THE RELATIONSHIP BETWEEN ASTHMA AND OUTDOOR AIR POLLUTANT CONCENTRATIONS OF SULPHUR DIOXIDE (SO_2), OXIDES OF NITROGEN (NO_X), OZONE, (O_3), TOTAL REDUCED SULPHATES (TRS), CARBON MONOXIDE (CO) AND RESPIRABLE PARTICULATE MATTER LESS THAN 10 MICRONS (PM_{10}) IN LEARNERS AND TEACHERS AT SETTLERS PRIMARY SCHOOL IN MEREBANK, SOUTH DURBAN

by

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Dissertation submitted in compliance with the requirements for the Masters Degree in Technology: Environmental Health in the Faculty of Health at the Durban Institute of Technology, Durban

I, Emilie Joy Kistnasamy, do declare that the dissertation is representative of my own work.

Approved for final submission

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The contents of this THESIS is dedicated to:

JESUS CHRIST

(my GOD, my constant SOURCE and my BEST FRIEND)

My encouraging and ever loving family

John (my *late* but ever cherished, motivated and wonderful **DAD**)
Elizabeth (my fantastic, supportive and praying **MUM**)
Barry (my visionary, skilful and innovative **BROTHER**)
Moreshnee (my determined and accommodating **SIS-IN-LAW**)

….And to the host of amazing friends and colleagues
who have assisted me in achieving an important goal
and who are too numerous to mention….

Thanks for the input into my life.

God richly bless you all

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ABSTRACT

South Durban is in the province of Kwazulu-Natal in South Africa and is home to two international petro-chemical refineries, a paper mill, sewage works, an international airport, a chemical tank farm with approximately 970 tanks, a number of landfill sites, an airport, various processing and manufacturing industries which are all in close proximity to residential and recreational areas. This area is known as the South Durban Industrial Basin (SDIB). Serious concerns have arisen about the potential health impacts that could arise from ambient air pollution from these industries.

Learners and staff at the Settlers Primary School situated in Merebank, a suburb in the SDIB, perceived themselves to be at risk for air pollutant related health effects owing to the schools' geographic location. The aims of this study was a) to determine the prevalence of asthma among learners from Grades 3 and 6 and staff at Settlers Primary School and b) To investigate whether outdoor air pollutant concentrations of sulphur dioxide (SO_2), oxides of nitrogen (NO_x), ozone (O_3), total reduced sulphur (TRS), carbon monoxide (CO) and respirable particulate matter less than 10 microns (PM_{10}) were associated with increased signs and symptoms of asthma in the study population.

SO_2, NO_x, O_3, TRS, CO and PM_{10} were measured continuously on the school grounds during the study period. The relationship between hourly and daily fluctuations in these air pollutants and fluctuations in respiratory symptoms and signs

were examined during an 18 day period (19^{th} April-6^{th} May 2001) among 222 learners from Grades 3 and 6 and 25 staff members. Methodologies used included baseline comprehensive parent and child questionnaires, bihourly completion during the school day of symptom and activity logs, completion of daily diaries and digital recording of peak expiratory flow (PEF) and forced expiratory volume at one second (FEV_1) measures. Pulmonary function tests included methacholine challenge testing and exhaled nitric oxide.

The prevalence of both asthma of any severity, and of moderate to severe asthma, among the students in grades 3 and 6 were high. Fifty-two percent had responses on the parent baseline consistent with known or probable asthma of any severity. Among these, 11% of the total appeared to have moderate to severe asthma and another 15% mild persistent asthma. The results of the methacholine challenge testing among students in grades 3 and 6 showed that 21% had marked airway hyperreactivity, 29% had probable airway hyperreactivity and 19% possible airway hyperreactivity, with only 32% in the clearly normal range. Among the 25 teachers, 1 (4%) had marked airway hyperreactivity, 1 (4%) had probable airway hyperreactivity, and 23 (92%) had no hyperreactivity.

All concentrations of ambient air pollutants measured at the school site during the study period for the selected pollutants fell below international and South African standards and guideline values. However, the study results provided strong evidence that ambient air pollution exposures were associated with acute changes in health status among students with moderate to severe asthma. Specifically, fluctuations in ambient pollution levels of both SO_2 and PM_{10} were strongly and consistently associated with adverse fluctuations in the health status of students with moderate to severe asthma as assessed both by lower respiratory symptom reports and, independently, by measures of lung function. Prior day and prior 48 hours exposure to both SO_2 and PM_{10} were associated with highly statistically significant increases in the odds for lower respiratory symptoms including cough, wheezing, chest tightness and, shortness of breath.

This study could serve as a guide to which pollutants and health outcomes merit careful investigation in a larger study and as to possible effective study designs in this setting. Also note should be taken by the stakeholders in South Durban as to implementing and sustaining feasible mechanisms to improve air quality and the treatment of asthma and thereby improving the quality of life for the asthmatic.

TABLE OF CONTENTS

CHAPTER 1

CHAPTER 2

CHAPTER 3

METHODOLOGY

CHAPTER 4

RESULTS

CHAPTER 5

DISCUSSION

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ANNEXURES

LIST OF ABBREVIATIONS

ATS	-	American Thoracic Society
BMRC	-	British Medical Research Council
CAMP	-	The Childhood Asthma Management Programme
CO	-	Carbon monoxide
CSIR	-	Council for Scientific and Industrial Research
DEAT	-	Department of Environmental Affairs and Tourism
DN	-	Danmarks Naturfredningsforening (Danish Society for the Conservation of Nature)
EIB	-	Exercise induced bronchospasm
eNO	-	Exhaled Nitric Oxide
FEV_1	-	Forced Expiratory Volume in one second
FVC	-	Forced Vital Capacity
GEE	-	Generalized Estimating Equations
H_2S	-	Hydrogen Sulphide
ISAAC	-	The International Study of Asthma and Allergies in Childhood
PEF	-	Peak Expiratory Flow
PM_{10}	-	Respirable particulate matter less than 10 microns
MCT	-	Methacholine Challenge testing
NHANES III	-	The third National Health and Nutrition Examination Survey
NO_X	-	Oxides of Nitrogen

O_3	-	Ozone
ORs	-	Odds Ratio
SA	-	South Africa
SDCEA	-	South Durban Community Environmental Alliance
SDIB	-	South Durban Industrial Basin
$SDSO_2SC$	-	South Durban Sulphur Dioxide Steering Committee
SES	-	Socio-economic status
SEA	-	Strategic Environmental Assessment
SO_2	-	Sulphur dioxide
TRS	-	Total Reduced Sulphates
US	-	United States
VOCs	-	Volatile Organic Compounds
WHO	-	World Health Organisation

CHAPTER 1

1.1 INTRODUCTION:

Located on the sub-tropical east coast, Durban is South Africa's third largest city with a population of over 2.5 million people (Common Ground Consulting, 1998). It is home to Africa's busiest port and the primary route for imported crude oil and exported refined petroleum and petrochemical products and these industries are located in the South Durban area (DN and SDCEA, 2002). In the port itself is the Island View bulk chemical storage that contains an extensive infrastructure of tanks and pipelines, some leading directly beneath residential streets to the South Durban Refineries (Butler and Hallowes, 2002).

This area of Durban is often termed the South Durban Industrial Basin (SDIB) and is recognised as one of the most highly industrialised and most heavily polluted areas in Southern Africa (Nriagu, *et al*. 1999; Matooane and Diab, 2002). The main problem relates to air pollution, mainly sulphur dioxide and is aggravated by the landform (basin shape) which is conducive to pollution accumulation during temperature inversions, especially in winter (Matooane and Diab, 2002).

Poor historic land use planning coupled with the racial discriminatory practices of the apartheid era created a mix of heavy industrial activity interspersed with dense community settlements (South Durban Basin Multi-Point Plan, 2002). Industrially zoned areas typically carry higher environmental burdens than any other area and tend to be concentrated in poor and minority neighbourhoods (Manntay, 2001).

Subsequently, planning difficulties emerged in the SDIB as local communities raised concerns over health and quality of life while industry sought sanction for a number of strategically important developments in the area (CSIR, 1999b; South Durban Basin Multi-Point Plan, 2002). Air pollution problems and its possible associated health effects in the SDIB has led to long term conflict between local communities and industry and has been a subject for concern among various stakeholders including all levels of government (Matooane and Diab, 2002). This aspect will be further discussed in Chapter 2. To date, no long term comprehensive health study had been performed in South Durban to assess the ambient air pollution impacts on the health of the local population (The Mercury, 2000a).

Limited resources advocated that it was more feasible to conduct a focused study in a designated area on a sample group that perceives itself to be at significant risk. It was anticipated that this study would produce reliable and scientifically generated data that can be used as a pilot for other studies and in other areas in South Africa where similar concerns need to be addressed. Due to the anecdotal history of the health complaints at the Settlers Primary School in Merebank in the SDIB, this school was chosen as the sample group. The outdoor air pollutants selected were based on a literature review of the sources of air pollution in the SDIB and the associated health effects and are reviewed in Chapter 2.

This study therefore focused on the relationship between asthma and outdoor air pollutant concentrations of sulphur dioxide (SO_2), oxides of nitrogen (NO_x), ozone (O_3), total reduced sulphates (TRS), carbon monoxide (CO) and respirable particulate matter less than 10 microns (PM_{10}) in learners and staff at Settlers Primary School in Merebank, South Durban during an 18 day period of intensive data collection (19th April-6th May 2001). These dates were chosen as the Engen Refinery was planning a shutdown and a change in fuel type that was expected to substantially reduce SO_2 emission levels. Therefore, information for this study was obtained before this change-over to ensure that data captured was as similar as possible to historical data.

It was hypothesised that hourly and daily fluctuations in ambient air pollution measured at the Settlers School would be predictive of fluctuations in prevalence and severity of symptoms and signs (i.e., changes in pulmonary function) referable to the upper and lower respiratory tract among learners and staff.

Aim/Purpose of study

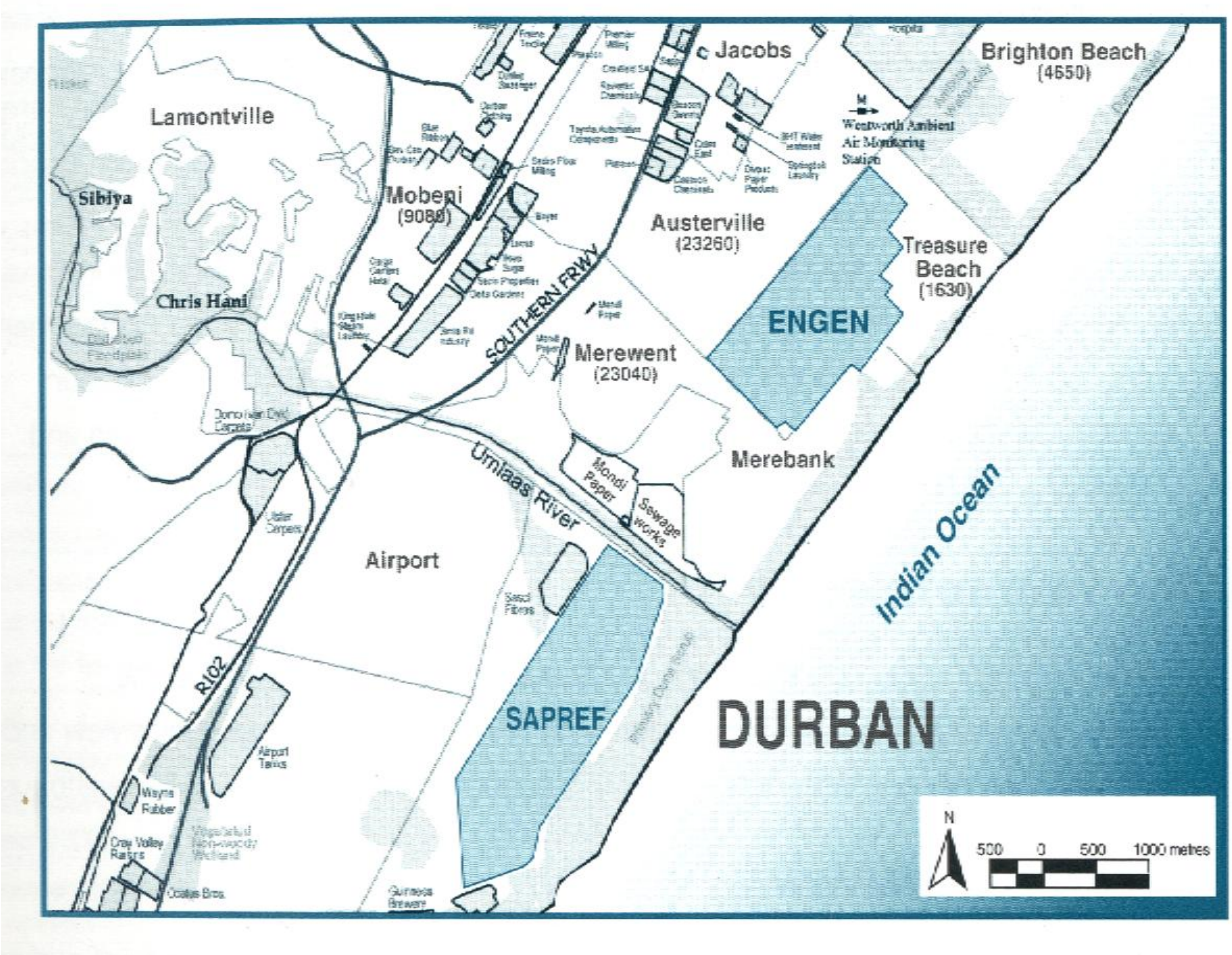
1. To determine the prevalence of asthma among learners from Grades 3 and 6 and staff at Settlers Primary School.

2. To investigate whether outdoor air pollutant concentrations of SO_2, NO_x, O_3, TRS, CO and PM_{10} are associated with increased symptoms of asthma in the study population.

CHAPTER 2

2.1. HISTORY OF AIR POLLUTION CONFLICT IN THE SDIB:

Figure 2.1: Map of the South Durban Industrial Basin (DN and SDCEA, 2002)



The South Durban Industrial Basin (SDIB) as shown in Figure 2.1, is a 27km long, 4km wide zone stretching from the port southwards to Amanzimtoti and is located between 29^{o}S-30^{o}S latitude and 30^{o}E-31^{o}E longitude on the south-eastern coast of South Africa (SA) in the province of Kwazulu-Natal (Carnie, 1998c; CSIR, 2002). In this area, there are five industrial belts with a combination of over 120 heavy and light industries including South Africa's two largest crude oil refineries, Sapref and Engen situated about one kilometre apart (Butler and Hallowes, 2002). Other components comprise the Mondi Paper Mill, Durban International airport, a sewage treatment plant, a freeway, landfill sites and many processing and manufacturing industries (Community News, 2003).

The residential areas sited between and adjacent to these industrial belts, as indicated in Plates 2.1 to 2.4 below, are Bluff, Clairwood, Jacobs, Wentworth / Austerville, Merebank, Isipingo, Umlazi, Amanzimtoti and Umbogintwini with a combined population of over 400 000 people (Tonnesen, 2001). This poor town planning left a legacy of environmental, development and social problems (Meintjies, 1998).

Plate 2.1: Proximity of community residences of the Bluff (back) to chemical storage tanks, Island View Complex (front)

Plate 2.2: Location of Sapref Oil Refinery (back) in relation to community residences in Merebank (front)

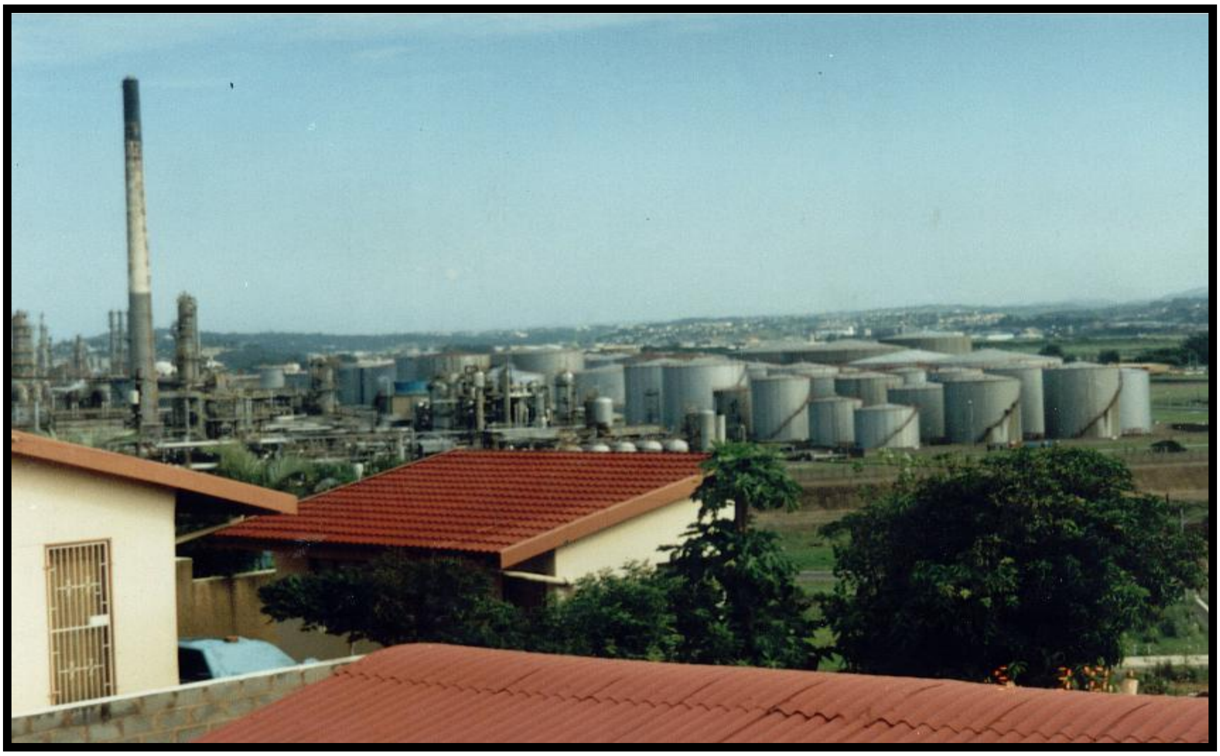


Plate 2.3: Engen Refinery (middle) with community residences of Wentworth/ Austerville (back) and Merebank (front)

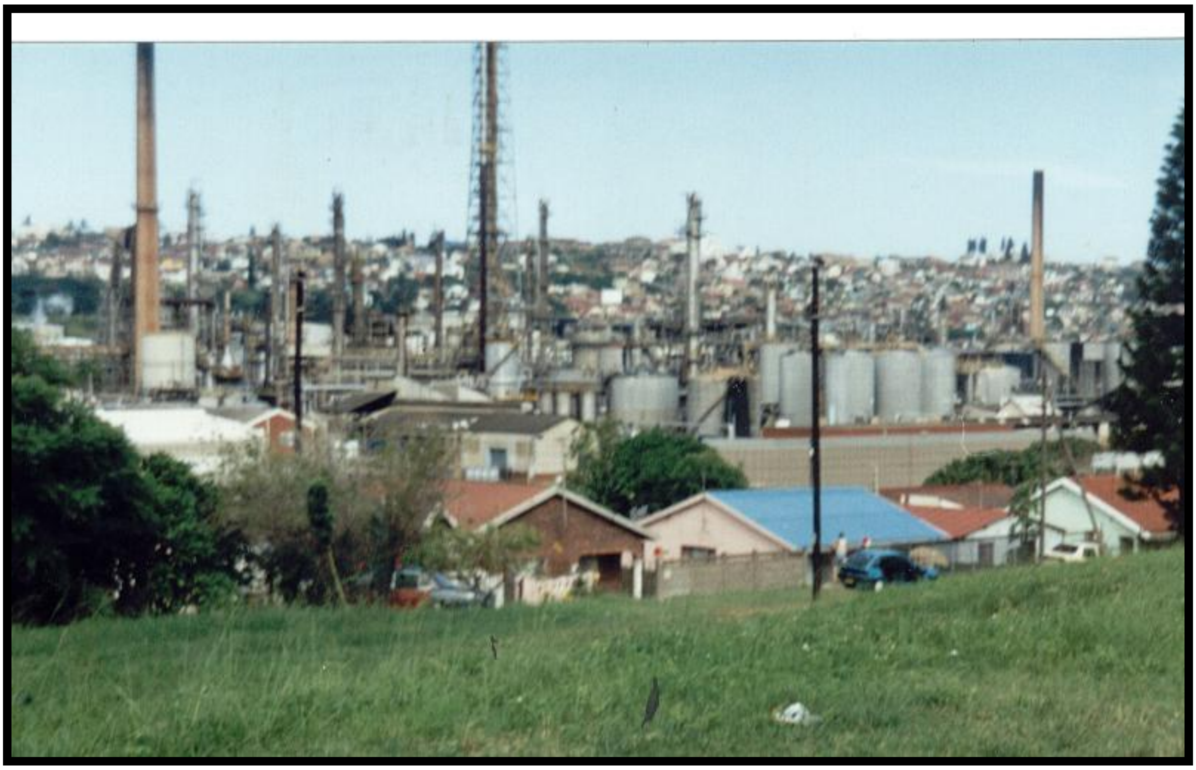
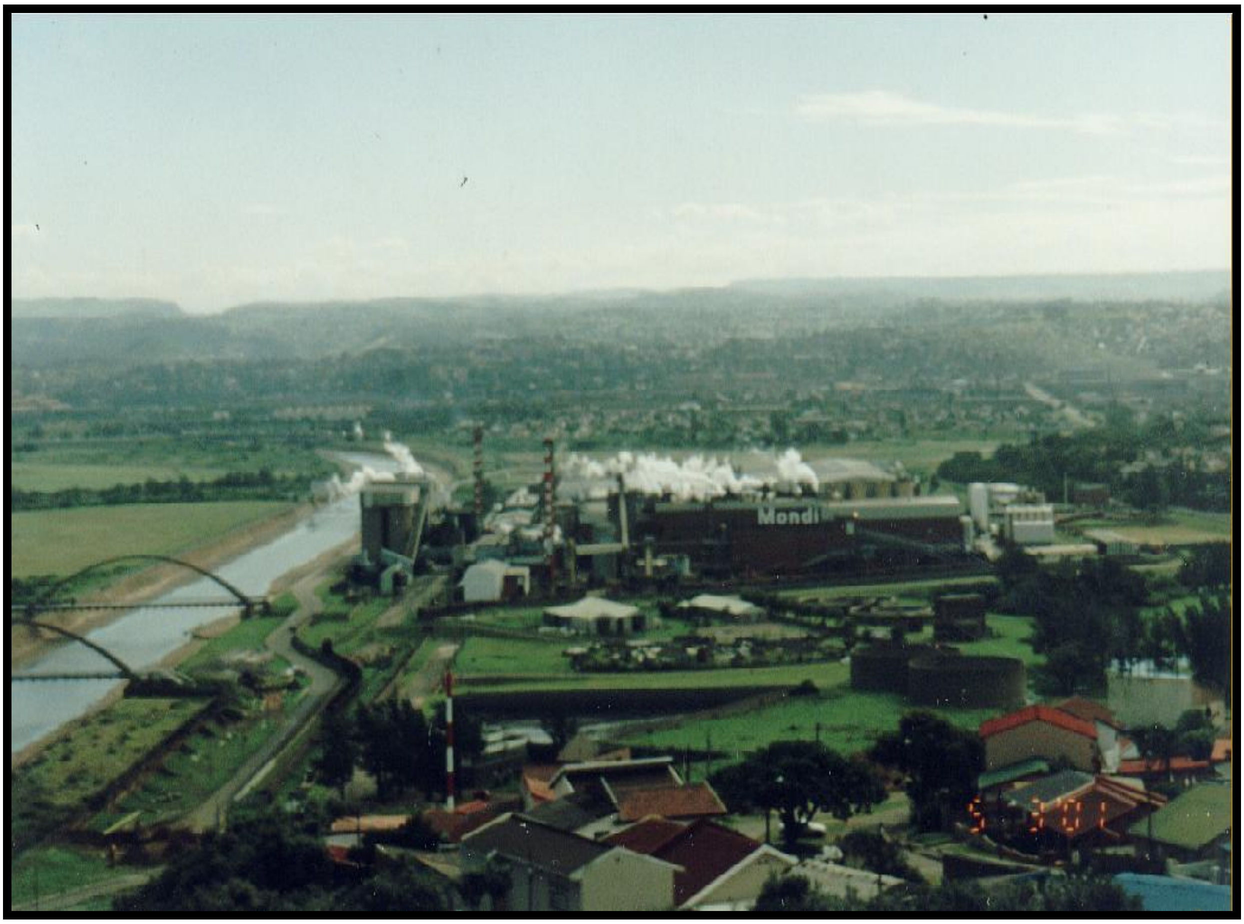


Plate 2.4: Community residences of Umlazi and Merebank (back), Mondi Paper Mill and Southern Sewage Works (middle) and community residences of Merebank (front)



Community environmental protest prior to 1994 was viewed as political dissent and silenced by the state. The major industrial installations were protected by the National Key Point legislation which denied access to information to local residents and regulators alike (Butler and Hallowes, 2002). Post 1994, according to Fouche and Diab (1994), the majority of all complaints made to the Durban air pollution control authorities cited odours (such as ‘burnt toast’ and ‘rotten cabbage’) which could cause nausea, sleeplessness, loss of appetite and effects such as sneezing, bronchodilation, decrease in breathing and increase in blood pressure.

In March 1995, the former President, Nelson Mandela, after a meeting with Merebank and Wentworth community representatives, remarked that the government regarded community health issues and environment impacts in a serious light and that these issues would be addressed urgently (Campbell, 1995; Khan, 1995). This meeting led to a workshop of relevant stakeholders, convened by the then Deputy Environment Minister in an endeavour to find a solution to the air pollution in the SDIB (The Mercury, 1995). However, in December 1995, Merebank and Wentworth residents were not invited to meetings on pollution between Engen staff and government officials and this led to a protest by residents who felt aggrieved at been left out of the process (Naidoo, 1995).

In early 1996, the government warned that stringent laws may be necessary to protect public health after expressing serious concerns about the Engen Refinery's air pollution problems and failure to resolve long standing complaints from Wentworth, Merebank and Bluff residents (Carnie, 1996a). Engen Refinery responded by declaring that the refinery's ambient air pollution levels were well below the World Health Organisation's (WHO) limits and disputed reports that pollution levels at Engen were ten times higher than safety standards in the United States. Engen claimed that the community's fears about health, rather than based on any real risk, was a 'perception problem'. At a subsequent meeting, Engen estimated that it was responsible for only 25% of SO_2 pollution in the basin with the remainder emanating from motor traffic and other industries (Carnie, 1996b).

In March 1996, an interruption in the electrical power supply caused a total shutdown of the Sapref Refinery and flaring occurred which resulted in a release of atmospheric waste products (Mills, 1996). Residents believed that the normal flaring process was hazardous and had expressed concerns for a number of years that ongoing health problems like respiratory infections, asthma and bronchitis were linked to pollution by local industries. As a result of this incident, the refinery was challenged by the community to produce scientific evidence to prove that flaring does not pollute the atmosphere. In October 1996, residents from South Durban staged a protest to make the SO_2 Steering Committee (consisting of government officials and industrial and community representatives) aware of the pollution problems that communities in South Durban faced and highlighted their grievances, claiming that the SO_2 monitoring system was not able to deal with the air pollution effectively (Peters, 1996).

Communities were now disillusioned with promises, surveys and committees and wanted action as they had the perception that air pollution levels had gone from being unacceptable to becoming a health hazard (Seeliger, 1997). It was also indicated that the number of complaints from residents ranged from visits to hospital for treatment of bronchial pneumonia, respiratory problems, rashes, headaches, asthma, nauseating smells and the use of asthma pumps to black soot on vehicles and curtaining. Seeliger (1997) reported that the SO_2 monitoring model and the proposed R2 million Strategic Environmental Assessment (SEA) of South Durban, to be conducted by scientists from the Council for Industrial and Scientific Research (CSIR), were met with much scepticism by the South Durban community. In the same article, an established doctor who had worked in the Merebank area for

20 years, said that at least 30% of his patients were permanently affected by the air pollution while a senior scientist at the Medical Research Council believed that the Metro Council should be analyzing the cocktail of pollutants and lobbying for a 5 year reduction plan for oil refineries in the area. Seeliger (1997) concluded that no conclusive research had been conducted illustrating the extent that the health of people in South Durban were affected by air pollution.

The South Durban Community Environmental Alliance (SDCEA), a coalition of community groups, was formed in 1997 to help unify the communities' pollution concerns under one umbrella. Nurick and Johnson (1998) in their research findings noted that the South Durban community had numerous concerns regarding the environmental impacts of industry. These concerns are summarized in Table 2.1.

Table 2.1: Industrial Impact Concerns in the SDIB for the period January to March 1997 (Nurick and Johnson, 1998)

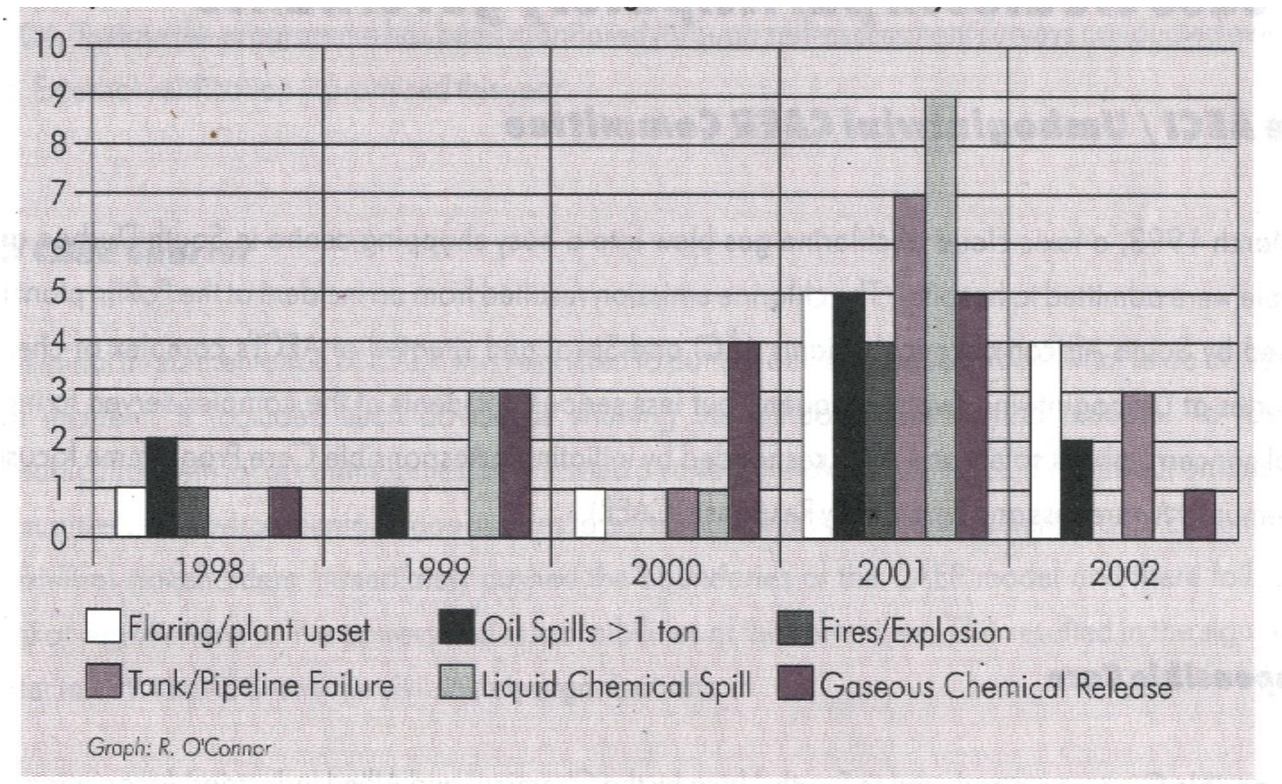
Category	Concerns
Types of pollution from different stages of the industrial/product cycle and different types of industry	• Air pollution : SO_2; particulates; dust; ash • Odour • Emission reduction programmes • Mitigation measures
Environmental risk	• Tanker accidents and spillages • Explosions
Health impacts of pollution	• Asthma from air pollution • Skin and other ailments associated with toxic waste • Headaches

Fires, explosions and chemical accidents, as evidenced in Table 2.2 and Figure 2.2 respectively, had become commonplace in the SDIB (Butler and Hallowes, 2002). The SDCEA now decided to place on record their position with regard to the future sustainability and development potential of South Durban in terms of socio-economic development and the quality of the environment (SDCEA, 1998).

Table 2.2: Number of chemical accidents (i.e. the release of oil to sea or the saturation of land with petrochemicals) by South Durban companies for the period 1998 to 2001 (Butler and Hallowes, 2002)

Name of Company	1998	1999	2000	2001
Sapref	4		1	11
Engen			1	5
Polifin / Sasol Polymers		2	3	
Other / not attributed		4	2	7

Figure 2.2: Number of chemical and oil refining incidents in the SDIB (Butler and Hallowes, 2002)



Also, media coverage was intensively focused on South Durban's pollution issues and associated community concerns (Carnie, 1998b; Meintjies, 1998; The Daily News, 1998; The Mercury, 1999a; The Mercury, 1999b; The Mercury, 1999c). Both the unified grouping and the media coverage had significantly contributed to increased attention from other stakeholders, namely the government and industry.

In addition, Carnie (1998a) observed that the air pollution study, commissioned as part of the Metro Council's SEA, concluded that information on air quality in South Durban:

- Was scanty and inadequate
- Had no comprehensive list of air pollution emissions in the area
- Had no indication of the ambient concentrations (the quality of air people breathe in a particular area).

While the report did not provide a detailed health study analysis, limited information was provided about the estimated levels of SO_2, NO_x and CO levels (CSIR, 1999a). The worst affected areas appeared to be Wentworth, Clairwood, Bluff and Umbogintwini (Carnie, 1998c). The community voiced their concerns and criticisms that none of the eight reports of the SEA had reviewed health impacts (The Mercury, 1998).

However, the final integrated report on the SEA by the CSIR (1999b) stated that the air quality of the SDIB appeared to be managed on an *ad hoc* basis with no clear or coordinated plan for emission reductions. The SDCEA argued that the SEA mainly focused on reviewing specific industrial projects and their expansion possibilities, straying from being a document to inform and guide, to being a weak, inconclusive and inadequately researched paper that did not address the underlying issues that communities faced in the area (SDCEA, 1999).

Emotions again ran high when in February 2000, the Sapref Refinery announced that due to calculation errors, it had been under-reading its SO_2 pollution levels by approximately 40% for the past 5 years (The Mercury, 2000b; Cooper, 2000). The community then engaged the assistance of American air pollution monitors to assist in their campaign and used their technology (i.e. an air pollution bucket) and their expertise (Carnie, 2000d; Carnie, 2000e). This monitoring system tested for a range of volatile organic compounds and total reduced sulphur compounds and found 23 compounds, 17 of which are listed as hazardous air pollutants by the US Environmental Protection Agency (Hallowes and Butler, 2004)

After an industrial air pollution incident in the SDIB where 200 people were hospitalised, the then National Minister of Environmental Affairs and Tourism, acknowledged that the government was incapable of monitoring industrial air pollution independently and relied mostly on industries policing their own pollution (Carnie, 2000f). However, there were strategies in the pipeline to help curb air pollution and included an air quality management plan for the SDIB, the undertaking of a health risk analysis and an epidemiological study to determine the extent of various pollutants impact(s) on peoples' health (Carnie, 2000a; Carnie, 2000c; Hallowes, 2001). Although this was a positive sign, the community was cautious as these commitments would not necessarily be translated into action until there was a powerful, well-resourced pollution inspectorate (Carnie, 2000a).

Given this historical context, the main focus of many South Durban community groups was concern regarding the potential adverse effects of ambient air pollution, especially from industry, on the health of their constituencies. In an effort to solve the chronic air pollution problems affecting the residents in the SDIB, the community decided to take the matter to court using the Settlers Primary School in Merebank as a test case (Premdev and Govender, 2000).

2.2. SETTLERS PRIMARY SCHOOL:

The Settlers School is located in Lakhimpur Road, Merebank (a pre-dominantly Indian suburb) in South Durban at 29^0 57' 31'' S, 30^0 58' 45'' E, at an elevation of about 17m. The school is approximately 500m away from the Engen Refinery (see Plates 2.5 and 2.6 respectively). This public school had approximately 860 learners from grades 1 to 7 and 25 staff members for the 2001 school year. Learners (either of Indian, African or Coloured origin) were primarily from a low socio-economic background. The majority of learners resided either in Merebank or Umlazi. A minority of learners lived in the surrounding suburbs of Wentworth, Lamontville and Bluff. Private vehicles or taxis transported children from the surrounding suburbs to and from the school.

Plate 2.5: Settlers Primary School (front) with Engen Refinery stacks (back) in Merebank

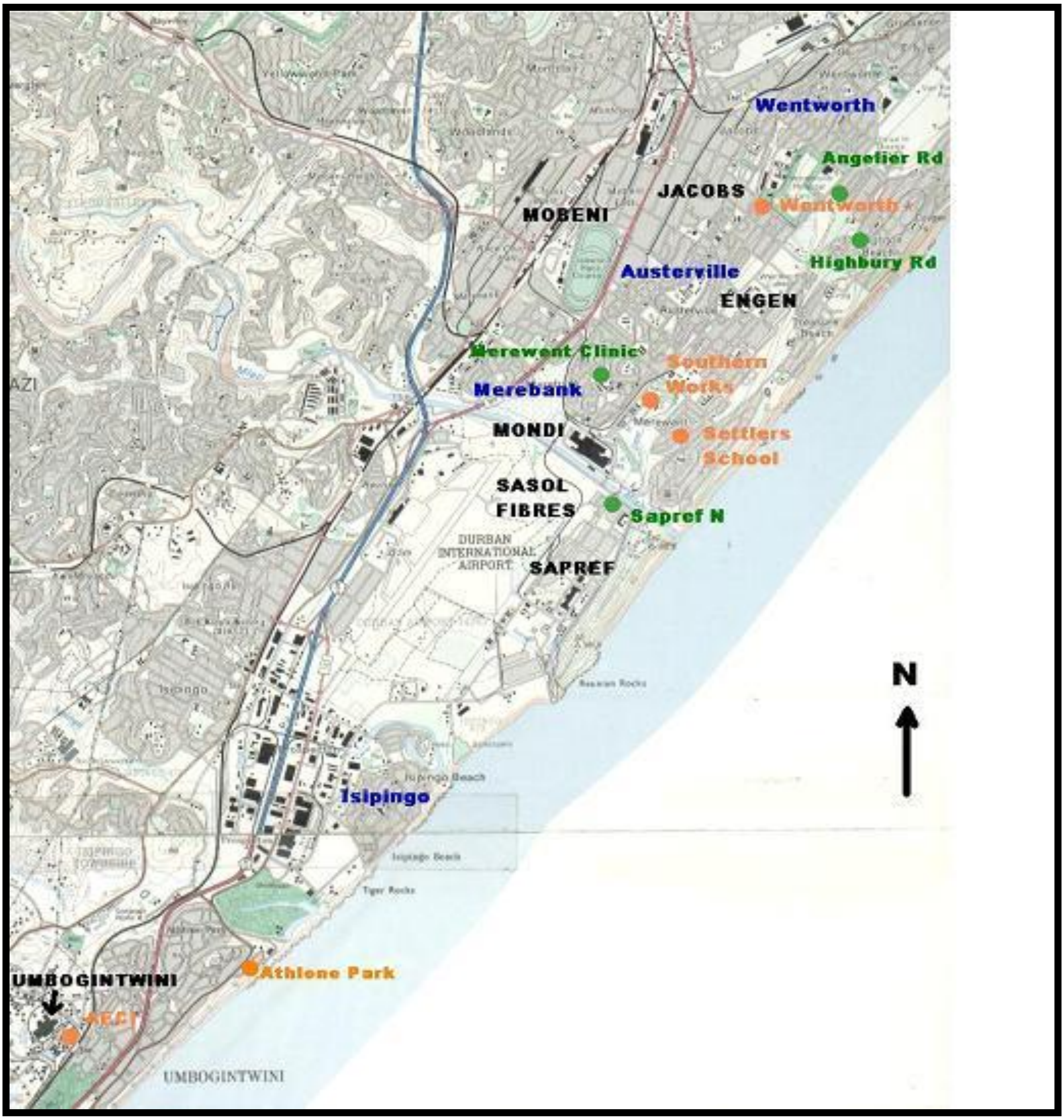
Plate 2.6: Settlers Primary School (front) with Engen Refinery's stack (back)

Anecdotal records collated from May to September 2000 by the staff of the school, suggested that there were unusually high and frequent episodes of respiratory complaints that were consistent with known pollutant effects (Premdev and Govender, 2000). The learners and staff of this school therefore perceived themselves to be at significant risk from the impacts of ambient air pollution (Premdev and Govender, 2000; Carnie, 2000b; Southlands Sun, 2000). A senior city health official noted that while pollution levels at Settlers Primary School exceeded WHO guidelines, it did not exceed South Africa's outdated and unenforceable guidelines (Carnie, 2000b).

In an unpublished study, Kistnasamy and Knapp (1991) found that learners at the Settlers Primary School were likely to report three times more respiratory symptoms of the lower tract, than learners from a school in Chatsworth which was not in close proximity to pollution sources. The study also noted that there was anecdotal evidence of many cancers in the area and merited further study (The Mercury, 1998). Since the study was never peer reviewed or published, Engen stated that the findings were inconclusive (Seeliger, 1997). However, Matkovic and colleagues (as cited by Jury, 2000) found that residents directly exposed to air polluting industries had significantly lower lung function capability than those living in non-polluted areas.

As indicated in Figure 2.3, the school is situated among a large number of industrial emission sources including Sasol Fibres, Southern Sewage Works, Engen Oil Refinery, Sapref Oil Refinery and Mondi Paper Mill [the last three collectively had been reported to emit on average, between 35 000-40 000 kilograms of SO_2 per day] (Hurt, 2001). In addition, factors such as the land contours, prevailing meteorological conditions, relatively short emission stacks (approximately 75 metres), fugitive emissions, incomplete scrubbing of refinery emissions and the proximity of other smaller polluting industries may have also contributed to the above perception (CSIR, 1999a).

Figure 2.3: Map of Settlers School in relation to local industry in the SDIB (Guastella, 2004b)

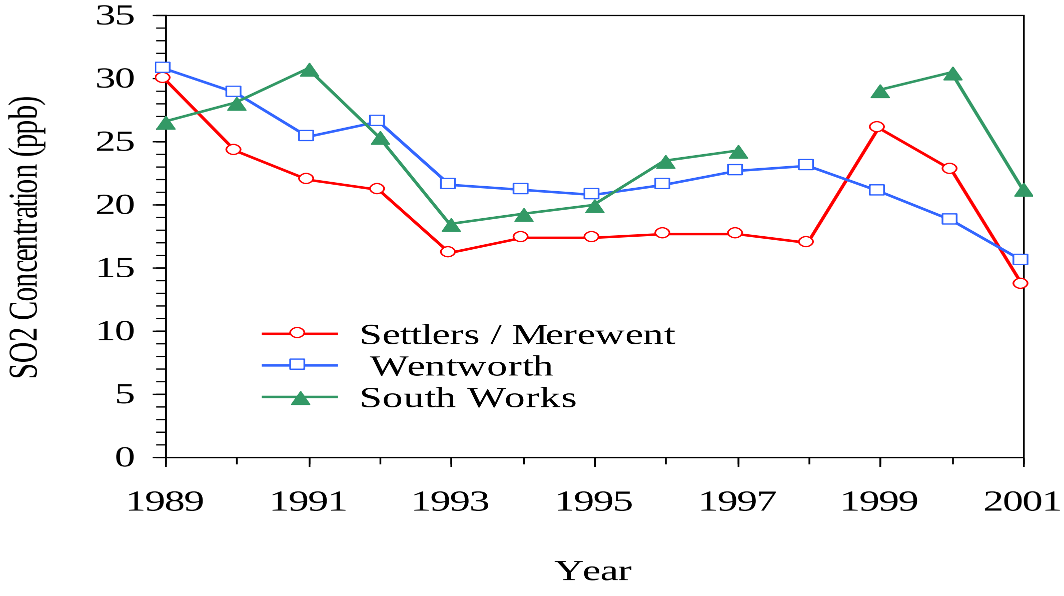


Under the auspices of the Durban metropolitan government and the industry-funded South Durban Sulphur Dioxide Steering Committee ($SDSO_2SC$), a consulting company, ECOSERV had continuously monitored the following air pollutants at the school namely, SO_2 (since June 2000) and NO_x, CO, TRS and PM_{10} since October 2000 : see Plate 2.7 below (Hurt, 2001).

Plate 2.7: Air Quality Monitoring Caravan at the Settlers School, South Durban

Figure 2.4 shows that SO_2 is the only pollutant for which long term data is available. Pollutants such as NO_x, CO and O_3 have limited data records (CSIR, 2002).

Figure 2.4: Long Term SO_2 Trends in the SDIB (CSIR, 2002)



As evidenced by an emissions inventory compiled in 2000, the major sources that contributed to ground level SO_2 concentration included major industrial installations (Sapref, Engen and Mondi) and mobile sources (ships, diesel and petrol-fuelled vehicles, railway locomotives and aircraft), with industries accounting for 66.1% whereas mobile sources accounted for 5.1% of all SO_2 emissions in South Durban (CSIR, 2002).

Available SO_2 data indicated that average and/or maximum exposures at the Settlers School had frequently exceeded the WHO and the South African standards and/or guidelines: see Table 2.3 (Hurt, 2001). A guideline is defined as any kind of recommendation or guidance on the protection of human beings from adverse effects of air pollutants while a standard is considered to be the level of an air pollutant that is adopted by a regulatory authority as enforceable (WHO Regional Publications, 2000). Monitoring of NO_x at Settlers Primary School indicated that levels were generally low with high concentrations occurring during peak traffic hours of 07h00-09h00 and 16h00-18h00 (CSIR, 2002). It was also reported that mobile sources contributed 82% of CO emissions in South Durban.

Table 2.3: National and International Air Quality Standards and Guidelines (CSIR, 2002)

Pollutant (units)	Standard/Guideline	1 hour average	24 hr average	Annual Average
SO_2 (ppb)	• SA • US EPA[1] • WHO	- - -	100 140 48	30 30 19
NO_2 (ppb)	• SA • US EPA • WHO	200 128 106	- - -	50 53 21
CO (ppm)	• US EPA • WHO	35 26	- -	- -
PM_{10} (ug/m^3)	• SA • US EPA • WHO	- - -	180 150 -	60 50 50

Where:
1 = United States Environmental Protection Agency
Note that a search of the literature did not reveal any standards or guidelines for TRS

Combinations of air pollutants may possibly, have greater effects on airway function than exposure to a single pollutant and may also enhance the asthmatic patient's reactivity to other stimuli (Barnes, 1994). Exposure to a contaminant has been defined as an event consisting of contact at a boundary between a human and the environment at a specific concentration and for a specific interval of time (John, 2001). Reviewed data had therefore indicated that South Durban communities were affected by various pollutants, some of which were found at very high concentrations above the recommended exposure guidelines while others occurred at minimal concentrations (CSIR, 2002). Given the above historical information and the cocktail of pollutants prevalent in the SDIB, there was therefore considerable interest in the relationship between air pollution and chronic respiratory diseases, including asthma. It was therefore concluded that using the Grade 3 and 6 students and staff of the Settlers School as a study population would assist in understanding the dynamics of the effects of air pollution and its relationship to asthma prevalence, especially on a vulnerable group such as children.

However, in order to operationalise the aims of this study, it was important to first have an understanding of asthma prevalence globally and the associated affects of air pollution on especially susceptible population groups as is discussed below.

2.3. ASTHMA:

2.3.1 Definition:

Asthma is a chronic inflammatory disorder of the pulmonary airway and is characterised by intermittent exacerbations that can range from acute, severe and even life threatening attacks increasing to a more indolent, gradual worsening of symptoms (Leikauf, *et al*. 1995). In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness and cough, particularly at night and/or in the early morning with an associated increase in the existing bronchial hyperresponsiveness to a variety of stimuli (Wood, 2002).

These symptoms are usually associated with widespread but variable airflow limitation and are at least partly reversible either spontaneously or with treatment (Nadel and Busse, 1998; American Thoracic Society, 2000b). Both the severity and frequency of asthma symptoms can be reduced by using medication and reducing exposure to environmental triggers[1]. There are two main types of medicines for asthma. Quick relief medicines, such as a short acting inhaled bronchodilator, are used only when needed, while persistent asthma can be treated with controller medication such as inhaled corticosteroid as this reduces the inflammation of the airways[3].

2.3.2 Diagnosis:

Accurate diagnosis of asthma is complex and continues to be under diagnosed and under treated (Helms, 2001). It is estimated that 80-90% of asthmatic children see general practice physicians for their care while an additional 10-20% are seen by pulmonologists, allergists and other clinicians (Clark, *et al*. 1999). However, a large proportion of children, primarily in low income, racial/ethnic minority communities, do not receive regular care for the disease.

Taylor (1997) noted that four commonly used diagnostic tests of asthma are spirometry, peak flow measurements, exercise testing and methacholine challenge testing (MCT). Spirometry and peak expiratory flow rate are all forced expiratory manoeuvres undertaken following a maximum inspiratory maneuver (Pearce, *et al*. 1998). The ratio of forced expiratory volume in one second (FEV_1) to forced vital capacity (FVC), measures how much air is inhaled and how fast it can be exhaled from the lungs after taking a deep breath. If results are lower than normal, as in asthma, then the airways are inflamed and narrowed[2]. A reduction in FEV_1 is closely correlated with reduced life expectancy (Beckett, 1999). Spirometry is also used to check the asthma progression/regression over time[2].

Portable hand held peak flow meters allow for multiple measurements of airflow over a period of many days while the subject goes about their usual activities (Beckett, 1999). Exercise is used as a challenge test to make a diagnosis of exercise induced bronchospasm in asthmatic patients with a history of breathlessness during or after exertion (American Thoracic Society, 2000a). MCT is most often considered when asthma is a serious possibility and a traditional method like spirometry has not established or eliminated the diagnosis (American Thoracic Society, 2000a). MCT is a well established means of evaluating the degree of airway responsiveness and is commonly used to confirm the diagnosis of asthma in patients with a history of asthma symptoms and a normal FEV_1 (Wubbel, *et al*. 2004).

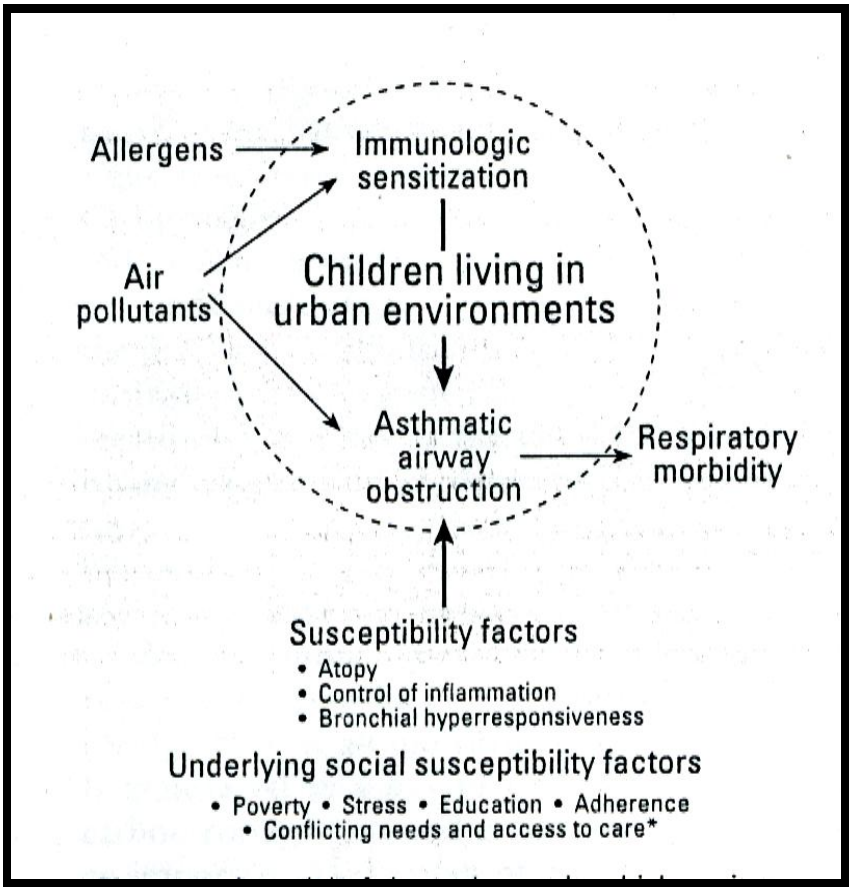
Increasing quantities of inhaled methacholine induces increasing degrees of bronchospasm in susceptible individuals where a significant amount of airflow limitation may be experienced (defined as a ≥20% fall in FEV_1 compared to baseline) in response to a threshold concentration of methacholine (typically <16 mg/mL of inhaled methacholine) and are considered to have airways hyperresponsiveness (Phillips and Schreiner, 2001). Joseph-Bowen *et al*. (2004) using a random sample of a community based cohort of 6 year olds, found that children with current asthma had small but significant deficits in lung function and were more sensitive to methacholine.

2.3.3 Risk Factors:

Lebowitz (1996) and Strachan (2000) noted that stimuli that caused an associated increase in airway responsiveness among asthmatic children were weather conditions, indoor and outdoor air pollution, respiratory infections, cold air, exercise, stress, tobacco smoke and allergens. Allergens included house dust mite, animal dander, cockroach, mould, pollen and fungal spores. Figure 2.5

illustrates the different pathways in which environmental exposures and individual susceptibility interact in children, leading to asthma.

Figure 2.5: A model of the pathways in which environmental exposures and individual susceptibility interact to lead to symptomatic asthma in children (Eggleston, *et al*. 1999)



Tortolero, *et al*. (2002) collected environmental data from 385 rooms in 60 elementary schools in Texas and found that of particular relevance were the high levels of both dust mites and mould spores. Additionally, 10% of the rooms sampled had cockroach allergen over the recommended level. Peters, *et al*. (1999) concluded that in a study of 12 Californian communities, the risk of physician diagnosed asthma was higher for males, blacks, children of asthmatic parents and those living in houses with pests, smokers and water damage.

In addition, the third National Health and Nutrition Examination Survey (NHANES III) conducted between 1988 to 1994, indicated that race/ethnicity, female gender, socio-economic status (SES), obesity, hay fever and pet ownership are important factors for evaluating asthma aggravation (Arif, *et al*. 2003).

The United States (US) Department of Health and Human Services noted in their Strategic Plan that although asthma affected Americans of all ages, races and ethnic groups, that low income and minority populations experienced substantially higher rates of fatalities, hospital admissions and emergency room visits due to asthma[1]. Weiss, Gergen and Crain (1992) indicated that in the US, the subpopulations at greater risk were ethnic minorities who were both poor and resided in certain urban environments such as inner cities that often had high poverty rates.

According to Poyser, *et al*. (2002), other contributing factors to chronic asthma were lack of access to medical care, reduced financial resources and scarce social support. However, Miller (2000) observed that asthma prevalence, hospitalisation and emergency room use declined with increasing income for non-Black but not for Black children. The National Cooperative Inner-City Asthma Study in the US (Kattan, *et al*. 1997) revealed that for predominantly poor African Americans and Hispanics, asthmatic symptoms were severe enough to impact on school attendance, sleep and caretaker activities.

Bearer (1995) explained the increased susceptibility of children to asthma by noting that children differed from adults in the following physiological areas:

pathways of absorption, tissue distribution, ability to biotransform and eliminate chemicals. Also, children responded differently than adults to environmental chemicals. Each of these differences must be accounted for when considering the health impacts of a particular exposure on children.

An understanding of the family environment is important and factors that contributed to asthma morbidity and mortality, for example, family dysfunction had been identified as an important risk factor for asthma mortality (Weiss, Gergen and Crain, 1992). Also in urban living, psychosocial factors such as lack of supportive relationships, insufficient community resources, economic worries and violence can contribute to increased asthma morbidity and mortality (Etzel, 2003). Other risk factors of increased crime, noise pollution and unsafe transportation may also impact on efforts to manage a child's or adult's asthma (Clark, *et al*. 1999).

2.3.4 Economic Costs:

Taking care of asthmatics is expensive and imposes financial burdens on patients and their families, including lost school and work days, loss of income and lost job opportunities as evidenced in the US where asthma is one of the leading causes of school absenteeism, accounting for over 10 million missed school days annually[1]. In addition, there are many nights of lost sleep, disruption of family and caregiver routines, generally restricting normal activities. In the US, asthma accounted for one third of all paediatric emergency department visits and was the fourth most common cause for physician office visits, which had costs in terms of monetary expenditure and human suffering (Becker, 2000). There were also substantial personal and financial costs leading to enormous direct and indirect expenditures for respective parents and children (Wood, 2002).

Illness associated with asthma accounted in the US for an estimated 27 million patient visits and 470 000 hospital admissions annually which translated into an estimated loss of 3 million workdays and 90 million days of restricted activity (Wood, 2002). The costs related to asthma were therefore enormous with an estimated cost in the US in 1990 of $6.2 billion (Koren and Utell, 1997). In 1998, the National Heart, Lung and Blood Institute estimated that the annual cost of asthma was $11.3 billion per year[1]. This estimate was inclusive of $7.5 billion in direct medical expenses and $3.8 billion in indirect expenses such as lost workdays for adults with asthma and lifetime earnings lost due to mortality from asthma.

In spite of active research and preventive efforts, the asthma related death rate for US children increased by 78% between 1980 and 1993 (McGovern, 2002). A literature search has indicated that similar statistics for the economic impacts of asthma in developing countries has not yet been established.

Given the above discussion on the definition of asthma, its diagnosis, the associated primary and secondary risk factors and the economic costs on patients and families, it is evident that the burden of asthma requires research priority regarding the factors that cause asthma and the use of primary and secondary intervention strategies to decrease asthma morbidity and mortality. This will ensure that cost-effective management approaches will be made available to many asthmatics worldwide.

2.4. ASTHMA PREVALENCE:

The prevalence of asthma and wheezing among children has increased worldwide. Current US estimates show that the number of children with asthma has increased by about 150% in the past 20 years (Wood, 2002). Further, the increase has occurred in both genders and in all ethnic groups with the sharpest increases occurring in children younger than 5 years and predominantly in minority populations within urban areas.

Asthma is a particular problem for schools and public health departments in the US as asthma exacerbations can be very disruptive to entire classrooms (Lurie, *et al*. 1998). Asthma affected approximately 10.2 million adults during 1996 and is among the most common chronic disease in the US (Bresnitz, *et al.* 2001; Helms, 2001). The NHANES III project using a total of 18 393 US adults greater than 20 years recorded the prevalence of current asthma as 4.5% and the prevalence of wheezing as 16.4% (Arif, *et al*. 2003).

Table 2.4 shows global and regional comparisons of asthma prevalence in 463 801 adolescents aged 13-14 years that participated in the International Study of Asthma and Allergies in Childhood (ISAAC) in 155 collaborating centres in 56 countries (Ehrlich, 2002).

Table 2.4: ISAAC: global and regional comparisons of asthma prevalence in adolescents aged 13-14 years (Ehrlich, 2002)

Region/Centre	Asthma prevalence (%)
Australia	28.2
United Kingdom	20.7
North America	16.5
Latin America	13.4
Cape Town	13.3
Global average	11.3
Western Europe	10.3
Asia (excluding India)	9.4
Africa (excluding South Africa)	9.1
India	4.5
Northern and Eastern Europe	4.4

Kaur, *et al*. (1998) found that in the ISAAC United Kingdom study that although the prevalence of asthma symptoms, diagnosis of asthma and current use of inhalers in 12-14 year old children across Great Britain was high, factors such as climate and outdoor environment were not the main determinants of prevalence.

Koren and Utell (1997) found that asthma was more prevalent among 6-11 year old American Black children than among White children of the same age while Evans (1992) noted that prevalence rates were significantly higher for boys than for girls and an even higher prevalence was observed among children of Puerto Rican descent. A cross sectional study conducted by Grant, Lyttle and Weiss (2000) on US asthma mortality records from 1991-1996 for the age groups 5-34 years, concluded that Black race/ethnicity appeared to be associated, independently from low income and low education, with an elevated risk for asthma mortality.

Kattan, *et al*. (1997) noted that although hospitalisation was an infrequent event, asthmatic symptoms were severe and frequent enough to have an impact on school attendance, sleep and caretaker activities. The Childhood Asthma Management Programme (CAMP) conducted from 1993-1995 in the US, with a total enrolment of 1 041 children aged between 5-12 years with asthma of mild-to-moderate severity, concluded that participants who had a past hospitalisation for acute asthma had greater asthma severity, younger age of onset and lower patient IQ than participants without prior hospitalisation (Bacharier, *et al*. 2003).

Nadel and Busse (1998) found that in 1982, the prevalence of asthma in Australian 8-11 year olds was 12.9% but in 1992, the prevalence in the same age bracket soared to 29.7%. Between 1980 and 1993, the childhood asthma rate has doubled to greater than 11% in the general population in Israel while Costa Rica, Panama, Brazil, Peru and Uruguay all now have childhood asthma rates of greater than 2% (McGovern, 2002). Jewish children had a higher prevalence (13.7% vs. 9.4%) of bronchial asthma than their Arab counterparts in a study conducted on schoolchildren of different ethnic origins from two neighbouring towns in Israel (Kivity, *et al*. 2001).

In developing countries, asthma prevalence was previously considered to be low but recent studies have shown that childhood asthma is on the increase (Weinberg, 2001). These increases were especially notable for those living in urban areas and there was a considerable difference in the prevalence of childhood asthma between countries and amid urban and rural areas. Epidemiological studies, mainly using exercise challenge tests in study populations, have shown that the prevalence of exercise induced asthma is greater among children in urban than in rural areas and may be due to increased exposure to both indoor and outdoor allergens, irritants and pollutants (Weinberg, 2001).

Yemaneberhan, *et al.* (1997) compared the prevalence of wheeze and asthma in urban and rural Ethiopia and found that all respiratory symptoms were rare in children and significantly less common in the rural than in the urban group with asthma prevalence reported to be 3.6% of the study population. Ng'ang'a, *et al.* (1998) undertook an urban-rural comparison of the prevalence of exercise induced bronchospasm (EIB) in Kenyan school children and concluded that the EIB rates in this study (22.9% of urban children) were higher than any other reported for African children. A further study in Harare's urban area found that asthma prevalence in the study population was 5.8% (as cited by Nriagu, *et al*. 1999).

Population based studies of asthma in SA, as noted in Table 2.5, were scarce, with the majority being of populations in the Transkei, Cape Town, Gauteng, North West Province and Durban with variations in the populations studied, age range and asthma measures used, making strict comparison difficult (Ehrlich, 2002). However, 213 households from the communities of Merewent and Austerville participated in a cross sectional study in south-central Durban, SA and approximately 10% of the 367 children and 12% of the 693 adults reported doctor diagnosed asthma (Nriagu, *et al*. 1999).

Also, a prospective study describing the nature of asthma in black children from Soweto, SA, investigated 455 black patients attending the children's asthma clinic at the Baragwanath Hospital, Johannesburg over a 18-month period from

November 1991 to May 1993 and found that differences between patient populations seemed more likely to be environmental than racial (Luyt, *et al*. 1995). Nagel (1993), in a study investigating the prevalence of childhood asthma in white primary schoolchildren in the southern suburbs of Cape Town, concluded that 52 (4.4%) of the 1 174 children studied had asthma and noted that this prevalence was higher than 3.1% reported in a previous study on black children in Gugulethu.

Table 2.5: Population based studies of asthma undertaken in South Africa (Ehrlich, 2002)

Type	Study (year published)	Population (number, age range)	Prevalence (%)
Non-specific bronchial hyperresponsiveness in SA populations	Van Niekerk *et al.* (1979)	Transkei (671, 6-9 yr) Gugulethu, CT* (694, 6-9 yr)	0.14 rural 3.17 urban
	Vermeulen (1990)	Transkei (1 014, 8-16 yr)	14.2
	Terblanche and Stewart (1990)	Northern suburbs, CT* (1 192, 6-19 yr)	5.1
	Nagel (1992)	Southern suburbs, CT* (1 180, 12 yr)	4.1
	Calvert and Burney (2000)	Transkei (1 672, 8-13 yr) Khayelitsha, CT* (1 632, 8-13 yr)	8.7 rural 14.5 urban
Self reported asthma in child and adolescent populations in SA	Burr *et al*. (1994)	Southern suburbs, CT* (1 180, 12 yr)	11.5
	Ehrlich *et al.* (1995)	Mitchell's Plain, CT* (1 955, 6-10 yr)	10.8
	Pather *et al.* (1999)	Mitchell's Plain, CT* (17 446, 2-15 yr)	13.1(2-6 yr) 11.2(7-12 yr)
	Nriagu *et al*. (1999)	Durban (367, <17 yr)	10
	Poyser (2000)	CT* (15 178, 13-14 yr)	13.3
Asthma (a) and symptoms of airflow obstruction (ao) in South African adult populations	Wicht and Kotze (1979)	Belville, CT* (507, 20-80 yr)	7.8 male 11.9 female
	Nriagu *et al.* (1999)	Durban (693, ≥17 yr)	28 (ao) 12 (a)

* CT = Cape Town

From the literature above, it can be noted that the burden of asthma in many countries is of sufficient magnitude to warrant its recognition as a priority disorder in government health strategies. Resources need to be made available to improve the care of disadvantaged groups including those with high morbidity who are of a certain racial group, may be poorly educated with a low socio-economic status and living in large cities[4]. In addition, resources need to be provided to address preventable factors such as air pollution which can trigger exacerbations of asthma.

2.5. RELATIONSHIP BETWEEN ASTHMA AND AIR POLLUTION:

The health effects of outdoor air pollution is a public health concern in developing and developed countries alike and megacities have the potential to generate unprecedented air quality problems (American Thoracic Society, 2000b). Air pollution principally affects the respiratory, circulatory and olfactory systems with the respiratory system been the main route of entry for air pollutants, some of which may alter the function of the lungs (Boubel, *et al*. 1994).

It should be noted that the critical underlying pathophysiologic process in asthma is chronic inflammation of the airway epithelium (lining) and is generally believed that, in asthmatics, exposure to ambient air pollutants sets off a cascade of pro-inflammatory chemical and cellular changes in the airways which typically take periods of roughly 24 to 48 hours to fully develop and therefore health effects can be induced not only on the days of exposure but also on subsequent days (Braga, *et al*. 2001).

Barnes (1994) noted that there are several ways in which air pollutants may have effects on the human airway:

- The pollutants may act as a trigger/inciter when the airways are hyperresponsive, resulting in airway narrowing;
- The pollutant may act as an inducer to increase airway inflammation and airways hyperresponsive, which may persist beyond the exposure time;
- The pollutant may have a direct toxic effect on the airways, leading to asthma-like symptoms in normal individuals and;
- The pollutant may affect the immune system resulting in sensitization or increase allergic response in the airway.

However, Clark, *et al*. 1999 noted that studies that determined direct causation between outdoor air pollution and asthma prevalence were inadequate. Although the ISAAC Study showed that the global pattern of asthma prevalence was consistent with evidence that air pollution was not a major risk factor for the development of asthma in populations (Ehrlich, 2002), a number of limitations needed to be recognised in the interpretation of such data. These limitations included such factors as biases in the comparability of information and that the prevalence of current asthma symptoms may not be equivalent to the prevalence of clinical asthma[4]. Further, wide variations in the prevalence of current asthma symptoms were often observed between centres within the same country and it was recognised that the prevalence of asthma symptoms was generally higher in urban than in rural areas.

However, secondary factors including geographical and climatic variation, industrial patterns, cultural factors, government policy, population differences, genetic make-up, respiratory infections during childhood, active and passive tobacco smoke and indoor air pollution, of which some may be more influential than outdoor air pollution could exacerbate asthma prevalence and further research is therefore needed as regards the individual and synergistic effects of these factors (Chhabra, *et al*. 2001; Rahman, *et al*. 2001). In general, however, a review of the literature indicated that air pollution was a major contributing factor to asthma prevalence despite the input by Clark etc.

Respiratory morbidity due to air pollution is indicated by increases in doctors' office and emergency room visits, hospital admissions and the increased use of medication (Fauroux, *et al*. 2000). Increased mortality from cardiopulmonary disease and cancer has been noted in areas with elevated air pollution concentrations while increased morbidity was associated with environmental exposure including respiratory symptoms and decreased pulmonary function (Leikauf, *et al*. 1995). Children, the elderly and persons with chronic heart and lung disease are particularly vulnerable to air pollution (Samet, 2001). Poor air quality appeared to exacerbate symptoms in a child who already presented with the disease (Tattersfield, 1996; Lee, *et al*. 2002). The impact of air pollutants on children's' health was further complicated by the number and type of air pollutant and by the variety of indicators of adverse health effects (Bates, 1995).

Table 2.6 indicates levels at which adverse health effects could be anticipated with respect to PM_{10}, SO_2, CO, O_3 and NO_2.

Table 2.6: Comparison of pollutant levels and general health effects (Boubel, Fox, Turner and Stern, 1994)

Pollutant level					**Health effects**
PM_{10} (24hr) µg/m^3	**SO_2 (24hr) µg/m^3**	**CO (8hr) mg/m^3**	**O_3 (1hr) µg/m^3**	**NO_2 (1hr) µg/m^3**	
≥ 500	≥ 2100	≥ 46.0	≥ 1000	≥ 3000	Premature death of ill and elderly. Healthy people will experience adverse symptoms that affect their normal activity
420-500	1600-2099	43.0-45.9	800-1000	2260-2999	Premature onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons
380-420	800-1599	17.0-33.9	400-800	1130-2259	Significant aggravation of symptoms and decreased exercise tolerance in persons with heart, or lung disease with widespread symptoms in the healthy population
150-380	365-799	10.0-16.9	235-400	-	Mild aggravation of symptoms in susceptible people with irritation symptoms in the healthy population

The location in which schools are placed is an important public health consideration (Korenstein and Piazza, 2002). Pastor, Sadd and Morello-Frosch (2002) in a study conducted in Los Angeles, indicated that minority students, especially Latinos, were more likely to attend schools situated near hazardous facilities and faced higher health risks associated with outdoor air pollution. In a similar study, an exposure assessment revealed that children attending four schools situated in close proximity to major roadways in the Los Angeles area were exposed to PM_{10} doses approaching 10-15 µg/m^3, an exposure predicted to cause negative health effects (Korenstein and Piazza, 2002).

Dependent on the height and mobility of the child, the breathing zone for a child is closer to the floor and it is within these breathing zones that heavier chemicals, such as respirable particulates, settle out. Also, Bearer (1995) noted that due to the high metabolic rate of children, their oxygen consumption rate was greater than adults per kilogram of body weight, and therefore their exposure to any air pollutant was higher.

Criteria pollutants (principal pollutants monitored for regulatory purposes) such as SO_X, NO_x, O_3, CO, PM_{10} and other risk factors such as exposure to environmental tobacco smoke and volatile organic compounds (VOCs), are constantly being evaluated as to their possible contributions to the adverse impact on the health of susceptible individuals (Leikauf, *et al*. 1995; American Thoracic Society, 2000b). The main sources of ambient pollutants are from industrial sources, vehicle emissions and domestic heating (Barnes, 1994). Delfino, *et al.* (2003) found positive associations between SO_2, NO_2, O_3, PM_{10} and VOCs and asthma symptoms in Hispanic children. The main concern was that other atmospheric pollutants such as CO, formaldehyde, secondary aldehydes and a mixture of short lived radicals may be contributing to asthma symptoms but research on their airway effects at relevant concentrations, is limited (Barnes, 1994).

Many of the published studies on the effects of air pollution on human health are related to the effects of outdoor air pollution on children of Caucasian descent from North American and Europe (Tattersfield, 1996). Children from these countries were usually of good nutritional status, living in uncrowded conditions, without physical stress or untreated chronic diseases (Murray, McGranahan and Kuylenstierna, 2001). These studies reported on the associated exposures to O_3, acid aerosols, particulates, NO_x, and SO_2 (Ayres, 1994). There were fewer studies in westernised countries on populations of other ethnic backgrounds, nutritional status, living conditions, stress, history of chronic diseases or studies of indoor air pollution (Murray, McGranahan and Kuylenstierna, 2001).

The results of a 1995 Dutch panel study of 61 children, aged 7 to 13 years, of whom 77% were taking asthma medication, noted that significant decreases in peak flow were found in the morning and in the evening and that acute respiratory symptoms and bronchodilator use significantly increased when pollutant concentrations were elevated (Gielen, *et al*. 1997). Yu, *et al*. (2000) indicated that more studies have found a correlation between SO_2 and NO_2 and symptoms in children with asthma. For example, in Paris, where a significant relationship was found between asthma aggravation and SO_2 concentrations while in another study in Sweden, the strongest association was seen with NO_2. In the US, decreased pulmonary function was associated with exposure to particulates and bronchial responsiveness to smoke, NO_2 and SO_2 (Sheldon, 1999; Clark, *et al*. 1999). These symptoms correlated with increased levels of PM, O_3 and SO_2.

Asthmatics appeared to be more susceptible to short term peak concentrations of air pollutants and when concentrations were high, evidence showed that suspended particles exacerbated asthma symptoms (Lebowitz, 1996). Even in countries like Switzerland, with moderate air pollution concentrations, rates of respiratory illnesses and symptoms among children were augmented with increasing levels of air pollution (Braun-Fahrlander, *et* al. 1997). With public pressure for less polluted air in cities, the availability of relatively cheap clean fuels and strong economic growth, governments in developed countries have slowly introduced measures to improve ambient air quality in cities (Murray, McGranahan and Kuylenstierna, 2001).

However, in many countries of the developing world, concentrations of air pollutants are rising with industrialisation and the increasing number of motor vehicles (American Thoracic Society, 2000b). Appreciable risks were found in studies relating to particulate concentrations and mortality in Santiago, Mexico City and Bangkok (Romieu, *et al*. 1996; Murray, McGranahan and Kuylenstierna, 2001).

In a study conducted in Sao Paulo, Brazil, Braga, *et al*. (2001) showed that daily respiratory hospital admissions for children and adolescents increased with air pollution and that the largest effects were found for the youngest, $\leq$2 years and oldest, 14-19 years. In central Taiwan, where the subjects were asthmatics from 8 junior high schools, study investigators noted that the increased risk of asthma and the frequency of monthly hospital admissions among asthmatics correlated positively for NO_2 and PM_{10} (Kuo, *et al*. 2002).

There are several major criteria pollutants in ambient air and their effects have been studied separately and in combination (Barnes, 1994). The following sub-sections will further explore the association between asthma and each criteria pollutant including TRS. These air pollutants were considered relevant in terms of the aims of this study.

2.6 ASSOCIATION BETWEEN ASTHMA AND:

2.6.1 Sulphur Dioxide (SO_2):

More than 1.2 billion people may be exposed to excessive levels of SO_2 emitted primarily by coal- and oil-fired plants and by industrial processes involving fossil fuel combustion (Murray, McGranahan and Kuylenstierna, 2001). SO_2 is a respiratory irritant that is mostly absorbed in the upper airways but increasing ventilation results in deposition in deeper parts of the lung (Koren, 1995). In ambient air, SO_2 along with other pollutants, may form an aerosol of sulphuric acid and a mix of other acids such as nitric, hydrochloric and acid fog (Barnes, 1994).

Exposure to SO_2 is marked by increased incidence and prevalence of respiratory symptoms, increased hospital visits for respiratory illnesses and impaired lung function (CSIR, 2002). Asthmatics, especially when exercising, are generally 10 times more sensitive to SO_2 than non-asthmatics (Carlisle and Sharp, 2001). For normal subjects, SO_2 concentrations of >5 ppm are usually required to provoke bronchoconstriction whereas for asthmatics, this develops at concentrations of >1 ppm (Barnes, 1994). Thurston and Bates (2003) found that air pollution was implicated as an inflammatory factor since individuals with asthma were shown to be more sensitive to SO_2 than those without asthma. Exposure to low levels of SO_2 does alter the lung function of asthmatics e.g. when exercising in air containing SO_2, asthmatics developed bronchoconstriction within minutes, even at levels as low as 0.25 ppm (Koren, 1995).

Although current levels of SO_2 were lower than past years, the collaborative European Air Pollution Health Project (APHEA) reported that daily admissions for childhood asthma in Barcelona, Helsinki, London and Paris remained significantly associated with increased SO_2 levels (Thompson, Shields and Patterson, 2001). A survey of SO_2 pollution and associated health risk in the SDIB concluded that it was possible to have sensitive individuals such as asthmatics react adversely to current SO_2 exposure levels (Matooane and Diab, 2002).

2.6.2 Oxides of Nitrogen (NO_x):

NO_x, of which NO_2 is the major component, are derived from vehicular emissions (principal source), power plants and fossil fuel-burning industries (Barnes, 1994; Koren, 1995). NO_2 is an oxidant gas that can penetrate deep into the lungs and damage delicate lung tissues (Etzel, 2003). In South Durban, a summary of the NO_x emissions inventory compiled in the year 2000, reported that vehicular emissions accounted for approximately 60% of all NO_x emissions (CSIR, 2002).

Barnes (1994) noted that there was little evidence that NO_2, even at the peak levels recorded, had any significant effect on airway function in normal or asthmatic individuals. However, subsequent studies have suggested that respiratory and allergic symptoms were more frequent in children living close to busy roads or near roads with high densities of heavy traffic with primarily diesel emissions (Brunekreef, 2001). Also, due to the use of kerosene in heating and for cooking in households, NO_2 occurred indoors and indoor levels could exceed those outdoors (Koren, 1995).

For short term exposures, concentrations of NO_2 below 4000 parts per billion (ppb) were likely to be associated with a small change in bronchial responsiveness only (Tattersfield, 1996). In studies conducted in Japan (Shima, *et al*. 2002) and in Seoul, Korea (Lee, *et al*. 2002), it was ascertained that incidence rates of asthma and the frequency of monthly hospital admissions correlated positively with atmospheric concentrations of NO_2. Shima and Adachi (2000) noted that a 10 ppb increase of outdoor NO_2 concentration was associated with an increased incidence of wheeze and asthma.

2.6.3 Ozone (O_3):

O_3 is a powerful oxidising agent formed by the action of sunlight on NO_2 in the presence of hydrocarbons resulting in photochemical smog (Barnes, 1994). Levels of O_3 were usually greatest on hot summer days and reached their peak in the late afternoons (Etzel, 2003). Controlled human exposure studies have demonstrated that the lung responds to O_3 exposure, by an irritative cough and substernal chest pain on inspiration; decrease in FVC and FEV_1 and increase in specific airway resistance and airway responsiveness and these affects wear off over 12-24 hours (Koren, 1995; Tattersfield, 1996). Barnes (1994) indicated that O_3 in high concentrations may increase airway responsiveness in both normal and asthmatic subjects by inducing airway inflammation.

O_3 was the pollutant most consistently associated with adverse health affects including acute asthma exacerbations in asthmatic children, attending a summer camp in the US, during the last week of June 1991, 1992 and 1993 respectively (Thurston, *et al*. 1997). Researchers, in a study undertaken on children with mild asthma and resident in the south of Mexico City, concluded that the study population was adversely affected by the high O_3 ambient levels observed in the area (Romieu, *et al*. 1997).

A cross sectional study of six primary schools in Sydney, revealed that moderate levels of ambient O_3 have an adverse health effect on children who have an history of wheezing and especially in children with bronchial hyper-reactivity and a doctor diagnosis of asthma (Jalaludin, *et al*. 2000). Fauroux, *et al*. (2000) noted that there was a significant relationship between O_3 and emergency room visits for acute asthma in Parisian children. However, in a Dutch study, Hoek and Brunekreef (1995) found that there were no associations of acute respiratory symptoms with same or previous day O_3 levels.

In a cohort of 4th grade school children who resided in 12 southern California communities, Gilliland, *et al*. (2001) found that short term change in O_3 was associated with a substantial increase in school absences due to both upper and lower respiratory illness. Ross, *et al*. (2002) in an Illinois study on asthmatics noted that exposure to both O_3 and pollen (individually or combined) was associated with adverse respiratory effects. O_3 was also associated with an increase in asthma attacks, respiratory infections, greater bronchodilator use, changes in lung function and irritation of the eyes, nose and throat in a study conducted on eighty two French medically diagnosed asthmatic children (Just, *et* al. 2002). Gent, *et al*. (2003) found that an immediate, same day effect of O_3 was significantly associated with increased risk of chest tightness and shortness of breath in asthmatics.

2.6.4 Total Reduced Sulphur (TRS):

The main sources of total reduced sulphur compounds [such as hydrogen sulphide (H_2S), methyl mercaptan (CH_3SH) and methyl sulphide] are the paper and pulp industry, coke ovens and refineries (Haahtela, *et al*. 1992; Abelsohn, *et al*. 2002). Haahtela, *et al*. (1992) evaluated the acute health effects of H_2S on 66 subjects in South Karelia, Finland by comparing the occurrence of symptoms during high and low exposure periods. Over the two emission days of high exposure, the 24-hour ambient air concentrations of H_2S were 35 and 43 $\mu g/m^3$ respectively, with the highest 4-hour concentration of H_2S=135 $\mu g/m^3$ and noted that 63% of the respondents reported experiencing at least one symptom during the high exposure period as compared to 26% during the low exposure period.

2.6.5 Carbon Monoxide (CO):

CO is a colourless and odourless toxic gas that causes hypoxia by the formation of carboxyhaemoglobin and by decreasing the delivery of oxygen to the tissues and to compensate, the heart must work harder and beat more frequently (Carlisle and Sharp, 2001). CO is emitted from the incomplete combustion of carbon containing fuels with the predominant source being gasoline powered vehicles while emissions from diesel engines and stationary combustion plants are fairly small (Harrison, 1999). In the 1997 Haze Disaster in Indonesia, investigators discovered that concentrations of CO and PM_{10} reached "very unhealthy and hazardous" levels where >90% of the 543 respondents had respiratory symptoms and elderly individuals suffered a serious deterioration of overall health (Kunii, *et al*. 2002). In a study investigating the short term effects of PM and CO on asthma symptoms and medication use in a group of asthmatic children from Seattle, Slaughter, *et al*. (2003) found that there were stronger associations between asthma severity and rescue inhaler use with CO than with PM. Braga, *et al*. (2001) and Lin, *et al*. (2003) concluded from the results of studies conducted on adolescents (14-19 years) in Sao Paulo, Brazil and asthma hospitalisation data of children (6-12 years) in metropolitan Toronto, respectively, that CO was positively and statistically correlated with increases in respiratory hospital admissions.

2.6.6 Respirable Particulate Matter less than 10 microns (PM_{10}):

Particulate matter (PM), an important component of air pollution, is a complex aerosol of solid and liquid organic and inorganic material and includes dust, soot, smoke, pollens, acid droplets and secondary aerosols and is measured as total suspended particulates or as PM_{10} [measures only those respirable particles <10 µm] (Barnes, 1994; Slaughter, *et al*. 2003). High particulate concentrations were associated with substantial short term increases in morbidity and mortality, especially with people who had cardiopulmonary disease and asthma, during dramatic air pollution episodes in London in the 1960s, in Ohio, 1974 to 1984 and in Philadelphia, Colorado and the Utah Valley during the latter part of the century (Koren, 1995).

In Anchorage, Alaska, where PM_{10} is composed primarily of earth crustal material and volcanic ash, investigators correlated that an increase in 10µg/m^3 in PM_{10} resulted in a 3-6% increase in hospital visits for asthma and a 1-3% increase in visits for upper respiratory diseases (Gordian, *et al*. 1996). Vedal, *et al*. (1998), in a study investigating the acute effects of PM_{10} in asthmatic and nonasthmatic children, concluded that asthmatic children were more susceptible as they experienced reductions in peak respiratory flow (PEF) and increased asthmatic symptoms after increases in relatively low PM_{10} concentrations.

Ostro, *et al*. (2001) study findings suggested that acute exposure to ambient PM was associated with exacerbation of respiratory symptoms in African-American asthmatics. Evidence was also provided by Horak, *et al*. (2002) in a 3 year prospective cohort study of 975 Austrian elementary schoolchildren where long term exposure to PM_{10} had a significant negative effect on the development of pulmonary function. Slaughter, *et al*. (2003) found that PM_{10} was significantly associated with an increased risk of more severe asthma attacks and medication use in the Seattle area in asthmatic children participating in the CAMP study.

Although this study was unable to measure $PM_{2.5}$, note must be taken that $PM_{2.5}$ consisting mainly of combustion particles from motor vehicles (which tend to be elevated near busy streets) and the burning of coal, fuel oil and wood does have adverse health effects on susceptible populations (Laden, *et al*. 2000). In a study conducted in Toronto, exposure to $PM_{2.5}$ had a significant effect on admission rates for a subset of respiratory diagnoses including asthma (Buckeridge, *et al*. 2002). Long term exposure to $PM_{2.5}$ has been associated with an increased risk of premature death, principally due to respiratory or cardiovascular disease while short term exposure has been linked to premature death, respiratory or cardiovascular hospitalizations, respiratory symptoms and other morbidity outcomes (Levy, 2003).

Krzyzanowsk and Schwela (1999) noted that rapid growth of the population in cities, levels of air pollutants, development of industry and intensification of road traffic can pose significant health challenges to susceptible individuals and vulnerable sub-populations such as the elderly, children and infirmed. This literature review has greatly emphasized the fact that intervention and reduction strategies are urgently needed to decrease asthma symptoms associated with air pollutant exposure. Therefore, the next section will detail some of these strategies that have been introduced quite successfully into various societies.

2.7 RECOMMENDED INTERVENTIONS AND REDUCTION STRATEGIES TO DECREASE ASTHMA SYMPTOMS ASSOCIATED WITH EXPOSURE TO AIR POLLUTANTS:

Air pollution abatement strategies are usually political in nature and should be targeted at policies, regulation and technology in mobile and stationary sources (Kunzli, 2002). Sustained air quality improvement depends on a regional commitment and complementary national policies (Hall, 1995).

Two reduction strategies that have proved to be successful in Hong Kong and India, respectively, included:

- A respiratory health survey conducted in Hong Kong in 1989 identified significant health differences between school age children living in an industrial area with poor ambient air quality and those in a control group living in a relatively clean area (Barron, *et al*. 1995). However, ambient SO_2 levels dropped sharply and particulate levels dropped moderately when the government banned the use of high sulphur fuel in 1990. A follow-up survey found a substantial improvement in the health of children from the industrial area.

- Another abatement strategy suggested by Shannigrahi, Sharma and Fukushima (2003), is a green belt development around the industrial/urban settlement which proved to be successful in Kolkata, India.

Beardsley, Davies and Hersh (1997) in their analysis of air pollution prevention programs in the US and internationally, advised that governments should undertake the following steps to enhance environmental management:

- Create clear and bold incentives that are aligned closely enough with direct economic benefits to attract the commitment and investment of industries;
- Design a process for implementing new initiatives that feature open exchanges of information, sensible levels of stakeholder participation and, if possible, trust;
- Measure and enforce environmental performance and;
- Embody the above measures in law.

The school can also play an important role in reducing asthma prevalence as evidenced when an American school introduced an interactive CD-ROM game as an asthma educational tool and found that children participating in this program gained and retained asthma related knowledge for over 4 weeks (Yawn, *et al*. 2000). Lwebuga-Mukasa and Dunn-Georgiou (2002) in their research findings noted that a school asthma program can prove feasible and effective in reducing the frequency of asthma exacerbations at school.

MacLehose, *et al*. (2001) on investigating the levels of knowledge about the management of asthma among primary school teachers in Essex, England, concluded that increasing teachers' knowledge and access to resources should result in improved care of children with asthma in schools. Lurie, *et al*. (1998) found that while asthma education programs were designed to be conducted at schools either during or after school hours and have been shown to have positive effects on knowledge and behaviour, there were a number of practical limitations to their implementation.

To circumvent these limitations, in terms of incorporating asthma education into the traditional maths and science curricula, the following benefits, as noted by Lurie, *et al*. (1998), could arise, namely:

- It will be a population based approach to a prevalent health problem
- Asthma will be presented as a mainstream health problem, reducing the stigma of separating out asthmatics
- Additional time will not be required from other lesson plans to teach about health
- Hands on daily practice with skills needed to monitor asthma will be provided
- Real life data for students to work with will be available, stimulating scientific curiosity
- On-going daily self care, breeding confidence and responsibility for one’s own health will be encouraged
- It could potentially serve as an additional school wide mechanism for identifying asthmatic students.

As regards the clinical control of asthma, Clark, *et al*. (1999) noted that enhancing clinical practice is essential as the clinician must not only understand effective therapeutic regimens for asthma but also be able to communicate effectively about the disease so that patient self management is optimized. As a point of reference, the Thoracic Society of Australia and New Zealand developed a six step asthma management plan as a guideline for clinicians to achieve and maintain disease control (see Table 2.7).

Table 2.7: The six-step asthma management plan as a guideline for clinicians to achieve and maintain disease control (Comino and Henry, 2001)

1	Assess asthma severity	Assess overall severity when the patient is stable, not during an attack
2	Achieve best lung function	Treat with intensive asthma therapy until the 'best' lung function is achieved. Back titrate to lowest dose that maintains good symptom control and best lung function
3	Maintain best lung function and avoid trigger factors	Identify and avoid trigger factors and inappropriate medication
4	Maintain best lung function with optimal medication	Treat with the least number of medications and use the minimum doses necessary. Ensure the patient understands the difference between 'preventer', 'reliever' and 'symptom controller' medications. Take active steps to minimize the risk of adverse effects from medication.
5	Develop an action plan	Discuss and write and individualized care plan for the management of exacerbations. Detail the increases in medication doses and include when and how to gain rapid access to medical care.
6.	Educate and review regularly	Ensure patients and their families understand the disease, the rationale for their treatment and how to implement their action plan. Emphasise the need for regular review, even when asthma is well controlled. Review inhaler technique at each consultation. Review compliance at each consultation.

Another intervention strategy is the introduction of written action plans for asthma which help facilitate the early detection and treatment of an exacerbation. Gibson and Powell (2004) noted that an action plan:

- was a set of instructions prescribed to an asthmatic for use in the management of deteriorating asthma,
- was tailored to the patient's underlying asthma severity and treatment and, informed the subject when and how to modify medications and how to access the medical system in response to worsening asthma.

This chapter has endeavoured to provide as detailed a literature review as possible as regards the historical and current situation of air pollution issues in the SDIB and its associated impacts on the community. A further analysis of global and national views on asthma prevalence and its association with air pollution was presented. Thereafter, it was important to assess the impact of several pertinent pollutants and the relationship to asthma. This chapter then concluded with a number of recommended interventions and strategies to reduce asthma symptoms associated with exposure to air pollutants. To follow, the next chapter will detail the methodology undertaken in this study in order to determine the prevalence of asthma and assess if the specified air pollutants were associated with increased signs and symptoms of asthma in the study population at the Settlers Primary school.

CHAPTER 3

METHODOLOGY

3.1 OVERVIEW:

The strategy of the study was to collect daily and bi-hourly health status data through a combination of questionnaires, logs and lung function testing. Study instruments included a screening questionnaire, classification of children's asthma status, parent/caregiver baseline interview, training manual for interviewers and child's baseline interview. These were adapted with permission from the University of Michigan (see Annexure A : Letter from the University of Michigan granting permission to cite, modify and use various documents).

Health data was examined with the measured pollutant levels available, which were mainly monitored at the Settlers school, for statistical associations. The Durban Municipality managed the Settlers monitoring station. ECOSERV (a specialist environmental and occupational health consulting company) was responsible for the maintenance of the instrumentation at the school. These were run to the same standards as the other stations in the South Durban area that were accredited by the South African National Accreditation System. The company also provided comprehensive data on SO_2, CO, PM_{10}, NO_x and TRS levels present at the school during the study period. Continuous monitoring of O_3 was conducted at a nearby monitoring station located north of the school at Wentworth in South Durban.

Before conducting formal statistical analysis, preliminary analyses were performed. Frequency tables and descriptive statistics such as means and variances of the variables of interest were calculated. Statistical analyses proceeded from univariate analyses, which are used to describe the characteristics of the study population and to examine the crude associations between variables of interests. For categorical dependent variables, odds ratios were calculated. For continuous dependent variables, correlation coefficients were calculated. Multivariate analyses using multiple regression models for longitudinal data was then performed to study the effects of ambient air contaminant levels on symptoms and pulmonary function status while adjusting for potential confounding variables.

3.2 STUDY POPULATION:

The total learner population of the school was 860 in Grades 1 to 7 with ages ranging from 6 to 14 years. Each grade had 110-120 learners. The solicited learners who served as the population representative of the entire school were restricted to the learners who were in Grades 3 and 6 in the 2001 school year.

The choice of these two grades was driven by the following considerations:

i) learners in grades lower than Grade 3 may have had difficulties in completing the survey instruments and correctly performing peak flow maneuvers,

ii) the desire to have a reasonably wide age range in case of any age-specific differential effects of pollutants and,

iii) a preference for learners that would still be at the school in the 2002 school year in the event of any follow-up studies being indicated.

Also, all teachers and other adult personnel at the school (n=25) were solicited to participate as any air contaminant effects on adults may differ from those on children. Although the population of adults was too small for reliable statistical analyses, their visible participation in the study strongly encouraged participation and compliance with the protocol by the learners.

3.3 STUDY METHODLOGY:

After several meetings at the school by the investigative team with the staff and community members and an oral explanation of the study at a school assembly, a pamphlet, subject information sheet and screening questionnaire (see Annexure B: Attachments 1, 2 and 3 respectively) explaining the study plan were distributed to all learners from Grades 3 and 6 and staff on 28th March 2001 for completion by the parent or caregiver. As an additional incentive, a pizza party was given at the school to all learners and staff. Screening questionnaires were returned between 29th March and 2nd April 2001. Completed screening questionnaires were categorized into responses consistent with guidelines established by the US National Asthma and Education Programme (see Annexure C).

All learners and staff returning a screening questionnaire with responses consistent with mild persistent or moderate to severe asthma, were solicited to participate. Two Hundred and twenty two learners from Grades 3 and 6 and 25 staff agreed to participate in the entire study. Written informed consent (see Annexure D) was sought from all the parents/caregivers of the children and staff who agreed to participate.

All study instruments and any other written information distributed to the school community was available in both English and Zulu. The Zulu versions were translated from English and then backtranslated by a second independent translator to ensure that the instruments were truly equivalent and valid for understanding, language and content.

3.4 HEALTH ASSESSMENTS:

The following health assessments were used In order to determine the prevalence of asthma among learners from Grades 3 and 6 and staff at Settlers Primary School. Study instruments used below were adapted from similar surveys being used in an ongoing study in Detroit, Michigan, USA.

3.4.1 Baseline comprehensive questionnaire:

Interviewers were drawn from the community and tertiary institutions to conduct baseline interviews with the participants' parent/caregiver (see Annexure E – Attachment 1). Intensive training was conducted on the 4th June 2001 and included techniques and practice in conducting consistent and neutral interviews (see Annexure E – Attachment 2: Training of Parent and Child Interviewers - Trainee's Version). These confidential interviews were completed either at the school or at the parent/caregiver's home from 20th June to the 11th July 2001.

Components of this questionnaire included:

- demographic information;
- an assessment of the presence and severity of respiratory and other possibly relevant symptoms using standardized validated questions from

sources such as the British Medical Research Council (BMRC) and American Thoracic Society (ATS);

- validated questions to specifically address the presence and severity of asthma among participants including information concerning wheezing, coughing, chest tightness, shortness of breath, activity limitations, and medication use;
- an assessment of the utilisation of health services for asthma;
- an evaluation of the caregivers' quality of life;
- a review of the perinatal history;
- information on place of birth and residential history;
- potential confounding factors such as exercise, viral respiratory infections, exposure to cigarette smoke and pre-existing medical conditions.

Between the 15th and 18th June 2001, a similar questionnaire (see Annexure E - Attachment 3) was administered to learners on an individual basis at school while teachers completed both survey instruments.

3.4.2 Spirometry and Methacholine Challenge Testing:

Under the direction of a Senior Pulmonologist, highly experienced Technologists from the Nelson R. Mandela School of Medicine conducted spirometry and methacholine challenge testing at the school between April and September 2001. All ATS guidelines for standardization of spirometry testing was conducted and followed (American Thoracic Society, 1995). This methodology is the official technique adopted for lung function testing as performed by the ATS and can be reviewed in its entirety, as per the above reference.

Jaeger pneumotach spirometers were calibrated at least once a day with the Jaeger one litre standard caliberation syringe. Of primary interest for the spirometry was the FEV_1. Spirometry was performed in a sitting position without nose clips. Participants with an obstructive pattern at baseline ($FEV_1/FVC < 0.73$) were administered with an inhaled bronchodilator and were tested again.

Those without a baseline obstructive pattern underwent methacholine nonspecific challenge testing on a separate day by trained technologists according to an abbreviated protocol used in epidemiological surveys (European Respiratory Society, 1993). This test is a very sensitive tool for the detection and quantification of bronchial hyperreactivity in asthmatics and correlates with the severity of the disease (Avital, Godfrey and Springer, 2000). The equipment used, procedures followed, safety measures instituted and classification of tests are highlighted in Annexure F. A medical doctor was on site at all times during the nonspecific challenge testing. Special instructions were given to participants to ensure that tested individuals did not take any anti-asthmatic inhalers 12 hours before or oral asthma medications 48 hours prior, to the test.

The scientific literature was searched to find prediction values for lung function tests among populations as similar as possible to the children participating in the current study. For children of Asian Indian descent, prediction equations for peak expiratory flow, FEV_1, and FVC were taken from a study of a population of healthy Asian Indian children in Durban (Wesley, Pather and Becker, 1989). For African and coloured children, prediction equations for peak expiratory flow, FEV_1, and

FVC were taken from a study of a population of healthy children in Umtata (Shamssain, 1991).

3.4.3 Exhaled Nitric Oxide (eNO)

The concentration of eNO is increasingly used as a marker of bronchial inflammation, especially in the study of asthma (Colon-Semidey, *et al*. 2000; Barreto, *et al*. 2001; Avital, *et al*. 2001). Using a Logan R2000 nitric acid analyzer and with the assistance of a trained technician, each participant received a baseline measurement of exhaled nitric oxide using the restricted breath technique and following all recommendations of the European Respiratory Society Task Force (Kharitonov, Alving and Barnes, 1997). The maneuver was started with exhalation to residual volume (RV) followed by rapid inhalation to total lung capacity. Thereafter the patient exhaled slowly and steadily from total lung capacity over 30 seconds with an exhalation flow rate of 1l/min into a wide-bore Teflon tube connected to the side arm sampler of the analyzer. All subjects were allowed several dummy practice runs. The latter level represented the alveolar sample of NO as verified by other previous studies (Kharitonov, *et al*. 1996; Massaro and Drazen, 1996) and is the value used in the present study.

3.4.4 Intensive data collection during a two-week period

Data, as stated in 3.3.4.1 to 3.3.4.3 below, was collected intensively during the period 19th April to 6th May 2001 in order to monitor daily and hourly fluctuations in health status for correlation with fluctuations in ambient pollution levels. Based on a review of nearly one year of historical data on daily and hourly fluctuations in SO_2 levels, there was a very high probability of substantial variation in meteorological conditions and ambient pollution levels during the study period. As a guard against any potential reporting bias, both the study participants and the directly involved study personnel who conducted the health assessments were blinded to all measured pollutant levels during the data collection period. This study considered the Hawthorne effect and in order to address this, all participants were advised of the methodology prior to the commencement of the study and staff and study monitors were requested not to influence the children in answering any questions on the two symptom/activity logs.

Data collection methods during the intensive study period included:

3.4.4.1 ***Maintenance of daily symptom/activity logs***

Each participant (learner), with the assistance of a parent or other adult caretaker, was asked to keep a daily log (see Annexure G) for the five school days and two weekend days for the duration of the study period. Symptoms, activities, medication use, encounters with the medical system, and child and parent quality of life measures were recorded. These logs were used to create single day summary severity, medication, and quality of life scores for use in statistical analyses which examined the relationship between daily and seasonal fluctuations in exposure measures and fluctuations in these outcome measures.

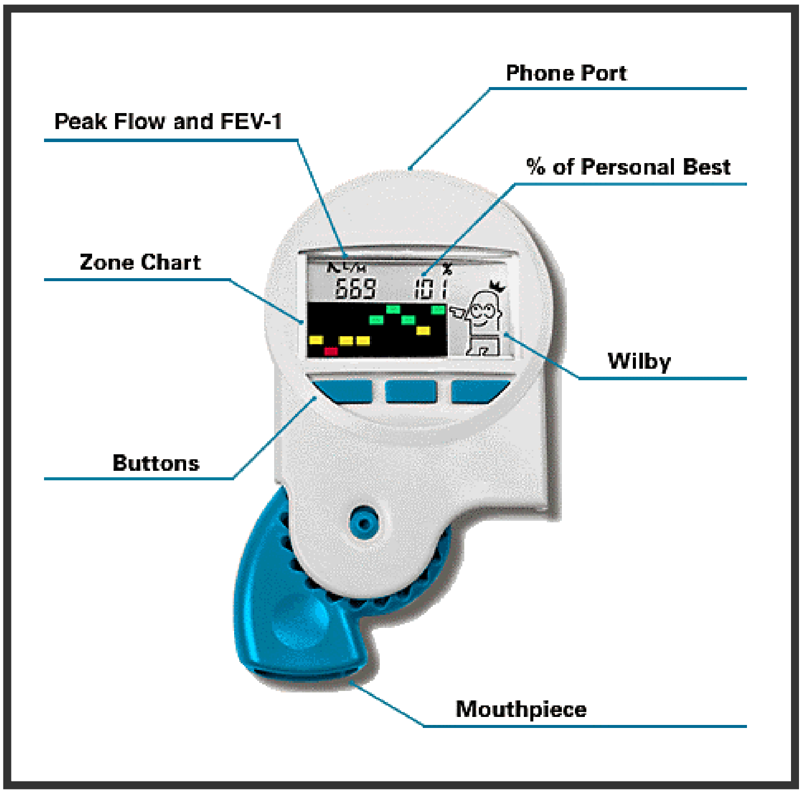
3.4.4.2 ***Completion of bi-hourly symptom/activity logs during the school day***

On each of the five schooldays during the week, participants completed a simple bihourly log (Annexure H) every one and a half to two hours (four times per 5.5 hour school day: approximately at 08h00, 09h45, 11h30 and 13h20). As all the learners, together with the teacher, had done this simultaneously in each of the sample groups, a very high compliance rate was obtained. In addition, study personnel were assigned to the classrooms during the study period to monitor these activities and provide assistance as needed.

3.4.4.3 ***<u>Bi-hourly measures of pulmonary function during the school day</u>***

Plate 3.1 illustrates an AirWatch Lung Function Monitoring Device acquired from a similar study that was conducted in Michigan, US. This device was used to monitor fluctuations in PEF and FEV_1 of each participant. This portable, hand-held device digitally stores results of up to 500 expiratory maneuvers with the time and date of each expiratory maneuver.

Plate 3.1: AirWatch Lung Function Monitoring Device



Each participant received his/her own peak flow device, which was kept at the school, and was clearly labelled with the participant's full name and study identification number which consisted of 4 numerical digits with the 1st number=Grade; the 2nd number=the classroom and the 3rd and 4th digits referred to the participant's class register number, for example, ID number 3215 referred to Grade 3, classroom B, number 15 in the class register. This was done avoid inadvertent exchange of devices. Data stored digitally in monitors were entered into a computerized data set by study staff.

Participants underwent intensive training on the 17th and 18th April 2001 at the school as regards the usage of this equipment (see Annexure I - Attachment 1). To ensure that his or her ability to perform valid and reproducible expiratory maneuver was acceptable, each participant was individually coached and observed by trained personnel. Also, on schooldays when the peak flow meters were used, trained technicians visited the classrooms of the participants and observed expiratory maneuvers. On each of the five schooldays during the week, participants were asked to perform a session of three consecutive maneuvers, everyone and a half to two hours (four times per 5.5 hour school day: approximately 08h00, 09h45, 11h30 and 13h20), i.e., immediately prior to completion of the bi-hourly logs described above. The readings were recorded in a log sheet (Annexure I - Attachment 2).

3.5 ETHICAL ISSUES:

Consent: All answering of questionnaires and testing was done on a completely voluntary basis. Informed written consent (see Annexure D) for children, teachers and parents or legal guardians were obtained prior to any tests being performed or interviews conducted. It was made clear to all participants that they were free to withdraw from the study at any time or refuse to participate in any aspect of the study without penalty. Informed consent included explanation of the expected benefits and risks of participation in each aspect of the study.

Confidentiality of results and follow up: All individuals and/or their parents/legal guardians were given a written copy of their own results with interpretation. Individual results were confidential and personal information would only be released, such as to a medical doctor, with written consent. To prevent personal information from becoming public, identifying information was kept in locked premises. The questionnaires were stored in confidential files until the completion of the study and then destroyed. All computer files identified study subjects by study identity number only. All participants with abnormal results were counselled and offered referral to a selection of local practitioners or University-affiliated practitioners.

3.6 DATA MANAGEMENT

The questionnaire, diary and pulmonary test results were established as both paper and computer versions. A well integrated data entry system was created for all data using Microsoft Access. Double entry was performed for accuracy checks. Databases and appropriate data checking and quality control systems were created. This database was merged with the separately collected exposure and meteorological databases for conducting data analyses. These latter databases were continuously available in an electronic format.

3.7 EXPOSURE ASSESSMENT

To measure whether outdoor air pollutant concentrations of SO_2, NO_x, O_3, TRS, CO and PM_{10} are associated with increased signs and symptoms of asthma in the study population, it was necessary for pollutants to be monitored at the Settlers Primary School and included SO_2, TRS, PM_{10}, NO_x and CO while O_3 was monitored north of the study area, at a monitoring site in Wentworth. Although minute data was available at the school, this was averaged to hourly data.

3.7.1 SO_2:

SO_2, in parts per billion (ppb), was measured at the Settlers School using two continuous monitors using ultra-violet absorption. The first (Advanced Pollution Instruments, Model 100A, San Diego CA) was used to measure both SO_2 and TRS providing 1-min averages of each pollutant over an alternating 3-min cycle. This monitor had been recording levels at the Settlers School site, using a 10 min average, since June 2000 till the study period. A second monitor (TECO, Model 43b), which was dedicated to SO_2 measurements using 1-min averages during the study period, was used to develop the exposure measures for the health effects study. In terms of quality assurance, instrument precision error may not exceed 15% (Guastella, 2004a).

3.7.2 NO_x:

NO_x was measured continuously in ppb by UV chemiluminescence (Model 200A, Advanced Pollution Instruments, San Diego, CA). Data from this monitor was available for the November 2000 through May 2001 period.

3.7.3 O_3:

O_3 levels were routinely monitored in ppb at Wentworth using a continuous Dasibi ozone analyzer, model 100 8RS (UV fluorescence).

3.7.4 TRS:

TRS was measured by converting TRS to SO_2 (Advanced Pollution Instruments, Model 102, San Diego CA), which was then read by the API SO_2 monitor. Data in ppb was available for the November 2000 through May 2001 period.

3.7.5 CO:

CO was monitored continuously using infrared absorption/correlation (Model 300, Advanced Pollution Instruments, San Diego, CA). Data, measured in parts per million (ppm), was available for the November 2000 through May 2001 period.

3.7.6 PM_{10}:

At the Settlers School, PM_{10} was measured using a tapered element oscillating microbalance (TEOM) with a PM_{10} inlet (Model Series 1400a, Rupprecht & Patashnick, Albany NY) and was expressed as µg/m^3. The TEOM monitor provides a continuous measure of PM levels. During the study period, PM_{10} at the Settlers School was also measured by 24 hr (noon-to-noon) samples of PM collected on a filter (Partisol Model 2025 Sequential Air Sampler, Rupprecht & Patashnick, Albany NY), followed by gravimetric determination. Data from this monitor was available for the November 2000 through May 2001 period.

3.7.7 Calibration and Data Processing:

Both the SO_2 monitors and the NO_x monitor were calibrated at the beginning of the study (17th and 18th April 2001). Quality assurance checks were done weekly until the end of the study period and included analyzer diagnostics, zero checks, aircon function, fans, pumps, sample filters and sample lines checks (Guastella, 2004a). In addition, usually a span check alternated with an external potable calibrator (Environment S.A) check on a weekly basis. No problems with calibration were reported.

The minute data was processed as follows: 15-min averages were computed if at least seven 1-min observations were present in that period. Longer-term statistics were computed if at least half of the 15-min averages in that period were available, e.g., the daily average required at least 48 (of 96 possible) 15-min averages; similarly, the daily 15-min peak required at least 48 valid 15-min averages. This approach ensured that exposure indicators were not unduly influenced by missing data. Both average and 15-min maximum were computed for these periods.

3.8 STATISTICAL ANALYSES

A key feature of this study was that it used a longitudinal design, which allowed investigation of how daily and bihourly fluctuations in ambient (outdoor) air contaminant levels are associated with fluctuations in symptoms and pulmonary function. The generalized estimating equations (GEE) approach was used which are multivariate analogs of conventional logistic and Poisson regression, implemented in the SAS statistical procedure. GEEs accounted for the correlation among the observations over time obtained from the same subject by constructing a robust covariance matrix in estimation of the standard errors of the regression coefficients (Diggle, Liang and Zegers, 1994; Horton and Lipsitz, 1999; Edwards, 2000). Possible lag effects (hours or days) were modelled to account for possible prior exposure effects. Adjustments were made for relevant covariates, including parent reports of other physiochemical exposures at home (presence of a smoker in the household, evidence of cockroach infestation, evidence of rodent infestation, ownership of dogs or cats), reported psychosocial stressors potentially associated with aggravation of asthma (environmental stress, financial stress, physical stress, exposure to violence, quality of life measures) and demographic variables (gender, school grade, location of home, annual family income).

Effect modifications owing to baseline severity of underlying asthma were examined by including interaction terms between exposure measures and asthma severity in the models. For purposes of regression models, asthma severity was classified into three categories:

a) persistent asthma (combining moderate to severe persistent asthma with mild persistent asthma),

b) mild intermittent asthma, and;

c) no asthma, using the responses on the parent baseline survey and decision rules essentially identical to those shown for the screening questionnaire.

The unit of exposure measure used in the presented GEE regression models was the interquartile range. The interquartile range was calculated separately for each specific air pollutant being investigated and was defined as the 75th percentile minus 25th percentile of the mean daily (24-hour) exposure during the 16-day time period of the intensive study. By using the interquartile range as the unit of exposure measure in the regression models, the effect measures, such as odds ratios, for different pollutants are directly comparable and specifically relevant to the population studied.

CHAPTER 4

RESULTS

4.1 STUDY POPULATION:

The participation rates of teachers and students invited to participate in the full study ranged from 100% among the teachers to 92% (Grade 3) and 90% (Grade 6).

As demographics, health status, and potential pollution-related health effects among the 25 teachers were expected to differ substantially from those of the invited students, almost all of the further analyses of the data presented below are restricted to students. Results for teachers are described separately when necessary.

Table 4.1: Demographic variables for student participants, Settlers School, South Durban

	Participants (% age) (n=222)
Home location (n=221)*	
% in Merebank	62.9
% in Umlazi	27.6
% other surrounding suburbs	9.5
Annual Family Income (n=187)*	
% <R5 000	15.5
% R5 001 – R50 000	66.8
% >R50 000	17.6
Number of Smokers in Household (n=190)*	
% of none	42.1
% of one or more	57.9

Where: * = the number of non-missing values for this variable among student participants

Demographic data of student participants are presented in Table 4.1. Sixty three percent of the participants lived in Merebank. The majority of participants (67%) reported annual family incomes between R5 001-R50 000, with 16% below and

18% above this range. 58% of participants lived in households with one or more smokers.

4.2 HEALTH ASSESSMENTS

4.2.1 Asthma severity

The distribution of presence and severity of asthma among the students in grades 3 and 6 based on the responses on the parent baseline interview are shown in Figure 4.1. Fifty-two percent had responses on the parent baseline consistent with known or probable asthma of any severity. Among these, 11% of the total appeared to have moderate to severe asthma and another 15% mild persistent asthma.

Figure 4.1: Percentage of asthma severity from parent baseline interview among students in grades 3 and 6 (n=147 students), Settlers School, South Durban

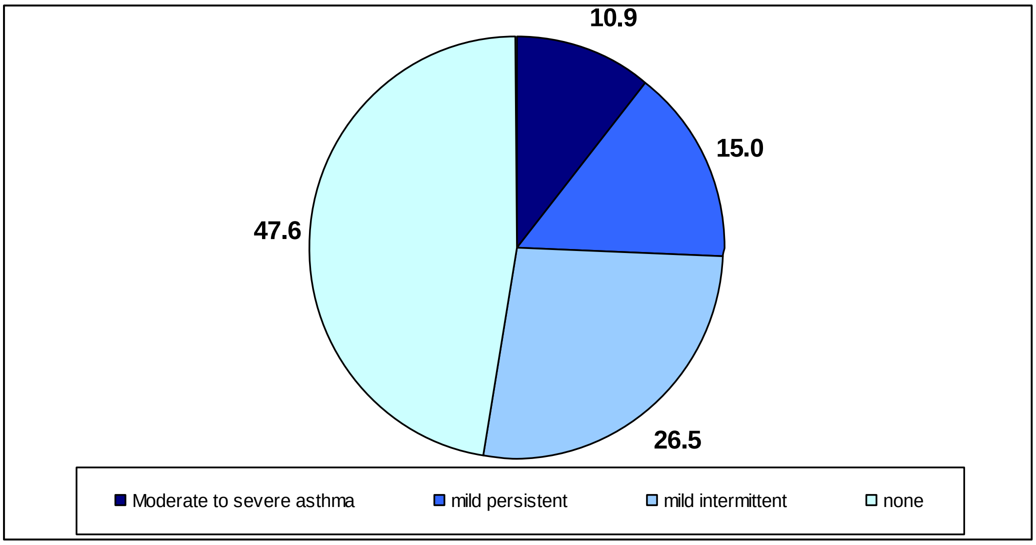


Figure 4.2: Student asthma severity from the baseline parent interview by various demographic variables among students in grades 3 and 6. (average n=143 students), Settlers School, South Durban

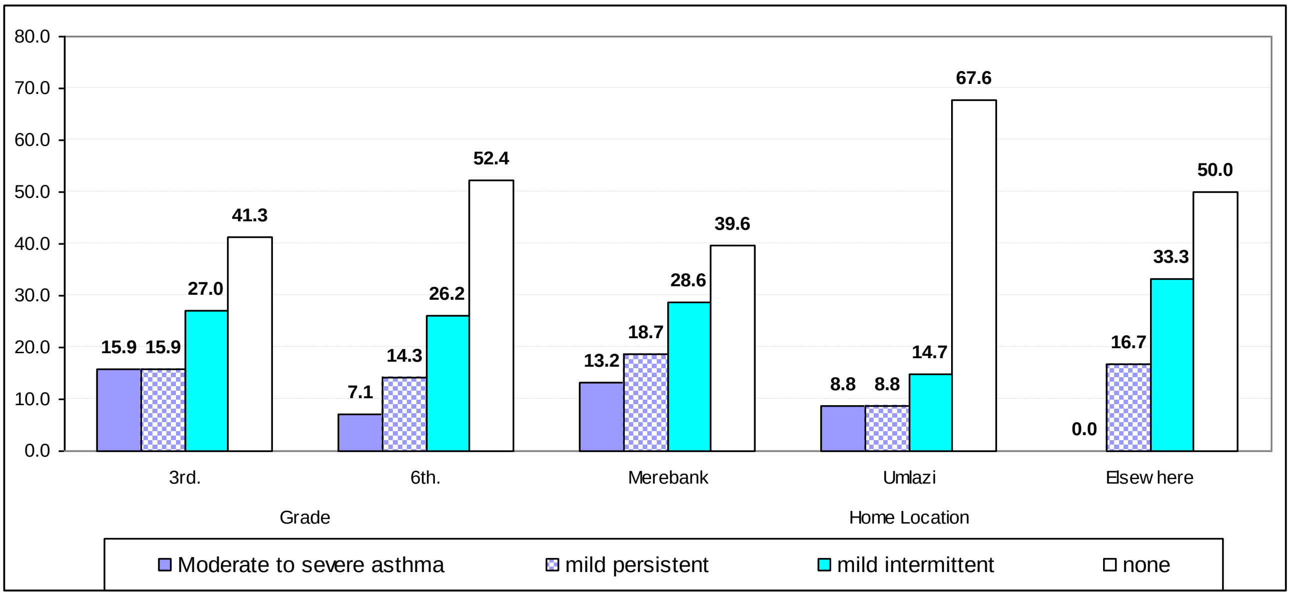
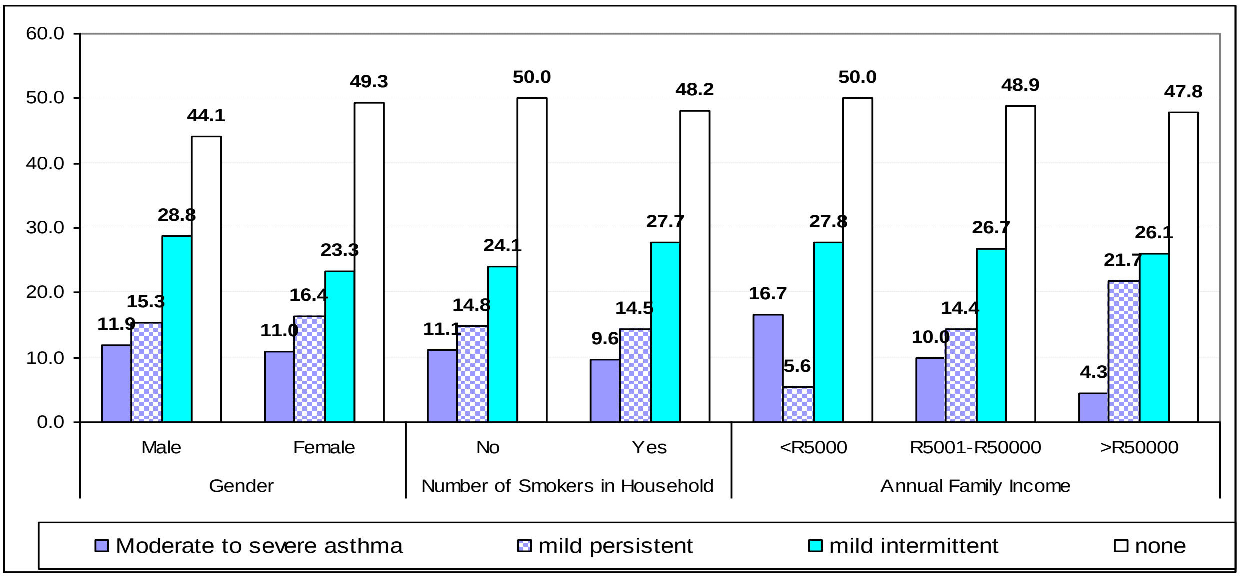


Figure 4.3: Student asthma severity from the baseline parent interview by various demographic variables among students in grades 3 and 6 continued. (average n=143 students), Settlers School, South Durban



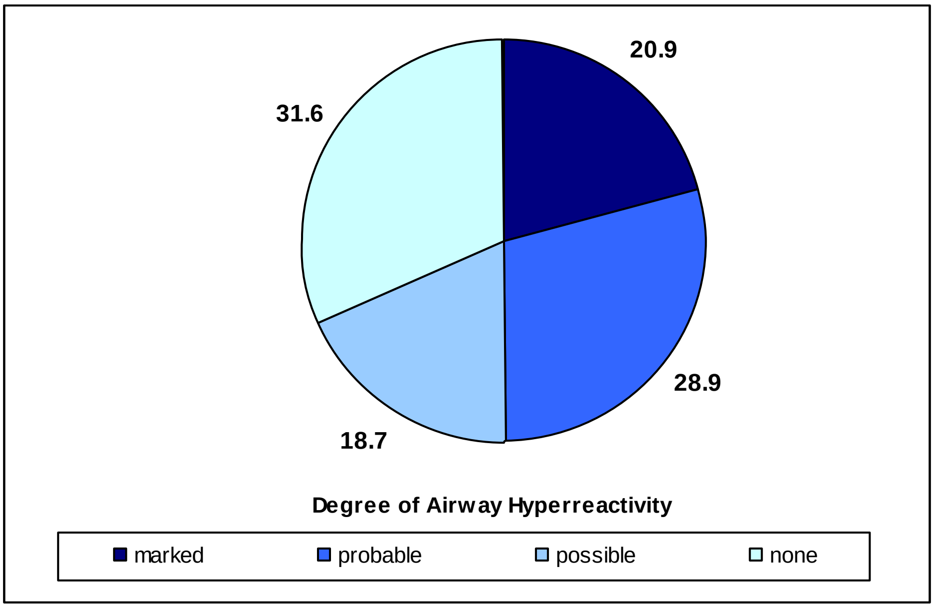
The relationships between asthma severity based on the parent baseline interview and various demographic variables are shown in Figures 4.2 and 4.3 respectively. Students in grade 3 were more likely to have moderate to severe asthma than students in grade 6 (16% versus 7%). Among those in grades 3 and 6, students living in Merebank had higher rates of persistent asthma (32%), i.e. either moderate to severe asthma or mild persistent, as compared to students living in Umlazi (17%) or other surrounding suburbs (17%).

Asthma status was quite similar in boys and girls. Asthma status did not appear significantly related to the presence of cigarette smokers in the household. The prevalence of moderate to severe persistent asthma was highest in those with annual family incomes below R5 000 (17%), intermediate in those with annual family incomes from R5 000-R50 000 (10%), and lowest in those with annual family incomes above R50 000 (4%).

Among the 23 teachers completing the "parent" baseline interview, 1 (4.3%) had responses consistent with moderate to severe asthma, 1 (4.3%) had responses consistent with mild persistent asthma, 9 (39.1%) had responses consistent with mild intermittent asthma, 12 (52.2%) had responses consistent with no asthma.

4.2.2 Airway Reactivity:

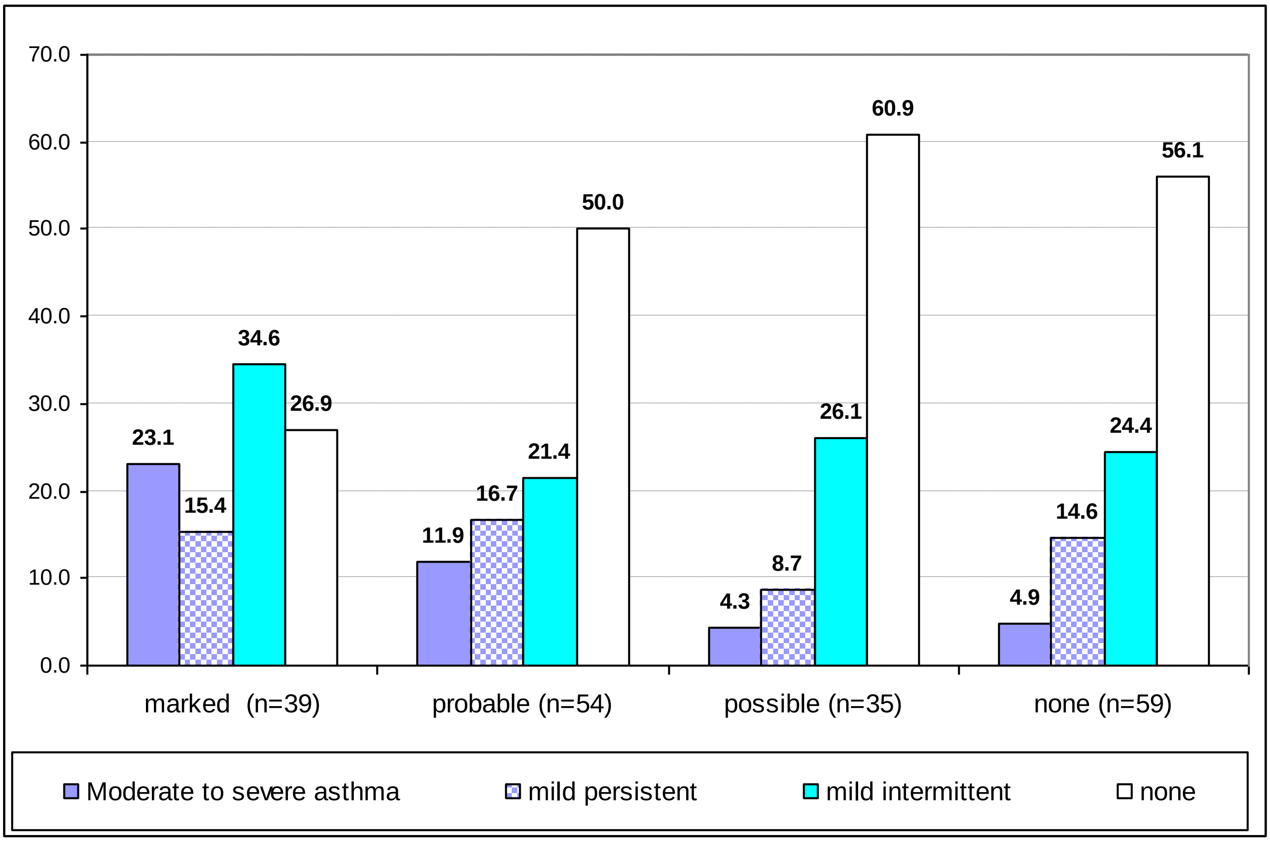
Figure 4.4: Percentage of methacholine challenge test results among students in grades 3 and 6. (n=204 students), Settlers School, South Durban



The results of the methacholine challenge testing among students in grades 3 and 6 are shown in Figure 4.4. Twenty-one percent had marked airway hyperreactivity (a PC20 less than or equal to 2mg/ml of methacholine) or greater than 20% increase in FEV1 post, 29% had probable airway hyperreactivity and 19% possible airway hyperreactivity, with only 32% in the clearly normal range. Among the 25 teachers, 1 (4%) had marked airway hyperreactivity, 1 (4%) had probable airway hyperreactivity, and 23 (92%) had no hyperreactivity.

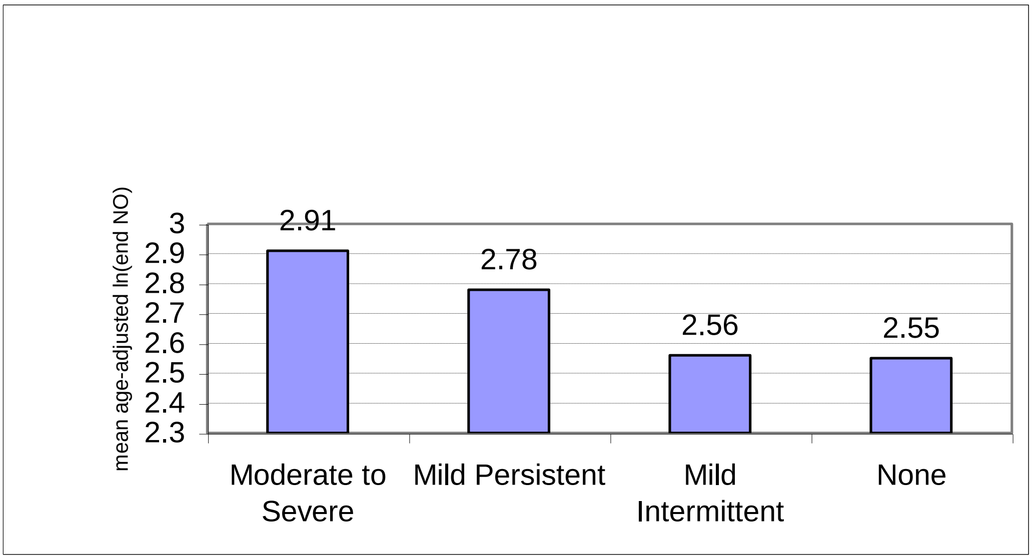
There was a significant association between greater degrees of airway reactivity and more severe asthma based on parent baseline interview responses as shown in Figure 4.5. There were also substantial numbers of participants with poor correlation of airway hyperreactivity with asthma severity. Most notably, more than half of those with marked airway hyperreactivity had parent baseline survey responses indicative of either mild intermittent or no asthma.

Figure 4.5: Asthma severity from the parent baseline interview compared to degree of airways hyperreactivity on methacholine challenge testing among students in grades 3 and 6 (n=147 students), Settlers School, South Durban



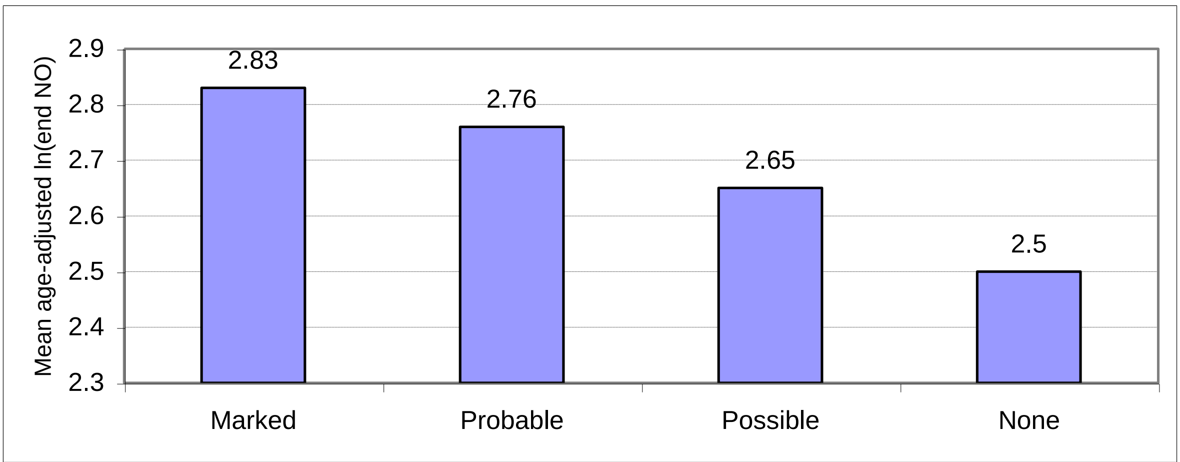
4.2.3 Exhaled Nitric Oxide:

Figure 4.6: Relationship of age-adjusted natural logarithm of end exhaled Nitric Oxide (NO) in ppb to asthma severity status from parent questionnaire, Settlers School, South Durban



In initial analyses, it was notable that increased levels of end exhaled nitric oxide appeared to be associated with increasing age. Therefore further comparisons of nitric oxide with other measures of health status were age adjusted. Figure 4.6 shows a strong association between increasing severity of asthma and increasing age-adjusted end exhalation nitric oxide (test for trend p-value <0.0001).

Figure 4.7: Relationship of age-adjusted natural logarithm of end exhaled Nitric Oxide (NO) in ppb to airway reactivity (marked, probable, possible, or none).



Also, Figure 4.7 supports the theory as suggested in a review of the literature, the eNo is more strongly associated with MCT. Therefore, a strong association can be seen between these two scientific and validated methods of assessment and this may be a strong indicator of the degree of asthma severity in the Settlers study population.

4.2.4 Maintenance of daily symptom/activity logs:

Figure 4.8: Student diaries across all 18 days - Percent of "yes" answers for asthma symptoms and quality of life measures from grade 3 and 6. (average n=116 students per day), Settlers School, South Durban

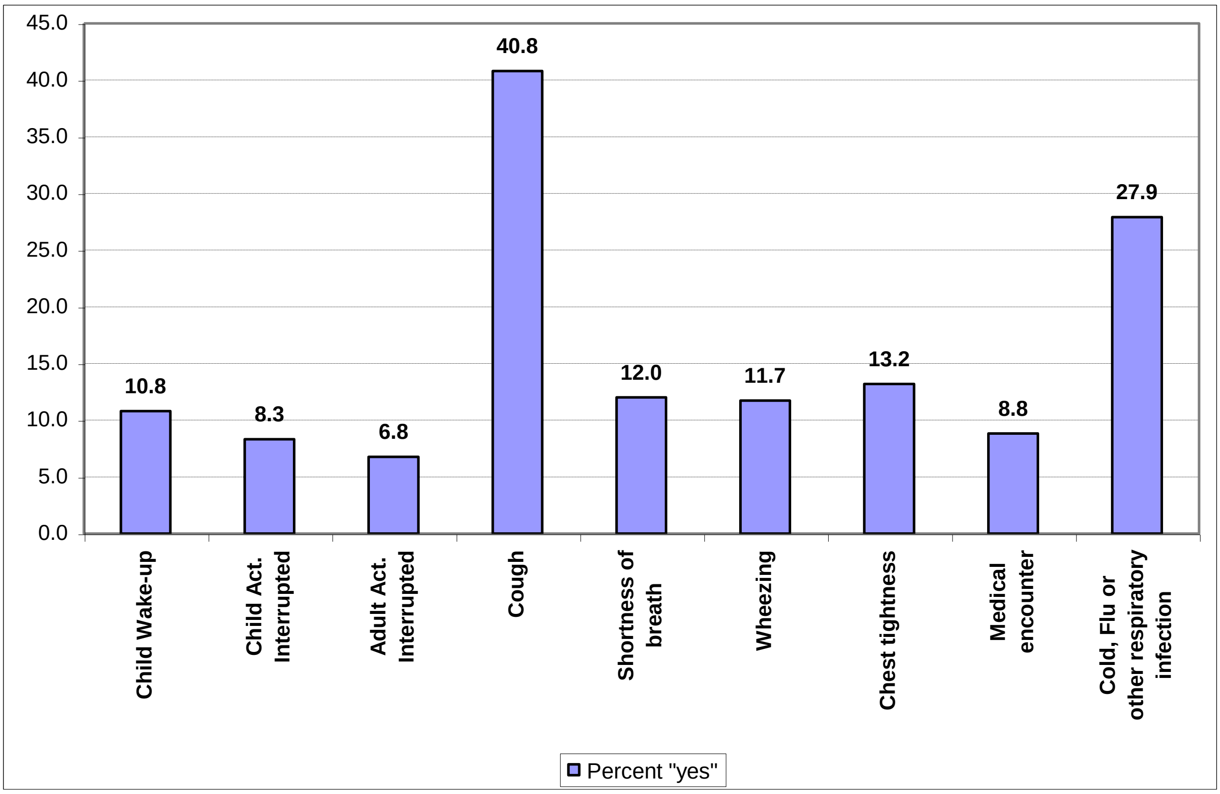


Figure 4.8 shows the percent of questions answered "yes" (out of the total number answered either "yes" or "no") for all students across all 18 days on which diary entries were requested. Cough was the most frequently reported symptom at 41%. Other symptoms frequently associated with asthma, i.e. shortness of breath,

wheezing, and chest tightness or heaviness, were reported at frequencies of 12-13%. The adverse effect on quality of life measure reported most frequently was the child waking at night because of breathing problems at 11%. On 9% of the days an unscheduled medical visit (doctor's office, emergency ward, or hospitalization) for breathing problems was required. Presence of cold, flu or other respiratory infection was reported 28% of the time.

4.2.5 Completion of bi-hourly symptom/activity logs during the school day:

Figure 4.9: Percent of "yes" answers for asthma symptoms and activities on grade 3 and grade 6 students bi-hourly logs across all 9 schooldays and all 4 times of day (08h00, 09h45, 11h30,13h20). (average n= 185 students per asthma symptom or activity), Settlers School, South Durban

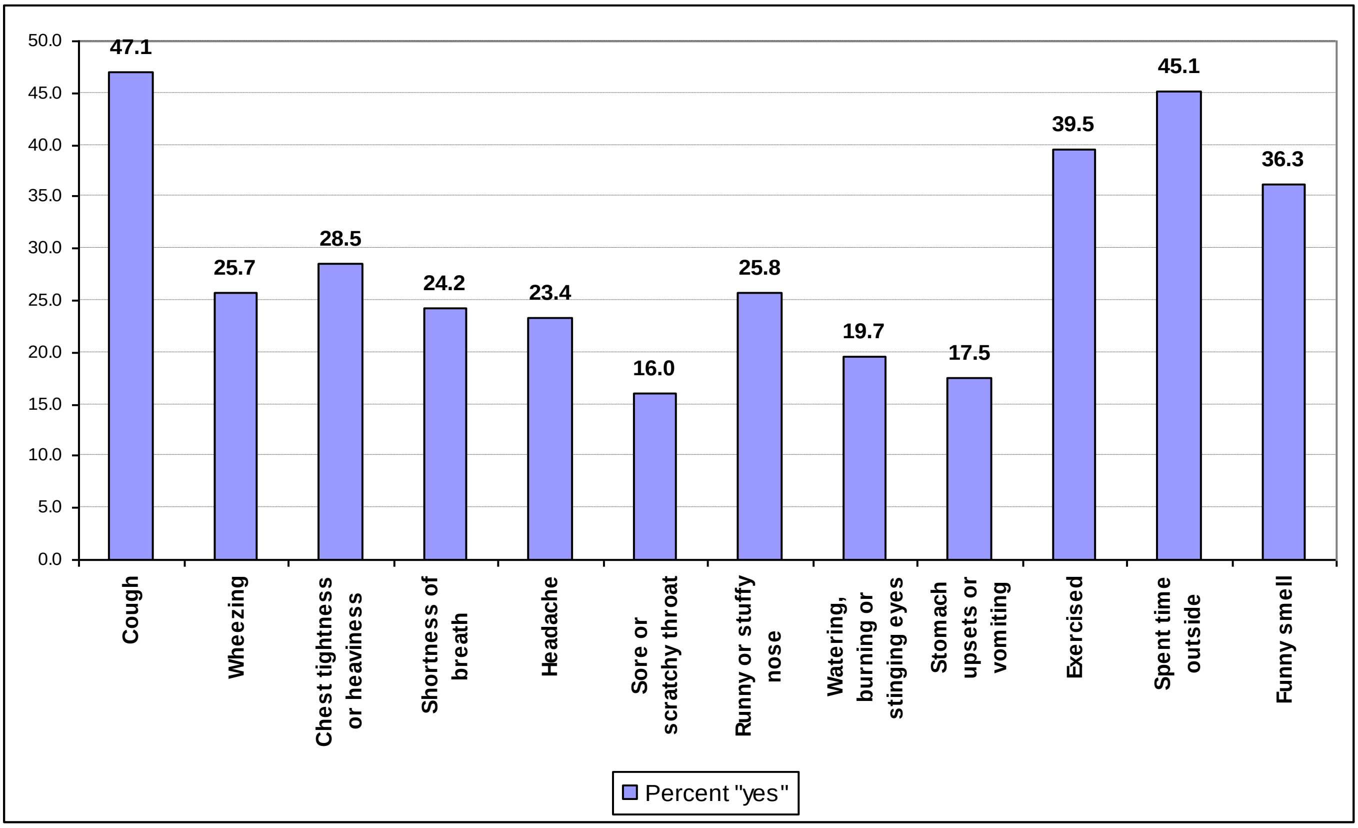


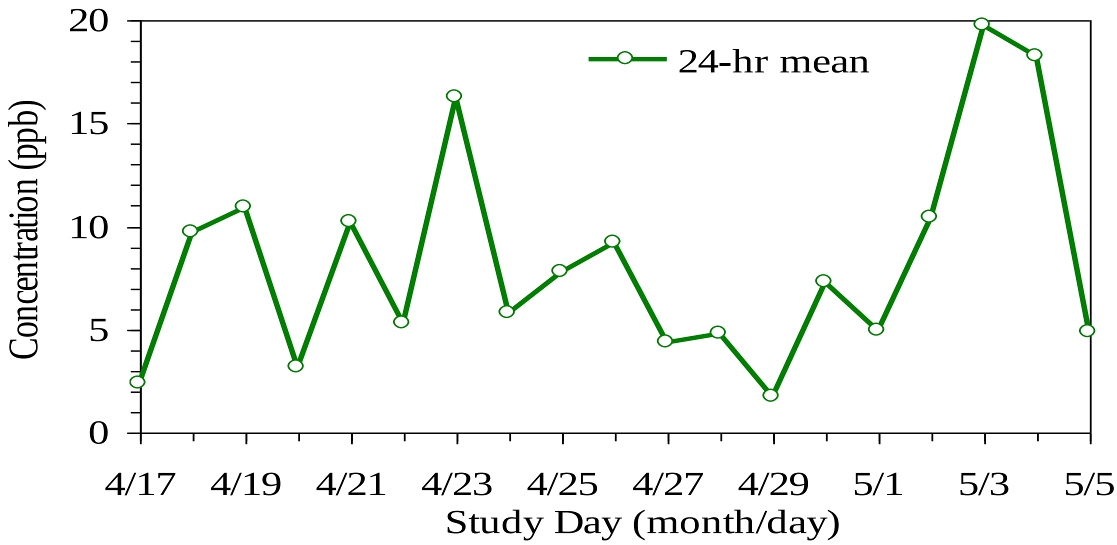
Figure 4.9 presents data from the bihourly logs completed on school days. Combining information across all 9 school days and four times of day (08h00, 09h45, 11h30, 13h20), cough was the most frequently reported symptom at 47%.

Other symptoms frequently associated with asthma, i.e. shortness of breath, wheezing, and chest tightness or heaviness, were reported at frequencies of 24-29%. Other symptoms queried were reported at 16 % or greater, with runny or stuffy nose at 26% and headache at 23%. The bihourly logs and diaries were not as highly correlated as might have been expected. As examples, while the p values were less than 0.0001, correlation coefficients for same-day reports of cough, wheezing, and chest tightness were, respectively, 0.39, 0.17,and 0.17 (data not shown) .

4.3 EXPOSURE ASSESSMENTS:

4.3.1 SO_2:

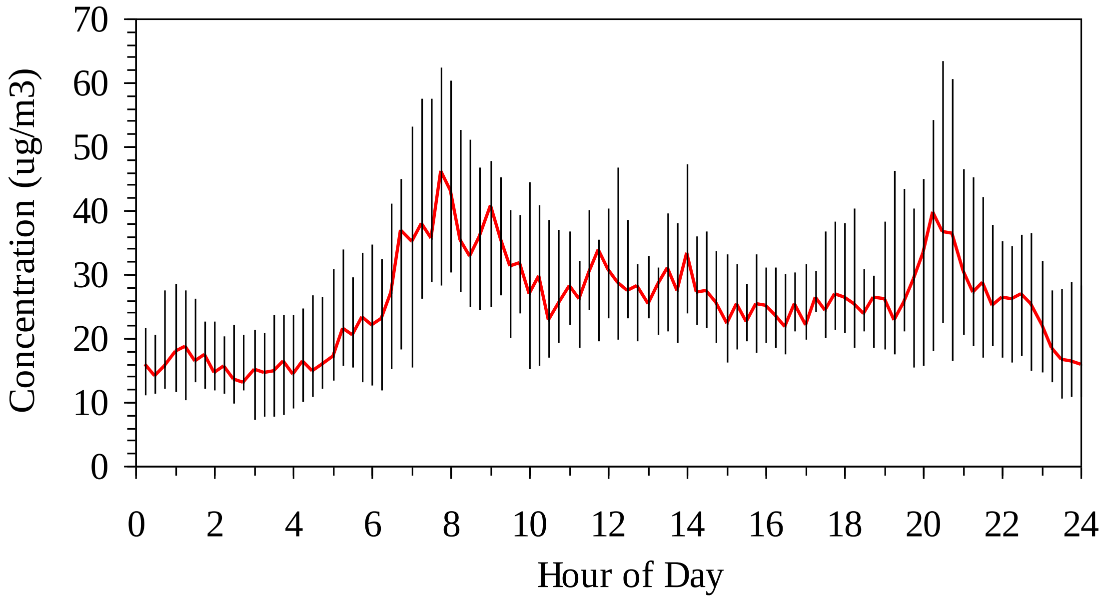
Figure 4.10: Daily trends of SO_2 concentration at the Settlers School, South Durban during the study period



Significant changes in daily averages of SO_2 as highlighted in Figure 4.10 were seen over the 19th April-6th May period of intensive health data collection. During this period the 24-hr average concentration was 8.2 ppb.

Figure 4.11 shows levels of SO_2 peak in the morning (from about 04h00 to 09h00) with median concentrations of ~14-16 ppb during this period. A second, but weaker peak is shown from about 19h00 to 23h00 with median concentrations of about 10-15 ppb. 75th percentile concentrations were approximately double these values; maximum values were about 80 ppb; and the highest 15-min average was 140 ppb.

Figure 4.11: Diurnal trends of SO_2 during the study period in 15-min intervals. Line shows median 15-min period; bars show interquartile range.



4.3.2 NO_x:

Figure 4.12 show trends and distributions for NO_2 over the study period. NO was also measured with concentrations that were highly correlated to NO_2 levels. NO more strongly shows the influence of vehicular and other nearby sources.

Figure 4.12: Daily trends of NO_2 concentration at the Settlers School, South Durban during the study period

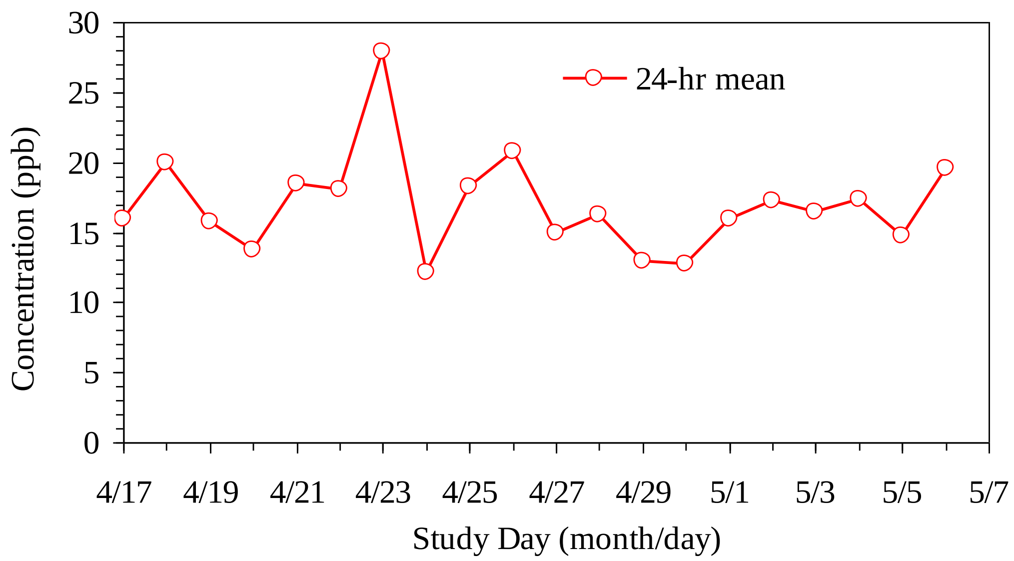


Figure 4.13: Diurnal trends of NO_2 during the study period in 15-min intervals. Line shows median 15-min period; bars show interquartile range.

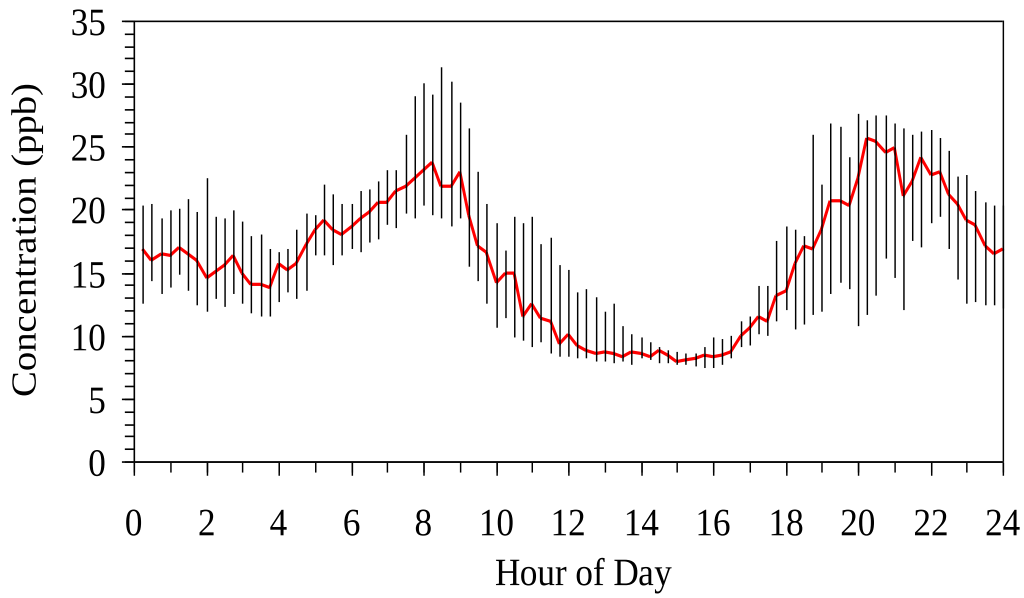


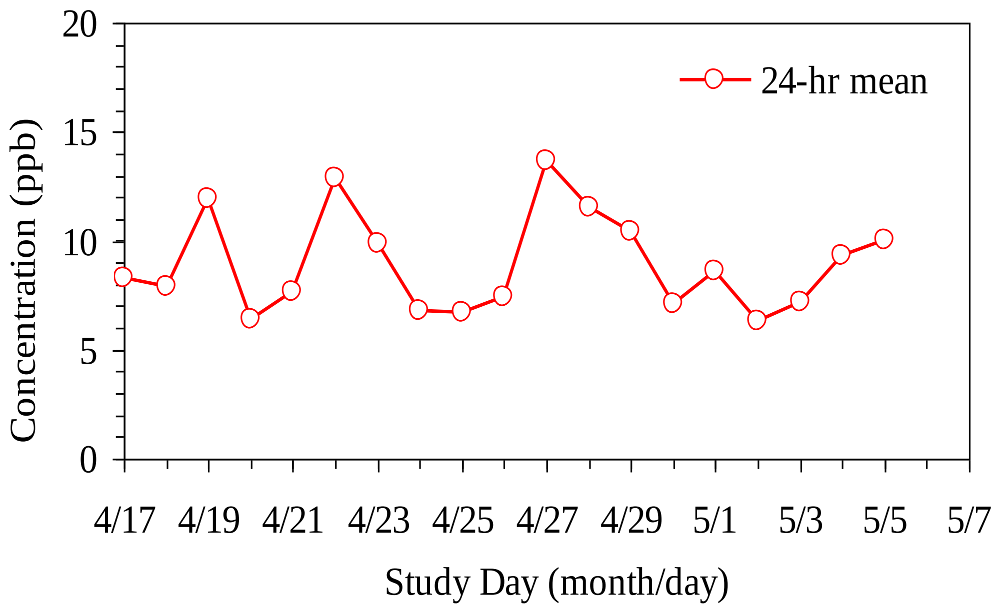
Figure 4.13 demonstrates a morning (07h00-09h00) and less pronounced evening (19h00-23h00) peaks. Outside of these peaks, night-time levels exceeded daytime levels. NO is a short-lived and reactive pollutant, and diurnal peaks were much stronger and higher in concentration than NO_2, especially in the morning.

4.3.3 O_3:

O_3 data was not used in any assessments as due to a malfunction of a pump, data was invalid from 24th April to 2nd May 2001 and therefore not available for approximately half of the study period. However, the available data showed the maximum O_3 instantaneous concentration was 49 ppb and falls below guidelines and standards.

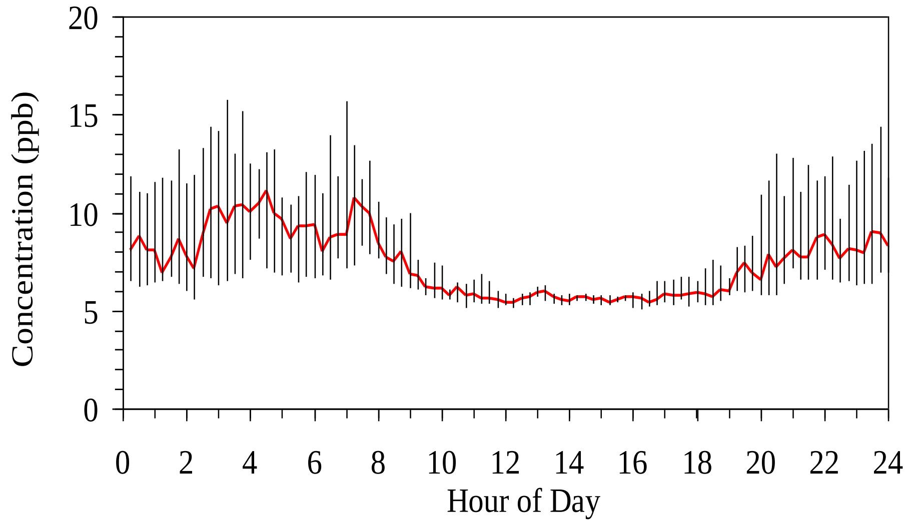
4.3.4 Total Reduced Sulphur (TRS):

Figure 4.14: Daily trends of TRS concentration at the Settlers School, South Durban during the study period



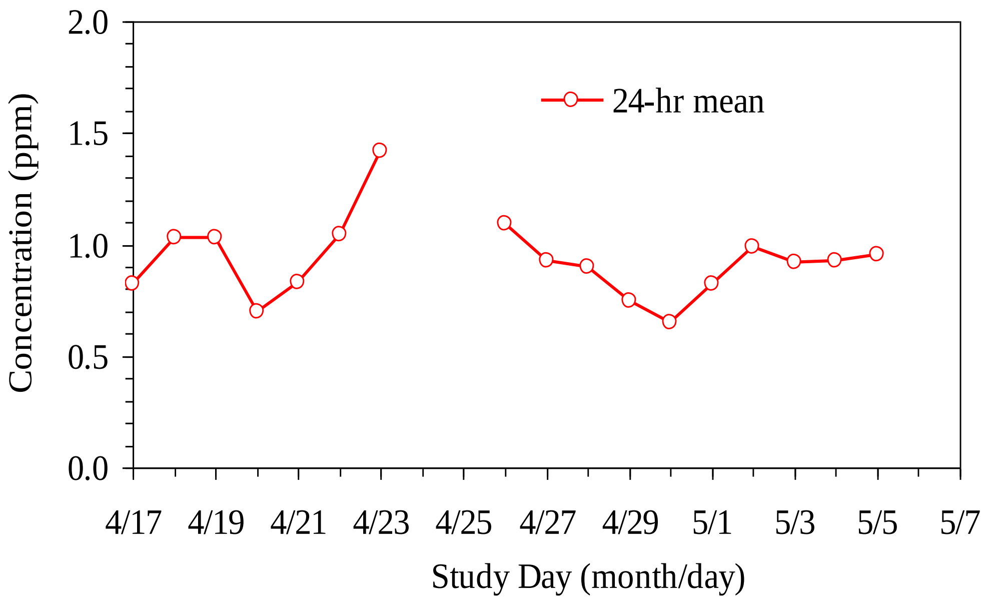
Monthly average TRS concentrations from November 2000 to April 2001 at the Settlers School ranged between 5 and 8 ppb. Figure 4.14 shows TRS trends and distributions for TRS over the study period. Figure 4.15 shows that TRS levels were highest at night (20h00 – 7h00).

Figure 4.15: Diurnal trends of TRS during the study period in 15-min intervals. Line shows median 15-min period; bars show interquartile range.



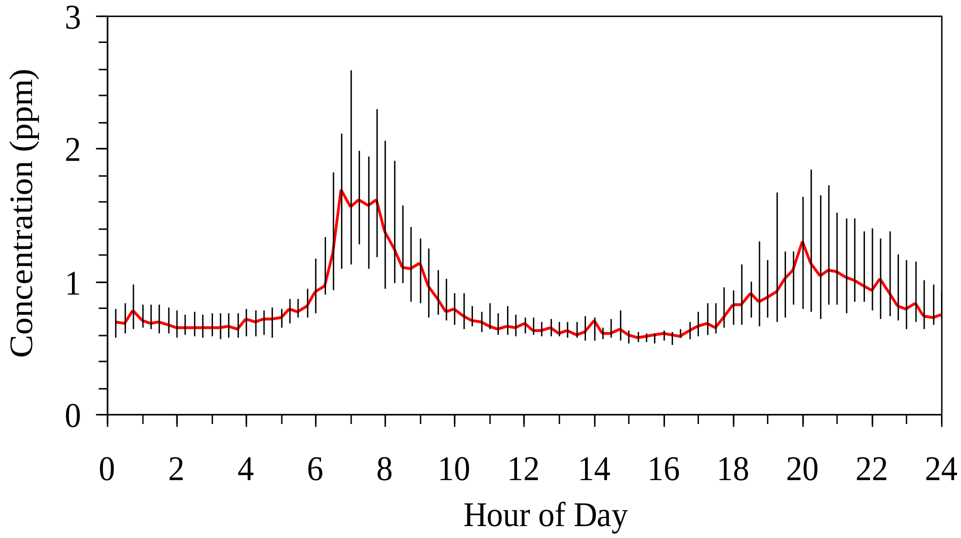
4.3.5 CO:

Figure 4.16: Daily trends of CO concentration at the Settlers School, South Durban during the study period



Monthly average CO concentrations from November 2000 to April 2001 at the Settlers School are ~0.8 ppm; levels rose to about 1.3 ppm in May 2001. Figure 4.16 show CO trends and distributions over the study period. Data is missing for the 24th and 25th May due to technical problems.

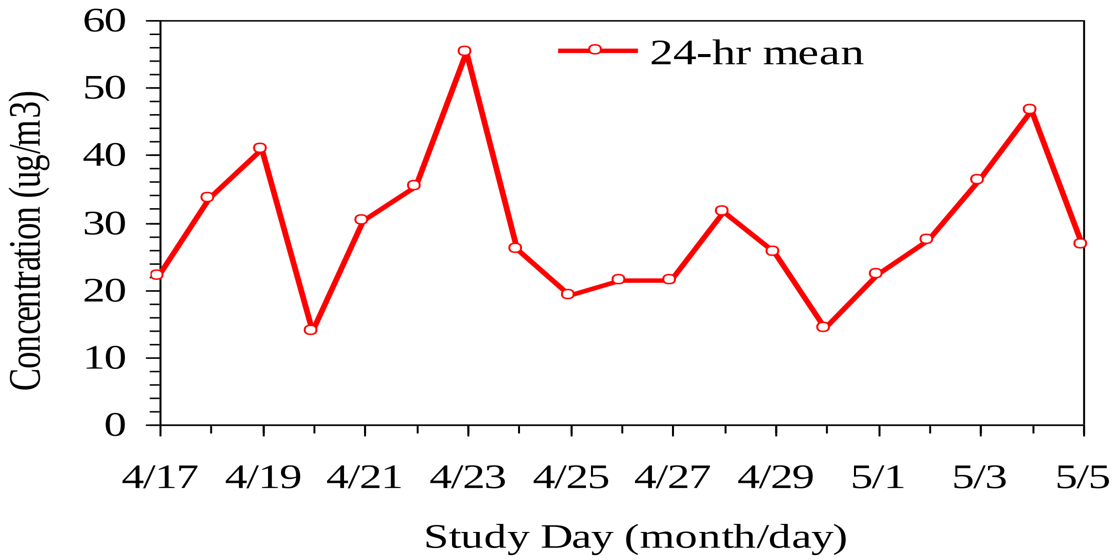
Figure 4.17: Diurnal trends of CO during the study period in 15-min intervals. Line shows median 15-min period; bars show interquartile range.



Like NO_2, Figure 4.17 shows concentrations peak in the morning and evening, and the morning peak is more pronounced. Few CO values were found below ~0.5 ppm. This CO baseline is unexpected as CO levels would be expected to decrease to near zero with offshore winds, for example.

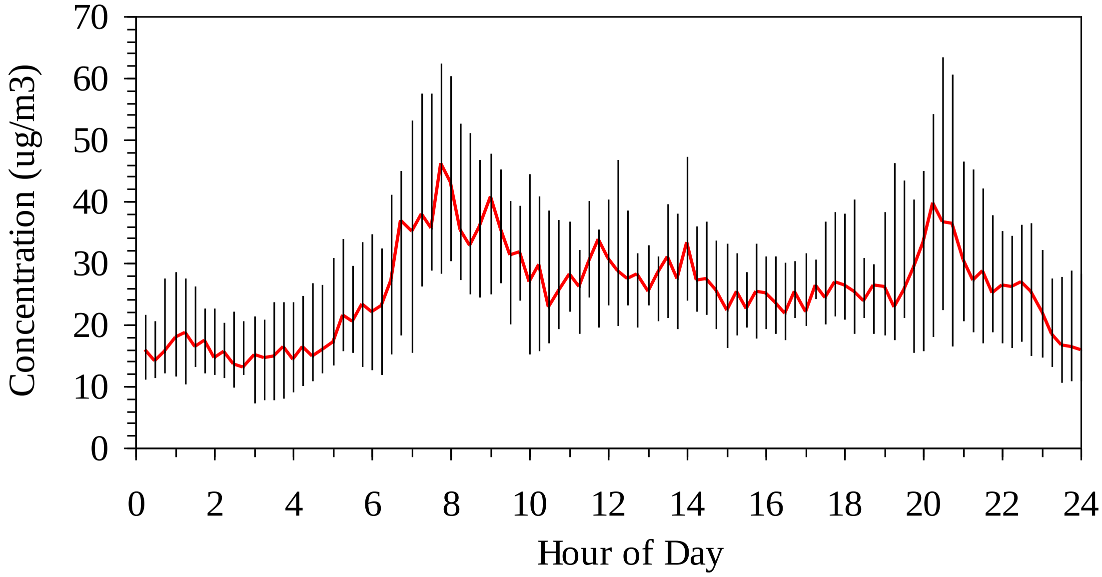
4.3.6 PM_{10}:

Figure 4.18: Daily trends of PM_{10} concentration at the Settlers School, South Durban during the study period



Monthly averages for PM_{10} concentrations from November 2000 to March 2001 at the Settlers School showed fairly constant levels of 24-30 µg/m^3, and then an increase in May 2001 to 55 µg/m^3. This increase is reflected on the 23rd of April and towards the end of this study period in Figure 4.18.

Figure 4.19: Diurnal trends of PM_{10} during the study period in 15-min intervals. Line shows median 15-min period; bars show interquartile range.



As indicated in Figure 4.19 and as seen with SO_2, diurnal trends are strong. PM_{10} levels were highest during the daytime and early evening (09h00 to 22h00), and particularly from 07h00-09h00 and 20h00-21h00).

4.3.7 Summary of exposure assessment results:

Table 4.2 summarises the air pollutant levels at the school during the study period while Table 4.3 compares 24 hour measurements of SO_2 and PM_{10} at the school to various recognized national and international air quality standards and guidelines. All concentrations measured at the school site during the study period for the selected pollutants fell below these standards and guideline values.

Table 4.2: Summary of Air Pollutant Levels at Settlers School, South Durban During Study Period

Measure	SO_2 (ppb)	TRS (ppb)	CO (ppm)	NO_x (ppb)	PM^{10+} ($\mu g/m^3$)	PM^{10*} ($\mu g/m^3$)
24-hr average						
Average	8.2	9.0	0.9	26.5	28.8	35.9
Median	7.3	8.3	0.9	26.6	26.5	36.0
Maximum	19.7	13.7	1.4	49.7	55.2	68.0
15-min peak						
Average	51.9	36.8	2.6	118.0	85.6	-
Median	53.5	20.8	2.5	118.6	76.1	-
Maximum	93.5	131.7	4.7	226.4	193.2	-

+ from TEOM *from gravimetric filter (Partisol)

Table 4.3: Comparison to National and International Air Quality Standards and guidelines to Settlers School Study, South Durban for SO_2 and PM_{10} (CSIR, 2002)

Pollutant & Standard/Guideline	Maximum 24 hr Average	Annual Average
SO_2 (ppb)		
SA	100	30
US EPA	140	30
WHO	48	19
Settlers School Study	**20**[1]	**8**[2]
PM_{10} ($\mu g/m^3$)		
SA	180	60
US EPA	150	50
WHO	-	50
Settlers School Study	**55**[1]	**29**[2]

Where: 1 = Maximum 24-hr average during study period
2 = Average during study period

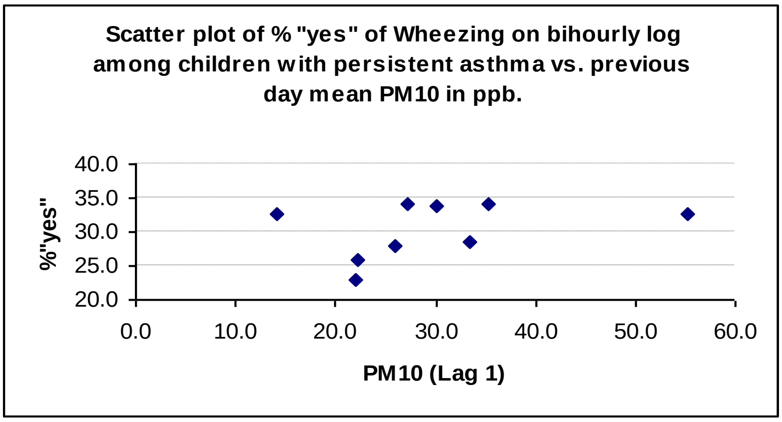
4.4 RELATIONSHIP BETWEEN EXPOSURE MEASURES AND SIGNS AND SYMPTOMS OF ASTHMA:

Ambient air pollutant measures initially considered candidates for the regression models included the six measured continuously at the school: PM_{10}, SO_2, NO_2, NO, CO, and TRS. Based on the measured levels of these pollutants, the first three of these were considered most likely to be important predictors of fluctuations in health status. NO was highly correlated with NO_2, and is not included in the final models presented here. Levels of CO were considered too low to be expected to have direct health effects. Similarly, levels present of TRS were considered unlikely to have substantial direct health effects. Moreover, PM_{10}, SO_2, and NO_2 showed more consistent and stronger associations with health effects than the other pollutants in preliminary models. In addition, examined preliminary models for CO and TRS generally had less stable parameter estimates (and thus were more difficult to interpret) than those for the other pollutants. However, as evidenced in the literature review under section 2.5, asthma signs and symptoms take periods of roughly 24 to 48 hours to fully develop and therefore health effects can be triggered not only on the days of exposure but also on subsequent days.

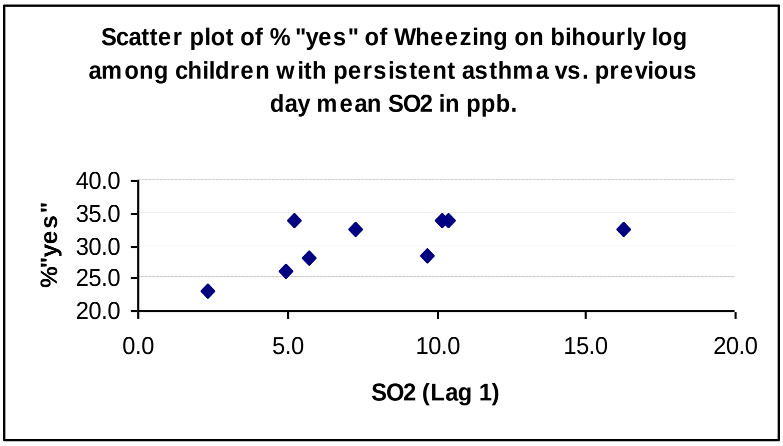
Therefore, as a preliminary step before running regression models, scatter plots examining bivariate associations between selected pollution measures and health outcomes were constructed. Such plots help provide an overall sense of the data including the ability to assess the likelihood of threshold or other nonlinear effects.

Figure 4.20: Scatterplots of selected air pollutant / health outcome associations at Settlers School, South Durban

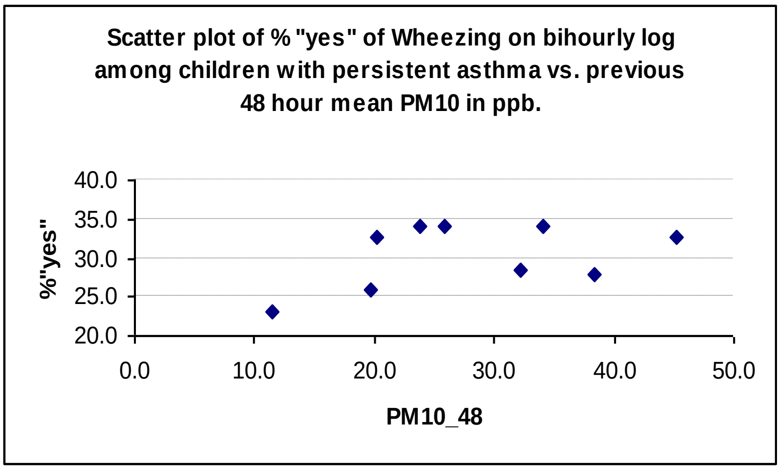
results from corresponding regression model:
OR=1.34; p-value<0.0001



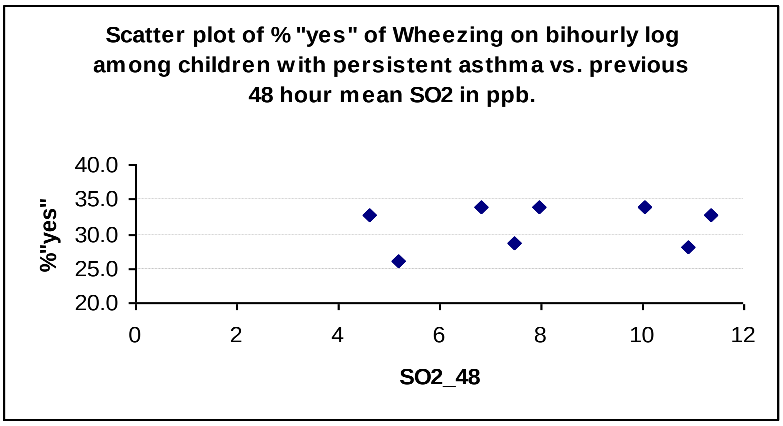
results from corresponding regression model:
OR=1.13; p-value=0.032



results from corresponding regression model:
OR=1.26; p-value<0.0005

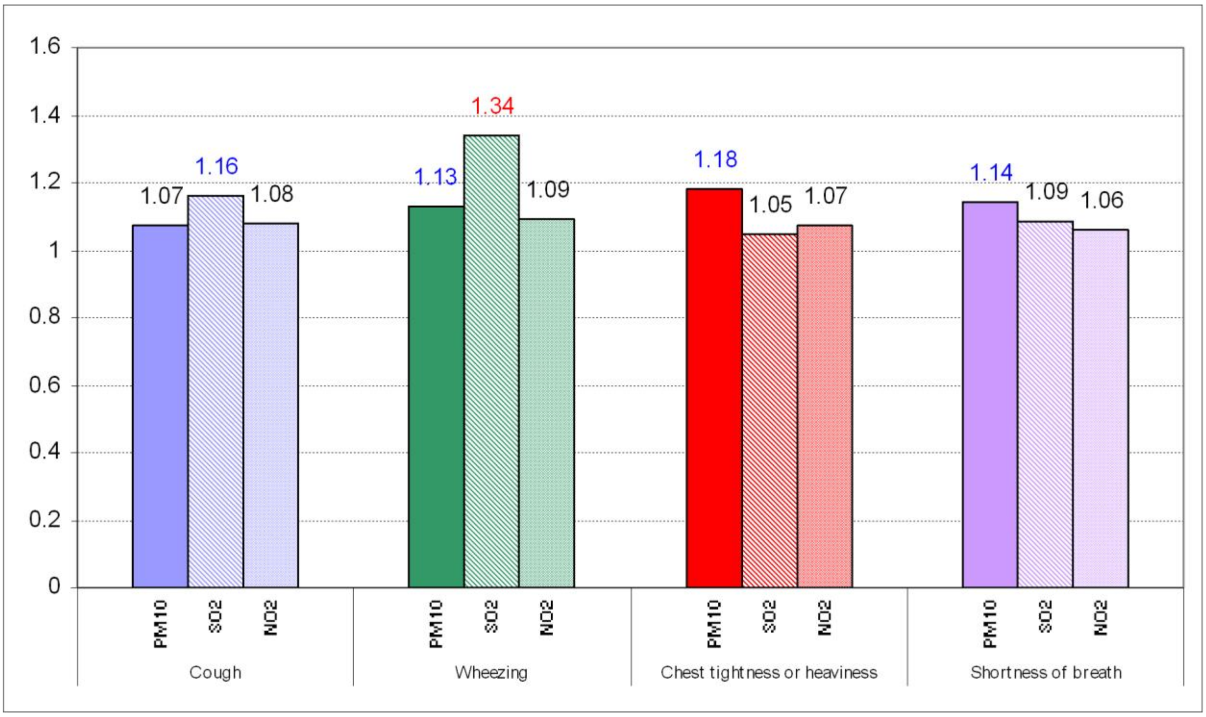


results from corresponding regression model:
OR=1.13; p-value=0.12



Four examples of scatter plots are shown in Figure 4.20. These plots examined the association of daily mean wheezing prevalence with either prior day or prior 48 hour mean levels of two air pollutants: PM_{10} and SO_2. The "shape" of the plots appeared quite consistent with the odds ratios and p-values from the corresponding multivariable regression models. For example, the plot of wheezing against prior day SO_2, suggested a substantial positive exposure-response association in agreement with the relatively large and highly significant odds ratio from the regression model. In contrast, wheezing appeared only to be weakly associated with the 48 hour mean SO_2 levels both on the scatter plot and reflected in the non-significant p value from the corresponding regression model.

Figure 4.21: Odds ratios (OR)[1] for presence of **symptoms** reported on bi-hourly logs for changes in measured levels of $\mathbf{PM_{10}}$[2], $\mathbf{SO_2}$[3] and $\mathbf{NO_2}$[4] at the school grounds of Settlers School, South Durban for the **prior day** among all students with persistent asthma[5]: from logistic regression models using generalized estimating equations (GEE)[6]



Note: ORs shown above bar are colour-coded according to associated p value:
black: p>0.05, blue: 0.01<p≤0.05; red: p≤0.01

[1]OR = odds ratio for an increase of one interquartile range in PM_{10} (11.3 micrograms per meter cubed (ug/m^3), SO_2 (5.40 parts per billion (ppb), or NO_2 (4.05 ppb) included one at a time in the models, i.e., each bar represents a separate regression model.

[2]PM_{10} = particulate matter of 10 microns or less in aerodynamic diameter

[3]SO_2 = sulphur dioxide

[4]NO_2 = nitrogen dioxide

[5]persistent asthma includes both moderate to severe persistent asthma and mild persistent asthma; classification based on parent baseline interview

[6]covariates in each model: gender, home location, annual family income, grade in school, presence of one or more smokers in household, having pets in household, having roach problem, having rodent problem, environmental stress, financial stress, neighborhood violence, physical stress, overall quality of life, asthma severity, interaction between asthma severity and exposure measure.

The relationships of lower respiratory symptoms (cough, wheezing, chest tightness or heaviness, and shortness of breath) reported on bi-hourly logs with exposure to PM_{10}, SO_2, and NO_2 on the previous day are shown in Figure 4.21. The strengths of the relationships between the exposures and the symptoms are presented as odds ratio (ORs), specifically the odds ratios for an interquartile increase in the particular pollutant. Scaling the ORs in this manner makes them directly relevant to the exposures experienced by the study participants and makes the ORs for different pollutants directly comparable to each other.

An OR of 1.00 would indicate that no association was found between the exposure and the symptom. ORs >1.00 indicate a positive association between the two (i.e., when exposure increases the likelihood of having the symptom also increases). ORs <1.00 indicate a negative associations (i.e., when exposure increases, the likelihood of the symptom decreases). The p-value associated with each odds ratio shows the probability of having found an OR this far away from 1.00 (when OR >1, this means an OR this high) by chance, if, in fact, there is no true association.

For example, the OR for chest tightness or heaviness ("chest") with prior day PM_{10} is 1.18 for those with persistent asthma is indicating that for an (interquartile) 11.3 ug/m^3 increase in PM_{10} on the prior day, the likelihood of having chest tightness goes up by approximately 18%. The p-value of 0.003 indicates that, if in reality there were no relationship between cough and SO_2, the probability of finding such a high OR is 3 in 1000. In other words it is very unlikely that the found association is due to chance. Conventionally, an OR or other measure of association with a p-value <0.05 is referred to as "statistically significant".

The 95% confidence interval (95% CI) gives the range of likely actual values for the true OR. Note, in this case, the range does not include 1.00, again indicating that this is likely to be a true association. In these models involving symptoms, a substantial portion of the odds ratios for those with persistent asthma are statistically significant. Prior day SO_2 shows a particularly strong influence on wheeze, whereas PM_{10} has greater influence on chest tightness and shortness of breath. The above patterns were not seen in children without persistent asthma i.e. those with more marked asthma were an especially sensitive subpopulation who responded to exposures below current international or national standards or guideline values. It would have been interesting to also note the OR for other models, involving for example, children classified as having marked reactivity according to the lung function test or MCT. This can be noted as a recommendation that should be implemented in future studies.

CHAPTER 5

DISCUSSION

5.1 STRENGTHS AND LIMITATIONS OF THE STUDY:

The study design offered a number of important strengths.

- It was the first to address in a scientifically rigorous fashion, potential health effects of air pollution in the SDIB.

- This study could serve as guide both as to which pollutants and health outcomes merit most careful investigation in a larger study and as to possible effective study designs in this setting.

- The study design was cost efficient in that it made use of detailed, high quality air pollutant data already being collected independently.

- The inclusion of detailed questionnaires, spirometry and methacholine challenge testing enabled both accurate estimation of the prevalence of diagnosed and undiagnosed asthma, and enabled an investigation of whether those with probable asthma may represent a subgroup particularly sensitive to pollution effects.

- This study enjoyed the enthusiastic support and co-operation of both a group of concerned teachers in the school, Settlers Primary Environment Committee (SPEC), the participants and an active and representative community grouping, the SDCEA.

Limitations in the study:

- The addition of comparative populations in the greater Durban metropolitan area of similar ethnic and socioeconomic background, but with differing exposure to air pollutants would have been useful to investigate any related differences in prevalence of baseline respiratory problem and/or degree of fluctuation in symptoms and pulmonary function. This would have more than doubled the cost of the study by requiring health data collection and new, detailed pollution measurements in areas not already being measured. However as the results of this study are suggestive of ambient air pollution associated health problems, then the cost of such a study appears merited.

- Additional tests to investigate potential confounders, e.g. indoor air quality and skin testing for common allergens would be of some use. This would have required an investigation of home environments of all the participants, including measurement of allergen levels in household dust and substantially increased study costs and complexity. To compensate, with the longitudinal repeated measures design, each participant essentially served as his or her own control and the need to control for every possible form of confounding was considerably less pressing.

- The use of the Airwatch lung function monitoring device was problematic, especially when used by the learners. Although there was prior training in the use of the device and the learners had been advised of undertaking only 3 blows at any given time period, multiple blows were done by the learners, resulting in information that could not be used by the study. However, note should be taken that despite the limitation of using the Airwatch lung function monitoring device in this study, it should be considered as an instrument to use in future asthma studies after due cognisance is taken of the training of the users of this instrument.

5.2 ASTHMA PREVALENCE:

The prevalence of asthma at Settlers Primary School based on the responses on the parent baseline interview showed that 52% of learners from Grades 3 and 6 and 48% of staff had responses consistent with known or probable asthma of any severity.

The prevalence of asthma among the learners from Settlers is considerablely higher than nearly all of the studies noted below where similar, well validated instruments were used to evaluate asthma prevalence. It is also interesting to note that nearly half of the staff had some form of asthma severity. Anderson, *et al*. (2004) as part of ISAAC, assessed the prevalence of asthma symptoms in the British Isles in both 1995 and 2002 by using questionnaire surveys, the same measurement tools and same schools, all validated by the core ISAAC protocol, found that prevalence had decreased from 34% to 28%.

A study in Poland was performed among 594 and 541 primary schoolchildren in 1995 and 2001 respectively, using in both years a modified and validated version of the European Community Respiratory Health Survey questionnaire (Emeryk, *et a*l. 2004). This study revealed that doctor's diagnosed asthma increased significantly from 3.4% (1995) to 9.6% (2001) while there was a substantial increase in asthma related symptoms of post exercise breathlessness, wheezing and dyspnoea between the years (namely 8.3-17.7%; 6.2-13,2% and 7.6-13.3% respectively). A questionnaire based study used to compare the respiratory symptoms of schoolchildren in China and Japan concluded that the prevalence of asthma like symptoms was 1.8% for boys in China and 9.6% in Japan (Kagawa, *et al*. 2001). In South Africa, Ehrlich (2002) noted that the highest prevalence recorded in population based studies of children was 14.5%. The prevalences observed in the studies above are well below the prevalence of asthma symptoms and diagnosis among learners from Grades 3 and 6 at Settlers Primary School. Therefore the learners at the Settlers school may be at an increased risk of attaining aggravating asthma symptoms and the current asthmatics are an especially sensitive and vulnerable subpopulation.

In assessing the asthma prevalence at the Settlers school, the MCT results noted in Figure 4.4 illustrates that nearly 104 students (50%) had marked or probable airway hyperresponsiveness (PC20 less than or equal to 8 mg/ml or post bronchodilator improvement in FEV_1 between 12-20%). This prevalence is high as compared to a review of the scientific literature as noted in Table 5.1 and raises cause for concern for all stakeholders in the SDIB.

Table 5.1: Percent of participants of current and comparative population-based studies with PC20 less than or equal to specified concentrations of methacholine (Kurukulaaratchy, *et al*. 2002; Joseph, *et al*. 2002; Forastiere, *et al*. 1991)

	Settlers Primary School	**Isle of Wight (UK)**	**Italy**		**United States**	
	Grade 3	Age 10	Ages 7 - 11		Ages 6 - 8	
			Urban	Rural	African-American	White
n	*84*	*784*	*621*	*594*	*79*	*490*
≤ 2 mg/ml	20.2%					
≤ 4 mg/ml	39.4%		20.0%	14.8%		
≤ 8 mg/ml	59.4%	14.4%				
≤ 10 mg/ml	*				41.7%	22.3%

* not directly measured in Settlers study

Figure 4.5 indicated that more than half of the learners with marked airway hyperreactivity on the MCT had parent survey responses indicative of either mild intermittent or no asthma. This result is cause for concern as it can be indicative that parents are unaware of the risk factors that initiate asthma or aggravate the signs and symptoms of asthma and in the medium to long term, this can prove detrimental to the health of the learner.

The majority of participants in this study were primarily from a low socio-economic background headed by mainly young single parents with mostly minimum education and low income levels. As the family plays a central role in recognising, managing and preventing asthma, ignorance of asthma and its treatment is likely to be more common among lesser educated and younger parents. Also, given that nearly 82.3% of learners had a family income < R50 000 per annum, the cost implications of managing asthma symptoms and preventing attacks may be overwhelming to the parent or caregiver. Parents worked long hours and given the many pressing financial and emotional issues facing them have much to prioritise.

Exhaled nitric oxide (eNO) is low in the exhaled breath of healthy subjects but has been shown to correlate with asthma severity in children (Olin, Alving and Toren, 2004). The degree of eNO elevation varies with severity, increasing with allergen or pollution exposure (Strunk, *et al*. 2003). Using the methodology in Chapter 3, Figure 4.6 shows that there was a strong association between increasing severity of asthma and increasing age-adjusted end exhalation nitric oxide and appears to be among the strongest ever reported and this is further confirmed by the strong association between eNo and MCT in Figure 4.7. In a study investigating eNO and asthma in young children, Avital, *et al*. (2001) concluded that the mean eNO level of the mild intermittent asthmatic children (5.6+/-0.4ppb) not receiving inhaled corticosteroids was significantly higher (ANOVA $P<0.0001$) than the other three groups studied. Sippel, *et al*. (2000), in a cross sectional study of 100 patients ranging in age from 7-80 years, found that eNO was significantly correlated with asthma symptoms ($p=0.02$), daily use of rescue medications ($p=0.01$) and reversibility of airflow obstruction ($p=0.02$). Salome, *et al*. (1999) found that in a study of 306 young adults, that eNO was significantly greater in asthmatic subjects (geometric mean, 22.2; 95% CI: 16.1-30.7 ppb) than in normal subjects (7.8, 7.1-8.4, $p < 0.001$).

5.3 RELATIONSHIP BETWEEN EXPOSURE MEASURES AND SIGNS AND SYMPTOMS OF ASTHMA:

Among the children of the Settlers School with persistent asthma, prior day exposure to both SO_2 and PM_{10}, and, to a lesser extent, NO_2, are associated with highly statistically significant increases in the odds for lower respiratory symptoms including cough, wheezing, chest tightness and, shortness of breath, and with increased variability in lung function as evidenced in Figures 4.20 and 4.21 respectively. This strongly suggested that fluctuations in health status were causally linked to fluctuations in the ambient air concentrations of these pollutants. These findings were supported by what other studies have reported and some of the studies are noted below i.e. SO_2 and PM_{10} and their significant association with the signs and symptoms of asthma and that the lagged exposures over two or more days almost always showed stronger associations than same day exposures (Mortimer, *et al*. 2002).

For the duration of the study period at the Settlers school, the 24 hour measurements of SO_2 and PM_{10} at the school were lower than various recognized national and international air quality standards and guidelines (See Table 4.2 and 4.3 respectively). Interestingly, when the Settlers data was compared to available SO_2 data, the average or maximum historical exposures at the Settlers School had frequently exceeded the WHO and South African guidelines (Hurt, 2001) yet there was quite a notable decrease in these and other air pollutant emissions during the study period.

However, exposure levels, even at levels below current standards can be harmful to sensitive subjects such as asthmatics. Cognisance, however, will have to be taken of the following issues:

1) The pollutants were measured at various sites in South Durban and were not measured at the height at which the learners could have been affected;
2) The standards or guidelines mentioned elsewhere in this study do not consider the synergistic effects of exposure to multiple pollutants.

Lee, *et al*. (2002), supported the lagged exposure hypothesis when on investigating the association between outdoor air pollution and asthma attacks among Korean children <15 years, noted that the estimated relative risk of hospitalisation for asthma was 1.07 for PM_{10} (95% CI = 1.04-1.11; IQR = 40.4 $\mu g/m^3$) and 1.11 for SO_2 (95% CI = 1.06-1.17; IQR = 4.4 ppb). Braga, *et al*. (2001), further found when assessing the health effects of air pollution exposure on children in Brazil that each interquartile range (IQR) increase in PM_{10} was associated with a 5.1% (95% CI: 0.3,9.8) increase in respiratory admissions. In the CAMP study involving 133 children (5-13 years old), PM_{10} lagged 1 day was associated with a 10% (95% CI, 3-16%) increase in the odds of asthma symptoms (Yu, *et al*. 2000). Therefore, these studies indicated that even in small doses, air pollutants over a lag period may increase or worsen asthma symptoms.

While the associations between fluctuations in ambient pollutant exposures and acute health status changes are quite strong and consistent in Settlers School study, the analyses conducted do not allow the health effects to be attributed clearly to one specific measured air pollutant over all the others. Leikauf, *et al*. (1995) noted that air pollution is a complex mixture and several investigators have hypothesised that any single exposure variable cannot solely be responsible for observed adverse effects. However, PM_{10} and SO_2 appear to make important and somewhat independent contributions. The question of which air pollutant sources are likely to be most responsible for observed adverse health effects cannot be answered unequivocally with the available data from this study.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION:

Poverty and financial constraints can contribute to under diagnosis and reduced use of preventive care for asthma. In this study, for example, the subjective analysis (parent surveys) when compared to the MCT has clearly indicated that there is a need for improving access to basic asthma medication, medical care, and reducing or eliminating barriers such as poverty, poor education and poor infrastructure. Additionally, given the proximity of polluting industries and traffic, study participants were exposed to ambient air pollutants outside the home whilst social, physical and behavioural issues prevailed within the home.

Polluted air in the home, workplace or ambient environment is responsible for serious health effects (Rahman, *et al*. 2001). Air pollution can produce acute adverse effects on the airways leading to increased hospital admissions and can cause much disability through days lost at school and work, and in premature death. However, we are still prone to think of asthma as an illness of minor importance with symptoms that are amenable to easy treatment (The Lancet, 1997). Given the above socio-economic, behavioural and environmental scenario, effective interventions will require an investment in social and community resources that goes beyond the medical care and into the behavioural and lifestyle changes, educational services, housing and environmental reforms (Hartert, 2003). Some of these interventions are recommended below.

6.2 RECOMMENDATIONS:

6.2.1 Improving Air Quality:

- *Air monitoring*:

  Air monitoring should be continued at the Settlers School site with a corresponding monitoring station either in Merebank and Umlazi. This monitoring will help to assess the trends of the pollutants (hourly, 24 hours, monthly and annually) and guide public officials in their decision making regarding taking care of the health of susceptible populations and the surrounding environment.

- *Improved technologies and reduction strategies*:

  Various government departments such as the Department of Health, Department of Environmental Affairs and Tourism, Department of Mineral and Energy Affairs and Department of Trade and Industry need to create a joint forum for discussion regarding pollution abatement strategies.

  Discussion should be concentrated on policy reforms including:

  - legislation and enforcement thereof;
  - factors such as the synergistic effects of pollutants and;
  - a review of associated standards or guideline values.

  Further, note must also be taken on improving technology in mobile and stationery sources of air pollution and the monitoring thereof. This discussion and any outcomes must then filter down to provincial and local levels of government. In addition, in the SDIB, there must be a commitment in deciding what air quality targets are reasonable and adopting policies to influences decisions so that emissions that degrade air quality are reduced effectively.

The study area has been historically impacted by significant emissions of SO_2, NO_x and PM emissions from industrial and other sources. Emission reduction can be realised by means of efficiency improvement, energy saving, fuel switching and by using specific abatement disposals. In the past, attempts have been made in the SDIB by some industries to reduce air emissions through various strategies. However, these strategies need to be evaluated to assess if the aims were achieved.

Therefore, as a matter of urgency, further investigation needs to be undertaken by the relevant government authorities and polluting industries in the SDIB to assess the significance and implementation of pertinent reduction strategies using improved technologies. The timely implementation of this recommendation will definitely help decrease the future capital, social and environmental costs of industry; enhance economic enrichment and attenuate the negative impacts of air pollution on the surrounding communities and the environment.

- *Improving Environmental Management*:

  Note should be taken that this study did not consider historical data which would have provided a good basis to note the general trend of air pollution in the SDIB. Further minutes of ad-hoc and formal meetings reflect that industry, community, local government and the media were well informed of the study, its objectives and methodology. Therefore, the pollutant levels as determined by the study may have been substantially different had the study been conducted more covertly. Also, mention must be made that community representatives from the SDIB and the Settlers School fraternity and parents/caregivers showed great concern over the high prevalence rate of 52% in feedback meetings.

Given the above scenario, it is imperative that environmental management in the SDIB improves and the sooner this happens, the better for all concerned. It is acknowledged that there are tight budgetary, knowledge and human resource constraints that may exist in the Durban municipality and therefore holistic air quality management in the SDIB may have many limitations and may only be restricted to those areas for which funding and / or expertise can be made available. These issues will have to be first resolved before any environmental reforms are successfully implemented.

However, the following factors can prove to be of assistance in the long term:

- Create tax and other commercially viable rebates as incentives for industry to improve their environmental management practices;
- Government needs to implement and fund fora where all interested and affected stakeholders such as industry, community, academia, local, national and international air pollution and environmental management experts, and media can have open and transparent discussions on how to improve environmental management in the

SDIB. The wealth of knowledge and expertise obtained from these fora will contribute to initiating trust and changing mindsets. These fora should have defined roles and defined outcomes.

- *Further studies*:

  More comprehensive or specialised studies should be designed and implemented in the SDIB to estimate total exposure inclusive of indoor and personal monitoring where other exposures like tobacco smoking, biomass fuels, allergens and lead exposure can impact on total exposure.

  Also, carefully designed prevention studies might help to understand both the importance of different risk factors for the development of asthma and the benefit that can be gained by implementing and evaluating various reduction strategies. This aspect particularly applies to the SDIB as there are numerous social, economic, cultural, behavioural and environmental factors to consider and all of these factors need to be studied either individually or collectively and the outcomes must be carefully analysed in order to implement feasible strategies.

To facilitate the implementation of the recommendations above, the Durban Metro should take the lead in co-ordinating a working group(s) or committee(s) representative of all stakeholders from the SDIB. These groups should have the capacity, knowledge, expertise and determination to help improve air quality in the area.

6.2.2 Improving Quality of Life for the asthmatic:

- *Assistance*:

  Given the socio-economic status, poverty level and education level of the study population and the caregivers/parents in this study, more knowledge, clinical follow up and an increase in financial support can help the families of asthmatic children to address the issues surrounding the disease and its treatment and control. The input and assistance of local industry, local NGOs, national and international donor organizations, health care providers and the health care system will be needed to initiate and continue with this function.

- *Implementation of self management programmes*:

  Self management programmes refers to the activities that the asthmatic and family undertake on their own with guidance and instruction from the clinician (Clark, *et al*. 1999). These programmes can focus on managing asthma symptoms, preventing attacks and developing communication between family members and the family and clinician. Interventions can include environmental control and special efforts to remove or avoid suspected irritants (e.g. tobacco smoke) and allergens (i.e. reduction of exposure to dustmites, cockroaches and animal dander) if these give rise to symptoms. It would be advisable to form health education support groups in Merebank to assist where necessary. These groups could include, amongst others, environmental health practitioners, educators and members of the medical fraternity.

- *Incorporating asthma education into the school curricula*:

  Using innovative outcome based education methods, asthma education could be incorporated into the maths and science curricula at the school, as evidenced by Yawn, *et al*. (2000), etc in Section 2.7.

  The strategies suggested below would be particularly relevant in increasing asthma awareness in the population of Settlers school where:

  ~ asthma, as a health problem, can be presented as a source of great concern and this additional knowledge given to the learners will help non-asthmatics better understand asthmatics;

  ~ this additional knowledge will also stimulate asthmatics to understand the disease better and will encourage the learner to take responsibility for his or her own health.

  ~ this strategy may serve as a tool to identify potential or current asthmatic students.

  Given the high prevalence rate of asthma and the enthusiasm of the school educators at the Settlers school, this strategy if implemented, can be beneficial to learners, parents / caregivers and staff alike.

6.2.3 Improving the treatment of asthma:

- *Written action plans*:

  There were no records of written action plans for asthmatics either at the Settlers school or at their homes. The learners in the study population need to be given individual written action plans on asthma and instructed in its use in the context of self-monitoring and a review of asthma medications and severity. Parents of asthmatics, teaching staff and clinicians in the SDIB will have to work closely together with the various stakeholders to assist in initiating and maintaining this process which can be considered a relevant and feasible strategy as evidenced by Gibson and Powell (2004).

- *Enhancing clinical practice*:

  There are fora consisting of members of the medical fraternity in the SDIB who can use their accumulative expertise in this area to help increase knowledge and understanding of this disease and the treatment and management thereof through the medium of workshops, specialized studies and conferences. The Thoracic Society of Australia and New Zealand developed a six step asthma management plan as reviewed under Section 2.7. This plan may however, have to be adapted to suit the context and complexities of the SDIB. Due consideration will have to be given to the processes of assessing funds, expertise, equipment and medication for the treatment and management of the asthmatic.

Recommendations are important tools in any document but to be truly effective need to be implemented in a prioritized, strategic and feasible manner with measurable goals and attainable outcomes. The recommendations discussed above will, hopefully, be a working document to assist government departments, local industry, media, the medical fraternity and the affected study population to achieve much success in decreasing signs and symptoms associated with exposure to air pollutants.

The long standing health issues involving the myriad of air pollutants and its perceived effects on the surrounding community of South Durban, had long been a bone of contention during the many years of apartheid and even now, has encroached on the new dispensation of South African democracy. Communities, especially the learners and teachers of the Settlers Primary school in South Durban, had viewed this as a blatant disregard of their rights as per the South African Constitution and other democratic instruments of law. Due cognizance therefore now needs to be taken by the relevant authorities, industries and communities in the SDIB to change the thinking of the past, proactively protect the present and preserve the future namely **THE CHILDREN OF SOUTH DURBAN.**

REFERENCES

1995. Bid to find solution to Durban pollution. *The Mercury*. 20th April.

1997. The future of asthma. *The Lancet*, **350**(9085):1113.

1998. High pollution level in city industries. *The Daily News*. 26th May.

1998. Expansion plan leaves health queries unanswered. *The Mercury*. 3rd February.

1999a. Air pollution red alert issued. *The Mercury*. 18th June.

1999b. Air pollution red alert in Durban lifted. *The Mercury*. 20th August.

1999c. Refinery to cut pollution levels. *The Mercury*. 6th December.

2000a. Industry growth in doubt. *The Mercury*. 2nd February.

2000b. Oil Refineries to face scrutiny. *The Mercury.* 4th February.

2000. School wants action soon. *Southlands Sun*. 13th October.

2003. Communities monitor industrial pollution. *Community News*, **3**:4.

Abelsohn, A., Stieb, D., Sanborn, M.D and Weir E. 2002. Identifying and managing adverse environmental health effects: 2. Outdoor air pollution. *Canadian Medical Association Journal*, **166**(9):1161-1167.

American Thoracic Society. 1995. Standardization of Spirometry-1994 Update. *Am J Respir Crit Care Med*, **152**:1107-1136.

American Thoracic Society. 2000a. Guidelines for Methacholine and Exercise Challenge Testing-1999. *Am J Respir Crit Care Med*, **161**:309-329.

American Thoracic Society. 2000b. What Constitutes an Adverse Health Effect of Air Pollution? *Am J Respir Crit Care Med*, **161**:665-673.

Anderson, H.R., Ruggles, R., Strachan, D.P., Austin, J.B., Burr, M., Jeffs, D., Standring, P., Steriu, A and Goulding R. 2004. Trends in prevalence of symptoms of asthma, hay fever and eczema in 12-14 year olds in the British Isles, 1995-2003: questionnaire survey. *BMJ*, **328**:1052-1053.

Arif, A.A., Delclos, G.L., Lee, E.S., Tortolero, S.R. and Whitehead, L.W. 2003. Prevalence and risk factors of asthma and wheezing among US adults: an analysis of the NHANES III data. *European Respiratory Journal*, **21**:827-833.

Avital, A., Godfrey, S and Springer, C. 2000. Exercise, Methacholine, and Adenosine 5'-Monophosphate Challenges in Children with Asthma. *Pediatric Pulmonology*, **30**:207-214.

Avital, A.; Uwyyed, K., Berkman, N.; Godfrey, S.; Bar-Yishay, E and Springer, C. 2001. Exhaled nitric oxide and asthma in young children. *Pediatric Pulmonology*, **32**:308-313.

Ayres, J. 1994. Asthma and atmosphere. *BMJ*, **309**:619-620.

Bacharier, L.B., Dawson, C., Bloomberg, G.R., Bender, B., Wilson, L and Strunk, R.C. 2003. Hospitalization for Asthma: Atopic, Pulmonary Function, and Psychological Correlates Among Participants in the Childhood Asthma Management Programme. *Pediatrics*, **112**(2):e85-e92.

Barnes, P.J. 1994. Air pollution and asthma. *Postgraduate Medical Journal*, **70**:319-325.

Barreto, M.; Villa, M.P.; Martella, S.; Falasca, C.; Guglielmi, F.; Pagani, J.; Darder, M.T. and Ronchetti, R. 2001. Off-line exhaled nitric oxide measurements in children. *Pediatric Pulmonology*, **32**:159-167.

Barron, W.F., Liu, J., Lam, T.H., Wong, C.M., et al. 1995. Costs and benefits of air quality improvement in Hong Kong. *Contemporary Economic Policy*, **13**(4):105-117.

Bates, D.V. 1995. The Effects of Air Pollution on Children. *Environmental Health Perspectives*, **103**(6):49-43.

Beardsley, D., Davies, T and Hersh, R. 1997. Improving environmental management. *Environment*, **39**(7):6-9; 28-35.

Bearer, C.F. 1995. How Are Children Different from Adults? *Environmental Health Perspectives*, **103**(Suppl 6):7-12.

Becker, A.B. 2000. Is Primary Prevention of Asthma Possible? *Pediatric Pulmonology*, **30**:63-72.

Beckett, W.S. 1999. Detecting Respiratory tract responses to Air Pollutants. *In*: Swift, D.L and Foster, W.M. (eds.) *Air Pollutants and the Respiratory Tract*. New York: Marcel Dekker, Inc. pp109-117.

Boubel, R.W., Fox, D.L., Turner, D.B and Stern, A.C. 1994. *Fundamentals of Air Pollution*. 3rd ed. San Diego: Academic Press.

Braga, A.L.F., Saldiva, P.H.N., Pereira, L.A.A., Menezes, J.J.C., Conceicao, G.M.S., Lin, C.A., Zanobetti, A., Schwartz, J and Dockery, D.W. 2001. Health Effects of Air Pollution on Children and Adolescents in Sao Paulo, Brazil. *Pediatric Pulmonology*, **31**:106-113.

Braun-Fahrlander, C., Vuille, J.C., Sennhauser, F.H., Neu, U., Kunzle, T., Grize, L., Gassner, M., Minder, C., Schindler, C., Varoneir, H.S., Wuthrich, B and the SCARPOL Team. 1997. Respiratory Health and Long-term Exposure to Air Pollutants in Swiss Schoolchildren. *Am J Respir Crit Care Med*, **155**:1042-1049.

Bresnitz, E., Grant, C., Ostrawski, S., Morris, C., Reetz, B. and Clugston, S. 2001. Self-Reported Asthma Prevalence Among Adults-United States, 2000. *JAMA*, **286**(13):1571.

Brunekreef, B. 2001. NO_2: the gas that won't go away. *Clinical and Experimental Allergy*, **31**:1170-1172.

Buckeridge, D.L., Glazier, R., Harvey, B.J., Escobar, M., Amrhein, C and Frank, J. 2002. Effect of Motor Vehicle Emissions on Respiratory Health in an Urban Area. *Environmental Health Perspectives*, **110**(3):293-300.

Butler, M and Hallowes, D.(ed.) 2002. *The groundwork Report 2002: Corporate Accountability in South Africa*. Pietermaritzburg: groundwork.

Campbell, C. 1995. Mandela brings parties together over pollution. *The Mercury*. 29th March.

Carlisle, A.J and Sharp N.C.C. 2001. Exercise and outdoor ambient air pollution. *British Journal of Sports Medicine*, **35**:214-222.

Carnie, T. 1996a. Holomisa cracks the whip. *The Mercury*. 28th February.

Carnie, T. 1996b. Oil group boss runs into flak over alleged pollution levels. *The Mercury*. 9th May.

Carnie, T. 1998a. Pollution report slams Government. *The Mercury*. 2nd February.

Carnie, T. 1998b. Mandate sought to monitor pollution. *The Mercury*. 10th February.

Carnie, T. 1998c. Durban's top polluters named in report. *The Mercury*. 2nd September.

Carnie, T. 2000a. Minister to raise funds to fight pollution. *The Mercury*. 10th May.

Carnie, T. 2000b. New gadget joins fight against dirty air. *The Mercury*. 17th May.

Carnie, T. 2000c. Enter the bucket brigade. *The Mercury*. 13th September.

Carnie, T. 2000d. Call for poison gas reduction. *The Mercury*. 20th September.

Carnie, T. 2000e. City Council may face tough choice. *The Mercury*, 12th October.

Carnie, T. 2000f. Moosa spells out anti-pollution plan. *The Mercury*. 29th November.

Chahabra, S.K., Chhabra, P., Rajpal, S and Gupta, R.K. 2001. Ambient Air Pollution and Chronic Respiratory morbidity in Delhi. *Archives of Environmental Health*, **56**(1):58-64.

Clark, N.M., Brown, R.W., Parker, E., Robins, T.G., Remick Jr, D.G., Philbert, M.A., Keeler, G.J. and Israel, B.A. 1999. Childhood Asthma. *Environmental Health Perspectives*, **107**(3):421-429.

Colon-Smidey, A.J., Marshik, P., Crowley, M; Katz R and Kelly, H.W. 2000. Correlation between reversibility of airway obstruction and exhaled nitric oxide levels in children with stable bronchial asthma. *Pediatric Pulmonology*, **30**:385-392.

Comino, E and Henry, R. 2001. Changing Approaches to Asthma Management in Australia. *Drugs*, **61**(9):1289-1300.

Common Ground Consulting. Durban Metropolitan Council. 1998. *Environmental Management Policy for the Durban Metropolitan Area*.

Cooper, A. 2000. Sapref congratulated for honesty. *The Daily News*. 1st February.

CSIR. 1999a. Air Quality indications in the South Durban Area: An Analysis based on sulphur dioxide (SO_2), nitrogen oxides (NO_X) and carbon monoxide (CO). Ref No: 14 ENV/P/C 97258. Environmentek, P.O. Box 17001, Congella, 4013.

CSIR. 1999b. Durban South Basin Strategic Environmental Assessment–Final Integrated Report, LA21. Report No. 51. Project No.:JX01J. Environmentek, P.O. Box 17001, Congella, 4013.

CSIR. 2002. Air Pollution and Health effects in South Durban-A review of existing data, Final Draft. CSIR report ENV-D-C 2002-011. Project: JX 337(020). P.O. Box 17001, Congella, 4013.

Danmarks Naturfredningsforening (DN) and South Durban Community Environmental Alliance (SDCEA). 2002. Comparison of Refineries in Denmark and South Durban in an Environmental and Societal Context.

Delfino, R.J., Gong Jr, H., Linn, W.S., Pellizzari, E.D and Hu, Y. 2003. Asthma Symptoms In Hispanic Children and Daily Ambient Exposures to Toxic and Criteria Air Pollutants. *Environmental Health Perspectives*, **111**(4):647-656.

Diggle, P., Liang K.Y and Zeger, S. 1994. *Analysis of Longitudinal Data*. Oxford, UK: Oxford University Press.

Edwards, L.J. 2000. Modern Statistical Techniques for the Analysis of Longitudinal Data in Biomedical Research. *Pediatric Pulmonology*, **30**:330-344.

Eggleston, P.A., Buckley, T.J., Breysse, P.N., Wills-Karp, M., Kleeberger, S.R and Jaakkola, J.J.K. 1999. The Environment and Asthma in U.S. Inner Cities. *Environmental Health Perspectives*, **107**(Supplement 3):439-450.

Ehrlich, R. 2002. The prevalence of asthma in South Africa. *Current Allergy and Clinical Immunology*, **15**(1):4-8.

Emeryk, A., Chojna, E., Bartkowiak-Emeryk, M and Postepski, J. 2004. Prevalence of asthma and some respiratory symptoms in the years 1995 and 2001 in schoolchildren from rural regions of Poland. *Ann Agric Enviro Med*, **11**:63-66.

Etzel, R.A. 2003. How Environmental Exposures Influence the Development and Exacerbation of Asthma. *Pediatrics*, **112**(1):233-239.

Evans III, R. 1992. Asthma among Minority Children-A Growing Problem. *CHEST*. **Supplement 101**(6):368S-371S.

European Respiratory Society. 1993. Airway Responsiveness. *European Respiratory Journal*, **6**(S16):58-83.

Fauroux, B., Sampil, M., Quenel, P and Lemoullec, Y. 2000. Ozone: A Trigger for Hospital Pediatric Asthma Emergency Room Visits. *Pediatric Pulmonology*, **30**:41-46.

Forastiere, F., Pistelli, R., Michelozzi, P., Corbo, G.M., Agabiti, N., Bertollini, R., Ciappi, G and Perucci, C.A. 1991. Indices of non-specific bronchial responsiveness in a pediatric population. *CHEST*, **100**:927-934.

Fouche, N and Diab, R.D. 1994. Community complaints about odours in Durban. *South African Journal of Science*. **90**:562-565.

Gent, J.F., Triche, E.W., Holford, T.R., Belanger, K., Bracken, M.B., Beckett, W.S and Leaderer, B.P. 2003. Association of Low-Level Ozone and Fine Particles with Respiratory Symptoms in Children with Asthma. *JAMA*, **290**(14):1859-1867.

Gibson, P.G and Powell, H. 2004. Written action plans for asthma: an evidence-based review of the key components. *Thorax*, **59**:94-99.

Gielen, H., van der Zee, S.C., van Wijnen, H., van Steen, C.J and Brunekreef, B. 1997. Acute Effects of Summer Air Pollution on Respiratory Health of Asthmatic Children. *Am J Respir Crit Care Med*, **155**:2105-2108.

Gilliland, F.D., Berhane, K., Rappaport, E.B., Thomas, D.C., Avol, E., Gauderman, W.J., London, S.J., Margolis, H.G., McConnell, R., Islam, K.T and Peters, J.M. 2001. The Effects of Ambient Air Pollution on School Absenteeism due to Respiratory Illnesses. *Epidemiology*, **12**(1):43-54.

Gordian, M.E., Ozkaynak, H., Xue, J., Morris, S.S and Splenger J.D. 1996. Particulate Air Pollution and Respiratory Disease in Anchorage, Alaska. *Environmental Health Perspectives*, **104**(3):290-297.

Grant, E.N., Lyttle, C.S. and Weiss, K.B. 2000. The Relation of Socioeconomic Factors and Racial/Ethnic Difference in US Asthma Mortality. *American Journal of Public Health*, **90**(12):1923-1925.

Guastella.L. (lisa@ecoserv.com) 12 October 2004a. *RE: Urgent-Need your help please!!*. E-mail to J. Kistnasamy (JoyK@dit.ac.za).

Guastella.L. (lisa@ecoserv.com) 1 November 2004b. *RE: Urgent-Need your help please!!*. E-mail to J. Kistnasamy (JoyK@dit.ac.za).

Haahtela, T., Marttila, O., Vilkka, V., Jappinen, P and Jaakkola, J.J.K. 1992. The South Karelia Study: Acute Health Effects of Maladorous Sulfur Air Pollutants released by a Paper Mill. *American Journal of Public Health*, **82**(4):603-605.

Hall, J.V. 1995. Air Quality Policies in Developing Countries. *Contemporary Economic Policy*, **13**(2):77-85.

Hallowes, D. 2001. Action plan for South Durban pollution. *Groundwork*, **3**(1):4-5.

Hallowes, D and Butler, M. (ed.) 2004. *The groundwork Report 2004: The Balance of Rights – Constitutional promises and struggles for environmental justice.* Pietermaritzburg: groundwork.

Harrison, R.M. 1999. Measurements of Concentrations of Air Pollutants. *In*: Holgate, S.T., Samet, J.M., Koren, H.S and Maynard, R.L. (eds.) *Air Pollution and Health*. San Diego: Academic Press. pp. 63-81.

Hartert, T.V. 2003. Acute asthma care interventions in improving asthma outcomes:putting guidelines into action. *Annals of Allergy, Asthma and Immunology*, **90**:8-9.

Helms, P.J. 2001. Issues in Pediatric Asthma. *Pediatric Pulmonology*, **Supplement 21**:49-56.

Hoek, G and Brunekreef, B. 1995. Effects of Photochemical Air Pollution on Acute Respiratory Symptoms in Children. *Am J Respir Crit Care Med*, **51**:27-32.

Horak, Jr, F., Studnicka, M., Gartner, C., Spengler, J.D., Tauber, E., Urbanek, R, Vieter, A and Frischer, T. 2002. Particulate matter and lung function growth in children: a 3-yr follow-up study in Austrian schoolchildren. *European Respiratory Journal*, **19**:838-845.

Horton, N.H and Lipsitz, S.R. 1999. Review of Software to Fit Generalized Estimating Equation Regression Models. *The American Statistician*, **53**:160-169.

Hurt, Q. 2001. Personal communication to Kistnasamy, J, 28 February 2001. Managing Director: ECOSERV. (t) 031–7101864, (f) 031–7101851, e-mail : hurt@ecoserv.co.za, 10a Caversham Rd, Box 416, Pinetown, 3600.

Jalaludin, B.B., Chey, T., O'Toole, B.I., Smith, W.T., Capon, A.G and Leeder, S.R. 2000. Acute effects of low levels of ambient ozone on peak expiratory flow rate in a cohort of Australian children. *International Journal of Epidemiology*, **29**:549-557.

John, J. 2001. Overview of exposure assessment research in children in South Africa-description of the gap. *Urban Health and Development Bulletin*, **4**(2):65-69.

Joseph-Bowen, J., de Klerk, N.H., Firth, M.J., Kendall, G.E., Holt, P.G and Sly P.D. 2004. Lung Function, Bronchial Responsiveness, and Asthma in a Community Cohort of 6-Year-Old Children. *Am J Respir Crit Care Med*, **169**:850-854.

Joseph, C.L.M., Ownby, D.R., Peterson, E.L and Johnson, C.C. Does low birth weight help to explain the increased prevalence of asthma among African-Americans? *Annals of Allergy, Asthma & Immunology*, **88**:507-512.

Jury, M.R. 2000. Determination of health impacts in urban regions exposed to atmospheric pollutants. *The Clean Air Journal*, **10**(6):7-13.

Just, J., Segala, C., Sahraoui, F., Priol, G., Grimfeld, A and Neukirch F. 2002. Short term health effects of particulate and photochemical air pollution in asthmatic children. *European Respiratory Journal*, **20**:899-906.

Kagawa, J., Nohara, M., Pan, G., Qu, C and Yang, Z.M. 2001. Comparison of respiratory symptoms between schoolchildren in China and Japan. *Allergology International*, **50**:303-309.

Kattan, M., Mitchell, H., Eggleston, P., Gergen, P., Crain, E., Redline, S., Weiss, K., Evans lll, R., Kaslow, R., Kercsmar, C., Leickly, F., Malveaux, F. and Wedner, H.J. 1997. Characteristics of Inner-City Children with Asthma: The National cooperative Inner-City Asthma Study. *Pediatric Pulmonology*, **24**:253-262.

Kaur B., Anderson, H.R., Austin, J., Burr, M., Harkins, L.S., Strachan, D.P and Warner, J.O. 1998. Prevalence of asthma symptoms, diagnosis and treatment in 12-14 year old children across Great Britain (international study of asthma and allergies in childhood, ISAAC, UK). *BMJ*, **316**:118-124.

Khan, F. 1995. State takes notice. *The Daily News*. 30th March.

Kharitonov, S., Alving, K and Barnes, P.J. 1997. Exhaled and nasal nitric oxide measurements:recommendations. *European Respiratory Journal*, **10**:1683-1693.

Kharitonov, S.A., Chung, K.F., Evand, D., O'Connor, B.J and Barnes, P.J. 1996. Increased Exhaled Nitric Oxide in Asthma Is Mainly Derived from the Lower Respiratory Tract. *Am J Respir Crit Care Med*, **153**:1773-1780.

Kistnasamy M.B. and Knapp M. 1991. The relationship between location of residency and respiratory symptoms of primary school pupils. [Unpublished].

Kivity, S., Sade, K., Abu-Arisha, F., Lerman, Y and Kivity, S. 2001. Epidemiology of bronchial asthma and chronic rhinitis in schoolchildren of different ethnic origins from two neighbouring towns in Israel. *Pediatric Pulmonology*, **32**:217-221.

Koren, H.S. 1995. Associations between Criteria Air Pollutants and Asthma. *Environmental Health Perspectives*, **103**(6):235-240.

Koren, H.S. and Utell, M.J. 1997. Asthma and the Environment. *Environmental Health Perspectives*, **105**(5):534-537.

Korenstein S and Piazza B. 2002. An Exposure Assessment of PM10 from a Major Highway Interchange: Are Children in Nearby Schools at Risk? *Journal of Environmental Health*, **65**(2):9-17.

Krzyzanowsk, M and Schwela, D. 1999. Patterns of Air Pollution in Developing Countries. *In*: Holgate, S.T., Samet, J.M., Koren, H.S and Maynard, R.L. (eds.) *Air Pollution and Health*. San Diego: Academic Press. pp. 106-113.

Kunii, O., Kanagawa, S., Yajima, I., Hisamatsu, Y., Yamamura, S., Amagai, T and Ismail, I.T.S. 2002. The 1997 Haze Disaster in Indonesia: Its Air Quality and Health Effects. *Archives of Environmental Health*, **57**(1):16-22.

Kunzli, N. 2002. The public health relevance of air pollution abatement. *European Respiratory Journal*, **20**:198-209.

Kuo, H.W., Lai, J.S., Lee, M.C., Tai, R.C and Lee, M.C. 2002. Respiratory Effects of Air pollutants among Asthmatics in Central Taiwan. *Archives of Environmental Health*, **57**(3):194-200.

Kurukulaaratchy, R.J., Fenn M., Twiselton, R., Matthews S and Arshad S.H. 2002. The prevalence of asthma and wheezing illnesses amongst 10-year-old schoolchildren. *Respir Med*, **96**(3):163-169.

Laden F., Neas, L.M., Dockery, D.W. and Schwartz, J. 2000. Association of Fine Particulate Matter from Different Sources with daily Mortality in Six US Cities. *Environmental Health Perspectives*, **108**(10):941-947.

Lebowitz, M.D. 1996. Epidemiological studies of the respiratory effects of air pollution. *The European Respiratory Journal*, **9**(4):1029-1054.

Lee, J., Kim, H., Song, H., Hong, Y., Cho, Y., Shin, S., Hyun, Y and Kim, Y. 2002. Air Pollution and Asthma Among Children in Seoul, Korea. *Epidemiology*, **13**(4): 481-484.

Leikauf, G.D., Kline, S., Albert, R.E., Baxter, C.S., Bernstein, D.I., Bernstein, J and Buncher C.R. 1995. Evaluation of a Possible Association of Urban Air Toxics and Asthma. *Environmental Health Perspectives*, **103**(6):253-273.

Levy, J. 2003. Health effects of Atmospheric Nitrogen Emissions. *Environment*, **45**(7):14.

Lin, M., Chen, Y., Burnett, R.T., Villeneuve, P.J and Krewski, D. 2003. Effect of short-term exposure to gaseous pollution on asthma hospitalization in children: a bi-directional case-crossover analysis. *J Epidemiol Community Health*, **57**:50-55.

Lurie, N., Straub, M.J., Goodman, N and Bauer, E.J. 1998. Incorporating asthma education into a traditional school curriculum. *American Journal of Public Health*, **88**(5):822-823.

Luyt, D.K., Davis, G., Dance, M., Simmank, K and Patel, D. 1995. Clinical characteristics of black asthmatic children. *SAMJ*, **85** (10):999-1001.

Lwebuga-Mukasa, J and Dunn-Georgiou, E. 2002. A School-Based Asthma Intervention Program in the Buffalo, New York, Schools. *The Journal of School Health*, **72**(1):27-32.

Maantay, J. 2001. Zoning, Equity, and Public Health. *American Journal of Public Health*, **91**(7):1033-1041.

MacLehose, R., Rao, M., Dyson, J and Milnes, P. 2001. Asthma knowledge and management in primary school in south Essex, UK. *Health Education*, **101**(6):255-263.

Massaro, A.F and Drazen J.M. 1996. Exhaled nitric oxide during exercise: site of release and modulation by ventilation and blood flow. *J Appl Physiol*, **80**:1863-1864.

Matooane, M and Diab, R. 2002. Initial Survey of sulphur dioxide (SO_2) pollution health risk in the South Durban Industrial Basin. Paper read at the National Association for Clean Air Proceedings, Durban, 2002.

McGovern,V. 2002. Taking a World View of Asthma. *Environmental Health Perspectives*, **110**(9):A514.]

Meintjies, M. 1998. No more heavy industry here. *The Daily News*. 1st October.

Miller, J.E. 2000. The Effects of Race/Ethnicity and Income on Early Childhood Asthma Prevalence and Health Care Use. *American Journal of Public Health*, **90**(3):428-430.

Mills, G. 1996. Refined Anger. *The Daily News.* 12th March.

Mortimer, K.M., Neas, L.M., Dockery, D.W., Redline, S and Tager, I.B. 2002. The effects of air pollution on inner-city children with asthma. *European Respiratory Journal*, **19**:699-705.

Murray, F., McGranahan, G and Kuylenstierna, J.C.I. 2001. Assessing Health effects of Air Pollution in developing countries. *Water, Air, and Soil Pollution*, **130**:1799-1804.

Nadel, J.A and Busse, W.M. 1998. Asthma. *Am J Respir Crit Care Med*, **157**:s130-s138.

Nagel, F.O. 1993. The Prevalence of Childhood Asthma in white primary schoolchildren in the southern suburbs of Cape Town. M.Med Degree (Part Three), Department of Paediatrics, University of Cape Town.

Naidoo, L. 1995. Protest over Engen. *The Daily News*. 14th December.

Ng'ang'a, L.W., Odhiambo, J.A., Mungai, M.W., Gicheha, C.M., Mderitu, P., Maingi, B., Macklem, P.T and Becklake, M.R. 1998. Prevalence of exercise induced bronchospasm in Kenyan school children: an urban-rural comparison. *Thorax*, **53**:919-926.

Nriagu, J., Robins, T., Gary, L., Liggans, G., Davila, R., Supuwood, K., Harver, C., Jinabhai, C.C and Naidoo, R. 1999. Prevalence of asthma and respiratory symptoms in south-central Durban. *European Journal of Epidemiology*, **15**:747-755.

Nurick, R and Johnson, V. 1998. Towards community based indicators for monitoring quality of life and the impact of industry in south Durban. *Environment and Urbanisation*, **10**(1):233-250.

Olin, A.C., Alving, K and Toren K. 2004. Exhaled nitric oxide: relation to sensitization and respiratory symptoms. *Clin Exp Allergy*, **34**:221-226.

Ostro, B., Lipsett M., Mann, J., Braxton-Owens, H and White, M. 2001. Air Pollution and Exacerbation of Asthma in African-American Children in Los Angeles. *Epidemiology*, **12**(2):200-208.

Pastor, M., Sadd, J.L and Morello-Frosch R. 2002. Who's Minding the Kids? Pollution, Public Schools, and Environmental Justice in Los Angeles. *Social Science Quarterly*, **83**(1):263-280.

Pearce, N., Beasley, R., Burgess, C and Crane J. 1998. *Asthma Epidemiology-Principles and Methods*. Oxford: Oxford University Press.

Peters, J.M., Avol, E., Navidi, W., London, S.J., Gauderman, W.J., Lurmann, F., Linn, W.S., Margolis, H., Rappaport, E., Gong Jr, H and Thomas, D.C. 1999. A Study of Twelve Southern California Communities with Differing Levels and Types of Air Pollution. *Am J Respir Crit Care Med*, **159**:760-767.

Peters, M. 1996. Residents in refinery protest over pollution in Durban south areas. *The Daily News*, 18th October.

Phillips, Y.Y and Schreiner, R.D. 2001. Streamlining Methacholine challenge testing. *CHEST*, **120**(6):1763-1765.

Poyser, M.A., Nelson, H., Ehrlich, R.I., Bateman, E.D., Parnell, S., Puterman, A and Weinberg, E. 2002. Socioeconomic deprivation and asthma prevalence and severity in young adolescents. *European Respiratory Journal*, **19**:892-898.

Premdev, D and Govender, S. 2000. 'We've had enough'. *Tribune Herald News,* 24th September.

Rahman, Q., Nettesheim, P., Smith, K.R., Seth, P.K. and Selkirk, J. 2001. International Conference on Environmental and Occupational Lung Diseases. *Environmental Health Perspectives*, **109**(4):425-431.

Romieu, I., Meneses, F., Ruiz, S., Sienra, J.J., Huerta, J., White, M.C and Etzel, R.A. 1996. Effects of Air Pollution on the Respiratory health of Asthmatic Children Living in Mexico City. *Am J Crit Care Med*, **154**:300-307.

Romieu, I., Meneses, F., Ruiz, S., Huerta J., Sienra, J.J., White, M., Etzel, R and Hernandez, M. 1997. Effects of Intermittent Ozone Exposure on Peak Expiratory Flow and Respiratory Symptoms among Asthmatic Children in Mexico City. *Archives of Environmental Health*, **52**(5):368-376.

Ross, M.A., Persky, V.W., Scheff, P.A., Chung, J., Curtis, L., Ramakrishnan, V., Wadden, R.A and Hryhorczuk, D.O. 2002. Effect of Ozone and Aeroallergens on the Respiratory Health of Asthmatics. *Archives of Environmental Health*, **57**(6): 568-578.

Salome, C.M., Roberts, A.m., Brown, N.J. Dermand, J., Marks, G.B and Woolcock, A.J. 1999. Exhaled Nitric Oxide Measurements in a Population Sample of Young Adults. *Am J Respir Crit Care Med*, **159**:911-916.

Samet, J.M. 2001. An air of uncertainty. *Forum for Applied Research and Public Policy*, **16**(3):92-96.

SDCEA, Danish Society for the Conservation of Nature and Danced. June 1998. Position Paper. P.O. Box 211150, Bluff, 4036, South Africa.

SDCEA, November 1999. Submission to the Durban Metro. The South Durban Strategic Environmental Assessment – A response by the residents of South Durban.

Seeliger, L. 1997. Clearing the air over pollution. *The Mercury*. 6th May.

Shamssain, M.H. 1991. Forced expiratory indices in normal black South African children aged 6-19 year. *Thorax*, **46**:175-170.

Shannigrahi, A.S.,Sharma, R.C and Fukushima, T. 2003. Air pollution control by optimal green belt development around the Victoria Memorial Monument, Kolkata (India). *Inter. J. Environ. Studies*, **60**:241-249.

Sheldon, T. 1999. Link between pollution and asthma uncovered. *BMJ*, **318**:756.

Shima, M and Adachi, M. 2000. Effects of outdoor and indoor nitrogen dioxide on respiratory symptoms in schoolchildren. *International Journal of Epidemiology*, **29**: 862-870.

Shima, M., Nitta, Y., Ando, M and Adachi, M. 2002. Effects of Air Pollution on the Prevalence and Incidence of Asthma in Children. *Archives of Environmental Health*, **57**(6):529-535.

Sippel, J.M., Holden, W.E., Tilles, S.A., O'Hallaren, M., Cook, J., Thukkani, N., Priest J, Nelson, B and Osborne M.L. 2000. Exhaled nitric oxide levels correlate with measures of disease control in asthma. *J Allergy Clin Immunol*, **106(**4):645-650.

Slaughter, J.C, Lumley, T., Sheppard, L., Koenig, J.Q and Shapiro, G.G. 2003. Effects of ambient air pollution on symptom severity and medication use in children with asthma. *Annals of Allergy, Asthma and Immunology*, **91**:346-353.

South Durban Basin Multi-Point Plan. Information Newsletter No. 1. October 2002. Programme Manager: MPP, 9th Floor, Embassy Building, 199 Smith St, Durban.

Strachan, D.P. 2000. The role of environmental factors in asthma. *British Medical Bulletin*, **56**(4):865-882.

Strunk, R.C., Szefler S.J., Phillips B.R., Zeiger, R.S., Chinchilli, V.M., Larsen G., Hodgdon, K., Morgan, W., Sorkness, C.A and Lemanske R.F. 2003. Relationship of exhaled nitric oxide to clinical and inflammatory markers of persistent asthma in children. *J Allergy Clin Immunol*, **112**(5):883-892.

Tattersfield, A.E., 1996. Air pollution:brown skies research. *Thorax*, **51**:13-22.

Taylor, D.R. 1997. Making the diagnosis of asthma. *BMJ*, **315**:4-5.

Thompson, A.J., Shields, M.D and Patterson, C.C. 2001. Acute Asthma Exacerbations and Air pollutants in Children Living in Belfast, Northern Ireland. *Archives of Environmental Health*, **56**(3):234-241.

Thurston, G.D. and Bates, D.V. 2003. Air Pollution as an Underappreciated Cause of Asthma Symptoms. *JAMA*, **290**(14):1915-1917.

Thurston, G.D., Lippman, M., Scott, M.B and Fine, J.M. 1997. Summertime Haze Air Pollution and Children with Asthma. *Am J respire Crit Care Med*, **155**:654-660.

Tonnesen, M.R. November 2001. The Role of Environmental NGOs in South Africa. Master's Thesis. University of Roskilde, Denmark.

Tortolero, S.R., Batholomew, L.K., Tyrrell, S., Abramson, S.L., Sockrider, M.M., Markham, C.M., Whitehead, L.W and Parcel, G.S. 2002. Environmental Allergens and Irritants in Schools: A Focus on Asthma. *Journal of School Health*, **72**(1):33-38.

Vedal, S., Petkau, J., White, R and Blair, J. 1998. Acute Effects of Ambient Inhalable Particles in Asthmatic and Nonasthmatic Children. *Am J Respir Crit Care Med*, **157**:1034-1043.

Weinberg, E.G. 2001.Urbanisation and childhood asthma in South Africa. *Urban Health and Development Bulletin*, **4**(2):19-26.

Weiss, K.B., Gergen, P.J. and Crain, E.F. 1992. Inner City Asthma-The Epidemiology of an Emerging US Public Health Concern. *CHEST*, **101**(6):362S-367S.

Wesley, A.G., Pather M and Becker P. 1989. Normal values for simple lung function tests in South African Asian children. *Annals of Tropical Paediatrics*, **9**:70-74.

WHO Regional Publications. 2000. WHO Air Quality Guidelines for Europe (2nd ed). European Series, No. 9.

Wood, R.A. 2002. Pediatric Asthma. *JAMA*, **288**(6):745-747.

Wubbel, C., Asmus, M.J., Stevens, G., Chesrown, S.E. and Hendeles, L. 2004. Methacholine Challenge Testing* Comparison of the Two American Thoracic Society-Recommended Methods. *CHEST*, **125**(2):453-458.

Yawn, B.P., Algatt-Bergstrom, P.J., Yawn, R.A., Wollan, P., Greco, M., Gleason, M and Markson, L. 2000. An In-School CD-ROM Asthma Education Program. *The Journal of School Health*, **70**(4):153-159.

Yemaneberhan, H., Bekele, Z., Venn, A., Lewis, S., *et al*. 1997. Prevalence of wheeze and asthma and relation to atophy in urban and rural Ethiopia. *The Lancet*, **350**:85-90.

Yu, O., Sheppard, L., Lumley, T., Koenig, J.Q. and Shapiro, G.G. 2000. Effects of ambient air pollution on symptoms of asthma in Seattle-Area children enrolled in the CAMP study. *Environmental Health Perspectives*, **108**(12):1209-1214.

Websites:

1. 2000. *Action against Asthma*. Department of Health and Human Services [online]. USA. Available from: http://www.aspe.hhs.gov/sp/asthma. Accessed 23rd July 2004].

2. *Asthma: How is asthma diagnosed?* National Heart, Lung, and Blood Institute. [online]. USA. Available from: http://www.nhlbi.nih.gov/health/dci/Diseases/Asthma/Asthma_Diagnosis.html [Accessed 23rd July 2004].

3. *Asthma: How is asthma treated?* National Heart, Lung, and Blood Institute. [online]. USA. Available from: http://www.nhlbi.nih.gov/health/dci/Diseases/Asthma/Asthma_Treatments.html [Accessed 23rd July 2004].

4. Masoli, M., Fabian, D., Holt, S and Beasley R. 2004. *Global Burden of Asthma.* United Kingdom. [online]. Available from: http://www.ginasthma.com/reportltem.asp?l1=2&12=2&intld=94. [Accessed 6 April 2005]

ANNEXURES

ANNEXURE A: A letter from the University of Michigan granting permission to cite, modify and use various documents

ANNEXURE B:

Attachment 1: Pamphlet

Attachment 2: Subject Information Sheet

Attachment 3: Screening Questionnaire

ANNEXURE C: Classification of Children's Asthma Status

ANNEXURE D: Written Informed Consent

ANNEXURE E:

Attachment 1: Parent/caregiver baseline interview

Attachment 2: Training of Parent and Child Interviewers – Trainee's Version

Attachment 3: Children's baseline interview

ANNEXURE F: Methacholine challenge testing

ANNEXURE G: Daily symptoms / activity log

ANNEXURE H: Bihourly symptom / activity for days at school

ANNEXURE I:

Attachment 1: Taking an airwatch measurement

Attachment 2: Bi-hourly airwatch log for days at school

ANNEXURE A: A letter from the University of Michigan granting permission to cite, modify and use various documents

THOMAS G. ROBINS, MD, MPH

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2 August, 2001

Ms. Joy Kistnasamy
Lecturer, Environmental Health
Technikon Natal
Durban, South Africa

Dear Ms. Kistnasamy:

By this correspondence, as a representative of the Regents of the University of Michigan, I am granting you permission to cite, modify, and otherwise use as you see fit the below (and attached) documents for your Masters thesis study entitled "The relationship between asthma and outdoor air pollutant concentrations of sulphur dioxide (SO2), oxides of nitrogen (NOx), ozone (O3), total reduced sulphates (TRS), carbon-monoxide (CO) and respirable particulate matter less than 10 microns (PM10) in learners and teachers at Settlers Primary School in Merebank, South Durban."

1) Classification of children's asthma status severity
2) Parent baseline questionnaire
3) Children's baseline interview.

Sincerely yours,

Thomas G. Robins, MD, MPH
Professor of Occupational Medicine

ANNEXURE B: Attachment 1: Pamphlet

Are you concerned about AIR POLLUTION in South Durban?

….and the health of you and your family ??? ☹

We encourage you and your child to take part in a study that will assess this risk!!!

PLEASE READ ON…

☞ THE STUDY

A study is planned for the year 2001 at

Settlers Primary School

☞ AIM

1. To assess the extent to which air pollution causes health problems for learners, teachers and other adult staff in this school.
2. To make recommendations after the study results have been analysed.

☞ WHO WILL CONDUCT THE STUDY?

This study is being conducted by the University of Michigan, USA (Dept. of Occupational Health), Nelson R. Mandela Medical School, Technikon Natal (Department of Environmental Health), Dr. B. Seetharam (GP in Merebank), Settlers Primary Environmental Committee, South Durban Community Environmental Alliance, City Health and Ecoserv.

☞ THE PARTICIPANTS…

- All adult personnel from Settlers Primary,
- All children in grades 3 and 6 and some children in grades 4, 5 and 7 from Settlers School – those children who have health problems reported in the SCREENING SURVEY.

☞ WHAT DO PARTICIPANTS DO?

- Screening and baseline questionnaires
- Complete baseline breathing tests
- Over 2 –3 weeks: keep daily diaries of problems and do daily breathing test (peak flow)

It's free!!! ☺ ☺

It's voluntary!!!

It's confidential!!! ☺ ☺

WHAT WILL BE DONE WITH THE FINDINGS?

- Confidential individual reports will be given to participants.
- Group report-back meetings examining whether air pollution does cause health problems:
  - School
  - Community
  - Government departments
  - Associated industries
  - Media

WHAT CAN YOU DO TO ASSIST?

Please complete the attached screening questionnaire(s) about your child(ren) in Grades 3, 4, 5, 6, or 7 (one per child) and return as soon as possible to the school.

WHY SHOULD YOUR CHILD PARTICIPATE?

HOW WILL YOU BENEFIT?

- ✔ Free info./testing on health status including medical referral if needed.
- ✔ Take steps to improve air pollution sources both outside and inside the home.
- ✔ The communities of South Durban will benefit.

To learn more….come to a meeting :

Where?

When?

For further information, please contact:

Ms. Joy Kistnasamy (co-investigator)

✆ 031 – 204 2082 (b/h)

ANNEXURE B: Attachment 2: Subject Information Sheet

IMPORTANT:

1)	**If you cannot understand this form, please request for the Zulu translated form.**
2)	**If you do not understand any words, please ask for an explanation before GIVING ASSENT.**

SUBJECT INFORMATION SHEET

TITLE OF RESEARCH:
The relationship between asthma and outdoor air pollutant concentrations of sulphur dioxide (SO_2), oxides of nitrogen (NO_x), ozone (O_3), total reduced sulphates (TRS), carbon monoxide (CO) and respirable particulate matter less than 10 microns (PM_{10}) in learners and teachers at Settlers Primary School in Merebank, South Durban.

INVESTIGATOR:
Ms. Joy Kistnasamy

CO-INVESTIGATORS:
This study is part of a bigger project that involves other researchers, namely, Ms. Nitasha Baijnath (Technikon Natal - Dept. of Environmental Health); Dr. Elvis Irusen (UND – Dept. of Respiratory Medicine) and Dr. Rajan Naidoo (UND – Dept. of Community Health).

INTRODUCTION:
You are being asked to take part in a study to determine the health effects of air pollution at your school. The purpose of the study is to find out whether you suffer from any health problems (like asthma, bronchitis and pneumonia) and whether this is made worse by air pollution. Your school was chosen as it is located near many factories that pollute the air and may be affecting your breathing.

SELECTION CRITERIA:
All learners from Grades 3 and 6 can be part of the study as well as any learners from Grades 4, 5 and 7 who have probable or known asthma. You will be given a screening questionnaire and an informed assent form to fill in. Both forms are to be returned to your teacher. You can refuse to take part or withdraw from the study at any time.

PROCEDURES:
If you agree to take part, then you will be asked some questions and also asked to do the following:

1) Complete simple breathing tests. You will be asked to blow several times into a machine, which measures how well your lungs are working. If this breathing test is normal, you will then be asked to inhale a medicine through a tube and repeat the breathing test.
2) Each day for a period of 2 weeks, fill out a daily book about activities and any breathing problems you may experience on that day.
3) Blow into a small machine 4 times a day to further test your breathing and record this.

p.t.o

DISCOMFORTS / RISKS:

There are no dangers from the questions asked, or keeping the daily books, or blowing into the small machine or the simple breathing test. In some people, the simple breathing test can cause the chest to become tight, your voice hoarse or give you a sore throat for a short period of time. Medication such as nebulising agents and ventolin plus oxygen and adrenaline which will be kept on site, will be administered **immediately** by trained personnel. Resuscitative equipment will also be kept on site and administered by trained personnel should the need arise. Follow-up checks will be carried out the following day. Should you be a participant, then special instructions will be given to you to ensure that no anti-asthmatic inhalers (12 hours before) or oral asthma medications (48 hours before) are taken prior to the test. However, if you need to take medication owing to symptoms or signs, you should do so ***immediately*** and inform the researcher as soon as possible.

BENEFITS:

Your parents will be given a written copy of all your results and what they mean so that your parents can take you to a doctor who can help make you well, if necessary. If health problems are found at your school, we may be able to help by finding some answers to make the air cleaner in your area. You will also help to protect the people of South Africa and people in other parts of the world who may have the same health problems as you have.

RENUMERATION:

No money will be paid to you for participating in the study. However, when your parent / guardian comes to the school to answer some questions, he / she will be given R10-00 to compensate for travel costs.

COSTS OF THE STUDY:

The study is offered at no cost to you. If a problem is discovered and you wish to visit a doctor, one will be recommended. However, the study cannot pay for these additional medical visits or treatment.

CONFIDENTIALITY:

The information that is collected from you will be kept private and confidential. Other than the study personnel, this information will never be seen by anyone without your written consent. The results of the study will be made available to the school and the community and will be presented so as to protect your identity.

PERSON TO CONTACT FOR PROBLEMS OR QUESTIONS:

Ms. Joy Kistnasamy (Lecturer)
Department of Environmental Health, Technikon Natal
P.O. Box 953, Durban, 4000
Tel: (031) 204 2082 / 2696 (Work) e-mail: JoyK@ntech.ac.za
082 9533 465 (Cell)

ANNEXURE B: Attachment 3: Screening Questionnaire

Study ID__________________

Settlers School Study

Screening Questionnaire

Please put a tick ☑ in the correct box for each question.

BACKGROUND INFORMATION

1. Child's full name ____

First Middle Surname

2. Child's current grade in school ____

3. Child's date of birth _____/_____/_____

day month year

4. Is your child: □1 Male
□2 Female

5. Usual language spoken at home: □1 English
□2 Zulu
□3 Xhosa
□4 Other (Specify:____________________)

6. Parent or guardian's name: ________________________ ______________________________

First Surname

7-9. Telephone number of person completing this questionnaire:

home: ________________ work: __________________ cell: __________________

10. Please provide a phone number of a relative or close friend in case we have trouble contacting you:

____

11-14. What is the complete address of the household where the child sleeps most often ?

____

House No. Road/Street

____

City Postal Code

****** Please turn over!** →

15. **<u>In the past 12 months,</u>** how often has your child had a **<u>cough that won't go away</u>**?

- □$_1$ every day
- □$_2$ more than 2 times per week
- □$_3$ more than 1 time per month
- □$_4$ 3 to 12 times in the whole year
- □$_5$ 1 or 2 times in the whole year
- □$_6$ never

16. **<u>In the past 12 months,</u>** how often has your child had **<u>wheezing</u>** (a whistling sound from the chest) **<u>with a cold</u>**?

- □$_1$ more than 1 time per month
- □$_2$ 3 to 12 times in the whole year
- □$_3$ 1 or 2 times in the whole year
- □$_4$ never

17. **<u>In the past 12 months,</u>** how often has your child had **<u>wheezing</u>** (a whistling sound from the chest) **<u>*without* a cold</u>**?

- □$_1$ every day
- □$_2$ more than 2 times per week
- □$_3$ more than 1 time per month
- □$_4$ 3 to 12 times in the whole year
- □$_5$ 1 or 2 times in the whole year
- □$_6$ never

18. **<u>In the past 12 months,</u>** how often has your child had an attack of **<u>wheezing</u>** that made it **<u>hard to breathe or catch his or her breath</u>**?

- □$_1$ every day
- □$_2$ more than 2 times per week
- □$_3$ more than 1 time per month
- □$_4$ 3 to 12 times in the whole year
- □$_5$ 1 or 2 times in the whole year
- □$_6$ never

19. **<u>In the past 12 months,</u>** how often has your child **<u>wheezed while exercising, running or playing</u>** ?

- □$_1$ every day
- □$_2$ more than 2 times per week
- □$_3$ more than 1 time per month
- □$_4$ 3 to 12 times in the whole year
- □$_5$ 1 or 2 times in the whole year
- □$_6$ never

****** Continued…** →

20. **<u>In the past 12 months,</u>** how often has your child **<u>coughed while exercising, running or playing</u>**?

- □1 every day
- □2 more than 2 times per week
- □3 more than 1 time per month
- □4 3 to 12 times in the whole year
- □5 1 or 2 times in the whole year
- □6 never

21. **<u>In the past 12 months,</u>** how often has your child complained that his or her **<u>chest felt tight or heavy</u>**?

- □1 every day
- □2 more than 2 times per week
- □3 more than 1 time per month
- □4 3 to 12 times in the whole year
- □5 1 or 2 times in the whole year
- □6 never

22. **<u>In the past 12 months</u>**, how often has your child's **<u>sleep been disturbed due to wheezing, coughing, chest tightness or shortness of breath</u>**?

- □1 most nights
- □2 more than 1 time per week
- □3 more than 2 times per month
- □4 more than 1 time per month
- □5 3 to 12 times in the whole year
- □6 1 or 2 times in the whole year
- □7 never

23. Has a doctor or nurse **EVER** said that your child had: (<u>check ALL that apply</u>)

- □1 Asthma
- □2 Bronchitis or Bronchiolitis
- □3 Reactive Airway Disease (RAD)
- □4 Pneumonia
- □5 Asthmatic Bronchitis
- □6 never

24. **<u>In the past 12 months</u>** has your child **<u>taken any medications, nebulisers, or inhalers (pumps) prescribed by a doctor</u>** for any of the conditions listed above?

- □1 No
- □2 Yes

****** Please turn over!** →

25. Does your child take **any of these doctor-prescribed medications every day**, even when he/she is **not** having trouble breathing?

- □1 No
- □2 Yes
- □8 Does not apply

26. Do you have any comments about the project or the questionnaire?

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE!

Please have your child return this questionnaire by

Monday, _____________ to his or her teacher.

ANNEXURE C: Classification of Children's Asthma Status

Classification of Children's Asthma Status Based on the Settler's School Study Screening Questionaire

7 Feb 01

I. A child will be considered to have **probable (or known) asthma** (of any severity) if any of the following are true:

a) three or more of the six non-exercise related symptoms (i.e., questions 15, 16, 17, 18, 21, and 22) were reported (at any level of frequency greater than "never")
b) either exercise symptom (i.e., question 19 and 20) was reported with a frequency of three times or more in the past year
c) there is a diagnosis of asthma (i.e., "asthma", "reactive airway disease", and /or "asthmatic bronchitis" were checked on question 23) with any symptoms (questions 15 through 22) or doctor-prescribed medication use (i.e., "yes" on question 24) in the past year)

II. A child will be considered to have **probable (or known) moderate to severe asthma** if, firstly, the child meets the diagnostic criteria for asthma above, and, secondly, any of the following are true:

a) Any daytime symptom (i.e., questions 15 through 21) is reported as being present "every day"
b) sleep disturbance (question 22) is reported "more than one time per week" or "most nights"
c) daily use of doctor-prescribed medicine (i.e., "yes" on question 25) with any daytime symptom reported as being present "more than two times per week"

III A child will be considered to have **probable (or known) mild persistent asthma** if, firstly, the child meets the diagnostic criteria for asthma above, and secondly, any of the following are true:

a) Three or more daytime symptoms are reported as being present "more than 2 times per week"
b) any use of doctor prescribed medication (i.e., "yes" on question 24) and 2 or more daytime symptoms reported as present "more than 2 times per week"
c) daily use of doctor prescribed medicine and nighttime symptoms reported as present "more than 2 times per month"

ANNEXURE D: Written Informed consent

SETTLERS SCHOOL STUDY

Informed Consent Form

Please note: this form is to be read, or read to, and signed by the child's parent or legal guardian and an adult witness

Your consent is required so that your child ____ can

FIRST NAME SURNAME

participate in a study of the health effects of air pollution at the Settlers School.

If you have any queries after reading this consent form, kindly call a representative of the research team, Ms. Joy Kistnasamy @ 204 2082 (b/h).

The study is being conducted by the Nelson R. Mandela Medical School. The purpose of the study is to find out whether health problems (like asthma, bronchitis, reactive airway disease, pneumonia and asthmatic bronchitis) experienced by learners and staff at the school, are caused by air pollution. If this is the case, then the study team will make recommendations to improve the situation. The study has the support of the school staff, community groups in South Durban and the City Health Department. We are studying this school because it is located near many sources of air pollution such as the oil refineries, airport, paper mill and sewage works.

If you agree to participate, you and your child will be interviewed. Your child will be asked to do the following:

- Complete baseline breathing tests
- Each day for a period of 2 or 3 weeks, fill out a daily log about activities and any breathing problems
- Blow into a hand held device several times a day to further test his or her breathing.

Baseline breathing tests:

Step 1: A simple breathing test will be taken. Your child will be asked to blow several times into a machine, which measures how well his or her lungs are working.

Step 2: If this simple breathing test is normal, your child will then be asked to breathe in either metacholine or histamine and repeat the breathing test as in Step 1. This test helps us find out if your child may have a breathing problem like asthma.

Risks:

There are no risks from the interviews, keeping the daily logs, blowing into the hand held device or the baseline simple breathing test. The breathing test using either metacoline or histamine, can cause chest tightness, hoarse voice or a sore throat for a short period of time in some people. Medication to relieve this, which you breathe in, will be administered ***immediately*** by trained personnel. This greatly reduces the chance of there been a serious problem.

Expected benefits to you, your child and others:

⇒ You will be given a written copy of all your child's test results with an explanation of what they mean. If you child is experiencing any health problems, you may wish to show these results to your child's doctor.

Please turn over…

.

- ⇒ If problems are found at Settlers School, we may be able to improve the situation by making specific recommendations about air pollution.
- ⇒ What we learn from this study may help to protect people in South Africa and other parts of the world from problems caused by air pollution.

Confidentiality:
The interview, diary and breathing test information that we collect from you and your child is ***completely confidential***. Other than the study personnel, this information will never be seen by anyone without your written consent. The results of the overall study will be made available to the school and the community and will be presented so as to protect the identity of individual participants.

Costs to you resulting from participation in the study:
The study is offered at ***no cost*** to you. If a problem is discovered and you wish to consult a doctor, we will recommend a doctor. However, the study cannot pay for these additional medical visits or treatments.

Voluntary nature of participation:
You and your child are free to decline to participate or to withdraw from the study at any time without suffering any penalty or disadvantage.

IMPORTANT:	**IF YOU DO NOT UNDERSTAND ANY OF THE INFORMATION IN THIS FORM, THEN PLEASE CONTACT Ms. Joy Kistnasamy on 204 2082 (b/h) or on 082 9533 465 (c). THIS SHOULD BE DONE BEFORE CONSENT IS GIVEN.**

Consent:
I understand the meaning of the information given above.

I hereby consent to having my child ____
FIRST NAME **SURNAME**
participate in the study.

Documentation of consent:

The child's parent or legal guardian and an adult witness should sign and date both copies of this document. You or your child should return ONE copy to your child's teacher at Settler's School by _______________________.

It will be given to the research staff and kept with the records of the study. The other copy is for you to keep.

ANNEXURE E: Attachment 1: Parent/caregiver baseline interview

Date:____/____/____ ID # ______________
Day Month Year

Settlers Primary School Study

Parent / Caregiver Baseline Survey

Cover Sheet

Name of respondent: ____
First Middle Surname

Phone numbers: **home:** ______________ **work:** ________________ **cell:** _______________

Name of child: ____
First Middle Surname

Interviewer's Name: ____

Interview time started: Time: _ _:_ _ am/pm

Who is the person most responsible for care of **[child]** or most familiar with any health problems (s)he has? ____

[If answer is not "me" then assess informally whether the person knows enough to complete the questionnaire.]

How are you related to **[child]**?

- ☐1 Mother
- ☐2 Father
- ☐3 Grandmother
- ☐4 Grandfather
- ☐5 Aunt
- ☐6 Uncle
- ☐7 Other (**SPECIFY:** __________________)

[INTERVIEWER: Enter gender of respondent ☐1 Male ☐2 Female

[INTRODUCTION: INTERVIEWER READS TO RESPONDENT]

The purpose of this questionnaire is to collect information about your child's health status. Your answers will help us figure out how to assist you and your child in protecting your child's health. If there is a question you do not want to answer, please let me know and we can skip it. All of your responses are confidential and will not shown to anyone outside the study team without your written consent.

1. Has a *doctor or nurse* ever told you that **[child]** has asthma?

☐1 Yes **[GO TO Q 2]**
☐2 No **[READ PASSAGE BELOW]**
☐9 Don't know **[READ PASSAGE BELOW]**

If NO or DON'T KNOW say: From now on, when I say asthma, I will be talking about breathing problems such as episodes of wheezing, coughing, tightness of the chest, heaviness in the chest or shortness of breath that **[child]** may sometimes experiences. I understand that [he or she] may or may not be having any problems like this. Okay? **[SKIP to Q 3]**

2. How old was **[child]** when a doctor or nurse told you that he/she had asthma?

____ years old

A. ASTHMA SEVERITY

3. In the past 12 months, how often has your child had a cough that won't go away? Would you say…

☐1 Every day
☐2 More than 2 times per week
☐3 More than 1 time per month
☐4 3 to 12 times in the whole year
☐5 1 or 2 times in the whole year
☐6 Never

4. In the past 12 months, how often has your child had wheezing (a whistling sound from the chest) with a cold?

☐1 Every day
☐2 More than 2 times per week
☐3 More than 1 time per month
☐4 3 to 12 times in whole year
☐5 1 or 2 times in the whole year
☐6 Never

5. In the past 12 months, how often has your child had wheezing (a whistling sound from the chest) *without* a cold?

☐1 Every day
☐2 More than 2 times per week
☐3 More than 1 time per month
☐4 3 to 12 times in the whole year
☐5 1 or 2 times in the whole year
☐6 Never

6. In the past 12 months, how often has your child had an attack of wheezing that made it hard for him or her to breathe or catch his or her breath**?**

- ☐ $_1$ Every day
- ☐ $_2$ More than 2 times per week
- ☐ $_3$ More than 1 time per month
- ☐ $_4$ 3 to12 times in the whole year
- ☐ $_5$ 1 or 2 times in the whole year
- ☐ $_6$ Never

7. In the past 12 months, how often has your child wheezed with exercise or running or playing hard?

- ☐ $_1$ Every day
- ☐ $_2$ More than 2 times per week
- ☐ $_3$ More than 1 time per month
- ☐ $_4$ 3 to12 times in the whole year
- ☐ $_5$ 1 or 2 times in the whole year
- ☐ $_6$ Never

8. In the past 12 months, how often has your child coughed with exercise or running or playing hard?

- ☐ $_1$ Every day
- ☐ $_2$ More than 2 times per week
- ☐ $_3$ More than 1 time per month
- ☐ $_4$ 3 to 12 times in the whole year
- ☐ $_5$ 1 or 2 times in the whole year
- ☐ $_6$ Never

9. In the past 12 months, how often has your child complained that his or her chest felt tight or heavy?

- ☐ $_1$ Every day
- ☐ $_2$ More than 2 times per week
- ☐ $_3$ More than 1 time per month
- ☐ $_4$ 3 to 12 times in the whole year
- ☐ $_5$ 1 or 2 times in the whole year
- ☐ $_6$ Never

10. In the past 12 months, how often has your child's sleep been disturbed due to wheezing, coughing, chest tightness or shortness of breath?

- ☐ $_1$ Most nights
- ☐ $_2$ More than 2 times per week
- ☐ $_3$ More than 1 time per month
- ☐ $_4$ 3 to 12 times in the whole year
- ☐ $_5$ 1 or 2 times in the whole year
- ☐ $_6$ Never

11. Are there any particular seasons or months when **[child's]** symptoms are worse?

- ☐$_1$ YES **[GO TO Q11.1]**
- ☐$_2$ NO **[SKIP TO 12]**

11.1 During which season (or months) does **[child]** have the most breathing problems? **[CHECK ALL THAT APPLY]**

- ☐$_1$ Spring (September, October, November)
- ☐$_2$ Summer (December, January, February)
- ☐$_3$ Autumn (March, April, May)
- ☐$_4$ Winter (June, July, August)
- ☐$_5$ Never has breathing problems

12 I am going to read a list of things that might bring on wheezing, tightness in the chest, cough, or shortness of breath in some children. I would like to know whether each of these things brings on these symptoms for **[child]**. **[CHECK ALL THE RESPONSES THAT R. MENTIONS, REMEMBER TO REPEAT QUESTION FROM TIME TO TIME]**

- ☐$_1$ Being active (running, playing, swimming, or exercising)
- ☐$_2$ Sprays or strong smells (such as colognes, perfumes, or cleaning supplies)
- ☐$_3$ Colds or flu
- ☐$_4$ Cold air

- ☐$_5$ Change in weather
- ☐$_6$ Laughing or crying hard
- ☐$_7$ Dust
- ☐$_8$ Pets
- ☐$_9$ Truck or car exhaust
- ☐$_{10}$ Hot summer days
- ☐$_{11}$ Pollen, trees, fresh cut grass
- ☐$_{12}$ Mold and mildew
- ☐$_{13}$ Smoke
- ☐$_{14}$ Cockroaches
- ☐$_{15}$ Certain foods
- ☐$_{16}$ Nothing causes breathing problems

12.1. Can you think of anything else that brings on **[child's]** breathing problems?

- ☐$_{17}$ Other (**SPECIFY: _______________**)

13. Has a doctor *ever* told you that **[child]** has.... **[READ ALL CHOICES]**

a. Allergies	☐1 YES ☐2 NO
b. Eczema	☐1 YES ☐2 NO
c. Hay fever	☐1 YES ☐2 NO
d. Reactive airway disease	☐1 YES ☐2 NO
e. Asthmatic bronchitis	☐1 YES ☐2 NO
f. Any other lung/breathing condition	☐1 YES (**SPECIFY:** ________________) ☐2 NO

14. Compared to this time last year would you say **[child's]** asthma symptoms [note: remind respondent what is meant by the term "asthma symptoms" as needed] are currently:

☐1 Better
☐2 The same
☐3 Worse
☐4 Never has problems

15. How would you rate the severity of your child's asthma at the moment? Would you say....

☐1 Very severe
☐2 Fairly severe
☐3 Not too severe
☐4 Not severe at all
☐5 Never has problems

16. In the past week, how well under control was your child's asthma? Would you say....

☐1 Very controlled
☐2 Fairly controlled
☐3 Not too controlled
☐4 Not controlled at all
☐5 Never has problems

B. ASTHMA MEDICATION

17. Did you bring all the medications in the home that **[child]** is has ever taken for asthma, wheezing, tightness in the chest, shortness of breath, or cough. This includes those medications that a doctor or clinic has prescribed and those that a doctor did not prescribe, for example, over-the-counter drugs or home remedies. **[IF CHILD HAS NEVER TAKEN ANY MEDICATION FOR ASTHMA, SKIP TO ASTHMA HEALTH SERVICES UTILIZATION SECTION, Q 18]**

Medication Name	Code [**LEAVE BLANK**]	Is this a. . .	Was this medicine prescribed by a doctor?	How often did the doctor say to take it or use it?		Can you tell me when [child] last used this medicine?
17a.		☐1 pill ☐2 liquid (to swallow) ☐3 inhaler/pump ☐4 added to a breathing machine or nebulizer	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/day	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month ago
17b.		☐1 pill ☐2 liquid ☐3 inhaler/puffer ☐4 breathing machine	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/day	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month ago
17c.		☐1 pill ☐2 liquid ☐3 inhaler/puffer ☐4 breathing machine	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/day	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month ago
17d.		☐1 pill ☐2 liquid ☐3 inhaler/puffer ☐4 breathing	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/da	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month

		machine			y	ago
17e.		☐1 pill ☐2 liquid ☐3 inhaler/puffer ☐4 breathing machine	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/day	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month ago

17f. Are there any other medications that **[child]** has taken in the last month that aren't here?

☐1 YES (**GO TO 17g)**
☐2 NO

17g. Complete chart below

Medication Name	Code [**LEAVE BLANK]**	Is this a. . .	Was this medicine prescribed by a doctor?	How often did the doctor say to take it or use it?		Can you tell me when [child] last used this medicine?
17h.		☐1 pill ☐2 liquid (to swallow) ☐3 inhaler/puffer ☐4 added to a breathing machine or nebulizer	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/day	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month ago
17i.		☐1 pill ☐2 liquid ☐3 inhaler/puffer ☐4 breathing machine	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/day	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month ago
17j.		☐1 pill ☐2 liquid ☐3	☐1 Yes ☐2 No	PRN (as needed)	__ times/day	☐1 today ☐2 yesterday ☐3 last week

		inhaler/puffer ☐4 breathing machine		☐1	or ___ puffs/day	☐4 last month ☐5 more than 1 month ago
17k.		☐1 pill ☐2 liquid ☐3 inhaler/puffer ☐4 breathing machine	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/day	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month ago
17l.		☐1 pill ☐2 liquid ☐3 inhaler/puffer ☐4 breathing machine	☐1 Yes ☐2 No	PRN (as needed) ☐1	__ times/day or ___ puffs/day	☐1 today ☐2 yesterday ☐3 last week ☐4 last month ☐5 more than 1 month ago

C. ASTHMA HEALTH SERVICES UTILIZATION

The following questions ask about **[child's]** visits to medical facilities for care.
[NOTE: IF R. SAYS NONE, WRITE IN "0"].

18. Not including emergency room visits, how many times in the past 12 months has **[child]** been to a doctor's office or health care clinic for asthma? ____ times

18.1 Not including emergency room visits, can you tell me the last time **[child]** saw a doctor or health care provider for asthma, wheezing, tightness or heaviness in the chest, or cough? **[ASK OPEN-ENDED AND FILL IN RESPONSE THAT MATCHES RESPONSE – IF NO RESPONSE THEN READ CHOICES]**

☐1 In the past 2 weeks
☐2 In the past 3 months
☐3 In the past 12 months
☐4 More than 12 months ago
☐5 Never

19. How many times in the past 12 months has **[child]** been to the emergency room (but not stayed overnight in the hospital) for asthma? **[IF RESPONDENT SAYS "ZERO," ENTER "0" ON BLANK AND SKIP TO Q 20]**

____ ER visits

19.1 When was the last time **[child]** went to the emergency room for asthma (but didn't stay overnight in the hospital)?

- ☐$_1$ In the past 2 weeks
- ☐$_2$ In the past 3 months
- ☐$_3$ In the past 12 months
- ☐$_4$ More than 12 months ago
- ☐$_5$ Never

19.2 What emergency room did you go to:

ER name___________________________________

[LEAVE BLANK – (ER ODE)_________________________]

19.3 What brought on that attack? **[ASK OPEN-ENDED – DO NOT PROBE]**

- ☐$_1$ Exposure to something (dust, pets, smoke, etc.)
- ☐$_2$ Weather change (cold to warm, wet to dry, etc.)
- ☐$_3$ Season change (winter to spring etc.)
- ☐$_4$ Not taking medication, ran out of medication
- ☐$_5$ Cold/flu/respiratory infection
- ☐$_6$ Emotional stress
- ☐$_7$ Other (**SPECIFY:** _____________________________)
- ☐$_9$ Don't know

20. How many times in the past 12 months has **[child]** had to stay in the hospital for one night or more because of asthma? **[IF RESPONDENT SAYS "ZERO," ENTER "0" ON BLANK AND SKIP TO Q 22]**

________ overnight stays

20.1 When was the last time **[child]** was in the hospital for one night or more for asthma? Would you say ….

- ☐$_1$ In the past 2 weeks
- ☐$_2$ In the past 3 months
- ☐$_3$ In the past 12 months

20.2. What hospital was **[child]** in when he/she last stayed for one night or more because of asthma?

Name of hospital __________________________

[LEAVE BLANK –(HOSPITAL CODE)__________]

20.3. How many nights was **[child]** in the hospital at that time?

_____ nights

21. How many times in the past 12 months has **[child]** been in the intensive care unit because of asthma? **[IF RESPONDENT SAYS "ZERO," ENTER "0" ON BLANK AND SKIP TO Q22]**

____ times in ICU

21.1 When was the last time **[child]** was in the intensive care unit for asthma?

- ☐1 In the past 2 weeks
- ☐2 In the past 3 months
- ☐3 In the past 12 months

21.2 What hospital was **[child]** in when he/she was in the intensive care unit?

Name of ICU hospital ___________________________________

[LEAVE BLANK- (ICU CODE)________________]

22. Not including the emergency room, does **[child]** have a *regular* family doctor or health care provider that you usually go to for his/her health care?

- ☐1 Yes What is Doctor or Clinic's name _______________
- ☐2 No **[IF "NO", SKIP TO Q 23]**

22.1 When is the last time you visited this doctor or clinic?

____

D. CAREGIVER'S QUALITY OF LIFE

Now, I am going to ask you some similar questions about how your child's asthma has affected you and also some questions about your health.

23.1 In the past 3 months, how often did you wake up or lose sleep because of [child's] asthma? Would you say you woke up or lost sleep……

- ☐1 Most nights
- ☐2 More than 2 times per week
- ☐3 More than 2 times per month
- ☐4 1 or 2 times per month
- ☐5 No nights

Is there a particular season or month when you wake up or lose sleep most because of **[child's]** asthma?

☐1 YES
☐2 NO **[SKIP TO Q 24]**

23.2 During what season or month do you wake up or lose sleep most because of **[child's]** asthma? **[CHECK ONE]**

☐1 Spring (September, October, November)
☐2 Summer (December, January, February)
☐3 Autumn (March, April, May)

☐4 Winter (June, July, August)

23.3 During the last **[USE ANSWER FROM 23.2]**, how often did you wake up or lose sleep because of **[child's]** asthma?

☐1 Most nights
☐2 More than 2 times per week
☐3 More than 2 times per month
☐4 1 or 2 times per month
☐5 No nights

24. In the past 3 months, how often did you have to change your daytime or evening plans because of [child's] asthma? Would you say it was…..

☐1 Most days/evenings
☐2 More than 2 times per week
☐3 More than 2 times per month
☐4 1 or 2 times per month
☐5 No days/evenings

24.1 Is there a particular season or month when you have to change your daytime or evening plans most because of **[child's]** asthma?

☐1 YES
☐2 NO **[SKIP TO Q 26]**

24.2 During what season or month do you have to change your daytime or evening plans most because of **[child's]** asthma? **[CHECK ONE]**

☐1 Spring (September, October, November)
☐2 Summer (December, January, February)
☐3 Autumn (March, April, May)
☐4 Winter (June, July, August)

25. During the last **[USE ANSWER FROM 24.2]**, how many days or nights per week do you have to change your daytime or evening plans because of **[child's]** asthma? Would you say it was…..

- ☐1 Most days/evenings
- ☐2 More than 2 times per week
- ☐3 More than 2 times per month
- ☐4 1 or 2 times per month
- ☐5 No days/evenings

E. HOUSEHOLD ENVIRONMENTAL CHECKLIST

26. Do you rent or own your home or neither?

- ☐1 Rent
- ☐2 Own **[SKIP TO Q 27]**
- ☐3 Neither **[SKIP TO Q 27]**

26a. In general, how easy or difficult would you say that it is to get your landlord to make repairs when they are needed? Would you say . . . **[READ CHOICES]**

- ☐1 Very easy
- ☐2 Somewhat easy
- ☐3 Neither easy or difficult
- ☐4 Somewhat difficult
- ☐5 Very difficult

27. At any time during the year is there standing water or puddles located in. . . **[READ EACH CHOICE]**

27a. **[Child's]** sleeping room?

- ☐1 Yes
- ☐2 No

27b. The sitting room?

- ☐1 Yes
- ☐2 No

27c. The kitchen?

- ☐1 Yes
- ☐2 No

27d. Another place I did not specify?

- ☐1 Yes (**specify________________**)
- ☐2 No

28. How many pets of each type come inside the home?

Dog? ________________

Cat? ___________________

Other pets (**SPECIFY:** ___________________________________)

☐ No pets in the house **[SKIP TO Q 29]**

[IF ANY CATS OR DOGS OR OTHER PETS WITH FUR ARE PRESENT, ASK 28.1 AND 28.2.]

28.1 Do any of these pets spend any time in child's bedroom?

☐$_1$ Yes
☐$_2$ No
☐$_9$ [**DON'T KNOW**]

28.2 Are the pets put out of the house at night?

☐$_1$ Yes
☐$_2$ No
☐$_3$ Sometimes
☐$_9$ [**DON'T KNOW**]

29. Are there cockroaches in your home?

☐$_1$ Yes
☐$_2$ No
☐$_9$ Don't know

29.1. Have you had any problems with cockroaches in your home during the past

☐$_1$ Yes
☐$_2$ No
☐$_9$ Don't know

30. Have you or someone else (your landlord, another family member, a professional) treated your home for cockroaches in the past year?

☐$_1$ Yes
☐$_2$ No **[SKIP TO Q31]**
☐$_9$ Don't know **[SKIP TO Q31]**

30.1 When was the last time it was treated ?

☐$_1$ Within last month

☐$_2$ 1 to 3 months ago
☐$_3$ 3 to 6 months ago

☐4 6 to 12 months ago
☐5 More than 12 months ago
☐9 Don't know

30.2 What was used to treat your home for roaches? **[READ EACH CHOICE AND CHECK ALL THAT APPLY]**

☐1 Dry powder
☐2 Spraying
☐3 Gel
☐4 Roach bait trap (**SPECIFY:** ______________)
☐5 Boric acid
☐6 Other (**SPECIFY:** ______________________)
☐9 Don't know

31. Have you had any problems with mice or rats in your home during the past year?

☐1 Yes
☐2 No
☐9 Don't know

31.1 Have you or someone else (your landlord, another family member, a professional) treated your home for rats or mice in the past year?

☐1 Yes
☐2 No **[SKIP TO Q 32]**
☐9 Don't know **[SKIP TO Q32]**

31.2 When was the last time?

☐1 Within last month
☐2 Between 2 and 6 months ago
☐3 Between 6 and 12 months ago
☐4 More than 12 months ago
☐9 Don't know

31.3 How is your home treated for rats or mice? [**READ EACH CHOICE AND CHECK ALL THAT APPLY**]

☐1 Spring traps
☐2 Glue traps
☐3 Poison
☐4 Other (**SPECIFY:** ______________)
☐9 Don't know

F. BEHAVIOR CHANGE TO REDUCE ENVIRONMENTAL HAZARDS

The purpose of these questions is to look at the environment in your home and how it relates to your child's asthma as well as the health of other household members.

32. Is there anyone whose paying job is working around chemicals (such as pesticides, paints) or dust living in the home?

☐1 YES
☐2 NO
☐9 Don't know

32. 1. If yes, do they usually wear their work clothes home?

☐1 YES
☐2 NO
☐9 Don't know

33. Is there anyone whose informal job (includes working with chemicals) is in or near the home?

☐1 YES
☐2 NO
☐9 Don't know

34. During the last 2 weeks, how many times was the room in which **[child]** sleeps dusted?

☐1 None
☐2 1
☐3 2
☐4 3
☐5 4 or more
☐9 Don't know

34.1. What do you use when you dust?

☐1 Dry cloth
☐2 Damp cloth
☐3 Other (**SPECIFY: __________**)

34.2. During the last 2 weeks, how many times were other rooms in the house dusted?

☐1 Yes (**SPECIFY: _______________**)
☐2 No
☐9 Don't know

39. How often does the cover on your child's bed get washed (i.e. bedspreads/comforters)?
[RECORD THE CATEGORY CLOSEST TO THE RESPONSE. IF RESPONDENT UNSURE, READ RESPONSES]

- ☐1 Once a week or more often
- ☐2 More than once a month
- ☐3 More often that every 3 months (4 times a year)
- ☐4 More often that every six months (2 times a year)
- ☐5 Less often than every six months
- ☐9 Don't know

40. Does **[child]** have stuffed animals in his or her bedroom?

- ☐1 Yes
- ☐2 No **[SKIP TO Q 41]**
- ☐9 Don't know

40.1. Do **[child's]** stuffed animals get washed?

- ☐1 Yes
- ☐2 No **[SKIP TO Q 41]**
- ☐9 Don't know or not applicable **[SKIP TO Q41]**

40.2 How many times per year do **[child's]** stuffed animals get washed?
[DO NOT READ RESPONSE CATEGORIES TO RESPONDENT; CHOOSE CATEGORY WHICH FITS RESPONSE]

- ☐1 Once a week
- ☐2 Once a month
- ☐2 Every three months (4 times a year)
- ☐3 Every six months (2 times a year)
- ☐4 Less than once a year

Now I'm going to ask you a few questions about smoking. These questions concern smoking of cigarettes.

42. How many people who live in **[child's]** home smoke?
[INCLUDE RESPONDENT IF SMOKER.]

________ people
- ☐1 None [**SKIP TO Q 44**]

43. Do you smoke cigarettes, even occasionally?

☐1 Yes
☐2 No [**SKIP TO Q 44**]

43.1 About how many cigarettes a day do you now smoke?
___________ cigarettes

43.2 How often do you go outside the home to smoke?
☐1 Always
☐2 Sometimes
☐3 Rarely
☐4 Never
☐9 Don't know

44. Does **[child]** smoke cigarettes?
☐1 Yes
☐2 No
☐9 Don't know

45. Do any frequent visitors smoke?
☐1 Yes
☐2 No
☐9 Don't know

46. Many people have difficulties keeping their children away from cigarette smoke. Do you have problems keeping **[child]** away from people who are smoking?

☐1 Yes
☐2 No

47. How frequently is your child around people who are smoking? Would you say. . . . **[READ CHOICES]**
☐1 Daily
☐2 Several times a week
☐3 Several times a month
☐4 Never
☐9 Don't know

G. STRESSORS & WORRIES

In this next section, I'm going to read a list of things that people sometimes worry about in their neighborhood. Thinking back over the last 12 months, for each one, please tell me whether you worry about it never, hardly ever, sometimes, often, all of the time.

48. How often do you worry about . . . **[READ ALL CHOICES]**

a. Your physical safety in your neighborhood
☐1 Never
☐2 Hardly ever
☐3 Sometimes

☐4 Often
☐5 All of the time

b. Being robbed or having your home broken into

☐1 Never
☐2 Hardly ever
☐3 Sometimes
☐4 Often
☐5 All of the time

c. Not having enough money to raise your children

☐1 Never
☐2 Hardly ever
☐3 Sometimes
☐4 Often
☐5 All of the time

d. Not having clean air to breath

☐1 Never
☐2 Hardly ever
☐3 Sometimes
☐4 Often
☐5 All of the time

e. Not having safe water to drink

☐1 Never
☐2 Hardly ever
☐3 Sometimes
☐4 Often
☐5 All of the time

f. Not having enough money to pay for health care for your children

☐1 Never
☐2 Hardly ever
☐3 Sometimes
☐4 Often
☐5 All of the time

g. Having your food run out before you have money to buy more

☐1 Never
☐2 Hardly ever
☐3 Sometimes
☐4 Often
☐5 All of the time

h. Your mode of transport

☐1 Never
☐2 Hardly ever
☐3 Sometimes
☐4 Often

☐5 All of the time

49. Are you afraid you or your children will be hurt by violence in your neighborhood?

☐1 Yes
☐2 No

50a. Do you keep your child(ren) indoors (that is, not let them play outside) because you are afraid they might be hurt by violence in your neighborhood?

☐1 Yes
☐2 No
☐9 Don't know

50. b How often do you worry about your children's safety when they play outside in your neighborhood

☐1 Never
☐2 Hardly ever
☐3 Sometimes
☐4 Often
☐5 All of the time

51a. While you have lived in this neighborhood, has anyone ever used violence, such as in a mugging, fight, or sexual assault, against you or any member of your household anywhere in your neighborhood?

☐1 Yes
☐2 No

51.b. Has this ever happened in your home?

☐1 Yes
☐2 No

52. Did any of the following occur in your neighborhood during the past 6 months?

52.a. A fight in which a weapon was used?

☐1 Yes
☐2 No [**SKIP TO 52b]**

52.a.1. **[IF YES]** More than once?

☐1 Yes
☐2 No

52.b. A violent argument between neighbors or friends?

☐1 Yes
☐2 No **[SKIP TO 52c]**

52.b.1. **[IF YES]** More than once?

☐1 Yes
☐2 No

52.c. A sexual assault or rape?

☐1 Yes

☐2 No **[SKIP TO 52d]**

52.c.1 **[IF YES]** More than once?

☐1 Yes
☐2 No

52.d. A robbery or mugging?

☐1 Yes
☐2 No **[SKIP TO 53]**

52. d.1. **[IF YES]** More than once?

☐1 Yes
☐2 No

G. DEMOGRAPHICS

Now I'd like you to answer some questions about you and your household.

53. What is your date of birth?

____
Month Day Year

☐1 Refused

54. What is your race? I'll read the choices . . .

☐1 African
☐2 Indian
☐3 Coloured
☐4 White
☐5 Other (**SPECIFY:** ____________________)

55. What about **[child's]** race? I'll read the choices….

☐1 African
☐2 Indian
☐3 Coloured
☐4 White
☐5 Other (**SPECIFY:** ____________________)

The next questions ask about your job, education, and total family income. This information, like all other information we collect, is confidential.

56. What is the highest grade or year of school you completed? **[READ CHOICES]**

☐1 Never attended school or only pre-school
☐2 Class 1 – Std 6 (Grades 1 through 8)
☐3 Std 7 – Std 9 (Grades 9 through 11-

Some high school
☐4 Std 10 / Matric (Grade 12 - High school graduate)
☐5 College / technikon / university (1 year to 3 years (Some college or technical school)
☐6 College 4 years or more (College graduate)
☐7 Refused

57. How many adults (18 years or older) usually live in your home?________________

57.a. How many are employed on a full-time basis? _________________

57.b. How many are employed on a part-time basis? _________________

58.a. How many children (less than 18 years of age) regularly live in your home? **[INCLUDE STUDY SUBJECT]** ________________

58.b. How many children (less than 18 years of age) who don't live in the house regularly spend time in the home during the daytime (for example for daycare, etc.) **[INCLUDE STUDY SUBJECT]** __________________

59. How long has **[child]** lived at his/her current address? ____________ (years) OR

_____________ (months)

60. How many rooms are there in your home?

________________rooms

61. Which category best describes the **total yearly combined income of all members** of your household? This includes money received from jobs, business, rent income, pension, grants, assistance, and any other income received by members of your household. Please stop me when I get to the category that describes your total income**. [READ CHOICES]**

☐1 Less than R1 000
☐2 R1 001-2 000
☐3 R2 001 5000
☐4 R5 001-10 000
☐5 R10 001–20 000
☐6 R20 001–30 000
☐7 R30 001–50 000
☐8 R50 001–75 000
☐9 R75 001–100 000
☐10 R100 000-150 000
☐11 R150 001 and above

END: Thank you for helping us! Interview completed at: Time:_ _:_ _ am / pm

ANNEXURE E: **Attachment 2: Training of Parent and Child Interviewers - Trainee's Version**

SETTLERS PRIMARY SCHOOL STUDY

a project of the

UNIVERSITY OF NATAL NELSON R. MANDELA SCHOOL OF MEDICINE

in collaboration with:

TECHNIKON NATAL, UNIVERSITY OF MICHIGAN, USA, METROPOLITAN DURBAN DEPARTMENT OF HEALTH, METROPOLITAN DURBAN DEPARTMENT OF WATER, SETTLERS PRIMARY ENVIRONMENT COMMITTEE, SOUTH DURBAN COMMUNITY ENVIRONMENTAL ALLIANCE, ECOSERV, DR. B. SEETHARAM

TRAINING OF PARENT AND CHILD INTERVIEWERS

Trainee's Version

31 May 2001

This training manual was adapted from a training manual developed by the Community Action Against Asthma Project in Detroit, Michigan, USA.

Welcome and Introductions

Welcome to the Parent and Child Interviewer training for the Settlers Primary School Study.

Housekeeping issues:

- Timing of today's session
- Logistics for meals
- Cellphones
- "Break" policy
- Getting reimbursed for training time
- Not all who participate in the training will necessarily actually become interviewers.

Interviewing in the way that we will be doing it in this project is a new way of interacting with others for most of us here. Some people find it very difficult because it is such a different way of communicating. Others find it interesting and enjoyable. Some people can develop skills that make them good interviewers, other people have skills that make them good at interacting with people in other ways but not as interviewers. After we go through some of the training, some of you might, or we might, realize that the job of interviewer isn't a good match for you – and that's fine and it doesn't mean that you're not good communicators. The differences in communication styles will become clearer as we get into the training.

Overview of Training Schedule

Welcome and Introductions (10 min.)
Overview of Training Schedule (5 min.)
Overview of Training Manual (5 min.)
Introduction to Settlers Primary School Study (15 min.)
Purpose of Interviews (15 min.)
Differences Between Interview & Conversation (Exercise) (15 min.)
Role and Responsibilities of the Interviewer (10 min.)
Confidentiality of Interviewing (10 min.)
Ethics of Interviewing (5 min.)

LUNCH BREAK (30 min.)

Stages of the Interview Process (5 min.)
Answers to Frequent Questions (5 min)
Questionnaire Introduction (5 min)
Introduce Different Question Types (Exercise) (20 min.)
Overview of Survey (10 min.)
Responses and Recording Data (Exercise) (10 min.)
Clarifying and Probing (Exercise) (20 min.)
Feedback (10 min.)

BREAK (10 min.)

Practice Adult Survey (Exercise and Role Plays) (30 min.)
Feedback and Discussion (20 min.)
Practice Adult Survey (cont.) (20 min.)
Editing the Survey (15 min.)
Closing the Survey (15 min.)
Feedback and Discussion (10 min.)

BREAK (10 min.)

Child Survey (10 MIN.)
Practice Child Survey 20 min.)
Feedback and Discussion (10 min.)

ASSIGNMENT: Interview a friend; interview a child

Overview of the Training Manual and Its Use

We will be going over the topics in each section but we won't be following the manual exactly. The manual is designed to serve as a resource guide for you when you are conducting interviews so that you can always go back over a section if you need a refresher, or if you want to review instructions or information. During the training we'll be presenting and talking about all of the information in a less formal way than it is presented in your manual.

The following 2 sources of data will be collected by the Interviewer:

The parents/caregivers will be interviewed to collect information on demographics, their child's experiences with asthma, home environment, their neighborhood, and other information.

The children who have agreed to participate in the study will be asked questions about their experiences with asthma and ways they manage their asthma.

Introduction to the Settlers Primary School Study

The study is being conducted by the University of Natal's Nelson R. Mandela Medical School. The purpose of the study is to find out whether health problems (especially asthma and other types of breathing problems) which may be experienced by students and staff at the school, are made worse by air pollution. If we do find that air pollution is causing problems, we will try to identify what are specific sources of the polluting chemicals which are causing problems. This then would help the study team to make quite specific recommendations to improve the situation. We are studying this school because it is located near many sources of air pollution such as the oil refineries, airport, paper mill and sewage works; and, because the teachers, parents of the students, and community were eager for such a study to be conducted.

The study team

In addition to the medical school, other collaborators on the study include Technikon Natal, University of Michigan, USA, Metropolitan Durban Department Of Health, Metropolitan Durban Department Of Water, Settlers Primary Environment Committee (a committee of concerned teachers at the school), South Durban Community Environmental Alliance (a concerned community organisation), ECOSERV (a consulting firm), and Dr. B. Seetharam (a practitioner in the community).

As an interviewer, your key contact person will be Joy Kistnasamy who is a Lecturer in Environmental Health at Technikon Natal. Her details: work phone: 204-2082; cellphone: 082-953-3465, e-mail: JoyK@ntech.ac.za

Who has been invited to participate?

All of the students in Grades 3 and 6 were invited to participate. These two grades were chosen because it was expected that students in grades lower than Grade 3 would have difficulties completely the bihourly diaries and correctly performing peak flow maneuvers, to have a reasonably wide age range, and to focus on students who would still be at the school in the 2002 school year in the event any follow-up studies were needed. In addition, any students from grades 4, 5, or 7, with known or probable asthma were invited to participate. These students were identified through a short screening questionnaire filled out at home by the parent or caretaker. Lastly, all teachers and other adult personnel at the school were invited to participate. The participating teachers, and the parent or caretaker of participating students had to sign informed consent forms which explain the purposes, risks, and benefits of the study before participation was allowed. All of the parents of the students you will be interviewing will have already given informed consent for their child to participate.

Progress of the study to date

The first phase of data collection for the health study was successfully completed between the 19 April and the 4 May, 2001. This phase included the collection of continuous monitoring of the air for pollutants at the school (including such things as particulate matter, sulfur dioxide, oxides of nitrogen, total reduced sulfurs, carbon monoxide, and volatile organic compounds). At the same time the participating students and teachers were keeping logs and diaries of symptoms and activities and performing peak flow maneuvers (to measure lung function) every two hours while at school. Participation rates of students and teachers at the school were very high, and it appears that collected health data is of very high quality. Presently, the collection of baseline pulmonary function data by experienced respiratory technicians is proceeding at the school. This baseline pulmonary function testing includes a special test called a methacholine challenge test which is quite useful in helping to make a diagnosis of asthma, as well as a test for a substance called nitric oxide in the air that participants are breathing out, which is a marker of inflammation in the breathing tubes (asthma is a type of inflammatory disease). Analysis of all of this collected data is just beginning. **You will be carrying out the critical final phase of health data collection: completing baseline interviews with the participating children and with their parents/caregivers.**

What are the expected benefits of the study to the participants and to others?

⇒ Each parent/caregiver will be given a written copy of all the child's test results with an explanation of what they mean. If you child is experiencing significant health problems, recommendations for medical follow-up will be included.

⇒ If problems are found at Settlers School, we may be able to improve the situation by making specific recommendations about air pollution.

⇒ What we learn from this study may help to protect people in South Africa and other parts of the world from problems caused by air pollution.

Confidentiality

The diaries and breathing test information that we collect -- as well as interview information that you will collect -- are ***completely confidential***. Other than the study personnel, this information will never be seen by anyone without the written consent of the parent. The results of the overall study will be made available to the school and the community and will be presented so as to protect the identity of individual participants.

Incentives and costs resulting from participation in the study

The parent/caregivers being interviewed in Umlazi will receive 20 Rand in cash at the successful completion of the interview. Parent/caregivers being interviewed in Merebank will receive 10 Rand at the successful completion of the interview. The reason that parents in Umlazi are receiving a larger incentive is because it is expected that most of them will need to take a taxi to and from the interview site, whereas, in Merebank it is expected that most will be able to walk to interview site. The children do not receive an incentive for completing interviews.

The study is offered at ***no cost*** to the participants. If a problem is discovered and the participant wishes to consult a doctor, we will recommend a doctor. However, the study cannot pay for these additional medical visits or treatments.

Voluntary nature of participation

The parent/caregiver and the child are free to decline to participate or to withdraw from the study at any time without suffering any penalty or disadvantage.

Key Study Staff

University of Natal Faculty of Medicine:
Barry Kistnasamy, MBChB, Dean
Rajen Naidoo, MBChB, Head, Occupational Health Unit
Umesh Lalloo, MBChB, Head, Department of Medicine
Elvis Irusen, MBChB, Department of Medicine

Technikon Natal:
Joy Kistnasamy, Lecturer, Environmental Health

University of Michigan, USA:
Stuart Batterman, PhD, Associate Professor, Environmental Health Sciences
Thomas Robins, MD, MPH, Associate Professor, Environmental Health Sciences

Purpose of the Baseline Interviews

I. Why Do the Baseline Interviews?

The baseline interviews are a very important component of the Settlers Primary School Study. It will provide the project with critical information about the participants. The survey serves a key basic purpose: to understand the severity and types of asthma symptoms or other breathing problems that learners at the school are experiencing. The survey will ask questions that will let us know how often the children have trouble breathing and the symptoms associated with the asthma attacks (e.g., whether there is coughing, wheezing, etc.). Plus, the survey will ask questions about the things that are found in the home that might be causing allergic reactions in their child, like pets, cigarette smoke, etc. The many questions on the survey will help us to understand what the children's asthma symptoms look like, how severe the asthma is, and what is in the house that might be making the asthma worse. The survey also include some questions regarding air pollution effects. Most of information about possible effects of air pollution were collected during the three week intensive data collection described above. The results of the survey will help us understand whether those participants with asthma are affected by air pollution differently than those without asthma.

II. Getting the Baseline Surveys Done

We plan to train all of you to conduct both the parent/caregiver baseline interview as well as the child baseline interview to ensure maximum staff flexibility in getting the job of interviewing all the participants accomplished.

We hope to begin interviews as soon as possible following this training and to complete all interviews over a period of one month to month in a half up to a maximum of two months.

Even though the families have already been informed about the study and given their permission to participate in the project and the survey, you may need to remind them. You should remind them that they filled out a survey about their child's breathing symptoms a couple of months before, and that they gave permission to participate in the study.

Child interviews. These will be conducted at Settlers Primary School during normal school hours. The schedule for interviewing children will be established by working with the school personnel. If and when you participate in the child interviews, you will be given time slots and a list of the names of the children are scheduled to interview ahead of time. It is expected these interviews will require approximately 15 to 20 minutes to complete on average. When conducting child interviews, you'll be paid at an hourly rate of 15 Rand.

Parent/caregiver interviews. These will be conducted at two centrally located sites: one in Umlazi (most likely Umlazi Centre), and one in Merebank (site to be determined). The current plan is to solicit the participation of the parent/caregivers by sending a note home with the student which includes a form for the parent to fill out showing days of the week and times they would be available for interviewing. A second note would be sent home with the student with a specific scheduled appointment for the parent.

If and when you participate in the parent interviews, you'll be given time slots and a list of names of the parents you are scheduled to interview ahead of time. However, please be aware that we plan to do some overbooking on the expectation that there will be a significant "no-show" rate. As a result there may be some trading of interviews to be conducted among the available interviewers present depending on which interviewers have time available.

For each interviewing session, we will have a study staff member or an appointed Lead Interviewer present. This person would be responsible for final decisions about altering interview assignments and schedules, as well as be responsible for handling the cash which will be used to award incentives at the completion of each interview. Persons handling cash will be required to sign for the amounts there are receiving for distribution and to obtain a signature from each parent when giving them the cash incentive at the completion of the interview.

It is expected that interviewing sessions will need to be set up at a variety of time slots on both weekdays and weekends to accommodate the varying schedules of the participating parents. Interviewers are expected to be flexible in their own schedules to accommodate these varying time slots.

The parent interviews are considerably longer than those of the children and we expect them to take on average 45 minutes or more to complete. Initially we plan to pay interviewers 20 Rand per parent interview -- this may be adjusted upward or downward once we see how long interviews are requiring on average. Appointed Lead Interviewers will be paid a modest additional bonus.

Project staff will be telephoning a random sample of the parents after interviews are completed to ensure whether they were comfortable with how interviewing was conducted, that they received the intended cash incentive at the completion of interview, and that they maintained a positive view of the overall study.

III. What Will Happen With the Information After Interviewing is Completed?

Researchers back at the University will enter all of the survey results without the names of the respondents. Once all of the information has been entered as data, we will analyze it and use the information to try to understand the causes of asthma and other breathing problems among the study participants.

The results will be reported to the school and the community in several different ways. Examples of the ways in which community residents may learn about the survey results are: through community forums coordinated by community organizers or school organizations and the local neighborhood groups; through newsletters of local community organizations; and in local newspaper articles.

It is important to understand, and to inform respondents, that none of the information that they give to us will be connected to them personally. Any results that are shared with others in the community will be shared in summary form, and at the level of the entire community - not individuals within the community. Respondents’ names and addresses will be kept confidential in locked file cabinets by project staff and not shared with others.

IV. Sensitivity of Questions

The baseline survey asks questions about sensitive issues, such as their experiences and frustrations with their child's asthma, behaviors and housekeeping practices that might impact their child's asthma, and family income. It is important to stress to the family that the study staff are interested in this information because it can impact their child's asthma. Explain that this information is important to us because it will help the study staff determine the specific factors that may affect children's asthma.

Differences Between a Standardized Interview and a Conversation

Note: Before introducing this exercise, recognize that this next exercise might be a repeat of information for some Community Interviewers who have already participated in a similar training or who have experience with interviewing.

Partner One: Your task is to take about five minutes and find out about your partners experience with asthma. For example, find out whether they have asthma or know someone with asthma, the ways in which the person with asthma felt, and how that person dealt with his or her asthma.

[start exercise]

Partner Two: (partner one, don't open your manual yet). Please ask these questions on asthma severity.

ASTHMA SEVERITY [Read all responses]

AS1. In the past 12 months, how often has your child had a cough that won't go away?

☐$_1$ Every day
☐$_2$ More than 2 times per week
☐$_3$ More than 1 time per month
☐$_4$ 3 to 12 times in the whole year
☐$_5$ 1 or 2 times in the whole year
☐$_6$ Never

AS2. In the past 12 months, how often has your child had wheezing (a whistling sound from the chest) with a cold?

☐$_1$ More than 1 time per month
☐$_2$ 3 to 12 times in whole year
☐$_3$ 1 or 2 times in the whole year
☐$_4$ Never

AS3. In the past 12 months, how often has your child had wheezing (a whistling sound from the chest) *without* a cold?

☐$_1$ Every day
☐$_2$ More than 2 times per week
☐$_3$ More than 1 time per month
☐$_4$ 3 to 12 times in the whole year

☐5 1 or 2 times in the whole year
☐6 Never

AS4. In the past 12 months, how often has your child had an attack of wheezing that made it hard for him or her to breathe or catch his or her breath**?**

☐1 Every day
☐2 More than 2 times per week
☐3 More than 1 time per month
☐4 3 to 12 times in the whole year
☐5 1 or 2 times in the whole year
☐6 Never

AS5. In the past 12 months, how often has your child wheezed with exercise or running or playing hard?

☐1 Every day
☐2 More than 2 times per week
☐3 More than 1 time per month
☐4 3 to 12 times in the whole year
☐5 1 or 2 times in the whole year
☐6 Never

AS6. In the past 12 months, how often has your child coughed with exercise or running or playing hard?

☐1 Every day
☐2 More than 2 times per week
☐3 More than 1 time per month
☐4 3 to 12 times in the whole year
☐5 1 or 2 times in the whole year
☐6 Never

Role and Responsibilities of the Interviewer

The interviewer is an important link between the study participants and the project staff. The interviewer represents the survey and the project to the participants and represents the child and caregivers' symptoms, attitudes, and circumstances back to the study staff. This role means that the interviewer is a crucial part of the project and has the responsibility of accurately presenting the ideas of the study and project to the respondent and the ideas of the respondent back to us, the project staff.

The primary job of the interviewer is to collect complete, accurate data. In order to do this, the interviewer must first make the respondent feel comfortable so that he/she will share their feelings and experiences honestly and fully.

Secondly, the interviewer must know the questionnaire well, so that he/she can ask all questions, in the right order, and so that all the necessary information can be collected. And, finally, the interviewer must record the information properly so that it can be understood and interpreted accurately by the study staff.

If there were no interviewers, there would be no surveys and we would have no information about the children's asthma symptoms. You, the interviewers, are literally the cornerstone of the survey. The quality of the data collected depends, to a great extent, on the skill of the interviewer.

Responsibilities of the Interviewer

Be familiar with the purpose and importance of the project so you can answer questions about the project.
Read over the description of this project and the purpose of the survey in the training manual. If you believe that the information obtained from the survey and the work that will follow are important for this community, your tone and manner will convey its importance to the respondents. Most people are willing to share their thoughts if they feel that their responses will be of some help to others and to their community.

Put study participant at ease so that he/she will feel free to answer personal questions.
The best way to do this is to be -- and feel -- relaxed. Show a compassionate attitude and an interest in what the person has to say. Be friendly and non-judgmental. Remember to show the study participants the respect that they deserve.

Know how to confront problems and less-than-ideal circumstances "in the field."
If there is a time that you feel uncomfortable during an interview, or you begin to feel that the respondent is really not understanding the survey, you may feel it is necessary to end the interview. You will need to use your own judgment. If this is the case, find a point in the interview to thank the respondent, tell them you have all the information you need, give them the incentive, and politely end the interview.

Know how to handle specific requests for advice and help.
Sometimes a respondent may ask you specific medical questions or for advice or referrals to deal with a specific problem or concern. Say something like, "You will need to talk with a doctor or nurse [or other professional] about that." You should also make note that this respondent asked a question, call and tell Joy about the content of the question, and the project staff will then contact the respondent. Your role as an interviewer is not to provide any medical or other advice or assistance. You should not attempt to counsel a respondent or try to steer anyone towards any goods or services.

Keep what is learned from or about respondents confidential.
Everyone working on this project must maintain confidentiality. All information obtained during the interview that concerns respondents or their families is privileged information. You should NEVER talk about a respondents' answers and use their name. Information should not be shared with your family, friends, co-workers or other respondents. The information may ONLY be shared with project staff. Breaking this rule of confidentiality may result in dismissal from the job of interviewing.

Be attentive to your appearance.
Your appearance is important to a successful interview. Try to dress in the middle range between very formal and very informal. We want you to be comfortable but we also want the respondent to feel comfortable around you. Dressing too formally may intimidate some respondents or make them feel uncomfortable. Dressing too informally may cause them to doubt your professionalism.

Confidentiality of Interviewing

We assure the respondent that his/her answers will be kept strictly confidential. Identifying information is found only on the coversheet, not in the interview, and the coversheet is separated from the interview when it is received in the project office. There, it will be kept in a locked cabinet. Only project staff will have access to information that links the ID number to respondents' names. The findings of the survey are reported in summary fashion only, so that no information about any individual will ever be shared.

You must also keep information which you collect confidential. Do not share an respondent's answers with anyone except the study staff!! Treat the study participants with respect -- both during and after the interview.

CHALLENGES TO CONFIDENTIALITY and SOLUTIONS

1. ____

2. ____

3. ____

Ethics of Interviewing

Do not use the interviewing situation for any personal gain. You must not sell anything, or promote your own beliefs in religious, political, or social causes.

Keep the conversation professional and focused on the survey questions. Do not ask the study participants personal questions that are not on the survey, and do not try to ask the study participants for their opinions or advice on any personal problems, political opinions, etc. It is important not to stray from the interview and ask information that may make the participants uncomfortable or is more than what is asked for in the questionnaire.

Keep your interactions with study participants professional. You should not initiate or accept offers of favors or social contact outside the interview.

Stages of the Interview Process

As an interviewer, there will be several stages of the interview process. Our goal is to train you in each of these stages and continue to support you and help you complete the interviewing tasks through supervision from the study staff.

Interview Process Flow Chart.

Review and Know Your Schedule for Conducting Interviews

↓

Remind Participant of Purpose of the Interview and the Study

↓

Conduct Interview

↓

Thank Respondent & Ensure Incentive Is Given

↓

Edit Interview

Important points to stress with interviewee:

1. Remind the interviewee that this is part of the Settlers Primary School Study and that the caregiver or parent agreed to participate.

2. You are a professional interviewer; you are not trying to sell anything or trying to get a donation.

3. You work for a partnership of legitimate and reputable organisations.

4. The survey will help the study team understand causes of asthma in the community and offer effective solutions.

5. The respondent's participation in the survey is vital to the success of the research.

Present yourself in a confident manner, and assume that the respondent will want to participate in this interesting and worthwhile survey.

Answers to Frequent Questions

1. What's this about?

We're talking with caregivers of children at Settlers Primary School, asking about any asthma or other breathing problems your child might have and things that may make those problems worse. This information will be used to help make recommendations to reduce exposures that contribute to breathing problems of the children in the community.

2. How long will this take?

That really can vary from person to person, but we find on average that the interview takes about 45 minutes ([parent interview].

3. How did you pick me and my child?

We have asked all the students and their parents in Grades 3 and Grades 6 at the Settlers Primary School to participate. In addition, based on the screening questionnaire about your child's health that you completed a couple of months ago, we have invited the students and their parents in Grades 4, 5, and 7 with known or probable asthma..

4. What will happen to my answers when you finish? What good will this do?

All your answers will be confidential. Results of the survey will be used to help figure what things may be causing asthma are similar breathing problems in your child or other children at the school. Based on the find the we will be making recommendations to improve the health of the children in the community.

9. Why are you asking my child questions, too?

We are also talking with your child to get a better idea of his or her experiences with asthma or other breathing problems. This information will help the study staff better understand what it is like for a child to have such problems from his or her perspective.

Introduction [Interviewer reads to respondent]

"The purpose of this questionnaire is to collect information about any breathing problems your child may have such as asthma. Your answers will help us figure out how to assist you and your child in reducing any breathing problems. Other questions are for research purposes and will help us figure out what kind of help to give all families with an asthmatic child.

"We are asking questions about any asthma are other breathing problems your child may have, visits to clinics and emergency rooms, the kinds of medication your child may have been prescribed, your attitudes, knowledge and beliefs about any breathing problems your child may have and questions about your home.

"If there is a question you do not want to answer, please let me know and we can skip it. All of your responses are confidential and will not affect any of the services you receive at the clinic or from your provider."

The respondent does not need to sign this form. However, the interviewer must read these paragraphs, which are on the interview cover sheet, before conducting the interview.

As a token of our appreciation of your taking the time and effort to participate,
you will receive [R10 (have been interview in Merebank)] [or] [R20 (if been interview than Umlazi)] at the completion of the interview.

Introduce Different Question Types

For the next portion of the training, we'll be working on these types of questions in our large group and in two small groups. We'll go over the information you need to know with examples from the actual survey, and then you'll be practicing reading each of these types of questions in small groups. Then, back in the large group we'll go over different ways to record the data for each of the questions and practice recording answers in our small groups.

Instructions to the Interviewer

Everything you will need to know and do once the interview has begun is contained within the questionnaire. The questionnaire is made up of several kinds of text. The most obvious kind of text is question text. In addition to questions, however, there are instructions for the interviewer and instructions that the interview needs to read to the respondent. The way that writing appears in the survey will give the interviewer information about whether to read things out loud or to herself as she goes through the interview with the respondent. **Bolded** text that appears in [ ] is not to be read to the respondent, unless the bolded text instructs the interviewer to do so. These are instructions to the interviewer. Example:

10.1 During which months does **[child]** have the most breathing problems? **[CHECK ALL THAT APPLY]**

Fall (March, April, May)	☐
Winter (June, July, August)	☐
Spring (September, October, November)	☐
Summer (December, January, February)	☐

Note that you don't read the instructions that are bolded and bracketed. However, you do read the instructions that are in quotations. For example:

[Please note: the next question and a few of the other examples of questions to follow are taken from a previous version of the questionnaire which may not exactly match the current version. However, the points being made about how to understand and ask various types of questions do apply to the current versions of the questionnaires which you will be using.]

[Interviewer read: "After each statement, indicate how often you felt that way during the past week—hardly ever, some of the time, or most of the time."]

CESD1. During the past week I felt depressed.

☐$_1$ Hardly ever
☐$_2$ Some of the time
☐$_3$ Most of the time

Here, the interviewer would read the bolded text in quotations.

There are several different types of instructions to interviewers. The next section will discuss and provide examples of those different types of instructions found in this survey.

Skip Patterns

Not all respondents need to be asked all questions. For example, some questions may be about a spouse or partner. If the respondent is not married, or does not have a partner, then asking her about a spouse or partner is not an appropriate question and should be skipped. Whether or not to skip certain questions for a certain respondent will depend upon how he/she answers previous questions. The skip instructions will appear next to the answer choices in each question. Skip patterns will be bolded. Below is an example of a skip pattern:

Do you rent or own your home or neither?

☐1 *Rent*
☐2 Own ***SKIP TO 17b***
☐3 Neither ***SKIP TO 17b***

D17a. In general, how easy or difficult would you say that it is to get your landlord to make repairs when they are needed? Would you say . . . **[READ CHOICES]**

☐1 Very easy
☐2 Somewhat easy
☐3 Neither easy or difficult
☐4 Somewhat difficult
☐5 Very difficult

Notice that if the respondent were to answer "own" to question D17, it wouldn't make sense to ask the respondent question D17a. which asks about the landlord. So, the instructions tell the interviewer to "**SKIP TO 17b**" which is written for an individual who owns a home.

Interviewer Checkpoint

At certain points in the interview, interviewers will be given instructions for certain questions or sections of the survey. These are called interviewer checkpoints. They appear bolded and bracketed. For example:

[Interviewer read: "The purpose of these questions are to look at the environment in your home and how it relates to your child's asthma as well as the health of other household members."]

B1a. Do household members generally remove shoes before coming inside?

☐1 YES
☐2 NO
☐9 Don't know

Instructions for Reading a Question

Some questions have special instructions for the interviewer that tell him or her how to read a specific question. Again, DO NOT read any instructions that are bolded and/or bracketed. For example:

11.1 Not including emergency room visits, can you tell me the last time **[child]** saw a doctor or health care provider for asthma, wheezing, tightness or heaviness in the chest, or cough? **[ASK OPEN-ENDED – IF NO RESPONSE THEN READ CHOICES]**

- ☐$_1$ In the past 2 weeks
- ☐$_2$ In the past 3 months
- ☐$_3$ In the past 12 months
- ☐$_4$ More than 12 month ago
- ☐$_5$ Never

Note that the instruction above **[ASK OPEN-ENDED – IF NO RESPONSE THEN READ CHOICES]**
tells the interviewer what he or she is to do in terms of reading a long list of items. Other questions may have instructions that tell interviewers NOT to read items.

Repeated Question Stems

The question stem is that part of a group of questions that is the same. An example of a question stem is: For most of these questions, we have listed the stem at the beginning of the question and then given you a list of items to read to the respondent. The stem is there for your use, to repeat in the middle of the list if it seems that the respondent has forgotten the stem and you want to refresh her memory of this important part of the question. Below is an example.

AS13. Has a doctor ever told you that **[child]** has.... **[READ ALL CHOICES]**

Allergies

- ☐$_1$ YES
- ☐$_2$ NO

Eczema

- ☐$_1$ YES
- ☐$_2$ NO

Bronchitis

- ☐$_1$ YES
- ☐$_2$ NO

Notice that the stem is in the original question. The interviewer may decide, after reading the first two items, to repeat the stem.

Silent "Don't Knows"

People who have done a lot of survey research have found that sometimes respondents will say "don't know," especially later in an interview, because they just want to move on to the next question. If "don't know" is read as a response option, people are more likely to choose it. However, sometimes a respondent may really feel that he/she doesn't know the answer to a given question. For these reasons, in certain questions, we have included a "don't know" response for the interviewer to mark but we are not reading that response nor are we giving it to them out loud as an option. The instructions will indicate that "don't know" is to be marked if the respondent says "don't know" but not read out loud. An example of a question with a silent "don't know" follows.

[IF RESPONDENT SAYS THEY "DON'T KNOW", CHECK THAT BOX, BUT DO NOT READ THAT RESPONSE ALOUD.]

	Always (1)	Most of the time (2)	Sometimes (3)	Never (4)	DON'T KNOW (9)
J1. If you needed help around the house, for example with cleaning or making small repairs, how often could you get somebody to help without paying them?					
J2. If you were sick, how often would there be somebody who would help care for you?					
J3. When you have problems, how often would there be somebody you could trust to help you solve them?					

Other questions DO read the "don't knows" such as:

B30. How frequently is your child around people who are smoking? Would you say. . . . [**READ CHOICES**]

- ☐1 Daily
- ☐2 Several times a week
- ☐3 Several times a month
- ☐4 Never
- ☐9 Don't know

Other -- Specify

In several questions, we are asking respondents about lists of items. Sometimes these lists are in grid form (e.g., list of medications) and sometimes they are in a checklist (e.g., knowledge, attitudes, beliefs, self-efficacy). In some cases, we ask a question with specific response categories, but provide an "other" category in case their response does not fit into the categories provided. This is done through the "other -- specify" response category. Below is an example:

From Coversheet:

How are you related to **[child]**?

☐1 Mother
☐2 Father
☐3 Grandmother
☐4 Grandfather
☐5 Aunt
☐6 Uncle
☐7 Other (specify: _________________)

In this example, the interviewer reads the list of options to the respondent but does not read "Other (specify________)" because it would sound awkward for this type of questions. In other questions, you <u>may be instructed</u> to read the "Other (specify____)" category. For example:

HE3. What is the <u>main</u> heating source in your home? **[READ EACH CHOICE]**

☐1 Electric
☐2 Gas/oil
☐3 Kerosene
☐4 Wood stove
☐5 Other (explain: __________________)

In this case, you are instructed to **[READ EACH CHOICE],** including the "Other" category.

<u>2 Types of Questions</u>

Interviewers ask two types of questions.

<u>1. Closed or pre-coded questions</u> with predetermined response categories from which the R must choose. For example:

B8. During the last 2 weeks, how many times did you or a household member vacuum the cloth covered furniture in the home?

☐1 None
☐2 1
☐3 2
☐4 3
☐5 4
☐6 5+
☐9 Don't know

<u>2. Open questions</u> that ask the R to express something in her own words. For example:

AS11. Can you think of anything else that brings on **[child's]** breathing problems?

Other (specify:____________________)

Notice that this question requires the respondent to provide an answer that is not pre-coded or pre-determined. Also, note the word **[child's].** Remember, as discussed above, interviewers do not read this word because it is bolded and bracketed. Rather, this is instructing the interviewer to insert the child's name here.

Regardless of the question type, basic questions are written using regular type similar to the type used in this sentence. Questions and response categories written in this manner should be read word-for-word, EXACTLY AS WRITTEN. In addition to being read exactly as written, questions should be read slowly and clearly - in an even tone unless otherwise indicated.

Emphasized Text in Questions

Words within basic questions that are underlined indicate that certain words must be emphasized when read to the respondent. Questions will still need to be read word-for-word but in this case you will stress a certain word or words. For example:

AS3. In the past 12 months, how often has your child had wheezing (a whistling sound from the chest) *without* a cold?

- ☐$_1$ Every day
- ☐$_2$ More than 2 times per week
- ☐$_3$ More than 1 time per month
- ☐$_4$ 3 to 12 times in the whole year
- ☐$_5$ 1 or 2 times in the whole year
- ☐$_6$ Never

EXERCISE: Practice Reading Questions

Responses and Recording Data

First, it is important to note that hearing responses and recording data accurately is extremely important. Interviewers will be responsible for recording responses to all questions (except when the respondent refuses to answer a question).

As we have discussed, most of the questions in the survey are closed-ended, or pre-coded questions. This means that respondents will be given specific choices for answers and the interviewer will need to make sure that they choose from among them. We call these choices "response categories." In most cases, response categories have a little box to check off in the questionnaire. Following are the different styles in which response categories are listed for the interviewer with instructions for recording the respondent's choice.

1. Basic Response Categories - In Single Line Form

This type of response category is written next to a little box with a number next to the box. As part of the question, the interviewer will read each of the possible responses. It is important that the respondent hears each of the possible responses before making her choice. If he/she interrupts the interviewer, the interviewer will need to continue politely with the rest of the categories. Then wait a second to see if he/she changes her answer. Once the respondent has heard all of the choices and gives her response, the interviewer should put an X through the corresponding box. For example:

AS7. In the past 12 months, how often has your child complained that his or her chest felt tight or heavy?

☐$_1$ Every day
☐$_2$ More than 2 times per week
☐$_3$ More than 1 time per month
☐$_4$ 3 to 12 times in the whole year
☐$_5$ 1 or 2 times in the whole year
☐$_6$ Never

Note how the response category has been marked. It is very important that interviewers mark the chosen response in exactly this way. A mark that is too small, or covers more than one response choice will be difficult to enter into the computer once the surveys are completed and analysis will be very difficult.

2. Basic Response Categories: In Grid Form

This type of response category format is very similar to the single line format with two exceptions: because the same categories are offered for more than one question, they appear, with the questions, in a grid.

Please show me all the medications that **[child]** is currently taking for asthma, wheezing, tightness in the chest, shortness of breath, or cough. Please include all the medications **[child]** uses. Include those medications that a doctor or clinic has prescribed and those that a doctor did not prescribe, for example, over-the-counter drugs or home remedies.

Medication Name	Code	Is this a. . .	Was this medicine prescribed by a doctor?	How often did the doctor say to take it or use it?		Can you tell me when [child] last used this medicine?
a.		☐$_1$ pill ☐$_2$ liquid (to swallow) ☐$_3$ inhaler/puffer ☐$_4$ added to a breathing machine or nebulizer	☐$_1$ Yes ☐$_2$ No	PRN (as needed)	__ times/day or ___ puffs/day	☐$_1$ today ☐$_2$ yesterday ☐$_3$ last week ☐$_4$ last month ☐$_5$ > 1 month ago
b.		☐$_1$ pill	☐$_1$ Yes	PRN	__	☐$_1$ today

		☐2 liquid ☐3 inhaler/puffer ☐4 breathing machine	☐2 No	(as needed)	times/day or ___ puffs/day	☐2 yesterday ☐3 last week ☐4 last month ☐5 > 1 month ago

Notice that for the grid format, the interviewer still records the response with an X.

3. Yes/No

The yes/no type of response category is similar to the basic response categories. Again an X should be place through the appropriate box, "yes" or "no." This type can appear in line or grid form as seen below:

HE2. Is there a basement you have access to?

☐1 Yes
☐2 No

4. The Open Ended Question

These questions are referred to as "open" because there are no specific response categories from which the respondent needs to choose. Usually we use these questions when the range of possibilities is too large for the survey designers to give all the possible response options. We also use this format when we ask respondents to give information about quantities that have a very wide possible range, or to give information such as their birth date or social security number.

A1. How long have you lived in your current neighborhood?

_____3_______ years OR
_____________ months

The interviewer will write the answer as given by the respondent, as close to word-for-word as possible.

There are also open questions which allow the respondent to provide the answer to the question, but the interviewer must then choose which response category to check with an "X".

B31. Tell me the things you do to keep your child from breathing tobacco smoke? **[Do not read responses but circle those items respondent mentions. Multiple responses accepted.]**

☐1 Not allow smoking in the house
☐2 Allow smoking only in certain rooms
☐3 Not allow smoking in a room if [**child**] is present
☐4 Change clothes I wear while smoking

before being with [**child**]
☐5 Not allow smoking in the car
☐6 Quit smoking myself
☐7 Get others in the house to quit smoking
☐8 Keep child away from smokers/smoking rooms
☐10 Other (specify: _________________)

5. Demographics

At the end of the survey, there are several questions asking for demographic information, such as income and education. These question and answer formats that are different from any of the other sections. Below are the examples and instructions for recording the answers to these questions:

Income:

D13. Which category best describes the total combined income of all members of your household? This includes money received from jobs, business, rent income, social security, assistance, and any other income received by members of your household. Please stop me when I get to the category that describes your total income**. [READ CHOICES]**

☐1 Less than R1 000
☐2 R1 001-2 000
☐3 R2 001 5000
☐4 R5 001-10 000
☐5 R10 001–20 000
☐6 R20 001–30 000
☐7 R30 001–50 000
☐8 R50 001–75 000
☐9 R75 001–100 000
☐10 R100 000-150 000
☐11 R150 001 and above

Education:

D14. What is the highest grade or year of school you completed? **[READ CHOICES]**

☐1 Never attended school or only kindergarten
☐2 Grades 1 through 8
☐3 Grades 9 through 11 (Some high school)
☐4 Grade 12 (High school graduate)
☐5 GED
☐6 College 1 year to 3 years (Some college or technical school)
☐7 College 4 years or more (College graduate)
☐8 Refused

In this question, we are asking the respondent for the HIGHEST grade in school that they completed. The interviewer should only place an "X" in the box of the highest grade. If respondent finished high school and went on to college, only the number corresponding to the highest grade in college completed should be circled.

Clarifications & Probing

For most of the examples so far today, respondents have been giving straightforward answers. They have been answering the questions using the response categories offered, giving only one response, not discussing the questions but only answering them, and not seeming to have any problems understanding the questions.

In reality, this would be ideal. Unfortunately, it is very unlikely that an interview in the field would go that smoothly! There will be times when respondents will want to give answers other than those that are offered as choices. And there will be times when other kinds of interruptions will occur. How will interviewers handle these "detours" from the questionnaire?

This section of the training manual will assist interviewers in responding to the individual situations that arise in the interviews. Whenever possible, interviewers should use the suggestions presented below. When this is not possible, interviewers will need to use their best judgment to help the respondent without changing the meaning of questions or leading the respondent to a specific answer.

Clarification

When to Clarify.
Interviewers may only clarify when R requests information. An interviewer may feel that a certain question is confusing. He or she may even have experienced in past interviews that a particular question often gives respondents trouble. Nonetheless, the interviewer is only to clarify when the respondent indicates that they need clarification.

How to Clarify. There are three kinds of clarification:

58. Accurate repetition of the entire question

2. Accurate repetition of a part of the question

3. Use of the phrase, "Whatever it means to you," or "Whatever you think of as _____." When R requests information that is not covered in the Q-by-Q.

Remember, the key to clarifying is that the interviewer only does that which is necessary to improve the respondent's understanding of the question. The interviewer should not say anything that might direct the respondent toward a particular response.

Probing

What we have been covering for the most part so far relates to some very important task of the interviewer: asking each question in exactly the way it is supposed to be asked and making sure the respondent understands each question.

Another important task we have covered is the recording of data in an accurate way and making sure that the respondents' answer is recorded as given. A second aspect of recording data is making sure that the respondent gives the kind of response needed. The interviewer needs to decide whether the respondent's replies are really answers to the questions that have been asked.

How does the interviewer decide if a reply is an acceptable answer to the question?

- by listening carefully to see whether you understand the reply, and

- by being familiar with the questions to make sure that the answer has the information required by the question. If the interviewer determines that an answer is not really appropriate he or she should use probes to get an answer that is appropriate.

<u>When to Probe</u>. Interviewers may only probe when they determine that the respondent hasn't really answered the question. For example: the question may refer to a specific time period and the respondent answers for a different time period; or there are specific response categories offered and the respondent gives an answer that is not one of the response categories offered.

<u>How to Probe</u>. There are three kinds of probing that interviewers may be using in this survey:

PROBING TECHNIQUE
1. Pause
2. Repetition of Q or Part of Q
3. "What do you think?" or "What do you expect?"

Pause
<u>Example 1 Pause:</u>

INTERVIEWER:
B251. Does anyone else who takes care of your child, such as a babysitter or day care worker, smoke?

☐ Yes
☐ No
☐ Don’t know

RESPONDENT: Hmmm, that's a tough question. Sometimes my sister takes care of my daughter and I don’t know if she smokes around her or not, but I think she does smoke sometimes.

INTERVIEWER: [PAUSE]

RESPONDENT: I guess I would have to say ‘yes’.

Example 2 Pause:

INTERVIEWER:
?? Replace with another example HE5: What daytime indoor temperature do you maintain in your home during heating season?

☐ Less than 55
☐ 55-60
☐ 60-68

RESPONDENT: I keep it cool during the winter because it's too expensive to be running the heater all the time.

INTERVIEWER: [PAUSE]

Note that in this case, a pause doesn't really help the respondent. The respondent thinks that he/she has answered the question and is probably waiting for the next question. Here, it would have been better for the interviewer to say "Let me repeat the response options" and repeat all three of the response categories. This strategy will be seen with the next example.

Repeating the Question

Repeating the question can take a number of different forms including
(1) repetition of the entire question;
(2) repetition of the remaining response options; or
(3) repetition of the misunderstood portion of the frame of reference.

1. Repeating the Entire Question:

Sometimes the interviewer might find it necessary to repeat the entire question because the respondent clearly did not understand the question. For example:

48b. During the past week, how worried or concerned were you about your child's asthma medications and side effects? Very worried, fairly worried, somewhat worried, a little worried, or not at all worried?

RESPONDENT: I've been really worried about money and making ends meet.

INTERVIEWER: Let me repeat the question. During the past week, how worried or concerned were you about your child's asthma medications and side effects? Very worried, fairly worried, somewhat worried, a little worried, or not at all worried?

RESPONDENT: Well, I guess I'd have to say I was somewhat worried.

Note: Repeat the entire question if the respondent's reply indicates that he/she didn't understand it, or if he/she needs more time to think about a response.

2. Repeating the Response Options

Sometimes it is only necessary to repeat the response options if it is clear that the respondent understood the question but not the responses provided. For example, using the same question as above:

INTERVIEWER: During the past week, how worried or concerned were you about your child's asthma medications and side effects? Very worried, fairly worried, somewhat worried, a little worried, or not at all worried?

RESPONDENT: Well, sometimes I worry but sometimes I just have faith that everything will work out.

INTERVIEWER: So, would you say that in general you're very worried, fairly worried, somewhat worried, a little worried, or not at all worried?

RESPONDENT: I guess I'd say I'm a little worried.

3. Repeating the Misunderstood Portion (e.g., time frame of question)

Respondents may need to be reminded of the specific time frame to which the question is referring. For example, several questions ask about events or feelings they experienced during the last week or the last month. The interviewer needs to make sure the respondent is answering for the designated time frame of each question. For example:

INTERVIEWER:
CESD3. During the past week my sleep was restless.

☐ Hardly ever
☐ Some of the time
☐ Most of the time

RESPONDENT: Most of the time. Two weeks ago I was on vacation and didn't sleep hardly at all.

INTERVIEWER: The question asks, During the past *week* my sleep was restless.

"What Do You Think" or "What Do You Expect?"

Sometimes we will be asking respondents about topics, issues, or events that they might feel they don't really know about. They may answer in a way that lets the interviewer know that they don't feel they can answer the question. If the question doesn't give the respondent an option to say "Don't Know" then we need another way to get them to give an answer. Ask them to tell the interviewer what they think or what they would expect, giving the respondent permission to give his/her best guess.

Example:

INTERVIEWER:
?? Replaced with another example A6a. In the past twelve months have you ever spoken to or written a letter to a public official about the environment?

☐Yes
☐No

RESPONDENT: I'm not really sure. I written a letter but I don't know if it ever made it to that public official's desk.

INTERVIEWER: What do you think happened to it?

RESPONDENT: Yeah, I guess it probably did get there. So, yes, I wrote a letter.

<u>"Which Would Be Closer" or "What Do You Think"</u>

In general, this probe should only be used when a respondent says he/she feels somewhere in between two of the given responses. For example:

INTERVIEWER:
Can you tell me when your child last used this medicine? Was it today, yesterday, last week, last month, or longer than a month ago?

RESPONDENT: It was probably a month ago or maybe longer.

INTERVIEWER: Can you tell me which it was closer to, last month or longer than a month ago?

Exercise: Practice Clarification and Probing

Feedback

Another role of the interviewer is to encourage the respondent to continue with the survey and to think about each question in order to answer accurately. The respondent will be more likely to do these things if the interviewer makes the respondent feel that he/she is being heard and understood, and lets the respondent know when he/she is doing a good job at answering questions.

Feedback is what interviewers use to send the messages to the respondent that he/she is being heard and understood and to let her know when he/she is doing what is expected.

Give short feedback for short responses to let the respondent know you've heard her. These are responses like:

"I see..."

"Uh-huh..."

"Thank You..."

"Thanks.."

Give longer feedback when the respondent gives longer or difficult answers or takes a longer time to answer. These are responses like:

"That's useful/helpful information"

"Thanks, it's important to find out what people think about this."

"I see, that's helpful to know."

"That's useful for the work we'll be doing in the neighborhood."

NEVER use feedback that indicates agreement or disagreement with a response.

NEVER use feedback if the respondent has gone off track or doesn't answer a question.

How often should the interviewer use feedback??

Generally speaking, Interviewers should give feedback for about 30 to 50% of the time that respondents give acceptable answers. Any more becomes tedious and takes up too much time. Any less will not really be effective in encouraging the respondent to perform well - and that is WHY we give feedback.

Practice Survey

Feedback and Discussion

Editing the Survey

The interview is not complete when you say good-bye to the respondent.

Editing the interview makes it understandable to the coders.

EDIT IMMEDIATELY AFTER THE INTERVIEW

Below are the steps you should follow while editing an interview.

STEP 1: **Before letting the respondent leave:** Review the completed questionnaire and make sure that had no questions which you should have asked have been skipped.

STEP 2: Edit responses to open-ended questions by:

a) adding pronouns or articles you may have left out;

b) converting all non-standard abbreviations into words; and

c) making all words legible.

STEP 3: Make sure the responses are all clearly marked, large enough to see and with no confusion as to which response is marked.

Closing the Survey

When you finish the survey:

1) always remember to thank the respondent for his or her time and willingness to provide information
2) be sure that the (adult) respondent receives the incentive payment

Child Survey

Things to Consider with Child Survey

Protocol for interviewing a child is slightly different from interviewing an adult. Some things to keep in mind when administering the child's interview.

1. Be patient. This may be a new experience for the child, the questions may be difficult to understand, and the child may be nervous or anxious about talking with you. Give the child time to think about his or her response.
2. If the child does not understand the question, re-read the question verbatim. Try not to ask the question using different words and do not explain the purpose of the question.
3. Be careful about using certain types of feedback with the child (e.g., "exactly" and "yes"). Showing the child that he or she is providing you with the answers you're looking for by using positive feedback, for example, may lead or bias the child's responses.

ANNEXURE E: Attachment 3 : Children's baseline interview

ID#_________________

Settlers Primary School Study
CHILDREN'S BASELINE INTERVIEW

Cover Sheet

ITEMS TO RECORD BEFORE INTERVIEW

1. **Name of Child:**

 ____
 First **Middle** **Surname**

2. **Name of Parent/Legal Guardian:**

 ____
 First **Middle** **Surname**

3. **Child's Date of birth:** _________________
 Day **Month** **Year**

4. **Child's Gender:**

 ____

5. **Interviewer's Name:**

 ____

Hi [child's name]! My name is________________ and I would now like to talk to you about your health. Before I begin, I want you to know that the answers you give me to the questions I ask about your health will be private and we won't share your answers with other kids or with your parents. Only project members of the Settlers Primary School Study will see the answers and they will use these answers to help you improve your health. There are no right or wrong answers to these questions I will ask you. We want to know how you feel. Also, if you do not want to answer one particular question or if you want to stop at any time and not answer any more questions, you can do that by telling me you don't want to continue. Nothing will happen to you if you decide not to answer these questions. But your participation is important and will help us understand health problems in children and this will help other children who might have it in the future.

Is it okay for me to start? Do you have any questions for me before I start?

A. Interviewer: ___________________________

B. Date: ____ / _____ / ____
 Day Month Year

C. Interview time started: Time:_ _:_ _ am / pm

QUALITY OF LIFE

1. How much did **COUGHING** bother you in the past week? **[BLUE CARD]**

☐1 Not bothered/troubled
☐2 Hardly bothered/troubled at all
☐3 Bothered/troubled a bit
☐4 Somewhat bothered/troubled
☐5 Quite bothered/troubled
☐6 Very bothered/troubled
☐7 Extremely bothered/troubled

2. How often did your breathing problems or asthma make you feel **FRUSTRATED** during the past week? **[GREEN CARD**]

☐1 None of the Time or Have No Breathing Problems At All
☐2 Hardly any of the time
☐3 Once in a while
☐4 Some of the time
☐5 Quite often
☐6 Most of the time
☐7 All of the time

3. How often did your breathing problems or asthma make you feel **TIRED** during the past week? **[GREEN CARD**]

☐1 None of the Time or Have No Breathing Problems At All
☐2 Hardly any of the time
☐3 Once in a while
☐4 Some of the time
☐5 Quite often
☐6 Most of the time
☐7 All of the time

4. How often did you feel **WORRIED, CONCERNED, OR TROUBLED** because of your breathing problems or asthma during the past week? **[GREEN CARD]**

☐1 None of the Time or Have No Breathing Problems At All
☐2 Hardly any of the time
☐3 Once in a while
☐4 Some of the time
☐5 Quite often
☐6 Most of the time
☐7 All of the time

5. How much did **ASTHMA ATTACKS** bother you during the last week? **[BLUE CARD]**

☐$_1$ Not bothered/troubled
☐$_2$ Hardly bothered/troubled at all
☐$_3$ Bothered/troubled a bit
☐$_4$ Somewhat bothered/troubled
☐$_5$ Quite bothered/troubled
☐$_6$ Very bothered/troubled
☐$_7$ Extremely bothered/troubled

6. How often did your breathing problems or asthma make you feel **ANGRY** during the past week? **[GREEN CARD]**

☐$_1$ None of the Time or Have No Breathing Problems At All
☐$_2$ Hardly any of the time
☐$_3$ Once in a while
☐$_4$ Some of the time
☐$_5$ Quite often
☐$_6$ Most of the time
☐$_7$ All of the time

7. How much did **WHEEZING** bother you during the past week? **[BLUE CARD]**

☐$_1$ Not bothered/troubled
☐$_2$ Hardly bothered/troubled at all
☐$_3$ Bothered/troubled a bit
☐$_4$ Somewhat bothered/troubled
☐$_5$ Quite bothered/troubled
☐$_6$ Very bothered/troubled
☐$_7$ Extremely bothered/troubled

8. How often did your breathing problems or asthma make you feel **IRRITABLE** during the past week? **[GREEN CARD**]

☐$_1$ None of the Time or Have No Breathing Problems At All
☐$_2$ Hardly any of the time
☐$_3$ Once in a while
☐$_4$ Some of the time
☐$_5$ Quite often
☐$_6$ Most of the time
☐$_7$ All of the time

9. How much did **TIGHTNESS IN YOUR CHEST** bother you during the past week? **[BLUE CARD]**

☐$_1$ Not bothered/troubled
☐$_2$ Hardly bothered/troubled at all
☐$_3$ Bothered/troubled a bit
☐$_4$ Somewhat bothered/troubled
☐$_5$ Quite bothered/troubled

☐6 Very bothered/troubled
☐7 Extremely bothered/troubled

10. How often did you feel **DIFFERENT OR LEFT OUT** because of your breathing problems or asthma during the past week? **[GREEN CARD]**

☐1 None of the Time or Have No Breathing Problems At All
☐2 Hardly any of the time
☐3 Once in a while
☐4 Some of the time
☐5 Quite often
☐6 Most of the time
☐7 All of the time

11. How much did **SHORTNESS OF BREATH** bother you during the past week? **[BLUE CARD]**

☐1 Not bothered/troubled
☐2 Hardly bothered/troubled at all
☐3 Bothered/troubled a bit
☐4 Somewhat bothered/troubled
☐5 Quite bothered/troubled
☐6 Very bothered/troubled
☐7 Extremely bothered/troubled

12. How often did you feel **FRUSTRATED BECAUSE YOU COULDN'T KEEP UP WITH OTHERS** during the past week? **[GREEN CARD]**

☐1 None of the Time
☐2 Hardly any of the time
☐3 Once in a while
☐4 Some of the time
☐5 Quite often
☐6 Most of the time
☐7 All of the time

13. How often did your breathing problems or asthma **WAKE YOU UP DURING THE NIGHT** during the past week? **[GREEN CARD]**

☐1 None of the Time
☐2 Hardly any of the time
☐3 Once in a while
☐4 Some of the time
☐5 Quite often
☐6 Most of the time
☐7 All of the time

14. How often did you feel **UNCOMFORTABLE** because of your breathing problems or asthma during the past week? **[GREEN CARD]**

☐1 None of the Time

☐$_2$ Hardly any of the time
☐$_3$ Once in a while
☐$_4$ Some of the time
☐$_5$ Quite often
☐$_6$ Most of the time
☐$_7$ All of the time

15. How often did you feel **OUT OF BREATH** during the past week? **[GREEN CARD]**

☐$_1$ None of the Time
☐$_2$ Hardly any of the time
☐$_3$ Once in a while
☐$_4$ Some of the time
☐$_5$ Quite often
☐$_6$ Most of the time
☐$_7$ All of the time

16. How often did you feel **YOU COULDN'T KEEP UP WITH OTHERS** because of your breathing problems or asthma during the past week? **[GREEN CARD]**

☐$_1$ None of the Time
☐$_2$ Hardly any of the time
☐$_3$ Once in a while
☐$_4$ Some of the time
☐$_5$ Quite often
☐$_6$ Most of the time
☐$_7$ All of the time

17. How often did you have trouble **SLEEPING AT NIGHT**, because of your breathing problems or asthma during the past week? **[GREEN CARD]**

☐$_1$ None of the Time
☐$_2$ Hardly any of the time
☐$_3$ Once in a while
☐$_4$ Some of the time
☐$_5$ Quite often
☐$_6$ Most of the time
☐$_7$ All of the time

18. How often did you feel **FRIGHTENED BY AN ASTHMA ATTACK** during the past week? **[GREEN CARD]**

☐$_1$ None of the Time
☐$_2$ Hardly any of the time
☐$_3$ Once in a while
☐$_4$ Some of the time
☐$_5$ Quite often
☐$_6$ Most of the time
☐$_7$ All of the time

19. Think about all the activities that you did in the past week. How much were you bothered by your breathing problems or asthma doing these activities? **[BLUE CARD]**

☐ 1 Not bothered/troubled
☐ 2 Hardly bothered/troubled at all
☐ 3 Bothered/troubled a bit
☐ 4 Somewhat bothered/troubled
☐ 5 Quite bothered/troubled
☐ 6 Very bothered/troubled
☐ 7 Extremely bothered/troubled

20. How often did you have difficulty taking a **DEEP BREATH** in the past week? **[GREEN CARD]**

☐ 1 None of the Time
☐ 2 Hardly any of the time
☐ 3 Once in a while
☐ 4 Some of the time
☐ 5 Quite often
☐ 6 Most of the time
☐ 7 All of the time

Now I want to ask you questions about smoking.

SMOKING

21. Does your mother [**OR PRIMARY CARETAKER**] smoke cigarettes **in the house**?

☐ 1 yes
☐ 2 no

22. Does **anyone [else]** in your home smoke cigarettes?

☐ 1 yes
☐ 2 no **Skip to Q23**

22.1 How many people who live in your home smoke? ____________# of people

23. Does anyone smoke cigarettes in a car, taxi, or bus while you are riding in it?

☐ 1 yes
☐ 2 no
☐ 3 never ride in a car, taxi, or bus

24. How many kids in your class would you say smoke cigarettes?

_____

25. Have you ever tried smoking cigarettes?

☐1 yes
☐2 no [**Skip to Q26]**

25.1 How often do you smoke cigarettes would you say...

☐1 Once a day
☐2 Once a week
☐3 Once a month
☐4 Once a year

26. Have you ever tried smoking dagga?

☐1 yes
☐2 no [**Skip to Q26]**

26.1 How often do you smoke dagga would you say...

☐1 Once a day
☐2 Once a week
☐3 Once a month
☐4 Once a year

<u>Neighborhood Questions</u>

Now I'd like to ask you a few questions about your neighborhood.

27. Are you afraid you will be hurt by violence in your neighborhood?

☐1 yes
☐2 no

28. While you have lived in your neighborhood, has anyone ever used violence, such as in a fight (hitting, pushing, shoving), against you or any member of your family anywhere in your neighborhood or home?

☐1 yes
☐2 no

29. Did any of the following occur or happen in your neighborhood during the past 6 months or since [**SAY MONTH THAT WOULD BE 6 MONTHS AGO**]?

29. a. A fight in which a weapon was used?

☐1 yes
☐2 no

29.a.1. [if yes] More than once?

☐1 yes

☐$_2$ no

29. b. A violent argument between neighbors or friends?

☐$_1$ yes
☐$_2$ no

29.b.1. [if yes] More than once?

☐$_1$ yes
☐$_2$ no

29.c. A gang fight?

☐$_1$ yes
☐$_2$ no

29.c.1. [if yes] More than once?

☐$_1$ yes
☐$_2$ no

29.d. A robbery or mugging?

☐$_1$ yes
☐$_2$ no

29.d.1. [if yes] More than once?

☐$_1$ yes
☐$_2$ no

30. Do you play indoors more because you are afraid you may be hurt by violence if you play outdoors in your neighborhood?

☐$_1$ yes
☐$_2$ no

END: You did a great job! Thank you for helping us! Do you have any questions for me?

Interview completed at: Time: _ _:_ _ am / pm

ANNEXURE F: Methacholine challenge testing

Equipment used included:

1. Standard glass Wright's nebuliser
2. Oxygen cylinder and gauge checked and calibrated to deliver a constant output of 0.13 L/min
3. Methacholine chloride made up to a concentration of 32 mg and then diluted serially down to a concentration of 0.03 mg.
4. Sodium chloride 0.9% as diluent for initial nebulisation.
5. Jaeger lung function equipment – same calibrated daily, connected to a laptop computer.
6. Salbutamol MDI with spacer device as rescue medication.

The procedure that was followed was:

1. Each child had a brief examination including air entry and history taking of any upper respiratory tract infection, cough, etc.
2. A full FEV1, FVC manoeuvre was then repeated and compared with the previous baseline spirometry.
3. If results were compatible (FEV1 > 1L), the challenge test was commenced.
4. A two minute nebulisation using sodium chloride 0.9% was then commenced.
5. FEV1 measurements were then taken at 30 sec and 90 sec post nebulisation.
6. A 20% drop in FEV1 was then calculated from the highest post saline nebulisation. This was taken as the target FEV1 to be reached.
7. Nebulisations were then commenced starting with the lowest dose of methacholine and increasing until target FEV1 was reached.
8. Target FEV1 manoeuvre was repeated to ensure validity.
9. Once target was reached 200 ug salbutamol was administered via a multi dose inhaler with a space device FEV1 was then checked at 10 mins and if necessary at 20 mins until a return to baseline FEV1 was achieved.

Safety measures instituted included:

1. O_2, nebulising agents such as Atrovent and Berotec, β_2 agonists and adrenaline were kept on site as well as standard resuscitative equipment.
2. Children were monitored for 2-4 hours post nebulisation and given instructions to return to the site should problems occur.
3. A 12 mg dose of methacholine was introduced in some of the children as a safety measure as some of them experienced a precipitous drop in FEV1 with the 16 and 32 mg doses.
4. Follow-up checks were carried out the following day on children who had a fall in FEV1 on the challenge test.

Results of methacholine/bronchodilator challenge test were classified as follows:

- Marked airway hyperreactivity = PC20<2 mg/ml, or greater than 20 % fall in FEV1 with saline alone, or %recovery>20
- Probable airway hyperreactivity = 2<PC20<8 mg/ml or 12<%recovery<20
- Possible airway hyperreactivity = 8<PC20<16
- No airway hyperreactivity= PC20>16 mg/ml
- Indeterminate=methacholine not administered or final dose<16mg/ml without 20% fall in FEV1 ***Where:*** - PC20 is the dose of methacholine causing a 20 % fall in FEV1 from the lowest post-saline FEV1

- %recovery=% improvement (recovery) from pre-saline baseline with use of a bronchodilator

ANNEXURE G: Daily symptoms/activity log

Name of child: ________________________________
first middle last

ID # ______________

DIARY FOR THE 4 DAYS BEGINNING THURSDAY , 19 / 04 / 2001
Day Month Year

Please fill out this diary once a day in the evening.
Please be sure to answer every question each day.
Turn page over for explanations of questions.

Put a tick ☑ in the correct box.

DAY OF THE WEEK	SAT	SUN	MON	TUE	WED	THU	FRI
a. Did your child wake up last night because of breathing problems?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
b. Was your child's activity interrupted today because of breathing problems?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
c. Did you or other adults have to change plans today because of your child's breathing problems?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
d. Did your child have any of the following symptoms in the past 24 hours:							
coughing?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
shortness of breath?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
wheezing?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
chest tightness or heaviness?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
e. Did these symptoms require going to the doctor or a hospital or emergency room?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
f. Does your child have a cold, the flu, or other respiratory infection today?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
g. Does your child **ever** use an **inhaler / pump**? ☐ yes ☐ no If yes, please fill out:							
1 **Write in name of inhaler #1 on line below** ________________ number of puffs today:	___	___	___	___	___	___	___
2 **Write in name of inhaler #2 on line below** ________________ number of puffs today:	___	___	___	___	___	___	___
3 **Write in name of inhaler #3 on line below** ________________ number of puffs today:	___	___	___	___	___	___	___
h. Does your child **ever** use **medicine** in a **nebulizer (breathing machine)**? ☐ yes ☐ no If yes, please fill out:							
1 **Write in name of nebulizer med. #1 below** ________________ number of treatments:	___	___	___	___	___	___	___
2 **Write in name of nebulizer med. #2 below** ________________ number of treatments:	___	___	___	___	___	___	___

i. Does your child **ever** take a **swallowed pill or liquid medicine** for **asthma**?

☐ yes ☐ no If yes, please fill out:

1 **Write in name of the <u>swallowed pill or liquid medicine</u> #1 on line below** ____________ used it today?:	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
2 **Write in name of the <u>swallowed pill or liquid medicine</u> #2 on line below** ____________ used it today?:	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
3 **Write in name of the <u>swallowed pill or liquid medicine</u> #3 on line below** ____________ used it today?:	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no

If you aren't sure what you should write down in the diary, look at the following explanations for some help. If you still have questions, please call 204 2082

Explanation for question **b**:

Your child's activity being interrupted includes staying home from school or leaving school early. It may also mean that the child was not able to participate in activities that he or she normally would, such as sports events or playing with friends.

Explanation for question **c**:
Changing plans includes things like missing work or coming home from work early, not being able to run errands or go out because your child was sick and you or other adults had to take care of him or her. This also includes changing plans to take your child to the doctor or hospital or emergency room for an unscheduled appointment.

Explanation for question **e**:
If your child made an **extra, unplanned** visit to the doctor, emergency room, or hospital in the past 24 hours because of coughing, shortness of breath, wheezing, or chest tightness or heaviness, you should check 'yes'. If it was a **regular, already scheduled** visit or check-up you should check 'no'.

Explanation for question **f:**
Check 'yes' if your child had any of the following today: a cold, sore-throat, fever, doctor-diagnosed middle ear infection, flu, sinus infection, pneumonia, bronchitis, croup, pharyngitis, laryngitis, tracheitis, or upper respiratory tract infection. If you believe your child was having problems only with allergies or hay fever, check 'no'.

Explanation for question **g**:
Write in the name of **each inhaler (pump)** your child **ever** uses. In the boxes next to each inhaler, write in the total number of puffs your child took today. For example, if your child took 2 puffs of the inhaler in the morning and 1 puff in the evening, you should write down '3'. **If he or she did not take any puffs from that type of inhaler today, write a '0'**. Do not leave it blank.

Explanation for question **h**:
Write in the name of **each** medicine your child **ever** uses in a **nebulizer (breathing machine)**. In the boxes next to each nebulizer medicine, write in the total number of treatments your child took today. **If he or she did not take any treatments using that type of nebulizer medicine today, write a '0'**. Do not leave it blank.

Explanation for question **i**:
Write in the name of **each swallowed pill or liquid medicine** your child **ever** takes for **asthma.** In the boxes next to each medicine, check the 'yes' box if your child took that medicine today. Check the 'no' box if your child has not taken any of that medicine today.

Please fill out the diary each evening together with your child to make sure the information is as accurate as possible.

REMINDER: Your child should also be using his or her Airwatch Monitor in the morning and in the evening every day this week: 3 blows in a row shortly after getting up (before using any inhalers / pumps), and 3 more blows in a row in the evening.

ANNEXURE H: **Bihourly symptom / activity for days at school**

Name of learner:_________________________________ ID no.______________
first middle surname

BI-HOURLY SYMPTOM / ACTIVITY LOG FOR DAYS AT SCHOOL

TODAY'S DATE: Monday, ______/______/______
Day Month Year

Dear learner, Please fill out this log sheet after you have blown into the Airwatch Hand held device

Put a tick ☑ in the correct box

	MONDAY			
	8h00	**9h45**	**11h30**	**13h20**
A. SYMPTOMS: **In the last one and a half hours**, have you had any problems with:				
a) Cough	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
b) Wheezing	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
c) Chest tightness or heaviness	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
d) Shortness of breath	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
e) Headache	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
f) Sore or scratchy throat	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
g) Runny or stuffy nose	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
h) Watering, burning or stinging eyes	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
i) Stomach upsets or vomiting	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no

B. ACTIVITIES: ***In the last one and a half hours:***				
1. Have you exercised or played (run around)?	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
2. Have you spent time outside (more than simply walking from one building to another)?	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no
3. Did you notice any bad or funny smell?	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no	☐ ☐ yes no

ANNEXURE I: Attachment 1:

Taking an Airwatch Measurement

✔	**STEP 1:**	Rotate the mouthpiece open until it *clicks*.
✔	**STEP 2:**	Press *any* button to turn the machine on.
✔	**STEP 3:**	Stand up straight with shoulders back (Make sure that the child does not bend at the waist when he or she blows)
✔	**STEP 4:**	Take the deepest breath possible. (Take a deep breath in *BEFORE* putting the mouth around the mouthpiece. The child should *NEVER* inhale through the mouthpiece)
✔	**STEP 5:**	Teeth and lips should be *AROUND* the Airwatch (no pursed lips), making a tight seal.
✔	**STEP 6:**	Blow as hard and as fast as he or she possibly can, for *2 whole seconds.*
✔	**STEP 7:**	Locate the correct date and time of the blow on the recording sheet.
✔	**STEP 8:**	Write down the number appearing on the left side of the screen on the recording sheet under the words '*Blow 1:* P*eak Flow*'.
✔	**STEP 9:**	Hold the *middle* button down for 3 seconds until a new number appears. Write this number down on the sheet under '*Blow 1: FEV1*'.
✔	**STEP 10:**	Repeat the steps above for two more blows writing down the results under '*Blow 2:* P*eak Flow*' and '*Blow 2: FEV1*', and then under '*Blow 3:* P*eak Flow*' and '*Blow 3: FEV1*'

PLEASE CHECK FOR THE FOLLOWING:

- Make sure the Airwatch is **<u>ON</u>** *before* each blow.
- They **<u>don't</u>** stick their tongue in the mouthpiece.
- They **<u>are</u>** blowing as **<u>forcefully</u>** as possible right from the beginning.
- Their hands / fingers **<u>do not cover</u>** the holes on the sides of the mouthpiece.
- They **<u>don't spit</u>** or **<u>cough phlegm</u>** into the mouthpiece.
- If they **<u>forget</u>** a session of three blows, just **<u>leave those boxes blank</u>**. When they next blow again, fill in the next set of boxes by the **<u>correct</u>** date and time.

ANNEXURE I: Attachment 2: Bi-hourly airwatch log for days at school

Name of Learner:___________________________________ ID #______________
first middle surname

BI-HOURLY AIRWATCH LOG FOR DAYS AT SCHOOL

TODAY'S DATE: Wednesday, _____/_____/_____
Day Month Year

Dear learner,
Please fill out this log sheet each time you blow into the Airwatch Hand held device.

TIME	BLOW 1 PEAK FLOW	BLOW 1 FEV1	BLOW 2 PEAK FLOW	BLOW 2 FEV1	BLOW 3 PEAK FLOW	BLOW 3 FEV1
08h00						
09h45						
11h30						
13h20						

REMEMBER:

After each blow write down the number you see on the left side of the AirWatch screen under "PEAK FLOW". Then hold the middle button down for three seconds until you see "FEV1" on the screen and write down the new number on the screen under "FEV1". Then you are ready to blow again.