Association between chronic airflow obstruction and socio-economic position in Morocco: BOLD results

M. Atassi,[1] A. C. F. Kava,[1] C. Nejjari,[1] M. C. Benjelloun,[2] M. El Biaze,[2] K. El Kinany,[1] J. Patel,[3] P. Burney,[3] K. El Rhazi[1]

[1]Department of Epidemiology and Public Health, Faculty of Medicine of Fez, and [2]Pneumology Service, Centre Hospitalier Hassan II of Fez, University Sidi Mohamed Ben Abdellah, Fez, Morocco; [3]National Heart & Lung Institute, Imperial College, London, UK

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B A C K G R O U N D : Chronic obstructive lung disease (COPD) is the third most common cause of death in the world. Factors other than smoking, such as socio-economic status, could be involved in the development of COPD.

O B J E C T I V E : To investigate the association between chronic airflow obstruction and socio-economic status in Morocco.

D E S I G N : Questionnaires were administered and spirometry tests performed as part of the BOLD (Burden of Obstructive Lung Disease) Study carried out in Fez, Morocco. Socio-economic status was evaluated using a wealth score (0–10) based on household assets. The ratio of forced expiratory volume in 1 s (FEV_1) to forced vital capacity (FVC) was used to measure airflow obstruction.

R E S U L T S : A total of 760 subjects were included in the analysis. The mean age was 55.3 years (standard deviation [SD] 10.2); the average wealth score was 7.54 (SD 1.63). After controlling for other factors and potential confounders, FEV_1/FVC increased by 0.4% (95%CI 0.01–0.78; $P < 0.04$) per unit increase in wealth score. Ageing, tobacco smoking, underweight, history of tuberculosis and asthma were also independently associated with a higher risk of airflow obstruction.

C O N C L U S I O N : Our findings suggest that airflow obstruction is associated with poverty in Morocco. Further investigations are needed to better understand the mechanisms of this association.

K E Y W O R D S : chronic obstructive lung disease; BOLD study; poverty; Morocco

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CHRONIC OBSTRUCTIVE PULMONARY disease (COPD) is a lung disease characterised by chronic airflow obstruction that interferes with normal breathing and is not fully reversible;[1] COPD is the third most common cause of death in the world.[2] According to the World Health Organization (WHO) estimates, almost 90% of COPD deaths occur in low- and middle-income countries (LMICs).[3]

The main risk factor for COPD is tobacco smoking,[4–6] but emerging evidence suggests that other risk factors are important, especially in LMICs. According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2017, in addition to tobacco smoking, COPD is related to the following factors: age and sex, indoor and outdoor air pollution, occupational exposures, lung growth and development, and chronic respiratory infections such as tuberculosis (TB) and socio-economic status.[5] There is less information on the association of airflow obstruction with these factors in LMICs.

The relationship between socio-economic position and the presence of airflow obstruction has not been sufficiently investigated at an individual level. An ecological analysis, conducted as part of the Burden of Obstructive Lung Disease (BOLD) study, showed little association between air obstruction and per capita Gross National Income (GNI).[7] Although information about the link between obstruction and poverty is available at individual level from previous studies, most of these have been conducted in high-income countries and do not measure obstruction for the majority or provided controversial results.[8] An analysis carried out recently by Townend et al.,[9] combining results from 12 sites participating in the BOLD study, showed that airflow obstruction is consistently associated with poverty at both individual and community levels.

According to previous results from the BOLD study conducted in Morocco in 2010,[10] the prevalence of COPD was 12.6% for GOLD stage 1 and 7.9% for GOLD stage 2. The authors showed that prevalence increased with age and the number of pack years smoked. However, the link between airflow obstruction and socio-economic position has not been studied yet. The present study is the first in Morocco

to answer the question whether or not socio-economic level could have an impact on airflow obstruction; we also hypothesised that the risk of airflow obstruction is higher among people with low socio-economic level in Morocco.

METHODS

The BOLD study

The BOLD study is a multisite, international study carried out in many regions in the world to estimate the prevalence and the determinants of obstructive lung disease. The details of the study design and methodology have been described elsewhere.[11] At each site, a questionnaire was administered and spirometry tests performed in a representative sample of adults aged ≥40 years.

Spirometry tests were conducted using a standardised BOLD protocol; each spirogram was read and quality-checked by the BOLD Pulmonary Function Reading Centre at the Imperial College London, London, UK.

The study protocol was approved by the ethics committee of the University Hospital Center Hassan II, Fez, Morocco; all participants provided written informed consent.

Wealth score calculation method

The socio-economic position was assessed using a wealth score, which is an international scale based on household assets.[12] The score met the requirements of a Mokken scale;[13,14] for example, all of the items were related to wealth and the ownership of one was independent of the others. The 10 items selected were electricity, television, cell phone, refrigerator, indoor bath, indoor tap, flush toilet, washing machine, car and landline telephone. The score was calculated by adding up the total number of these assets owned by the respondents or their household. The total score ranged from 0 (no assets) to 10 (all assets).[9,12] As the score is approximately suggestive of an individual's wealth, we will use the term 'wealth score' to refer to the score calculated by this method.

Statistical analyses

Means and standard deviations (SDs) were provided for quantitative variables and frequencies for categorical ones. The association between the wealth score and the airflow obstruction was estimated using linear regression of the post-bronchodilator forced expiratory volume in 1 s (FEV_1)/forced vital capacity (FVC) ratio expressed in percentage (%). Low scores indicate increased airflow obstruction. The analysis was firstly adjusted for age and sex and secondarily adjusted to potential confounding factors in order to investigate the effect of these latter on the association between the wealth score and airflow obstruction. Factors included in the multivariate analysis were body mass index (BMI), education, smoking status,

whether or not dusty job, TB and familial history of COPD; these factors have been previously identified as having both an effect on airflow obstruction and poverty.[9,15] Educational level was defined as six levels of completed education (none, primary school, middle school, secondary school, technical college and university), and also by the number of completed education years. The BMI was included in the models as a categorical variable (underweight, <18.5 kg/m²; normal, 18.5–25 kg/m²; overweight, 25–30 kg/m²; or obesity, >30 kg/m²). Tobacco smoking was defined as the respondents' total consumption of cigarettes in their lifetimes. Exposure to a dusty job was defined by an exposure for over 1 year. Except for education and BMI, all other potential confounders were included as binary variables. Age was included as continuous variable assuming a linear relation to obstruction with increasing age.

All statistical analyses were conducted using R software v3.5.1 (R Core Team, R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Characteristics of the study population

A total of 760 participants provided adequate spirometry and questionnaire information and were included in the analysis. Among these, 350 (46%) were male and the mean age was 55.3 years ± 10.2. The majority were illiterate or had a primary educational level; only 6.5% had university level education. More than half were overweight or obese (respectively 38.1% and 31%). Smoking was moderate, 27.2% had smoked cigarettes in their lives and 13.9% were exposed to cigarette smoke in their familial environment. The exposure to dusty job for over a year was mentioned for 325 subjects (42.7%).

The mean FEV_1/FVC ratio was 78.0 ± 8.3; family history of COPD was noted in 10% of the sample. Other conditions reported included 13 (1.7%) with TB, 58 (9.2%) with asthma or respiratory allergy and 5 (0.6%) who were hospitalised for breathing problems before the age of 10 years (Table 1).

Assets ownership items and wealth score

The current wealth score was calculated using 10 items, more than 90% owned electricity, television, cell phone, refrigerator and indoor tap. Only 26.7% had a car, and almost half had flush toilet. An indoor bathroom and a washing machine were owned by 82% and 72% of the sample. Finally, as fixed phones are less often used now, only 41.4% declared that they possessed a landline. The mean wealth score calculated based on these items was 7.54 (SD 1.63) (Table 2).

Association between FEV_1/FVC ratio and the wealth score

Linear regression analysis adjusted for age and sex

Table 1 Patient variables and their association with FEV_1/FVC% on simple linear regression ($n = 760$)

Characteristics	Mean ± SD	Subjects n	%	Coefficient*	95%CI	P value
FEV_1/FVC%	78.0 ± 8.3	760				
Age, years	55.3 ± 10.2	760		−0.24	−0.30 to −0.19	<0.001
Sex						
Male		350	46.0			
Female		410	54.0	2.92	1.75 to 4.09	<0.001
Educational level						
None		431	56.7	0		
Primary school		143	18.8	1.80	0.22 to 3.37	0.024
Middle school		70	9.2	1.21	−0.88 to 3.31	0.256
Secondary or technical school		66	8.6	2.79	0.64 to 4.94	0.011
University		50	6.5	0.32	−2.10 to 2.75	0.792
Completed education, years	3.9 ± 5.2			0.09	−0.01 to 0.21	0.089
BMI, kg/m^2						
<18.5		12	1.5	−3.81	−8.63 to 0.99	0.120
18.5–25		222	29.2	0		
25–30		290	38.1	1.59	0.14 to 3.04	0.031
>30		236	31.0	2.16	0.64 to 3.68	0.005
Tobacco smoking†		207	27.2	−2.93	−4.25 to −1.61	<0.001
Passive smoking‡		106	13.9	−1.05	−2.76 to 0.65	0.226
Job with exposure to dust§		325	42.7	−1.36	−2.55 to −0.16	0.025
Antecedent of TB		13	1.7	−6.39	−10.94 to −1.84	0.006
Antecedent of asthma		58	9.2	−4.39	−6.60 to −2.17	<0.001
Family history of COPD¶		77	10.1	0.29	−1.67 to 2.26	0.768
Childhood hospitalisation#		5	0.6	−2.43	−9.76 to 4.90	0.516

* Indicates the effect of having the characteristic vs. not having that characteristic on FEV_1/FVC% or for one unit increase in that variable. Coefficients are based on simple linear regression.
† Current or ex-smoker.
‡ Somebody else in the household smoked during the past 2 weeks.
§ Participant has worked for at least 1 year in a job with exposure to dust.
¶ Parent or a close family member with physician-diagnosed emphysema, chronic bronchitis or COPD.
# Hospitalised for breathing problems before the age of 10 years.
FEV_1 = forced expiratory volume in 1 s; FVC = forced vital capacity; SD = standard deviation; CI = confidence interval; BMI = body mass index; TB = tuberculosis; COPD = chronic obstructive pulmonary disease.

showed that FEV_1/FVC (%) was significantly associated with the wealth score, and increased on average by 0.50% for each increased point in the wealth score (95% confidence interval [CI] 0.16–0.84; $P < 0.003$); it also increased by 2.28% in women compared to men, and decreased by 0.23% for each increasing year of age. After adjusting for tobacco smoking, the association between airway obstruction and sex disappeared but the association between FEV_1/FVC (%) and wealth remained significant following

Table 2 Description of the household assets included in the wealth score ($n = 760$)

Asset	Respondents having each asset n	%
Electricity	758	99.7
Television	754	99.2
Cell phone	698	91.8
Refrigerator	730	96.0
Indoor bath	625	82.2
Indoor tap	729	95.9
Flush toilet	374	49.2
Washing machine	549	72.2
Car	203	26.7
Fixed phone	315	41.4
Wealth score, mean ± SD	7.54 ± 1.63	

SD = standard deviation.

adjustment for other risk factors. An increase on average of 0.4% per one increased point in the wealth score was noted (95%CI 0.01–0.78; $P < 0.04$). Age, tobacco smoking, low BMI and a history of TB or asthma were all associated with lower FEV_1/FVC values (Table 3).

DISCUSSION

The objective of our study was to assess the association between airflow obstruction assessed using the FEV_1/FVC ratio and socio-economic status in Morocco. Our results showed a significant inverse association between airflow obstruction and wealth: the FEV_1/FVC ratio increased significantly with increasing wealth score. We also demonstrated significant associations with age, tobacco smoking, BMI, TB and asthma.

These findings are consistent with those reported by Townend et al.[9] In an analysis conducted at 12 BOLD sites located in 11 countries, they reported a strong inverse association between airflow obstruction and wealth, both within and across the 12 sites. Similar associations have also been reported by previous studies which have examined the link between poverty and poor lung function,[8] although

Table 3 Associations between $FEV_1/FVC\%$ and wealth score adjusted for potential confounding factors

	Adjusted for age and sex only (n = 760)			Adjusted for age, sex and other potential confounders (n = 760)		
	Coefficient*	95%CI	P value	Coefficient*	95%CI	P value
Wealth score	0.50	0.16 to 0.84	0.003	0.40	0.01 to 0.78	0.041
Female	2.28	1.16 to 3.41	<0.001	1.12	−0.50 to 2.75	0.177
Age, years	−0.23	−0.29 to −0.18	<0.001	−0.24	−0.30 to −0.18	<0.001
Tobacco smoking				−2.89	−4.54 to −1.25	<0.001
Completed education, years				0.03	−0.09 to 0.16	0.572
BMI, kg/m²						
<18.5				−4.72	−9.19 to −0.26	0.037
18.5–25				0		
25–30				0.42	−0.94 to 1.79	0.542
>30				0.31	−1.22 to 1.85	0.692
Job with exposure to dust				0.60	−0.68 to 1.88	0.358
Antecedent of TB				−5.83	−10.06 to −1.59]	0.006
Antecedent of asthma				−4.50	−6.59 to −2.41	<0.001
Family history of COPD				−0.01	−1.84 to 1.82	0.991
Childhood hospitalisation				−1.17	−7.96 to 5.61	0.734

* Indicates the effect of having the characteristic vs. not having that characteristic on $FEV_1/FVC\%$ or for one unit increase in that variable adjusted on all the other variables in that column.
FEV_1 = forced expiratory volume in 1 s; FVC = forced vital capacity; CI = confidence interval; BMI = body mass index; TB = tuberculosis; COPD = chronic obstructive pulmonary disease.

in an earlier ecological analysis from the BOLD study,[7] Burney et al. showed little relationship between the prevalence of chronic airflow limitation at the 22 BOLD sites where this ecological study was conducted and the gross national income (GNI) of the country and a much stronger association with the mean pack years of cigarettes smoked.

In this study, wealth was assessed based on the ownership of household assets, which is an easy way to assess one component of socio-economic status. Townend et al. showed that the mean scores for the centres correlated well with the GNI of the country.[12]

Although an inverse association between wealth and airflow obstruction has been reported, the mechanisms that could explain this association are unknown. In our study and a previous analysis from the BOLD study,[9] age and tobacco smoking were strong confounders; however, adjustment for these and other potential confounders did not explain the majority of the association with the wealth score. Although some of the residual association could be explained by these and other risk factors where they have not been precisely measured, this seems an unlikely explanation by itself.

Our findings indicate significant associations between airflow obstruction and other factors such as age, tobacco smoking, BMI and a history of TB or asthma. The impact of age and tobacco smoking has been widely described in previous studies.[7,9,15] In our study, we showed that lifetime consumption of cigarettes is a strong risk factor for airflow obstruction. In a secondary analysis, we tested the dose-effect relationship between smoking and airflow obstruction, we found that the risk of COPD was only significant among subjects who had smoked more than 20 pack years. A dose-effect relationship between cigarette smoking and COPD has been previously reported.[4]

The association between sex and airflow obstruction disappeared after adjusting for smoking. Smoking could be a potential confounder in this association. In fact, the majority of participants who smoked in our study were male (98%). However, in secondary analyses, sex was associated with airflow obstruction in non-smokers after stratification on smoking status. This suggests that smoking modifies the effect of sex on airflow. In previous studies, it has been suggested that women may be at different risk from men because of factors such as airway geometry, how particles are deposited in the airway and hormonal factors.[16] These findings are consistent with previous studies, although COPD prevalence in the PLATINO study was similar in males and females.[17] Nevertheless, in other BOLD analyses, Hooper et al. showed that the ratio of FEV_1/FVC was higher for women than for men;[15] the same finding was reported by Townend et al.[9] These differences with our study could be explained by the large number of participants, as these studies included 14 and 12 BOLD sites respectively in the analyses. As in this study, Townend et al. also noted the decline in the association between sex and FEV_1/FVC ratio; however, as in our study, this was not statistically significant.

The antecedent of TB has been shown to be associated with a higher risk of airflow obstruction.[15,18,19] Similarly, our results showed that after controlling for sex, age, smoking and the other factors, TB remained independently associated with an increased risk of airflow obstruction. Furthermore, poverty is widely recognised as an important risk factor for TB.[20] Poverty and TB could act jointly to increase the risk of airflow obstruction.

The present study was conducted following the BOLD protocol, a representative sample of participants was included and data were collected using standardised methods and by well trained staff. Collected data and spirometry tests results were sent to London, UK, for quality control, and data that did not meet the quality criteria were removed from the analysis. Nevertheless, the study could have some biases, as exposures were evaluated using a questionnaire, exposures were self-reported, which could lead to bias, particularly in case of exposures or events that may have occurred early in life. Recall bias should thus be considered before interpreting results from such studies. Another possible limitation is the location of the survey, which may have impacted the socio-economic level of the participants and the association with airflow obstruction. Findings might have been different if the study had been conducted at other lower or higher income level sites.

In conclusion, in a low-middle income country such as Morocco, factors other than smoking, such as socio-economic position, should be considered in the management of COPD. Our study revealed that a higher FEV_1/FVC ratio is associated with increased wealth. These findings implied that the measure of socio-economic position may be useful to describe the social distribution of chronic airflow obstruction, and underline the importance of considering the socio-economic position by health decision makers when implementing health strategies. Further studies are needed to investigate the mechanisms by which socio-economic position generates health differences.

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RÉSUMÉ

CADRE : Les bronchopneumopathies chroniques obstructives (BPCO) sont la troisième cause de décès dans le monde. Des facteurs autres que le tabagisme pourraient être impliqués dans la survenue des BPCO comme par exemple le statut socio-économique.

OBJECTIF : Rechercher une association entre obstruction chronique des voies aériennes et statut socio-économique au Maroc.

SCHÉMA : L'étude BOLD (*Burden of Obstructive Lung Disease*) réalisée à Fès, Maroc, a utilisé des questionnaires et des tests de spirométrie. Le statut socio-économique a été évalué grâce à un score de ressources (0–10) basé sur les biens du foyer. Le rapport du volume expiratoire maximal seconde (FEV_1)/capacité vitale forcée (FVC) a permis de mesurer l'obstruction aérienne.

RÉSULTATS : Au total, 760 sujets ont été inclus dans l'analyse. L'âge moyen a été de 55,3 ans (déviation standard [DS] 10,2) ; le score de ressources a été en moyenne de 7,54 (DS 1,63). Après contrôle des autres facteurs et des facteurs de confusion potentiels, le rapport FEV_1/FVC a augmenté de 0,4% (IC95% 0,01–0,78 ; $P < 0,04$) par augmentation d'une unité du score de ressources. L'âge, le tabagisme, la maigreur, des antécédents de tuberculose et d'asthme ont également été indépendamment associés à un risque plus élevé d'obstruction.

CONCLUSION : Nos résultats suggèrent que l'obstruction des voies aériennes est associée à la pauvreté au Maroc. Davantage de recherche est requise pour mieux comprendre les mécanismes de cette association.

RESUMEN

MARCO DE REFERENCIA: La enfermedad pulmonar obstructiva crónica (EPOC) es la tercera causa más frecuente de defunción en el mundo. Otros factores diferentes del tabaquismo, como la situación socioeconómica, podrían participar en la aparición de la EPOC.

OBJETIVO: Investigar la asociación entre la obstrucción crónica del flujo aéreo y la situación socioeconómica en Marruecos.

MÉTODO: El estudio BOLD (*Burden of Obstructive Lung Disease*) realizado en Fez, en Marruecos, comportó cuestionarios y pruebas espirométricas. La situación socioeconómica se evaluó mediante una escala de la riqueza (0–10) basada en los bienes familiares. Se utilizó el cociente del volumen espiratorio forzado en el primer segundo (FEV_1) y la capacidad vital forzada (FVC) a fin de medir la obstrucción del flujo aéreo.

RESULTADOS: Se incluyeron 760 personas en el análisis. El promedio de la edad fue 55,3 años (SD 10,2); la escala de la riqueza fue en promedio 7,54 (SD 1,63). Tras ajustar con respecto a otras variables y posibles factores de confusión, el FEV_1/FVC aumentó un 0,4% (IC95% 0,01–0,78; $P < 0,04$) por cada unidad de aumento de la puntuación de la riqueza. También se asociaron de manera independiente con un mayor riesgo de obstrucción del flujo aéreo el envejecimiento, el tabaquismo, la insuficiencia ponderal y los antecedentes de tuberculosis y asma.

CONCLUSIÓN: Estos resultados indican que en Marruecos, la obstrucción del flujo aéreo se asocia con la pobreza. Se precisan nuevas investigaciones que aclaren los mecanismos de esta asociación.