A respiratory survey in a black Johannesburg workforce

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Abstract

Background – The burden and determinants of airway disease in the population of southern Africa, which is currently undergoing rapid, often uncontrolled, urbanisation and industrialisation, are unknown. Previous surveys have focused on specific occupational groups and few have included women. This paper describes the respiratory status in a 30% probability sample of 206 men and 203 women drawn from an urban black Johannesburg workforce of almost 1500, all working for an educational institution.

Methods – Subjects answered a respiratory questionnaire and performed spirometric tests. Symptom rates and age and height standardised forced vital capacity (FVC), forced expiratory volume in one second (FEV₁), FEV₁/FVC%, and forced expiratory flow (FEF_{25–75}) were analysed by gender in relation to smoking, past work exposures, past and recent respiratory conditions, and socioeconomic indicators.

Results – Symptom prevalence was high, bronchitic symptoms in men being related to smoking and previous occupational exposure, and in women to smoking despite the low intensity of their habit. Phlegm and wheezing were related to childhood respiratory illness in both men and women. FVC and FEV₁, based on all subjects including smokers, were higher than previously reported for black residents of southern Africa. FVC was also positively related to education and job category. Higher values for ever smokers than for never smokers suggested health selection into the habit, while significant negative smoking effects were seen only on FEV₁/FVC% and only in women.

Conclusions – Despite the high prevalence of symptoms – some smoking related – in this urban workforce, lung function levels were higher than previously reported in African blacks, and may reflect improving socioeconomic conditions.

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tom questionnaire, lung function tests and, for certain diseases, chest radiography.^{1–5} To date, most surveys carried out in black southern African adult populations^{6–20} have focused on occupational groups with exposures to identified airborne pollutants such as mine dust,^{9 12 16 18} grain,^{11 20} cotton,¹⁴ and asbestos dust.¹⁰ Only two studies included women,^{6 8} and there have been few descriptions of both symptoms and lung function in black South Africans in relation to the major recognised determinants of respiratory health, namely age, gender, and smoking. In a joint World Health Organisation (WHO)/International Union Against Tuberculosis and Lung Disease (IUATLD) consultation on chronic airways disease³ Chaulet pointed out that, in 1987, of approximately 560 million inhabitants on the African continent, 100 million were in southern Africa including south tropical Africa and the Indian Ocean islands.⁴ This population is young, over 50% being under the age of 20, and is experiencing rapid and often uncontrolled urbanisation as well as industrialisation. Non-specific airways diseases constitute an important public health problem because of their frequency as well as their medical and social cost.

The primary objective of the present study was to contribute to the better documentation of the respiratory health status of the black men and women of southern Africa. A secondary objective was to gather information pertinent to the development of southern African based reference values for lung function for use in the clinical interpretation of pulmonary function tests.^{21–23} While such values are available both for black^{24–28} and white subjects^{28–32} based on studies carried out in non-smoking populations resident in other parts of the world, current recommendations are that they should be based on appropriately selected local populations.²³ In the rapidly urbanising societies of southern Africa the influence of changing socioeconomic status on lung function may also be considerable.^{33 34}

Methods

POPULATION

The source population for the present study comprised all 1480 black men and women employed at the University of the Witwatersrand in 1986, a workforce not exposed to specific industrial hazards but covering a wide range of ages, education, and jobs. University administration staff lists of black employees, stratified by gender, were used as a sampling frame. A 30% computer generated random sample yielded the names of 222 men and 222

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Respiratory surveys, community or workforce based, are used to establish the burden and determinants of respiratory diseases or conditions in populations. Commonly used measurement tools are the respiratory symp-

women. Because of the small number of black academic staff all 25 of them were included in the study sample, yielding a total study sample of 469 subjects. Permission to perform the study at the university and to collect data during working hours was granted by the University with the cooperation of the Black University Workers' Association. Participation was voluntary. The protocol was approved by the University ethics committee.

MEASUREMENTS

Respiratory health status was evaluated from questionnaire information and lung function measurements. Two trained interviewers administered a modified version of the American Thoracic Society respiratory questionnaire¹ currently in use at the National Centre for Occupational Health in Johannesburg.⁵ Additional questions dealt with education and position(s) held in the present job structure. Questions from an English version of the questionnaire were either read out in English or translated by the interviewers into Sotho, Zulu, Tswana, or Xhosa, whichever the interviewee preferred.⁵ Questionnaire data were processed using Dbase III computer software. Standing height was measured with the subject standing upright without shoes, and sitting height with the subject seated upright on a bench. Weight was measured in kilograms without shoes, coats, or jackets. The body mass index ($\text{weight}/\text{height}^2$) was considered to indicate obesity when it exceeded 25 in men and 26 in women.⁷

Spirometric lung function tests were performed using a Model 5 Vitalograph linked to a computer for direct recording. The machine was calibrated for volume every morning and afternoon using a five litre syringe. Subjects performed the tests standing without nose-clips; the test procedure followed and the criteria for acceptability were those recommended by the American Thoracic Society.² Full instructions were given on how to do the test, and most participants had the opportunity of watching others perform the test while waiting. A minimum of three acceptable tracings and a maximum of five were obtained from each participant. Barometric and temperature readings were taken throughout the study period. The spirometric values analysed were forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), $\text{FEV}_1/\text{FVC}\%$, and forced expiratory flow 25%–75% (FEF_{25-75}). Analysis was based on the best FVC and FEV_1 measurements extracted from all the trials recorded, while FEF_{25-75} was taken from the trial with the maximum sum of FVC and FEV_1 .²

ANALYSIS

Data were analysed using the statistical analysis system (SAS). Results for men and women were analysed separately. Means and standard deviations were calculated for continuous data, and percentages for categorical data. Because of the small number of ex-

smokers, these were combined with current smokers as "ever smokers" for analysis. Packs per year were calculated by multiplying the number of cigarettes smoked per day by 365 and dividing by 20, the average pack size. Two socioeconomic indicators based on job title and education level achieved were derived for each subject as follows. Jobs were classified as unskilled and semi-skilled/professional, according to a widely used South African job classification system,³⁵ taking into account that used at the University. Educational achievement was classified into three categories: none to grade 4, grades 5 to 9, and grade 10 (school leaving certificate) and above.

The prevalence of cough and phlegm was derived from a "yes" response to either of the following two questions: "do you usually cough (or bring up phlegm) first thing in the morning", or "during the day or at night?" Prevalence of breathlessness was derived from a "yes" response to any of the following questions on breathlessness: "when hurrying or walking up a slight hill"; "when walking with people of own age on level ground"; and having "to stop for breath when walking at own pace on level ground." The prevalence of "wheeze" was derived from a "yes" answer to the question "does your chest ever sound wheezy or whistling?" The presence of any of the respiratory conditions listed was based on a "yes" answer to the question "have you ever had any of the following conditions", and the conditions were then listed by name. Logistic regression analyses (SAS) were used to identify the determinants of respiratory symptoms. A backward selection procedure was employed. Odds ratios and 95% confidence intervals were calculated for factors significant at the 5% level. Explanatory variables included in the analysis were age, smoking (ever/never), reported past and recent respiratory illnesses, previous dust exposure, educational achievement (three categories), and job category (semi-skilled/skilled and/or professional).

Mean lung function values, standardised for height, were calculated for men and women in four age groups (20–34, 35–44, 45–54, 55+ years) and two smoking (never/ever) categories. Multiple regression analysis (GLM) was used to assess the effects of all the explanatory variables listed above for symptoms on lung function level, and stepwise regression analysis was used to identify significant determinants. Estimates of β coefficients and R^2 were also computed for the following models to enable comparison with published data: (1) lung function = f (age, standing height); (2) lung function = f (age, sitting height).

Results

Response rates were 92.1% (218 men, 214 women) for the questionnaire and 87.2% (206 men, 203 women) for both questionnaire and lung function tests. Of the 37 individuals who completed neither, six were out on assignments and one was on sabbatical leave. There were 13 refusals and, for 17, the reasons for non-participation were unknown.

Table 1 Characteristics of study subjects

	Men (n = 206)		Women (n = 203)	
	n	%	n	%
Language of interview				
Sotho	51	24.7	42	20.7
Zulu	44	21.3	55	27.1
Tswana	42	20.4	65	32.0
Venda	34	16.5	8	3.0
Xhosa	9	4.5	25	12.4
Other*	26	12.6	8	3.9
Childhood residence				
Urban	84	40.7	146	71.9
Rural	122	59.3	57	28.1
Education completed				
None to grade 4	88	42.7	49	24.1
Grades 5–9	77	37.3	117	57.6
Grade 10 and above†	41	20.0	37	18.3
Current job				
Semiskilled	68	33.0	57	28.0
Skilled	124	60.2	138	67.9
Professional	14	6.8	8	16.1
Smoking				
Never	65	31.6	174	85.7
Ever	141	68.4	29	14.3

* Includes Tsonga, Ndebele, Pedi.

† Grade 10 is the matriculation (school leaving) class.

Table 2 Prevalence (%) of reported respiratory symptoms and conditions

	Smoking status	Men (n = 206)		Women (n = 203)	
		n	%	n	%
Symptoms†					
Usual cough	Never	11	16.9	38	21.8
	Ever	52	36.8*	15	51.7*
Usual phlegm	Never	5	7.7	29	16.6
	Ever	36	25.5*	6	20.6
Ever wheeze	Never	7	10.7	35	20.1
	Ever	20	14.2	9	31.0
Short of breath	Never	13	20.0	94	54.0
	Ever	40	28.4	21	72.4*
Conditions‡					
Chest illness before 16	Never	1	1.5	18	10.3
	Ever	12	8.5	5	17.2*
Measles	Never	23	35.3	72	41.4
	Ever	39	27.6	14	48.2
Chest injury	Never	1	1.5	5	3.2
	Ever	13	9.2*	2	6.8
Bronchitis	Never	8	12.3	41	23.6
	Ever	31	21.9	2	6.8
Bronchial asthma	Never	1	1.5	7	4.0
	Ever	4	2.8*	0	0
Flu in past month	Never	16	24.6	62	35.8
	Ever	49	34.7	15	51.7

For men, the numbers of never smokers were 65, and ever smokers 141; for women these numbers were 174 and 29 (table 1).

* Significantly different from non-smokers of the same gender in univariate analyses.

† Based on "yes" answers to certain symptom questions (see text).

‡ Based on a "yes" answer to the questions: "have you ever had or do you have any of the following conditions?" (see text).

Table 3 Determinants of respiratory symptoms expressed as odds ratios with confidence intervals

Symptom	Determinant	Men	Women
Usual cough	Smoking	2.4 (1.1 to 5.3)	5.3 (2.3 to 11.7)
	Past dusty work	2.6 (1.3 to 5.5)	NS
	Flu in past month	2.2 (1.1 to 4.4)	NS
	Recent chest illness	5.1 (1.7 to 15.1)	2.8 (1.3 to 5.8)
	Measles	0.3 (0.1 to 0.9)	NS
Usual phlegm	Smoking	2.9 (1.1 to 8.2)	NS
	Past dusty work	2.9 (1.3 to 3.8)	NS
	Recent chest illness	5.2 (1.5 to 17.3)	NS
	Past chest illness	2.7 (1.2 to 6.4)	NS
	Chest illness before 16	NS	3.0 (1.2 to 7.7)
	Measles	0.3 (0.1 to 0.9)	NS
	Job category	0.3 (0.2 to 0.9)	NS
Ever wheeze	Education	0.4 (0.1 to 0.9)	NS
	Past chest illness	6.2 (2.3 to 16.8)	2.9 (1.2 to 6.8)
Short of breath	Chest illness before 16	7.4 (2.1 to 25.6)	2.8 (1.1 to 1.9)
	Flu in past month	2.2 (1.1 to 4.2)	2.1 (1.4 to 3.9)
	Recent chest illness	6.8 (2.4 to 19.3)	NS
	Past chest illness	NS	2.5 (1.4 to 4.6)
	Job category	NS	3.5 (1.6 to 7.7)
	Education	NS	4.2 (1.6 to 7.7)

The table lists only the significant ($p \leq 0.05$) odds ratios derived from models containing all the potential determinants (see text) and yielded by logistic regression analyses carried out separately in the data for men and women. For smoking and past dusty work the comparisons were ever v never smoked; for all respiratory conditions reported v not; for job category skilled/professional v semiskilled; for education grades 5–9 v grades 0–4 (usual phlegm) and grades 10+ v grades 0–4 (short of breath).

The average ages for men and women were similar, 42 years and 41 years respectively. Social, smoking, and other exposure characteristics of the study population are shown in table 1. The major ethnic groups in this workforce (as reflected by language of interview) were Sotho, Zulu, and Tswana, with Venda being the next most frequently represented group in men, and Xhosa in women. The majority of men (59.3%) were born and spent their childhood in rural areas, the majority of women (71.9%) in urban areas. This probably explains why the educational level achieved exceeded grade 4 for more women than men. Although 68% of men and 14% of women were current smokers, only 25 men and two women smoked more than 15 cigarettes per day. The men smoked an average of 30.9 packs per year, the equivalent of approximately 13 cigarettes per week, while the women smoked an average of 17.9 packs per year, the equivalent of approximately seven cigarettes per week.

Prevalences of respiratory symptoms and reported illnesses are shown in table 2. In both men and women the prevalences of cough, phlegm production, wheeze, and shortness of breath were higher in ever smokers than in never smokers. However, the differences were only significant for cough and phlegm in men, and for cough and shortness of breath in women. Shortness of breath was also significantly more frequently reported in women than in men, possibly related to their body mass index which, on average, fell into the obese range for all age groups.⁷ When the definition of shortness of breath was limited to that experienced "when walking with other people of your own age on level ground" and "stopping for breath when walking at your own pace on level ground", the overall prevalence of this symptom was less than 2% in both men and women. Generally past chest illnesses were reported by a higher proportion of ever smokers than never smokers, and in more women than men.

Table 3 shows the determinants of respiratory symptoms in men and women. Smoking increased the risk of cough and phlegm in men, and of cough in women. Although women were lighter smokers their risk of coughing if they smoked was more than double that of men. Previous exposure to dust at work also increased the risk of cough and phlegm production in men, but not in women. There was also an association between recent illness (flu in the past month and/or recent chest illness) and cough and phlegm in men, and cough in women. Among past chest illnesses measles was, surprisingly, associated with a lower risk of cough and phlegm in men but not in women, whereas other past illness in men and chest illness before the age of 16 in women were associated with usual phlegm. Better socioeconomic status, reflected in education level achieved and job category, was associated with a lower risk of phlegm in men but with an increased risk of shortness of breath in women. Reported past chest illness and chest illness before the age of 16 were both strongly associ-

Table 4 Mean (SD) anthropometric characteristics and lung function (standardised for height) of study subjects

	Men					Women				
	20-34 years	35-44 years	45-54 years	55+ years	All	20-34 years	35-44 years	45-54 years	55+ years	All
Number	55	58	54	39	206	55	63	63	22	203
Height (cm)										
Standing	170.7	168.6	168.6	166.3	168.7	157.0	157.9	158.3	160.1	158.0
Sitting	85.4	85.3	85.2	84.2	85.1	80.9	82.8	82.0	83.7	82.1
Weight (kg)	67.6	69.8	71.6	67.7	69.2	64.9	74.5	73.7	80.6	72.3
FVC (l)										
Never smoked	4.32	4.28	3.89	3.63	4.04(0.65)	3.29	3.23	2.89	2.74	3.09(0.45)
Ever smoked	4.43	4.20	4.19	3.93	4.22(0.51)*	3.45	3.42	2.74	3.17	3.17(0.53)*
FEV ₁ (l)										
Never smoked	3.74	3.54	2.98	2.78	3.27(0.68)	2.70	2.59	2.22	2.08	2.45(0.46)
Ever smoked	3.81	3.28	3.14	2.88	3.33(0.56)*	2.91	2.70	1.97	1.90	2.42(0.54)
FEV ₁ /FVC										
Never smoked	0.86	0.83	0.77	0.77	0.81(0.08)	0.82	0.80	0.76	0.76	0.79(0.08)
Ever smoked	0.86	0.79	0.75	0.73	0.79(0.09)	0.83	0.79	0.72	0.61	0.76(0.09)*
FEF ₂₅₋₇₅ (l/s)										
Never smoked	4.53	4.11	2.86	2.37	3.49(1.5)	2.84	2.47	1.95	1.83	2.34(0.96)
Ever smoked	4.61	3.02	2.63	2.19	3.23(1.5)	3.13	2.38	1.38	0.88	2.09(1.03)*

FVC=forced vital capacity; FEV₁=forced expiratory volume in one second; FEF₂₅₋₇₅=forced expiratory flow.* Ever smokers significantly different from never smokers of the same gender ($p \leq 0.05$).

ated with wheeze in men and women, and with shortness of breath in women.

Table 4 shows the anthropometric characteristics of the subjects and their spirometric lung functions, standardised for height by gender, age, and smoking status. A secular trend in FVC, FEV₁, and FEF₂₅₋₇₅ with age is evident, with height standardised values progressively decreasing in the older age groups. In addition, in both men and women higher levels of FVC were recorded in ever smokers than in never smokers; however, these differences were not significant in the multivariate analysis when other determinants of lung function level were taken into account (table 5). In men, although height standardised spirometric flow rates reflecting both large airway status (FEV₁/FVC%) and small airway status (FEF₂₅₋₇₅) were lower in ever smokers than in never smokers in univariate analyses, only the differences in FEV₁/FVC% were significant in the multivariate analyses. In women the findings in relation to smoking were directionally similar, although none of the differences were significant in the multivariate analyses (table 5). In addition, all spirometric values were higher in asymptomatic smokers than in never smokers (results not

shown), although the differences were only significant for FVC ($p < 0.05$).

Other findings in the multivariate analysis (table 5) deserve comment. In women past dusty work was also associated with higher levels of FVC and FEV₁, consistent with a "healthy" worker effect. Job category (skilled/professional *v* not) was also associated with higher levels of FVC in men and women, whereas the relations of education level to FEF₂₅₋₇₅ were inconsistent in men, and non-significant in women. In women, but not in men, past chest injury was associated with a significant reduction in FVC, while chest illness before the age of 16 was associated with significant reductions in FEV₁ and FEV₁/FVC%, and flu in the last month with a significant reduction in FEV₁/FVC%.

Regression equations for FVC and FEV₁ derived from the data collected in the present study, based on age (in years) and standing or sitting height (in cm), are as follows:

Men:

FVC = 0.053 (standing height) - 0.021 (age) - 3.85 ($R^2 = 0.427$);
 FVC = 0.083 (sitting height) - 0.025 (age) - 1.83 ($R^2 = 0.330$);
 FEV₁ = 0.035 (standing height) - 0.036 (age) - 1.15 ($R^2 = 0.507$);
 FEV₁ = 0.050 (sitting height) - 0.039 (age) + 0.72 ($R^2 = 0.449$);

Women:

FVC = 0.045 (standing height) - 0.023 (age) - 3.04 ($R^2 = 0.370$);
 FVC = 0.064 (sitting height) - 0.024 (age) - 1.20 ($R^2 = 0.254$);
 FEV₁ = 0.034 (standing height) - 0.028 (age) - 1.87 ($R^2 = 0.388$);
 FEV₁ = 0.051 (sitting height) - 0.029 (age) - 0.55 ($R^2 = 0.319$).

Both in men and in women age and standing height accounted for a greater proportion of variation than age and sitting height, while equations including age, standing height, sitting height, and sitting/standing height ratio (not shown) only marginally increased the R^2 for FVC (to 0.432 in men and to 0.375 in women), and for FEV₁ (to 0.517 in men and to 0.392 in women).

Table 5 Determinants of lung function expressed as mean (SD) differences from the age standardised average value for the reference category

Lung function	Determinant	Men	Women
FVC (l)	Past dusty work	NS	+0.15 (0.09)
	Chest injury	NS	-0.33 (0.15)
	Job category	+0.27 (0.06)	+0.15 (0.09)
	Education (grade 10 + <i>v</i> grade 0-4)	+0.24 (0.06)	NS
FEV ₁ (l)	Past dusty work	NS	+0.21 (0.04)
	Chest illness before 16	NS	-0.04 (0.09)
FEV ₁ /FVC (%)	Smoking	-2.8 (0.59)	NS
	Flu in the last month	NS	-1.9 (1.0)
	Chest illness before 16	NS	-2.2 (1.6)
FEF ₂₅₋₇₅ (l/s)	Education		
	(grade 10 + <i>v</i> grade 0-4)	+0.37 (0.20)	NS
	(grade 5-9 <i>v</i> grade 0-4)	-0.34 (0.14)	NS

FVC=forced vital capacity; FEV₁=forced expiratory volume in one second; FEF₂₅₋₇₅=forced expiratory flow.

Only significant ($p \leq 0.05$) differences in average values are shown derived from multiple linear regression analyses containing all the potential determinants examined (see text) for subjects exhibiting compared with those not exhibiting the determinant listed. For instance, in women mean FVC for those reporting past dusty exposure was on average 0.15 l higher than those not reporting such exposure after taking into account all other determinants.

Table 6 Forced vital capacity (FVC) in selected studies of black men in southern Africa

Reference	Population, city/area, (country)	Mean (SD or range) age (years)	Mean (SD or range) height (cm)	Prediction equation		Intercept (R ²)	FVC predicted for age 35, ht 170 cm	Selection criteria for subjects
				Regression coefficients				
				Height	Age			
Johanssen (1968) ⁶	120 hospital workers, Pretoria (S Africa)	34.1 (9.1)	167.0 (6.4)	+0.038	—	-2.84 (0.22)	3.98*	Included smokers
Cookson (1976) ⁸	141 urban workers, Harare (Zimbabwe)	43.6 (15.1)	171.3 (7.1)	+0.039	-0.017	-2.32 (0.30)	3.72	Included smokers, exclusions only for abnormal radiography
Yach (1984) ¹¹	153 package plant workers, Cape Town (S Africa)	36.1 (13.7)	171.9 (7.2)	+0.047	-0.027	-3.27 (0.38)	3.78	Included smokers (68%); 86% subjects were Xhosa, 14% coloured
Myers (1985) ¹⁰	203 stevedores, Port Elizabeth (S Africa)†	45	Not reported	+0.045	-0.033	-2.44 (0.42)	4.05	Included smokers (76%) and men with radiographic changes 1/0 or more (30%)
Fox (1988) ¹²	300 mine and smelter workers, Selebi Phikwe (Botswana)	34.2 (20-60)	172.9	+0.057	-0.008	-5.23 (0.32)	4.11§	Included smokers without symptoms (26%)
Coetzee (1989) ¹⁹	518 workers in an asbestos cement factory (S Africa)	33.1 (8.8)	169.4 (6.3)	+0.055	-0.016	-4.50 (0.37)	4.29§	All subjects clinically normal; included smokers (60%)
Hessel (1989) ¹⁸	646 rural mining and industrial workers (S Africa)	41.6 (7.9)	171.4 (6.2)	+0.052	-0.021	-3.86 (0.36)	4.25§	Included smokers; not exposed
White (1989) ¹⁴	109 textile workers, Cape/Natal (S Africa)	36.1 (8.3)	167.3 (6.9)	+0.065	-0.022	-6.16 (0.64)	4.12§	Non-smokers; not exposed to cotton dust
Goldin (1989) ¹⁷	106 bank workers, Johannesburg (S Africa)	Approx 41	Approx 170	+0.048	-0.024	-3.08 (0.33)	4.24§	Healthy non-smokers without symptoms
This study (1990)	206 university workers, Johannesburg (S Africa)	42.0 (10.5)	168.7 (6.5)	+0.053	-0.021	-3.85 (0.43)	4.42§	All subjects (n=206)
				+0.055	-0.024	-4.25 (0.42)	4.26§	Never smokers (n=172)
				+0.053	-0.029	-3.66 (0.51)	4.33§	Never smokers without symptoms (n=49)

* Results were reported at ATPS; corrected to BTS by a factor of 10%.

† Handle asbestos cargoes.

§ Measured using a Vitalograph.

Discussion

SYMPTOM PREVALENCE AND DETERMINANTS IN THE PRESENT STUDY

This study of the respiratory health status of a workforce comprising men and women not currently exposed to dust or fumes at work has shown high prevalences of bronchitic symptoms (related principally to current smoking and past exposures to inhaled pollutants, and to past respiratory illness), of wheezing (also related to past respiratory illness), and of shortness of breath in women (probably related to their high body mass index). While these associations are coherent and many have been reported in other more homogeneous populations, consideration of the potential sources of bias in the present findings is in order, particularly since all the explanatory variables examined were self reported. Such information is inevitably subject to recall bias which could not be evaluated. In addition, administration of the questionnaire in this study was not standard, since the interviewers translated freely from a written English version to the interviewee's language of choice. However, this method has been previously tested in a similar Johannesburg workforce and yielded a level of reproducibility, for instance, for sputum questions comparable to that obtained by standard methods in more homogeneous populations in the UK and the USA.⁵ In addition, psychological perceptions influence the reporting of respiratory symptoms³⁶ and may have affected internal validity in the present study. For instance, in women childhood respiratory illness before the age of 16 was significantly associated with "usual phlegm" but not "usual cough" (table 3), suggesting that in this population coughing to bring up phlegm is perceived and reported as phlegm, and not otherwise reported. This issue is pertinent to the use of any internationally acclaimed questionnaires among populations whose perception of symptoms such as

cough and phlegm production may not be the same as that of populations among whom the questionnaire was originally validated.

COMPARISON OF SYMPTOM PREVALENCE WITH PUBLISHED DATA

In theory generalisability of the present findings to other urban workforces, even in South Africa, is likely to be limited since selection factors, recruitment policies, turnover rates, and perceptions of the employer by employees and vice versa are all likely to affect study findings. Of interest, therefore, is the fact that using the same questionnaire and method of administration the prevalence of usual phlegm in men in the present study was 19.3%, comparable to 19-23% reported in a study in another largely male Johannesburg workforce not exposed to dust or fumes at work,⁵ but less than the 43.4% reported by men working in a Johannesburg grain mill,²⁰ an exposure known to be associated with industrial bronchitis. Likewise, generalisability of this study to other populations of different cultural and language groups is likely to be even more limited. Nevertheless, some of the present findings are in agreement with the results reported in the Tucson, Arizona, study of the natural history of chronic obstructive pulmonary disease in which an association was also shown between wheezing symptoms in adulthood and chest illness before the age of 16, defined by the questionnaire³⁷ as in the present study.

LUNG FUNCTIONS AND DETERMINANTS IN THE PRESENT STUDY

Smoking is recognised as a major cause of reduced lung function.³⁹ Unusual aspects of the relation of lung function level to smoking status in the present study which deserve comment are: (1) the only significant negative effect of smoking was in men, and only for the

Table 7 Forced vital capacity (FVC) in selected studies of black women in southern Africa

Reference	Population, city/area, (country)	Mean (SD or range) age (years)	Mean (SD or range) height (cm)	Prediction equation			FVC predicted for age 35, ht 160 cm	Selection criteria for subjects
				Regression coefficients		Intercept (R ²)		
				Height	Age			
Johanssen (1968) ⁶	100 hospital workers, Pretoria (S Africa)	34.6 (8.7)	156.6 (6.6)	+ 0.023	- 0.014	- 0.66 (0.32)	2.79	Mainly nurses; very few smokers
Cookson (1976) ⁸	102 urban workers, Harare (Zimbabwe)	36.7 (11.6)	160.7 (5.9)	+ 0.030	- 0.019	- 1.24 (0.38)	2.89	Includes smokers; exclusions only for abnormal radiography
White (1989) ¹⁴	119 textile workers, Cape/Natal (S Africa)	29.5 (7.5)	160.1 (6.7)	+ 0.037	- 0.027	- 1.54 (0.31)*	2.79	Non-smokers; not exposed to cotton dust
This study (1990)	203 university workers, Johannesburg (S Africa)	41.0 (9.8)	158.0 (5.5)	+ 0.045	- 0.023	- 3.04 (3.7)	3.35	All subjects (n = 203)
				+ 0.042	- 0.021	- 2.71 (0.34)	3.27	Never smokers (n = 174)
				+ 0.044	- 0.023	- 2.87 (0.33)	3.36	Never smokers without symptoms (n = 94)

* Prediction formula includes a coefficient for weight in kg (-0.008).
Number of subjects in the regression analysis.

FEV₁/FVC% ratio (table 5); (2) FVC and FEV₁ levels were higher in ever smokers than in never smokers. The absence of demonstrable negative effects on the level of spirometric lung functions may be related both to the low intensity of smoking in the present study population and to the "healthy" smoker effect. This term has been used to draw attention to the fact that there appears to be selective uptake of the smoking habit by individuals with higher levels of lung function (for which there is no obvious biological explanation), and lower levels of airway responsiveness to inhaled materials (for which there are biologically plausible explanations).^{40,41} Similar observations have been reported elsewhere in longitudinal⁴² and cross sectional studies,⁴³ including studies on black subjects resident elsewhere in Africa.⁴⁴ Also, given that FEV₁ is a function of FVC, a "healthy" smoker effect on FEV₁ is likely to be detectable in individuals at the time of taking up the habit or soon after - that is, before the negative effects of tobacco exposure have become evident.^{39,41} In the present results it is therefore somewhat surprising that differences between ever and never smokers consistent with the "healthy" smoker effect on FEV₁ were demonstrable, even in men in the 45-54 and 55-64 age subgroups. The explanation may also lie in the low intensity of the smoking habit in the study participants.

COMPARISON OF LUNG FUNCTIONS WITH PUBLISHED DATA

One of the goals of the study was to contribute information pertinent to establishing reference values for use in the clinical interpretation of lung function in black South African men and women. A strength of the data as a source of reference values derives from the fact that both men and women were studied by the same team using the same methodology. Pertinent also are comparisons with other studies in southern African subjects. These were carried out by calculating the predicted values for FVC for a 35 year old man 170 cm in height and a 35 year old woman 165 cm in height, using the published regression equations for each study, and comparing these with the predicted values derived from the equations based on the present study. Of note in the data for men, shown chronologically in table 6, is a

secular trend with FVC values increasing over the past decades. Note also that values in the present study (including smokers) are higher than those derived from other studies of non-smoking black men¹⁴ and of non-smoking black men without symptoms¹⁷ resident in southern Africa. Values for the present study are also higher than those derived from the only other studies conducted in workforces without known harmful industrial exposure, namely hospital workers in Pretoria⁶ and package plant workers in Cape Town,¹¹ and higher than values obtained in all other studies using the same instrumentation - that is, the Vitalograph.^{6,10,12,20} Only three reports of spirometric values in black women from southern Africa were found,^{6,8,14} and these also yield lower values than those found in the present study (table 7).

Factors which may have contributed to the high values for the spirometric parameters obtained in the present study include the use of standing posture for testing, and the absence of known harmful industrial exposure in the workforce studied. In addition, methodology for measuring spirometric values has evolved over the years. A more pertinent factor may be the changing socioeconomic status of the blacks in southern Africa. For instance, in the present study socioeconomic indicators such as education level achieved and job position were associated with higher FVC levels in men, even though the number of subjects in the upper socioeconomic group was small. Negative effects of urbanisation such as environmental and occupational exposures may therefore have been offset by improved nutrition and access to health care through medical aid plans, all of which may be pertinent in an employed population such as the one studied here.

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