalation device were more adherent to their treatment, and furthermore, those who received training in the use the device by specialist physicians were more adherent. Understanding the factors that can influence the degree of adherence to treatment will improve the control of symptoms, reduce complications and improve the quality of life of patients with COPD.

Data Sharing Statement

Data access: https://www.protocols.io/private/7B30076C264811EE9D0F0A58A9FEAC02.

Ethics Approval and Consent to Participate

The protocol was approved by the Bioethics Committee of the Universidad Tecnológica de Pereira (Technological University of Pereira) in the category of risk-free research (Code: 02-070620). The ethical principles established by the Declaration of Helsinki were respected.

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