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Adult Asthma Prevalence, Morbidity and Mortality and Their Relationships with Environmental and Medical Care Factors in Singapore

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SUMMARY **We have conducted a series of studies on adult asthma in Singapore that describe the prevalence, morbidity and mortality and their relationships with environmental and medical care factors. There was no evidence of a temporal increase of mortality from 1976 to 1995 for adults. The prevalence rate of asthma is 2.4% in men and 2.0% in women. There is considerable morbidity among asthmatics, corticosteroids are under-used, and patients' knowledge and self-management skills is poor. Increased morbidity is significantly associated with current keeping of pets, current smoking, and the patients' knowledge and self-management skills. Occupational exposure contributes up to a third of asthma morbidity. Malays and Indians have higher rates of asthma mortality and morbidity than Chinese. They have greater exposures to airborne allergens from keeping rugs or carpets, and pets. Malays experience the most morbidity from asthma, but make less use of health services, and receive less medical attention, than Indians or Chinese.**

Wide variations in rates of asthma prevalence, morbidity and mortality have been described among Caucasian populations in developed countries. In particular, striking increases in asthma mortality have been documented in the past several decades in many countries, and high rates of asthma prevalence and mortality have been noted in Australia and New Zealand.[1] Epidemiological data on population rates of asthma are scarce in developing countries. It would appear that rates of asthma are generally lower in populations in Asia and Africa.[2,3] Mortality rates of asthma have been reported to increase from 1979 to 1985 among Chinese in Hong Kong.[4] Very high rates of asthma prevalence and mortality occur in certain ethnic populations in both developed and developing countries, including Blacks in the United States,[5] Coloreds in South Africa.[6]

Against the backdrop of worldwide concern over rising morbidity and mortality from asthma, it generally recognized that the attributable factors in medical care include the under-use of corticosteroids, failure to recognize the severity of asthma exacerbations by both patients and care providers, delay in initiating appropriate treatment, and inadequate patient education and supervision. Current evidence-based practice guidelines emphasize the use of allergen avoidance, inhaled or oral steroids, patient self-monitoring of symptoms and peak flow, and decision skills in the self-management of acute exacerbations.

Asthma is an important common disease in Singapore that consumes considerable amount of available health service resources. It ranks fifth as the most common reason for hospital discharges. About 3,000 discharges for adults, and another 3,000 discharges for children, are for the principal diagnosis of asthma, or about a total of 2.4 discharges per 100,000 per year. There are no complete data

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for emergency room treatments of asthma, but it is estimated that there are about 20,000 emergency room visits for asthma per year, or about 7 visits per 1,000 population.[7] Data from the National Morbidity Surveys in 1988 and 1993[8,9] show that asthma is the sixth most common disease condition for visits to private general practitioners' and government primary care clinics. About 240,000 adult visits, and another 290,000 visits by children, are for asthma, making up about 4% of the total number of visits. These data suggest that a considerable amount of unnecessary healthcare resources utilization could be averted by reducing the morbidity among asthmatics through improved quality and outcomes of asthma care.

Since 1992, the primary focus of a program of research on adult asthma in Singapore is to describe the prevalence, morbidity and mortality, and patterns of medical care of asthmatic patients, and to elucidate the roles of personal, behavioural and lifestyle, environmental and medical care factors. As Singapore is a multi-ethnic population comprising Chinese (75%), Malays (14%), and Indians (7%), a special focus of research has therefore been on ethnic differences in asthma prevalence, morbidity and mortality among them. These may be explained by a multiplicity of known and unknown factors, but have been addressed in very few studies.

METHODS

In Singapore, adult asthma prevalence, morbidity and mortality, and their associated risk factors, was examined in a number of studies.

The Singapore Adult Respiratory Health Study (SARHS)[10] is a cross-sectional population-based sample study carried out in 1992. Among 2,868 randomly selected adults aged between 20 and 74 years, the prevalence of asthma was determined by an interviewer-administered questionnaire. Asthma was defined as symptoms (wheeze, or wheeze with shortness of breath, or nocturnal attacks of wheeze with shortness of breath) with a physician diagnosis of asthma, in the absence of known cardiac disease. Other data were also collected on chronic and allergic rhinitis, atopy, and behavioural, lifestyle and environmental risk factors such as the keeping of carpets and rugs, cats, dogs and other pets, smoking, incense burning, gas-stove cooking, etc.

Asthmatic morbidity and its risk factors was studied in 1993 in the community-based Singapore Adult Asthma Morbidity Study (SAAMS)[11-13] of 802 asthma patients aged 20-54 years, who had been treated for symptoms in the previous one year in five large primary care outpatient clinics run by the Ministry of Health. In this study, asthma morbidity was deter-

Table 1 Trends in sex and age-specific asthma mortality rates per 100,000 person-years, 1976-95, Singapore

		5-14 years	15-34 years	35-59 years	60+ years
Males	1976-80	0.10	1.08	7.48	38.9
	1981-85	0.46	1.11	6.09	39.3
	1986-90	0.29	1.47	6.17	31.9
	1991-95	0.93	1.05	4.29	40.8
Females	1976-80	0.32	1.07	5.09	23.0
	1981-85	0.50	0.68	4.75	21.5
	1986-90	0.72	1.03	5.93	22.6
	1991-95	0.50	0.84	3.69	22.7
Total	1976-80	0.21	1.08	6.32	30.4
	1981-85	0.48	0.90	5.42	29.8
	1986-90	0.50	1.25	6.05	26.9
	1991-95	0.72	0.95	3.99	31.1

Table 2 Significant risk factors associated with increased asthma morbidity, Singapore Adult Asthma Morbidity Study, 1993

Risk factor	Category	Patients with risk factor (n)	Patients with increased morbidity (%)	Odds ratio	95% confidence interval
Ethnicity	Chinese	385	44.7	1.00	
	Malay	249	57.4	1.67	1.20-2.32
	Indian	153	54.9	1.51	1.03-2.21
Rhinitis/eczema	No	341	46.3	1.00	
	Yes	446	54.0	1.36	1.03-1.81
Keeping cats or dogs	Never	637	49.9	1.00	
	Past	73	42.5	0.74	(0.45-1.21)
	Current	77	64.9	1.86	(1.13-3.04)
Keeping birds	Never	694	49.9	1.00	
	Past	39	46.1	0.86	(0.45-1.65)
	Current	54	64.8	1.85	(1.04-3.30)
Smoking	Never	576	48.8	1.00	
	Past	80	52.5	1.16	(0.73-1.86)
	Current	131	58.0	1.45	(0.99-2.13)
High risk occupations	Never	446	53.4	1.00	
	Past	227	50.7	0.89	0.64-1.22
	Current	114	39.5	0.56	0.37-0.86

mined by the frequency of daytime and nocturnal attacks, the number of visits to primary care or hospital emergency rooms for treatment of acute attacks, the number of hospitalization episodes and the number of days of sick leave in the past year. Using defined cut-off criteria, the presence of any excess of symptoms or uses of health service utilization for asthma exacerbations, or activity restriction was taken to indicate 'increased morbidity' (Table 2). Data collected on risk factors included personal lifestyle and behavioural factors that predispose to exposure to known environmental precipitants of asthma, ethnicity, clinical atopic status (current rhinitis/eczema), smoking, occupation, keeping of pets, rugs and carpets, use of brooms, burning of mosquito coils or incense, and outdoor air pollution, as well as the patient's knowledge of asthma care.

The extension to this study was a community-based Singapore Adult Asthma Case-Control Study (SAACCS),[14] which included 1591 matched non-asthmatic controls from among patients in the same clinics with other diagnoses. Data were collected on family history of asthma, personal histories of atopy, and smoking.

RESULTS AND DISCUSSION

Adult asthma mortality, prevalence and morbidity

Rates of adult asthma mortality are available from national health registration data of the Ministry of Health (Table 1). Asthma mortality increases with age from about 1.0 per 100,000 persons per year in persons aged 15 to 34 years, to 5.4 per 100,000 in

those aged 35-59 years, and 29.0 per 100,000 in those aged 60+ years. Males had about 1.5 times greater risks of mortality than females. There is no evidence of a temporal increase of mortality from 1976 to 1995 for adults, especially in younger adults in the age group from 15 to 34 years, where diagnostic certainty is more assured by less confusion with cardiac and chronic pulmonary airways diseases. (However, there appears to be an increase in rate among children).

In Singapore Adult Respiratory Health Study,[10] the 1-year period ('current') prevalence of asthma was estimated to be 2.4% in men and 2.0% in women.

Among adult asthmatic patients in government primary care clinics who were studied,[11] a sizable proportion (about 20%) of asthmatics were found to experience severe morbidity from their disease. One fifth of the patients had attacks every night or every day, 10% had 4 or more acute attacks requiring emergency room treatments, 18% had at least one hospital admissions in the previous year, and 21% had sick absence due to asthma for one week or more. Using, 70% of the patients were considered to have moderate to severe asthma requiring close medical supervision and steroid treatment.

Asthma care in the community

The community-based Singapore Adult Asthma Morbidity Study[11] showed that corticosteroids were under-used, as only 19% of 186 patients who needed bronchodilaters 3 times or more a day were on inhaled steroids.

Knowledge of asthma and its medications[12] was poor with a mean score of 1.4 (median: 1) out of a total score of 6. The best knowledge score was associated with subjects who had the highest education, who had a family history and who had been exposed to pamphlets and books. Only one-third (37%) used steroid inhalers regularly as prescribed, and only half (54.5%) of those with no schooling used the correct inhaler technique. Important target groups are the older, lesser educated and the patients with moderate to severe asthma requiring steroid inhalers.

In anticipation of a wider implementation of a patient education program of asthma self-management based on current practice guidelines, the question to be asked are 'Will patients be able to self-manage their asthma well?' What factors are likely to influence self-care efficacy? In a subsequent study[16] of 198 asthmatic patients from three of the primary care clinics in the original study, who had symptoms for the previous 6 months, about 70% of the patients were considered by conventional criteria from the International Consensus Guidelines on Management of Asthma[15] to have moderate to severe asthma requiring close medical supervision. Asthma morbidity was significantly predicted by the patients' knowledge of medications and attack management skills. However, only a minority of the patients had satisfactory levels of these skills and knowledge. A high level of stigmatization from asthma was generally present among the patients but most of them appeared to possess a high level of self-confidence in the management of their asthma. These factors were also associated with asthma morbidity, although they were as likely to have resulted from morbidity as to have influenced it. The patients' attitude towards medications were mostly negative but their confidence in their doctors and their level of family support were high; none of these factors, however, were associated with morbidity. Attack management skills as a behavioral measure of self-care efficacy was not significantly predicted by any of these personal or psychosocial factors. A practical implication of these findings is that asthma self management should focus on developing specific knowledge and skills in the self treatment of asthma attacks.

Environmental allergenic exposures and asthma morbidity

The important roles of allergen exposures, especially from household mites and pets, in asthma morbidity, are well known. In the Singapore Adult Asthma Morbidity Study,[13] increased morbidity was significantly associated with current keeping of cats or dogs, current keeping of birds, and current smoking (Table 2). Despite this, it is interesting to note that a considerable proportion of the patients continued to keep their pets and to smoke. Paradoxically, patients currently employed in an occupation known to be at high risk of asthma are significantly less likely to suffer increased morbidity from their asthma. This could be explained by the fact that most asthmatics leave occupations that cause or aggravate their asthma, leaving behind a 'survivor' group of patients who are either unaffected by their asthma, or in whom it is well tolerated. Many of those

who are currently holding onto 'high-risk' jobs are therefore likely to report less morbidity from their asthma. Unlike allergenic exposures to household mites or pets, many occupational induction of asthma symptoms are more dramatic in their onset and intensity, and patients will often change jobs quickly as a result. On the other hand, most patients have an emotional attachment to their pets, and many are inclined to keep their pets, despite their symptoms, and the advice of their physicians. A multiplicity of interacting factors and behavioural responses appear to influence the effects of allergens and other environmental precipitants on asthma morbidity in patients.

There was no strong evidence from the study that asthma morbidity was increased by regular passive smoking, incense burning, mosquito coil burning, outdoor pollution, or insecticide use.

Occupational exposures

Despite the paradoxical relationship between asthma morbidity and occupational exposures that was observed in the SAAMS, we were able, in fact, to establish significant positive associations with 'high-risk' occupations in the Community-based Adult Asthma Case-Control Study.[14] Whereas the SAAMS looked at associations that compared asthmatics with and without increased morbidity, the SAACCS looked at associations that compared all the asthmatics in the study with an external group of non-asthmatic controls. We were able to show that members of this group of asthmatics are in fact significantly more likely to have been at some time in their lives employed in certain high-risk occupations. The SAACCS thus also provided data to identify occupational high-risk groups for population-based occupational surveillance and control in Singapore. Occupations in Singapore that were found to be at high risks of asthma morbidity include service workers and manufacturing production and related workers. Among them, increased risks were observed for cleaners, particularly municipal cleaners and sweepers, textile workers, garment markers, electrical and electronic production workers, printers, and construction/renovation workers. Relative to other occupations, there are no occupationally associated risks of asthma for clerical or sales workers in general, but there are significantly reduced risks of association with asthma for professional, technical, administrative, and managerial occupations. The excess risk of asthma in manual service and production-related occupations, relative to non-manual professional/ technical, administrative/managerial, clerical, and sales occupations, is estimated to be 72%. The estimated population attributable risk of 0.33 suggest that potentially as much as a third of the asthma morbidity in the population could be averted or reduced by eliminating or reducing environmental exposures in these occupations.

Ethnic variations in asthma mortality, prevalence, morbidity

Ethnic differences in asthma mortality rates were examined using population data from the National Registration Department from 1989-95, the years when such data by ethnic groups became available. Standardized for sex and age, asthma mortality rates are about 2-3 times higher in Indians, and about four times higher in Malays, compared to those of Chinese (Figure 1 and Table 3). These variations in asthma deaths may be related to variations in incidence, prevalence or severity of asthma, as a consequence of differing patterns of environmental exposures, or differences in access and effectiveness of care. Do Malays have higher asthma prevalence and morbidity than Indians, and do both have higher prevalence and morbidity than Chinese?

In the Singapore Adult Respiratory Health Study, the one-year prevalence rates in Chinese is estimated at 0.9%, in Indians 4.5%,

Table 3 Age-standardized asthma mortality rates per 100,000 person-year, in Chinese, Malay and Indian adults, 1989-95 Singapore

	Males	Females
Chinese	4.5	2.8
Indian	7.7	6.8
Malay	13.9	12.4

Mortality rates were directly standardized to the age distribution of the general Singapore population in 1992

and in Malays 3.3% (Fig. 2 and Table 4). Thus, the observation of higher mortality rates from asthma in non-Chinese (Indians and Malays) is supported by the fact that they also have higher prevalence of asthma. The higher asthma prevalence in non-Chinese (Indians and Malays) is partly explained by the fact that they have greater exposures to airborne allergens as a result of lifestyle habits and practices.[10] Malays and Indians are very much more likely to keep rugs or carpets, cats, dogs, or birds, than Chinese. Malays smoke cigarettes in greater numbers than Chinese, but Indians smoke the least. Both Malays and Indians reported greater frequencies of cockroach infestation in their homes than Chinese.[16] (Fig. 3)

However, it is interesting to note that, between Indians and Malays, whereas Malays have been noted to have clearly higher rates of mortality from asthma than Indians, they do not show higher prevalence of the disease. The prevalence rate of asthma in Indians is in fact slightly higher than that in Malays. It is possible, however, that among Indians, a cultural bias in self-reporting of symptoms could result in higher rates of asthma, without any increase in disease morbidity among them. It may still be postulated that in Malay asthmatics, more morbid disease and poorer management of near-fatal asthma attacks could increase their risk of dying.

Table 4 Age-standardized 1-year period asthma prevalence rates per 100, in Chinese, Malay and Indian adults, 1992

	Males	Females
Chinese	0.9 (0.1-1.7)	1.0 (0.1-2.0)
Indian	4.8 (2.5-7.1)	4.2 (2.2-6.2)
Malay	4.4 (2.4-6.5)	2.2 (0.9-3.5)

'Asthma' was defined as any symptom of episodic 'wheeze', or 'wheeze with attacks of shortness of breath', or 'nocturnal attacks of wheeze or shortness of breath', with a physician diagnosis of asthma.
Rates (95% confidence intervals) were directly standardized to the age distribution of the whole Singapore population in 1991

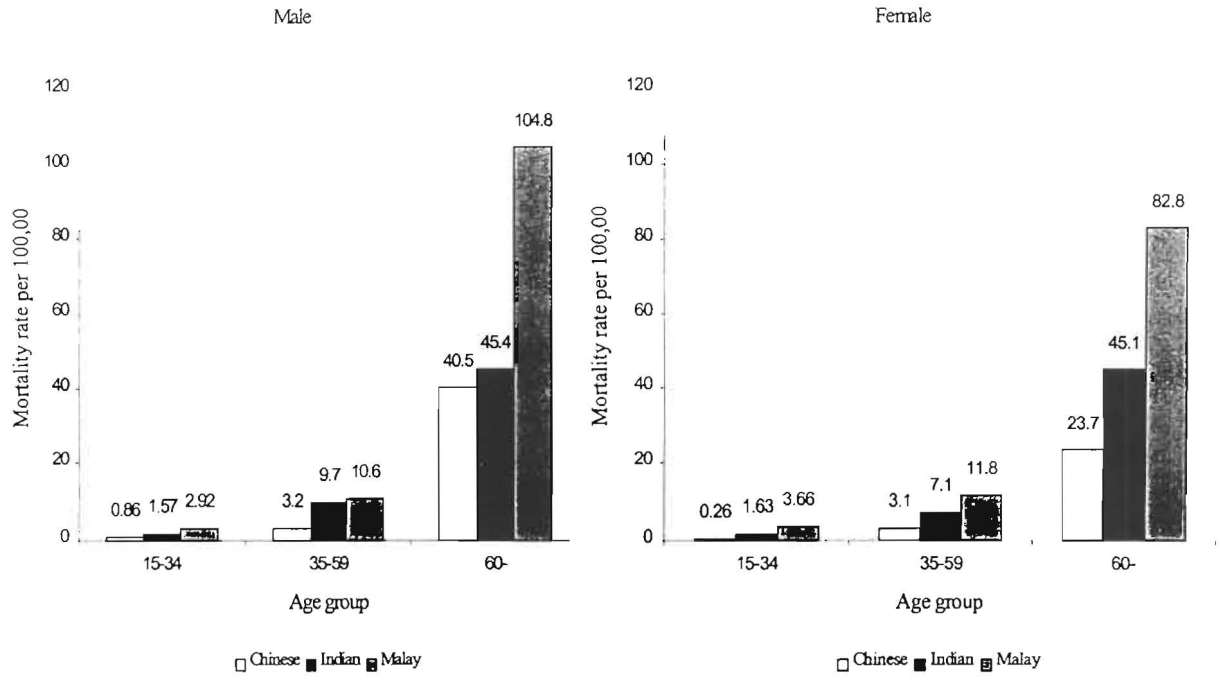

Fig. 1 Sex- and age-specific mortality rates in Chinese, Malays and Indians. Singapore, 1976-1995.

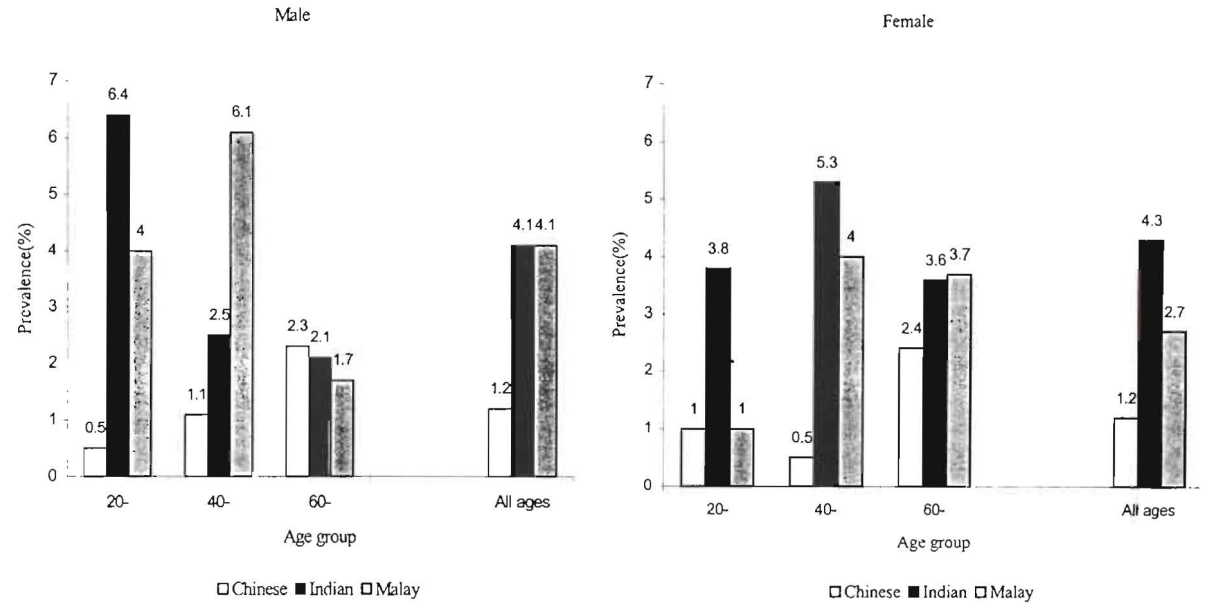

Fig. 2 One-year period prevalence of asthma, Singapore Adult Respiratory Health Study, 1992.

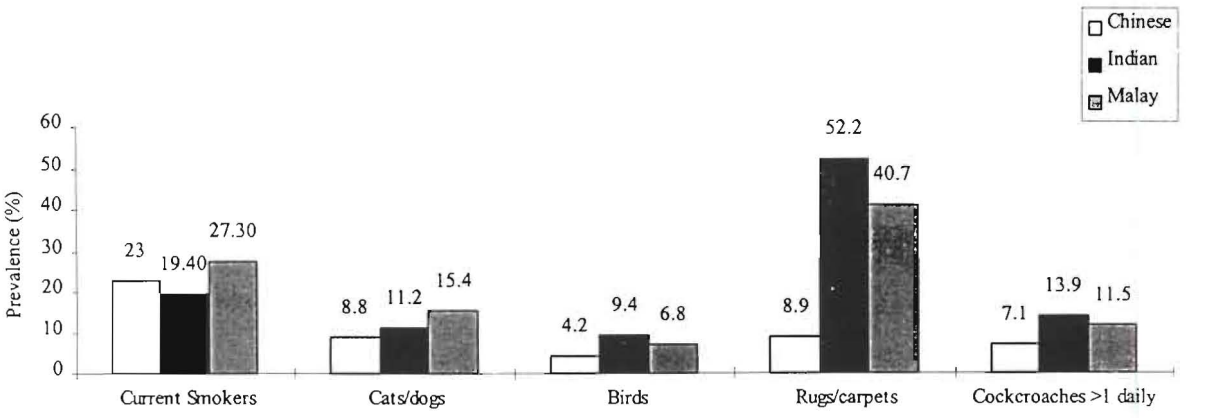

Fig. 3 Prevalence of asthma-related lifestyle risk factors by ethnic groups in Singapore, Singapore Adult Respiratory Health Study, 1992.

There is some evidence for this from analyzing data in the Singapore Adult Asthma Morbidity Study[13] (Table 5). Asthma symptoms are more frequent in Malays than in either Indians or Chinese. In particular, nocturnal exacerbations of asthma, which is widely recognized as a marker of asthma severity, are most frequent in Malays. Despite this, they make less frequent use of the emergency room services for acute asthma exacerbations than Indians, and hence also do not get hospitalized as frequently as would be warranted. On the other hand, Indians makes use of emergency room services more frequently and, by the same token, increase their likelihood of hospitalization. Because they seek medical attention more readily, they also take more frequent sick absence from work.

These findings strongly suggest that Malay asthmatics suf-

Table 5 Asthma morbidity by ethnic groups, Singapore Community-based Asthma Study

	No.	%	Sex and age-adjusted odds ratio
Daytime attacks one or more times a week			
Total (N=787)	168	21.3	
Chinese (N=385)	72	18.7	1.00
Malays (N=249)	60	24.1	1.42 (0.96-2.10)
Indians (N=153)	36	23.5	1.39 (0.88-2.20)
Nocturnal attacks one or more times a week			
Total	246	31.2	
Chinese	110	28.6	1.00
Malays	90	36.1	1.43 (1.02-2.02)
Indians	46	30.1	1.08 (0.71-1.63)
Attacks unrelieved by usual medications requiring urgent treatment by outpatient or hospital ER 4 or more times in year:			
Total	81	10.2	
Chinese	36	9.3	1.00
Malays	25	10.0	1.08 (0.63-1.86)
Indians	20	13.1	1.47 (0.82-2.66)
Hospitalization one or more times a year			
Total	105	13.3	
Chinese	39	10.1	1.00
Malays	41	16.5	1.82 (1.13-2.93)
Indians	25	16.3	1.79 (1.03-3.10)
Sick absence from work ≥ 7 days in year			
Total	164	20.8	
Chinese	58	15.1	1.00
Malays	64	25.7	2.03 (1.35-3.04)
Indians	42	27.4	2.35 (1.47-3.73)
Index of increased morbidity (any of above):			
Total	399	50.7	
Chinese	172	44.7	1.00
Malays	143	57.4	1.73 (1.25-2.39)
Indians	84	54.9	1.57 (1.07-2.53)

fer more from their disease, but they generally make less use of health services and receive less medical attention. In Singapore, there are no financial barriers to access to health care, since the Ministry of Health outpatient services provides highly subsidized care to all. Hence, it is likely that, despite this, the level of utilization of health care services by Malays is lower because they have higher thresholds of symptom recognition and are less ready to seek medical attention. Also, among Malay patients who received continuing care at the government primary care clinics, asthma knowledge scores were poorer compared to Indians or Chinese, as were their scores on inhaler techniques. It is also possible that cultural and language barriers may be posed by poorer quality of patient education, given that the health care providers are predominantly non-Malay.

In conclusion, variations in asthma morbidity and mortality in Singapore can thus be explained by personal lifestyle factors related to environmental airborne allergen and occupational exposures, and by cultural and behavioral factors related to the utilization of medical care and patient education.

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