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Chronic obstructive Pulmonary Disease (COPD) in non-smoking Sri Lankan adults; a cross-sectional study

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Abstract

Objective To estimate the prevalence of Chronic Obstructive Pulmonary Disease (COPD) among non-smoking Sri Lanka adults as part of a larger study which assessed the burden of obstructive lung disease (BOLD) in Sri Lanka.

Results The prevalence of COPD among non-smokers was 5.3%, with mild to moderate disease. Among spirometry-diagnosed COPD patients, a higher proportion was females and above age 40. Use of biomass (Odds Ratio (OR) = 1.339, 95% Confidence Interval (CI) 1.070–1.821), exposure to passive smoking (OR = 2.376, 95% CI 1.557–3.397) and female sex (OR = 1.353, 95% CI 0.992–1.648) significantly increased the odds of developing COPD and/or related symptoms. Having a chimney, reduced the risk of COPD and/or related symptoms by 29% when cooking with biomass/kerosene.

Keywords COPD, Non-smokers, Sri Lanka, BOLD, Prevalence, Spirometry, Respiratory diseases

Introduction

Chronic obstructive pulmonary disease (COPD) is characterized by progressive airflow limitation and tissue destruction; this leads to structural lung changes due to chronic inflammation from prolonged exposure to noxious particles or gases, most commonly cigarette smoke [1]. Other causes include second-hand smoke, environmental and occupational exposures, and alpha-1 antitrypsin deficiency (AATD) [1, 2]. It is a highly prevalent chronic disease with high morbidity and mortality in adult populations [3]; in 2010, COPD was the third leading cause of global deaths [4].

A post bronchodilator FEV1/FVC ratio < 0.70 is considered diagnostic of COPD [5]. COPD, largely due to smoking, becomes clinically apparent during late productive life, sometimes manifesting as chronic bronchitis and emphysema.

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In 2011, the US nationwide prevalence of self-reported or physician-diagnosed COPD was 6.5% [6]. In Sri Lanka, a prevalence of 7.2% was reported; among those who had COPD, the majority (56.5%) did not have a smoking history [7]. It has been documented that environmental pollution, by particulate matter and/or tobacco smoke, contribute to the development of COPD among non-smoking individuals [8–10].

Animal studies report that foetal lung development is adversely influenced by maternal smoking, a potential risk factor for COPD [11]. Parental, especially maternal, smoking increases the susceptibility of infants and children to lower respiratory tract illnesses [12]. Environmental tobacco smoke has significant effects on the occurrence of chronic respiratory symptoms in adults; a few studies have reported that exposure to environmental tobacco smoke is associated with a small impairment of lung function. Measures to reduce passive exposure to tobacco smoke among both children and adults should be developed [13].

Work-related exposures such as chronic exposure to fumes, chemical substances, and dust are important risk factors for COPD other than smoking. The risks are very high for miners, quarry and construction workers, and agricultural and transport workers [5, 14, 15].

Every 10 $\mu g/m^3$ increase in PM_{10} (suspended particulates with aerodynamic diameter less than 10 μg), increases cardiovascular disease mortality by 3.4% and total mortality by 1% [13].

Several compounds derived from heating, combustion, photochemical reactions, furniture, building material, biological organisms and fibres, have been identified as indoor air pollutants affecting respiratory health. The main health effects are reduced lung function, bronchial hyper-responsiveness and respiratory infections, some of which are also characteristic of COPD [13]. Apart from that, low socioeconomic status is also considered a risk factor for development of emphysema and chronic bronchitis [16, 17].

This study was conducted to determine the prevalence of COPD and to identify possible risk factors of COPD among non-smokers in Sri Lanka.

Methods

This cross-sectional survey was conducted from June to July 2013 in one district in each of 7 provinces of Sri Lanka; Colombo district (Western Province), Kandy district (Central province), Jaffna district (Northern Province), Galle district (Southern province), Kurunegala district (North Western Province), Anuradhapura district (North Central Province), and a tea plantation region in the Badulla district (Uva Province).

The study was carried out as part of a larger study which assessed the burden of obstructive lung disease (BOLD) in Sri Lanka. 1987 participants between 18 and 90 years were recruited using a cluster sampling technique. Each cluster was defined as a Medical Officer of Health (MOH) area of a district or a ward in a Municipal Council area. A minimum sample of 196 participants from each cluster was required to estimate a prevalence of current wheezing in 20% of the adult population with a 95% confidence interval ranging from to 17–23% and a design effect of 2. The number of participants to be selected from each cluster was based on the probability proportionate to the size of the population of each district. Participants were randomly selected based on the most updated voting list in each district. The final sample recruited included 241 from the Kurunegala district, 226 from the Anuradhapura district, 191 from the tea plantations in the Badulla district, 688 from the Colombo district, 137 from the Galle district, 286 from the Jaffna district and 218 from the Kandy district. These participants then attended a mobile clinic where they were assessed for COPD. The details of participant selection are given in Gunasekera et al., (2022) [18].

Data collection tool

The interviewer administered BOLD Core questionnaire was used to obtain information about respiratory symptoms (cough, sputum, wheezing, shortness of breath), exposure to potential risk factors, occupation, respiratory diagnoses (asthma, emphysema, COPD, chronic bronchitis, etc.), co-morbidities, healthcare utilization, medication use, activity limitation, and health status without any modifications (see supplementary file 1– BOLD core questionnaire) [26]. The questionnaire included sections from the American Thoracic Society/Division of Lung Disease (ATS/DLD) Respiratory Symptoms Questionnaire [19] and the European Community Respiratory Health Study [20] questionnaire, the Clinical Nutrition Research Study (CNR) study [21], the Obstructive Lung Disease in Northern Sweden (OLIN) study [22] and Short Form-12 (SF-12) to assess the overall health status [23]. A section to assess exposure to use of biomass fuels in the home for either heating or cooking was included.

All questionnaires were translated into Sinhala and Tamil according to accepted methods. The translated versions of the questionnaire were pilot tested on 20 subjects from the Colombo district who did not take part in the main study to check familiarity of wording and ease of understanding.

Spirometry

Severity of COPD was assessed based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria which was done through spirometry. Spirometry testing was performed in all subjects using the NDD EasyOne™ Spirometer as prescribed by the BOLD

protocol, as per standards proposed by the American Thoracic Society/European Respiratory Society (ATS/ERS) Task Force [24, 25].

Two readings were recorded, before and 15 min after administration of salbutamol 200mcg via a metered dose inhaler and spacer. Participants were advised not to take any bronchodilators 6–12 h before the testing. Spirometry was conducted with participants in a seated position using disposable mouthpieces; staff were trained to watch for signs of dizziness or other problems and to stop the manoeuvre, if necessary. All spirometry data were reviewed by experts and quality control was assured as per the BOLD study protocol [26].

Other related conditions

Diagnosis of asthma, emphysema and bronchitis were made based on the questions "Has a doctor or other healthcare provider ever told you that you have emphysema/ bronchitis/asthma/COPD?". A positive response to any of the options was taken as a positive history.

Definitions used

Passive smoking was defined as the presence of a smoker in the household.

The highest reading for the forced expiratory volume during the first second (FEV_1) and the forced vital capacity from the accepted study trials were obtained as the measurements [24].

A post-bronchodilator FEV_1/FVC ratio of <0.70 was considered diagnostic of COPD. The GOLD system categorises airflow limitation into stages.

In patients with $FEV_1/FVC < 0.70$:

GOLD 1– mild; $FEV_1 \geq 80\%$ of predicted: GOLD 2– moderate; $50\% \leq FEV_1 < 80\%$ of predicted: GOLD 3– severe; $30\% \leq FEV_1 < 50\%$ of predicted: GOLD 4 - very severe: $FEV_1 < 30\%$ of predicted [26].

Table 1 Profile of all non-smoking participants ($n = 1496$)

Characteristic	COPD*	Non-COPD*
	N (%)	*N* (%)
Sex		
Male	34 (6.8)	469 (93.2)
Female	45 (4.5)	948 (95.5)
Age		
< 40	11 (1.9)	570 (98.1)
≥ 40	68 (7.4)	847 (92.6)
Highest educational status		
Primary School	31 (10.7)	258 (89.3)
Middle School	35 (4.6)	721 (95.4)
High School	09 (2.4)	364 (97.6)
College	00 (0.0)	16 (100.0)
Four Year College/ University	01 (2.9)	33 (97.1)
None	02 (9.1)	20 (90.9)
Unknown	01 (20.0)	04 (80.0)

* COPD based on GOLD criteria

Data analysis

Statistical analysis was performed using SPSS software version 26. The prevalence of COPD among non-smokers (%) was calculated by dividing the number of participants diagnosed to have COPD through spirometry with the total non-smoking population. Demographic characteristics and prevalences of other respiratory symptoms are reported for spirometry-diagnosed COPD and non-COPD subgroups separately. Since the number of people diagnosed to have COPD through spirometry was small, a new sample was defined by pooling the spirometry-diagnosed COPD sample with those who responded positively to the questions whether they had coughing without a cold, coughing up phlegm and wheezing, symptoms suggestive of COPD, even without a significant reduction in spirometry. The relationship between different exposures and having symptoms suggestive of COPD was tested using chi-square tests and multivariate logistic regression analysis using the pooled data.

Ethics statement

Approval was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Kelaniya (ERC No P5/01/2011). Informed written consent was obtained from all participants including consent to publish anonymised data was obtained from the participants. Confidentiality of data was maintained. If participants had a medical problem, they were advised or referred to the nearest chest clinic which provided healthcare services free-of-charge.

Results

A total of 1987 18–90 years aged adults participated in the study. Of them, 149 had not revealed their smoking status and 342 had a history of smoking. Data from 1496 non-smoking individuals were included in the analysis. Of the 1496 participants, 79 (5.3%) had COPD based on GOLD criteria.

The profile of all non-smoking participants is given in Table 1.

Disease severity

Based on GOLD criteria, the highest number of patients were in GOLD 2 ($n = 36$) (Fig. 1). There was no significant association between sex and disease severity (Fisher's exact test $p = 0.254$).

Other respiratory illness among non-smoking individuals

Table 2 gives the prevalences of spirometry-diagnosed COPD and physician diagnosed other respiratory diseases among those who had respiratory symptoms.

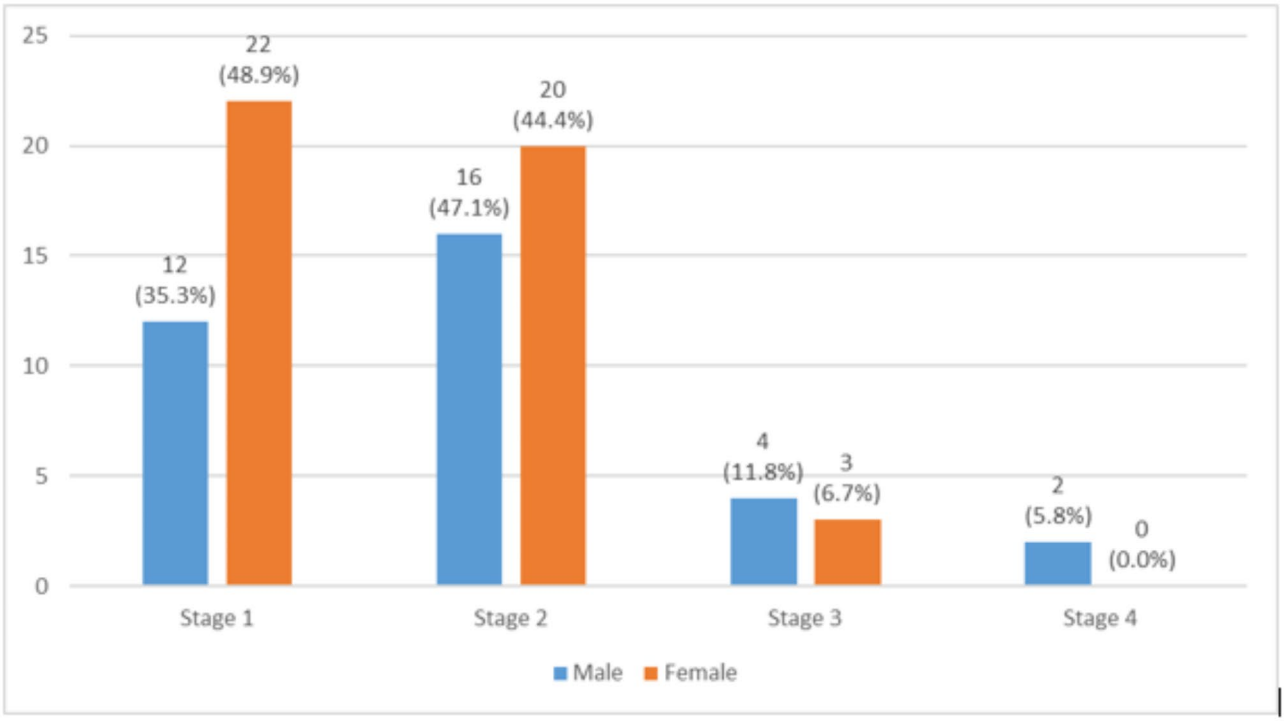

Fig. 1 Disease severity among those who had COPD based on GOLD criteria by sex ($n=79$)

Table 2 Prevalences of COPD based on GOLD criteria among those who had respiratory symptoms and physician diagnosed respiratory diseases in the non-smoking population ($n=1496$)

Condition	*N*	COPD* *N* (%)	No COPD* *N* (%)
Symptoms			
Coughing without a cold	353	30 (8.5)	323 (91.5)
Coughing on most days for more than 3 months	74	16 (21.6)	58 (78.4)
Bring up phlegm when coughing	487	41 (8.4)	446 (91.6)
Bring up phlegm when coughing for more than 3 months	141	19 (13.5)	122 (86.5)
Wheezing or whistling in chest at any time in the last 12 months	372	44 (11.8)	328 (88.2)
Wheezing when there is a cold	224	29 (12.9)	195 (87.1)
Wheezing or whistling that caused shortness of breath	266	37 (13.9)	229 (86.1)
Diagnosed by a physician			
Emphysema	34	06 (17.6)	28 (82.4)
Asthma, asthmatic bronchitis, allergic bronchitis	66	13 (19.7)	53 (80.3)
Still have Asthma, asthmatic bronchitis, allergic bronchitis	43	09 (20.9)	34 (79.1)
Chronic bronchitis	21	05 (23.8)	16 (76.2)
Still have chronic bronchitis	14	04 (28.6)	10 (71.4)
COPD	12	03 (25.0)	09 (75.0)

* Based on GOLD criteria

Prevalence of other respiratory symptoms among non-smokers

Among those who had COPD, 46.2% reported having shortness of breath when hurrying on level ground or walking up a slight hill compared to 27.7% of those who did not have COPD (. When asked whether they walked slower than people of the same age on level ground because of shortness of breath, 59.7% of those with COPD responded positively compared to 73.3% of those who did not have COPD; there was no significant difference between the proportions.

Exposure to indoor air pollution and passive smoking among non-smokers

Sixty-six participants (4.4%) did not cook at home. Three hundred and seventy participants (24.7%) used clean fuel (electricity or LP Gas) for cooking and 1060 (70.9%) used biomass alone or in combination with a clean fuel source.

Participants were asked the type of fuel they regularly use for cooking: clean fuel (electricity and Liquefied petroleum gas (LPG)), kerosene, charcoal, wood, dung, crop residue or any other type of fuel. The majority of the participants used wood (63.2%) as their primary source of fuel; there was no association between biomass use and COPD (0.758, $p=0.406$). Of the participants with spirometry diagnosed COPD, 65.3% used wood. None used charcoal, dung or crop residues. Twelve participants used kerosene (Table 3).

Table 3 Regularly used fuel type among non-smokers ($n = 1496$)

Regularly Used Fuel	Spirometry-diagnosed COPD		Symptoms suggestive of COPD with or without spirometry evidence*	
	Yes *N* (%)	No *N* (%)	Yes *N* (%)	No *N* (%)
Clean fuel (Electricity and Liquefied Petroleum Gas)**	15 (4.1)	355 (95.9)	163 (44.1)	207(55.9)
Wood (alone or in combination with clean fuel)	43 (5.6)	731 (94.4)	396 (51.2)	378 (48.8)
Wood in combination with other type of unclean fuel (with or without clean fuel)	04 (2.9)	134 (97.1)	77(55.8)	61 (44.2)
Kerosene/Dung/Crop/Charcoal	08 (5.4)	140 (94.6)	76 (51.4)	72 (48.6)
Not cooking at home	09 (13.6)	57 (86.4)	29(43.9)	37(56.1)

* Coughing without a cold, coughing up phlegm and wheezing, symptoms suggestive of COPD, even without a significant reduction in spirometry

** Only those who used electricity and/or LPG regularly were categorized under clean fuel. Those who used a clean fuel type in combination with an unclean fuel type were categorized under the unclean fuel type

Table 4 Association between having symptoms suggestive of COPD (with or without spirometry evidence) and selected risk factors

Variable	Unadjusted			Adjusted		
	Odds Ratio (OR)	*p*-value	95% CI* of OR	Odds Ratio (OR)	*p*-value	95% CI* of OR
Female sex	1.353	0.006	1.091–1.678	1.279	0.058	0.992–1.648
Use of unclean fuel (biomass and kerosene)**	1.339	0.015	1.058–1.696	1.396	0.014	1.070–1.821
Having a chimney	0.807	0.063	0.644–1.012	0.715	0.007	0.561–0.910
Hours spent on cooking	1.041	0.133	0.988–1.098	1.008	0.788	0.950–1.070
Exposure to passive Smoking	2.376	< 0.001	1.643–3.438	2.300	< 0.001	1.557–3.397

*CI refers to confidence interval

**Those who regularly used an unclean fuel type or a combination of an unclean and a clean fuel

Nine participants with COPD (11.4%) reported that they were exposed to passive smoking; there was no association between exposure to passive smoking and having COPD($\chi_1^2 = 0.328$, $p = 0.694$).

In the pooled data comprising persons with symptoms suggestive of COPD with or without spirometry evidence, a significantly higher proportion of females (52.1%) had reduced pulmonary functions and/or respiratory symptoms indicative of COPD as compared to males (44.5%) ($\chi_1^2 = 7.576$, $p = 0.006$). A significantly lower proportion of individuals ($\chi_1^2 = 5.901$, $p = 0.015$) who used clean fuel for cooking had respiratory symptoms and/or reduced pulmonary functions compared to those who used unclean fuel (biomass and kerosene) (Table 3).

The multivariable logistic regression model (using symptoms suggestive of COPD with or without spirometry evidence as the dependent variable) revealed that the use of clean fuel (electricity and LPG) had a significant protective effect (26% reduction) from developing respiratory symptoms and COPD (OR 0.74, 95% CI: 0.59–0.94). Passive smoking significantly increased the risk of developing respiratory symptoms by 2.37 times (OR 2.376, 95% CI: 1.55–3.39).

Having a chimney reduced the risk of developing respiratory conditions to a certain extent even after controlling for time spent on cooking. Females had a 1.279 ($p = 0.058$; OR = 1.279, 95% CI: 0.992–1.648) higher odds of having symptoms suggestive of COPD with or without spirometry evidence after controlling for passive smoking, use of biomass for cooking and having a chimney; however, the risk was only marginally significant (Table 4).

Discussion

This study reports the characteristics and severity of the disease among non-smoking COPD patients in Sri Lanka. 5.3% of non-smoking individuals had COPD which was much lower than the global prevalence of 23.3% estimated by a survey done in 14 countries [27]. The majority of the non-smoking individuals who were diagnosed with COPD was above 40 years. Among the non-smokers, a higher proportion of males (though not significantly) were diagnosed to have COPD through spirometry as compared to females (6.8% vs. 4.5%). However, when other symptoms suggestive of COPD were accounted for, a higher proportion of females were detected compared to males. These results are similar to those reported by Tan et al., (2015) (7.4% in females vs. 5.0% in males, $p < 0.03$) [28].

The smoking prevalence in Sri Lanka has been decreasing; the prevalence was 57.9% among middle aged men in central province in 1994, 29.8% in males in Colombo suburbs in 2002 and 21.1% among men from the southern part of the country in 2005 [29–31]. This trend prompts to shift the focus to other causes of COPD.

Indoor air pollution and passive smoking lead to COPD; indoor air pollution especially due to the use of biomass as cooking fuel is the main cause of COPD among women [32, 33]. In this study, though not statistically significant, people who were exposed to indoor air pollution had more respiratory symptoms than those who were not. Exposure to biomass and kerosene fuel smoke was not associated with spirometry-diagnosed COPD among the non-smoking population. In Sri Lanka, a significantly higher concentrations of Carbon Monoxide (CO) and Particulate Matter < 2.5 μg ($PM_{2.5}$) have been reported in households using biomass and kerosene as cooking fuel (CO mean (sd) = 2.77 (2.63) ppm, $PM_{2.5}$ mean (sd) = 0.62 (0.99) mg/m^3) compared to households using electricity and liquefied petroleum gas (CO mean (sd) = 1.44 (1.60) ppm, $PM_{2.5}$ mean (sd) 0.19 (0.27) mg/m^3). The significantly higher concentrations of CO and $PM_{2.5}$ were associated with a 1.6 times increased risk of having infection induced asthma in children under 5 years of age. Other developing countries have reported similar findings [34, 35].

In this study, many of the non-smoking individuals who were diagnosed with COPD were of GOLD grades 1 (mild) or 2 (moderate). The analysis of the pooled sample (persons with symptoms suggestive of COPD with or without spirometry evidence) revealed that passive smoking (OR 2.300, 95% CI 1.557–3.397) and use of biomass and kerosene (OR 1.39, 95% CI 1.070–1.821) significantly increased the risk of developing COPD and other related respiratory symptoms. Having a chimney in the cooking area significantly reduced the risk of developing respiratory conditions but did not eliminate the risk altogether; this has been demonstrated with coal stoves as well [36].

We observed that many individuals who had not been diagnosed with COPD through spirometry still had other respiratory symptoms that cause symptoms like wheezing and coughing, early signs of COPD or other respiratory diseases like asthma. Spirometry and assessment of respiratory symptoms may not be adequate to diagnose COPD [37]; perhaps the true disease burden among non-smokers is underestimated. Some symptoms such as dyspnoea and dyspnoea on exertion may be caused by other co-morbidities such as cardiovascular diseases or other acute respiratory illnesses.

This study supports the hypothesis that indoor air pollution caused by using biomass as cooking fuel can lead to COPD and other respiratory symptoms; using clean fuel and/or having a chimney can significantly reduce the risk of developing COPD.

The type of cooking fuel used was determined based on the questionnaire. Demographic and Health Surveys conducted in Sri Lanka have revealed that the percentage of households that use wood as the principal cooking fuel was 78.3% and 78.5% in 2000 and 2007, respectively [38]. In our non-smoking sample, 63.2% of the households regularly used wood as the principal cooking fuel; we are confident that this figure is correct and that our population is representative of the country as many developments took place after the end of the protracted civil disturbances in 2009.

Limitations

We acknowledge several limitations of this study. The small sample size of spirometry-diagnosed COPD in the never-smoker population is a limitation. To overcome this problem, we pooled persons having symptoms suggestive of COPD but without spirometry evidence and investigated the association between symptoms suggestive of COPD and other factors which is unlikely to have been affected by pooling the data. This is due to the low prevalence of COPD in the non-smoking population. Occupational exposure to air pollution and environmental pollution and outdoor air pollution were not assessed in this study. Other important risk factors such as childhood infections, past history of tuberculosis, occupational exposures and poverty were not evaluated which is a limitation of this study. Moreover, we have sampled one district per province which may not be representative of the entire province.

Despite these limitations we confirm a known relationship of indoor air pollution and COPD and other respiratory conditions in the Sri Lankan setting. Replication of the study with a larger sample is recommended.

Conclusion

The prevalence of COPD among non-smoking individuals in Sri Lanka is 5.3%, most of whom have mild to moderate disease. Indoor air pollution and passive smoking were significant predictors of COPD and symptoms suggestive of COPD among non-smokers.

Abbreviations

AATD	Alpha-1 antitrypsin deficiency
ATS/ERS	American Thoracic Society/European Respiratory Society
ATS/DLD	American Thoracic Society/Division of Lung Disease
BOLD	Burden of Obstructive Lung Disease
CNR	Clinical Nutrition Research Study
CI	Confidence interval
COPD	Chronic Obstructive Pulmonary Disease
FEV	Forced expiratory volume
FVC	Forced vital capacity
GOLD	Global Initiative for Chronic Obstructive Lung Disease
LPG	Liquefied petroleum gas
MOH	Medical Officer of Health
OLIN	Obstructive Lung Disease in Northern Sweden
OR	Odds ratio
SF-12	Short Form-12

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13104-025-07146-x.

Supplementary Material 1

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Author contributions
KDG, WADLA, UCMU, HKMSS, AS, WG, AF, and ARW designed and conducted the study. WADLA, BPRP and ARW contributed to manuscript writing and revision, ARW did the overall supervision and revision. All authors reviewed the manuscript.

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Data availability
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Ethics approval was obtained from the Ethics Review Committee of Faculty of Medicine, University of Kelaniya Sri Lanka. Reference No- P5/01/2011. Informed consent was obtained from all the research participants. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Written informed consent to publish anonymised data was obtained from the participants.

Competing interests
The authors declare no competing interests.

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