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Original Article

Factors affecting work productivity and activity impairment among chronic obstructive pulmonary disease patients

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Abstract: Chronic obstructive pulmonary disease (COPD) can negatively affect patients' employment and work-life activities with a significant indirect economic impact. The current study aimed to measure unemployment, work productivity, activity impairment, and their associated factors among COPD patients. A cross-sectional study was conducted in the Chest outpatient clinic, Mansoura University Hospital, Egypt. COPD patients completed an interviewer-administered questionnaire including sociodemographic, occupational data, clinical history, medical research council (mMRC) dyspnea scale, the COPD assessment test (CAT), and work productivity and activity impairment Questionnaire (WPAI-COPD). A total 140 patients were included in the study and 22.1% of them gave up their jobs because of their COPD. Due to COPD, the mean percentage of daily activity impairment was 39.8 among all patients. The mean percentages of absenteeism, presenteeism, and overall work impairment among the 84 working patients were 0.07, 24.4, and 24.5. The CAT score was the significant predictor of all components of WPAI. In conclusion, COPD causes early retirement, high work productivity loss, and impaired daily activities. Higher CAT scores and increased disease severity significantly increase absenteeism, presenteeism, overall work, and activity impairment. Thus, timely diagnosis of COPD with appropriate management can help improve outcomes and lower the disease burden and economic impact.

Key words: COPD assessment test (CAT), Chronic obstructive pulmonary disease (COPD), Modified medical research council (mMRC), Productivity, Work productivity and activity impairment questionnaire (WPAI)

Introduction

Chronic obstructive pulmonary disease (COPD) is a common progressive lung disease characterized by persistent respiratory symptoms and airflow limitation[1)]. COPD

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is a leading cause of morbidity and mortality worldwide that is ranked as the third leading cause of death globally[2]. The global prevalence of COPD ranges from 10.9 to 13.4%[3].

COPD is associated with a significant burden on patients and a decline in their quality of life. Most COPD patients face a significant challenge to perform their daily activities. In addition, they experience impaired sleep quality and greater psychological distress (anxiety and depression)[4]. This burden of COPD is associated with a substantial economic impact, either directly (medical and healthcare costs) or indirectly (reduced productivity)[5, 6].

Although COPD is considered a disease of old age, it is highly prevalent among the working age group and its adverse effects on work productivity have been a focus of studies from different countries. Among these studies, Dhamane *et al.*[7] studied nearly 200,000 employed COPD patients with a mean age of 56.5 yr in the United States. Another study examined nearly 4,000 COPD patients from the United States and five European countries with a mean age of 59 yr from whom only 27% were employed[8] and from South Asia Ghoshal *et al.*[9] studied 1,000 Indian COPD patients with a mean age of 45 yr and 46% of them were in employment.

Collectively, prior studies found that COPD patients, compared to individuals without COPD, had lower employment rates. In addition, among employed COPD patients, most studies showed that patients with COPD took more time off work, worked fewer hours, reported poorer work performance, and had a higher chance of absenteeism. The level of work impairment and productivity worsens with increasing age, disease severity, and the number of comorbidities[7–9].

Furthermore, a study on nearly 60,000 COPD patients from the Middle East and North Africa (MENA) region reported that 28.4% stopped working because of their COPD condition. In addition, 21.5% of those who were employed had limited work capacity and 17.2% had missed work in the previous year due to their COPD. At least 30% of subjects reported limitations in all areas of daily life activities[10]. Moreover, in Jordan, the perceived quality of life (QoL) among COPD patients was low with the lowest scores in the physical domain (which relates mainly to patients' physical abilities to perform tasks)[11].

In Egypt, COPD is a major contributor to morbidity and mortality (the 9th cause of death in 2019) with a prevalence of 1,899 cases /100.000 in 2019[12]. In Egypt, COPD is more frequent in men (60.7%) than in women and those of working age (20–65 yr) represent 65.3% of COPD cases. Those figures are comparable to MENA region figures (57.6% and 60.2%) but higher than global figures (49.4% and 42.1%)[13].

In addition, over the period 1990–2019, although the age-standardized burden of COPD has decreased, the largest increases in the age-standardized point prevalence of COPD were found regionally in the MENA region and nationally in Egypt[14]. Although some research reported reduced health-related quality of life in Egyptian COPD patients[15], no data is present on the specific effects of COPD on employment, and work productivity in Egyptian COPD patients.

Thus, this study aimed to measure the prevalence of unemployment, assess work productivity and activity impairment, and describe their associated factors among Egyptian COPD patients. Highlighting the indirect economic load of COPD may encourage targeted preventive and proper management efforts to improve COPD outcomes and diminish its burden.

Subjects and Methods

Study design and setting

This observational descriptive cross-sectional study with an analytic component was conducted in the outpatient Chest Clinic, Mansoura University Hospital, Mansoura, Egypt during the period from January 1st, 2021, to December 31st, 2021.

Study population and sample size calculation

A previous study showed that the mean (standard deviation) of the percent activity impairment due to COPD was 55.6 (20.7) among COPD patients[9]. Using similar assumptions, 80% power, 95% confidence level, and 2-tailed significance, the estimated sample size was at least 137 patients. The sample size calculation was done using the G*Power program (http://www.gpower.hhu.de/). Patients were recruited sequentially while attending the chest outpatient clinic. Inclusion criteria included patients diagnosed with COPD for at least one year who were willing to participate in the study. Patients were diagnosed with COPD following GOLD criteria[1]. An overall of 140 patients agreed to participate in the study.

Data collection tool

Each patient completed a predesigned interviewer-administered questionnaire during his/her visit to the clinic. It included:

1. Sociodemographic data
- Age, sex, residence, education, smoking history, height, and weight.
- Occupational history (currently working or not, cause of unemployment/retirement, and type of job).

2. Clinical data

Duration of disease, last 12 months exacerbation history (number and severity)[1)], last 12 months COPD-related health care resource utilization (HCRU) (number of hospitalizations, visits to an emergency department and/or physicians), and comorbidities (number and type).

3. Modified Medical Research Council (mMRC) dyspnea scale

A simple measure of breathlessness that is considered adequate for assessment of COPD symptoms. It is easy-to-use five statements that describe nearly the full range of dyspnea in daily living from none (Grade 0) to almost complete incapacity (Grade 4). An mMRC threshold of ≥2 is used to separate "less breathlessness" from "more breathlessness"[1, 16)].

4. The COPD Assessment Test (CAT)

A simple, standardized, reliable, and validated 8-item questionnaire, with good discriminant properties. It is used to measure the health status of patients with COPD and the impact of COPD on a patient's health status which is useful for assessing and monitoring COPD with worldwide relevance. The 8 items cover cough, sputum production, wheezes, dyspnea, activity limitation at home, social function, energy/fatigue, and sleep disturbance on a 6-point Likert scale (0–5). The total score range of 0–40 with higher scores indicating a higher impact of the disease and worse health[17)]. It also can provide a reliable score of COPD severity and is considered one of the COPD progression markers[18, 19)]. A CAT total score of ≥10 has been suggested to classify patients as highly symptomatic[1)].

5. Work Productivity and Activity Impairment Questionnaire (WPAI-COPD)

A 6-item questionnaire designed to measure impairments in work and daily activities in COPD patients during the previous 7 d. First, the patients were asked whether they are currently employed (Q1); if *yes*, the patients complete all questions 2 to 6, if *no*, they answer directly question 6. Questions 2–5 asked for the number of hours missed from work due to COPD (Q2), hours missed from work due to causes other than COPD (Q3), total hours actually worked (Q4), and the extent to which COPD limits the patient at work (scale 1–10) (Q5). Question 6 asked all patients about the degree to which their COPD limits their performance of regular daily activities (scale 1–10). Scores are multiplied by 100 to be expressed in percentages and the WPAI yields four scores; absenteeism (work time missed) [Q2/(Q2+Q4)], presenteeism (diminished efficiency on-the-job) [Q5/10], overall work impairment (absenteeism + presenteeism) [Q2/(Q2+Q4)+{(1-(Q2/(Q2+Q4) × (Q5/10)}], and daily activity impairment [Q6/10]. The higher scores imply more impairment and less productivity[20–22)].

Statistical analysis

Data were collected, coded, and analyzed using IBM SPSS version 25. Quantitative variables were tested for normality using the Kolmogorov–Smirnov test. Quantitative data were summarized using median (minimum and maximum) or mean (standard deviation). Qualitative data were described using numbers and percentages. A nonparametric independent samples (Mann–Whitney U or Kruskal–Wallis) test was used to compare scores of WPAI-COPD domains between groups. Non-normally distributed data were log-transformed. The correlation between scores of WPAI-COPD domains and patients' characteristics was tested using Spearman's correlation. Significant correlations were entered in multivariate stepwise linear regression analysis for the detection of independent predictors of WPAI-COPD domains. *P*-value ≤0.05 was considered significant.

Ethical considerations

The proposal was approved by the Institutional Research Board (IRB), Faculty of Medicine-Mansoura University (Reference number R.20.04.790.R1.R2). Informed consent was obtained from each participant who was willing to participate in the study after clarification of study objectives and assurance of data confidentiality.

Results

A total of 140 COPD-diagnosed patients participated in the study. At the time of the study, 56 (40%) patients were not working. Most of those were males (92.9%) and >55 yr old (82.1%). The majority of them were from rural residences (62.5%), currently married (58.9%), with lower educational levels (69.6%), and ex-smokers (55.4%). They previously were employed in a wide variety of jobs with half of them worked medium-skilled jobs. More than half

(58.5%) of them owed their retirement to their COPD status. Regarding their clinical status, 69.6% had COPD for more than 5 yr and all of them (100%) had an mMRC score ≥2 and a CAT score ≥10. During the last 12 months nearly half of them had >2 exacerbations, 75% had moderate/severe exacerbations, and 71.4% were hospitalized because of their COPD status.

Amongst all 140 studied patients, the mean ± SD percentage of daily activity impairment due to COPD was 39.8 ± 21.4. In addition, work productivity impairment was reported among the 84 patients who were employed at the time of the study. Due to COPD, the mean ± SD percentage of; work time missed (absenteeism) was 0.07 ± 0.12, impairment while working (presenteeism) was 24.4 ± 15.4, and overall work impairment was 24.5 ± 12.1.

Significantly lower work productivity (higher absenteeism, presenteeism, and overall work impairment) was reported among older patients and those working low-skill jobs. Absenteeism was significantly higher among patients from rural residences and ex-smokers. Patients with lower educational levels reported significantly higher absenteeism and presenteeism. However, significantly greater daily activity impairment was found among older patients, from rural residences, currently single, with lower educational levels, ex-smokers, obese, unemployed, or who worked a low-skill job (Table 1).

Moreover, work productivity and activity impairment were significantly variable in relation to the clinical characteristics of the studied patients (Table 2). Significantly lower work productivity and higher daily activity impairment were found among patients with more than one associated comorbidity, suffering from COPD for more than 5 yr, with an mMRC score ≥2, and a CAT score ≥10. In addition, during the last 12 months, patients who had more than one COPD exacerbation that was moderate or severe, were hospitalized or visited the emergency department at least once, or consulted a physician more than 3 times because of their COPD status had significantly higher daily activity impairment and lower work productivity.

Furthermore, the three domains of work productivity (absenteeism, presenteeism, and overall work impairment) had a significant correlation with all clinical characteristics as well as age and type of worked job. However, daily activity impairment significantly correlated with all studied sociodemographics (except for sex) and all clinical characteristics among studied patients (Table 3).

Multivariate stepwise linear regression analysis was conducted to find out which of the studied variables can predict different domains of WPAI-COPD. For percent work time missed (absenteeism) due to COPD, significant predictors were the CAT score and the number of physician visits during the last 12 months ($F=11.642$, $p<0.001$). Approximately 52.6% of the variance of absenteeism could be accounted for by both the CAT score (20.9%) and the number of physician visits (31.7%). However, the CAT score was the only significant predictor for both percent impairment while working (presenteeism) ($F=106.41$, $p<0.001$) and percent overall work impairment ($F=68.52$, $p<0.001$) due to COPD. CAT scores accounted for 56.5% and 45.5% of the change in both percentages respectively (Table 4).

As for percent daily activity impairment due to COPD, employment status, mMRC score, and the CAT score were significant predictors ($F=177.25$, $p<0.001$). Together they can explain 79.6% of the variation in activity impairment. The individual contribution of the CAT score was 72.4%, while the mMRC score was 5.9% and employment status was 1.2% (Table 4).

Discussion

Egypt is one of the lower-middle-income countries with a complex healthcare system joining both public and private providers and financiers. With several strengths and opportunities of the Egyptian healthcare system, there remain points of weakness and challenges[23]. Although it provides a large infrastructure, the main concern is very limited funding (4.7% of gross domestic product) making private expenditures the main source of health funding in Egypt. This has led to discrepancies in health care provision -and its level- between urban and rural areas as well as among different socioeconomic levels. In addition, the private sector has more and/or better medical equipment than underfunded public facilities[24]. Recently, the government has approved and initiated the implementation of the Social Health Insurance law which will guarantee adequate and continuous funding for health and diminishes the share of out-of-pocket expenditures[25].

COPD is a major threat to respiratory health in Egypt, not only because of the abundance of non-targeted risk factors but also because of its underdiagnosis/misdiagnosis. Initial diagnosis of COPD is often reached when it is moderately advanced, usually at the time of an acute exacerbation. At the level of primary care, there is a lack of awareness regarding COPD as well as a lack of access to spirometry to confirm its diagnosis. However, this is not the case in higher levels of care, specialists with good expertise in respiratory health readily diagnose COPD

Table 1. Overall scores of different domains of WPAI and their variation according to sociodemographic characteristics of studied patients

Characteristics	Work productivity impairment Median (min–max)				% Activity impairment	
	n (%)	% Absenteeism	% Presenteeism	% Work impairment	n (%)	Median (min–max)
Overall	84 (100)	0.0 (0.0–0.43)	20 (10–80)	20 (10–80)	140 (100)	30 (10–90)
Age						
≤50	43 (51.2)	0.0 (0.0–0.43)	20 (10–70)	20 (10–50)	47 (33.6)	20 (10–80)
>50	41 (48.8)	0.0 (0.0–0.43)	30 (10–80)	27 (10–80)	93 (66.4)	55 (10–90)
		p=0.004	p<0.001	p=0.002		p<0.001
Sex						
Male	76 (90.5)	0.0 (0.0–0.43)	20 (10–80)	20 (10–80)	128 (91.4)	40 (10–90)
Female	8 (9.5)	0.0 (0.0–0.0)	25 (20–30)	25 (20–30)	12 (8.6)	30 (20–60)
		p=0.066	p=0.900	p=0.473		p=0.290
Residence						
Rural	31 (36.9)	0.0 (0.0–0.43)	30 (10–70)	25 (10–50)	66 (47.1)	40 (10–90)
Urban	53 (63.1)	0.0 (0.0–0.33)	20 (10–80)	20 (10–80)	74 (52.9)	30 (10–90)
		p=0.012	p=0.239	p=0.562		p=0.008
Marital status						
Single[a]	13 (15.5)	0.0 (0.0–0.29)	30 (10–70)	26 (10–58)	36 (25.7)	55 (10–90)
Married	71 (84.5)	0.0 (0.0–0.43)	20 (10–80)	20 (10–80)	104 (74.3)	30 (10–90)
		p=0.988	p=0.673	p=0.462		p=0.007
Education[b]						
≤Basic	18 (21.4)	0.0 (0.0–0.43)	30 (10–70)	29 (10–50)	57 (40.7)	50 (10–90)
>Basic	66 (78.6)	0.0 (0.0–0.43)	20 (10–80)	20 (10–80)	83 (59.3)	30 (10–80)
		p<0.001	p=0.023	p=0.079		p<0.001
Smoking						
Ex–smoker	23 (27.4)	0.0 (0.0–0.33)	30 (10–70)	25 (10–58)	55 (39.3)	40 (10–90)
Current smoker	61 (72.6)	0.0 (0.0–0.43)	20 (10–80)	20 (10–80)	85 (60.7)	30 (10–90)
		p=0.029	p=0.300	p=0.662		p=0.001
Obesity						
No	68 (81.0)	0.0 (0.0–0.43)	20 (10–70)	20 (10–58)	100 (71.4)	30 (10–90)
Yes	16 (19.0)	0.0 (0.0–0.43)	30 (20–80)	26 (17–80)	40 (28.6)	50 (20–90)
		p=0.238	p=0.088	p=0.185		p<0.001
Currently employed						
No			Not applicable		56 (40.0)	60 (20–90)
Yes					84 (60.0)	30 (10–80)
						p<0.001
Type of job[c]						
Low skill	12 (14.2)	0.2 (0.0–0.33)	40 (20–70)	32 (20–50)	30 (19.3)	55 (20–90)
Medium skill	36 (42.9)	0.0 (0.0–0.43)	25 (10–80)	23 (10–80)	64 (45.7)	30 (10–90)
High skill	36 (42.9)	0.0 (0.0–0.33)	20 (10–50)	20 (10–42)	46 (32.9)	30 (10–80)
		$p1$<0.001, $p2$=0.001	$p1$=0.001, $p2$=0.028	$p1$=0.002		$p1$<0.001, $p2$=0.030

[a] single, divorced, widowed; [b] according to International Standard Classification of Education; [c] according to International Standard Classification of Occupations (ISCO-88).

n: number; *p1*: significance between low and high; *p2*: significance between low and medium; WPAI: Work Productivity and Activity Impairment.

and prescribe GOLD-recommended pharmacological therapies. Pharmacological therapies are also available, although relatively expensive, especially for uninsured patients. Unfortunately, newer drugs and nonpharmacological interventions for the management of COPD are not quite available in Egypt[26, 27].

Productivity losses and early retirement are the main contributors to the indirect costs of chronic diseases[6]. The current study investigated the effect of COPD on employment, work productivity, and daily activity impairment

Table 2. Overall scores of different domains of WPAI and their variation according to studied clinical characteristics of studied patients

Characteristics	Work productivity impairment Median (min–max)				% Activity impairment	
	n (%)	% Absenteeism	% Presenteeism	% Work impairment	n (%)	Median (min–max)
Overall	84 (100)	0.0 (0.0–0.43)	20 (10–80)	20 (10–80)	140 (100)	30 (10–90)
Comorbidities						
No	21 (25.0)	0.0 (0.0–0.29)	20 (10–70)	20 (10–50)	22 (15.7)	20 (10–70)
Yes	63 (75.0)	0.0 (0.0–0.43)	30 (10–80)	25 (10–80)	118 (84.3)	40 (10–90)
		p=0.007	p=0.018	p=0.069		p<0.001
Comorbidities, n[a]						
≤1	37 (58.7)	0.0 (0.0–0.43)	20 (10–80)	20 (10–80)	56 (47.5)	30 (10–80)
>1	26 (41.3)	0.2 (0.0–0.43)	40 (10–70)	30 (10–50)	62 (52.5)	50 (10–90)
		p=0.001	p=0.001	p=0.001		p=0.002
Disease duration						
≤5	59 (70.2)	0.0 (0.0–0.43)	20 (10–70)	20 (10–50)	76 (54.3)	30 (10–80)
>5	25 (29.8)	0.0 (0.0–0.43)	30 (10–80)	29 (10–80)	64 (45.7)	55 (10–90)
		p=0.024	p=0.024	p=0.032		p<0.001
Exacerbation, n[b]						
≤1	49 (58.3)	0.0 (0.0–0.43)	20 (10–50)	20 (10–40)	105 (75.0)	30 (10–70)
>1	35 (41.7)	0.0 (0.0–0.43)	30 (10–80)	29 (10–80)	35 (25.0)	60 (10–90)
		p=0.001	p<0.001	p<0.001		p<0.001
Exacerbation severity						
Mild	57 (67.9)	0.0 (0.0–0.43)	20 (10–50)	20 (10–40)	71 (50.7)	20 (10–70)
Moderate/Severe	27 (32.1)	0.0 (0.0–0.43)	40 (10–80)	30 (10–80)	69 (49.3)	60 (10–90)
		p<0.001	p<0.001	p<0.001		p<0.001
HCRU[b]						
• Hospitalizations						
No	58 (69.0)	0.0 (0.0–0.43)	20 (10–50)	20 (10–40)	74 (52.9)	25 (10–70)
Yes	26 (31.0)	0.2 (0.0–0.43)	40 (10–80)	32 (10–80)	66 (47.1)	60 (10–90)
		p<0.001	p<0.001	p<0.001		p<0.001
• ED visits						
No	58 (69.0)	0.0 (0.0–0.43)	20 (10–50)	20 (10–40)	66 (47.1)	20 (10–60)
Yes	26 (31.0)	0.2 (0.0–0.43)	40 (10–80)	32 (10–80)	74 (52.9)	60 (10–90)
		p<0.001	p<0.001	p<0.001		p<0.001
• Physician visits[c]						
≤3	63 (75.0)	0.0 (0.0–0.43)	20 (10–60)	20 (10–43)	86 (61.4)	30 (10–70)
>3	21 (25.0)	0.0 (0.0–0.33)	30 (10–80)	27 (10–80)	54 (38.6)	60 (10–90)
		p=0.099	p=0.156	p=0.181		p<0.001
mMRC score						
<2	17 (20.2)	0.0 (0.0–0.43)	10 (10–30)	10 (10–30)	17 (12.1)	10 (10–30)
≥2	67 (79.8)	0.0 (0.0–0.43)	30 (10–80)	25 (10–80)	123(87.9)	40 (10–90)
		p=0.004	p<0.001	p<0.001		p<0.001
CAT score						
<10	7 (8.3)	0.0 (0.0–0.43)	20 (10–20)	20 (10–20)	7 (5.0)	20 (10–20)
≥10	77 (91.7)	0.0 (0.0–0.43)	20 (10–80)	20 (10–80)	133 (95.0)	40 (10–90)
		p=0.088	p=0.040	p=0.050		p=0.001

[a] among comorbidities (Yes); [b] during the last 12 months; [c] outpatient/chest specialist.

CAT: COPD assessment test; ED: emergency department; HCRU: healthcare resources utilization; mMRC: modified medical research council–dyspnea scale; n: number; WPAI: Work Productivity and Activity Impairment.

Table 3. Correlation between different domains of WPAI and studied sociodemographic and clinical characteristics of studied patients

Characteristics	%Absenteeism[a] n=84		%Presenteeism[a] n=84		%Work impairment[a] n=84		%Activity impairment[a] n=140	
	r	*p*	r	*p*	r	*p*	r	*p*
Age (yr)	0.36	0.001	0.43	<0.001	0.39	<0.001	0.64	<0.001
Sex	–0.20	0.07	–0.01	0.90	0.08	0.47	–0.09	0.29
Residence	–0.28	0.011	–0.13	0.24	–0.06	0.57	–0.23	0.007
Marital status	0.002	0.99	0.05	0.68	–0.08	0.47	–0.23	0.007
Education	–0.39	<0.001	–0.25	0.022	–0.19	0.08	–0.47	<0.001
Current smoking	0.24	0.028	0.11	0.30	0.05	0.67	0.29	<0.001
BMI (kg/m^2)	0.06	0.60	0.16	0.14	0.15	0.17	0.32	<0.001
Currently employed			Not applicable				–0.63	<0.001
Type of job	–0.44	<0.001	–0.37	0.001	–0.33	0.002	–0.34	<0.001
Comorbidities (n)	0.45	<0.001	0.42	<0.001	0.35	0.001	0.44	<0.001
Disease duration (years)	0.28	0.009	0.26	0.019	0.23	0.034	0.49	<0.001
Exacerbation (n)	0.36	0.001	0.47	<0.001	0.45	<0.001	0.68	<0.001
Exacerbation severity	0.68	<0.001	0.6	<0.001	0.51	<0.001	0.72	<0.001
HCRU[b]								
Hospitalizations (n)	0.68	<0.001	0.65	<0.001	0.56	<0.001	0.77	<0.001
ED visits (n)	0.61	<0.001	0.61	<0.001	0.55	<0.001	0.76	<0.001
Physician visits (n)	0.25	0.023	0.29	0.007	0.28	0.009	0.54	<0.001
mMRC score	0.49	<0.001	0.62	<0.001	0.58	<0.001	0.82	<0.001
CAT score	0.63	<0.001	0.75	<0.001	0.67	<0.001	0.89	<0.001

[a] log-transformed variable; [b] during the last 12 months.

n: number; WPAI: Work Productivity and Activity Impairment; CAT: COPD assessment test; ED: emergency department; HCRU: health-care resources utilization; mMRC: modified medical research council dyspnea scale.

Categorical variables were entered as dummy variables with codes as: Sex (male=1, female=2), Residence (rural=1, urban=2), Marital status (single=1, married=2), Education (≥basic=1, >basic=2), Current smoking (Yes=1, No=2), Currently employed (No=1, Yes=2), Type of job (low skill=1, medium skill=2, high skill=3), Exacerbation severity (mild=1, moderate/severe=2).

Table 4. Multivariate stepwise linear regression of significant independent predictors of different domains of WPAI among studied patients

Characteristics	%Absenteeism[a] n=84			%Presenteeism[a] n=84			%Work impairment[a] n=84			%Activity impairment[a] n=140		
	B (SE)	*p*	Added R^2	B (SE)	*p*	Added R^2	B (SE)	*p*	Added R^2	B (SE)	*p*	Added R^2
Physician visits (n)[b]	–0.144 (0.038)	0.001	0.317	–	–	–	–	–	–	–	–	–
Currently employed	–	–	–	–	–	–	–	–	–	–0.076 (0.26)	0.005	0.012
mMRC score	–	–	–	–	–	–	–	–	–	0.142 (0.028)	<0.001	0.059
CAT score	0.059 (0.014)	<0.001	0.209	0.033 (0.003)	<0.001	0.565	0.026 (0.003)	<0.001	0.455	0.022 (0.003)	<0.001	0.724
Constant	–1.49			0.827			0.913			0.834		
Significance	F=11.642, p<0.001			F=106.41, p<0.001			F=68.52, p<0.001			F=177.25, p<0.001		
Total R^2	R^2=0.526			R^2=0.565			R^2=0.455			R^2=0.796		

[a] log–transformed variable; [b] during the last 12 month.

n: number; WPAI: Work Productivity and Activity Impairment; mMRC: modified medical research council dyspnea scale; CAT: COPD assessment test.

Categorical variables were entered as dummy variables with codes as: Sex (male=1, female=2), Residence (rural=1, urban=2), Marital status (single=1, married=2), Education (≥basic=1, >basic=2), Current smoking (Yes=1, No=2), Currently employed (No=1, Yes=2), Type of job (low skill=1, medium skill=2, high skill=3), Exacerbation severity (mild=1, moderate/severe=2).

and their associated factors and predictors.

At the time of the study, 40% of studied patients were not working, with more than half of them referring their unemployment to their COPD. In a global study of 26 countries, there was variability in the unemployment rates due to airflow obstruction ranging from as low as 6% up to 60%, with higher rates in high-income countries, which could be explained by different benefits and welfare systems. Even with the observed variability, obstructive lung diseases were associated with lower work-life participation and increased levels of unemployment which may reveal some of the high economic impacts of COPD[28].

In addition, like the current study, Adab *et al.*[19] reported that older age, lower educational level, and worse prognostic scores were associated with a smaller chance of being employed and with follow-up an association between an increasing number of COPD-related hospital admissions, worsening of mMRC scores, and decreased likelihood of remaining in paid employment was found.

Another sector of the economic impact of COPD can be owed to the reduced work productivity of working COPD patients. The current study reported a mean percentage work time missed (absenteeism) of 0.07, impairment while working (presenteeism) of 24.4, and overall work impairment of 24.5. Scores were noticeably low for absenteeism similar to the results of Brakema *et al.*[29], which makes presenteeism the main contributing component to the reported high productivity loss in agreement with previous research[9, 30–32].

Previous studies reported higher absenteeism mean percentages, however, comparable results were reported for presenteeism[7, 33–35]. Moreover, for overall work impairment while similar mean percentages were reported[7, 30, 35, 36], relatively lower[31, 32], as well as relatively higher mean percentages, were also reported in different countries[9, 33, 34].

In Egypt, informal employment is increasing across almost all forms of work, and it employs over half of the Egyptian workers. An important feature of informal employment is the low pay and lack of social insurance coverage and other related benefits applicable to formal employment. Informal workers lack maternity and sickness leaves, disability, unemployment, and old age benefits as well as private health care. They receive only a basic pension and basic medical care in a lower-quality public healthcare system[37]. This is probably what compels most employed COPD patients to show up at work and work while sick at the cost of decreased productivity, making absenteeism scores lower than reported in other countries[38].

Moreover, it was reported that even in a country with universal and free access to health care services; low SES, low education, and low-skilled jobs, among COPD patients, represent a barrier to early diagnosis and proper management of COPD, and are associated with worse clinical manifestations and poorer health-related quality of life[39]. This, and having to use public hospitals in Egypt, may have contributed to higher absenteeism in COPD patients employed in low-skilled jobs in the current study. Indeed, absenteeism, in the current study, was in part predicted by the number of physician visits during the last 12 months as was previously reported among asthma patients[40].

As the current study agreed with previous research on the negative effect of COPD on work productivity, the predictors of such effects were further investigated. The three domains of work productivity (absenteeism, presenteeism, and overall work impairment) significantly correlated with all clinical characteristics of the patients, and a high CAT score (≥10) was the significant independent predictor of all three domains.

Similarly, a high CAT score (≥10) was reported by previous research to be significantly associated with one or more of the work productivity scores of WPAI[18, 35, 41–43]. In addition, increasing COPD severity, evaluated by variable measures, almost always negatively impacts work productivity, and was significantly associated with the use of sick leaves, working while ill, and work productivity loss[7, 8, 19, 42, 44–46].

In addition, work productivity scores in the current study significantly correlated with all the assessed clinical parameters of the studied patients that can be considered as disease progression makers in agreement with prior research. The mMRC score, the number of exacerbations, hospital admissions, and/or comorbidities were the most described and their increase significantly heightened productivity losses[8, 29, 41–43, 47, 48].

Regarding the daily activity impairment component of WPAI, the current study found a mean percentage of 39.8, however, previous studies reported variable mean percentages across different countries. Similar overall means were reported in 6 countries in the Asia-Pacific region and five European countries and the United States[34, 35]. Still, higher means[36], as well as lower means were also reported[9, 30–33, 43]. This discrepancy may be due to differences in the demographics, the prevalence of COPD, and the number of patients with different disease severity across countries.

Further analysis described a significant correlation between activity impairment and all studied characteristics, however, CAT score, mMRC score, and employment status were the significant predictors of daily activity impairment. High CAT (≥10) and mMRC (≥2) scores imply high symptom burden and increased severity of the disease, and together they predicted more than 75% of impaired daily activities among studied COPD patients. Similarly, Ding *et al.*[35] and Igarashi *et al.*[43] described increased activity impairment with higher CAT scores, while Gruenberger *et al.*[45], Brakema *et al.*[49], Albarrati *et al.*[50], and Michalovic *et al.*[51] reported higher mMRC scores and increased breathlessness as robust predictors of high activity impairment.

GOLD recommends the use of CAT or mMRC to evaluate the symptoms of COPD, however, CAT utilizes multi-symptom assessment in contrast to just measuring the breathlessness via mMRC[1]. Although not completely independent, CAT was found to be more effective than mMRC in the evaluation of clinical symptoms. Cheng *et al.*[52] concluded that, in COPD patients, the CAT score truly reflects the severity of symptoms and medical resources utilization more than the mMRC score. This may explain the CAT score being an independent predictor of all measured WPAI domains in the current study.

Moreover, other authors noted a similar correlation between heightened activity impairment and increased disease severity, number of exacerbations, visits to emergency departments, and duration of COPD. All of which can be indicators of disease progression and increased severity[7, 45, 51, 53].

Another predictor of activity impairment detected in the current study was employment status. Those who were unemployed at the time of the study had significantly higher activity impairment than those who were employed. This could be explained by the fact that their COPD status and breathlessness degree (severe breathlessness was more frequent in unemployed patients) had reached a degree that impaired their working activities thus they had to quit their jobs, as was described by Brakema *et al*[29].

Moreover, some sociodemographic characteristics correlated significantly with impaired work productivity and daily activity. Increasing age, smoking status, obesity, and lower education were associated with increased impairments in agreement with other studies[29, 42, 43, 48, 51, 53]. These associations can be related to the progression of the disease, increasing severity, associated health problems, and health-related quality of life[42, 53, 54].

Although standardized tools were used, the authors acknowledge some limitations of the current study. The causal relationship between COPD severity and outcomes cannot be determined by the cross-sectional design. The subjective self-reported nature of collected data is another limitation, however, pulmonary function tests could not be done as being restricted due to regulatory COVID-19 protocols (as in many countries of the Middle East and Africa region) to avoid virus transmission due to coughing and droplet formation during the tests. The adopted consecutive sampling approach from a single center may limit the generalizability of the study results. Still, the current results, up to the authors' knowledge, are the first to discuss the negative impact of COPD on work productivity and its predictors among Egyptian COPD patients.

In conclusion, COPD has a significant impact on patients in terms of employment, work, and activity limitations. Productivity losses and activity impairments among COPD patients correlated primarily with their health and clinical parameter. CAT scores highly predict absenteeism, presenteeism, overall work impairment, as well as activity impairment among COPD patients.

Thus, tailored strategies for early and timely diagnosis of COPD as well as appropriate management which can control the disease at an early stage can help improve outcomes, lower the disease burden, and health care costs, and reduce the economic impact on health systems, patients, and employers. Strategies to ease breathlessness, improve symptoms, and reduce exacerbation should be incorporated into patients' daily routines to improve their ability to perform their daily activities and stay in active employment. Specific longitudinal population-based research is necessary to investigate the associated factors of early retirement and reduced productivity among working COPD patients. In addition, interventions that help keep people actively employed should be identified. Moreover, productivity losses among COPD workers should be acknowledged by employers and specific workplace programs are necessary to identify those with higher odds of facing increased work productivity loss. Interventions that allow COPD patients to remain employed and improve their productivity, according to their abilities, should be identified and implemented.

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