University of the Witwatersrand

Faculty of Health Sciences-School of Public Health

RESEARCH REPORT

TITLE: HOUSING-RELATED RISK FACTORS FOR RESPIRATORY DISEASE IN LOW COST HOUSING SETTLEMENTS IN JOHANNESBURG, SOUTH AFRICA.

Dr Christina Makene

Research Report Submitted in Partial Fulfilment of the Degree of Master of Science in Medicine in the field of Epidemiology and Biostatistics

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG.

Supervisor: Dr Angela Mathee

2006 – 2007

Declaration:

I, Dr Christina Makene declare that this research report is my own work. It is being submitted for the degree of Master of Science (Med) in the field of Epidemiology and Biostatistics at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

………………………..

This day of………………….2008

Dedication

I dedicate this degree to the Lord God who has made it possible for me to complete this course. I also dedicate it to my father (Late Prof WJ Makene) and Mother (Jonia Makene).

Abstract

Rapid migration of people to the urban areas of developing countries resulted in a shortage of housing and the location of people in poor housing and unhealthy environments. Studies have shown that people who live in poor housing are at increased risk of exposure to the determinants of respiratory diseases.

Objective: This study investigated the influence of housing conditions on respiratory disease in selected low cost housing settlements in Johannesburg, South Africa.

Methodology: Secondary data analysis based on the Health, Environment and Development (HEAD) cross-sectional study were used to explore housing conditions in relation to respiratory health.

Results: Black African households comprised (77%) the major population group in the study. The overall mean number of people per household was five with household size ranging from 1 to 22 people permanently living in the household. Most of the households (48%) had an average monthly income of R1001 to R2000. The self reported household prevalence of asthma was highest among households in Riverlea (21%). Households in Riverlea had reported higher levels of asthma 33% relative to households in Bertrams. Hairdressing activities within dwellings increased the risk of asthma (OR: 2.89, 95% CI 1.46-5.73). Tuberculosis was associated with household size (OR 0.9, 95% CI 0.79 – 0.99) and smoking (OR 0.4 CI 0.12 - 0.96) in the univariate analysis. However in the multivariate analysis there was no significant association between tuberculosis with household size (OR 0.92, 95% CI 0.80 - 1.05) or smoking (OR 0.03, 95% CI 0.12 – 1.00).

Conclusion: In this study housing quality was an important determinant of respiratory health. More intervention strategies need to be employed to improve the living environment. These include increasing awareness and education to the public and other sectors, source reduction and more guidelines for healthy housing. Finally, more research on housing and health is needed to determine the effect of housing on health.

Acknowledgements

My special appreciation goes to my supervisor Dr Angela Mathee for her flexibility and support which had enabled me in understanding housing and environmental issues and without her support it would have been impossible to complete this report.

I am also grateful to Dr Edmore Marinda who assisted me in the analysis and whose encouragement and motivation helped me to complete the course. Lindy Mataboge and Lawrence Mpinga the course administrators provided me with the needed administrative support to complete this work and I wish to thank them too.

I must use this opportunity to thank my family who in one way or the other encouraged and supported me to complete this work.

Finally, I would like to record my thanks for guidance to Dr Edward Mwavu of Makerere University,Kampala Uganda.

List of Acronyms and Abbreviations

AIDS: Acquired Immunodeficiency Syndrome

HEAD: Health Environment and Development

HIV: Human Immunodeficiency Virus

IgE: Immunoglobulin E

NO_2: Nitrogen dioxide

SO_2: Sulphur dioxide

TB: Tuberculosis

UN-HABITAT: United Nations Human Settlement Program

VOCs: Volatile organic compounds

WHO: World Health Organization

DALYs: Disability Adjusted Life Years

UNCHS: United Nations Centre for Human Settlements

CI: Confidence intervals

Table of contents

List of tables

List of figures

Chapter 1

1.0. General introduction and literature review

Rapid migration of people to the urban areas of developing countries resulted in a shortage of housing and the location of people in poor housing and unhealthy environments. The United Nations Human Settlements Program (UN-HABITAT) estimates that 600 million urban dwellers, and one billion rural dwellers in developing countries live in unsafe housing with poor water quality, a lack of sanitation, inadequate garbage collection and overcrowding (Brown, 2003). About 30-60% of urban residents in Africa live in slums and squatter settlements without basic infrastructure (United Nations Centre for Human Settlements, 2001). The South African Department of Housing estimated a backlog of about two million units in 1997 (National Department of Housing, 2003). This figure continues to grow by about 204 000 every year because of increasing human population growth and in-migration (National Department of Housing, 2003). A survey conducted in one suburb of Johannesburg showed that up to eight people were living in a bachelor flat and about 72 people living in dwellings designed for single households (Mathee and von Schnirnding, 1994). The number of households in informal settlements in Johannesburg grew by 31% from over 1 million in 1996 to nearly 1.4 million in 2001 (Knight, 2004).

Dwellings in informal settlements are often constructed with cardboard, wood and galvanized sheeting, and are poorly maintained (i.e. with cracks and leaking water pipes). Houses in informal settlements are unsafe, with increased risk of environmental hazards that include biological and chemical exposures, inadequate ventilation, overcrowding and concomitant risk of a range of ill health outcomes (e.g. tuberculosis).

Exposure to unhealthy environmental conditions is believed to contribute to about 25% of ill health, particularly acute respiratory diseases such as bronchitis, asthma and tuberculosis (WHO, 1999). A report from India showed that respiratory disorders were mainly due to unfavorable housing and living conditions (Agnihotram, 2005). Respiratory diseases have been shown to contribute up to 6% of the global burden of mortality (WHO, 1999), and indoor air pollution is associated with around 60% of the global burden of respiratory disease (WHO, 2002). Currently, 80 million people suffer from moderate to severe chronic obstructive respiratory diseases; 300 million from asthma and millions of others from mild chronic obstructive disease (WHO, 2006). It is also estimated that in 2005 globally, about four million people died from chronic respiratory disease (WHO, 2006). Globally, two billion people are infected with tuberculosiskills about two million people a year with 95% of cases and 99% of all the deaths coming from developing countries (Dye *et al*., 1999).

1.1. Literature review

1.1.1. Housing and prevalence of respiratory disease in South Africa

In South Africa approximately 61% of the population live in formal housing, for example flats, townhouses and retirement houses, while 14% (one million people) live in informal houses usually located in sprawling settlements or in backyards (Beall *et al*., 2000).

In Johannesburg about 71% of households live in formal houses, while the rest live in informal houses (Beall *et al*., 2000). Housing shortages and poor construction expose people to numerous determinants of respiratory diseases, such as biological organisms and spores, as well as chemical substances (Bendahmane, 1997).

In South Africa, respiratory disease as a group, with the exception of tuberculosis, was ranked as the seventh most important cause of Disability Adjusted Life Years (DALYs) (4.7%) in 2000 (Bradshaw *et al*., 2003). Furthermore, chronic obstructive diseases accounts for almost one-third of healthcare utilization at the primary care level. A study done by the International Study of Asthma and Allergy in Childhood (ISAAC) using self reported symptoms found a prevalence of asthma of 13% in South African children aged 13 to 14 years, compared to a global average of 11% or an African average of 9% (ISAAC, 1998). Furthermore, the asthma case fatality rate in South Africa is reported as being the fifth highest in the world at 18.5 per 100 000 asthmatics (Masoli *et al*., 2003).

South Africa has one of the highest incidence rates for tuberculosis worldwide (558 per 100,000) (WHO, 2004). According to the Health Systems Trust (2003), the tuberculosis incidence rate has increased due to the worsening of HIV epidemic with the number of cases of tuberculosis more than doubling since 1996 (Department of Health's National TB Control Program, 2003). Furthermore, a WHO report on anti-tuberculosis drug resistance revealed that in South Africa 55% of patients with smear-positive or culture-positive tuberculosis are also HIV positive. Tuberculosis associated with HIV is the number one cause of mortality in the country (WHO, 2004; Statistics South Africa, 2003).

1.1.2. Biological exposure

Biological exposure is defined as exposure to pathogenic organisms such as pests, moulds and cockroaches. Poorly constructed and designed dwellings offer breeding environments for house moulds, pests and micro-organisms. Some houses have leaking pipes, are built from materials vulnerable to moisture damage and may have poorly maintained furniture and dusty floors which provide favorable environments for pathogens to thrive. In a case-control study to assess the link between asthma and dampness 102 patients aged 5 to 14 years diagnosed with asthma, and matched controls, were recruited. The findings demonstrated that asthmatic patients were twice as likely to live in damp houses (Williamson *et al*., 1997). In addition, there was a dose-response relationship with asthma severity (Williamson *et al*., 1997). A range of further studies provide evidence for an association between respiratory symptoms and damp housing (Iversen *et al,* 1990; Strachan *et al*., 1990; Lindfors *et al*., 1995).

Exposure to pathogenic organisms found in households such as cockroaches, moths and flies may trigger asthmatic responses in sensitive individuals (NIEHS, 2006). Community-based studies in rural India revealed that rural children between the ages of 6 and 12 years suffered symptoms suggestive of asthma with the major causative agents implicated being animal epithelia, dust mite allergens and fungal spores (IIPS, 1999). In the Netherlands, Van Strien (1994) found a positive correlation between house dust mite allergens and the type and age of the house, as well as the number of occupants.

1.1.3. Chemical and physical exposure

Furnishings, carpets, wallpapers, pesticides and other items emit organic compounds such as diisocyanates, organic acid anhydrides, styrene, hydroquinone and formaldehyde that increase respiratory diseases (Becher *et al.,* 1996, Pickles, 2005). For example, a study by Pickles (2005) revealed that persistent wheezing in children 3 to 5 years of age was associated with prenatal exposure to domestic chemicals.

The use of the home as a working place, for example, hairdressing, may predispose occupants to exposure to hazardous chemical substances (Mournier-Geyssant, 2006). Hairdressing products, hair dyes and bleaches contain chemicals which are airway irritants and may induce impairment of lung function resulting in chronic bronchitis. Mournier-Geyssant *et al.* (2006) revealed that hairdressers were at increased risk of asthma due to repeated exposure to chemical products used in hairdressing salons and other allergens.

1.1.4. Exposure to indoor pollution

Volatile organic compounds (VOCs) are organic compounds released into the air from furnishing, building materials, stoves and heating places. VOCs release gases (SO_2, NO_2) which have higher concentrations indoors than outdoors. Most indoor pollutants are from exposure to environmental tobacco smoke, and volatile organic compounds from fuels used in domestic cooking and heating. Some indoor air pollutants have been reported to have an effect on host defense systems or respiratory infections. They also may potentially increase the severity of respiratory diseases and ultimately increase morbidity and mortality. For example, nitrogen dioxide (NO_2) has an effect (i.e. reduces resistance to respiratory infections) on the mucocilliary apparatus, humoral and cellular immunity of people. Sulfur dioxide (SO_2) and other gases were reported to reduce human host defenses against microbial agents and respiratory tract inflammation (Canadian Public Health Association, 1997). Such activities lead to the emission of various types of gases (e.g. [1]sulfur dioxide (SO_2), [2]nitrogen dioxide (NO_2), and carbon monoxide [3]etc.) that may cause indoor pollution. It is reported that about half of the households in developing countries use unprocessed solid fuel for cooking, despite the fact that burning of fossil fuel, wood, and plant material can emit toxic inorganic and organic gases (Smith *et al.*, 2000).

---

[1] Sulfur dioxide (SO_2) is released primarily from burning fuels that contain sulfur (like coal, oil and diesel fuel). Sulfur dioxide reduces respiratory volume, and increases breathing resistance in those exposed, especially asthmatics.

[2] The major mechanism for the formation of nitrogen dioxide (NO_2) in the atmosphere is the oxidation of nitric oxide (NO), which is produced by most combustion processes. Nitrogen dioxide has been shown to irritate lung tissue, cause bronchitis and pneumonia, and reduce resistance to respiratory infections.

[3] Carbon monoxide is an invisible odorless, tasteless gas produced by incomplete combustion of carbon containing fuel. Sources of carbon monoxide include poorly vented furnaces, stoves, and cigarette smoke. Carbon monoxide reduces the amount of oxygen that is delivered to organs and tissues.

Al-Habshi (2006) singled out air pollution (indoor and outdoor air pollution) as a major environment-related health threat and risk factor for both acute and chronic respiratory disease. According to the World Health Organization Report “Making the Difference” of 1999, an estimated 36% of all lower respiratory infections and 22% of chronic obstructive diseases in the world were caused by indoor air pollution (WHO, 2002). The report showed further that indoor air pollution is responsible for the deaths of two million people every year- that is one death every second (WHO, 2005).

1.1.4a. Exposure to tobacco smoke

There are two sources of tobacco smoke (i.e. the sidestream[4] and the mainstream smoke[5]). Sidestream smoke emits a higher concentration of carcinogens than mainstream smoke. Passive smokers are more likely to inhale sidestream smoke and are at greater risk of exposure to associated carcinogens. According to Angle (1988), several studies have demonstrated that prevalence of respiratory diseases among school-aged children increased as the number of smokers in the household increased. He also pointed out that some studies have shown an increase in bronchitis and pneumonia in the first two years of life among children whose parents are smokers.

A study in America as stated by Maier *et al* (1997) as well as a systematic review and meta-analysis of epidemiological studies from 1950 to 2006 (Lin *et al*., 2007), revealed

[4] Sidestream smoke is emitted from burning end of lit cigarettes.
[5] Mainstream smoke is inhaled into the smoker’s lungs and exhaled.

that prevalence of asthma was high among children who lived with one or more smokers in the households. These results were consistent in all studies (Lin *et al.*, 2007).

1.1.4b Exposure to biomass fuels

Studies conducted on children in South Africa, Gambia, Zimbabwe, Argentina, Nepal, India and Brazil showed increased (from moderate to severe) episodes of acute respiratory disease per child with increased time spent near the stove (Bendahmane, 1997). In South Africa children living in homes with wood stoves are five times more likely to develop respiratory infections than those in homes without (WRI, 2005), while in Gambia children carried by their mothers as they cooked with smoky stoves were more likely to develop respiratory disease than unexposed children (World Resources Institute, 2005). In Tanzania children under five years of age who died from respiratory diseases were three times more likely to have been sleeping with an open cooking stove in their houses or rooms (World Resources Institute, 2005). A World Health Organisation Division of Child Health and Development review of ten studies examining the association between acute respiratory infections and exposure to indoor air pollution also showed a positive correlation between acute respiratory infection and exposure to indoor air pollution (Bruce *et al*., 2002).

In four Chinese cross sectional studies, 7 058 children were recruited to examine associations between respiratory health outcomes and multiple household risk factors. The results showed that higher exposure to heating coal smoke was associated with higher reporting of cough with phlegm, wheeze and asthma (Qian *et al.,* 2004). The study was carried out in two rural villages, the first where cooking was undertaken indoors, whereas in the second cooking was undertaken outdoors. The prevalence of chronic bronchitis in the two rural villages was 22% and 13% for indoor and outdoor cooking respectively (Albalak *et al*, 1999).

1.1.5. Overcrowding

Crowding may be defined, for example, as the number of households with less than one room per person, or the number of households with less than fourteen square meters available space per person (WHO, 2004). In crowded and poorly ventilated rooms where people are sneezing, coughing or simply talking, there can be an increase in the transmission of respiratory infections through the air by droplets or aerosols. For example, the incidence of pneumonia increased as the number of persons in the household increased, even after controlling for the socio-economic conditions of the families (Victora, 1994). There was also a reported increase in acute respiratory infections in Kenyan children with more than five siblings (Ballard and Neumann, 1995) relative to smaller households. Furthermore, Gupta and Singh (1999) found that crowding, insanitary conditions, and low economic status were among the factors leading to increased prevalence of acute respiratory infections in children under five years of age in a year-long house survey carried out in ten slum colonies of Delhi (India).

1.2. Definition of terms

Household is defined as group of persons who live together, and provide themselves jointly with food and/or other essentials for living, or a single person who lives alone

Dwelling: Any structure intended or used for human habitation.

Health: is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO definition, 1948).

Asthma: The definition of asthma includes bronchial hyper-responsiveness, airway inflammation, and the presence of airflow obstruction, which may be relieved spontaneously or with medication.

Environmental impact assessment (EIA) is a tool that is widely used to either prevent or minimize the environmental impact associated with various activities and to promote sustainable development.

Emphysema/Chronic bronchitis: is among a group of diseases known as chronic obstructive lung disease (COPD), characterized by obstruction to airflow that interferes with normal breathing. Emphysema and chronic bronchitis frequently co-exist, and are then usually referred to as COPD

Immunoglobulin E: a class of immunoglobulins that includes the antibodies elicited by an allergic substance (allergen).

1.3. Justification of the study

A healthy human population is essential for the economic growth and development of a nation. Poor and overcrowded houses are associated with a high prevalence of respiratory diseases, resulting in poor and unhealthy households and loss of income by those already deprived. South African mortality data indicate that in 1990 acute respiratory and chronic obstructive diseases accounted for 4% of all the deaths (Louw, 1995). But the burden of chronic obstructive diseases in Johannesburg is not well documented. Understanding the causes of poor health in the population, and finding preventive measures, can go a long way toward preventing economic loss due to time away from work and resources used in treating the sick. This study will determine the prevalence of respiratory diseases among members of households from five low cost housing settlements in Johannesburg. The relationship between housing factors and respiratory symptoms will also be explored. The information generated will be useful to the Health Department of the City of Johannesburg and policymakers in planning and implementation of health and housing programmes.

1.4. Research Question

In order to answer the above objectives this study poses the following research question:

Is there an association between selected housing-related factors and the prevalence of respiratory diseases?

1.4.1. Broad Objective

The broad objective of this study was to investigate the influence of housing factors on the respiratory health status of members of households in low cost housing settlements in Johannesburg, South Africa.

1.4.2. Specific objectives

- To describe the distribution of selected respiratory–related housing risk factors in the study sample overall, and by study sites;
- To describe the prevalence of selected respiratory ill heath conditions across the study sites;
- To examine the relationship between housing-related risk factors and selected respiratory factors.

Chapter 2

2.0. Methodology

2.1. Study design

This specific study is nested within the Health, Environment and Development (HEAD) study. The objective of the HEAD study is to conduct annual surveys of living conditions and health status in five different low-income Johannesburg housing settlements over a five-year period. The HEAD project is a panel study, with cross-sectional surveys being conducted at the same sites each year.

2.1.1. Description of study area

The City of Johannesburg covers an area of 1 644 square kilometres, and is at an altitude of 1 753 metres (6 000 feet) above sea level. It is amongst the largest cities in Africa, with a landscape surrounded by gold mining dumps (http://www.joburg-archive.co.za). The climate has an average temperature of 22.4 degrees Celsius in summer and an average rainfall of 710 mm per year. According to a census conducted in 2001, the population of Johannesburg was 3.2 million people clustered into 1 006 239 households (ibid). Air pollution caused by dust from mine dumps, industry, emissions from motor vehicles and from the use of solid fuel are some of the key environmental problems in Johannesburg (Department of Agriculture, Conservation, and Environment, 2004).

2.1.2. Study Sites

The study population was household members from 584 households in Hospital Hill/Sweetwater (two informal settlements on the western boundary of the City of Johannesburg) Riverlea Extension 1 (a degraded, old apartheid-era township), Braamfisherville (RDP housing), Bertrams (an area of standard, mixed development inner city housing), and Berea/Hillbrow (a high rise inner city area).

Housing in Hospital and Sweetwater comprises mainly shacks, and only communal services such as sanitation, electricity and water are available. Riverlea is a suburb located to the south-west of central Johannesburg, and is surrounded by a number of industries and mine dumps. Demographic data showed that 91% of the population group were Coloured (Statistics South Africa, 1998), and that most of the dwellings were dilapidated, with only two bedrooms and small yards.

Braamfisherville is a relatively new housing settlement, constructed under the umbrella of the Reconstruction and Development Programme (RDP). The RDP aims to deliver low cost housing for those in need. Bertrams is an area of standard, mixed development (commercial and residential) inner city housing. The area has undergone a process of degeneration over the past two decades, but is expected to be regenerated as part of preparations for the World Cup 2010 soccer tournament. Hillbrow is a densely populated high-rise area in the inner-city of Johannesburg. About 65 000 people live in the suburb and are accommodated in around 28 000 dwelling units (Crankshaw and White, 1992). A Human Sciences Research Council survey put the average number of persons per unit at

2.3 in Hillbrow and Berea (Adler, 1994). The housing in this area consists predominantly of high rise apartment buildings.

2.1.3. Sampling Procedure

The selection of dwellings was undertaken using a map and housing a list obtained from Johannesburg's Planning Department. Within each of the five sites the first household was randomly selected, and thereafter every second household was included in the study. In Hillbrow apartment buildings for inclusion in the study were randomly selected. The procedure was repeated for the selection of floor within apartment buildings and for the selection of apartment on any particular floor. For informal settlements, a list of dwellings was not available; hence the starting point was randomly selected from a map, from there onwards every second house was included in the study. Around 50% of households in the selected sites were therefore sampled. In total, 625 dwellings were visited, with 584 households agreeing to participate, resulting in a response rate of 93%.

2.1.4. Data collection

Secondary data, collected in 2005 during the pilot phase of the HEAD study, were used. The data were collected using pre-structured questionnaires administered to suitable respondents in each household, and the responses recorded. The questionnaire was designed to collect information on demographics (e.g. living conditions of dwelling, socio-economic status, race), exposure variables (e.g. energy used for cooking, presence of pests, pesticide use, tobacco smoke), and outcome variables (e.g. self reported respiratory diagnosis of household members). The use of biomass fuels for cooking and heating was used as a proxy for exposure to indoor air pollution.

2.1.4a. Exposure variables

Household characteristics obtained from the questionnaire included crowding, energy used for cooking, presence of pests, pesticide use, tobacco smoke and house characteristics (e.g. type of floor, dampness, type of roof materials).

2.1.4b. Outcome variables

Outcome variables were respondents' reports of members of the household being affected by asthma, emphysema/chronic bronchitis and tuberculosis (12-month recall period).

2.1.4c. Confounders

The study had the following potential confounders; age, race and socio-economic status. Younger children and elderly people living in poor housing facilities are likely to be more vulnerable to pollution exposure as they spend more time indoors. Hence prevalence of respiratory diseases will be higher among children and elderly people living under poor housing conditions.

It is also thought that among the South African population there are economic differences related to population group. Thus certain population groups are thought to be less economically endowed than others. As a result, they live in houses often overcrowded and with poor sanitation, thus exposing them to various environmental hazards. These groups are likely to have poor nutrition and have limited access to medical treatment, making them more vulnerable to respiratory and other diseases. It is therefore expected that race, socio-economic status and age will interact among themselves, and with exposure variables, to influence the prevalence of respiratory diseases among the population.

2.2. Data processing and data analysis

Data were cleaned of inconsistencies. Descriptive statistics were calculated, prevalence of reported respiratory diseases between study sites and crude odds ratios, adjusted odds ratios (OR) and 95% confidence intervals was calculated. Household was the unit of analysis when assessing the prevalence of reported respiratory illnesses and housing factors.

Logistic univariate analyses was employed to find associations between biological, chemical and physical characteristics of housing and respiratory outcomes. Crude odds ratios, adjusted odds ratios (OR) and 95% confidence intervals were calculated. All statistical tests were two-sided. A P-value of < 0.05 was considered statistically significant. In addition a multivariate logistic analysis was constructed for the variables that show statistical significance in the prediction of respiratory diseases in the univariate analysis (p value <0.05). All the statistical analyses were performed using STATA version 9 (Stata Corporation, 2005).

2.3. Limitations of the study

This study has limitations in that it employed a cross-sectional design, making it difficult to measure temporal relationships between the exposure and outcome variables. In other words, data on risk factors and outcome variables were collected simultaneously. It was also very difficult to measure housing quality (leakage, mould, dampness).

The reliance on self reported data might have introduced bias, such as recall bias. For example, a respondent with a current disease was more likely to remember an exposure than asymptomatic respondents. Misclassification of an individual as having the outcome of interest might have occurred due to reliance on self reported diagnosis.

The data were collected as a household survey, and information on the individuals was not available; this could have had an effect on the result of diseases such as tuberculosis which depend on sex and age. Finally, this study does not provide information on the impact of Acquired Immunodeficiency Disease (AIDS)/human immunodeficiency virus (HIV) in respect of households or individuals. Yet, HIV is a major contributing risk factor of infection such as tuberculosis and other infectious respiratory diseases.

Chapter 3

3.0. Results

This chapter outlines the main results from the analysis of the study, including dwelling characteristics, and factors associated with the prevalence of respiratory diseases.

3.1. Descriptive characteristics

3.1.1. Demographic characteristics of households

The characteristics of households in the survey (by suburb and overall) are summarized in Table 1**.** A total of 584 households were surveyed. Overall, the mean number of people per household was five, with household size ranging from 1 to 22 people. Bertrams had the highest number of people living in one dwelling (22), with a mean of six people per dwelling.

Black African households comprised 77% of the total number of households in the study (see Table 1). The majority of households in Riverlea were Coloured (92%). Most of the households (48%) had an average monthly income of R1001 to R2000 and most dwellings used flush toilets (76%). All dwellings in informal settlements used pit latrines.

TABLE 1: Demographic characteristics of households in five Johannesburg settlements, South Africa, 2005 (overall and by site/suburb).

Suburb (total no of households)	Informal (125)	Riverlea (110)	Braamfischerville (122)	Bertrams (109)	Hillbrow (118)	Overall (584)
Proportion of Population group (%)						
Coloured	1	92	1	13	0	20
Black African	99	8	99	74	99	77
White	0	0	0	9	1	2
Indian	0	0	0	3	0	1
Number of people/households						
Mean	4	6	4	6	4	5
Max	12	13	10	22	17	22
Average monthly income%						
no income	0	2	2	4	3	2
<R1000	15	6	7	1	2	7
R1001 to R2000	70	52	64	32	15	48
R2001 to R5000	12	25	17	34	43	25
R5001 to R10000	3	13	8	24	27	15
>R10000	0	2	2	6	11	3
Type of working toilet %						
Flush	0	95	100	90	99	76
Pit latrine	100	2	0	3	0	23
Communal toilet	0	3	0	3	0	1
other	0	0	0	3	1	0

Apart from the informal settlements (95% of households used paraffin for cooking), most households (71%) used electricity as their main cooking fuel (Table 2). A total of 89% of the roof material in informal dwellings were corrugated iron, and 66% and 78% of roof materials in Riverlea and Braamfisherville respectively were asbestos.

Table 2 shows the living conditions of the households in the survey. The table compares overall, and by site, percentages of variables of interest

Table 2: Distribution of living conditions of households in five Johannesburg settlements, South Africa, 2005 (overall and by site).

Suburb (total no of households)	**Informal (125)**	**Riverlea (110)**	**Braamfischerville (122)**	**Bertrams (109)**	**Hillbrow (118)**	**Overall (584)**
Floor material						
Cement	44	42	67	14	8	36
Bare earth	40	1	8	1	0	10
Tiles	5	43	12	35	45	27
Carpet	10	11	13	31	31	19
Others	1	3	0	19	16	8
Roof material						
Corrugated iron	92	28	11	69	11	42
Tiles	4	5	6	20	13	9
Plastic	2	0	0	0	0	0
Asbestos	2	66	78	4	1	30
Others	0	1	5	7	75	17
Fuel used for cooking						
Electricity	0	99	91	79	94	71
Paraffin	95	1	6	13	0	24
Gas	2	0	2	7	6	3
Coal	2	0	1	1	0	1

3.1.2. Prevalence of respiratory diseases

The prevalence of respiratory diseases is summarized in Figure 1. The self-reported household prevalence of asthma was high in Riverlea (21%). Self-reported prevalence of tuberculosis was 6% in Riverlea and 3% in the informal settlements. In contrast, the prevalence of chronic bronchitis/emphysema was approximately equally distributed across all the study sites.

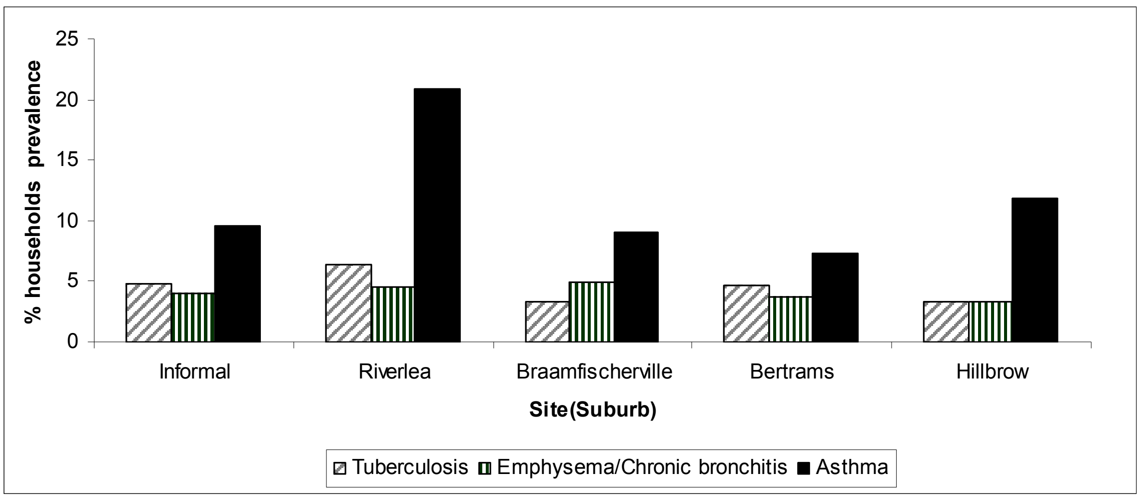

Figure 1: Prevalence of respiratory disease among households in five Johannesburg settlements, South Africa, 2005 (by site/suburbs).

3.2. Logistic regression

3.2.1. Univariate analysis of factors associated with respiratory diseases

Univariate analyses were conducted to show associations between different housing characteristics and respiratory diseases. Table 3 gives a summary of univariate analyses of the factors associated with respiratory diseases. The odds ratios and 95% confidence intervals were calculated for each variable of interest.

There was no significant association between cockroaches and respiratory disease. However presence of mould was significantly associated with reporting of tuberculosis. There was no significant association between fuel used for heating or cooking and respiratory disease, or with wall and roof materials of the dwellings. There was no significant association between other sources of chemical and physical exposure (pesticide, paraffin, coal) and respiratory diseases

Occupational activities inside the dwelling (hairdressing) was significantly associated with asthma, as was smoking and household size with households reporting of asthma and tuberculosis. A multivariate analysis was conducted and variables of significance (p value < 0.05) were included in a stepwise multivariate model.

Table 3: Odds ratios for characteristics of households related to respiratory disease (univariate analysis) in five Johannesburg settlements, South Africa, 2005.

Variable	Asthma OR (95% CI)	Tuberculosis OR (95% CI)	Emphysema/Chronic bronchitis OR (95% CI)
Biological characteristics			
Flies	1.7 (1.02 – 2.83)	1.7 (0.76 – 3.68)	0.9 (0.39 – 2.25)
Bedbug	1.6 (0.79 – 3.20)	1.9 (0.69 – 5.23)	1.0 (0.32 – 3.82)
Cockroaches	1.7 (0.90 – 3.24)	0.9 (0.36 – 2.01)	1.5 (0.54 – 4.03)
Chemical characteristics			
pesticides	0.9 (0.79 – 1.15)	1.2 (0.89 – 1.60)	1.2 (0.88 – 0.61)
Hairdressing	*2.9 (1.52 – 5.8)	0.4 (0.25 – 1.61)	0.9 (0.27 – 3.35)
Fuel used for heating			
paraffin	1.4 (0.58 – 3.49)	1.5 (0.33 – 6.66)	1.6 (0.36 – 7.09)
wood	0.7 (0.25 – 1.91)	0.4 (0.10 – 2.15)	0.4 (0.12 – 1.59)
Coal	3.3 (0.43 – 25.23	1.1 (0.14 – 8.58)	-
Don't heat	1.2 (0.61 – 2.19)	1.4 (0.47 – 4.42)	2.1 (0.59 – 7.23)
Cook appliance			
Paraffin	1.4 (0.73 – 2.64)	0.7 (0.30 – 1.69)	1.6 (0.55 – 4.95)
Gas	0.8 (0.22 – 2.80)	0.8 (0.10 – 6.42)	-
Physical characteristics			
Described cracks in wall	*0.7 (0.50 – 0.94)	0.4 (0.22 – 0.58)	1.0 (0.58 – 1.74)
Floor material			
Bare earth	0.8 (0.60 – 1.07)	1.2 (0.32 – 4.34)	1.2 (0.24 – 5.71)
Tiles	1.0 (0.41 – 2.46)	1.2 (0.46 – 2.92)	0.8 (0.28 – 2.07)
carpet	1.7 (0.72 – 3.84)	2.2 (0.60 – 7.91)	1.4 (0.37 – 5.49)
Other	0.9 (0.32 – 2.21)	-	0.6 (0.14 – 2.19)
Roof material			
Tiles	1.3 (0.49 – 3.60)	0.6 (0.15 – 2.26)	0.6 (0.15 – 2.26)
Asbestos	0.8 (0.47 – 1.50)	0.6 (0.21 – 1.44)	0.6 (0.21 – 1.43)
Other (specify	1.3 (0.58 - 2.57)	1.1 (0.29 – 4.33)	1.1 (0.29 – 4.33)
Income			
R2001 to R 5000	0.6 (0.28 – 1.44)	4.8 (0.59 – 3.89)	1.0 (0.28 – 3.53)
R5001 to R 10,000	0.9 (0.45 – 1.65)	1.2 (0.52 – 3.02)	1.7 (0.62 – 4.43)
Number of people smoking cigarettes			
1 person	0.9 (0.50 – 1.70)	*0.4 (0.12 – 0.96)	1.3 (0.49 – 3.20)
2 people	0.9 (0.40 – 1.86)	*0.3 (0.09 – 0.95)	2.1 (0.46 – 9.46)
Household size	*0.9 (0.83 – 0.98)	*0.9 (0.79 – 0.99)	1.0 (0.87 – 1.19)

***Significant at p value<0.05**

3.2.2. Multivariate analysis of factors associated with respiratory diseases

Multivariate analysis was conducted and variables which showed a statistically significant association between housing characteristics and respiratory diseases were included in the model. The variables that did not show significant associations at a p value of <0.05 were dropped from the model. Table 4 shows variables that show significant associations with respiratory diseases, together with the corresponding odds ratios and 95% confidence intervals.

Certain kinds of work, when undertaken indoors, results in the emission of chemical pollutants. In this survey, 10% of households had hairdressing activities inside their dwellings. In the multivariate analysis households with hairdressing activities inside the dwelling were at an increased risk of asthma by 29% (OR: 2.9, 95% CI 1.46-5.73) more than households without hairdressing activities inside the dwelling (Table 4).

Households that reported having problems with fungus or mould on the walls inside the dwelling had an increased risk of reporting tuberculosis by 60% (Table 4). Households in Riverlea had reported higher levels of asthma (33%) relative to households in Bertrams. Households in other sites reported increased risk of asthma relative to Bertrams but not statistically significantly different from Bertrams (see Table 4 below).

Table 4: Odds ratios for characteristics of households related to respiratory disease (multivariate analysis) in five Johannesburg settlements, South Africa, 2005.

Respiratory diseases	Variable	OR (95% CI)
Asthma	**Number of people/household**	0.9 (0.82 – 0.99) ns
	Hairdressing at home	2.9 (1.45 – 5.76)**
	Crack in walls	1.06 (0.77 – 1.48) ns
	Number of people smoking cigarretes	
	1 person	0.98 (0.52 – 1.85) ns
	2 persons	1.55 (0.64 – 3.74) ns
	***Suburb** [6]	
	Informal	1.3 (0.53 – 3.41) ns
	Riverlea	3.3 (1.42 – 7.84)**
	Braamfischerville	1.3 (0.48 – 3.23) ns
	Hillbrow	1.7 (0.68 – 4.22) ns
Tuberculosis	**mould**	0.4 (0.22 – 0.60)**
	Number of people/household	0.92 (0.80 – 1.05)ns
	Number of people smoking cigarettes	
	1 person	0.03 (0.12 – 1.00) ns
	2 people	0.37 (0.11 – 1.25) ns

6 ***Reference being Bertrams suburb (low prevalence of household asthma)**

**** significant at p value<0.05**
ns not significant p value >0.05

Chapter 4

4.0. Discussion

Studies that investigate housing-related factors and health face challenges of methodological quality. The current survey for example, utilized a cross-sectional approach to assess the outcome and exposure variables. Some of the housing variables were not associated with respiratory diseases. This may have resulted from a small number of data collected on some variables, thereby resulting in inconclusive findings. However, some variables were related to respiratory diseases. The study was cross sectional and therefore could only provide evidence of a link between respiratory health and housing.

4.1. Living conditions

The living conditions in the study vary between the study sites in respect of the number of people who live in the household, roof materials and fuel used for cooking and/or heating. In Bertrams and Hillbrow, maximums of 22 and 17 people respectively lived in one dwelling. The high number of people in households may increase the risk and transmission of respiratory diseases.

All households in the informal settlements used paraffin as their main cooking and/or heating fuel. Many studies have shown an increase in respiratory symptoms in households using biomass fuels such as paraffin and coal (Bruce *et al*., 2002, Qian *et al.,* 2004, WRI, 2005). In this study, the analysis of the association between living conditions and respiratory diseases was done at the level of household.

The roof materials of the households in Braamfisherville (78%) and Riverlea (66%) were made of asbestos. Asbestos is a common, naturally occurring group of fibrous minerals once widely used in a variety of building materials. Intact or sealed asbestos materials are not hazardous but asbestos materials can be disturbed when remodeling. If disturbed, asbestos releases fibres that can lead to a variety of respiratory diseases including asbestosis, lung cancer, and mesothelioma (cancer of the lung lining). Asbestos-related lung cancer tends to result from substantial long-term exposure; however, mesothelioma may result from much smaller exposures to asbestos (Hodgson *et al*., 1988, Stayner *et al.,* 1997). Although there was no significant association between asbestos and respiratory diseases in this study, the use of asbestos still predisposes households to respiratory ill health over an extended period.

4.2. Prevalence of respiratory diseases

In the pilot phase of the HEAD study, the main outcome was respiratory diseases. The outcomes studied were asthma, emphysema/chronic bronchitis, and tuberculosis. Chronic obstructive respiratory disease and asthma lack standard definitions; therefore it is very difficult to compare these diseases across different studies (Ehrlich *et al.*, 2004). Most epidemiological studies indicate that it is very difficult to distinguish between asthma and emphysema/chronic bronchitis especially in adult and older people because they both present similar symptoms such as wheezing.

4.2.1. Prevalence of emphysema/chronic bronchitis

In South Africa, the prevalence of asthma and chronic obstructive diseases, reflect the society's high levels of industrialization, persistence rates of infections, and high rates of smoking in some populations. In this study, the overall household prevalence of emphysema was 3.4%. This is higher compared to a national survey done in 2004 in which the prevalence of obstructive lung disease was 1.5% and 1.9% among males and females respectively. The prevalence between the ages of 13-44 years were 4.2% and 4.3% in older age groups (>44 years) in males and females respectively.

In the current survey, there was no significant association between housing factors and emphysema/chronic bronchitis. These results may be due to the fact that the data were collected as survey data and the unit of measurement was the household, and respiratory data were not available in respect to individuals. In addition, it is difficult to measure asthma by asking a question "*have you ever experienced wheezing in last 12 months*" in adult studies because the prevalence of wheezing declines with age.

4.2.2. Prevalence of asthma

The household prevalence of asthma was high among households living in Riverlea (21%). The multivariate analysis reported 33% more of asthma in Riverlea than Bertrams. In contrast, the prevalence of asthma in South Africa was between 13% and 14% (Ehrlich *et al.,* 2004). The high prevalence of asthma in this area may be due to the location of Riverlea in close proximity to an industrial area, which is surrounded by gold mine dumps; another possible source of outdoor pollution. It has been shown that industrial processes are major sources of harmful pollutants that include particulate matter[7], sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) which have negative effects on the respiratory system. A Gauteng Provincial Government Report on air quality points out that the operational mining dumps, operate tailings dams and waste rock dumps which are sources of pollutants in the areas where they occur (www.environment.gov.za). These results were consistent with the studies done in a localised industrial areas of Durban and Cape Town which showed an increased prevalence of asthma among households living near industrial areas (White *et al*., 2004; Poyser *et al*., 2002). Furthermore, a number of studies have found an elevated prevalence of respiratory diseases and infection in communities with high levels of air pollution (Nriagu *et al*., 1999, Aligne *et al.,* 2000).

[7] particulate matter is a dispersed mixture of: (a) the heavier, coarse-sized solid or liquid particles that are derived mainly from naturally occurring sources, such as wind-blown dust, sea sprays, plant particles, etc., and (b) the lighter, fine particulate fraction (aerodynamic diameters less than 2.5 micrometers in size), which is principally a product of human activity, such as industrial processing and fossil fuel combustion. Fine particles are small enough to evade the respiratory system's clearance mechanism for removing coarser particles, allowing them to penetrate and deposit into the deeper (alveolar) regions of the lung.

Hairdressing activities inside the dwellings may also contribute to the observed high prevalence of asthma in Riverlea.

4.2.3. Prevalence of tuberculosis

Household prevalence of tuberculosis (TB) in the current survey was 4.5%. The prevalence may be underestimated because it relies on active case findings. The diagnosis of tuberculosis relied on household members' report on diagnosis of tuberculosis and whether a patient is on treatment for tuberculosis. Pronyk *et. al* (2001), indicated in a study done in rural South Africa that, using active case finding ,for every nine cases of sputum-positive pulmonary TB (PTB) currently on treatment, two undiagnosed prevalent cases reside in the community.

Moreover, it is estimated that 55% of tuberculosis patients in South Africa are also HIV positive (Department of Health's National TB Control Program, 2003). It has been shown that there is a delay of case finding in TB patients co-infected with HIV due to sub-clinical presentation, sputum negative result and negative chest x-ray (Grange, 1999). The nature of the current study design did not take into account variables such as HIV infection, lack of such variables may confound the results seen. However, the current study gives a snapshot of the burden of the disease in the surveyed sites

The other reason for possible underestimating prevalence of tuberculosis among households is stigma among those with disease. Baral *et al* (2007) showed that patients suffering from tuberculosis are stigmatized and socially isolated by family and friends.

Furthermore, studies have shown some patients diagnosed with tuberculosis are forced to eat and sleep alone (Hurtig *et al. 1999,* Johansson *et al*., 1999). Ultimately, patients on treatment or with active tuberculosis do not disclose their status to the household members.

4.3. Association between housing risk factors and respiratory diseases

4.3.1. Exposure to smoking inside the dwelling

Tobacco and cigarette smoking emits sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). These compounds impair phagocyte functioning of the lower respiratory system and thus reduce immunity. A systematic review of 33 papers indicated that passive smoking (second hand smoking) and smoking were associated with an increased risk of tuberculosis. The review further revealed that compared to non-smokers, smokers had an increased risk of having active tuberculosis and testing positive on tuberculin skin test (Lin *et al.,* 2007).

A study by Richards *et al* (1996), found an association between maternal smoking and a range of upper and lower respiratory diseases among adolescents in the Vaal triangle. Another cross sectional study found that there was association between asthma/wheezing and nicotine found in the urine of school children and the smokers in the household (Jordaan *et al*., 1999).

Results from this study showed an association between the number of people smoking inside the dwelling and increased risk of reported tuberculosis in univariate analysis. However, in the multivariate analysis, there was no association between the number of people who smoked in the house and tuberculosis; this may be due to confounding factors. In addition, there was no association between asthma and the number of people who smoked; this may be due to a small sample size of the households surveyed.

4.3.2. Exposure to hairdressing activities

The study revealed that using the home as a working place had a significant impact on the health of the household members. In a survey done by Surveillance of Work-Related and Occupational Respiratory Diseases in South Africa (SORDSA) reported 324 cases of occupational asthma, a national incidence of 17.5 million per employed person in South Africa between 1997-1999 (Esterhuizen *et al.,* 2001).

In this study, 10% of household members used their dwellings as working places (hairdressing activities). Hairdressing products use a wide variety of chemicals (toluene, ethanol, isopranol, diaminotoluene); that act as airway irritants (Gagliadi *et al*., 1992, van Muiswinkel *et al.*, 1997). In addition, hair bleaches contain persulphate salts (sodium and potasium persulphate) which cause respiratory symptoms, allergic dermatitis and urticaria among hairdressers and workers in the chemical industry (Leino *et al.,* 1997, Brown, 1989). Hairdressing at home was associated with increased reporting of asthma in households. These results were consistent with many studies which showed significant associations between hairdressing and development of occupational asthma (Ammeille et al., 2003, Malo et al., 2001, Kopferschmitt-Kubler et al., 2002).

4.3.3. Exposure to fuel used for cooking and heating

Use of biomass fuel (mainly wood, charcoal, animal dump) for cooking or heating can lead to exposure to noxious gases that are harmful to health. Also, there is a danger of increased indoor air pollutants especially when the fuel is burnt in an open flame and poorly functioning stoves.

In the current survey there was no significant association between type of fuel used for cooking or heating and respiratory symptoms. It has been documented that half of South African households use solid or liquid fuel for cooking, which are major sources of indoor pollutants (SSA, 2003). However, in this survey most households used electricity (71%) and paraffin (24%) as their main source of fuel for heating and cooking. A study done in Seattle, United States of America, found no association between using wood stove, or kerosene and wheezing among children of 5-9 years old with diagnosed asthma, and those without physician diagnosed asthma (Maier *et al.,* 1997).

4.3.4. Exposure to mould.

Different studies have linked exposure to mould with increase in prevalence of respiratory symptoms (Richardson *et al.,* 1993, Ambrose *et al*., 1997, Strachan *et al.*, 1990). However, it is impossible to establish causation between the respiratory symptoms and visible mould and fungi in this study design. In the current study visible fungus (mould) was associated with increased risk of tuberculosis. There are no reported studies that link tuberculosis directly to mould. In the current study no objective measurements were undertaken such as measurement of relative humidity and temperature to assess dampness.

4.3.5. Exposure to cockroach allergens

Unlike many studies, there was no association between prevalence of respiratory diseases and exposure to cockroach allergens. Cockroach allergens are proteins found in cockroach droppings. Different studies have demonstrated that exposure to cockroach allergens cause asthma in susceptible individuals (Verhoeff *et al*., 1996, Rosenstreich *et al*., 1997). These studies were case control studies and employed objective and subjective measurements of cockroach allergens. In the current study only a proxy measure of exposure to cockroach allergens was used. Furthermore, the data collection, cockroach problems were missing in some sites resulting in inconclusive findings.

4.3.6. Overcrowding

Measurement of overcrowding differs across the continent, countries and communities. Also, it depends on social, economic, cultural seasonal and geographical factors (Clauson-Kaas, 1996). The WHO technical committee defines overcrowding as objective measurement (floor area or number of inhabitable rooms available per person) and subjective perception and awareness of sufficient or insufficient space for daily living (WHO, 2004).

Even though there are different measurement of overcrowding used in different epidemiological studies, such as total number of residents in the home, number of siblings, number of persons sharing a bed, room occupancy, and population density, reports from several studies still indicate associations between crowding and respiratory diseases (Victora *et al*., 1989, Cerqueiro *et a*l., 1990., Ballard *et al*,.1995).

In the current analysis there was no significant association between overcrowding and respiratory symptoms as the measurement of overcrowding was based on the perspective of the member of households on the problem of overcrowding. Similarly, Al-Khatib (2006), found no association between overcrowding, influenza and bronchial asthma (Al-Khatib *et al.*, 2006).

Chapter 5

5.0. Conclusion and recommendations

5.1. Conclusion

Based on the results obtained from the current study, there is no doubt that housing is linked to respiratory health. Nevertheless, a scientific study that directly links specific exposure factors and health may be difficult to conduct due to the following methodological, and study design issues:

First, many housing indicators are difficult to measure or costly since they need laboratory equipment (such as dampness, mould, cockroach, and indoor air quality). For that reason, further research which will use quantitative measurement as well as laboratory and experimental equipments to quantify the amount of allergens and particulate matter in dwellings are needed.

Second, surveying a small sample of population may lead to difficulties in controlling for potential confounders, and in turn may lead to difficulties in generalisation of the findings. As a result, more large scale controlled study on housing intervention which will incorporate qualitative and quantitative data is needed.

5.2. Recommendations arising from this study

The following are recommendations based on the results obtained from the study:

1. **Equip researchers with better research implementation tools**.

Researchers, especially in the developing world, need to be equipped with right monitoring equipment, facilities, and models so that they can effectively explore the influence of housing on health.

2. **Advise communities to reduce the use of products that are a source of indoor pollution.**

Even though there was no association between fuel used for cooking and heating and respiratory disease. Strategy to improve stoves used for heating and cooking by provision of vented stoves, thereby reducing carbon monoxide from biomass fuel should continued to be emphasized. Electrification of households is another s beneficial strategy of reducing indoor air pollution caused by biomass fuels.

3. Provide health education and increase awareness.

The effect of indoor pollutants must be addressed and current knowledge used effectively to educate the community on the risks of poor housing environment and health to policy makers and general public. A massive campaign through the media and other sources must be put into use to educate the public. An additional strategy is to provide education on stopping cigarette smoking inside dwellings and hence reducing the exposure of tobacco smoke.

4. Provide guidelines on healthy housing.

The use of asbestos as building material is banned in some countries due to respiratory effect. In a current study, some households had roof materials made of asbestos which increase the risk of respiratory diseases with long exposures. Integration of activities and programs among city planning, environmental professionals, policy makers, and public health professionals who may help in setting guidelines on different policies pertaining to healthy housing as well as support on construction of high quality affordable houses.

5. Improve safety at work places by preventing occupation-related hazards.

In a current study, the reported prevalence of asthma has been associated with households with hairdressing activities. Improvement of ventilation and the use of protective gears and equipment can reduce accumulation of indoor pollutants.

6. Curb industrial emissions by enforcing set policies.

Critical findings from this study show that households living near industries and gold mines (sources of outdoor pollutants) had high prevalence of respiratory diseases. Environmental policies such as environmental taxes and charges will be useful tools to harness pollution from industries.

7. Environmental Impact Assessment (EIA).

The study has shown that households living near industries and goldmines have higher prevalence of respiratory diseases. In this case, Environmental Impact Assessment should be emphasized to regulate industrial and land use activities

References:

Agnihotram, V.R. 2005. Reviewing respiratory disease burden in rural India: Household environment matters Rural and Remote health. vol 5, pp. 357. <http://rrh.deakin.edu.au> [Accessed 12th July, 2006].

Adler, T. 1994. Life in an informal settlement. Urban Forum, vol 5, no 2, pp. 99-11.

Albalak, R., Frisancho, A.R., Keeler, A.J. 1999. Domestic biomass fuel combustion and chronic bronchitis in two rural Bolivian villages. Thorax, vol 54, pp. 1004-1008.

Al-Habshi, S. 2006. Environment threatens children's health. (Editorial). Yemen Times January 5-8.; vol 14, Issue 909. <http://yementimes.com/view.shtml> [Accessed 6th July, 2006].

Al-Khatib, I.A., Tabakhna, H. 2006. Housing conditions and health in Jalazone Refugee Camp in Palestine. Eastern Mediterranean Health Journal, vol. 12, nos 1/2, pp. 1-8.

Aligne, C.A., Auinger, P., Byrd, S.R., et al. 2000. Risk factors for pediatric asthma. Am J Respir Crit Care Med, vol 162, pp. 873–877.

Ameille, J., Pauli, G., Calastreng-Crinquand, A., et al. 2003. Reported incidence of occupational asthma in France, 1996–99: the ONAP programme. Occup Environ Med, vol 60, pp. 136–141. doi: 10.1136/oem.60.2.136.

Angle, C.R. 1988. Indoor air pollution. Advanced Pediatrics, vol 35, pp. 239-280.

Ballard, T.J., Neumann, C.G. 1995. The effects of malnutrition, parental literacy, and household crowding on acute lower respiratory infections in young Kenyan children. J. Trop Pediatric, vol 41, pp. 8-13.

Baral, S., D. Karki, et al. (2007). Causes of stigma and discrimination associated with tuberculosis in Nepal: a qualitative study." BMC Public Health vol **7** no 1:pg 211.

Beall, J., Crankshaw, O., Parnell, S. 2000. Local government, poverty reduction and inequality in Johannesburg. Environment and Urbanization, vol 12, no. 1, pp. 107-122.

Becher, R., Hongslo, J.K., Janfunen, M.J. 1996. Enviromental chemical relevant for the respiratory hypersensivity, the indoor environment. Toxico letter, vol 86, pp. 155-162.

Bendahmane, B.D. 1997. Environmental Health Project. Air pollution and child health: priorities for actions: Report of a Meeting of an EHP Technical Advisory Group on air pollution. Activity report no 38. Arlington, Virginia.

Bradshaw, D., Groenewald, P., Laubscher, R., et al. 2003. Initial Burden of Disease Estimates for South Africa, 2000, Cape Town: South African Medical Research Council. <http://www.mrc.ac.za/bod/bod.htm> [Assessed 23rd June 2007].

Bradshaw, D., Groenewald, P., Laubscher, R., et al. 2005. Provincial mortality in South Africa, 2000-priority-setting for now and a benchmark for the future. South African Medical Journal; vol 95, no.7, pp. 496-503.

Brown N.J. 1989: Health Hazard Manual for Cosmetologists Hairdressers Beauticians and Barbers" Albany: New York State Department of Health, Bureau of Occupational Health and Cornell University, Chemical Hazard

Program

Brown, V. 2003. Give me shelter: The global housing crisis. Environmental Health Perspectives, vol 111, no 2. <http://www.ehponline.org/members/2003/111-2/EHP111pa92PDF.pdf> [Accessed 7th July, 2006].

Bruce, N., Perez-Padilla, R., Albalak, R. 2002. The health effects of indoor air pollution exposure in developing countries. Geneva, World Health Organization. WHO/SDE/OEH/02.05.

Brunekreef, B., Janssen, N.A., De Hartog, J., et al. 1997. Air pollution from truck traffic and lung function in children living near motorways. Epidemiology, vol 8, pp. 298-303.

Canadian Public Health Association. 1997. Health impact of social and economic condition: Implication for public policy (Board directors' discussion papers). <http://www.cpha.ca/english/policy/pstatem/impact/health> [Accessed 7th July, 2006].

CASE. 2003. Key performance indicators – Gauteng – Demographic Health Survey & Actuarial Society of South Africa. http://www.environment.gov.za/soer/reports/gauteng> [Accessed 21st July 2006].

Cardoso, A.R., Cousens, S.N., Siquera, L., et al. 2004. Crowding: risk factor or protective factor for lower respiratory disease in young children? BMC Public Health.4:19.doi:10.1186/1471-2458-4-19. http://www.pubmedcentral.nih.gov> [Accessed 3rd may 2007].

Cerqueiro, M.C., Murtagh, P., Halac, A., et al. 1990. Epidemiologic risk factors for children with acute lower respiratory tract infection in Buenos Aires, Argentina:

a matched case-control study. Rev Infec Dis, vol 12(Suppl 8):S1021-S1028.

Clauson-Kaas, J., Dzikus, A., Stephens, C., et al. 1996. "Urban health: human settlement indicators of crowding". Third World Planning Review, vol 18, no.3, pp. 349-63.

Crankshaw, O., White, D.F. 1992. Results of the Johannesburg Inner-city Survey, Group for Human Resources, HSRC, Johannesburg. <www.joburg.archive.co.za/2006/pdfs/final_term> [Accessed 20th July 2007].

Delfino, R.J. 2002. Epidemiologic evidence for asthma and exposure to air toxics: linkages between occupational, indoor, and community air pollution research. Environ Health Perspective, vol 110, no 4, pp. 573–89.

Department of Agriculture, Conservation and Environment. 2004. Gauteng State of Environment Report 2004. Gauteng Provincial Government. http://www.environment.gov.za/soer/reports/gauteng/MEC> [Accessed 10th May 2007].

Department of Health. TB Fact Sheet – 2003. National TB Control Programme www.doh.gov.za/tb/factsheets/factsheet2003.pdf

Department of Health, South Africa and WHO. 1996. Tuberculosis control in South Africa joint programme review. WHO/TB/96.208.

Duhme, H., Weiland, S.K., Keil, U., et al. 1996. The association between self-reported symptoms of asthma and allergic rhinitis and self-reported traffic density on street of residence in adolescents. Epidemiology, pp. 578-582.

Dye, C., Scheele, S., Dolin, P. 1999. Consensus statement. Global burden of tuberculosis: estimated incidence, prevalence, and mortality by country. WHO Global Surveillance and Monitoring Project. JAMA, vol 282, pp. 677-686.

Ehrlich, R., White, N., Norman, R., et al. 2004. Predictors of chronic bronchitis in South African adults. Int J Tuberc Lung Dis, vol 8, pp. 369-376.

Esterhuizen, T.M., Rees, D., Kielkowski, D, et al. 2001. Consequences of occupational asthma after diagnosis. NCOH Report 04/2001. Johannesburg: National Centre for Occupational Health.

Gagliardi, L., Ambroso, M., Mavro, J., et al. 1992. Exposure to paraphenylendiamine in hairdressing parlours. Int J Cosmet Sci., vol 14, pp. 19–31.

Grange, J.M. 1999. The global burden of tuberculosis. In: Porter JDH, Grange JM eds. Tuberculosis – an interdisciplinary perspective. London: Imperial College, pp. 3-32.

Health Systems Trust. National Primary Health Care Facilities Survey 2003. www.hst.org.za/publications/617[Accessed 12th October, 2007]

Hurtig, A. K., Porter, J. D. H., et al. 1999. Tuberculosis control and directly observed therapy from the public health/human rights perspective. Int J Tuberc Lung Dis vol 3, no7, pp 553 – 560.

Gupta, R.K., Singh, A.P. 1999. Factor analysis of acute respiratory infections among children under five in Delhi slums. Indian Pediatric, vol 36, pp. 1113-1149.

IIPS/NFHS. National Family Health Survey Phase-II. International Institute for Population Sciences. 1999. Deonar, Mumbai, India. <http://www.nfhsindia.org/> [Accessed 9th May, 2006].

ISAAC Steering Committee. 1998. Worldwide variations in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. Lancet, vol 351, pp. 1225-1232.

Iversen, M., Dahl, R. 1990. Allergy to storage mites in asthmatic patients and its relation to damp housing conditions. Allergy, vol 45, no.2, pp. 81-85.

Johansson, E.,. Long N. H, et al. 1999. Attitudes to compliance with tuberculosis treatment among women and men in Vietnam. Int J Tuberc Lung Dis vol 3, no.10, pp 862 – 868.

Jordaan, E.R., Ehrlich, R.I., Potter, P. 1999. Environmental tobacco smoke exposure of primary school children in Cape Town: household, community, and socioeconomic factors. Arch Environ Health, vol 54, pp. 319-327.

Knight, R. 2004. A decade of democracy: Housing, services, and land in South Africa. (South Africa Delegation Briefing Paper, April 22 – May 2, 2004). <http://richardknight.homestead.com/files/richardknight.htm> [Accessed 9th May, 2006].

Kopferschmitt-Kubler, M.C., Ameille, J., Popin, E., et al. 2002. A 1-yr report of the Observatoire National de Asthmes Professionnels project. Eur Respir J, vol 19, pp. 84-89.

Lawrence, R. 2004. Housing health, and wellbeing: Moving forward. Reviews on Environmental Health, vol 19 no (3-4), pp. 161-176. <www.iaps-association.org/Documents/LawrenceEditorial.pdf> [Accessed 9th May 2006].

Leino, T., Tammilehto, L., Paakkulainen H., et al. 1997. Occurrence of asthma and chronic bronchitis among female hairdressers. JOEM, vol 39, no.6, pp. 534-539.

Lemus, R., Albdelghani, A.A., Akers, T.G. 1998. Potential health risk for exposure to indoor formaldehyde. Review of Environmental Health, vol 13, pp. 91-98.

Lindfors, A., Wickman, M., Hedlin, G., et al. 1995. Indoor environment risk factors in young asthmatics: A case control study. Archives of disease in childhood, vol 73, pp. 408-412.

Lin, H.H., Ezzati, M., Murray, M. 2007. Tobacco Smoke, Indoor Air Pollution and Tuberculosis: A Systematic Review and Meta-Analysis. PLoS Med 4(1): e20. <http://dx.doi.org/10.1371/journal.pmed.0040020> [Accessed 10th march 2007].

Louw, S. 1995. Respiratory diseases. In: Fourie, J., Steyn, K., eds. Chronic Diseases of lifestyle in South Africa., Cape Town: Medical Research Council.

Mahalannabis, D., Gupta, S., Paul, D., et al. 2002. Risk factors for pneumonia in infants and young children and the role of solid fuel for cooking: A case-control study. Epidemiology of infection, vol 129, pp. 65-71.

Maier, W.C., Arrighi, H.M., Morray, B., et al. 1997. Indoor risk factors for asthma and wheezing among Seattle school children. Environ Health Perspective, vol l105, no.2, pp. 208–214.

Malo, J.L., Chan-Yeung, M. 2001.Occupational asthma. J Allergy Clin Immunol; vol 108, pp. 317–328. doi: 10.1067/mai.2001.116432.

Masoli, M., Fabian, D., Holt, S., et al. 2003. Global Burden of Asthma. < http://ginasthma.com/ReportItem> [Accessed 9th June, 2007].

Mathee, A., von Schnirnding, Y. 1994. Environment and health in rapidly urbanizing cities. Critical Health, vol 46, pp. 21-27.

Mathee, A., von Schnirnding, Y. 1995. Shelter and health. EnviroHelp, vol 45, pp .48.

Meredith, S., Nordman, H. 1996. Occupational asthma: measures of frequency from four countries. Thorax, vol 51, pp. 435-440.

Mounier-Geyssant, E., Oury, V., Mouchot, L., et al. 2006. Exposure of hairdressing apprentices to airborne hazardous substances. Environmental Health: A Global Access Science Source.5:23. doi:10.1186/1476-069X-5-23 .<http:www.ehjournal.net> [Accessed 10th March 2007].

National Department of Housing, 2003. A Social Housing Policy for South Africa. Revised Draft. Housing Code Part 1. Pretoria. Chapter 2.

National Institute of Environmental Health Sciences (NIEHS). 2006. Chemical in household products may cause reductions in lung function. Medical research news. <http://www.niehs.nih.gov/external/plan2006> [Accessed 3rd may 2007].

Nriagu, J., Robins, T.R., Gary, L., et al. 1999. Prevalence of asthma and respiratory symptoms in south-central Durban, South Africa. Eur J Epidemiol, vol 15, pp. 747-755.

Norback, D., Bjornsson, E., Janson, C., et al. 1995. Asthmatic symptoms and volatile organic compound, formaldehyde, and carbon dioxide in dwellings. Occupation and Environmental Medicine, vol 52, pp. 388-395.

Pickles, J. (2005). A novel approach to vaccination for common respiratory pathogens. Thorax vol 60 no1, pp 49.

Poyser, M.A., Nelson, H., Ehrlich, R.I., et al. 2002. Socioeconomic deprivation and asthma prevalence and severity in young adolescents. Eur Respir J, vol 19, pp. 1-7.

Pronyk, P.M., Joshi, B., Hargreaves J.R. 2001. Active case finding understanding the burden of tuberculosis in rural South Africa. Int J Tuberc Lung Dis, vol 5, pp. 611–618.

Qian, Z., Zhang, J., Korn, L.R., et al. 2004**.** Factor analysis of household factors: are they associated with respiratory conditions in Chinese children? International Journal of Epidemiology, vol 33, no.3, pp. 582-588.

Richards, G.A., Terblanche, A.P.S., Theron, A.J., et al. 1996. Health effects of passive smoking in adolescent children. S Afr Med J, vol 86, pp. 143-147.

Richardson, G., Eick ,S., Jones, R. 2005. How is the indoor environment related to asthma?: literature review. Journal of Advanced Nursing, vol 52 ,no.3, 328–339.

Rosenstreich, D.L., Eggleston, P., Kattan, M., et al. 1997. The role of cockroach allergy and exposure of cockroach allergen in causing morbidity among inner city children with asthma. The New England Journal of Medicine, vol 336, no.19, pp. 1356-1363.

Skov, P., Valbjorn, O., Perdersen, B.V., et al. 1990. Influence of indoor climate on sick building syndrome on office environment. Scand J Work Environ Health, vol 16, pp. 363-371.

Smith, R.K., Msamet, J., Romieu, I., et al. 2000. Indoor air pollution in developing countries and acute lower respiratory infections in children. Thorax, vol 55, pp.518-532. <http://thorax.bmjjournals.com/cgi/content> [Accessed 9th May, 2006].

Stata statistical software: release 9.0. College Station (TX): Stata Corporation; 2005.

State of Environment. 1999. The status of the social environment National State of the environment report - South Africa.http://www.ngo.grida.no/soesa/nsoer/issues/social/state2.htm#poverty> [accessed 3rd may 2007].

Statistics South Africa. 1998. Census in Brief, 1996. The people of South Africa population census 1996. Pretoria: Statistics South Africa. <http://www.statssa.gov.za> [Accessed 15 June 2007].

Statistics South Africa. 2003. Census in Brief. Report No 03-02-03 (2001).

Statistics South Africa. Mortality and causes of death in South Africa, 1997 - 2003: Findings from death notification. Statistical Release P03093. <www.statssa.gov.za> [Accessed 15 June 2007].

Stayner, L., Smith, R., Bailer, J., et al. 1997. Exposure-response analysis of risk of respiratory disease associated with occupational exposure to chrysotile asbestos. Occup Environ Med, vol 54, no 9, pp. 646-652.

Strachan, D.P., Flannigan, B., McCabe, E.M., et al. 1990. Quantification of airborne moulds in homes of children with and without wheeze. Thorax, vol 45, no.5, pp. 382-7.

Surveillance of Occupational Diseases in South Africa (SORDSA). 2000. Alert: Diagnosis and Management of Asbestos Related Diseases in South Africa. Johannesburg: National Centre for Occupational Health.

United Nations Centre for Human Settlements. 2001. State of the world cities, Nairobi, UNCHS.

van Muiswinkel W.J, Kromhout, H., Onos, T., et al. 1997. Monitoring and modeling of exposure to ethanol in hairdressing salons. Ann occup Hyg, vol 41 no 2, pp. 235–247.

Van Strien, R.T., Verhoeff, A.P., Brunekreef, B.D., et al. 1994. Mite antigen in house dust: Relationship with different housing characteristics in the Netherlands. Clinical and Experimental Allergy, vol 24, no.9, pp. 843-53.

Verhoeff, A.P., Van Strien, R.T., Van Wijnen, J.H., et al. 1996. Damp housing and childhood respiratory symptoms: The role of sensitization to dust mites and molds, American Journal of Epidemiology, vol 141, no.2, pp. 103-110.

Victora, C.G., Fuchs, S.C., Flores, J.A., et al. 1994. Risk factors for pneumonia among children in a Brazilian metropolitan area**.** Pediatrics, vol.93, no. 6 Pt 1**,** pp. 977-985.

White N, Ehrlich R.I., te Water Naude J et al. 2003. A study of allergic diseases and the urban environment in the northern communities of Cape Town, South Africa. first report. Cape Town: UCT Lung Institute.

Williamson, I.J., Martin, C.J., McGil, G., et al. 1997. Damp housing and asthma: A case control study. Thorax, vol 52, pp. 229-234.

Wjst, M., Reitmeier, P., Dold, S., et al. 1993. Road traffic and adverse effects on respiratory health in children. British Medical Journal, vol 307, pp. 596-600.

World Health Organization. 1999. Making a difference. World Health Report, Geneva.

World Health Organization. 2002. The World Health Report.: Reducing Risks, Promoting Healthy Life. Geneva, World Health Organization.

World Health Organization. (WHO). 2004. Global tuberculosis control: surveillance, planning, financing. ISBN 92 4 156264 1. Geneva.

World Health Organization. 2006. Indoor air pollution and health. <http://www.who.int/mediacentre> [Accessed 12th June 2007].

World Health Organization. 2006. Launch of Global Alliance against Chronic Respiratory diseases (GARD). Press release 28th March, 2006. <http://www.who.int/respiratory/gard> [Accessed 12th July 2006].

World Resources Institute. 2005. Rising energy use: Health effects of air pollution. World resources. <http://pubs.wri.org> [Accessed 17th July 2006].

Appendix 1. Ethical clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Makene

CLEARANCE CERTIFICATE	PROTOCOL NUMBER M060905
PROJECT	Housing-Related risk Factors for Respiratory Diseases in Low Cost Housing Settlements in JHB, SA
INVESTIGATORS	Dr CL Makene
DEPARTMENT	School of Public Health
DATE CONSIDERED	06.09.29
DECISION OF THE COMMITTEE*	APPROVED UNCONDITIONALLY

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE

CHAIRPERSON ....
(Professors PE Cleaton-Jones, A Dhai, M Vorster, C Feldman, A Woodiwiss)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Ms A Mathee

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 2. Part of HEAD study questionnaire

THE JOHANNESBURG HEALTH, ENVIRONMENT AND DEVELOPMENT (HEAD) PROJECT

Study ID number

Area code

Interview date

Interviewers group number

Respondent name	
Respondent physical address	

A. **DEMOGRAPHIC** & **SOCIO-ECONOMIC STATUS**

Al. Where were you born? City/ Town/ Village ____________________________________ Province Country

A2. What is the main language spoken by this household?

A3. What is the main population group in this household?
(Please explain to the respondent why we are asking this question. In South Africa, population groups have been linked to socio-economic status. This, in turn, is closely linked to health. In this study we would like to see whether there is still a relationship between these factors)

Race	**Tick**
Black	
White	
coloured	
Indian	
Others/specify	

A4. For how long have you been living in this dwelling? Years

A5. How many households live in this dwelling?
(Definition of a household: a group of people who usually eat together)

A6. How many people permanently live in this dwelling?

A7. Are there any backyard dwellings on the property? Yes

A8. If yes, how many backyard dwellings are there?

AlO. What is the average monthly income for this household, excluding grants and pensions?

Income level	Tick appropriate block
<R1000	
R1001- R2000	
R2001- R5000 R5001-R10000	
>R1 0000	

All. How many people in the household receive the following grants?

Old age grant/ pension	
Disability grant	
War veterans grant	
Care dependency grant	
Foster child grant	
Child support grant	
Grant in aid	
Social relief of distress	

A12. Asset registers:

(State only those in working order):

Assets	**State how** many of **each item you have**
Radio	
Hi fi	
Black and white television	
Colour television	
Refrigerator	
Washing machine	
Video	
Microwave	
Car	
Personal computer	
Landline telephone	
Cell phone	

A13. How much does this household spend on the following items every month?

Expense	**Amount in Rends**
Food	
Transport	
Housing- rent, bond etc	
Water	
Fuels e.g. electricity, paraffin,	
Entertainment/ Leisure activities	

Medical expenses includes transport to clinics, medication etc)

D4. How often do you damp dust *(dust with a wet cloth)* **this dwelling?**

More than once a week   Once a week   Once every few weeks   Never   Not applicable

D5. Do you have problems with any of the following? *(Tick more than one if necessary)*

Rats

Mice

Flies

Fleas

Ants
Cockroaches
Cats
Dogs
Pigeons
Others (specify)

D6. How often do you use pesticides?

Daily
More than once a week
Once a week
Once every few weeks
Never
Other(Specify)

D. 7. On average how much money do you spend on pesticides every month? R

D 8.2: Do you keep domestic animals/birds in or around the dwelling? *(Tick more than one, if both inside and outside)*

Type of animal	Number	Inside	Outside
Cat			
Dog			
Rodent e.g. Hamster			
Goat			
Sheep			
Chickens			
Birds			
Other: (Please specify)			

D 8.3. Does anyone regularly do any of the following at home?

Activity	Yes	No	I don't know
Fix cars			
Spray painting of cars			
Make metal jewellery			
Make stained glass			
Fix electrical appliances using lead solder			
Scrap metal recycling			
Hairdressing			

E10. How would you describe the following issues in this dwelling?

	No problem	Moderate Problem	Significant Problem
leaking water pipes-outside			
darnpness			
any obvious fungus or mould on walls or ceilings *Muzzy mat like growth-green, grey blue or white)*			
Stagnant water around the unit	'		
Overcrowding in the unit			
Overcrowding in other units in the area			
Indoor odours			
Outdoor odours			
Dust			
Proper laundry facilities (e.g. Washing lines)			
Lifts (where applicable)			
Fire escapes (where applicable)			

Health outcomes.
GI; Is there anyone suffering from the following conditions?

	Did anyone have this during the last 12months	If yes proceed	Was it diagnosed by a doctor	Have you taken prescribed medicine for this?
Heart attack	Yes No		Yes No	Yes No
~ Stroke	Yes No		Yes No	Yes No
Malignant tumour (cancer) specify	Yes No		Yes No	Yes No
Asthma	Yes No		Yes No	Yes No
Chronic bronchitis, emphysema	Yes No		Yes No	Yes No
Chronic anxiety or ~ depression ~	Yes No ~		Yes No	Yes No
Migraine and frequent headaches	Yes No		Yes No	Yes No
Serious skin disease	Yes No		Yes No	Yes No
Hypertension	Yes No		Yes No	**Yes** No
Allergy (excluding allergic asthma ~	Yes No		Yes No	Yes No
Osteoporosis	Yes No		Yes No	Yes N
Tuberculosis	Yes No		Yes No	Yes No