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Original Research

Physical activity among adults with chronic obstructive pulmonary disease in Spain (2014–2020): Temporal trends, sex differences, and associated factors

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ABSTRACT

Objectives: To evaluate trends in the prevalence of physical activity (PA) from 2014 to 2020; to identify sex differences and sociodemographic and health-related factors associated with PA in individuals with chronic obstructive pulmonary disease (COPD); and to compare PA between individuals with and without COPD.
Methods: Cross-sectional and case-control study. Source: European Health Interview Surveys for Spain (EHISS) conducted in 2014 and 2020. We included sociodemographic and health-related covariates. We compared individuals with and without COPD after matching for age and sex.
Results: The number of adults with COPD was 1086 and 910 in EHISS2014 and EHISS2020, respectively. In this population, self-reported "Medium or high frequency of PA" remained stable (42.9% in 2014 and 43.5% in 2020; $p = 0.779$). However, the percentage who walked on two or more days per week rose significantly over time (63.4%–69.9%; $p = 0.004$). Men with COPD reported more PA than women with COPD in both surveys. After matching, significantly lower levels of PA were recorded in COPD patients than in adults without COPD. Multivariable logistic regression confirmed this trend in COPD patients and showed that male sex, younger age, higher educational level, very good/good self-perceived health, and absence of comorbidities, obesity, and smoking were associated with more frequent PA.
Conclusions: The temporal trend in PA among Spanish adults with COPD is favorable, although there is much room for improvement. Insufficient PA is more prevalent in these patients than in the general population. Sex differences were found, with significantly more frequent PA among males with COPD.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is characterized by persistent and usually progressive airflow limitation. The main risk factor is smoking, although the disease is also associated with environmental pollution and occupational exposures, genetic alterations, and accelerated aging [1]. COPD is a preventable and incurable disease. Early diagnosis and treatment, including lifestyle changes such as smoking cessation and regular exercise can improve the quality of life of affected patients and delay disease progression [2].

COPD is the third leading cause of death worldwide. In 2019, it caused 3.23 million deaths, of which nearly 90% occurred in individuals aged under 70 years in countries with middle or low incomes [3]. Despite the burden resulting from high morbidity and mortality, COPD remains an underdiagnosed disease, thus increasing its impact. The WHO Global Action Plan for the Prevention and Control of Noncommunicable Diseases includes a strategic rehabilitation approach to improve physical functioning and mitigate disability in affected patients [4].

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Abbreviations

COPD	Chronic obstructive pulmonary disease
EHISS	European Health Interview Survey in Spain
PA	Physical activity

In Spain, the overall prevalence of COPD has decreased in recent decades, standing at 8.8% in 2017. However, there has been a significant increase in the number of women affected during the last decade. The rate of underdiagnosis reached 78%, particularly in women and in younger cohorts [5]. According to the Annual Report of the National Health System 2020–2021, during this period, there were 13,808 deaths from COPD, with a crude mortality rate of 29.3 deaths per 100,000 persons [6].

The annual cost of the disease is estimated to be €3 billion [7]. Costs increase with more severely impaired lung function and are mainly associated with exacerbations (almost 60% of direct costs) and comorbidities [8,9].

Physical inactivity is one of the main risk factors for mortality from non-communicable diseases and can increase disability and reduce quality of life [10]. Worldwide data indicate insufficient physical activity (PA) in 1 in 4 adults. Regular PA provides multiple health benefits at all ages: it improves muscular, cardiorespiratory, skeletal, and functional status; it reduces the risk of hypertension, coronary heart disease, stroke, diabetes, cancer, and depression and the risk of falls and hip or vertebral fractures; and it helps to maintain a healthy body weight [11].

Skeletal muscle dysfunction, a major comorbidity in patients with COPD, is multifactorial in nature and affects both ventilatory and non-ventilatory muscle groups [12]. Along with dyspnea, it contributes to exercise intolerance, which characterizes the disease, and leads to progressive limitation of activities of daily living and deterioration of well-being. Inactivity promotes muscle deconditioning, further compromising the patient's ability to engage in PA, thus generating a vicious cycle [13]. Physical inactivity has been linked to exacerbations and hospitalizations and has been identified as a strong predictor of all-cause mortality in COPD patients, with a linear association between the two [14,15].

Comprehensive pulmonary rehabilitation programs, which include physical training, health education, and patient self-management to promote long-term adherence to healthy lifestyles including PA, have been shown to decrease symptoms and resource utilization, increase functional capacity, and improve quality of life [16].

The European Health Interview Survey in Spain (EHISS), which was conducted in 2020 (EHISS2020) [17,18], is a highly informative data source based on the collection and analysis of sociodemographic and clinical variables, lifestyle, medication consumption, and use of health services. The EHISS has proven useful for studying disease and disability trends, identifying barriers to access to adequate healthcare, evaluating the impact of healthcare programs, and facilitating progress towards national health goals [19–23].

To date, national and international research studies have consistently shown that COPD patients have lower levels of PA than the general population [22,24]. However, a favorable trend over time in the PA levels of these patients has been suggested [25].

Several sociodemographic and clinical variables have been associated with PA in COPD patients, including sex, age, place of residence, mental disorders, self-perceived health, and severity of COPD [21,22,26]. However, the factors influencing the levels of PA in these patients are inconclusive [27], probably owing to factors such as differences in sampling methods, study variables, data collection, and control of confounding variables [20–22,24,27–30].

The most common type of PA in patients with COPD is walking, which leads to better clinical outcomes, quality of life, survival, and independence [10,11,28]. However, the little available research on walking in COPD patients has been performed indirectly under the umbrella of PA or during monitoring of activity under controlled conditions [31].

Few studies have analyzed a representative nationwide sample of people with COPD to assess PA, including walking patterns. Most of the few published studies involved small samples in healthcare settings. Furthermore, information on the characterization and determinants of PA in COPD is lacking, as previous investigations focused mainly on clinical variables, without considering mental and social components or quality of life as determinants of PA or walking patterns. The rising burden of COPD worldwide (particularly in Spain), the importance of PA and walking in this population, and the risks associated with walking (e.g., falls) underscore the high need for large-scale, real-world investigations in people with COPD [32].

In this investigation, we used two EHISS, one carried out in 2014 and the other in 2020, to analyze the time trend in self-reported PA among people with COPD. We also aimed to identify whether sex and other sociodemographic and health-related variables were associated with PA. Finally, each participant was matched by sex and age with a participant without COPD to compare their frequency of PA.

2. Materials and methods

2.1. Study design and data source

The study design was cross-sectional and case–control. The EHISS for the years 2014 (EHISS2014) and 2020 (EHISS2020) were used as the data source [17,18].

Briefly, the EHISS are conducted every four years to collect self-reported data on the health status of a sample of individuals (≥15 years) residing in households. The information includes sociodemographic characteristics, self-reported clinical conditions, use of medication and healthcare services, and lifestyles. Selection of participants in the EHISS was based on three-stage sampling in order to obtain a representative sample of the Spanish population. The first-stage units were the census sections (37,000), which are grouped into seven strata according to the size of the municipality to which they belong. The second-stage units were the main family dwellings and all the members of the household. The third-stage units (individuals) were selected at random from the list of surveyable people (aged 15 years or older) in the dwelling at the time of the interview. One participant was randomly selected within each household. Information was collected using computer-assisted personal interviewing, which was supplemented, if necessary, by a telephone interview. The interviewers visited the selected dwellings to conduct the interviews and complete the questionnaires. As many visits as necessary were made to obtain the required information from the interviewee. The interviews were conducted over a 12-month period, namely, January to December 2014 for EHISS2014 and July 2019 to July 2020 for EHISS2020.

Efforts were made to ensure that the interviews were conducted throughout an entire year so that the number of respondents was homogeneous in all the weeks, with the aim of equally representing any period of the year. It is important to note that from March to July of 2020, the interviews were held by telephone owing to the COVID-19 pandemic. Details on the EHISS methodology can be found elsewhere [17,18].

2.2. Study population and matching method

The study population included all participants in both surveys aged 40 years or over. The survey identified those with COPD by asking the question: "Has your doctor told you that you are suffering from COPD?". Those who answered "no" were classified as non-COPD.

For each participant with COPD, we matched a non-COPD person interviewed in the same EHISS and with identical sex, age, and

community of residence. If more than one non-COPD person was available for a participant with COPD, the selection was random.

2.3. Study variables

To measure how frequently participants engaged in PA, the survey used two variables, namely, "Frequency of PA" and "Number of days per week of walking". For the first, the survey asked the questions "Which of these possibilities best describes how often you do some PA in your free time?" Those who answered "I don't exercise. I occupy my free time almost completely seated" or "I do some occasional physical or sports activity" were classified as "sedentary or with a low frequency"; and those who responded, "I do PA several times a month" or "I do sports or physical training several times a week" were classified as "medium or high frequency".

For the second variable the question used was "How many days (0–7), in a typical week, do you walk fast and continuously for at least 10 min? The answer was categorized in "none or one day" and "two days or more".

Sex, age, educational level, and marital status were the sociodemographic characteristics analyzed.

Regarding health-related information we included self-rated health and self-reported clinical conditions (diabetes, heart disease, stroke, cancer, mental disorders, and high blood pressure). Alcohol consumption, active smoking, and body mass index were also analyzed. Table S1 shows how the interview questions and the possible answers were categorized to create the study covariates.

2.4. Statistical analysis

The study populations are described according to the study variables, which are expressed as absolute numbers with percentages and means with standard deviations (SD). The chi-square or the McNemar test was applied to compare qualitative variables, and the *t*-test or the paired *t*-test to compare quantitative variables. The normality of the distribution of continuous variables was verified using the Kolmogorov-Smirnov test.

To identify which study variables were independently associated with PA among participants with COPD, we calculated the adjusted odds ratios (ORs) with 95% confidence intervals (95% CIs) using multivariable logistic regression models. To construct these models, we followed the methods suggested by Hosmer et al. [33]. The steps used to build the models were as follows: 1) Selection of the variables, including those with a significant association in the bivariate analysis or that were considered essential after the literature review; 2) Decision on which individual variables should remain in the model using the Wald statistic; 3) Comparison of the models that were consecutively generated with the previous one using the likelihood ratio test; 4) Exclusion of collinearities and interactions (2 x 2) between variables once a final model was constructed.

The statistical analysis was performed using STATA 14.0 (Stata Statistical Software Version 14. StataCorp LP. College Station, TX, USA).

2.5. Sensitivity analysis

To confirm a possible association between COPD and PA, we constructed two multivariable logistic regression models: one for "Frequency of PA" and another for "Number of days per week of PA involving walking". The models included all those variables significantly associated with PA in the bivariate analysis. Data from the entire study population were used.

2.6. Ethical aspects

The databases of the EHISS2014 and the EHISS2020 can be freely downloaded from the Spanish Ministry of Health website [34]. According to Spanish law, the approval of an ethics committee is not necessary for epidemiological studies based on publicly available anonymous data.

3. Results

The number of participants aged 40 years or over with self-reported physician-diagnosed COPD was 1086 in EHISS2014 and 910 in EHISS2020. After excluding those with missing data, the total number of matched couples reached 86.74% (942) and 90.23% (821) in these years, respectively.

As can be seen in Table 1 the distribution according to study variables of people with COPD was very similar in both surveys. Only around one quarter of the study population self-rated their health in the previous year as "Very good/good". The most frequent self-reported clinical conditions were high blood pressure, mental illness, and heart disease. Over 44% and 20% reported alcohol consumption and active smoking. According to body mass index (BMI), obesity affected 29.8% in 2014 and 28.3% in 2020.

Medium-to high-frequency PA remained stable (42.9% in 2014 and 43.5% in 2020; $p = 0.779$). However, the proportion that engaged in two or more days per week of walking rose significantly over time (from 63.4% to 69.9%; $p = 0.004$).

Table 1
Distribution according to study variables of people with self-reported Chronic Obstructive Pulmonary Disease (COPD) included in the European Health Interview Surveys for Spain (EHISS) conducted in years 2014 and 2020.

Variable	Categories	EHISS 2014		EHISS 2020		
		n	%	n	%	p
Sex	Men	451	47.9	390	47.5	0.875
	Women	491	52.1	431	52.5	
Age (Years)	Mean (SD)	69.15	(13.06)	69.19	(12.77)	0.952
Year groups (Years)	55–64	71	19.2	65	20.6	0.533
	65–74	116	31.4	103	32.6	
	≥75	182	49.3	148	46.8	
Educational level	No studies/ primary	732	77.7	621	75.6	0.333
	Secondary	96	10.2	102	12.4	
	High education	114	12.1	98	11.9	
Living with a partner	Yes	493	52.4	414	50.5	0.42
Self-rated health	Fair/poor/ very poor	703	74.6	588	71.6	0.155
	Very good/ good	239	25.4	233	28.4	
Diabetes	Yes	219	23.2	180	21.9	0.508
Heart diseases	Yes	284	30.1	230	28.0	0.325
Stroke	Yes	57	6.1	49	6.0	0.942
Cancer	Yes	99	10.5	102	12.4	0.207
Mental disease	Yes	290	30.8	248	30.2	0.792
High blood pressure	Yes	460	48.8	436	53.1	0.073
Alcohol consumption	Yes	419	44.5	371	45.3	0.745
Active smoking	Yes	199	21.1	203	24.8	0.070
Body mass index (kg/m^2)	<25	262	30	258	33.9	0.242
	25–29.9	351	40.2	288	37.8	
	≥30	260	29.8	215	28.3	
Frequency of PA	Sedentary or low	537	57.1	463	56.5	0.779
	Medium or high	403	42.9	357	43.5	
Number of days per week of walking	None or one day	344	36.6	247	30.1	0.004
	Two day or more	595	63.4	574	69.9	

PA Physical activity. Metal disease included "anxiety and/or depression". P value for differences between EHISS 2014 and EHISS 2020 using Chi square and t-Student tests.

3.1. Sex differences in self-reported PA between men and women with COPD

As can be seen in Fig. 1, compared with women with COPD, men with COPD reported a significantly higher frequency of medium- or high-frequency PA (47.7% vs. 38.5% in 2014 and 48.8% vs. 38.7% in 2020) and two or more days of walking per week (65.3% vs. 61.6% in 2014 and 72.8% vs. 67.3% in 2020) in both surveys (all $p < 0.01$). A significant increment in the number of days per week of walking was observed for both men and women between the surveys (all $p < 0.01$).

3.2. Differences in self-reported PA between participants with COPD and age- and sex-matched non-COPD persons

Table 2 shows the prevalence of the PA variables stratified by sociodemographic characteristics. After matching and when the participants of both surveys were joined, the prevalence of self-reported medium- or high-frequency PA was significantly greater among non-COPD persons (59.8%) than among participants with COPD (43.2%; $p < 0.001$). In addition, non-COPD people reported walking two or more days per week in a significantly higher proportion than COPD patients (78.5% vs. 66.4%; $p < 0.001$).

The frequency of PA and the number of days per week of walking were significantly higher among sex- and age-matched non-COPD participants than among those with COPD after stratification by sociodemographic variables.

The variables significantly associated with a higher frequency of PA among people with and without COPD included male sex, younger age, higher educational level, and living with a partner. These same variables were associated with more days of walking.

Table 3 shows the prevalence of medium- or high-frequency PA and the number of days per week of walking ≥2 days among participants with COPD and sex- and age-matched participants without COPD according to clinical variables and lifestyles.

For all categories of variables shown in Table 3, participants without COPD reported a medium or high frequency of PA in a significantly higher proportion than those with COPD. The prevalence of ≥2 days of walking was also higher for all categories but did not reach statistical significance for those with heart disease or mental illness.

Among people with COPD, those who reported "Very good/good" self-rated health and none of the chronic conditions analyzed, except for cancer, had a significantly higher prevalence of medium- or high-frequency PA and number of days per week of walking ≥2.

3.3. Results of multivariable logistic regression to identify study variables independently associated with PA among participants with COPD

As can be seen in Table 4, after adjustment of the multivariable models, the variables associated with medium- or high-frequency PA included male sex (OR 140; 95% CI 1.14–1.72), younger age, higher education, very good/good self-rated health, not reporting stroke, mental disorders, active smoking, and having a BMI below 30 kg/m^2. The variables associated with ≥2 days per week of walking are the same, except for active smoking, which was not included in the final model, and reporting heart disease, for which a negative association was observed (OR 0.64; 95% CI 0.50–0.82)

Regarding the trend in prevalence from 2014 to 2020, the adjusted OR found for walking ≥2 days per week was 1.34 (95% CI 1.10–1.64), indicating an improvement over time among participants with COPD.

3.4. Sensitivity analysis

The results of the logistic regression model to confirm whether COPD was associated with a lower frequency of PA and number of days of walking are shown in Table S2. When the entire study population was analyzed, the variables associated with PA were very similar to those reported for participants with COPD (Table 4). Therefore, the factors most closely associated with more-frequent PA were male sex, younger age, higher educational level, very good/good self-rated health, no concomitant diseases, no obesity, and not smoking.

Finally, the sensitivity analysis confirmed that people with COPD reported medium- or high-frequency PA (OR 0.68; 95% CI 0.58–0.79)

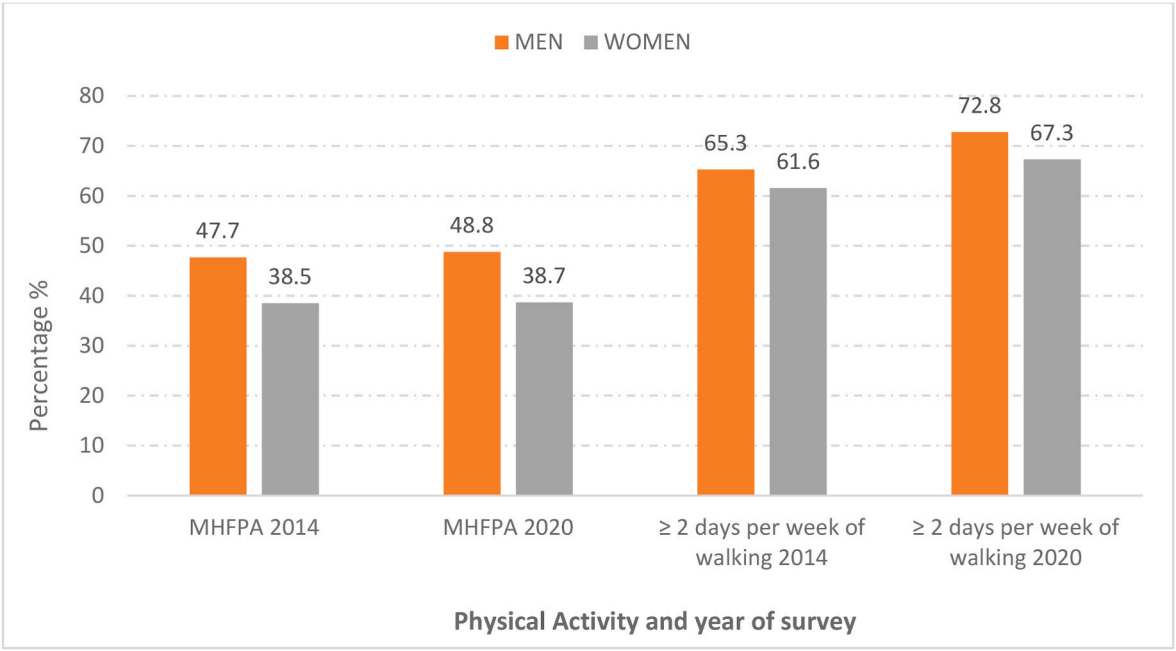

Fig. 1. Frequency of medium or high frequency of physical activity (PA) and number of days of walking per week ≥2 according to sex among people with self-reported Chronic obstructive pulmonary disease (COPD) included in the European Health Interview Surveys for Spain (EHISS) conducted in years 2014 and 2020.
MHFPA: medium or high frequency of physical activity
All differences between men and women were statistically significant ($p < 0.01$).

Table 2
Medium or high frequency of physical activity and number of days per week of walking ≥2 days among subjects with Chronic obstructive pulmonary disease (COPD) and sex-age matched subjects without COPD participants in the European Health Interview Surveys for Spain (EHISS) conducted in years 2014 and 2020 according to socio-demographic variables.

Variable	Categories	Medium or high frequency of physical activity					Number of days per week of walking ≥2 days				
		No COPD n	%	COPD n	%	P value	No COPD n	%	COPD n	%	P value
Sex[a,b,c,d]	Men	553	65.8	404	48.2	<0.001	695	82.8	578	68.8	<0.001
	Women	502	54.4	356	38.6	<0.001	686	74.5	591	64.2	<0.001
Age groups[a,b,c,d]	55–64	418	67.1	311	50.0	<0.001	518	83.3	446	71.7	<0.001
	65–74	341	72.6	228	48.5	<0.001	411	87.4	340	72.3	<0.001
	≥75	296	44.2	221	33.1	<0.001	452	67.7	383	57.3	<0.001
Educational level[a,b,c,d]	No studies/primary	655	53	538	39.8	<0.001	924	74.9	859	63.6	<0.001
	Secondary	156	72.2	107	54	<0.001	185	85.6	149	75.3	<0.001
	High education	244	78.7	115	54.5	<0.001	272	87.7	161	75.9	<0.001
Living with a partner[a,b,c]	No	444	55.0	344	40.3	0.038	614	76.2	552	64.8	<0.001
	Yes	607	64.0	415	45.9	<0.001	761	80.4	616	68.1	<0.001

p value for difference between participants with COPD and non-COPD age and sex matched controls.
[a] Significant association between the variable and frequency of Physical activity among participants without COPD.
[b] Significant association between the variable and Number of days per week of walking ≥2 days among participants without COPD.
[c] Significant association between the variable and Physical activity among participants without COPD.
[d] Significant association between the variable and Number of days per week of walking ≥2 days among participants with COPD.

Table 3
Medium or high frequency of physical activity and number of days per week of walking ≥2 days among subjects with Chronic Obstructive Pulmonary Disease (COPD) and sex-age matched subjects without COPD participants in the European Health Interview Surveys for Spain (EHISS) conducted in years 2014 and 2020 according to clinical variables and lifestyles.

Variable	Categories	Medium or high frequency of physical activity					Number of days per week of walking ≥2 days				
		No COPD n	%	COPD n	%	P value	No COPD n	%	COPD n	%	P value
Self-rated health [a,b,c,d]	Fair/poor/very poor	358	45.4	473	36.7	<0.001	525	66.8	788	61.2	0.011
	Very good/good	697	71.5	287	60.8	<0.001	856	87.9	381	80.7	<0.001
Diabetes [a,b,c,d]	No	903	61.1	610	44.8	<0.001	1162	78.8	936	68.7	<0.001
	Yes	152	53.1	150	37.7	<0.001	219	76.6	233	58.7	0.006
Heart diseases [a,b,c,d]	No	920	62.4	571	45.8	<0.001	1187	80.6	889	71.2	<0.001
	Yes	135	46.9	189	36.9	<0.001	194	67.4	280	54.7	0.073
Stroke [a,b,c,d]	No	1016	60.6	733	44.3	0.035	1329	79.4	1125	68.0	<0.001
	Yes	39	45.3	27	25.7	<0.001	52	60.5	44	41.9	0.011
Cancer	No	985	60.0	679	43.6	0.016	1290	78.7	1041	66.8	<0.001
	Yes	70	57.9	81	40.3	<0.001	91	75.2	128	63.7	0.032
Mental disease [a,b,c,d]	No	914	63.3	554	45.3	<0.001	1184	82.2	849	69.4	<0.001
	Yes	141	44.2	206	38.3	<0.001	197	61.8	320	59.6	0.350
High blood pressure [a,b,c,d]	No	615	63.7	395	45.6	<0.001	784	81.4	601	69.4	<0.001
	Yes	440	55.1	365	40.8	0.005	597	74.9	568	63.5	<0.001
Alcohol consumption [a,b,c,d]	No	448	50.6	350	36.1	<0.001	649	73.4	572	59.1	<0.001
	Yes	604	69.2	410	51.9	<0.001	728	83.5	595	75.3	<0.001
Active smoking[d]	No	912	60.0	589	43.4	0.001	1188	78.3	879	64.8	<0.001
	Yes	139	58.4	171	42.6	<0.001	188	79.3	289	71.9	<0.001
Body mass index [a,b,c,d]	<25	390	69	227	43.7	<0.001	460	81.4	353	67.9	<0.001
	25–29.9	456	61.8	311	48.7	<0.001	601	81.4	467	73.1	<0.001
	≥30	150	45.7	182	38.3	<0.001	246	75.2	287	60.5	0.005

COPD, Chronic obstructive pulmonary disease. Metal disease included "anxiety and/or depression".
p value for difference between participants with COPD and non-COPD age and sex matched controls.
[a] Significant association between the variable and frequency of Physical activity among participants without COPD.
[b] Significant association between the variable and Number of days per week of walking ≥2 days among participants without COPD.
[c] Significant association between the variable and Physical activity among participants without COPD.
[d] Significant association between the variable and Number of days per week of walking ≥2 days among participants with COPD.

and walking ≥2 days per week (OR 0.71; 95% CI 0.59–0.84), that is, significantly less than sex- and age-matched non-COPD participants.

4. Discussion

Over the period studied (2014–2020), we observed a significant increase in the percentage of patients with COPD who walked for 10 min two or more days a week, with a stable frequency of medium to high PA. A Danish study on temporal trends in leisure-time PA based on national health surveys found objectively higher levels of PA from 2000 to 2005, with a more pronounced increase in COPD patients than in healthy controls. However, PA levels remained stable between 2005 and 2010 [25].

In Spain, temporal studies on COPD focus on resource utilization. In their analysis of National Health Service data from 2006 to 2012, de Miguel et al. [23] found a decrease in primary care visits but no changes in hospital visits. Based on data from a regional death registry, Fernández et al. [35] reported a consistent decrease in COPD mortality in Galicia from 1996 to 2017, with a progressive increase in age at death. These trends could be explained by advances in targeted therapies, as well as by general health promotion campaigns specific to affected patients, since the general adult population, both nationally and globally, has experienced a decline in PA levels, thus highlighting the need for continuous monitoring [36,37].

In Spain, the Update of the COPD Strategy of the National Health System in 2014, under its general objective 3, "Reduce morbidity and

Table 4
Variables associated with medium or high physical activity and with number of days per week of walking ≥2 days among participants with COPD. Results of multivariable logistic regression analysis.

		Medium or high physical activity	Number of days per week of walking ≥2 days
		OR (95% CI)	OR (95% CI)
Sex	Women	1	1
	Man	1.40 (1.14–1.72)	1.26 (1.04–1.47)
Age groups	≥75 years	1	1
	65–74 years	1.80 (1.38–2.34)	1.76 (1.33–2.32)
	40–64 years	1.90 (1.46–2.49)	1.31 (1.01–1.72)
Educational level	No studies/ primary	1	1
	Secondary	1.48 (1.06–2.05)	1.51 (1.03–2.21)
	High education	1.38 (1.01–1.90)	1.44 (1.01–2.08)
Self-rated health	Fair/poor/ very poor	1	1
	Very good/ good	2.17 (1.72–2.74)	2.01 (1.53–2.66)
Heart diseases	No	–	1
	Yes	NIFM	0.64 (0.50–0.82)
Stroke	No	1	1
	Yes	0.58 (0.36–0.93)	0.47 (0.30–0.73)
Mental disorder	No	1	1
	Yes	0.80 (0.70–0.99)	0.71 (0.62–0.84)
Active smoking	No	1	–
	Yes	0.65 (0.50–0.85)	NIFM
Body mass index	≥30	1	1
	25–29.9	1.43 (1.11–1.84)	1.63 (1.25–2.13)
	<25	1.19 (0.91–1.55)	1.21 (0.92–1.59)
YEAR	2014	–	1
	2020	NIFM	1.34(1.10–1.64)

Metal disease included “anxiety and/or depression”. OR Odds ratios CI Confidence interval. COPD, Chronic obstructive pulmonary disease. NIFM. Not included in final the model.

mortality in people with COPD and improve health-related quality of life," states that "Health centers will have, in a standardized manner, a set of individual or group actions aimed at facilitating rehabilitation activities and improving the physical condition of patients diagnosed with COPD" (specific objective 3.8., 2) [19].

Although the improvement observed in our study population is significant, it remains insufficient: according to the 2020 data, more than half of the patients (56.5%) reported a sedentary lifestyle or low frequency of PA, and 30.1% walked for 10 min only one or no days per week.

The current recommendation for adults from the American College of Sports Medicine is at least 30 min of moderate-intensity exercise (five days a week) or 20 min of high-intensity exercise (three days a week) [38]. Two Spanish observational multicenter studies that classed COPD patients as inactive if their daily walking fell below 30 min found prevalence values of 13.7% in 2014 [39] and 15% in 2017 [40].

The variability in the methodology used to quantify PA in COPD patients, which is based on total amount of PA, intensity, or estimates of energy expenditure, hinders comparisons between studies. Additionally, it is important to note that self-reported assessments of PA tend to overestimate levels when compared with objective measurements based on monitors [41]. It is generally accepted that PA measured by questionnaires can be used to categorize patients in large epidemiological studies [42].

In their study of the 2009 EHISS, Barbolla Benito et al. [22], found that 45% of COPD patients did not meet the minimum walking recommendations, defined as more than 150 min per week. Based on data from the 2017 EHISS, Sanchez Castillo et al. [21], reported that 37.9% of patients had low PA levels (<600 MET-min/week). Both studies point to a positive trend in PA levels, consistent with the results we present.

In their analysis of the 2010 Danish national health survey, Hansen et al. [25] found a physical inactivity level of <30% in COPD patients. The SPACE study, which was conducted in ten European countries and Israel with a sample of 2190 COPD patients, found that 32.9% self-reported being completely inactive, compared to 11.9% when assessed by a physician [43].

The Latin American LASSYC study, a multicenter and multinational study with a sample of 734 COPD patients, measured PA using the short version of the International Physical Activity Questionnaire and classified it based on a combination of frequency and energy expenditure. The authors concluded that 37.9% had low PA levels [44].

In the United States, Chen et al. [26] recently published a cross-sectional analysis of 274 COPD patients, with data collected from a national survey, where the prevalence of insufficient PA reached 69.3%.

As expected, we found that persons with COPD engaged much less in PA, in both variables used, than age- and sex-matched controls, thus confirming the findings of previous studies on PA in COPD [22,24,25,27,45]. These patients are characterized by a significantly shorter duration, lower intensity, and lower frequency of PA than their healthy counterparts [24]. This observation has been associated with lower exercise capacity and higher dyspnea intensity scores [27]. It seems that, regardless of disease severity, PA decreases over time, accompanied by a decline in lung function and health status [46]. Furthermore, both moderate and severe exacerbations accelerate the decline in PA in patients with COPD [47].

We also found significant sex differences in PA among COPD patients, with males reporting more frequent PA. This association is not consistent in the literature. National studies based on the EHISS by Sánchez Castillo et al. [48] and Barbolla et al. [22], as well as the Latin American LASSYC study [44], found sex differences in PA. However, in a national observational multicenter study of 4574 patients aged 40 years or older attending primary care and pulmonology clinics, Naberan et al. [49] did not find this relationship. Similarly, the relationship was not found in the investigation by Albarrati et al. [27] on risk factors associated with reduced PA in 88 stable community COPD patients compared with 44 controls or in the studies by Pitta et al. [45], Hansen et al. [25], or Chen et al. [26].

It should be noted that most studies on PA and COPD have been conducted in predominantly male populations, although we know that the prevalence of this disease is increasing in women, likely owing to their increasing exposure to risk factors. Sex differences in PA have been studied in the Spanish general population. Patterns differ between age groups, with higher PA levels in adult women than men and a higher prevalence of vigorous and light PA in men, while women engage in more moderate PA [50], likely owing to more competitive motivation to achieve long-term goals in men than in women. On the other hand, women with COPD who have had a myocardial infarction are significantly more likely to die in hospital, probably owing to the greater burden of comorbidities [51]. Consequently, pending further sex-specific research results, female COPD patients are a target group for promoting adherence to healthy lifestyle recommendations, including PA.

We also found higher inactivity with increasing age and lower educational level, consistent with other studies in the COPD population [21,22,25,26,44], making these vulnerable groups important targets for promoting PA.

We observed a negative association between PA and obesity measured by BMI, which has also been reported in the literature [21,22,25,52]. A study in Japan on the impact of extrapulmonary comorbidities on PA in COPD concluded that lean body mass index correlates better with exercise capacity, as it better reflects muscle mass [52], thus emphasizing the importance of assessing body composition in this group using multiple measures [53].

Smoking was also associated with higher levels of inactivity, a finding generally supported by studies published to date on COPD patients [21,54]. Moreover, inactivity has been associated with a higher pack-year index [54]. The significance of this finding lies, in part, in the reduction of premature mortality and hospitalization in COPD

associated with the declining prevalence of smoking in Spain over the past two decades [55]. PA reduces the number of hospital admissions in both smokers and non-smokers with COPD [56]. Additionally, increasing PA levels are associated with better self-perceived health status in the general population, including smokers, former smokers, and non-smokers [57]. Moreover, health behaviors tend to cluster, with smoking being the factor most closely associated with other unhealthy lifestyle factors, such as physical inactivity [58].

Consistent with previous studies, other predictors of less frequent PA in our study were a history of stroke or mental disorders and poorer self-perceived health status [20,22,44,51,59]. The negative association between anxiety and depression and PA appears to be bidirectional, as it has been observed that COPD patients with more frequent PA have a lower risk of developing these conditions [59]. This finding is particularly relevant, considering that mental disorders are more prevalent in the COPD population than in the general population and have a negative impact on prognosis by increasing the risk of exacerbations and mortality [60].

Efforts must continue to promote greater adherence to PA recommendations in the Spanish COPD population. Significant health benefits have been observed with relatively small increases in PA in both the general population and COPD patients at all stages of the disease [15]. Population-based campaigns targeting these patients will be optimized if they promote daily activity, walking, structured exercise, and reduced sedentary lifestyle. It is important to implement lifestyle improvement programs for the most vulnerable patient groups, namely, those over 65 years of age, those with a low educational level, obese persons, women, and individuals with mental disorders.

Healthcare professionals need to be aware of these patient profiles. Their approach should be individualized, with a person-centered focus that includes optimizing pharmacological treatment for symptom control and reducing exacerbations, comprehensive assessment with emphasis on exercise tolerance, body composition, and mental well-being, as well as behavioral interventions to identify internal and external barriers to participation in PA [61]. Integrating licensed professionals in sports and exercise sciences into therapeutic teams will facilitate the necessary multidisciplinary approach to these patients.

No specific intervention has consistently improved participation in PA in persons with COPD [62]. However, interventions promoting PA, particularly those incorporating wearables that enable self-monitoring of activity, contribute to a significant increase in the number of steps taken while walking [63]. Group exercise is recommended, as it provides psychological strength, reduces social isolation, and improves well-being.

Future research on PA in COPD should align with standardized measurement methodology recommendations [42]. Studies defining recommendations for different intervention models are needed. The role of digital technologies, which can facilitate patient participation in PA promotion programs and self-care, also requires further investigation.

Investing in policies to promote PA will contribute directly to achieving improved health and well-being and to reducing inequalities in this area [4]. Active and healthy aging among people with chronic diseases, including COPD, will make it possible to face the challenges of a sedentary lifestyle and decreased functional capacity. Our study generates knowledge that allows us to address some gaps regarding PA in COPD clinical guidelines and helps to improve the management of these patients, their clinical care, and their treatment. Data on the variables associated with less frequent PA and walking can be used to train health professionals to identify inappropriate patterns and tailor their care more efficiently. Our findings for sociodemographic variables can promote equity and equality in health among vulnerable groups, with a gender perspective. We provide information that should enable local, national, and international government agencies to become more sensitive and effective in promoting PA and walking in people with COPD. The outcome will be to improve patients' daily lives while reducing societal and healthcare burdens.

4.1. Strengths and limitations

The main strengths of this study are that we obtained data on COPD patients from the general Spanish population and were thus able to analyze variables such as self-rated health, lifestyles, and sociodemographic characteristics, which cannot be obtained from clinical records.

Our findings are subject to a series of limitations. First, as this is a cross sectional study, it cannot address causality. Second, the questions used for self-reported COPD and to assess PA have not been validated in the EHISS. Third, treatment, duration of treatment, and complications of COPD are not collected in the EHISS. Fourth, since the initial participation rates for the EHISS were 61% and 59% in the years 2014 and 2020, respectively, a non-response bias must be considered [17,18]. Fifth, it did not analyze the participants' nationality (immigrants/Spanish-born), despite the importance of this sociodemographic variable. We followed this approach because the immigrant population was small, representing only 4.39% in the EHISS2014 and 4.58% in EHISS2020. Sixth, the question used to identify participants with diabetes (Supplementary Table 1) prevented us from distinguishing between type 1 and type 2 diabetes. Seventh, the EHISS is based on self-reported data and, therefore, may be affected by the bias inherent to interview-based population surveys. Since the initial participation rates for the EHISS were 61% and 59% in the years 2014 and 2020, respectively, a non-response bias must be considered [17,18]. Recall bias, i.e., recalling specific information better and more frequently than other information, must also be considered. Finally, social-desirability bias, defined as the tendency of participants to answer questions in a way that will be viewed more favorably by others, led participants to over-report "good behavior" or under-report "bad", or "undesirable behavior" with respect to PA [64,65].

Finally, as commented on in the methods section, we must take into account the effect on our results of the COVID pandemic and the subsequent changes that had to be introduced in the EHISS 2020 methodology [18].

5. Conclusion

The trend in self-reported adherence to PA among Spanish COPD patients is favorable but limited. Insufficient PA levels are more prevalent in COPD patients than in the general population. The main predictors of insufficient PA were female sex, older age, lower educational level, smoking, obesity, and mental disorders. Public health strategies should focus on these vulnerable groups. More evidence is needed on PA outcomes in COPD, with emphasis on sex differences.

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CRediT authorship contribution statement

Carlos Llamas-Saez: Conceptualization, Validation, Writing – original draft, Writing – review & editing. **Teresa Saez-Vaquero:** Conceptualization, Validation, Writing – original draft, Writing – review & editing. **Rodrigo Jiménez-García:** Data curation, Writing – original draft, Writing – review & editing. **Ana López-de-Andrés:** Data curation,

Writing – review & editing. **David Carabantes-Alarcón:** Writing – original draft, Writing – review & editing. **José J. Zamorano-León:** Software, Writing – review & editing. **Natividad Cuadrado-Corrales:** Validation, Writing – review & editing. **Ricardo Omaña-Palanco:** Validation, Writing – review & editing. **Javier de Miguel Diez:** Validation, Writing – review & editing. **Napoleón Pérez-Farinos:** Conceptualization, Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

All authors declare that they have none Conflict of Interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rmed.2023.107458.

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