Economic burden of chronic obstructive pulmonary disease in Morocco: a cost of illness study

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Abstract

Chronic obstructive pulmonary disease (COPD) carries an important economic burden worldwide. However, the cost of this disease in Morocco is not well explored. This study aimed to estimate the economic cost associated with COPD in Morocco and identify its determinants.

A cost-of-illness, prevalence-based study using a bottom-up approach method, including COPD patients, was carried out in 2021-2022. The cost was estimated from a societal perspective, and the time horizon was 1 year. Data collection was performed using a questionnaire including socio-demographic, clinical data, and utilization of health care resources in 2019: hospitalization, medical tests, medications, and medical visits.

Direct health cost (DHC) was estimated by multiplying the use of health services by the official prices (unit costs) published by the National Agency for Health Insurance. The indirect cost (IC) represented by labor productivity losses was calculated using the human capital method. Costs were compared according to different sociodemographic and clinical factors. We included 159 patients; 82.4% were men, 80.4% were current or former smokers, and 78.7% were categorized as "high-risk" groups (grades C-D).

The DHC was estimated at $1816.6 per patient per year. Pharmaceutical and hospitalization costs represented the highest part of the total DHC (42.5% and 22.1%, respectively). The IC was estimated at $709.5±1081.3 per patient per year.

DHC increased with increasing disease severity and with the number of severe exacerbations ($p<0.001$). Current and former smokers were more costly to the healthcare system than nonsmokers ($p=0.029$). IC also increased with the number of severe exacerbations ($p=0.003$).

In this study, we showed that COPD in Morocco generates important costs for the health system, mainly related to smoking and the severity of the disease. It is therefore important to strengthen tobacco control measures in our country.

Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disease defined by permanent obstruction of the airways. It is an important cause of morbidity and mortality. In 2019, 212.3 million prevalent cases of COPD were reported worldwide [1].

The incidence rate of COPD was 200.5 per 100,000 [2]. More than 3 million people died of COPD in 2019 [1], and COPD was the 3rd leading cause of death worldwide [2].

COPD is a chronic disease requiring lifelong clinical care and

management, which consumes significant health-care resources (hospitalizations, medical visits, medications, medical tests), thus involving important direct costs incurred by individuals, families, governments, and insurers. Studies evaluating direct COPD costs have generated widely variable estimates across countries. In an international survey conducted in 12 countries, the annual direct cost of COPD per patient ranged from $504 in South Korea to $9981 in the USA [3].

COPD is also associated with a substantial economic burden in terms of indirect costs incurred by lost working days. According to the Centers for Disease Control and Prevention, total absenteeism costs were $3.9 billion in 2010, with an estimated 16.4 million days of work lost due to COPD [4].

Various factors are associated with the cost of COPD management. Data from the literature [5] have shown that there is a direct relationship between the severity of COPD and the cost of care. Indeed, the cost increases as COPD severity increases.

The chronic and progressive course of COPD is often marked by "exacerbations", and their management is associated with a high economic cost due to hospitalization and intense medical treatment to manage symptoms, which has been documented in several studies [5].

Smoking is seen as the most important risk of COPD. The results of the studies showed that smoking is associated with higher health care utilization and cost [6,7]. Smoking was associated with additional annual costs of €743 per current smoker and €1108 per former smoker [8]. In fact, smoking will lead to higher medical costs and a greater loss of productivity in COPD patients who smoke.

In low- and middle-income countries, most of the people suffering from this disease live [9,10], and related deaths account for 90% of deaths worldwide [11]. The results of the BREATH study showed that the prevalence of COPD in the Middle East and North Africa (MENA) region was 3.6%, ranging from 1.9% in the United Arab Emirates to 6.1% in Syria [12].

In Morocco, the BOLD study reports the prevalence of COPD at 12.6% [13], and mortality related to respiratory diseases, including COPD, represents 6% of all deaths [14]. High morbidity and mortality are also accompanied by an important socioeconomic burden [5,15]. However, research on the cost of COPD management is limited for most of these countries, including Morocco.

The objective of this study was to estimate the economic cost associated with COPD in Morocco and to identify its determinants.

Materials and Methods

Study design and population

A cost-of-illness study was carried out in 2021-2022 at the Pulmonology Department of Hassan II University Hospital of Fez [16]. Patients aged 40 years or older diagnosed with COPD at least 1 year before 2019 and whose electronic medical records were available for 2019 were included. The diagnosis of COPD was performed according to the guidelines of the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2018 [17]. The choice of the year 2019 for data collection is justified by the propagation of the COVID-19 pandemic during 2020 and 2021, which has influenced the management and follow-up of patients.

Data collection

Data collection was carried out using a standardized structured questionnaire, including sociodemographic and socioeconomic data (age, sex, profession, and medical insurance). Exposure to tobacco and household smoke were considered risk factors.

Clinical data included year of COPD diagnosis, severity of the disease according to GOLD classification, and number of severe exacerbations per year.

COPD exacerbation is defined as "an acute worsening of respiratory symptoms that results in additional therapy" [17]. It is classified as mild [treated with short-acting bronchodilators (SABDs) only], moderate (treated with SABDs plus antibiotics and/or oral corticosteroids), or severe (patient requires hospitalization or visits the emergency room) [17].

Regarding severity, according to the guidelines of the GOLD [17], COPD patients were classified into four groups: low-risk groups (A, B) and high-risk groups (C, D).

Data collection also included: utilization of health care resources in 2019 – medical visits to the pulmonology specialist; medication linked to the respiratory system – short-acting β2 agonist, long-acting muscarinic antagonist, long-acting β2 agonist, inhaled corticosteroid, and anitibiotics; vaccines – flu or pneumococcal; medical tests – laboratory tests, functional tests (arterial gas-analysis, spirometry, walk test), and imaging chest tests (X-ray and/or computed tomography); hospital admissions – in the emergency room, intensive care unit or in pulmonology department and, length of stay at the hospital; and home long-term oxygen therapy (LTOT) and noninvasive home ventilation (NIV).

Measuring patient costs

Costs were estimated from a societal perspective that includes all direct medical costs and lost productivity for all members of a given society [16]. It is the most complete and recommended for cost-of-illness studies. Costs were calculated using a prevalence-based approach that considers all existing cases during a given year and all health care resources and lost productivity used within that year [18]. The time horizon adopted in the study was 1 year.

In our study, we estimated both the direct and indirect costs of COPD. Direct costs refer to the expenses directly associated with the diagnosis, treatment, and management of the disease [16]. Indirect costs encompass the financial impact of the illness on productivity due to absenteeism, reduced work productivity [16].

For estimating the direct cost, this study adopted a bottom-up approach that consists of measuring and quantifying the health inputs used and then estimating the unit costs of these inputs. Total costs are calculated by multiplying the unit costs by the quantities used [16]. We first listed the different direct health resources used for each patient during the year 2019. Then, direct health cost was estimated by multiplying the use of health services by the official prices (unit costs) published by the national agency for health insurance for university hospitals [19]. Concerning the cost of home oxygen therapy and NIV, it was calculated based on prices reimbursed by the national agency for health insurance [20]. Regarding the costs of medication consumed by the patient, they were extracted directly from the Reimbursable Drug Guideline developed by the health insurance agency [21]. Finally, all costs were converted from Moroccan Dirhams to USD ($) (31 December, 2019 value) [22].

Indirect cost represented by labor productivity lost by the patient was measured using the human capital method [23,24]. This method is based on the equivalence between the value of lost productivity and the associated annual earnings for obtaining this production.

Labor productivity losses for each patient included days of absenteeism from work due to medical visits, medical tests, and hospitalizations. IC was calculated by multiplying the annual work

loss by the annual average income per capita and by the employment rate, according to the formula below [Eq. 1]:

$$IC = \frac{NxExGDP}{365} \quad \text{[Eq. 1]}$$

Where *IC* is the indirect cost, *N* is the average number of days of lost productivity per year; *E* is the employment rate of working-age population: 0.922 (men) and 0.865 (women) (High Planning Commission of Morocco) and *GDP* is the gross domestic product per capita (3230 USD in 2019 according to the World Bank). The estimation of *IC* was only considered in patients of working age based on the effective retirement age in Morocco. The cost per patient per year refers to the average cost of COPD per patient per year.

Statistical analysis

Descriptive statistics were used to describe the main variable, which is the direct medical cost and its components, as well as the socio-demographic and clinical characteristics of participants: mean and standard deviations were calculated for all continuous variables, and frequencies were calculated for categorical variables. The normality of the cost variable was tested by the Kolmogorov-Smirnov test. Cost comparison was carried out by smoking, sex, COPD severity group, and by frequency of exacerbation using the Mann-Whitney test, due to non-normality of cost variables. The linear regression was used to assess the association between cost and age. Statistical significance was set at 0.05. The statistical analyses were performed using SPSS Statistics V28.0 (IBM, Armonk, NY, USA).

Results

Description of population

Out of 159 patients, 82.4% were men. The mean age was 68.7(9.7) years. Almost half of the patients were employed (49.6%), and 24.2% had medical insurance. The majority of COPD patients were current smokers or ex-smokers (80.4%), and 15.8% were exposed to household smoke.

According to the GOLD classification, 78.7 % were categorized as "high-risk" groups (grades C-D), and 40.9% had one or more exacerbations per year. The demographic and clinical characteristics of COPD patients are presented in Table 1.

Utilization of health care resources

The average number of pulmonology visits was 3.7±1.7 per patient per year, and the mean number of days in hospitalizations was 0.7±1.15 per patient per year. The mean of days in the hospital was 13.01±11.48. The most frequently performed medical tests were spirometry (2.21±2.06), walk test (1.52±1.36), arterial gas analysis (1.45±1.45), and chest X-ray (1.32±1.66). Overall, 20.1% of the patients used home oxygen therapy, and 5.7% used NIV.

Table 2 shows the description of the utilization of different health care resources by COPD patients in 2019.

Cost estimations

Direct cost

The mean annual direct cost of COPD was estimated at $1816.6 ±1582.7 per patient (Table 3). The pharmaceutical treatment cost of COPD was estimated at $773.3±470.7 per patient per year. It represented 42.5% of the total direct health cost. The cost of hospital admissions accounted for 22.1% of direct health costs and was estimated at $402±807. The mean cost for medical tests and medical visits represented, respectively, 15.4 % and 1.7% of total direct health costs. The cost of the vaccines (flu and pneumococcal) constituted 0.6% of direct health costs. The cost of home oxygen therapy and NIV constituted 17.7% of direct health costs; it was estimated at $321.3 (Table 3).

The annual direct cost for patients of "high-risk" groups

Table 1. Demographic and clinical characteristics of chronic obstructive pulmonary disease patients (n=159).

Characteristics	Results, n (%)
Age [mean (SD)]	68.7 (9.7)
Gender (n=159)	
Female	28 (17.6)
Male	131 (82.4)
Working status (n=113)	
Retired	20 (17.7)
Employed	56 (49.6)
Unemployed	37 (32.7)
Medical insurance (n=128)	
RAMED	97 (75.8)
Medical insurance	31 (24.2)
Smoking habits (n=158)	
Ex-smoker/current smoker	127 (80.4)
Non smoker	31 (19.6)
Exposure to household smoke (n=158)	
Yes	25 (15.8)
No	133 (84.2)
Years of COPD [mean (SD)]	6.09 (2.92)
Frequency of severe exacerbation (n=159)	
0 per year	94 (59.1)
≥1 per year	65 (40.9)
GOLD classification (n=155)	
A-B	33 (21.3)
C-D	122 (78.7)

SD, standard deviation; COPD, chronic obstructive pulmonary disease; RAMED, medical assistance scheme; GOLD, Global Initiative for Chronic Obstructive Lung Disease.

Table 2. Utilization of health care resources in 2019 (n=159).

Resources typology	Mean±SD / n (%)
Medical tests	
Arterial gas-analysis	1.45±1.45
Spirometry	2.21±2.06
Walk test	1.52±1.36
Chest X-ray	1.32±1.66
Tomography	0.44±0.69
Pneumology visit	3.7±1.7
Hospitalization admission	0.7±1.15
Number of days in hospital	13.01±11.48
Vaccination	
Flu	44 (27.7)
Pneumococcal	16 (10.1)
Use of home oxygen therapy	32 (20.1)
Use of noninvasive home ventilation	9 (5.7)

SD, standard deviation.

(GOLD groups C-D) was significantly higher compared to the cost for patients of "low-risk" groups (GOLD groups A-B) ($791.7±522.8 *vs*. $2080.6±1618.6, p<0.001). The analysis also showed statistically significant differences between direct health costs and the frequency of severe exacerbations (p<0.001). The cost is approximately threefold higher among patients with ≥1 per year severe exacerbations ($2983.4±1812.8 *vs*. $1009.8±620.3). Former smokers and current smokers were more costly to the healthcare system than nonsmokers (p=0.029). There was no significant association between costs and age or sex.

Table 4 shows different factors associated with direct health costs in COPD patients.

Lost work of productivity and indirect cost

The average days of lost productivity were 88. The mean annual indirect cost of COPD was estimated at $709.5±1081.3 per patient. It was 2.5 times higher among patients with ≥1 per year severe exacerbations ($1181.5±1334.8 *vs*. $473.9±862.7) (p=0.003). No significant association was observed between indirect costs and tobacco smoking and the frequency of severe exacerbations. There was no significant association between costs and age or sex.

Table 4 shows different factors associated with indirect costs in COPD patients.

Discussion and Conclusions

To our knowledge, this is the first study to estimate the economic cost of COPD in Morocco. The results showed that the direct and indirect cost was estimated at $1816.6 and $709.5, respectively.

The annual per-patient direct health cost was reported as $10,367 in the USA, while in Asian countries, such as Iran, Korea, and Singapore, the annual per-patient direct medical cost was reported as $1544, $3077, and $2335, respectively. In Europe, it varies from $1889 in Spain to $11,787 in Norway [25]. The variability of direct health costs between countries is due to differences in the unit prices of different healthcare services, variation in care practices, and the variability of the COPD patients included in each study in terms of disease severity and the different methods used for evaluating the cost.

In European countries, the cost of work productivity loss varied between approximately $300 and $5000 [25]. It was estimated at $20,844, $5243, and $5467 in the USA, Japan, and South Korea, respectively [3]. The variability observed in the indirect cost between countries is related to differences in the approach used.

Our results indicated that the proportion of direct health costs corresponding to pharmacological costs was 42.5%. This result is similar to the one found in a Spanish study (44.5%) [26]. However, the cost of medications used in the management of COPD accounted for between 4 and 33% of total direct health costs across countries [3]. This disparity in drug costs in various countries is due to variations in prescribing practices. The higher percentage of medication cost in our study may be explained by the fact that our survey was conducted in a tertiary center, where most patients (78%) had advanced COPD (C-D). The review of Rehman *et al*. reported that medication cost was higher for patients attending tertiary care facilities than for patients attending primary care facilities [27].

The cost of hospitalization constituted 22.1% of total direct costs. This proportion is similar to that found in Spain (23.1%) [26], in Russia (22%), in the Netherlands (20%), and in the UK (20%) [3]. In other countries, such as France, Italy, this percentage exceeds 50% [3].

In line with our analysis, the results of recent systematic reviews have documented the direct relationship between the level of severity of COPD, frequency of exacerbations, and the direct costs [5,25,27,28]. Advanced stages of COPD and exacer-

Table 3. Description of direct health cost per patient in dollars.

Direct cost categories	Total mean direct cost per patient (SD)	Percentage of direct cost
Medications	773.3 (470.7)	42.5
Hospital admissions	402 (807.0)	22.1
Medical tests	278.6 (201.4)	15.4
Medical visits	30.5 (14.2)	1.7
Vaccination	10.6 (28.2)	0.6
Home oxygen therapy/home noninvasive ventilation	321.3 (630.3)	17.7
Direct health cost	1816.6 (1582.7)	100

SD, standard deviation.

Table 4. Factors associated with direct and indirect costs in chronic obstructive pulmonary disease patients.

	Direct cost [mean (SD)]	p	Indirect cost [mean (SD)]	p
Smoking status		0.029		0.21
Non smokers	1306.1 (1093.6)		544.9 (915.0)	
Former and current smokers	1944.4 (1587.3)		800.9 (1169.8)	
COPD severity		<0.001		0.87
GOLD A-B	791.7 (522.8)		210.4 (65.2)	
GOLD C-D	2080.6 (1618.6)		886.6 (1213.6)	
Frequency of severe exacerbations		<0.001		0.003
0	1009.8 (620.3)		473.9 (862.7)	
≥1	2983.4 (1812.8)		1181.5 (1334.8)	

SD, standard deviation; COPD, chronic obstructive pulmonary disease; GOLD, Global Initiative for Chronic Obstructive Lung Disease.

bations lead to long lengths of stay in intensive care units and in the emergency room, and an increase in the use of antibiotics, corticosteroids, and oxygen therapy, which explains the increase in direct health costs as a function of severity and number of exacerbations. In addition, patients with advanced COPD may be treated with domiciliary LTOT or NIV [17], which leads to additional costs of care.

In the same direction, results of the BREATHE study [29], a large survey in the MENA region, including Morocco, have demonstrated that the use of all healthcare resources was significantly higher in subjects classified (C-D) than in those classified (A-B), and greater in those with exacerbations than in those without. According to the ARTIC study [30], patients with a high frequency of exacerbations have a high risk of future exacerbations, mortality, and rapid decline in lung function, and thus, a significant economic burden.

COPD is underdiagnosed, and many patients do not receive a diagnosis until the disease is clinically advanced. A study on the knowledge of Moroccan general practitioners on COPD [31] has shown insufficient management of this pathology by the general practitioner, who should normally be involved in the early diagnosis and management. This lack of knowledge can lead to a high percentage of cases being diagnosed late and, therefore, a high economic cost in our country.

Regarding smoking, the results showed a higher direct cost for smokers and ex-smokers compared to non-smokers. This result is in agreement with other studies [32,33], which show that tobacco smoking is associated with more use of health care resources and higher medical costs. Morocco is considered one of the largest consumers of tobacco; its prevalence is estimated at 13.4% [14], which will lead to an increase in the cost in our context. These results highlight the importance of smoking cessation; quitting smoking improves symptoms and lung function in COPD patients, thus reducing costs [34].

This study allowed us to estimate the cost of COPD management and its determinants in Morocco using a bottom-up approach. However, it has some limitations: first, it was conducted in a tertiary center, where most cases are in advanced stages, which may overestimate the cost. Second, intangible and direct non-medical costs could not be estimated due to the retrospective data collection, which can underestimate the cost of this disease.

In conclusion, the results of the present study show that the management of COPD in Morocco is associated with a significant economic burden. Direct costs for the COPD population were mainly represented by costs associated with hospitalizations as well as drug costs. This cost was related to the frequency of severe exacerbations, the severity of COPD, and smoking.

Recommendations

These conclusions highlight the importance of prevention, the detection of disease in its early stages, and the control of the frequency of exacerbations in reducing the cost of the disease. To prevent the disease and reduce its prevalence, it is necessary to fight its risk factors, especially tobacco, by educating people about the adverse effects of smoking and strengthening the legislative and regulatory aspects of tobacco control, especially by ratifying the World Health Organization Framework Convention on Tobacco Control signed in our country since 2004.

Regarding early detection, it requires training primary health care facilities personnel as well as private general practitioners to improve their knowledge of symptoms and management of the disease. It is also necessary to organize screening campaigns. In addition to controlling exacerbations and limiting hospitalization, patients with COPD should benefit from education sessions to better understand their disease and the importance of therapeutic compliance. Finally, it should be noted that more research is needed on this topic, especially for the measurement of indirect costs, so that we can conclude with more reliable estimates and compare the results with international studies.

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