International Journal of Community Medicine and Public Health
*Saleem M et al. Int J Community Med Public Health. 2017 Nov;4(11):4113-4119*
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20174629

**Original Research Article**

# A study on the prevalence of chronic obstructive pulmonary disease among adults in Madurai, Tamil Nadu

**Mohamed Saleem[1], Sivasubramanian Priya[1]*, Manimaran Pradeep[2], Kalifulla Sabeetha[3]**

[1]Institute of Community Medicine, Madurai Medical College, Madurai, Tamil Nadu, India
[2]Dental surgeon, Madurai, Tamil Nadu, India
[3]PSNA College of Engineering and Technology, Dindigul, Tamil Nadu, India

**Received:** 09 September 2017
**Revised:** 26 September 2017
**Accepted:** 27 September 2017

***Correspondence:**
Dr. Sivasubramanian Priya,
E-mail: drpriyagsh@gmail.com



## ABSTRACT

**Background:** Chronic obstructive pulmonary disease (COPD) is a major public health problem with increasing prevalence especially in developing countries. Burden of disease estimation is important for decision making, planning, prioritising and allocating funds. It has been found that the recent data on prevalence of COPD is less in south India, especially Tamil Nadu. Hence this study was undertaken in order to estimate the prevalence of COPD in Madurai among adults and its association with socio demographic variables.
**Methods:** This is a community based cross-sectional study done in Kallendiri block of Madurai district with adults aged >30 years of both the sexes as study population. Sample size was 480. Using cluster sampling method, study participants were interviewed with semi-structured questionnaire and peak expiratory flow rate was measured using peak flow meter.
**Results:** Prevalence of COPD was 22.1% among the study population. Males (39.2%) had higher prevalence than females (12.2%). COPD prevalence was significantly higher among increasing age, male sex, illiteracy, low BMI, smokers, inadequate ventilation and those using biomass fuels for cooking.
**Conclusions:** This study has established the fact that COPD is highly prevalent among adults in rural area. For practitioners, the results call for a high index of suspicion of COPD among >30 years with substantial exposure to risk factors. For health policy makers, the results of the current study urge for the development of COPD prevention programs failing which the burden of COPD might result in increased mortality, morbidity and economic burden.

**Keywords:** COPD, Prevalence, PEFR, Peak flow meter

## INTRODUCTION

"Chronic obstructive pulmonary disease (COPD), one of the non-communicable diseases, is characterised by persistent airflow limitation that is usually progressive".[1]

As per WHO, Non communicable diseases refer to "Diseases that are chronic, life style related and usually progressive when not intervened". This holds true for COPD also as it is chronic, progressive and most of the risk factors are lifestyle related (smoking, biomass fuel exposure etc).

It is the leading cause of chronic morbidity and mortality worldwide and it has been projected to become third leading cause of death worldwide by 2020 and in middle income countries by 2030.[2,3] Also, COPD is expected to rise to become the fifth leading cause of loss of Disability Adjusted Life Year (DALY) by 2020 as per the global burden of disease study.[3] It also causes huge economic and social burden on patients. In India, according to

National Commission on Macroeconomics and Health background paper by Murthy et al., the annual treatment costs for COPD had been estimated to be greater than Rs. 35,000 crores in 2011 and Rs. 48,000 crores in 2016.[4]

According to WHO, COPD is a major public health problem with increasing prevalence especially in developing countries. Jindal et al from the department of Pulmonary Medicine, Chandigarh had reviewed all Indian studies on COPD in 2001.[5] Out of 14 review studies, only two were from south India.[6,7] Prevalence rates in most of these studies varied around 4-6% for males and 2-4% for females. The Indian Council of Medical Research (ICMR) sponsored study in India in 2006 reported a prevalence rate of 5.0% for males and 3.2% for females >35 years of age.[8]

COPD is a polygenic disease as it results from gene-environment interaction. Like all other chronic diseases, COPD has modifiable and non-modifiable risk factors that are preventable.[1] Cigarette smoking is the commonest risk factor noticed globally, but various epidemiological studies have got enough evidence that non-smokers may also develop COPD.[9,10] This indicates the presence of other factors like environmental tobacco smoke exposure, dust exposure at work place, outdoor air pollution and indoor air pollution.[11] A recent study has reported that exposure to biomass smoke produced during heating and cooking biomass in poorly ventilated houses has become an important risk factor among women especially in developing countries.[12] Low socioeconomic status was also found to be an important risk factor in many epidemiological studies.[13] Thus COPD is preventable to a large extent if the risk factors are controlled.

Burden of disease estimation is important for decision making, planning, prioritising and allocating funds.[5] This is specifically important for diseases that are associated with preventable factors like tobacco smoking and indoor air pollution from cooking fuels. But it was noted after exhaustive review of literature that, there are not much data on prevalence of COPD in south India, especially in Tamil Nadu. Hence the objective of the study is estimate the prevalence of COPD in Kallendiri block of Madurai district among adults aged 30 years and above and its association with socio demographic variables.

## METHODS

This is a community based cross sectional study done in Kallendiri block of Madurai district with adults aged 30 years and above of both the sexes as study population in 2016. The exclusion criteria were those not willing to participate, pregnant women, those with pulmonary tuberculosis, those unable to understand and perform lung function test and heart disease. The sample size was calculated as 480 based on previously conducted studies and cluster sampling method.

Survey instrument has 2 parts. Part 1 is the semi structured questionnaire developed based on GOLD guidelines.[1] It includes information on socio demographic details, respiratory symptoms and risk factors. Part 2 is the measurement of airflow obstruction using Peak expiratory flow meter which is American Thoracic Society/European Respiratory Society (ATS/ERS) compliant. Validity of this instrument is ± 10% satisfying the ATS/ERS task force recommendations and reliability was tested daily against another instrument.[14] Data was collected by house to house visit using cluster sampling method. Among subjects who met the inclusion and exclusion criteria, questionnaire was filled after obtaining informed consent. Each study subject was then subjected to peak expiratory flow rate (PEFR) after measuring their height and weight.

PEFR was measured following ATS/ERS task force guidelines in litres/minute.[14] After giving prior instructions, technique was demonstrated separately to each individual. Following demonstration, subjects were asked to make trial attempts to detect faults. Once the study subject had gained confidence, the test was performed in the sitting position and he/she was asked to inspire maximally and blow out without any hesitation as fast and as hard as possible into the meter. It was taken care that mouth was sealed tightly around the mouth piece of the peak flow meter during the procedure. The test was repeated three times for every individual and best of the three attempts was taken for data analysis. Disposable mouth piece was used for each individual. Both within manoeuvre and between manoeuvre evaluations of the PEFR performance of each individual was done as per ATS/ERS guidelines.

As PEFR is influenced mainly by sex, age & height of the individual, each observed value was compared with the reference values (also known as predicted values) for that particular age, height and sex for interpretation. Predicted values for this study was obtained from a study by Prasad et al.[15] Formula for predicted values are as follows,

For males: $-2.294 \times \text{age} + 3.38 \times \text{Height in cms}$

For females: $-2.8 \times \text{age} + 3.05 \times \text{Height in cms}$

COPD was diagnosed when the observed PEFR is lesser than 80% of the corresponding predicted value. This cut-off point has a sensitivity of 91% and specificity of 82% in diagnosing COPD.[16]

Data Analysis was carried out using SPSS Software version 16.0. The final data were summarized into percentages and analyzed by cross tabulations for different variables. A 95% confidence interval (CI) was calculated wherever appropriate and $\chi 2$ test was used for finding the statistical significance. Associations were assessed through odds ratio (OR) and its CI at 95%.

## RESULTS

This cross sectional study included 480 participants from Panchayat villages in Kallendiri block of Madurai district, Tamil Nadu. Table 1 shows that majority of the study population belonged to the age group of 40-49years (32.1%) followed by 30-39 years (29.8%). Females were predominant in the study with 63.3%. Among the study participants, 92.3% were Hindus. Majority of the study participants were illiterates (35.8%). Among the literates, those completed high school and above were the highest (33.8%) followed by primary education (30.4%).

**Table 1: Descriptive statistics for socio demographic variables collected from study population.**

| Variables | Total | Percentage (%) |
|---|---|---|
| **Age in years** | | |
| 30-39 | 143 | 29.8 |
| 40-49 | 154 | 32.1 |
| 50-59 | 124 | 25.8 |
| 60 and above | 59 | 12.3 |
| **Sex** | | |
| Male | 176 | 36.7 |
| Female | 304 | 63.3 |
| **Education** | | |
| Illiterate | 172 | 35.8 |
| Primary | 146 | 30.4 |
| High school and above | 162 | 33.8 |
| **Occupation** | | |
| Blue collar | 343 | 71.5 |
| Household work | 137 | 28.5 |
| **BMI (kg/m$^2$)** | | |
| Low (<18.5) | 58 | 12.1 |
| Normal (18.5-24.9) | 313 | 65.2 |
| Overweight/obese (>25) | 109 | 22.7 |
| **Smoking status** | | |
| Smokers | 105 | 21.8 |
| **Ventilation** | | |
| Inadequate ventilation | 375 | 78.1 |
| **Cooking fuels** | | |
| Biomass (cow dung, coal, wood) | 193 | 40.2 |
| Kerosene/LPG | 287 | 59.8 |

Majority of the study population were blue collars (agriculture, non-agriculture, skilled labour) (71.5%), remaining were household workers (28.5%). Among the study population 12.1% had BMI less than 18.5 kg/m$^2$ and 65.2% had normal BMI and 22.7% were overweight/ obese.

Among the study population 21.8% were smokers and 40.2% used biomass (cow dung/coal/wood) as cooking fuels and 59.8% used LPG/kerosene as cooking fuel. 78.1% of the study population lived in houses with inadequate ventilation.

Peak flow meter was used in the current study to measure PEFR of the study population. It was noted that mean PEFR among males (401.13) was significantly higher than the mean PEFR of females (306.37). A negative correlation between age and PEFR ($r^2$=0.138, i.e. as age increases, PEFR decreases) and a positive correlation between height and PEFR value ($r^2$=0.282, i.e. as height increases, PEFR value also increases) was found.

To find out the prevalence of COPD, the predicted values for PEFR were constructed for each individual based on their age and height using prediction models for Indians. Those with predicted values less than 80% were diagnosed as having COPD as this cut-off value has a sensitivity of 91% and specificity of 82% in diagnosing COPD.

Table 2 show that the prevalence of COPD in the study population was 22.1% (95% CI: 18.4%-25.8%). Apart from this, it is also noted that as age increases, COPD prevalence also increases gradually (i.e.) from 10.5% among 30-39 years to 55.9% among population of 60 years and above. With respect to sex, males had higher prevalence (39.2%) than females (12.2%).The COPD was more prevalent among illiterates (27.9%) and household

workers (23.4%). The prevalence of COPD was more (55.2%) among persons having BMI less than 18.5 kg/m$^2$.

**Table 2: Prevalence of COPD based on socio demographic variables collected from study population.**

| Variables | Total | COPD no | Percentage (%) | 95% CI |
|---|---|---|---|---|
| **Overall prevalence** | 480 | 106 | 22.1 | 18.4 -25.8 |
| **Age in years** | | | | |
| 30-39 | 143 | 15 | 10.5 | 05.5-15.5 |
| 40-49 | 154 | 26 | 16.9 | 11.0-22.8 |
| 50-59 | 124 | 32 | 25.8 | 18.1-33.5 |
| 60 and above | 59 | 33 | 55.9 | 43.3-68.6 |
| **Sex** | | | | |
| Male | 176 | 69 | 39.2 | 32.0-46.4 |
| Female | 304 | 37 | 12.2 | 08.5-15.8 |
| **Education** | | | | |
| Illiterate | 172 | 48 | 27.9 | 21.2-34.6 |
| Primary | 146 | 36 | 24.6 | 17.6-31.6 |
| High school and above | 162 | 22 | 13.5 | 08.3-18.8 |
| **Occupation** | | | | |
| Blue collar | 343 | 74 | 21.6 | 17.2-26.0 |
| Household work | 137 | 32 | 23.4 | 16.3-30.4 |
| **BMI (kg/m$^2$)** | | | | |
| Low (<18.5) | 58 | 32 | 55.2 | 42.4-68.0 |
| Normal (18.5-24.9) | 313 | 66 | 21.1 | 16.6-25.6 |
| Overweight/obese (>25) | 109 | 08 | 7.3 | 02.4-12.2 |
| **Smoking status** | | | | |
| Smokers | 105 | 61 | 58.1 | 48.7-67.5 |
| **Ventilation** | | | | |
| Inadequate ventilation | 375 | 92 | 24.5 | 20.2-28.9 |
| **Cooking fuels** | | | | |
| Biomass (cow dung, coal, wood) | 193 | 67 | 34.7 | 28.0-41.4 |
| Kerosene/LPG | 287 | 39 | 13.6 | 09.6-17.5 |

**Table 3: Association between COPD and socio demographic variables collected from study population.**

| Variables | Total (n=480) | With COPD (n=106) | Without COPD (n=374) | Odds Ratio | 95% CI | P value |
|---|---|---|---|---|---|---|
| **Age in years** | | | | | | |
| More than 50 | 183 | 65 | 118 | | | |
| Less than 50 | 297 | 41 | 256 | 3.5 | 02.2-05.4 | 0.001 |
| **Sex** | | | | | | |
| Male | 176 | 69 | 107 | | | |
| Female | 304 | 37 | 267 | 4.6 | 02.9-07.3 | 0.001 |
| **Education** | | | | | | |
| Illiterate | 172 | 48 | 124 | | | |
| Literate | 308 | 58 | 250 | 1.1 | 01.1-02.6 | 0.025 |
| **Occupation** | | | | | | |
| Blue collar | 343 | 74 | 269 | | | |
| Household work | 137 | 32 | 105 | 0.9 | 00.6-01.4 | 0.750 |
| **BMI (kg/m$^2$)** | | | | | | |
| <18.5 | 058 | 32 | 026 | | | |
| >18.5 | 422 | 74 | 348 | 5.8 | 03.3-10.3 | 0.001 |
| **Smoking status** | | | | | | |
| Smokers | 105 | 61 | 044 | | | |
| Non smokers | 375 | 45 | 330 | 10.2 | 06.2-16.7 | 0.001 |
| **Ventilation** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Inadequate ventilation | 375 | 92 | 283 | | | |
| Adequate ventilation | 105 | 14 | 091 | 2.1 | 01.2-03.9 | 0.025 |
| **Cooking fuels** | | | | | | |
| Biomass fuel | 193 | 67 | 126 | | | |
| Kerosene/LPG | 287 | 39 | 248 | 3.4 | 02.2-05.3 | 0.001 |

Table 2 also shows that COPD was more prevalent among smokers (58.1%). The COPD prevalence was 24.5% among persons living in inadequately ventilated houses and 34.7% among those using biomass fuels (cow dung/coal/wood) for cooking.

Table 3, shows the association between COPD and certain socio demographic variables among the study population. From Table 3, it was inferred that increasing age, males, illiteracy, low BMI, smokers, inadequate ventilation and those using biomass fuels for cooking were significantly associated with prevalence of COPD. There was no statistically significant difference between COPD and occupation in the study population.

## DISCUSSION

This community based cross sectional study was done to estimate the prevalence of COPD among adults aged 30 years and above and also to find out the associated risk factors of COPD like smoking, exposure to biomass fuels etc., among them. This study was carried out in selected panchayat villages of Kallendiri block of Madurai district.

There were conflicting prevalence estimates in the published literature. This was mainly due to differences in methodology, definitions used to measure the disease and inclusion of varied age groups. All these methods have their own advantages and limitations when it comes to field application with different sensitivities and specificities to diagnose COPD and also the cost. However, for epidemiological purpose, measurement of airflow limitation with either a Peak flow meter or Spirometer remains the most useful tool to asses COPD. Peak flow meter was used in the current study due to low cost and ease of application.

In the current study, 106 (22.1%) subjects were identified as having COPD. Viegi et al reported a similar prevalence of 18.3% in the study conducted among adults >25 years in rural area of north Italy in 2004.[17] This prevalence was based on clinical criteria. In Upsala, a study involving adults aged 40 years and above by Danielsson et al in 2011 found almost similar prevalence of 16.2%.[18] Many Indian field studies done upto1995 had reported very low prevalence of COPD ranging from 2% to 9%.[6,7,19,20,21]

Many earlier studies in India diagnosed COPD based on the definition of chronic bronchitis only (cough on most of the days for 3 months in a year for 2 consecutive years), thereby missing the breathlessness component i.e. airflow limitation.[6,7,20-22] But the current study diagnosed COPD based on peak flow meter that measures the airflow limitation, thereby contributing to the increased prevalence of COPD. It is also proved by the fact that few earlier Indian studies which used peak flow meter showed relatively higher prevalence of COPD when compared to studies that used questionnaire alone.[7,21,22]

Varied age groups were recruited by different studies whereas the present study included the age group of 30 and above.[6,20,21,23] It is evident that COPD is uncommon in younger age group and the inclusion of that age group would dilute the true prevalence to lower levels.

There are studies on North-south differences in prevalence estimates. Higher prevalence estimates were found in south India in previous studies as well.[7] Moreover, those studies in India were conducted before 1990 and hence the high prevalence of the present study could be attributed to changes in lifestyle like increased prevalence of both active and passive smoking, increased environmental pollution, increased use of chemical pesticides & fertilizers in agriculture which is also an air pollutant.

In the current study, it has also been observed that increasing age was significantly associated with higher prevalence of COPD (OR=3.44, p value is 0.0001). This finding is consistent with the reports by other studies namely, a large population based study conducted in China by Zhong et al, Waked et al among Lebanon adults, a prospective study on COPD by Ray et al in rural south India, a community based cross sectional study on COPD in rural India by Salvi et al and a multicentric study in India by Jindal et al.[7,8,24-26] Though the younger age group had a lesser prevalence compared to older age (60 and above), it is of public health importance as the younger age subjects would continuously be exposed to the risk factors.

There was higher prevalence of COPD among males (39.2%) than females (12.2%) and the difference was found to be statistically significant with OR= 4.6, p=0.0001. A study by Jindal et al in India, Zhong et al in China and Salvi et al also found the similar findings.[8,24,26]

The present study also made a statistically significant observation between low BMI and COPD (OR=5.78, p=0.0001). Similar findings had been reported in the literature.[24]

The present study has found a significant association between smoking and COPD (OR=10.16, p=0.0001) and has been consistently observed in many studies. Smoking as an etiology of COPD has been proved in many international reports.[9,27]

In the present study, inadequate ventilation was significantly associated with the development of COPD (OR=2.1, p=0.025). This finding agreed with the findings of the study in rural China by Ran et al which reported a higher odds ratio for worse ventilation.[28]

As mentioned earlier, exposure to biomass fuels (cowdung /wood/coal) is an independent risk factor especially for females. In the present study, prevalence was significantly more among biomass fuel users (34.7%) than those using other fuels (13.6 kerosene / LPG users) with OR=3.4, p=0.0001. A meta analysis on risk of COPD from biomass exposure by Guoping Hu et al in 2010 found a higher odds of developing COPD for those exposed to biomass, relative to those not exposed.[29] Also, a study by Liu et al in rural south China and by Goel et al in India showed a significant association between COPD and exposure to biomass fuels for cooking.[30,31]

## CONCLUSION

The current study has established the fact that COPD is highly prevalent among adults in rural area. For practitioners, the results call for a higher index of suspicion of COPD in persons aged 30 years and above with substantial exposure to risk factors especially underweight individuals. For health policy makers, the results of the current study urge for the development of COPD prevention programs failing which the burden of COPD might result in increased mortality, morbidity and economic burden. The baseline prevalence information provided in the current study also paves the way for future epidemiological studies.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Vestbo J, Hurd SS, Agusti AG, Jones PW, Vogelmeier C, Anzueto A, et al. Global strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease, GOLD executive summary. Am J Respir Crit Care Med. 2013;187:347–65.
2. Lopez AD, Shibuya K, Rao C, Mathers CD, Hansell AL, Held LS, et al. Chronic obstructive pulmonary disease: current burden and future projections. Eur Respir J. 2006;27(2):397-412.
3. Murray CJ, Lopez AD. Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study. Lancet. 1997;349:1498-504.
4. Murthy KJ, Sastry JG. Economic burden of chronic obstructive pulmonary disease. Burden of Disease in India, National Commission on Macroeconomics and Health, New Delhi. 2005: 264-274.
5. Jindal SK, Aggarwal AN, Gupta D. A review of population studies from India to estimate national burden of chronic obstructive pulmonary disease and its association with smoking. Indian J Chest Dis Allied Sci. 2001;43:139-48.
6. Thiruvengadam KV, Raghava TP, Bharadwaj KV. Survey of prevalence of chronic bronchitis in Madras city. Advances in chronic obstructive lung disease. Delhi: Asthma and Bronchitis Foundation of India; 1977: 59–69.
7. Ray D, Abel R, Selvaraj KG. A 5-year prospective epidemiological study of COPD in rural south India. Indian J Med Res. 1995;101:238–44.
8. Jindal SK, Aggarwal AN, Chaudhry K, Chhabra SK, D Souza GA, Gupta D, et al. A multicentric study on epidemiology of chronic obstructive pulmonary disease and its relationship with tobacco smoking and environmental tobacco smoke exposure. Indian J Chest Dis Allied Sci. 2006;48:23-9.
9. US Department of Health and Human Services. The health consequences of smoking: chronic obstructive pulmonary disease. A report of the Surgeon General. US Department of Health and Human Services. Public Health Service, Office of the Assistant for Health, Office of Smoking and Health. DHHS Publication. 1984;(84-50):205.
10. Celli BR, Halbert RJ, Nordyke RJ, Schau B. Airway obstruction in never smokers: results from the Third National Health and Nutrition Examination Survey. Am J Med. 2005;118:1364-72.
11. Yin P, Jiang CQ, Cheng KK, Lam TH, Lam KH, Miller MR, et al. Passive smoking exposure and risk of COPD among adults in China: the Guangzhou Biobank Cohort Study. Lancet. 2007 ;370:751-7.
12. Naeher LP, Brauer M, Lipsett M, Zelikoff JT, Simpson CD, Koenig JQ, Smith KR. Woodsmoke health effects: a review. Inhal Toxicol. 2007;19:67-106.
13. Viegi G, Scognamiglio A, Baldacci S, Pistelli F, Carrozzi L. Epidemiology of chronic obstructive pulmonary disease (COPD). Respiration. 2001;68:4-19.
14. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. Eur Respir J. 2005;26:319–38.
15. Prasad R, Verma SK, Agrawal GG, Mathur N. Prediction model for peak expiratory flow in North Indian population. Indian J Chest Dis Allied Sci 2006;48:103-6.
16. Jackson H, Hubbard R. Detecting chronic obstructive pulmonary disease using peak flow rate: cross sectional survey. BMJ. 2003;327:653-4.

17. Viegi G, Pedreschi M, Pistelli F, Di Pede F, Baldacci S, Carrozzi L, et al. Prevalence of airways obstruction in a general population: European Respiratory Society vs American Thoracic Society definition. Chest. 2000;117(5):339-45.
18. Danielsson P, Olafsdottir IS, Benediktsdottir B, Gíslason T, Janson C. The prevalence of chronic obstructive pulmonary disease in Uppsala, Sweden–the Burden of Obstructive Lung Disease (BOLD) study: cross-sectional population-based study. Clin Respir J. 2012;6:120-7.
19. Jindal SK. A field study on follow up at 10 years of prevalence of chronic obstructive pulmonary disease & peak expiratory flow rate. Indian J Med Res. 1993;98:20-6.
20. Radha TG, Gupta CK, Singh A, Mathur N. Chronic bronchitis in an urban locality of New Delhi-an epidemiological survey. Indian J Med Res. 1977;66:273-85.
21. Viswanathan R. Epidemiology of Chronic Bronchitis: Morbidity Survey in Patna Urban Area. Indian J Med Res. 1966;54:105-11.
22. Bhattacharya SN, Bhatnagar JK, Kumar S, Jain PC. Chronic bronchitis in rural population. Indian J Chest Dis. 1975;17:1–7.
23. Malik SK. Profile of chronic bronchitis in north India-the PGI experience (1972-1985). Lung India. 1986;4:89-100.
24. Zhong N, Wang C, Yao W, Chen P, Kang J, Huang S, et al. Prevalence of chronic obstructive pulmonary disease in China: a large, population-based survey. Am J Respir Crit Care Med. 2007;176:753-60.
25. Waked M, Khayat G, Salameh P. Chronic obstructive pulmonary disease prevalence in Lebanon: a cross-sectional descriptive study. Clin Epidemiol. 2011;3:315-23.
26. Salvi S, Juvekar S, Londhe J, Brashier B, Madas S, Barnes P. Prevalence of COPD in a rural population in India. Eur Respiratory J. 2011;38(55):2954.
27. Reddy KS, Gupta PC. Tobacco control in India. New Delhi: Ministry of Health and Family Welfare, Government of India. 2004: 43-47.
28. Ran PX, Wang C, Yao WZ, Chen P, Kang J, Huang SG, et al. The risk factors for chronic obstructive pulmonary disease in females in Chinese rural areas. Zhonghua Nei Ke Za Zhi. 2006;45:974-9.
29. Hu G, Zhou Y, Tian J, Yao W, Li J, Li B, Ran P. Risk of COPD from exposure to biomass smoke: a metaanalysis. Chest. 2010;138:20-31.
30. Liu S, Zhou Y, Wang X, Wang D, Lu J, Zheng J, Zhong N, Ran P. Biomass fuels are the probable risk factor for chronic obstructive pulmonary disease in rural South China. Thorax. 2007;62:889-97.
31. Goel S, Gupta BP, Kashyap S, Bhardwaj AK. Epidemiological aspects of chronic bronchitis in Shimla hills. Indian J Chest Dis Allied Sci. 2007;49:143–7.

**Cite this article as:** Saleem M, Priya S, Pradeep M, Sabeetha K. A study on the prevalence of chronic obstructive pulmonary disease among adults in Madurai, Tamil Nadu. Int J Community Med Public Health 2017;4:4113-9.