Original Article

Epidemiological Survey of Smoking and Pulmonary Function Test among Adult Male Smokers in Poverty Coastal Fishing Community

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Objective: To investigate the smoking prevalence and explore the smoking duration (pack-years), which are relevant to potential lung function changes among adult men smoker in a poverty-stricken coastal fishing community.

Materials and Methods: This community-based cross-sectional study was conducted in 371 adult men living in ten coastal fishing communities. Self-administered questionnaires, physical examinations, and pulmonary function tests (PFTs) were used to collect data. The diagnostic criteria of chronic obstructive pulmonary disease (COPD) were forced expiratory volume in one second (FEV_1) over forced vital capacity (FVC) of less than 70%, and obstructive ventilatory defect (OVD) was indicated by FEV_1 over FVC of less than 80% or FEV_1 of less than 80% of the predicted value (%predicted).

Results: The present study revealed that half of smokers had a pack-years of 20 years or less (24.3±12.7). The group with a pack-years of more than 30 years had the lowest mean spirometric index. The statistics showed a difference in the mean spirometric index between every group of pack-years. Only the mean predicted FEV_1% and the FVC indices showed differences between the less than 20 years group (G1) and the 20 to 30 years group (G2), and between G1 and the more than 30 years group (G3). The OVD prevalence was 21.2%, and the COPD prevalence was 1.2%.

Conclusion: The smoking situation in the present study area was serious. Long pack-years clearly affected potential lung function. The OVD prevalence was low, but COPD was still not a serious health problem. The promotion of smoking cessation among early OVD patients is very important, and it could reverse the effects of COPD.

Keywords: COPD, Smoker, Coastal fishing community, Southernmost Thailand

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A serious world health problem is non-communicable diseases (NCDs). Globally, over 1.7 million premature deaths every year are caused by NCDs[1,2]. Two-thirds of these premature deaths are linked to unhealthy behaviors, including tobacco use[3]. Tobacco is one of the largest public health threats, resulting in outcomes such as cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes. Smoking killed almost 6.1 million people and resulted in a loss of 143.5 million disability-adjusted life years (DALYs)[4,5]. Approximately one person dies every six seconds due to tobacco use, accounting for one in ten adult deaths. Up to half of the current users will eventually die of a tobacco-related disease[4].

Smoking is also the most commonly encountered risk factor for chronic obstructive pulmonary disease (COPD)[5,6]. Adult smokers have a high prevalence of respiratory symptoms, reduced lung function, a

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greater annual rate of decline in forced expiratory volume in one second (FEV_1), a greater loss of lung density, and a greater COPD mortality rate than non-smokers[7]. The early detection of COPD is related to health surveillance policy and should be given the highest medical priority, which would include providing healthcare and health advice on smoking cessation[7]. The effects of early detection also include reducing medical treatment expenses and disability.

According to the recent results of a smoking report by the Tobacco Control Research and Knowledge Management Center (TRC), Mahidol University, Southern region, the highest prevalence of smoking was found among the rural population[8]. The impoverished coastal fishing community in southernmost Thailand has a high prevalence of smoking areas. Most of the residents were likely to have low education levels and low income. However, few epidemiological studies on smoking status and pulmonary function test (PFT) have been carried out in those communities.

The present study was carried out to investigate the smoking prevalence and explore pack-years, which were relevant to potential lung function change in this population. The present study aim was focused on informing patients with early COPD and obstructive ventilatory defect (OVD) on smoking cessation, leading to a reversible effect, including reduced exacerbation. These results would provide medical evidence leading to the promotion of smoking cessation programs in other remote areas around the world, and these programs would include preventative and management measures focused on medical practice for COPD and OVD.

Materials and Methods

Study design

The present research was an epidemiological community-based cross-sectional study carried out between October 2016 and July 2017 and was approved by the Ethics Committee of the Faculty of Medicine, Princess of Naradhiwas University (MED PNU 03-2558). Data collection was approved by the community administration committee. All eligible participants were invited to join the study. Written informed consents were obtained from all recruited participants.

Study setting

Muang District, Narathiwat Province was purposively selected as the study setting because most of the fishery communities were located in this district. In addition, the prevalence of smoking among adult men was higher than 80%, and the region did not have a PFT program. The following ten coastal fishing communities were selected by cluster sampling, Bang Manao, Khao Tanyong, Pu La Ka Pa, Ao Manao, Chai Talae, To Ko Do, Kampong Ta Ko, Lang Talard, Pitak Likhit, and Ta Ruea. The study communities were characterized by poverty, low literacy, and low incomes. In addition, these areas had specific societies, cultures, languages, lifestyles, and health believes. The local residents were unique from those in other regions of the country.

Study sample and sampling methods

The present study participants were adult men living in coastal fishing communities. The sample size was calculated based on the recent report of smoking proportion among adult men in southern provinces in Thailand[8]. The smoking proportion among adult men was 27%, the type I error $z_{\alpha/2}$ was 1%, the design effect was 2, the precision was 9% and the power was 0.8. Based on an estimated 15% incomplete information and lack of cooperation with the PFT, the total sample size was 359 men.

The proportionate to size study method was used for participant recruitment. Each of the chosen communities was divided into four localities according to the optional criteria of 15 to 18 house density and 80 to 120 population size. Five to 10 men in each locality of the community were drawn, and those sampled men were invited to be a study participant by local assistant researchers.

Inclusion and exclusion criteria

Adult male smokers aged between 20 and 60 years living in the coastal fishing communities for more than 10 years were included. The participants had not completed a PFT with any health service agency and were willing to provide personal and smoking data, including cooperating with physical examinations and PFTs. Participants who did not cooperate in the PFT or those who had any abnormal respiratory conditions such as bronchiectasis, pulmonary tuberculosis, lung cancer, and congestive heart failure that might affect the results of PFT were excluded.

Data collection procedure

The head of the community and the community administration committee in the present study areas were contacted to acknowledge project information and to provide permission to collect data. Three to

five community health volunteers in each locality were invited to be research facilitators who performed the tasks during the research operations in the study areas. The research operation staff comprised of two community practitioner nurses and two volunteer medical scientists who were working in the laboratory of the physiology department of the faculty of medicine, Princess of Naradiwas University. The research operation team received special skills training for the physical examination and pulmonary function for two days by a physician. The community research assistant and research operation team underwent a complete training, which aimed to inform the team members of the purposes, methods, and procedure of the study as well as their tasks and compensation.

Adult male smokers in each locality were screened and invited to be study participants by community health volunteers. The objectives of the study were explained, and the eligible participants signed the consent form. The eligible participants were assigned to complete a self-administered questionnaire related to personal characteristics and smoking behaviors. The physical examination, respiratory symptoms, and PFT were assessed through standardized spirometry to collect the spirometric indices of the participants by community practitioner nurses and two volunteer medical scientists.

Measures and instrument

Self-administered questionnaire: The study data were gathered and applied using a uniform self-administered questionnaire, which was designed by the research team. There were two parts within the three pages of the study questionnaire form. The preface was the project title and general guidance on completing the form. The second page was the first part of the questionnaire, which inquired about the personal information. It was completed with tick marks, and the text filled in by the participant. The second part was related to smoking history, and the participants could use free text to fill in their related information. All personal gathering process was under the support and advise of the research team for the competed data.

Physical examination: The physical examination comprised three main items, chest circumference, heart rate, and respiratory rate. When the participant finished with the self-administered questionnaire phase, the research operation team and community practitioner nurses explained the physical measurements to all the participants, thereafter, they remained seated for 15 minutes to increase the preciseness of data. The chest circumference was measured in centimeters using a measuring tape while the participants spread their arms and stood straight. The respiratory rate was measured by observing their chest movement and simultaneously counting the number of breaths per minute. Additionally, heart rate was measured by the electronic automatic blood pressure monitor (Arm Type, Model: RAK283) during the gathering of personal data, and it was recorded in a unit of beats per minute.

Spirometry and PFT: Spirometry was performed according to the American Thoracic Society criteria and the European Respiratory Society by trained community practitioner nurses and medical laboratory scientists. The spirometer test was performed using the Spirolab III® spirometer (MIR Medical International Research, Roma, Italy), which was standardized, calibrated, and supported by the physiology department of the faculty of medicine, Princess of Naradiwas University.

After 15 minutes of relaxing, the participants remained in a seated position and then released all of their breath when the start signal was on. During the lung function test, the forced vital capacity (FVC) and the FEV_1 were measured three times, and the greatest values were used. The data of the participants who had differences between the highest and lowest values smaller than 5% or 150 ml, were excluded.

Diagnostic criteria

The diagnostic criterion of COPD was a calculated value of the FEV_1 over FVC index below 70% of the predicted normal value. The diagnostic criteria of OVD was a calculated value of the FEV_1 over FVC index below 80% of the predicted value or an FEV_1 below 80% of the predicted value.

Statistical analysis

EpiData version 3.1 (EpiData Association, Odense, Denmark) was used for data processing, analysis, data input, data correction, data completion, and missing data were excluded. R software, version 3.2.3 (2015-12-10, "Wooden Christmas-Tree") (The R Foundation for Statistical Computing 2008, Austria) and R studio version 1.0.153 (2009 to 2017 RStudio, Inc.) were used to analyze the study data. Demographic characteristics were presented as the mean, standard deviation (SD), and maximum and minimum values. The categorical variables were presented as proportional data of frequency and percentage. Smoking history and smoking behaviors

Table 1. Demographic characteristics of the participants

Factors	Total (n=371) n (%)	Factors	Total (n=371) n (%)
Dwelling areas		Family income (baht)	
East beach	158 (42.6)	<8,000	124 (33.4)
South site	43 (11.6)	8,001 to 12,000	38 (10.2)
North site	96 (25.9)	12,001 to 20,000	73 (19.7)
West beach	74 (19.9)	20,001 to 25,000	21 (5.7)
Sex		>25,000	115 (31.0)
Male	371 (100)	Mean±SD	24,292.4±29,571.6
Religion		Min-max	2,000 to 350,000
Islam	365 (98.4)	Household size (persons)	
Buddhism	6 (1.6)	≤3	38 (10.2)
Age (years)		4 to 6	185 (49.9)
≤30	110 (29.6)	7 to 9	79 (21.3)
31 to 40	96 (25.9)	10 to 12	46 (12.4)
41 to 50	79 (21.3)	>12	23 (6.2)
51 to 60	66 (17.8)	Mean±SD	6.7±3.3
>60	20 (5.4)	Min-max	2 to 19
Mean±SD	40.2±12.4	Body mass index (kg/m^2)	
Min-max	20 to 83	Thin (<18.5)	40 (10.8)
Occupation		Slender (18.5 to 22.9)	251 (67.7)
Agriculture	10 (2.7)	Obese (≥23.0)	80 (21.6)
Trader	98 (26.4)	Pack-years	
Employee	191 (51.5)	≤20 years	172 (46.3)
Others	72 (19.4)	21 to 30 years	83 (22.4)
Education		>30 years	116 (31.3)
Primary school	108 (29.1)	Mean±SD	24.3±12.7
Secondary school	245 (66.0)	Min-max	2 to 67
Bachelor or higher	18 (4.9)		

SD=standard deviation

were compared and tested using the chi-square test and Fisher's exact test. The spirometry test results were presented by pack-years and were compared using the one-way ANOVA. Significant differences between the groups' mean values for any variable were shown. The Tukey post hoc test was applied to test for significant differences within the sub-groups of those variables. All significance tests were two-tailed, and a p-value of less than 0.05 was considered significant.

Results

Participant characteristics

Four hundred fifty-six men in the study areas were invited to participate. Three hundred seventy-one men participated in part I of the study. Two hundred eighty-six men declined to participate in the PFT, and 85 men participated in part II of the study. The recruited participants are presented in Figure 1. Ninety-eight-point-four percent of the participants were Muslim males. Two-thirds of the subjects had a secondary school education, and the body mass index (BMI) of the participants indicated that they were slender. About half of the participants had a pack-years of less than or equal to 20 years (24.3±12.7). The demographic characteristics of the participants are presented in Table 1.

Physical examination and PFT

In part II, 85 men participated in the physical

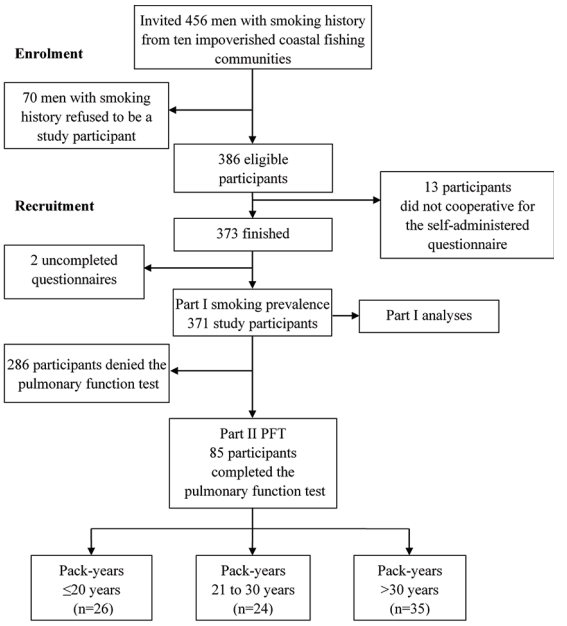

Figure 1. Flow diagrams of the screening process and participant recruitment.

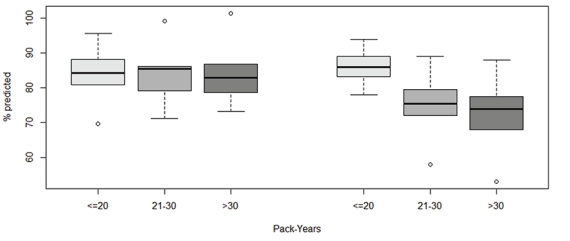

Figure 2. Boxplot median (P_{25}, P_{75}) of FEV_1 %predicted and FVC %predicted by pack-years.

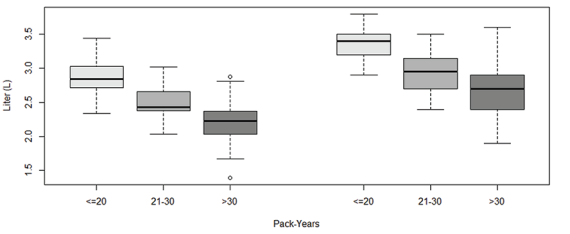

Figure 3. Boxplot median (P_{25}, P_{75}) of FEV_1 and FVC by pack-years.

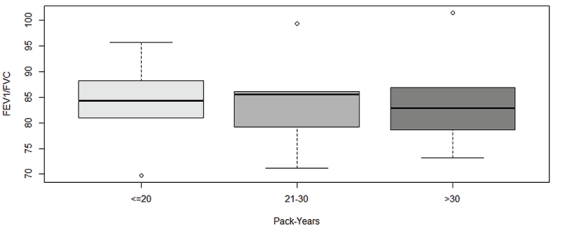

Figure 4. Boxplot median (P_{25}, P_{75}) of FEV_1/FVC by pack-years.

examination and the pulmonary function examination. The average chest circumference was 86.0±5.9 centimeters. The average respiratory rate was 26.1±1.9 breaths per minute. The highest respiratory rate was observed in the group of individuals who smoked cigarettes for more than 30 years (G3), with a respiratory rate of 27.1±1.9 breaths per minute. The statistical analysis showed a difference in respiratory rate between the group with a pack-years of 20 years or less (G1) and the group with a pack-years of 21 to 30 years (G2) and between G1 and G3 ($p<0.001$). The average heart rate was 73.9±5.3 beats per minute, and a significant difference between groups was not found.

The average FEV_1 and FEV_1 %predicted were 2.5±0.4 liters and 80.2±8.6%, respectively. The FEV_1 indices showed a significant difference between the averages of every pack-years group ($p<0.001$), and the FEV_1%predicted indices showed a difference in the average values between G1 and G2 and between G1 and G3 ($p<0.001$). The average FVC and FVC %predicted were lowest in the G3 group at 2.7±0.4 liters and 72.9±8.7%, respectively. The FVC indices showed a significant difference between G1 and G2 and between G1 and G3 ($p<0.001$), and the FVC %predicted indices showed a difference between all pack-years groups ($p<0.001$). The indicator of COPD (FEV_1/FVC) was 84.3±6.3, and the lowest FEV_1/FVC index was found in the G3 group.

The lung function diagnosis result showed that the OVD prevalence was 21.2% and that the 95% confidence interval (CI) was 12.5% to 29.9%. One-point-two percent of the participants were categorized as having COPD, and the 95% CI was 1.1% to 3.5%, as presented in Table 2 and Figure 2-4.

Discussion

The present study found that half of the participants had smoked for more than 20 years, and the average was 24.3 years. A pack-years of more than 30 years was associated with the lowest mean in every spirometric index. The study showed a difference in the means of every group of pack-years, except the FEV_1 %predicted and the FVC indices showed differences only between G1 and G2 and between G1 and G3. The OVD prevalence among adult male smokers in the present study was 21.2%, and the COPD prevalence was 1.2%.

The pack-years group with a longer than 30

Table 2. Physical examination and clinical characteristics by pack-years (n=85)

Factors	Mean±SD	Min-max	Pack-years; mean±SD			p-value (F-test)
			≤20 years (G1, n=26)	21 to 30 years (G2, n=24)	>30 years (G3, n=35)	
Physical examination						
Chest circumference (cm)	86.9±5.9	72.0 to 107.0	86.5±2.6	86.1±5.3	87.7±7.9	0.5609
Respiratory rate (breaths/minute)	26.1±1.9	22.0 to 30.0	24.6±1.7	26.2±1.7	27.1±1.5	<0.001*
			G1:G2 <0.01*, G1:G3 <0.001*; G2:G3=0.0790			
Heart rate (beats/minute)	73.9±5.3	51.0 to 89.0	72.1±2.7	73.9±6.2	75.3±5.9	0. 0652
Spirometric indices						
FEV_1 (L)	2.5±0.4	1.4 to 3.4	2.9±0.3	2.5±0.2	2.2±0.3	<0.001*
			G1:G2, G1:G3, G2:G3 <0.001*			
FEV_1 (%predicted)	80.2±8.6	62.0 to 100.0	86.8±6.4	78.7±7.4	76.2±8.0	<0.001*
			G1:G2, G1:G3 <0.001*; G2:G3=0.408			
FVC (L)	3.0±0.5	1.9 to 3.8	3.4 ±0.2	2.9±0.3	2.7±0.4	<0.001*
			G1:G2, G1:G3 <0.001*; G2:G3=0.397			
FVC (%predicted)	77.6±9.1	53.0 to 94.0	86.0±4.4	75.4±7.1	72.9±8.7	<0.001*
			G1:G2, G1:G3, G2:G3 <0.001*			
FEV_1/FVC (%)	84.3±6.5	69.7 to 101.5	84.6±5.4	84.7±6.9	83.8±7.2	0.837
Lung function diagnostic; n (%)						
OVD#						
• Yes	18 (21.2)		2 (7.7)	6 (25.0)	10 (28.6)	0.1231
• Prevalence† (95% CI)	21.2 (12.5 to 29.9)		7.7 (4.7 to 10.6)	25.0 (14.9 to 35.0)	28.6 (19.1 to 38.0)	
COPD‡						
• Yes	1 (1.2)		1 (3.8)	0 (0.0)	0 (0.0)	0.5882
• Prevalence† (95% CI)	1.2 (1.1 to 3.5)		3.8 (2.4 to 5.3)	0.0	0.0	

FEV_1=forced expiratory volume in 1 second; FVC=forced vital capacity; OVD=obstructive ventilatory defect; COPD=chronic obstructive pulmonary disease; SD=standard deviation

* p<0.05 is considered statistically significant, # FEV_1/FVC <80% or FEV_1 %predicted <80%, ‡ FEV_1/FVC <70%, † per 100 populations

year had the lowest mean for every spirometric index. The present study results were similar to those studies conducted in the Netherlands, China, and Korea[9-11], which claimed that the potential of lung function decreased with increasing age and pack-year smoking history. Similar to the study in Rwanda, an African country[9], lung potential was associated with cigarette smoking. This evidence could explain the biomedical mechanism of how hazardous smoke components, including nicotine, tar, carbon monoxide, formaldehyde, ammonia, hydrogen cyanide, arsenic and others, irritated the tissue of the bronchi, trachea, and alveoli. Long-term smoking impaired lung function and the mechanisms of the respiratory system and led to abnormal symptoms and an increased risk of other diseases, such as lung cancer. In addition, the results of PFT among OVD and COPD patients influenced the decision to provide immunization, especially influenza vaccines, in the elderly population to avoid serious complications.

The present study showed a difference in the mean values of every group of pack-years, except FEV_1 %predicted and FVC indices, which showed differences only between G1 and G2 and between G1 and G3. For biomedical reasons, the long-duration smoker group always showed a low potential of lung function[9,10]. However, it was surprising that FEV_1/FVC indices were not significantly different in the present study. This phenomenon could be possible due to an error in the measurement procedure or the performance of spirometry equipment that was used in general practice settings[12]. Nevertheless, the G2 group (20 to 30 years) was long enough to reduce the potential lung function to the level of G3 (more than 30 years), so it might not show the difference in FEV_1/FVC indices.

OVD prevalence among adult men smokers was 21.2% (95% CI 12.5 to 29.9). The present study result was quite higher and not consistent with two studies conducted in Rwanda and Hong Kong that showed that the OVD prevalence was 14% and 14.6%, respectively[9,13]. In addition, the present study result was in contrast with a previous study conducted in China that showed that OVD prevalence was 2.6%[10]. This inconsistency might be the result of differences in the study participants. The present study participants were 20 to 60 years-old male smokers, but the study in Rwanda, Hong Kong and China were 15 to 80, more than 30, and more than 20 years-old of both gender smokers. Those previous studies were conducted with the general population who were undergoing a health check-up in the Health Management Center. Therefore, the proportion of smokers might be lower than that of the present study population. In addition, gender factors might have been different. These were important reasons why the OVD prevalence results of the study conducted in China were lower than those of the present study.

The present study finding revealed that the COPD prevalence was 1.2% (95% CI 1.1 to 3.5). The present study result was similar to the results of the two studies conducted in Taiwan and Thailand, in which the COPD prevalence among the general population was 6.1% and 7.11%[14,15]. However, the present study finding was different from the results of the two previous studies conducted in Sweden in which the COPD prevalence among smokers was 23% and 16.2%[16,17]. The different finding was the result of the variations in COPD definition and criteria in each study. The present study used the criterion for diagnosing COPD based on a FEV_1 over FVC ratio less than 70%, but other studies were different.

Conclusion

The smoking situation in the present study area was serious. Long-term pack-years clearly affected the potential of lung function. OVD prevalence was high, but COPD is still not a serious health problem. The promotion of smoking cessation among early OVD patients is very important, and it could reduce the incidence of COPD.

What is already known on this topic?

Pack-years associated with the potential of lung function decrease. Long-term smoking impaired lung function and the mechanisms of the respiratory system. It led to abnormal symptoms and increased risk of OVD, COPD, and other diseases. However, the smoking situation was different in each area.

What this study adds?

The smoking situation in poverty-stricken coastal fishing communities in the southernmost provinces of Thailand was serious. The OVD prevalence was high, but COPD was still not a serious health problem. The promotion of smoking cessation among early OVD patients is very important, and it could reverse the effects of COPD.

Acknowledgement

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Conflicts of interest

The authors declare no conflict of interest.

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