Chapter 5

POTENTIAL RISK FACTORS OF RESPIRATORY DISEASES AND SYMPTOMS AMONGST ADULTS IN SOUTH AFRICA

Objective: To determine the prevalence and potential risk factors (occupational and environmental, socio-demographic, BMI, TB) of various respiratory symptoms and diseases in a representative adult population (15 years and older) of South Africa.

Methods: During 1998, a probabilistic national survey was performed in 12 763 households. 13 826 individuals from 6 457 households were interviewed for the health survey. Univariate and multivariate logistic regression analyses were used to generate crude and adjusted odds ratios (OR) and 95% confidence intervals (CI) in order to assess the influence of possible risk factors on respiratory diseases and symptoms.

Results: The survey also revealed relatively low crude prevalence rates for doctor diagnosed asthma (3.7%), chronic bronchitis (2.4%), doctor diagnosed emphysema/bronchitis (4.2%) and TB (2.7%), but higher respiratory symptoms: wheeze and shortness of breath (11.1%), cough with phlegm (6.8%); nocturnal coughing (13.1%), nocturnal wheezing/tight chest (10.8%). Nearly 1.7% of the respondents reported using asthma medication, whilst 0.5% were using TB medication. In general most of the potential risk factors were significantly related to the respiratory diseases and symptoms in the unadjusted models. The multivariate logistic regression analyses suggested that the prevalence of respiratory symptoms and diseases could be diminished in South Africa by health promotion predictors (increasing connection to electricity, having a medical aid and improved education). This preliminary analysis suggests that the following potential risk factors should be lessened in order to have a beneficial influence on the prevalence rates of respiratory symptoms and diseases: households going hungry, years smoked, households with smokers, exposure at work to fumes, smoke, dust or strong smells and period worked in such a job as well as BMI increase for the underweight and decrease of the obese. Other potential risk factors included age and race.

Conclusions: Although there is potential for residual confounding despite adjustment in this preliminary analysis, the documented international evidence on most of the potential risk factors suggests that these associations may be real. It is trusted that more detailed South African analytical intervention studies will

scrutinise these results in order to develop integrated intervention programmes to improve adult respiratory health in the country.

5.1 Introduction

The ultimate endeavour of epidemiology is to identify modifiable risk factors of disease occurrence and progression and to contribute in testing the efficacy and effectiveness of interventions on these risk factors including the health services.

Chronic diseases were the main cause of death amongst South Africans in 2000.[1] Much of what must be done to prevent respiratory symptoms and diseases lies outside of the sphere of health care. Therefore interventions should be targeted at risk factors, rather than only providing medical treatment for those already affected.

However, without a clear understanding of the complex interaction between the personal, educational, political, social, economic, cultural, occupational and environmental risk factors, the prevention of chronic diseases at a population level will be hampered. South Africa, a middle income country, is faced by health risk factors from a First World situation (e.g. industry, traffic, aging population) along those from a Third World situation (e.g. domestic burning of coal/biomass fuels, poor sanitation, overcrowding). Thus intervention strategies deduced from studies conducted in developed countries are not merely applicable in this country.

Globally the prevalence of chronic obstructive pulmonary disease (COPD)(such as chronic bronchitis and emphysema) has not been studied to the same extent as asthma. Although there are a number of studies of chronic bronchitis in selected populations in middle- and low income countries, the overall burden and risk factors of COPD in these countries are not well documented.[2-6]

Most environmental epidemiological studies in South Africa focused on children health.[7-18] The 1998 South African Demographic and Health Survey (SADHS) is the first national health survey conducted across the entire country.[19] Data from this survey provided the opportunity to examine the prevalence and potential risk factors of various respiratory symptoms and diseases in a representative national population (both adults and children) rather than a selected high risk population, as has been the case in most previous studies in developed countries.

It is trusted that the results of this preliminary analysis will draw attention to the socio-demographic, environmental and occupational risk factors and lead to debate on potential integrated intervention programs.

5.2 Methods

5.2.1 Survey method

The 1998 SADHS had a cross-sectional design and was a national household survey of the population living in private households in the country. Detailed information on the survey design is outlined elsewhere.[19] The sampling frame for the SADHS was the list of approximately 86 000 enumeration areas (EAs) created by Central Statistics (now Statistics South Africa, SSA) for the Census conducted in October 1996. The EAs, ranged from about 100 to 250 households and were stratified by 9 provinces, urban and non-urban residence and by EA type. The number of households in the EA served as a measure of size of the EA.

The first stage (proportional stratified sampling) of the two-stage sampling led to a total of 972 EAs being selected for the SADHS (690 in urban areas and 282 in non-urban areas). The second stage involved a systematic random sample of 10 and 20 houses in selected urban and rural EAs, respectively. Oversampling was conducted in some areas to enable inference to be made about differences across provinces and race – and in the Eastern Cape province, across health districts.

In addition to the main survey of households an adult health questionnaire was administered individually to a sample of adults aged 15 and over in half of the households selected for the main survey. The SADHS questionnaires were translated into 9 of the 11 official languages of South Africa and checked by backtranslation (Refer to Appendices 1 and 2).[19] The questionnaires were pretested in November/December 1996 as part of a pilot study.

The household questionnaire characterised all household members, including their age, sex, race and education, household characteristics such as fuels use for cooking and heating. The adult health questionnaire elicited information about medical history, symptoms of disease, utilisation of health services, occupational history and smoking habits of the respondents. The questionnaire was accompanied by measurements of height and weight.

Interviewers were trained over several weeks. Interviews were conducted after working hours. Interviewers were constructed to return twice if a suitable respondent was not found at home. Fieldwork commenced late January 1998 and was completed in September 1998. The response rate at the household level was 97% of 12 860 households in 966 EAs. Of the 6 457 households selected for the adult survey, 95.3% were completed. At the individual level, 92.6% of eligible adults were included in the survey, although not all of them had all the measurements taken. The overall response rate for the adult survey was 89.7%. It was substantially lower in Gauteng (67.5%) where a large proportion of adults were not at home (13%). The response rate was higher in the non-urban than urban area.

Ethical approval was granted by the Ethics Committee of the South African Medical Research Council. Informed consent was obtained from each respondent.

5.2.2 Variable definitions

Chronic phlegm was defined as usual cough with phlegm every day for at least 3 months a year for at least 2 successive years. Participants were considered having asthma, emphysema/bronchitis and TB if they answered affirmatively the questions, "Has a doctor or nurse or staff member at a clinic or at a hospital told you that you had or have any of the following conditions: asthma or emphysema/bronchitis or TB". The four respiratory symptoms were prompted by the following questions: "During the last year have you had wheezing or tightness of your chest? If "yes" were you also short of breath?; Is your sleep ever interrupted by you coughing?; Is your sleep ever interrupted by wheezing or a tight chest?; Do you usually cough?; When you cough, do you usually bring up phlegm from your chest?" [19]

Socio-demographic variables included residence in urban/rural area, more than two persons per room, household going hungry, covered by medical aid/medical benefit scheme, payment of medication, age distribution (categorised in quartiles) and ethnic identity (African/Black, Coloured, White, Asian/Indian). Under Apartheid, South Africans were categorised into one of four socially defined groups: White (mainly European ancestry), Asian (Indian sub-continent ancestry), African or Black (descent primarily from one of a number of Bantu language groups in Southern Africa) and Coloured (general grouping, including a mixture of black, Malay, European and indigenous Khoisan ancestry). Race is very much linked to past access to resources, socio-economic status and educational status. Educational status was classified as less or equal to primary school, secondary and tertiary education.

Environmental exposure variables included home connection to electricity, type of cooking and heating fuels used (classified as electricity only, electricity and other fuels - such as gas, paraffin, coal, wood and animal dung) and other fuels only - and living in household with smokers.

Occupational exposure variables included, having a job with smokers, ever worked in a job where regularly exposed to smoke, dust, fumes or strong smells and period worked in a job where regularly exposed to smoke, dust, fumes or strong smells (categorised in quartiles).

Variables related to active smoking included ever smoked tobacco, used snuff or chewed tobacco, ever smoked at least 100 cigarettes (5 packets) in lifetime, years smoked on a daily basis (categorised in quartiles) and frequency smoking.

BMI was included in the analysis because of a renewed interest in the association with various respiratory conditions.[20,21] Weight and height were used to calculate the BMI (the weight in kilograms divided by the square of the height in meters, $kg.m^{-2}$) which was used as a measure of adiposity. Categories of BMI were created (<22, 22–24.9, 25–27.4, 27.5–29.9, ≥ 30 $kg.m^{-2}$). The decision to select 22–24.9 $kg.m^{-2}$ as the reference category is based on a large prospective study where the lowest rates of death from all causes were found at a BMI between 22-23.4 $kg.m^{-2}$ in women and between 23.5-24.9 $kg.m^{-2}$ in men.[22] The cut-off points as proposed by the World Health Organisation were used where a BMI of 25–29.9 $kg.m^{-2}$ is termed overweight or pre-obese and a BMI of 30 $kg.m^{-2}$ or higher is considered obese.[23]

5.2.3 Data analysis

All subsequent statistical analyses of results were done using SAS version 8. The 1998 SADHS report pointed out that the potential risk factors might be correlated with each other.[19] Independence among the potential risk factors was investigated with a χ^2 analysis. It was observed that most of the potential risk factors were significantly correlated at the 95% confidence level, although very poorly with correlations coefficients varying from 0.01 to 0.40. Table 1 lists the variables found to be significantly related ($p \leq 0.001$) with Phi coefficients larger than 0.5. Consequently conventional logistic regression analysis was conducted, instead of a conditional analysis.

Table 1 Correlations among potential risk factors with Phi coefficients > 0.50 (averaged over strata)

	Connected to electricity	Residence location in urban area	Covered by medical aid/medical benefit scheme	Payment of medicine	Age distribution in years	Educational status	Years smoked on a daily basis
Fuel type used for cooking and heating	✓	✓					
Ethnic identity			✓	✓		✓	
Covered by medical aid/medical benefit scheme				✓			
Age distribution in years				✓			✓
Period worked in job exposed to smoke, dust, fumes or strong smells					✓		✓
Educational status			✓	✓			

The survey population reflected the ethnic make-up of the South African population: Africans (77.2%), Whites (10.5%), Coloureds (8.8%) and Indians (2.5%).[24] Thus no weighting was conducted during the analysis. Simple descriptive statistics were used to examine the potential risk factors and in calculating the prevalence of respiratory symptoms and conditions. The crude odds ratio (OR) and 95% confidence intervals (CI) were derived from conventional univariate logistic regressions performed for binary (coded as 1 for an affirmative response and 0 for a negative response) dependent variables, specifying Mantel-Haenszel tests. The adjusted odds ratio (OR) and 95% confidence intervals (CI) were derived from a conventional multivariate logistic regression analysis.

The PROC LOGISTIC statement was applied. By specifying the FAST option, PROC LOGISTIC eliminates insignificant variables without refitting the model repeatedly. This analysis uses a significance level of 0.2 (SLSTAY=0.2) to retain variables in the model. Owing to the small number of observations in the dependent variables categories, the following procedure was implemented during the multivariate logistic regression analysis: the analysis was conducted using all variables that were significantly associated with the particular dependent variable in the univariate logistic regression analysis. The first variable selected by the stepwise procedure was then excluded, and the procedure recalculated with the remaining variables. Finally, only those variables selected by each iteration were used and a stepwise multivariate logistic regression model was fitted to these variables. The analyses were not computed separately for men and women as only nocturnal coughing, nocturnal wheezing/tight chest and medically diagnosed TB were significantly influenced by the sex of the participants.

5.3 Results

The data presented here represent a more detailed analysis of the first national survey of the symptoms and prevalence of chronic lung disease in South Africa. Table 2 lists the characteristics of the 13 826 individuals from 6 457 households.

Table 3 summarises the crude prevalence of respiratory symptoms and conditions among South African adults. About 3.7% were reported as having doctor diagnosed asthma. The survey also reveals high incidence of other respiratory symptoms and diseases including wheeze and shortness of breath (11.1%), cough with phlegm (6.8%); chronic bronchitis (2.4%), nocturnal coughing (13.1%), nocturnal wheezing/tight chest (10.8%) and doctor diagnosed bronchitis (4.2%) and TB (2.7%). Nearly 1.7% of the respondents reported using asthma medication, whilst 0.5% was using TB medication.

Table 2 Characteristics of study population in terms of socio-demographic, active smoking, BMI, environmental and occupational exposure variables

Characteristics/feature	Percentage
Residence	
Urban	56
Rural	44
Connected to electricity	65
Cooking and heating fuels	
Electricity only	35
Electricity and biomass or fossil fuels	15
Biomass or fossil fuels	50
People per room	
< 2	40
≥ 2	60
Household going hungry	
Often	13
Sometimes	34
Seldom	5
Never	48
Covered by medical aid/medical benefit scheme	15
Payment of medicine	
Respondent	30
Family	4
Medical aid	23
Provided at clinic/public hospital	42
Employer	1
Age distribution in years	
15-23	48 (M*), 52 (F*)
24-35	40 (M), 60 (F)
36-51	41 (M), 59 (F)
52-95	37 (M), 63 (F)
Ethnic identity	
Black/African	76
Coloured	13
White	8
Asian/Indian	3
Ever smoked tobacco, used snuff or chewed tobacco	37
Ever smoked at least 100 cigarettes in lifetime	74
Years smoked on a daily basis – distribution	
1-7	
8-16	26
17-28	25
29-78	24
	25

** Male; Female*

Table 2 *(continues)*
Characteristics of study population in terms of socio-demographic, active smoking, BMI, environmental and occupational exposure variables

Characteristics/feature	Percentage
Frequency smoking	
Daily	18
Occasionally	72
Not at all	10
Household with smokers	36
Job with smokers	31
Ever worked in job where regularly exposed to smoke, dust, fumes or strong smells	21
Period worked in job exposed to smoke, dust, fumes or strong smells – distribution in years	
0-2	21
3-5	30
5-13	25
14-50	24
Gender	
Male	42
Female	58
Educational status	
≤ Primary school	43
Secondary school	51
Tertiary education (partly or completed)	6
Province of residence	
Western Cape	8
Eastern Cape	24
Northern Cape	9
Free State	9
KwaZulu-Natal	15
North West	9
Gauteng	8
Mpumalanga	9
Limpopo	9
Body Mass Index (BMI) $kg.m^{-2}$	
<22	37
22-24.9	21
25-27.4	13
27.5-29.9	9
30+	20

The effects (expressed in crude odds ratios) of various socio-demographic, environmental and occupational potential risk factors on prevalence of respiratory symptoms and conditions are summarised in Table 4.

The adjusted odds ratios are presented in Table 5. Race was the only potential predictor that remained significant for wheezing and shortness of breath. The risk of Asians/Indians increased now nearly 1.7 fold from the crude model, whilst Blacks/Africans were also significantly decreased compared to Whites. The results suggested that risk of nocturnal coughing was now significantly influenced by connection to electricity, covered by medical aid, educational status and household with smokers. The first three predictors were somewhat less beneficial, whilst the detrimental impact of the latter predictor increased somewhat compared to the crude model. Two potential risk factors remained significantly associated with nocturnal wheezing/thigh chest: Exposed at work to fumes, smoke, dust or strong smells along with educational status. The effect of these potential risk factors decreased somewhat from the univariate analysis.

Table 3 Crude prevalence (%) of respiratory symptoms and conditions in the survey population

Condition	Overall prevalence (%)
Wheezing and shortness of breath	11.1
Nocturnal coughing	13.1
Nocturnal wheezing/tight chest	10.8
Cough with phlegm	6.8
Chronic bronchitis	2.4
Medically diagnosed asthma	3.7
Medically diagnosed emphysema/bronchitis	4.2
Medically diagnosed TB	2.7
Currently using asthma medication	1.7
Currently using TB medication	0.5

The results hinted that cough with phlegm was significantly influenced in a protective manner by connection to electricity and detrimentally by years smoked on a daily basis along and BMI. The odds ratios decreased and increased somewhat for the protective and harmful potential predictors, respectively compared to the crude

Table 4 Potential risk factors for respiratory symptoms and conditions: Crude OR (95% CI)

Characteristics/feature	Wheezing and shortness of breath	Nocturnal coughing	Nocturnal wheezing/tight chest	Cough with phlegm	Chronic bronchitis	Medically diagnosed asthma	Medically diagnosed emphysema or bronchitis	Medically diagnosed TB
Residence in urban area	1.02 (0.84-1.23)	0.83 (0.75-0.92)*	0.74 (0.66-0.82)*	0.68 (0.56-0.83)*	0.64 (0.47-0.88)*	1.29 (1.07-1.54)*	1.42 (1.19-1.69)*	0.65 (0.53-0.80)*
Connected to electricity	1.11 (0.92-1.35)	0.78 (0.71-0.87)*	0.68 (0.61-0.76)*	0.63 (0.51-0.77)*	0.57 (0.41-0.78)*	1.10 (0.92-1.33)	1.34 (1.11-1.61)*	0.47 (0.38-0.58)*
Cooking and heating fuels								
Electricity only†								
Electricity and other fuels	1.17 (0.85-1.61)	0.83 (0.70-0.97)*	1.07 (0.89-1.27)	1.19 (0.87-1.62)	0.75 (0.43-1.30)	0.59 (0.44-0.78)*	0.39 (0.29-0.53)*	1.42 (1.00-2.03)
Other fuels only	0.92 (0.75-1.13)	1.15 (1.03-1.28)*	1.45 (1.29-1.64)*	1.75 (1.40-2.18)*	1.60 (1.11-2.32)*	0.69 (0.58-0.84)*	0.46 (0.39-0.56)*	2.18 (1.69-2.80)*
≥ 2 people per room	0.83 (0.69-1.01)	1.09 (0.99-1.21)	1.07 (0.96-1.19)	1.09 (0.89-1.34)	0.97 (0.70-1.34)	0.83 (0.69-0.99)*	1.13 (0.92-1.40)	0.67 (0.56-0.79)
Household going hungry								
Never†								
Seldom	1.70 (1.00-2.90)	0.82 (0.63-1.07)	0.98 (0.74-1.30)	1.28 (0.76-2.14)	0.98 (0.44-2.21)	1.10 (0.74-1.64)	0.22 (0.11-0.43)*	1.07 (0.60-1.91)
Sometimes	1.16 (0.94-1.44)	1.25 (1.11-1.39)*	1.52 (1.34-1.71)*	0.89 (0.72-1.11)	1.81 (1.26-2.62)*	0.99 (0.81-1.21)	0.46 (0.37-0.57)*	2.18 (1.72-2.77)*
Often	1.09 (0.82-1.45)	1.40 (1.20-1.63)*	1.83 (1.56-2.15)*	1.75 (1.28-2.41)*	2.61 (1.64-4.16)*	1.05 (0.80-1.39)	0.80 (0.62-1.03)	2.50 (1.85-3.37)*
Covered by medical aid/medical benefit scheme	0.93 (0.71-1.21)	0.76 (0.65-0.88)*	0.62 (0.52-0.74)*	0.85 (0.62-1.16)	0.85 (0.51-1.42)	1.75 (1.42-2.17)*	3.11 (2.60-3.72)*	0.33 (0.21-0.51)*
Payment of medicine								
Provided at public clinic/hospital†								
Respondent	0.87 (0.53-1.42)	1.04 (0.81-1.32)	0.97 (0.75-1.25)	1.38 (0.85-2.22)	1.32 (0.65-2.67)	1.19 (0.86-1.63)	1.04 (0.72-1.50)	0.52 (0.31-0.86)*
Family	1.40 (0.40-4.92)	0.75 (0.44-1.30)	1.19 (0.72-1.99)	0.88 (0.31-2.53)	0.86 (0.15-5.04)	0.95 (0.48-1.91)	0.73 (0.31-1.73)	0.47 (0.14-1.53)
Medical aid	0.48 (0.29-0.80)*	0.55 (0.40-0.74)*	0.43 (0.31-0.60)*	1.30 (0.68-2.46)	0.86 (0.31-2.42)	1.08 (0.76-1.53)	2.01 (1.43-2.84)*	0.18 (0.08-0.42)*
Employer	0.63 (0.12-3.23)	1.13 (0.39-3.25)	0.94 (0.30-2.93)	1.54 (0.27-8.63)	- (-)	0.93 (0.21-4.12)	0.58 (0.08-4.47)	2.68 (0.75-9.60)

*† Reference category * $p<0.05$ for stratum OR*

Table 4 *(continues)*
Potential risk factors for respiratory symptoms and conditions: Crude OR (95% CI)

Characteristics/feature	Wheezing and shortness of breath	Nocturnal coughing	Nocturnal wheezing/tight chest	Cough with phlegm	Chronic bronchitis	Medically diagnosed asthma	Medically diagnosed emphysema or bronchitis	Medically diagnosed TB
Age distribution in years								
15-23†								
24-35	1.41 (1.04-1.92)*	1.31 (1.11-1.54)*	1.26 (1.05-1.51)*	1.05 (0.76-1.44)	1.14 (0.62-2.09)	1.20 (0.89-1.63)	1.24 (0.91-1.67)	2.35 (1.56-3.55)*
36-51	1.71 (1.27-2.29)*	1.92 (1.64-2.25)*	1.78 (1.50-2.12)*	1.80 (1.32-2.46)*	1.59 (0.91-2.80)	1.90 (1.43-2.52)*	1.91 (1.43-2.53)*	3.87 (2.62-5.73)*
52-95	1.71 (1.30-2.26)*	2.73 (2.35-3.17)*	2.76 (2.35-3.25)*	1.85 (1.38-2.47)*	2.71 (1.59-4.60)*	2.70 (2.06-3.54)*	3.45 (2.65-4.48)*	4.29 (2.91-6.33)*
Ethnic identity								
White†								
Black/African	1.29 (0.96-1.73)	1.18 (0.96-1.44)	1.47 (1.17-1.85)*	1.07 (0.72-1.59)	0.68 (0.37-1.25)	0.39 (0.31-0.50)*	0.12 (0.10-0.15)*	3.56 (1.83-6.93)*
Coloured	1.29 (0.89-1.88)	1.94 (1.55-2.43)*	1.66 (1.27-2.15)*	1.01 (0.66-1.55)	0.34 (0.17-0.68)*	0.52 (0.38-0.72)*	0.36 (0.28-0.45)*	5.07 (2.52-10.18)*
Asian/Indian	4.31 (2.05-9.05)*	1.63 (1.19-2.23)*	1.63 (1.14-2.33)*	0.61 (0.31-1.22)	0.32 (0.09-1.14)	0.77 (0.49-1.19)	0.23 (0.15-0.37)*	1.06 (0.32-3.45)*
Educational status								
≤Primary school†								
Secondary school	0.74 (0.60-0.89)*	0.47 (0.42-0.52)*	0.48 (0.43-0.53)*	0.63 (0.51-0.77)*	0.64 (0.45-0.90)*	0.60 (0.50-0.72)*	0.91 (0.76-1.09)	0.41 (0.33-0.50)*
Tertiary education (partly or completed)	0.57 (0.37-0.88)*	0.29 (0.22-0.38)*	0.26 (0.19-0.37)*	0.48 (0.26-0.87)*	0.82 (0.30-2.27)	1.07 (0.77-1.49)	1.93 (1.46-2.55)*	0.10 (0.04-0.28)*
Male	0.90 (0.74-1.10)	0.71 (0.64-0.79)*	0.75 (0.67-0.84)*	1.01 (0.82-1.23)	1.02 (0.74-1.42)	0.90 (0.75-1.08)	0.92 (0.78-1.09)	1.37 (1.12-1.68)*
BMI								
<22	1.08 (0.83-1.42)	1.22 (1.06-1.40)*	1.30 (1.11-1.51)*	1.38 (1.05-1.83)*	1.13 (0.72-1.79)	1.10 (0.86-1.42)	0.98 (0.78-1.24)	2.30 (1.71-3.12)*
22-24.9†								
25-27.4	0.87 (0.62-1.23)	0.96 (0.80-1.15)	1.01(0.82-1.24)	1.24 (0.86-1.78)	0.60 (0.33-1.11)	0.95 (0.68-1.33)	0.98 (0.72-1.32)	0.87 (0.55-1.37)
27.5-29.9	1.06 (0.73-1.54)	0.92 (0.75-1.13)	0.96 (0.76-1.20)	1.18 (0.79-1.76)	1.15 (0.60-2.20)	1.09 (0.77-1.55)	1.04 (0.75-1.44)	1.16 (0.74-1.82)
30+	1.08 (0.81-1.46)	1.33 (1.14-1.56)*	1.40 (1.18-1.67)*	1.18 (0.86-1.62)	0.99 (0.59-1.66)	1.42 (1.08-1.86)*	1.23 (0.95-1.59)	0.85 (0.57-1.26)
Household with smokers	1.08 (0.89-1.31)	1.34 (1.21-1.48)*	1.19 (1.06-1.33)*	0.98 (0.81-1.20)	0.66 (0.47-0.91)*	1.18 (0.99-1.41)	1.16 (0.98-1.38)	1.04 (0.84-1.29)
Ever smoked tobacco, used snuff or chewed tobacco	1.13 (0.94-1.37)	1.73 (1.56-1.91)*	1.61 (1.45-1.80)*	1.40 (1.15-1.71)*	1.19 (0.86-1.63)	1.54 (1.29-1.84)*	2.26 (1.91-2.67)*	2.45 (1.99-3.01)*

*† Reference category * p<0.05 for stratum OR*

Table 4 *(continues)*

Potential risk factors for respiratory symptoms and conditions: Crude OR (95% CI)

Characteristics/feature	Wheezing and shortness of breath	Nocturnal coughing	Nocturnal wheezing/tight chest	Cough with phlegm	Chronic bronchitis	Medically diagnosed asthma	Medically diagnosed emphysema or bronchitis	Medically diagnosed TB
Ever smoked at least 100 cigarettes in lifetime	0.83 (0.60-1.15)	1.02 (0.86-1.21)	0.83 (0.70-0.99)*	1.05 (0.76-1.44)	1.05(0.64-1.72)	1.27 (0.93-1.73)	1.73 (1.29-2.32)*	1.06 (0.78-1.45)
Years smoked on a daily basis – distribution								
1-7†								
8-16	1.43 (0.89-2.30)	1.10 (0.85-1.43)	1.22 (0.91-1.63)	1.15 (0.73-1.84)	1.01 (0.44-2.34)	1.07 (0.68-1.70)	0.77 (0.52-1.13)	1.63 (0.99-2.69)
17-28	1.21 (0.78-1.90)	1.84 (1.44-2.35)*	1.78 (1.35-2.34)*	1.72 (1.08-2.75)*	1.20 (0.55-2.64)	1.35 (0.86-2.10)	1.31 (0.93-1.85)	2.44 (1.52-3.92)*
29-78	1.88 (1.22-2.91)*	2.32 (1.83-2.93)*	2.21 (1.70-2.88)*	1.99 (1.29-3.07)*	1.85(0.90-3.81)	2.22 (1.49-3.31)*	1.58 (1.13-2.19)*	2.50 (1.57-3.98)*
Frequency smoking								
Daily†								
Occasionally	1.08 (0.73-1.59)	1.14 (0.92-1.43)	0.97 (0.77-1.24)	0.98 (0.61-1.57)	0.96 (0.45-2.07)	0.65 (0.46-0.92)*	0.47 (0.36-0.62)*	0.73 (0.51-1.04)
Not at all	1.30 (0.72-2.33)	0.99 (0.71-1.38)	1.23 (0.88-1.73)	0.94 (0.49-1.80)	1.44 (0.51-4.05)	0.75 (0.44-1.28)	0.44 (0.27-0.71)*	0.51 (0.27-0.96)*
Job with smokers	0.86 (0.66-1.13)	1.17 (1.01-1.35)*	1.01 (0.86-1.18)	0.96 (0.72-1.28)	0.77 (0.47-1.26)	0.79 (0.61-1.03)	1.82 (1.45-2.30)*	0.70 (0.50-0.98)*
Ever worked in job where regularly exposed to smoke, dust, fumes or strong smells	1.96 (1.57-2.44)*	2.03 (1.82-2.26)*	1.97 (1.75-2.22)*	1.26 (1.02-1.57)*	1.16 (0.83-1.63)	2.56 (2.13-3.07)*	3.04 (2.57-3.61)*	1.99 (1.60-2.48)*
Period worked in job exposed to smoke, dust, fumes or strong smells – distribution in years								
0-2†								
3-5	1.94 (1.10-3.43)*	1.14(0.87-1.49)	1.23 (0.92-1.63)	1.34 (0.79-2.27)	1.32 (0.52-3.35)	0.87 (0.55-1.38)	1.22 (0.81-1.83)	0.97 (0.59-1.61)
5-13	1.30 (0.75-2.25)*	1.11 (0.84-1.47)	1.10 (0.81-1.48)	1.28 (0.73-2.26)	1.92 (0.74-4.96)	1.57 (1.02-2.42)*	1.12 (0.73-1.71)	0.97 (0.57-1.64)
14-50	1.22 (0.72-2.08)	1.13 (0.85-1.49)	1.06 (0.78-1.44)	1.40 (0.81-2.42)	1.38 (0.54-3.55)	1.49 (0.96-2.31)	1.90 (1.28-2.82)*	0.97 (0.57-1.65)

*† Reference category * p<0.05 for stratum OR*

Table 5 Potential risk factors for respiratory symptoms and conditions in adult population of South Africa: Adjusted OR (95% CI)

Characteristics/feature	Wheezing and shortness of breath (n=1535)	Nocturnal coughing (n=1816)	Nocturnal wheezing/tight chest (n=1491)	Cough with phlegm (n=937)	Chronic bronchitis (n=325)	Medically diagnosed asthma (n=514)	Medically diagnosed emphysema or bronchitis (n=578)	Medically diagnosed TB (n=378)
Connected to electricity	-	0.58 (0.37-0.92)*	-	0.61 (0.41-0.89)*	-	-	-	-
Household going hungry								
Never†								
Seldom	-	-	-	1.48 (0.58-3.59)	0.95 (0.42-2.16)	-	-	0.59 (0.14-2.51)
Sometimes				0.66 (0.45-0.96)*	1.72 (1.18-2.50)*			2.12 (1.30-3.46)*
Often				1.30 (0.75-2.27)	2.42 (1.50-3.90)*			2.21 (1.15-4.25)*
Covered by medical aid/medical benefit scheme	-	0.37 (0.22-0.62)*	-	-	-	-	-	-
Age distribution in years								
15-23†								
24-35	-	-	-	-	1.23 (0.66-2.29)	0.56 (0.31-1.02)	-	-
36-51					1.56 (0.88-2.76)	0.92 (0.54-1.57)		
52-95					2.53 (1.48-4.34)*	1.28 (0.75-2.17)		
Ethnic identity								
White†								
Black/African	1.89 (1.17-3.07)*	-	-	-	-	0.37 (0.23-0.58)*	0.23 (0.15-0.35)*	-
Coloured	1.68 (0.91-3.10)					0.44 (0.26-0.73)*	0.54 (0.35-0.83)*	
Asian/Indian	7.18 (1.63-31.64)*					0.63 (0.29-1.34)	0.21 (0.08-0.54)*	
Years smoked on a daily basis – distribution								
1-7†								
8-16	-	-	-	1.19 (0.73-1.93)	-	-	-	-
17-28				2.00 (1.23-3.27)*				
29-78				2.24 (1.42-3.55)*				
Household with smokers	-	1.85 (1.27-2.71)*	-	-	-	-	-	-

*† Reference category * p<0.05 for stratum OR*

Table 5 *(continues)*
Potential risk factors for respiratory symptoms and conditions in adult population of South Africa: Adjusted OR (95% CI)

Characteristics/feature	Wheezing and shortness of breath (n=1535)	Nocturnal coughing (n=1816)	Nocturnal wheezing/tight chest (n=1491)	Cough with phlegm (n=937)	Chronic bronchitis (n=325)	Medically diagnosed asthma (n=514)	Medically diagnosed emphysema or bronchitis (n=578)	Medically diagnosed TB (n=378)
Ever worked in job where regularly exposed to smoke, dust, fumes or strong smells	-	-	1.66 (1.17-2.36)*	-	-	2.34 (1.74-3.17*)	-	-
Period worked in job exposed to smoke, dust, fumes or strong smells – distribution in years	-	-	-	-	-	-		-
0-2†								
3-5							1.45 (0.83-2.54)	
5-13							0.92 (0.50-1.68)	
14-50							2.08 (1.21-3.58)*	
Educational status	-			-	-		-	
≤Primary school†								
Secondary school		0.59 (0.39-0.90)*	0.38 (0.26-0.55)*			0.57 (0.39-0.83)*		0.49 (0.30-0.78)*
Tertiary education (partly or completed)		0.20 (0.06-0.70)*	0.24 (0.11-0.52)*			0.47 (0.23-0.95)*		0.14 (0.02-1.02)
BMI	-	-	-		-	-	-	
<22				2.12 (1.36-3.29)*				3.58 (1.76-7.27)*
22-24.9†								
25-27.4				1.45 (0.80-2.64)				0.88 (0.27-2.90)
27.5-29.9				0.71 (0.35-1.42)				1.97 (0.65-6.00)
30+				1.42 (0.80-2.51)				1.96 (0.72-5.36)

*† Reference category * p<0.05 for stratum OR*

model. The significant level of household going hungry with cough with phlegm changed now from often (detrimental) to sometimes (protective) in the adjusted model. Chronic bronchitis was negatively, yet a bit less, influenced by household going hungry (sometimes and often stratum) and age (>51 years) compared to the crude model.

The results implied that medically diagnosed asthma was beneficially (yet weaker) influenced by race and educational status. Having some tertiary education was beneficial to lower medically diagnosed asthma prevalence. Exposed at work to fumes, smoke, dust or strong smells remained potentially detrimental (yet weaker) to medically diagnosed asthma. Two potential risk factors remained significantly associated with medically diagnosed emphysema/bronchitis: race (beneficial) and period exposed at work to fumes, smoke, dust or strong smells. (detrimental). The effect of these potential risk factors generally increased somewhat from the univariate analysis. The results inferred that medically diagnosed TB was potentially negatively influenced by household going hungry (sometimes and often) and BMI (22 $kg.m^{-2}$). Increased educational status may potentially reduce medically diagnosed TB, however the tertiary stratum was now insignificant compared to the crude model. The influence of educational status and BMI strengthened somewhat, whilst that of household going hungry weakened.

5.4 Discussion

Airway obstructive diseases and respiratory symptoms have increased world-wide.[25-27] The crude prevalence rate for chronic bronchitis (2.4%) from the 1998 SADHS was much lower compared to those from other developing countries (13-27%), but comparable to developed countries (3-17%).[28] Chronic bronchitis rates in men are considerably lower than those reported in working populations and in some general populations in Africa including South Africa, which range from 10-45%.[3]

The prevalence of asthma varies between countries but also between different areas within the same country.[25-27,29] Asthma is not necessarily more prevalent in industrialised than non-industrialised countries (Global Initiative for Asthma, 2004). Nriagu et al reported a rate of 12% for doctor diagnosed asthma amongst adults living in the highly industrialsed area of Durban South, South Africa.[13] The report issued by the Global Initiative for Asthma (GINA) estimated the mean prevalence of clinical asthma in Southern Africa as 8.1%, compared to the crude rate of 3.7% found in the SADHS.[19,27] The prevalence of asthma is higher in Southern Africa than in many other regions in Africa. South Africa is 25th on the list of 84 countries in terms of asthma prevalence and 5th out of 49 countries in terms of asthma mortality rates. Asthma prevalence rates for other developing countries are: Brazil (11.4%), Mexico (3.3%), Nigeria (5.4%), India (3.0%), China (2.1%).[27]

In Southern Africa, mining-related diseases such as pneumoconiosis remain the leading occupational respiratory diseases, but occupational asthma is becoming increasingly prevalent as non-mining industrialisation expands. Occupational asthma now represents the second most frequently reported occupational respiratory disease.[19]

Globally only six countries have more cases of TB than South Africa (243 000 cases, 0.55% compared to population of 44 million). These are India (1 820 000 cases), China (1 448 000 cases), Indonesia (582 000 cases), Bangladesh (328 000 cases), Nigeria (275 000 cases) and Pakistan (247 000 cases).[30]

Nriagu et al reported self-reported prevalence rates for wheezing and chronic phlegm as 37±40% and 31±32% amongst adults from Durban South, South Africa, respectively.[13] The SADHS rate for wheeze and shortness of breath (11.1%) was comparable to those from the European Community Respiratory Health Survey (ECRHS), which ranged from 3.0% (Mumbai, India) to 16.1% (Melbourne, Australia).[31] Nocturnal cough (13.1%) compared well to the rate from Mumbai, India (11.2%) and Athens, Greece (17.8%), but was much lower to those reported at Portland, USA (32.5%) and much higher than rural Beijing, China (2.6%).[31,32] The SADHS rate for nocturnal tight chest (10.8%) was comparable to those from Wellington, New Zealand (10.4%) and Melbourne, Australia (11.4%), but higher than Algiers, Algeria (4.4%) and rural Beijing, China (1.4%).[31,32] The SADHS rate for coughing with phlegm (6.8%) was lower compared to that reported by Langhammer et al (8.3% for 20-44 year olds from Norway), but higher than those from rural Beijing, China (1.9%).[32,33]

The univariate logistic regression analyses suggested that the prevalence of the various respiratory symptoms and conditions were influenced differently by the range of socio-demographic, environmental and occupational potential risk factors. The multivariate logistic regression analyses suggested that the prevalence of respiratory symptoms and diseases may potentially be diminished in South Africa by health promotion predictors (increasing connection to electricity, having a medical aid and improved education). The following potential risk factors should be lessened in order to have a beneficial influence on the prevalence rates of respiratory symptoms and diseases: households going hungry, years smoked, households with smokers, exposure at work to fumes, smoke, dust or strong smells and period worked in such a job as well as BMI increase for the underweight and decrease of the obese. Other potential risk factors included age and race. One aspect of the chronic disease prevention that has been particularly successful in South Africa has been the introduction of strong tobacco control legislation At the time of the survey, South Africa did not have any comprehensive strong anti-tobacco legislation that was enforced in public places and the working environment. The legislation only came into force on 1 January 2001.[34] Tobacco control initiatives have increased dramatically in South Africa, especially since 1994. In 1993, the first Tobacco Products Control Act was passed and in 1999 the Tobacco Products Control Amendment Act.

The risk of acquiring chronic bronchitis increased with increasing age. This is in agreement with studies from Nepal and England.[35,36] Studies from the United States and Canada, however, have failed to show an increase with age.[37,38] Campello et al also did not observe an increase of risk for asthma and asthma-like symptoms amongst Italian adults (as observed in this analyses), whilst Zhang et al did amongst adults (≥15 years) in rural Beijing, China.[32,39]

The risk for nocturnal cough, nocturnal wheezing/tight chest, asthma and TB diminished with increasing educational status. The results are consistent with those from a cross-sectional analysis in Hordaland County in Sweden after adjustment for sex, age, smoking, and occupational exposure.[40]

In general, White people had a lower risk for wheezing and shortness of breath compared to the other ethnic groups, except for asthma and emphysema/bronchitis. In contrast, the Global Burden of Asthma report reported that asthma mortality rates are disproportionately higher among Africans and Coloureds.[27] It further reported that the majority of asthma deaths in the region occur outside hospitals. Poor availability of health care, poor transport and emergency services and inadequate home management of acute asthma are therefore recognised as important contributing factors.

The SADHS results revealed that households going hungry often and sometimes were more at risk for chronic bronchitis and TB compared to households never going hungry. A recent review by Brug et al documented that there are some indications from epidemiological studies on the potential protective role of some nutrients, high intake of fish and fresh fruits in the development of COPD related diseases and symptoms.[41-46] The evidence is not extensively sufficient to justify dietary recommendations for primary prevention of COPD. Most of the evidence refers to omega-3 fatty acids, vitamins C and E, which have an antioxidant action that may supposedly counteract the oxidative damage produced by exposures like smoking and air pollution.[47]

Being connected to electricity significantly reduced the risk for nocturnal coughing, and cough with phlegm. It is estimated that two-thirds of the households in the developing world are still primarily dependent on biomass and fossil fuels in conditions of inadequate ventilation. These household conditions have the potential to produce high concentrations of indoor air pollution, which are many times higher than outdoor concentrations.[48,49] Very few quantitative environmental exposure assessment or analytical epidemiological studies have been conducted in South Africa. Most of the studies also focused on children as study population. Exposure is usually based on a proxy measures, such as smoking status or use of biomass fuels for space heating.[13,14,17,18]

Gas use was included in the "other fuels" category during this investigation, as there is evidence that people who use gas for cooking have reduced lung function than those who use electricity for cooking.[50,51] NO_2 is the main pollutant produced during unvented gas cooking.

The prevalence of nocturnal coughing was significantly elevated in households with smokers. ETS is a common indoor exposure in many countries and it is a major contributor to indoor RSP concentrations.[52] It was estimated that 37% of the South

African respondents had ever smoked, used snuff or chewed tobacco, 36% were living in a home where someone smoked and 31% had a job with smokers (Table 2). The ECRHS study indicated that between 8.6% (Umeå, Sweden) and 50.6% (Galdakao, Spain) of respondents are exposed to ETS at home.[53]

The research on health effects of ETS has expanded since the 1980's. Among children there is relatively strong evidence showing that parental smoking is associated with respiratory symptoms.[54-57] In contrast, the studies carried out in adult populations have provided more inconsistent results. Some studies did not observe significant associations.[58,59] However, far more cross-sectional studies have shown increased occurrence of chronic respiratory symptoms and deficits in ventilatory lung function in relation to ETS exposure at home and/or at work.[60-63]

It was found that the prevalence of wheeze/tightness of chest and asthma was significantly elevated when respondents were exposed to smoke, dust, fumes or strong smells at work. This was also observed for emphysema/bronchitis and period worked in a job where regularly exposed to smoke, dust, fumes or strong smells. While there are a number of specific work exposures that have been shown to cause fibrosis of the lung[64-67] and chronic bronchitis[68,69], there is more general evidence associating work in dusty occupations with COPD.[70] Work-related asthma is one of the most common occupational lung diseases worldwide.[67,71] Menezes et al reported a significant increase in risk of chronic bronchitis due to occupational exposure to dust (OR = 2.48, 95% CI 1.56 to 3.94).[72]

The key to prevention of occupational respiratory disease is the control of occupational air pollution. This requires the enforcement of engineering and other workplace control solutions as required by legislation. However, a large proportion of South Africans are employed in the informal sector, where this legislation does not apply. A revamp of the administration system for occupational diseases, whose flaws currently signify a main blockage to the coverage and management of occupational diseases, is required.[73] The division of compensation and preventions systems further enhances to incompetence.

The adjusted risk models indicated no significant relationship between BMI and TB and cough with phlegm. The SADHS study differs from others in that it describes data from a population of diverse ethnic and socioeconomic background. However, it is difficult to compare the risks pose by being obese (BMI $\geq$ 30 $kg.m^{-2}$) to those reported by other studies as different reference groups are applied. The role of diet and sedentary indoor lifestyle have been speculated in asthma development.[74,75] Obesity can directly affect the airway caliber through the chest wall restriction. Narrowing of airway and the reduction of lung volume have been associated with bronchial hyperreactivity.[76] Pooled data from three large epidemiologic studies in Australia found that underweight individuals had an increased risk for asthma, respiratory symptoms and airway hyperresponsiveness, whereas obese subjects had increased risk for asthma and respiratory symptoms, but not airway hyperresponsiveness. Gender differences were not reported.[77] Celedon et al found among adult men and women living in rural China that both underweight and overweight were associated with an increased risk of asthma.[78]

There are some important limitations in this study, which should be taken into account when interpreting the results. The SADHS had a cross-sectional design. Cross-sectional studies are weak to prove causation as they are subject to difficulties interpreting the temporal sequence of events since health status and risk factors are measured simultaneously.

Reliance on self-reported data does, however, carry a risk of differential or nondifferential misclassification of disease and exposure status resulting in statistical significance arising by chance. However, the biological plausibility of the potential risk factors has been addressed. Consequently the direction of bias on the association is not easy to predict. Respondents with current symptoms and diseases may be more likely to report exposures and remember past TB infections than asymptomatic respondents.

Self-reporting of emphysema and bronchitis can be used only as a very rough guide to the prevalence of chronic lung diseases for a variety of reasons. First, use of diagnostic terms reflects health service access, which in South Africa varies considerably by socio-economic status and geography. A term such as emphysema is likely to be used inconsistently by medical practitioners based on varying clinical criteria. Lung function testing, which contributes important information to diagnosis, is uncommon at primary care level. Bronchitis also is a non-specific term that would elicit reports of acute bronchitis as well as chronic bronchitis. Acute bronchitis is a common ailment, often a mild and self-limiting viral infection, which may occur without underlying chronic disease. A literature review of asthma symptoms assessed by questionnaire found that "physician-diagnosed asthma" had a mean specificity of 99% and a mean sensitivity of 68% for asthma defined by symptoms, suggesting that underdiagnosis is more likely than overdiagnosis.[79] Finally, asthma in adults is probably frequently misdiagnosed as bronchitis. On the one hand, self-reporting of asthma is likely to reflect some degree of under-diagnosis. On the other hand, asthma rates may be inflated by confusion with emphysema and chronic bronchitis, particularly in older age groups. Reporting of symptoms is less likely to be influenced by contact with health services than is reporting of diagnoses. The chronic bronchitis symptom complex is defined by chronic bronchitis every day for at least 3 months a year, for at least 2 successive years. It was one of the earliest symptom complexes to be defined by standard respiratory questionnaires, and has entered into common usage as both a clinical and epidemiological definition.

Furthermore, other factors that might contribute to adult respiratory health, such as outdoor and indoor air pollution (e.g. location of household close to industry, transportation sources or waste fill sites, insecticide or fertiliser use, allergens such as pollen, dust, fungal spores from mildew and moulds), meteorological variables (precipitation, temperature, humidity), the current HIV/AIDS epidemic and respiratory infections, were not recorded. Excluding these risk factors from the analysis might introduce substantial bias (differential or nondifferential). Thus the direction of bias on the calculated association measures is not easy to predict. The definition of a confounder is important to remember: it must be associated with both the exposure variable of interest and the health effect. As the association among these different risk factors and the investigated potential risk factors is not readily available from the literature, it is impossible to predict the direction of the potential bias on the association measure.

Differential and/or nondifferential misclassification may have influenced the risk estimates for cooking and heating fuel use. Many households in South Africa in general use a combination of cooking and heating fuels. The calculated effects may be underestimated if only considering using high polluting fuels (wood and dung) exclusively and not in combination with paraffin, coal, LPG/natural gas and/or electricity. However, none of the households under investigation used wood or dung exclusively or paraffin or coal exclusively. No quantitative exposure assessment (including duration of exposure, as reflected by frequency and duration of fuel use for heating and cooking per day) was conducted during the SADHS. It is recommended that future SADHS should separate the type of fuels use for cooking and heating in two separate questions. Exposure to smoke from polluting fuels during heating is much longer than exposure during cooking.

The most common indicators used for measurement of socio-economic status are income level, occupation and educational level.[80] Demographic and Health Surveys traditionally do not include questions on income and expenditure. Educational level measures one aspect of socioeconomic status and we cannot rule out that the results would have been different with another measure. However, the relation between socioeconomic status (SES) and socioeconomic factors with respiratory health in adults is not well understood. Existing studies are heterogeneous regarding the definition of the socioeconomic indicators used. Possibly, a more ideal measure would be one that took into account several aspects, e.g. educational level and household assets.

Another bias is that employed low-income men are underrepresented, as they work overtime, shifts or away from home. Male worker hostels, a common form of housing for African migrant workers in mining and certain urban areas, were not surveyed. Nevertheless the results presented here are the first national survey of the symptoms and prevalence of chronic lung disease in South Africa. Previous morbidity information was derived from surveys of selected adult populations only.[3,81]

During the analysis it was assumed that confounding is additive and not multiplicative. If confounding is additive, then the confounding variable would produce the same additional risk of a health outcome in the exposed and unexposed; but if the health outcome is rare in unexposed, it would follow that the confounder might account for a much larger proportion of health outcome in that group. Conversely, if two exposures act multiplicatively, the proportional increase in health outcome rates due to confounding would be the same in exposed and unexposed;

but if the health outcome is more prevalent in the exposed group, the absolute increase would be larger in the exposed. This issue thus has important risk assessment and public health policy implications.

There is a deficiency of local studies investigating risk factors for adult respiratory health. In order to improve respiratory health of the unique South African adult population through epidemiological studies, it is imperative that future studies should attempt to minimise systematic and random errors and subsequently strengthen their validity and accuracy. Yach et al addressed the methodological difficulties in undertaking epidemiological studies in developing countries.[82] They pointed out the use of ecological and cross-sectional studies in determining the relationship between risk factors and disease and consequently applying detailed analytical studies to determine the reasons for these relationships. In South Africa, detailed analytic epidemiology studies will have to compete with the demands on the public and research purse for work on common diseases of pressing current importance (e.g. HIV/AIDS). Therefore analytical studies should not merely redocument the impact of known risk factors, but should provide a basis for designing interventions.

In conclusion, although there is potential for residual confounding despite adjustment in this preliminary analysis, the documented international evidence on most of the potential risk factors suggests that these associations may be real. It is trusted that more detailed South African analytical intervention studies will scrutinise these results in order to develop integrated intervention programmes to improve adult respiratory health in the country.

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