**The association between chronic airflow obstruction and poverty in 12 sites from the multinational Burden of Obstructive Lung Disease study**

J. Townend, PhD1

C. Minelli, PhD1

K. Mortimer, PhD2

D.O. Obaseki, MD3

M. Al Ghobain, MD4

H. Cherkaski, PhD5

M. Denguezli, PhD6

K. Gunesekera,MD7

H. Hafizi, MD8

P. Koul,MD9

L.C. Loh, MD10

C. Nejjari, PhD11

J. Patel, MSc1

T, Sooronbayev,MD12

A.S. Buist,MD13

P. Burney, MD1

1 National Heart and Lung Institute

Imperial College

Emmanuel Kaye Building

1b Manresa Road

London SW3 6LR

UK

2 Liverpool School of Tropical Medicine

Pembroke Place

Liverpool L3 5QA

UK

3 Department of Medicine

Obafemi Awolowo University

Ile-Ife

Nigeria.

4 College of Medicine

Department of Medicine

King Saud bin Abdulaziz University for Health Sciences

Riyadh

Saudi Arabia

5 University Badji Mokhtar of Annaba  
Department of Pneumology, Faculty of Medecine Annaba, Route Zaâfrania BP 205, Annaba 23000, Algeria.

6 Faculté de Médecine Dentaire de Monastir

Université de Monastir

Département des Sciences Fondamentales et Mixtes

Laboratoire de Physiologie et des Explorations Fonctionnelles

Faculté de Médecine de Sousse

Université de Sousse

Tunisia

7 Central chest clinic

MRI building

Baseline Road

Colombo 8

and

The National Hospital of Sri Lanka

E W Perera Mawatha

Colombo 10

8 Third Pulmonology Service, Faculty of Medicine

Tirana University Hospital "Shefqet Ndroqi"  
Tirana

Albania

9 **Sher-i-Kashmir Institute of Medical Sciences,**

**Srinagar,**

**Jammu and Kashmir,**

**India**

10 Department of Medicine

Penang Medical College

4 Jalan Sepoy Lines

Penang 10450

Malaysia

11 Department of Epidemiology and Public Health

Faculty of Medicine

University Sidi Mohammed Ben Abdellah

Fez

Morocco.

12 Pulmonary Division,

National Center of Cardiology and Internal Medicine,

Bishkek,

Kyrgyzstan

13 Pulmonary & Critical Care Medicine

Oregon Health & Science University

3181 SW Sam Jackson Park Rd. MC:UHN67

Portland

OR 97239

USA

Corresponding author:

Professor Peter Burney, MA MD FRCP FFPH FMedSci

National Heart and Lung Institute, Imperial College, Emmanuel Kaye Building, 1b Manresa Road, London SW3 6LR, UK

[p.burney@imperial.ac.uk](mailto:p.burney@imperial.ac.uk)

Tel: 0207 594 7941

Words: 3,229; tables: 2; figures: 3; references 19; supplementary tables: 1

Short sentence:

Poverty is a strong predictor of chronic airflow obstruction independent of age, sex, smoking, and tuberculosis.

**Summary (200 words)**

**Background:** Poverty is strongly associated with mortality from COPD, but little is known of its relation to airflow obstruction.

**Methods:** In a cross-sectional study of adults aged ≥40 years from 12 sites (N=9,255) participating in the Burden of Obstructive Lung Disease (BOLD) study, poverty was evaluated using a wealth score (0-10) based on household assets. Obstruction, measured as FEV1/FVC (%) after 200 g salbutamol, and prevalence of FEV1/FVC<lower limit of normal were tested for association with poverty for each site, and the results combined by meta-analysis.

**Findings:** Mean wealth scores ranged from 4 in Blantyre (Malawi) and Kashmir (India) to 10 in Riyadh (Saudi Arabia), and the prevalence of obstruction from 16% in Kashmir to 3% in Riyadh and Penang (Malaysia). Adjusting for age and sex, FEV1/FVC increased by 0·36% (absolute change) (95%CI: 0·22, 0·49; p<0·001) per unit increase in wealth score. Adjusting for other confounders reduced this effect to 0·23% (0.11, 0·34), but this remained highly significant (p<0·001). Results were consistent across sites (I2=1%; phet=0·44). Mean wealth scores explained 38% of the variation in mean FEV1/FVC between sites (r2=0·385, p=0·031).

**Interpretation:** Airflow obstruction is consistently associated with poverty at individual and community levels across a wide range of countries.

**Introduction**

Chronic Obstructive Pulmonary Disease (COPD) is the 3rd most common cause of death in the world [1](#_ENREF_1) and the 6th most common cause of living with disability.[2](#_ENREF_2) National mortality rates from COPD are associated with per capita Gross National Income (GNI).[3](#_ENREF_3) Changes over time in GNI are also strongly correlated with changes in mortality from COPD.[4](#_ENREF_4) At an individual level mortality from COPD has been strongly associated with social class in England and Wales.[5](#_ENREF_5)

However, there is little information on the relation between poverty and the prevalence of airflow obstruction at an individual level. In the Burden of Obstructive Lung Disease (BOLD) study, an international study of the prevalence and risk factors associated with airflow obstruction, an ecological analysis showed very little association between chronic airflow obstruction and GNI.[3](#_ENREF_3) This could have been due to confounding at the ecological (country) level which might have hidden a true association between airflow obstruction and poverty at an individual level. Information at an individual level on the relation between poverty and spirometry is available from studies using a wide variety of indicators of socioeconomic status,[6](#_ENREF_6) but few of these have measured obstruction and those that have done so provide contradictory results.[6](#_ENREF_6) A French study in adults found an association between obstruction and socioeconomic status,[7](#_ENREF_7) while a Canadian study among children did not, finding only an association with lung volumes.[8](#_ENREF_8) Earlier analyses from the BOLD study have shown associations with education which is associated with wealth,[9](#_ENREF_9),[10](#_ENREF_10) but wealth itself has not so far been assessed at an individual level.

In this study we examined the association between poverty and airflow obstruction in 12 sites from the BOLD study with estimated per capita GNI (US$ purchasing power parity, PPP) ranging between US$750 (Malawi) and US$53,760 (Saudi Arabia). Poverty at an individual level was evaluated using a wealth score based on household assets, ranging from 0 (poorest) to 10 (richest), and airway obstruction was assessed using post-bronchodilator FEV1/FVC (%) and FEV1/FVC<lower limit of normal (LLN).

**Methods**

The BOLD study is an international multi-site study of the prevalence and determinants of chronic lung disease. Details of the study design and methodology have been described elsewhere.[11](#_ENREF_11) Sites were selected in all the regions of the world defined by the Global Burden of Disease programme, with the exception of the Latin America, the Asian Pacific high income regions and Oceania. Each site was asked to administer questionnaires and carry out spirometric tests on a representative sample of at least 600 adults aged 40 years and above. All the spirometry was conducted using the same equipment and all technicians were trained using the BOLD protocol. Spirometry data were reviewed centrally for quality. Where the quality of any technician fell below the quality required for the programme, the technician was temporarily withdrawn and re-trained. The current analysis includes the 12 sites that entered the study after new questionnaires were introduced that included the 15-item asset inventories used to create a measure of individual wealth.[12](#_ENREF_12)

An automated item selection procedure was used to choose a subset of the asset ownership questions which met the requirements of a Mokken scale. [13](#_ENREF_13),[14](#_ENREF_14) This is a non-parametric method that uses a set of questions which can be ordered in increasing stringency, such that anyone who answers yes to owning one of the assets is likely to have answered yes to all of the more basic assets. Items in our questionnaire were selected because we expected they would all be desirable, but that they would cover a range of obtainability such that some would be owned by most people whilst the less basic items would only be owned by the better off. From the initial 15-asset ownership questions, ten were found to meet the requirements of a Mokken scale: (i) all are related to the same trait (wealth), (ii) ownership of one is independent of ownership of the others, (iii) the probability of ownership increases monotonically with the trait being measured. The ten selected assets in decreasing order of prevalence of ownership were electricity, television, cell phone, refrigerator, indoor bath or shower, indoor tap, flush toilet, washing machine, car and landline telephone. Individuals’ scores were calculated by adding up the total number of these assets owned by the respondent or their household; the scores were therefore in the range 0 (no assets) to 10 (all assets). Previous work showed that the number owned was correlated with educational level and other variables likely to be related to socioeconomic position, and that the mean number owned in each country was highly correlated with the GNI per capita of the country where the survey took place.[12](#_ENREF_12) We therefore refer to these scores as “wealth scores” as they are broadly indicative of an individual’s wealth. We previously also showed that the rank ordering of prevalence of ownership of these assets was fairly consistent across a wide range of countries with GNI/capita ranging from $4,750 to $53,760 (Cronbach’s alpha=0·96), suggesting that this is a useful scale to compare individuals both within and between countries.[12](#_ENREF_12)

The association of the wealth score with spirometric outcomes was estimated for each of the sites using linear regression of FEV1/FVC ratio (expressed as a %) on wealth score, with higher ratios indicating less airflow obstruction; analysis was adjusted for age and sex. In a secondary analysis we used logistic regression to evaluate the association between the wealth score and airflow obstruction as a binary outcome defined as a FEV1/FVC ratio below the LLN. To be consistent with earlier BOLD publications we have computed these from reference values given by the NHANES III study for Caucasian Americans.[15](#_ENREF_15) Since age and sex are used to determine the LLN for an individual, the logistic regression model for the odds ratio (OR) of obstruction was not further adjusted for these variables. All of the regressions were weighted to allow for different probabilities of selection of the participants in the samples, and standard errors were adjusted for clustering or stratification included in the study design in each site, using survey analysis methods.[9](#_ENREF_9)

To investigate the extent to which any other factors could explain the association between wealth and chronic airflow obstruction, whether as confounders or as factors on a causal pathway between wealth score with FEV1/FVC, the regression analyses were repeated adjusting for factors previously identified as having an effect on FEV1/FVC ratio or obstruction[9](#_ENREF_9) and possibly associated with poverty: body mass index (BMI), education, smoking, passive smoking, exposure to a dusty job, family history of breathing problems, childhood hospitalisation for breathing problems, and previous diagnosis of TB.[9](#_ENREF_9) Education was defined as the highest completed level of education on a six point scale from none to completed university education, and modelled as a continuous variable assuming a linear trend in obstruction with increasing level of schooling. Smoking was defined as the respondent’s lifetime exposure to cigarette smoking or to other tobacco products measured in equivalent pack years, where one pack year equals twenty cigarettes per day for one year.[16](#_ENREF_16) Exposure to a dusty job was the self-reported number of years the respondent had worked in a dusty job. BMI was included in the models as a categorical variable: <18·5 (underweight), ≥18·5 and <25 (normal), ≥25 and ≤30 (overweight), or >30 (obese). The other potential confounding and explanatory factors were included as binary variables.

Pooled estimates of the associations of the wealth score with FEV1/FVC ratio and obstruction across sites were obtained with inverse variance-weighted meta-analysis, using random-effects models to allow for some heterogeneity between sites. Between-site heterogeneity was evaluated using the I2 statistic and the Q-test.

Subsequent to the main planned analysis we also adjusted for current smoking status as a three category variable (current, former, or never smoker) in addition to total pack years, and exposure to open fires for cooking and/or heating for more than 20 years, neither of which had been independently associated with obstruction in the earlier analysis, and ever having suffered from asthma which, though associated with obstruction was viewed as a diagnostic label rather than as a truly independent risk factor.

Finally, the relationship between poverty and FEV1/FVC ratio at an aggregate level in the 12 sites was investigated by plotting the mean FEV1/FVC against the mean wealth score for each site. The percentage of variation in mean FEV1/FVC explained by mean wealth score (r2 value) in the 12 sites was estimated using linear regression, weighted for the number of subjects in each site. The relationship between mean wealth score and percentage of subjects with airflow obstruction (FEV1/FVC<LLN) in each site was analysed similarly.

All analyses were carried out using Stata v13·1 (StataCorp, College Station, TX.)

Ethics

The study was approved by the local ethical committee in each site and by the Charing Cross Ethical Committee in London (06/Q0411/97), the relevant committee for the co-ordinating centre. Participants were only included if they gave written informed consent.

Role of the funding source

The funders played no part in the design or implementation of this study nor in the decision to publish the results.

**Results**

Data were collected from 12 sites in 11 countries. Each site collected usable information on between 400 and 1,100 individuals, fairly evenly divided between men and women. Response rates were mostly over 70% but ranged from 46% (Chui, Kyrgyzstan) to 92% (Annaba, Algeria) (Table 1). Overall of 13,903 people approached, 9,255 provided adequate information and are included in the analyses. The centres included in this study were all those which had information on the wealth score. They are biased towards the poorer countries but the mean wealth score ranged from 4 in Blantyre (Malawi) and Kashmir (India) to 10 in Riyadh (Saudi Arabia). Smoking was light to moderate in all sites apart from Kashmir. The high pack years smoked in Kashmir are due to two factors. First, in Kashmir there is heavy smoking among the older population, in contrast with most other areas where smoking is heaviest in the younger cohorts. Second, the most common type of smoking in Kashmir is shisha pipe, which is given a high equivalent pack years compared with cigarettes in the formula of Masters and Tutt.[**16**](#_ENREF_16) In most other areas smoking is heaviest in the younger cohorts. The overall mean age was 53. (Table 1). In line with this, the prevalence of obstruction (FEV1/FVC<LLN) was not high, and was lowest in Riyadh and Penang (Malaysia) (3%) and highest in Kashmir (16%).

Regression analysis adjusted for age and sex showed that FEV1/FVC(%) was significantly associated with the wealth score, increasing on average by 0.36% (absolute change) for each point increase in the score (95% confidence interval: 0·22 to 0·49; p<0·001), as well as being higher in women and falling with age (Table 2). When adjusted for other potential confounders there was a major change in the association between airway obstruction and sex due to adjustment for the confounding effects of smoking, but there was still a strong association between FEV1/FVC(%) and wealth, with an increase of 0·23% per point increase in the score (0·11 to 0·34; p<0·001). As well as the effects of age and sex, lower BMI, smoking, occupational exposure to dust and a history of tuberculosis were associated with lower FEV1/FVC (Table 2). However, none of these factors individually had a strong confounding effect on the association between wealth score and FEV1/FVC ratio.Among the dusty jobs the most common was farming. When the effect of wealth score on FEV1/FVC ratio was further adjusted for asthma, current smoking status and whether or not the individual had been exposed to >20 years of using open fires for cooking and/or heating (Table E1) there was no appreciable change in the coefficient for the wealth score (0·20 (95% CI: 0·08, 0·33; p=0·002).

Figure 1 shows that there was no significant heterogeneity between the individual sites in the association between the FEV1/FVC and wealth score (I2<1%; phet=0·44). The two estimates that are most against the trend are from the two richest countries, Saudi Arabia and Malaysia.

When the prevalence of obstruction (FEV1/FVC<LLN) was regressed against the wealth score (adjusted for potential confounders), the prevalence fell by approximately 9% (relative change) for each point increase in the wealth score (OR: 0·91; 0·84 to 0·98; p=0·010) and, whilst there was evidence of some heterogeneity between sites, this was not statistically significant (I2=17%; phet=0·275) (Figure 2).

Figure 3a shows the same positive association between FEV1/FVC ratio and wealth score at the aggregate level as was found within sites. Approximately 40% of the variation in mean FEV1/FVC ratio could be explained by variations in the mean wealth score (r2=0·385, p=0·031). A corresponding trend was observed for the proportion of subjects with airflow obstruction in the different sites, the proportion decreasing as mean wealth score increased (r2=0·358, p=0·040) (Figure 3b)

**Discussion**

Our study shows an increase in FEV1/FVC and a decrease in the risk of airflow obstruction with increased wealth, both within and across the 12 BOLD sites located in 11 countries.

These findings are consistent with the generally reported association between poverty and poor lung function[6](#_ENREF_6), though much of this literature has related to the FEV1, which can reflect either reduced lung volume or reduced flow with a normal lung volume, rather than the FEV1/FVC ratio which provides a more appropriate measure of airflow obstruction. It is also consistent with the association between COPD mortality and GNI at an ecological level.[4](#_ENREF_4) It is less obviously consistent with an earlier report from the BOLD Study,[3](#_ENREF_3) which found little relation between GNI and the prevalence of airflow obstruction, and a much stronger relation between a low FVC and GNI. Only two of the sites in the earlier analysis, Sousse (Tunisia) and Kashmir (India), were also included in this analysis as the questions on household assets were only introduced into the BOLD protocol relatively late, so the wealth scores could not be calculated for the earlier sites. One possible reason for the inconsistency between our results and the previous ecological evidence from BOLD is that the smoking rates in the sites analysed in this paper are almost all low to medium, with the exception of Kashmir. Smoking is by far the most important cause of airflow obstruction[9](#_ENREF_9) and the relation between income and smoking is complicated. Where income is very low smoking is usually rare. As income rises so smoking also increases, but in affluent countries smoking is predominantly a habit of the less well-off.

The mechanisms by which poverty is associated with airflow obstruction are unknown. In this analysis the strongest confounder was age which was negatively associated with both FEV1/FVC and wealth, but some of the association was also explained by the associations with a lower BMI, a history of tuberculosis or of working in a dusty job as well as with smoking. In a cross-sectional study it is difficult to be certain to what extent these variables should be viewed as confounders, and how far as mediating variables on a causal pathway between poverty and low lung function. Even after adjusting for the potential confounding and explanatory variables measured in the study, there is a consistent inverse association between the risk of airflow obstruction and the wealth score which appears to explain 35% of the variation in the prevalence of a low FEV1/FVC ratio. Explaining this association is not simple. The association between poverty and airflow obstruction among individuals in each site could be explained by unmeasured confounders or by error in measured confounders. However, the consistency of the findings across sites and the association between poverty and obstruction observed at the aggregate level in the 12 sites suggest that poverty is an important explanatory variable requiring further investigation, and is a potentially important policy target when addressing poor lung health.

Barker pointed out the strong ecological association between high mortality from pneumonia and bronchitis in early life and mortality from chronic lung disease half a century later among adults born at the same time,[17](#_ENREF_17) and subsequently showed a relation of birth weight and weight at one year with both mortality from COPD and low lung function.[18](#_ENREF_18) He also pointed out the strong association between poverty and both outcomes. However, the association of birth weight and weight at one year was mainly with FVC rather than FEV1/FVC. Diet is possibly a more likely explanation for the association. Although the nature of the association between diet and lung function is far from clear, there is an association[19](#_ENREF_19) and this is likely to be influenced by household resources. On the other hand much of this association with diet was found only among smokers whilst tobacco consumptions was low in the sample examined in the current analysis.

The BOLD study is a large multinational study of ventilatory function and risk factors of chronic lung disease. The central standardised protocol and training programme ensured consistency across the sites, and the quality of the spirometry was strictly controlled by central checks on all tests. The sites represented in this analysis are very diverse in wealth, culture and social conditions. The consistency of the findings across these sites gives support to the finding that there is a strong relation between poverty and the level of airflow obstruction.

The wealth score used is based on household assets which are easy to count and conveniently form a one-dimensional score, the average of which correlates well with the per capita GNI of the countries in which it has been studied.[12](#_ENREF_12) However, wealth is not itself a one-dimensional concept and an understanding of the relation between this measure and airway obstruction requires further study. Moreover, this instrument is likely to be more sensitive at picking up differences in poorer countries,[12](#_ENREF_12) although this is probably not a substantial problem in this case as the evidence from mortality rates strongly suggests that the association with poverty is predominantly seen among countries with a per capita GNI below approximately US$20,000 per annum. Our analysis is limited to the effects on chronic airflow obstruction and does not consider the effects on vital capacity. This is because the standardisation of the FEV1/FVC ratio using a single norm is less controversial than standardising the FVC.[15](#_ENREF_15) With only 12 sites in 11 countries this would have been impossible.

The study has a number of limitations. First, although the sites covered a broad range of socio-economic conditions, they are not representative of the whole global range, and this analysis includes only 12 BOLD sites. This lack of complete geographical representativeness could potentially produce results that might not be reproduced in a more comprehensive study or might show weaker associations. Second, our study was unable to identify intermediate variables that adequately explained the observed association. This may in part be because some of the important variables have not been collected in our study, or because the variables have been measured with low precision or accuracy. There is therefore a need to further investigate the role of factors that can explain why poverty is associated with airway obstruction. This limitation is likely to be more important in a study that relies heavily on self-reported exposures.

In conclusion, our study in countries with a low overall consumption of tobacco found an inverse association between wealth and airflow obstruction (a low FEV1/FVC ratio); sites with a relatively high mean wealth score had a relatively low prevalence of airflow obstruction. Understanding this relationship better may provide much needed pathways to the improvement of lung health in poorer countries, particularly those where smoking is still uncommon.

**Author contributions**

PB, CM and JT designed the analysis and drafted the initial manuscript. JT & JP carried out statistical analysis. KM, DOO, M Al G, HC, MD, KG, HH, PK, LCL, CN, TS, & ASB contributed to the design and conduct of the study. All authors critically reviewed and approved the final manuscript.

**Declaration of Interests**

**Funding:** The Wellcome Trust (085790/Z/08/Z), with further local funding from: **Ile-Ife, Nigeria:**The Wellcome Trust (08405/2/09/Z), National Population Commission, Ile-Ife, Osun State, Nigeria***;*  Naryn and Chui, Kyrgyzstan:** Kyrgyz Thoracic Society; **Tirana, Albania:** GlaxoSmithKline; **Blantyre, Malawi:** GlaxoSmithKline, Liverpool School of Tropical Medicine, the Malawi Liverpool Wellcome Trust; **Riyadh, Saudi Arabia:** The Saudi Thoracic Society, King Abdullah International Medical Research Center KAIMRC; **Annaba, Algérie:** Boehringer Ingelheim; **Penang, Malaysia:** GlaxoSmithKline Pharmaceutical Sdn. Bhd.. **Sousse, Tunisia:** Boehringer Ingelheim. **Fes, Morocco*:*** Boehringer Ingelheim; **Srinagar, India:** Sher-i-Kashmir Institute of Medical Sciences, Srinagar, J&K; **Colombo, SriLanka**: The Respiratory Diseases Study Group of Sri Lanka and the World Health Organisation - Sri Lanka.

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19. Shaheen SO, Jameson KA, Syddall HE, et al. The relationship of dietary patterns with adult lung function and COPD. *Eur Respir J* 2010; **36**(2): 277-84.

**Figure 1**. Forest plot for the effect of wealth score on FEV1/FVC, adjusted for age, sex, and all other confounders (BMI, education, smoking, passive smoking, exposure to a dusty job, family history of breathing problems, childhood hospitalisation for breathing problems and previous diagnosis of TB). The coefficient gives the mean change in FEV1/FVC (%) for a one unit increase in the wealth score in each of the sites.

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**Figure 2.** Forest plot showing the association between the odds of having FEV1/FVC below the lower limit of normal (NHANES equations) and wealth score. The odds ratios show the effect of a one unit increase in the wealth score on the odds of obstruction in each of the sites, adjusted for BMI, education, smoking, passive smoking, working in a dusty job, family history of COPD, hospitalisation as a child for breathing problems, and TB.

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**Figure 3.** Association between site-level means of wealth score and a) mean FEV1/FVC (%), b) proportion of subjects with obstruction (FEV1/FVC<LLN). The dashed lines show the linear regression lines of best fit weighted to allow for the number of subjects included in each site.

C:\Users\pburney\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Outlook\5UTD3KGC\Figure 3 (23-9-16) (002).tif

**Table 1. Characteristics of the study population in the 12 centres1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Sousse,**  **Tunisia** | **Kashmir,**  **India** | **Ife,**  **Nigeria** | **Fes,**  **Morocco** | **Tirana,**  **Albania** | **Annaba,**  **Algeria** | **Penang,**  **Malaysia** | **Riyadh,**  **S. Arabia** | **Blantyre,**  **Malawi** | **Sri Lanka** | **Naryn,**  **Kyrgyzstan** | **Chui,**  **Kyrgyzstan** |
| Number of subjects2 | 798 | 1077 | 1683 | 974 | 1188 | 938 | 1200 | 843 | 758 | 1408 | 1160 | 1876 |
| Participants (%)3 | 660 (83) | 738 (69) | 864 (51) | 760 (78) | 928 (78) | 862 (92) | 649 (54) | 679 (81) | 402 (53) | 1035 (74) | 820 (71) | 858 (46) |
| Sex (% male) | 51 | 52 | 54 | 52 | 49 | 50 | 49 | 52 | 54 | 48 | 48 | 42 |
| Age (years), Mean (SD) | 52 (9) | 52 (10) | 53 (11) | 55 (12) | 56 (12) | 54 (11) | 55 (10) | 51 (8) | 51 (9) | 53 (9) | 52 (10) | 53 (10) |
| BMI ≥25 (%) | 76 | 23 | 44 | 66 | 73 | 69 | 55 | 88 | 40 | 45 | 62 | 65 |
| Height (cm), Mean (SD) | 164 (9) | 160 (9) | 165 (8) | 162 (9) | 164 (9) | 164 (10) | 159 (8) | 162 (9) | 163 (8) | 157 (9) | 162 (9) | 163 (9) |
| Smoking (pack years), Mean (SD)4 | 16 (25) | 133 (207) | 1 (6) | 8 (19) | 12 (19) | 11 (19) | 6 (16) | 9 (24) | 2 (26) | 3 (9) | 6 (12) | 10 (18) |
| Passive smoking (%)5 | 35 | 64 | 2 | 12 | 38 | 11 | 26 | 6 | 3 | 8 | 3 | 11 |
| Dusty job (%)6 | 50 | 1 | 38 | 44 | 64 | 28 | 32 | 17 | 26 | 36 | 6 | 34 |
| Tuberculosis (%)7 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 2 | 5 | 1 | 1 | 1 |
| Family history of COPD (%)8 | 6 | 2 | 0 | 10 | 8 | 6 | 5 | 3 | 20 | 3 | 2 | 7 |
| Childhood hospitalization (%)9 | 3 | 0 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 1 | 7 |
| Post primary education (%)10 | 50 | 18 | 59 | 28 | 80 | 56 | 65 | 65 | 46 | 73 | 94 | 97 |
| FEV1/FVC %, Mean (SD) | 80 (7) | 77 (10) | 79 (8) | 79 (8) | 78 (10) | 78 (7) | 81 (7) | 83 (6) | 79 (8) | 80 (9) | 78 (7) | 76 (9) |
| FEV1/FVC<LLN (%) | 5 | 16 | 7 | 9 | 9 | 7 | 3 | 3 | 7 | 8 | 8 | 13 |
| Wealth score, Mean (SD)11 | 9 (1) | 4 (2) | 5 (2) | 8 (2) | 9 (2) | 8 (1) | 9 (1) | 10 (0) | 4 (3) | 6 (2) | 5 (1) | 6 (2) |
| GNI per capita (US$ PPP) | 9680 | 4750 | 4930 | 6160 | 9950 | 12860 | 22530 | 53760 | 750 | 9480 | 3100 | 3100 |
| Asthma ever (%) | 8 | 2 | 1 | 7 | 6 | 8 | 4 | 31 | 5 | 6 | 2 | 3 |
| Open fire > 20 years (%)12 | 23 | 100 | 27 | 22 | 91 | 18 | 26 | 17 | 51 | 44 | 88 | 55 |
| Smoker (%)13 | 45 | 53 | 14 | 30 | 37 | 39 | 25 | 26 | 17 | 24 | 31 | 38 |

**Notes:**

1 Individual responses have been weighted according to the probability of selection to provide population estimates of means and percentages for each of the study areas.

2 Number of individuals selected for possible inclusion in the BOLD study using a random sampling process

3 Number of individuals included in this study (i.e. those who agreed to take part in the BOLD study and provided useable data from both the questionnaire and spirometry tests)

4 1 pack year equals an average of 20 cigarettes per day for 1 year or the equivalent amount of other types of tobacco smoking

5 Somebody else in the household smoked during the past 2 weeks

6 The respondent was employed in a dusty job for at least one year

7 Ever diagnosed with TB

8 A close sibling or parent had been diagnosed as having emphysema, chronic bronchitis or COPD by a health professional

9 Hospitalized for breathing problems before the age of 10 years.

10 Highest level of education completed was above primary school

11 Calculated from ownership of a range of assets (see methods and reference #12)

12 Exposure to open fires for cooking and/or heating for more than 20 years

13 Current or ex-smoker

**Table 2: Associations between FEV1/FVC (%) and wealth score, adjusting for age and sex only and then for multiple potential confounding factors.**

The coefficients give the effect on FEV1/FVC (%) of an individual having the stated characteristic (vs. not having that characteristic) or for a one unit increase

in that variable, adjusted for all other variables in that column (e.g. individuals with a history of TB had an FEV1/FVC (%) 2·3% lower on average than

comparable individuals without a history of TB).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Adjusted for age and sex only** | | | **Adjusted for age, sex and other potential confounders** | | |
| **Coefficient** | **95% CI** | **P** | **Coefficient** | **95% CI** | **P** |
| **Wealth Score (/ unit)** | **0·36** | **(0·22, 0·49)** | **<0·001** | **0·23** | **(0·11, 0·34)** | **<0·001** |
| **Female** | **2·43** | **(1·63, 3·24)** | **<0·001** | **0·76** | **(0·01, 1·50)** | **0·046** |
| **Age (/ year)** | **-0·27** | **(-0·31, -0·23)** | **<0·001** | **-0·25** | **(-0·29, -0·22)** | **<0·001** |
| BMI <18·5 |  |  |  | -0·85 | (-2·64, 0·94) | 0·351 |
| ≥18·5 and <25 |  |  |  | 0 |  |  |
| **≥25 and ≤30** |  |  |  | **0·85** | **(0·50, 1·19)** | **<0·001** |
| **>30** |  |  |  | **1·23** | **(0·68, 1·77)** | **<0·001** |
| Education (/level completed) |  |  |  | -0·10 | (-0·32, 0·12) | 0·383 |
| **Smoking (/pack year)** |  |  |  | **-0·06** | **(-0·09, -0·04)** | **<0·001** |
| Passive smoking |  |  |  | -0·31 | (-1·14, 0·53) | 0·474 |
| **Worked in a dusty job (/year)** |  |  |  | **-0·04** | **(-0·06, -0·01)** | **0·003** |
| Family history of COPD |  |  |  | -0·75 | (-1·87, 0·37) | 0·191 |
| Hospitalised as a child |  |  |  | -2·44 | (-5·18, 0·29) | 0·080 |
| **Tuberculosis** |  |  |  | **-2·30** | **(-4·40, -0·19)** | **0·032** |

**TABLE E1: Sensitivity analysis: effect of further adjustment of FEV1/FVC for a history of asthma, open fire exposure and current smoking status.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Adjusted for age and sex only** | | | **Adjusted for age, sex and other potential confounders** | | | **Sensitivity analysis, further adjusted for asthma, open fire exposure and current smoking status** | | |
| **Coefficient** | **95% CI** | **P** | **Coefficient** | **95% CI** | **P** | **Coefficient** | **95% CI** | **P** |
| **Wealth Score (/ unit)** | **0·36** | **(0·22, 0·49)** | **<0·001** | **0·23** | **(0·11, 0·34)** | **<0·001** | **0·20** | **(0·08, 0·33)** | **0·002** |
| **Female** | **2·43** | **(1·63, 3·24)** | **<0·001** | **0·76** | **(0·01, 1·50)** | **0·046** | **0·79** | **(0·16, 1·42)** | **0·014** |
| **Age (/ year)** | **-0·27** | **(-0·31, -0·23)** | **<0·001** | **-0·25** | **(-0·29, -0·22)** | **<0·001** | **-0·25** | **(-0·29, -0·21)** | **<0·001** |
| **BMI**  <18·5 |  |  |  | -0·85 | (-2·64, 0·94) | 0·351 | -0·80 | (-2·47, 0·87) | 0·349 |
| ≥18·5 and <25 |  |  |  | 0 |  |  | 0 |  |  |
| **≥25 and ≤30** |  |  |  | **0·85** | **(0·50, 1·19)** | **<0·001** | **0·83** | **(0·47, 1·19)** | **<0·001** |
| **>30** |  |  |  | **1·23** | **(0·68, 1·77)** | **<0·001** | **1·28** | **(0·80, 1·77)** | **<0·001** |
| Education (/level completed) |  |  |  | -0·10 | (-0·32, 0·12) | 0·383 | -0·09 | (-0·28, 0·10) | 0·340 |
| **Smoking (/pack year)** |  |  |  | **-0·06** | **(-0·09, -0·04)** | **<0·001** | **-0·05** | **(-0·08, -0·02)** | **<0·001** |
| Passive smoking |  |  |  | -0·31 | (-1·14, 0·53) | 0·474 | -0·26 | (-1·03, 0·52) | 0·519 |
| **Worked in a dusty job (/year)** |  |  |  | **-0·04** | **(-0·06, -0·01)** | **0·003** | **-0·03** | **(-0·05, -0·01)** | **0·004** |
| Family history of COPD |  |  |  | -0·75 | (-1·87, 0·37) | 0·191 | -0·56 | (-1·67, 0·55) | 0·323 |
| Hospitalised as a child |  |  |  | -2·44 | (-5·18, 0·29) | 0·080 | -1·19 | (-3·70, 1·32) | 0·353 |
| **Tuberculosis** |  |  |  | **-2·30** | **(-4·40, -0·19)** | **0·032** | **-2·34** | **(-4·33, -0·36)** | **0·020** |
| **Asthma, ever** |  |  |  |  |  |  | **-6·38** | **-8·18, -4·57** | **<0·001** |
| **Open fire exposure (>20 years** |  |  |  |  |  |  | -0·39 | -1·04, 0·25 | 0·234 |
| **Smoker never** |  |  |  |  |  |  | 0 |  |  |
| **ex-** |  |  |  |  |  |  | -0·44 | -1·15, 0·28 | 0·235 |
| **current** |  |  |  |  |  |  | -0·74 | -1·84, 0·36 | 0·187 |