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Prevalence of asthma and respiratory symptoms in south-central Durban, South Africa

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Abstract. The prevalence of asthma and respiratory symptoms in south-central Durban, one of the most heavily polluted areas of South Africa, has been determined using a cross-sectional survey of 213 households in the communities of Merewent (97% Indians) and Austerville (98% coloreds). The study population consisted of 367 children (less than 17 years old) and 693 adults. About 10% of the children and 12% of adults reported doctor diagnosed asthma. The self-reported prevalence rates for wheezing (37–40%) and attacks of shortness of breath with wheeze (16–28%) were much higher than that for doctor diagnosed asthma and common co-occurrence of the three symptoms is found. The prevalence rates for other respiratory symptoms include 33–35% for chronic cough, 31–32% for chronic phlegm, 44–50% for frequent blocked-runny nose, and 16–27% for sinusitis. Factors in the community that were associated with asthma, wheeze and shortness of breath with wheeze among the adult population included cigarette smoking, use of insecticides (coils and pump spray) and home ownership. An association between asthma among children and a number of household risk factors including dampness, carpet, pets or use of pesticides was not apparent in the community. Asthma prevalence was strongly correlated with missing of school by children (odds ratio (OR): 44; 95% confidence interval (CI): 13–141). The study serves to draw attention to a growing but neglected public health problem in urban areas of Africa.

Key words: Air pollution, Asthma, Prevalence, Risk factors, South Africa

Introduction

Asthma is an emerging disease in Africa, the available evidence suggesting that it was rare among children in the continent up to the late 1970s [1]. More recent studies often find a gradient in asthma prevalence from rural to urban populations. Ng'ang'a [2], for instance, found a prevalence of <0.5% among children in Kenyan villages with limited transportation and no electricity and where traditional foods were mostly consumed. By comparison, the rate in urban areas of the country (Kenya) was estimated to be >9% [3]. In Harare, asthma prevalence was found to be 5.8% compared to only 0.1% in rural parts of Zimbabwe [4]. A large difference in prevalence was likewise reported among Xhosa children in rural areas of Transkei (0.14%) compared to those that resided in Cape Town in 1979 (3.2%) [5]. By 1993, the prevalence of asthma among school children in Cape Town had risen to 11% [6]. The fact that the prevalence has risen sharply only in urban areas (compared to villages with traditional lifestyles) strongly implicates environmental changes as key risk factors for asthma, which may well be largely a disease of the Western society. This study focuses on asthma prevalence in an area that combines high ecological risk factors with high levels of air pollution.

South-central Durban is heavily industrialized and one of the most polluted areas in southern Africa. Major industries include two refineries and other petrochemical plants, pulp and paper mills, wastewater treatment works, lead, chromium and other metal processing plants, fabric, leather, and food processing industries. Durban international airport is part of the complex which is located in a topographic depression with fairly restricted air dispersion. Regional atmospheric circulation pattern results in frequent temperature inversions in the area especially in winter time. Most of the industries were established during the apartheid period and since they were then deemed to be of national interest, were allowed to operate with little or no restriction on the release of pollutants to the environment. Severe local air pollution has been inevitable. Residents often complain about malodorous air in their neighborhoods. Between 1989 and 1991, average SO_2 concentration in the area was 57 $\mu g/m^3$ compared to 12 $\mu g/m^3$ at the Municipal Center [7]. Average monthly concentrations of suspended particulates at the Municipal Center ranged from 50 to 120 $\mu g/m^3$ and by extrapolation (vis-a-vis the relative SO_2 values), the levels in south-central region are estimated to be between 200 and 500 $\mu g/m^3$, values that are well above the US National Ambient Air Quality Standard of 80 $\mu g/m^3$ annual mean [8]. A recent survey found atmospheric lead levels close to the WHO ambient air guideline (1.5 $\mu g/m^3$) in many parts of the area [9]. Current ambient levels of most of the expected air toxics in the area have yet to be quantified.

Air pollution has been associated with a number of negative health endpoints including mortality, respiratory morbidity, pulmonary function changes, emergency room visits and hospital admissions [10]. A systematic study of the effects of air pollution on the health of residents of south-central Durban has not been done, however. Quite apart from the scientific need-to-know, several factors make south-central Durban an interesting site for environmental health assessment. It has sizable populations of the main racial types: blacks (about 10%), coloreds (28%), Indians (35%), and whites (28%). The population can thus be used to test possible cultural or racial differences in susceptibility to local environmental pollutants. A large fraction (15%) of the residents are either young children (<6 years old) or the elderly who are particularly vulnerable to air toxics. Because of previous residency laws, few people (non-whites) were allowed to move from their communities. A study in the area can thus provide some insight on effects of lifetime exposure to contaminants in the particular environment as well as familial aggregations of health effects of the air pollutants.

This paper presents the results of a cross-sectional study of a random sample of households in two racially distinct communities (Merewent and Austerville) in the suburb of Merebank in south-central Durban. The objectives of this study are to determine the prevalence of respiratory and asthma symptoms and evaluate the degree of under-diagnosis of asthma in the population. The prevalence data should aid in future planning of public health intervention and can be used in developing necessary research on potential environmental risk factors. Ecologically, urban areas of Africa should be a fertile ground for asthma – considering the presence of common risk factors such as high humidity, high incidence of respiratory infections, overcrowding, malnutrition and low socioeconomic status. It is hoped that the results of this study will serve to draw attention to what is rapidly becoming a major public health problem in many other towns and cities of Africa.

Methods

Selection of study population

The suburb of Merebank was divided into enumerator areas. This information, which is normally used for local elections, was obtained as a geographic information system (GIS) database. Streets were randomly selected from each of the 96 enumerator areas in the communities of Merewent and Austerville. Two to three houses were then randomly selected from each enumerator area. A knock-on-the-door approach was used to make contact with potential participants. If the head-of-household or self-appointed surrogate was unwilling to participate or if there was nobody in the house at the particular time, the family in the next house was approached. Alternative households comprised less than 20% of the sample population. Recruitment bias is believed to be minor because of the relative (apartheid-driven) homogeneity of each community in terms of race, schools, career choices and culture.

Survey method

The questionnaire was administered by trained interviewers to the head-of-household or self-designated surrogate adult member of the family. English was the language preferred by all the participants. The respondent reported for all children (less than 17 years old) and adults living in the household. After explaining the objectives of the study and the risks to the family, the respondent was asked to sign a consent form. The answers were recorded using pen and paper and latter transformed into a computer database. The determination of the demographics, morbidity prevalence and risk factors is based on the report of the adult member of the household.

The questionnaire

The survey instrument used included a modified version of the questionnaire recommended by the World Health Organization (WHO) for asthma studies [11, 12]. It evaluated lifetime and early childhood prevalence as well as prevalence during the past 12 months. In addition to the occurrence of self-reported respiratory symptoms (chronic cough, chronic phlegm, wheeze and shortness of breath with wheeze, chest tightness, bronchitis and pneumonia), the questionnaire included information on socio-demographic characteristics (age, sex, ethnic background, length of residence in area, job location, education and occupation of adult members of the household, and home ownership) and family history of allergic diseases. Related items about respiratory diseases included doctor diagnosed asthma, bronchitis, pneumonia and sinusitis, and use of asthma medication. Environmental (closeness to sources of pollution), and household (carpeting, pets and dampness) risk factors as well as parental/adult risk behaviors (smoking and pesticide use) were also covered. The questionnaire included items about some limitations that may be attributed to respiratory morbidity (absence from school) and perceptions of environmental quality in the neighborhood. Only a portion of the survey data is discussed in this report.

The study was approved by the Ethics Committee of the Faculty of Medicine, University of Natal and the Human Subjects Committee of the School of Medicine, University of Michigan.

Data analysis

The scores on data sheets were transferred to a computer database using Epi Info (Centers for Disease Control, Atlanta, Georgia) version 6. All subsequent statistical analyses of results were done using the Epi Info and SYSTAT (SPSS Inc., Chicago, IL) version 7 computer software packages. Simple descriptive statistics were used to examine the population demographics and other numeric variables and in calculating the prevalence of respiratory symptoms. The odds ratio (OR) and 95% confidence intervals (CI) were derived from multiple logistic regressions performed for both binary (coded as 0 for nonresponse and 1 for response) and multinomial (coded as integer ranging from 0 to $k-1$) dependent variables. Nonparametric procedures were employed in the test of significance. The logistic regression was done using SYSTAT, with and without specified categorical variables, which allowed for the control of potentially confounding factors during the data analysis.

Hierarchical cluster analysis was used to evaluate groupings among the symptoms and risk factors. The method is based on a measure of the similarity or dissimilarity between variables – similar objects should appear in the same cluster and dissimilar objects in different clusters. The output includes distance measures of similarity, which give an indication of the proximity of observations to one another across the variables in a cluster variate. The most commonly used measure is the Euclidean distance which is estimated using the following formula [13].

$$d = \sqrt{\sum_{i=1}^{n} (x_{i2} - x_{i1})^2}$$

where d is distance in Euclidean unit and x_i is the variable. Various methods have been used to compute distance of one object or cluster from another and to determine whether the two should be merged in a given step. In this study, a single linkage method was used. The linkages were constituted into a hierarchy of treelike structure or dendrogram using an agglomerative (amalgamation) procedure in which each variable starts out as its own cluster. Two closest clusters are subsequently combined into a new aggregate cluster and eventually all variables are grouped into one large cluster. The cluster analysis was done using the subroutine in SYSTAT without standardization of the data.

Results

The 213 households that were sampled had 1060 individuals (693 adults and 367 children), which represented about 2% of the combined population of the communities of Merewent (26,380) and Austerville (22,730). Of the children less than 17 years old, 44% were girls and about 14% were <2 years old (Table 1). The study group was predominantly Indian (67%) and coloreds (31%), reflecting the ethnic make-up of the communities of Austerville (98% coloreds) and Merewent (97% Indians). About half of the households have monthly income of 1000–5000 Rand (exchange rate at time of study: US$1.0 = 4.5 Rand). The long average family residence in Merebank (23.5 years) reflects the old

Table 1. Demographic characteristics and adult risk behaviors of households in suburb of Merebank, Durban

Characteristics/feature	Average occurrence
Number of adults per household	3.2
Number of children (0–17) per household	1.8
Age distribution, children	
0–2	21 (F); 30 (M)
3–5	26 (F); 45 (M)
6–10	54 (F); 66 (M)
11–18	61 (F); 64 (M)
Length of family residence in Merebank	23.5 years
Ethnic identity	
Black	1.9%
White	1.0%
Colored	31%
Indian	67%
Other	4.8%
Mean monthly household income	
<R500	6.7%
R500–R1000	17%
R1001–R3000	31%
R3001–R5000	18%
R5001–R10,000	8.8%
Over R10,000	2.1%
Unknown	16%
Home ownership	68%
Household with smokers	55%
Number of cigarettes per day per smoker	14
Households with carpeted rooms	52%
Households with pets	33%
Insecticide use in house	
Mosquito coils	39%
Pump spray	73%
Closeness of house to industrial operation	
<500 m	59%

apartheid policy which confined non-whites to specific communities for most of their lives. About two-thirds of the families own their homes (Table 1). Most (>70%) of the adults work outside the Merebank area.

Table 2 summarizes the prevalence of asthma in children and adults of Merebank households. About 12% of the adults and 10% of the children were reported as having doctor diagnosed asthma. There was no significant racial difference in the reported prevalence of asthma among the adults and children in the community. The survey also reveals high incidence of other respiratory symptoms and diseases in the community including chronic cough (33–35%), chronic phlegm (31–32%), frequent blocked-runny nose (44–50%), and doctor diagnosed bronchitis (20–25%).

The effects of various household, environmental and behavioral (adult) risk factors on prevalence of asthma, wheeze and shortness of breath with wheeze are summarized in Table 3 for the adult population. Unlike many other studies, we find no significant association between prevalence of asthma in children and the common household risk factors such as pets in the house, room carpeting, dampness or use of insecticides.

In addition to doctor diagnosed case, the two symptoms – wheezing and shortness of breath with wheezing – are often considered to be indicative of asthma. The wheeze rates (40% for adults, 37% for children) and shortness of breath with wheezing (28% adult, 16% children) during the past 12 months (Table 2) are much higher than the prevalence rates reported for children in many parts of the world [14]. The question, have you had wheezing or whistling in the chest in the last 12 months, was used in recent study of worldwide variation in prevalence of symptoms of asthma [14]. The prevalence rates of asthma self-reported by 13- to 14-year old school children in African cities during the study included 7% in Algiers (Algeria), 11% in Addis Ababa (Ethiopia), 16% in Nairobi (Kenya), 11% in Ibadan (Nigeria), 15% in Cape Town (South Africa) and 6–10% in various cities of Morocco [14]. It is believed that differences in ambient air quality is an important contributor to the difference in wheeze rate (37%) among children in south-central Durban compared to reported rates (6–16%) in the other urban areas of Africa.

Table 2. Prevalence (%) of respiratory symptoms in the survey population of Merebank, Durban

Symptoms	Adults (n = 693)	Children (n = 367)
Chronic cough for at least 3 months during last 12 months	33	35
Chronic phlegm for at least 3 months during last 12 months	31	32
Frequent blocked-runny nose during last 12 months	44	50
Attacks of shortness of breath with wheeze during last 12 months	28	16
Chest tightness during last 12 months	42	24
Wheezy chest, ever	40	37
Doctor diagnosed asthma, ever	12	10
Currently using asthma medication	9.9	10
Doctor diagnosed bronchitis, ever	25	20
Doctor diagnosed pneumonia, ever	7.2	6.1
Doctor diagnosed sinusitis, ever	27	16
Allergies (to anything)	14	10
History of allergy in family	7.6	7.5

Many risk factors for asthma exist in the community including high levels of air pollution, high prevalence of smoking by family members and climatic conditions that favor proliferation of house mite and molds. One would expect the development of asthma to be accompanied by other atopic diseases in individuals [15]. We find significant correlations of asthma with other respiratory symptoms in the community (crude odds ratios in Table 4). Of these symptoms, the associations of asthma with wheeze, chest tightness and pneumonia were most robust among the adult population. After adjusting for all the symptoms, significant associations remained between asthma and wheeze (adjusted odds ratio (AOR): 2.6; 95% confidence interval (CI): 1.1–6.0), asthma and chest tightness (AOR: 13.4; 95% CI: 1.4–125), and pneumonia (AOR: 3.8, 95% CI: 1.1–13.6). The socio-ecological environment of south-central Durban can result in pulmonary dysfunction and a common disposition to these symptoms. Increasing the awareness of local physicians of the association of symptoms should facilitate early diagnosis and prevention of asthma.

Smoking was associated with wheeze (crude odds ratio (COR): 2.9; 95% CI: 1.5–4.9) and shortness of breath with wheeze (COR: 2.6; 95% CI: 1.4–4.8) among the respondents. The results of this study are consistent with those of many studies that have closely linked environmental tobacco smoke (ETS) with asthma and wheeze in different populations [16–17]. We found only a week association between the number of smokers in household and prevalence of asthma (Table 3).

The much higher rates of wheeze (40% for adults, 37% for children) as well as shortness of breath with wheezing (28% adult, 16% children see Table 2) compared to doctor diagnosed asthma (12% for adult and 10% for children) suggest that these

Table 3. Effects of environmental and household risk factors on prevalence of asthma in adult population of Merebank

Risk factor	Adjusted odds ratio (confidence interval)		
	Wheeze	Shortness of breath with wheeze	Asthma
Closeness (<500 m) of home to industry	0.98 (0.49–1.96)	0.66 (0.32–1.36)	0.60 (0.21–1.79)
Closeness (<500 m) of home to airport	4.11 (0.73–23.3)	2.87 (0.44–18.6)	0.96 (0.08–11.6)
Closeness (<500 m) of home to shopping center	1.04 (0.50–2.14)	1.58 (0.77–3.28)	2.24 (0.81–6.22)
Number of children in the house	1.63 (0.71–3.74)	0.56 (0.23–1.35)	0.50 (0.12–2.06)
Number of adults in the house	0.73 (0.35–1.51)	1.07 (0.51–2.26)	1.05 (0.35–3.12)
Smoking by respondent	1.16 (5.50–2.70)	1.54 (0.67–3.57)	0.82 (0.25–2.64)
Smoker in the house	0.60 (0.29–1.27)	0.52 (0.24–1.12)	2.86 (0.94–8.33)[b]
Carpet in home	0.61 (0.3–1.22)	0.48 (0.23–0.98)[a]	0.72 (0.26–2.02)
Use of insect coils	2.52 (1.19–5.34)[a]	1.41 (0.67–2.99)	2.22 (0.76–6.42)
Use of pump spray insecticides	1.49 (0.63–3.47)	0.84 (0.36–1.95)	3.67 (1.19–11.3)[a]
Pets in home	1.19 (0.57–2.51)	1.08 (0.50–2.32)	0.41 (0.11–1.50)
Home dampness	2.13 (0.95–4.75)[b]	1.04 (0.46–2.34)	1.91 (0.61–6.01)
Educational level of respondent	0.90 (0.38–2.14)	0.76 (0.32–1.83)	0.76 (0.21–2.70)
Gender	0.58 (0.38–0.88)[a]	0.82 (0.55–1.24)	1.08 (0.59–1.97)
Family income level	0.61 (0.32–1.16)	0.80 (0.43–1.49)	0.89 (0.32–2.48)
Age of respondent	0.98 (0.71–1.36)	1.02 (0.73–1.42)	1.21 (0.75–1.93)
Home ownership	0.34 (0.15–0.77)[a]	0.32 (0.14–0.71)[a]	0.32 (0.11–0.98)[a]

[a] Significant at $p < 0.05$; [b] Significant at $p < 0.10$.

Table 4. Effects of respiratory symptoms on prevalence of asthma among the adult population

Symptom	Crude odds ratio (confidence interval)	Adjusted odds ratio (confidence interval)
Chronic cough	4.52 (1.96–10.5)[a]	0.86 (0.24–3.09)
Phlegm	5.29 (2.24–12.5)[a]	1.04 (0.24–4.52)
Constant runny nose	2.43 (1.03–5.89)[a]	0.49 (0.12–1.94)
Wheezy chest	14.4 (4.18–49.7)[a]	2.60 (1.14–5.98)[a]
Shortness of breath with wheeze	10.1 (3.84–26.4)[a]	0.61 (0.32–1.17)
Bronchitis	7.02 (2.94–16.8)[a]	3.82 (1.07–13.6)[a]
Pneumonia	5.47 (1.91–15.7)[a]	1.60 (0.39–6.44)
Sinusitis	1.15 (0.49–2.72)	0.34 (0.10–1.11)
Eczema	0.79 (0.17–3.63)	1.42 (0.23–8.88)
Chest tightness	32 (4.48–253)[a]	13.4 (1.42–125)[a]
Allergy	1.90 (0.73–4.92)	2.40 (0.51–9.54)
History of allergy in family	0.58 (0.13–2.61)	0.34 (0.06–1.97)

[a] Significant at $p < 0.05$.

particular symptoms might have been over-reported during the study. However, there is no reason to suspect such over-reporting. Rather, under-reporting or under-diagnosis of asthma appears a much more likely explanation. Few doctors in the local health clinics are trained to diagnose asthma.

Discussion

To the best of our knowledge, this is the first study to determine the prevalence of asthma and respiratory symptoms among the childhood and adult populations in an urban area of Durban or Kwazulu/Natal province for that matter. It is also believed to be the first to address some of the environmental and household risk factors for respiratory morbidity in the more polluted areas of the province. South-central Durban reflects the decades of apartheid planning and racial segregation in which the Indian and colored communities are co-located with industries in a valley while the white communities occupy the peripheral high grounds. By focusing on people with the highest risk of exposure to atmospheric pollutants, it is hoped that the results of this study will draw attention to existing environmental health inequities associated with past apartheid policies and lead to debate on possible intervention programs.

Doctor diagnosed asthma prevalence (10%) in childhood population of Merebank is higher than the rate reported among children in many countries such as the 4.3% in the USA, 5% in the UK, 0.4–2.4% in Norway, 2.0–6.8% in Sweden, 1.0–3.0% in Finland, 4% in Denmark, 2% in rural areas of Indonesia, 0.5% in rural areas of Papua New Guinea and 2% in China [1, 18]. The rate, however, is similar to the asthma prevalence found in many urban areas: 11% in Cape Town, South Africa [6], 12% in Hong Kong [18], 8% in urban areas of Malaysia [18], 15% in London [19], 10% in Baltimore [20], 9.5% in Detroit [21], 11% in Seattle [16], 14% in Bronx, New York [22] and 10–12% in Haifa [23]. Any comparison with other studies should be made in circumspect manner since differences in survey methods may contribute to differences in asthma prevalence obtained. Nevertheless, this study serves to put Durban on the growing list of urban areas where asthma in children is an important public health problem. It is not clear yet whether the high prevalence is city-wide or restricted to the south-central industrial basin.

A general medical practitioner's survey of 899 patients in Merebank done in March 1990 reported an asthma prevalence of 5.9% [7] which is lower than the doctor diagnosed rates found in this study. It is, however, not clear whether the reported rate pertains to recent presentation of asthma at the time of the study or to asthma ever prevalence measured in this study. Abigail Hardie (personal communication, 1997) did a survey of randomly selected medical records of 313 children born between 1 January 1991 and 30 June 1997. The records were in community clinics at Merebank and Austerville where local residents went for well-baby examinations and vaccinations and for medical treatment. She found asthma diagnosis in 1.2% of the children and the prevalence of asthma-related symptoms (wheeze, cough with wheeze and cough with cold symptoms) to be 13%. The suggestion, based on her data, that the prevalence of asthma may be very low among infants, presumably reflects under-diagnosis by local medical professionals.

Respiratory infections are common in Merebank: the medical practitioner's survey found 24% rate of upper-respiratory tract infection (URTI) among patients of all ages, while Abigail Hardie (personal communication, 1997) also found URTI rate of 24% among infants. Symptoms of respiratory infections, in addition to asthma, may include cough, runny nose and phlegm. Respiratory infections clearly represent a major confounder or a co-morbidity with asthma in the present study. A number of studies have noted increased incidence of respiratory infections in areas with higher air pollution [24]. In view of the low rate of asthma often found in children living in traditional lifestyles, it has been suggested that early respiratory infections may be protective by stimulating the production of T helper (Rh)1 rather than Th2 lympocytes [1]. The present study has documented high prevalence of symptoms that reflect substantial burden of respiratory diseases in the Merebank communities. How the respiratory infections relate to underlying environmental conditions in the development of supervening symptoms in the neighborhoods remains unclear, however.

In population and case–control studies, sensitization to common allergens found in a house has often been found to be a common risk factor for asthma [14–15]. In a recent study, Silverstri et al. [25] found that over 50% of their cohort were allergic to at least one of the 12 allergens tested and that over 80% of the allergic children they examined were sensitized to house dust mites, over 50% to pollen, about 20% to pet dander and only 5% to molds. Self-reported prevalence of allergy in south-central Durban was 14% among adults and 10% among the children (Table 2). Carpeting and pets in the house often exercise some influence on the quantity of allergens to be expected, but neither of these factors is significantly associated with asthma among the adult population of south-central Durban (Table 3). The number of families with pets was relatively small (about 33%), however. History of family allergy was nearly identical (about 7.5%) for adults and children (Table 2) but the rate was not correlatable with asthma prevalence.

Home dampness is indicated as a potential risk factor for wheezing (AOR: 2.1; 95% CI: 1.0–4.8) in adults (Table 3). In the humid semi-tropical environment, house dampness may promote the growth of house dust mites and molds which are well documented risk factors for childhood asthma [16, 26]. Dampness may also be an indicator of poorer housing quality and a reflection of lower socio-economic status.

Co-occurrence of respiratory morbidity in parents and their children in Merebank should be noted, the crude ORs (and CIs) being 2.6 (1.2–5.6) for chronic cough, 2.3 (1.1–4.8) for chronic phlegm, 4.4 (2.1–9.1) for chronic blocked-runny nose, 1.7 (0.9–3.4) for wheeze, 2.9 (1.0–9.1) for shortness of breath with wheeze, 3.4 (1.0–11) for asthma, and 3.0 (1.1–8.1) for sinusitis. The relative effects of genetic versus environmental factors in promoting familial co-occurrences of symptoms in Merebank population cannot be resolved on the basis of data from this investigation.

A number of population-based studies have found respiratory symptoms and diseases to be more prevalent in communities with high air pollution [12, 23]. Whether one lived in Merewent or Austerville was not significantly associated with wheeze (W), shortness of breath with wheeze (S) and asthma (A) among the adults or children. This should not be surprising since the two communities are closely located in an industrial valley so that most of the people are exposed to elevated levels of pollutants. Indeed, living <500 m from an industry, airport or shopping center did not seem to increase the incidence of asthma (Table 3).

Significant gender difference in prevalence of wheeze ($p = 0.016$, ↑ in males) was found among the adult population. Women comprise 60–65% of adults with this symptom. A number of studies have found higher prevalence of asthma among men compared to women, the difference being attributed to added exposure from occupational sources for the men [27]. In south-central Durban, Indian women are more likely to stay home (to raise children). Home ownership appears to be a protective risk factor for W and S among the adult population (Table 3), due presumably to the fact that home ownership is an indicator of socio-economic status (SES) [28]. Parental home ownership, however, does not appear to be a factor in prevalence of asthma and wheezing among the children.

Hierarchical cluster analysis (HCA) of the data shows the relative linkages between four symptoms (allergy, asthma, wheeze and shortness of breath with wheeze) and risk factors (Figures 1 and 2). For this study, the X-axis is used to represent the normalized Euclidean distance and the tree branches are ordered so that the most similar objects are the closest to each other. An important observation is that the dendrograms for adults and children are similar in terms of subgrouping of symptoms and risk factors. For both populations, the four symptoms form a close cluster joined at about the same distance while the risk factors form several nests. The fact that the risk factors do not form very distinct groupings can be attributed to their inter-relatedness.

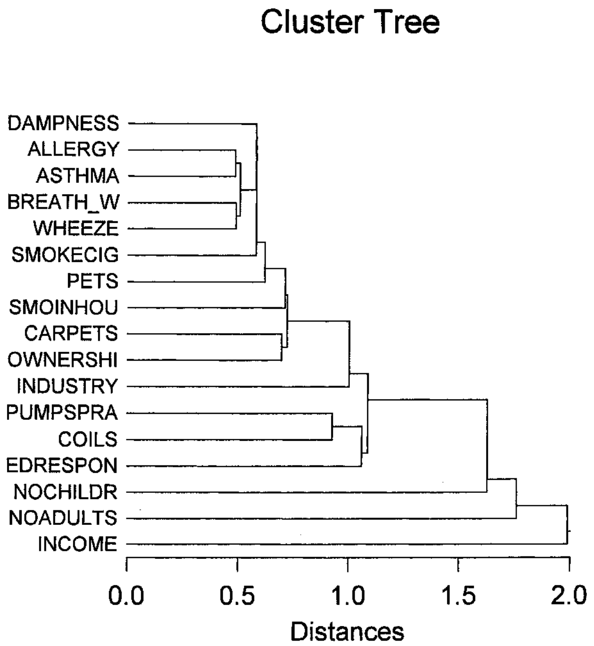

Figure 1. Dendrogram from hierarchical cluster analysis of risk factors and symptoms for adult population of south-central Durban. Abbreviated variables are BREATH_W = attack of shortness of breath with wheeze; SMOKECIG = smoking of cigarette; SMOINHOU = smokers in household; OWNERHI = ownership of home where family lives; PUMPSPRA = use of pump spray insecticides; EDRESPON = educational level of respondent; NOCHILDR = number of children in household; NOADULTS = number of adults in household.

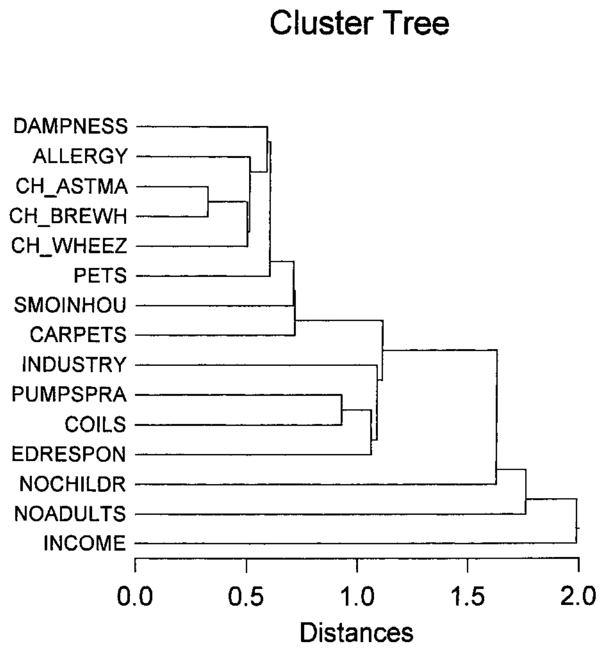

Figure 2. Cluster tree for risk factors and symptoms for children in south-central Durban. CH_ASTMA = asthma; CH_BREWH = shortness of breath with wheeze; CH-WHEEZ = wheeze. For abbreviations of risk factors see legend of Figure 1.

For adult population, the four pairs of variables closest to each other are asthma and allergy (joining distance, $r = 0.48$ unit), wheeze and shortness of breath with wheeze ($r = 0.48$), carpeting and home ownership ($r = 0.70$), and use pump spray and coil insecticides ($r = 0.93$). The two risk factors closest to the symptoms are home dampness and cigarette smoking; both are significantly associated with asthma (Table 3). The next group of risk factors closely aligned to the symptoms are smokers in the house, pets, carpets and home ownership; significant associations between these factors and asthma have been reported in a number of studies [29–30]. One thing that emerges from Figure 1 is the fact that the socio-economic factors (family income, number of adults and children in household and educational level of parents) are the most distant from the symptoms and thus form the root of the tree graph. Lack of significant association between SES and respiratory symptoms may be related to uniformity in distribution of household income in the community – one third of the households make 1000–3000 Rands/month and over two-thirds make 500–5000 Rands/month (Table 1). According to the dendrogram and closeness to the symptoms (Figure 1), the SES can be regarded as the root system while environmental risk factors (residential neighborhood and proximity of household to major industry) fall mainly on the stem of the tree and the household risk factors make up the stem (coil and spray insecticides, carpets, and smokers in the house) or branches (pets, smoking cigarette, and home dampness).

The dendrogram for children (Figure 2) is not very different from that of the adults (Figure 1). Four subgroupings can be identified: (a) the symptoms plus home dampness and pets in the home; (b) smokers in the home and floor carpeting; (c) proximity to industry, use of insect coils and sprays, and educational level of respondent; (d) household income and number of children and adults in a home (Figure 2). In terms of closeness to symptoms, the clusters approximately follow the sequence: SES $>$ environmental risk factors $>$ household risk factors $\approx$ behavioral risk factors. This sequence should be viewed in a circumspect manner since the effects of risk factors are often inter-related. Lack of direct relationship between household income and respiratory symptoms among the children should be noted.

Although not considered in this study, the impacts of respiratory diseases on the physical and mental well-being of the sufferer need to be noted. Individuals with sinusitis (rate estimated to be 16% among children and 27% among adults in Merebank) often show worsened perception of general health and have diminished social functioning, more problems with work or normal daily activities, and diminished vitality [31–32]. One study found that patients with sinusitis have significantly more bodily pain than those with back pain or sciatica [32]. Asthmatics have been known to suffer sleep deprivation [33]. Results from this and other studies point to the fact that children with asthma miss school more often and are thus liable to classroom under-achievement. High prevalence of asthma and other respiratory diseases clearly entail major but disproportionate economic, medical and social costs to the community, a fact that is rarely recognized as an important legacy of the past racial policy in South Africa.

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