Prevalence of asthma and risk factors among Chinese, Malay, and Indian adults in Singapore

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Abstract

Background **– The prevalence and morbidity of asthma vary greatly among different ethnic communities and geographical locations, but the roles of environmental and genetic factors are not fully understood. The differences in prevalence of adult asthma among Chinese, Malay, and Indian ethnic groups in Singapore were examined, and the extent to which these could be explained by personal and environmental factors were investigated.**

Methods **– A stratified disproportionate random sample (n=2868) of Chinese (n=1018), Malays (n=967), and Indians (n=883) of both sexes was drawn from households in five public housing estates, and an interviewer administered questionnaire was used to determine cumulative and current prevalence of "physician diagnosed asthma" (symptoms with a physician diagnosis of asthma).**

Results **– Lifetime cumulative prevalence (standardised to the general population) of "physician diagnosed asthma" was 4·7% in men and 4·3% in women; 12 month period prevalences were 2·4% and 2·0%, respectively. Cumulative prevalence of asthma was significantly higher in Indians (6·6%) and Malays (6·0%) than in Chinese (3·0%); period prevalences of asthma were 4·5% in Indians, 3·3% in Malays, and 0·9% in Chinese. Ownership of cats or dogs was more frequent in Malays (15·4%) and Indians (11·2%) than in Chinese (8·8%). Rugs and carpets were also more frequently used by Malays (52·2%) and Indians (40·7%) than by Chinese (8·9%). Current smoking prevalences were higher in Malays (27·3%) than in Indians (19·4%) and Chinese (23·0%). Malays and Indians did not have higher rates of atopy (11·1% and 15·2%, respectively) than Chinese (15·4%). Adjustment for these factors in multivariate analyses reduced the greater odds of asthma in Malays and Indians, but not to a significant extent.**

Conclusions **– There are ethnic differences in the prevalence of asthma in Singapore which are not entirely explained by differences in smoking, atopy, or other risk factors. Other unmeasured environmental factors or genetic influences are likely to account for residual differences in the prevalence of asthma.**

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The prevalence of asthma varies widely in populations residing in different geographical areas and among different ethnic communities.[1,2] Indians in the UK have been reported to have higher rates of asthma than white Caucasians,[3–5] although other reports have also indicated a lower[6–8] or similar[9,10] prevalence. There is much evidence to indicate that environmental factors are the major cause of variation in the prevalence of asthma among different population groups. A westernised lifestyle, urban living, and higher material standards of living appear to be associated with a higher prevalence of asthma.[2,11] However, the precise role of specific environmental factors in explaining ethnic differences in the prevalence of asthma is unclear.

It has long been suspected that Malays and Indians in the multiracial population of Singapore are more likely than Chinese to have symptoms of asthma. In a questionnaire survey of children and young people in 1972 a history of asthma was reported by 6·7% of Malay primary and secondary students, 7·7% of Indian students, and 2·7% of Chinese students.[12] No corresponding data for older adults are available. There are no known explanations for the observed ethnic differences in asthma morbidity in Singapore. Singapore is a small island city state (633 square kilometres), situated close to the Equator, with a uniformly hot and humid climate throughout the year. The country enjoys a high standard of living and is highly urbanised, but traditional ways are still very much the fabric of life for all except the young. A moderate difference in socioeconomic levels exists among the races (with the Chinese having higher standards of living), but the differences in culture, lifestyle, and living habits are wide.

This study was undertaken to examine differences in the prevalence of adult asthma among the three major ethnic populations of Singapore, and to determine whether these could be accounted for by differences in the prevalence of specific personal and environmental factors in each of the three ethnic groups.

Methods

Over 85% of households (those within the low to middle income brackets in Singapore) live in modern, low cost, high rise flats in public housing estates. We chose to study residents of public housing estates with this socioeconomic restriction in mind for the study population. Public housing estates are uniform with regard to the socioeconomic distribution of residents according to different housing types defined by

the size of flats (one room, two rooms, three rooms, four rooms, five rooms, or executive flats) and racial groups, as a result of the deliberate government policy for social class integration and racial coexistence. Five estates were chosen from widely scattered parts of the island, including areas close to heavy manufacturing industries, near the city centre, and in the suburbs. A stratified two stage cluster disproportionate random sample of adults aged between 20 and 74 years was selected. A first stage random sample of housing blocks in each of the five public housing estates was drawn and all eligible residents within each of the housing units (households) were asked to participate. Disproportionate sampling was employed to obtain equal quotas of subjects belonging to each of the three races and 11 five year age groups in the study sample, in order to ensure stable statistical estimates for the minority groups of Malays and Indians, which form 14·1% and 7·1% of the population respectively, and for older adults in the population.

Among the households in 199 randomly selected housing blocks 506 were not contactable after at least three attempts (most of these being due to relocation under estate renewal programme), 474 households refused, and 1866 households responded. Of a total of 3940 eligible persons residing in these responding households between the ages of 20 and 74 years, 2868 persons (72·8%) were interviewed.

Data were collected by a team of trained interviewers who administered a structured questionnaire in the languages usually understood and spoken by the respondents. Most people in Singapore use English in addition to their ethnic language, so in most cases the interview could be conducted effectively in English. In cases where very old respondents could not understand English it was always possible to enlist the help of their English speaking children in the household or appropriate interviewers who spoke Chinese, Malay, or Tamil.

Asthma was defined in a number of ways in the survey: (1) episodic wheeze; (2) episodic wheeze and "attacks" of shortness of breath; (3) nocturnal "attacks" of wheeze or shortness of breath; (4) any of the above symptoms with a physician diagnosis of asthma ("physician diagnosed asthma") in the absence of known cardiac disease. The analyses showed that the symptom of wheeze alone was more common than either of the other sets of symptoms, but closely corresponded with physician diagnosed asthma. We have therefore used physician diagnosed asthma as the end point for analysis and reporting. The subjects were asked whether he or she had ever had these symptoms (lifetime cumulative prevalence), and whether he or she had had the symptoms in the past year (one year period prevalence).

The questionnaire included questions related to a number of known personal and environmental risk factors for asthma. For atopy, subjects were asked whether they had ever had symptoms of chronic rhinitis, eczema, or both, related to contact with allergens. Other questions were asked on past and current smoking habits, current and previous occupations, and whether they currently kept rugs or carpets, cats or dogs, and birds. Socioeconomic status was defined according to the sizes of flats occupied by the households, since residents in larger flats (four or more rooms) generally have higher mean monthly household incomes (S$3165) than those in one to three room flats (S$2063).[13]

Because of the disproportionate sampling by age, the prevalence of asthma for each of the three ethnic groups was examined by extrapolating the sample estimates to reflect the actual age distribution in the general population in 1991 using the direct method for age standardisation. Differences in age specific prevalence between races were evaluated using the Mantel-Haenzsel procedure for data stratified according to age. Multiple logistic regression was used to calculate adjusted prevalence odds ratios of asthma associated with Malays and Indians with reference to Chinese which took into account age, housing estate, flat size, rhinitis/eczema, smoking (never smoker, ex-smoker, and current smoker), keeping of dogs or cats, keeping of birds, keeping of rugs or carpets, and occupational risk groups. Based on the results of a recent community based case-control study of asthma in Singapore[14] several occupational risk groups were defined: a high risk group included those in service, agricultural and manufacturing occupations, while a low risk group included those in professional, technical, and executive occupations, and the intermediate (reference) group comprised other occupations (sales, clerical, housewives, military, etc). An alternative definition of specific high risk occupations such as bakers, cleaners, chemical workers, farmers, nursery workers, textile workers, garment workers, electronic workers, solderers, woodworkers, etc, was also used in the analyses with similar results, hence the previous definition was presented instead.

The data were analysed using procedures from the SAS package of statistical software[15] and confidence interval analysis.[16]

Results

As a result of the sampling procedure used, the three ethnic subsamples in the sample population were about equally distributed by sex, age, and area of residence (table 1). As expected, a greater proportion of Chinese occupied larger flats (four or more rooms) than did Malays or Indians.

The cumulative prevalence (standardised to the age distribution of the general population) of physician diagnosed asthma was 4·7% (95% CI 3·6 to 5·8) in men and 4·3% (95% CI 3·1 to 5·5) in women; period prevalences were 2·4% (95% CI 1·6 to 3·2) and 2·0% (95% CI 1·2 to 2·7), respectively. The point estimates and 95% confidence intervals of the prevalence of asthma for the three ethnic groups are shown in table 2 and were significantly higher in Malays and Indians (cumulative prevalence 6·6% in Indians, 6·0% in Malays, and 3·0% in

Table 1 Demographic characteristics of sample population by race

	Total	Chinese (%)	Malays (%)	Indians (%)	p
No.	2868	1018	967	883	
Sex:					
Men	1430	49·6	49·8	50·2	
Women	1438	50·4	50·2	49·8	NS
Age:					
20–39 years	1156	37·5	41·6	42·1	
40–59 years	1048	37·2	34·8	37·6	
60–74 years	664	25·2	23·6	20·3	NS
Housing estate:					
Bukit Merah	461	15·2	15·8	17·3	
Jurong East	678	23·4	24·6	22·6	
Geylang/Eunos	735	25·5	27·0	24·2	
Toa Payoh	427	16·7	12·7	15·2	
Yishun	567	19·0	20·0	20·6	NS
Apartment size:					
1–3 rooms	1779	54·1	66·8	65·9	
4–5 rooms	1089	45·9	33·2	34·1	<0·001

Table 2 Sex and age standardised rates (%) of physician diagnosed asthma by ethnic group

	Cumulative prevalence (95% CI)	Period prevalence (95% CI)
Chinese	3·6 (2·21 to 5·06)	0·9 (0·33 to 1·57)
Malay	6·0 (4·39 to 7·71)	3·3 (2·12 to 4·54)
Indian	6·6 (4·77 to 8·44)	4·5 (2·98 to 6·03)

Rates were standardised to the sex and age distribution of the 1991 census population (combining all three ethnic groups).

Chinese; period prevalence 4·5% in Indians, 3·3% in Malays, and 0·9% in Chinese). These ethnic differences were also consistently shown in the age-specific rates (data not shown), especially in the age groups between 20 and 59 years which are less likely to be attributable to cardiac disease or other chronic obstructive pulmonary disease.

We next examined whether the racial differences in the prevalence of asthma were explained wholly or in part by known predisposing factors in the environment. Both Malays and Indians were very much more likely to keep cats or dogs than Chinese (table 3). They were also more likely to keep birds, and rugs or carpets. Malays were more frequently ever smokers than Chinese or Indians, as well as being more likely to be engaged in service, agricultural, and manufacturing occupations. The prevalence of rhinitis or eczema, however, was not higher in Indians or Malays than in Chinese; indeed the Chinese appeared to have a higher prevalence than Malays.

The odds ratios of association of asthma with race, when adjusted for these factors in multiple logistic regression analyses, are shown in table 4. These adjusted odds ratios remained significantly high for Malays and Indians. Possible modifications between sex and race were examined in the logistic models

Table 3 Percentage prevalence of environmental risk factors by race

	Chinese	Malays	Indians	p
Rhinitis/eczema	15·4	11·1	15·2	<0·01
Smoking:				
Ex-smokers	8·0	7·2	6·8	
Current smokers	23·0	27·3	19·4	<0·001
Keeping of dogs or cats	8·8	15·4	11·2	<0·001
Keeping of birds	4·2	9·4	6·8	<0·001
Keeping of rugs or carpets	8·9	52·2	40·7	<0·001
High risk occupations	21·7	27·2	23·3	<0·05

Table 4 Adjusted odds ratio of association of physician diagnosed asthma with ethnic group

	Cumulative prevalence (95% CI)	Period prevalence (95% CI)
Chinese	1·00	1·00
Malay	1·83 (1·08 to 1·83)	4·41 (2·01 to 9·70)
Indian	1·97 (1·23 to 3·15)	4·56 (2·27 to 9·17)

Odds ratios were adjusted for age, housing estate, flat size, smoking, rhinitis/eczema, ever keeping of dogs or cats, birds, rugs and carpets, and employment in high risk occupations.

but no statistically significant interactions were observed.

In these multivariate analyses rhinitis or eczema was shown to be very strongly and significantly associated with all sets of asthma symptoms including physician diagnosed asthma; the odds ratios for "ever physician diagnosed asthma" was 3·51 (95% CI 2·43 to 5·09), and for "current physician diagnosed asthma" was 3·23 (95% CI 1·97 to 5·30). The odds ratios of associations with past smoking were significant for "current physician diagnosed asthma" (2·28, 95% CI 1·16 to 4·48), and of borderline significance for "ever physician diagnosed asthma" (1·74, 95% CI 0·98 to 3·10). Area of residence was also significantly associated with physician diagnosed asthma being higher in two areas (Jurong East and Toa Payoh). The keeping of dogs or cats at home was significantly associated with ever nocturnal symptoms (1·74, 95% CI 1·08 to 2·95). Other factors were not shown to be independently associated with asthma.

Discussion

The difficulties of defining asthma in epidemiological studies are well known. Despite the efforts made to ensure valid responses to questions about the presence of asthma, it is possible that wheeze may nevertheless be understood differently among the three races. As is commonly observed in other studies, responses to wheeze appeared to be more variable and less specific, especially in women. However, the use of a combined set of asthmatic symptoms, supported by a physician diagnosis of asthma, would appear to lend great intrinsic validity. It would be desirable, nevertheless, to conduct further studies using non-specific bronchial provocation tests to confirm the observed racial differences in asthma.

The response rate of 72·8% was reasonably high, but the possibility of sampling bias should still be considered. There was some variation in response rate by ethnic group: Chinese 68%, Malays 82%, and Indians 81%. However, we do not know how the responses varied among asthmatic and non-asthmatic subjects within the population. If asthmatic subjects were more inclined to agree to an interview, it is possible to attribute the observed ethnic differences in the prevalence of asthma to differential response bias among ethnic groups. However, we do not think this is likely. In many previous community surveys we have repeatedly observed that non-Chinese subjects are more likely to consent to interview than Chinese and this is likely to reflect a

cultural and socioeconomic characteristic rather than a health related bias. In a related community based polyclinic study[14] we have also noted that Malays and Indians were, if anything, less inclined than Chinese to seek medical attention for their symptoms. The results should also be viewed together with a previously reported observation of similarly higher rates of asthma in children and young people among Malays and Indians.[12] Furthermore, the present findings were well corroborated by results from a parallel case-control study of adult asthma[14] which also showed that Indians and Malays do, indeed, experience higher rates of asthma and more severe disease than Chinese.

The confidence intervals associated with the adjusted odds ratio for race are not as wide as should be the case if intraclass correlation arising from cluster sampling is taken into account. Nevertheless, the directly standardised estimates of asthma prevalence should carry even wider confidence intervals than with indirect adjustment, yet clear ethnic differences are still evident.

The ethnic differences in the prevalence of asthma were shown to be statistically significant after multivariate adjustment for other confounding risk factors. It is possible, however, that adjustment for these risk factors might be less than adequate. It is likely that the odds of association of asthma with certain risk factors, such as the keeping of rugs and carpets, or dogs and cats, were underestimated. Hence, although these factors were not shown to be significantly associated with asthma in multivariate analyses, the possibility that some of these risk factors – for example, keeping of rugs and carpets, pet animals, smoking, and occupational exposures – may explain the observed ethnic differences of asthma cannot be ruled out. The results, based on a cross sectional study only, allow for limited depths of examination of the underlying roles of environmental factors, but the main findings firmly indicate a real difference in prevalences of asthma and risk factors in these ethnic groups.

Intercountry comparison of the prevalence of asthma is made difficult by limited data in adult populations and differences in methods employed, but the overall prevalence of adult asthma observed in Singapore appears to be lower than in many developed countries and higher than in developing countries. Estimates of the prevalence of self-reported current asthma varies from 5·6% to 8% in Australia,[17–20] 3·6% to 6·2% in the USA,[21 22] and 3·3% in the Maldives.[23] The cumulative prevalence of diagnosed asthma was as high as 16·3% in Western Australia,[20] but in Zimbabwe was only 1·6%.[24] In Singapore, while the rates of asthma in Indians may well approximate those in Caucasian populations in the west, the rate in the Chinese is remarkably low.

It is interesting to note that all three ethnic groups live in close proximity to each other rather than in ghettos, and occupy the same block of flats in each housing estate in the same proportion as that found in the general population. It is therefore evident that climatic and other general environmental factors including industrial or urban air pollution cannot explain these ethnic differences in rates of asthma. The higher proportion of Chinese who resided in larger flats is consistent with a known moderate difference in socioeconomic status among the three races (average monthly household income for Chinese, Indians, and Malays are S$3213, S$2859, S$2246, respectively in 1990[13]). The evidence for an association of asthma with social class is variable,[9 25–28] with the weight of evidence favouring the view that those with lower socioeconomic status are less likely to have asthma. Hence, socioeconomic differences were even less likely to explain the observed racial difference in the prevalence of asthma.

Clinical atopic disease is well known to be associated with asthma, as are other markers of atopy. Although rhinitis and eczema were shown to be the strongest risk factors for asthma in the present study, there were no significant differences in atopic disease among the ethnic groups to explain the observed ethnic differences in asthma. Although differences in the prevalence of atopy may account for regional differences in the prevalence of asthma, such differences have not always been shown when comparing areas of high and low asthma prevalence.[29–31]

Environmental factors such as the keeping of cats, dogs, or birds, and rugs or carpets are well known to predispose to the development of common allergies. In this study only the keeping of dogs or cats was shown to be significantly associated with nocturnal symptoms of asthma. Findings of nil or negative associations have been commonly reported,[32–34] however, probably because current exposure may not be relevant and only a few subjects with potential exposure to aeroallergens through contact with pets or the use of rugs and carpets develop asthma. Despite the demonstrable lack of association of these factors with asthma in the present study, it is likely that the higher frequencies of keeping rugs and carpets and pet animals is a contributing factor to the high rates of asthma in Malays and Indians.

Smoking has been shown to be a positive factor leading to the development of asthma symptoms and exacerbations.[35 36] This was also suggested by the data in the present study, and was especially evident in past smokers rather than current smokers (explainable by the fact that many with asthmatic symptoms had stopped smoking, probably upon doctor's advice). The prevalence of smoking is highest in Malays and lowest in Indians. Hence, while smoking may contribute to higher rates of asthma in Malays, the higher prevalence of asthma in Indians cannot be explained by smoking at all. Occupational exposures are a known factor causing or aggravating asthma and, indeed, Malays are more likely to be engaged in service, agricultural, or manufacturing jobs involving greater likelihood of occupational exposures. Hence, occupational

exposures may also partly explain the higher rates of asthma in Malays.

In conclusion, higher rates of asthma were observed among Malays and Indians than Chinese in Singapore. These were not explainable by differences in socioeconomic status or atopy. Greater prevalence of environmental factors such as the keeping of carpets and rugs and of pet animals, smoking, and occupational exposures were found in Malays and Indians, although these factors do not entirely explain the observed ethnic differences in asthma. Other unmeasured environmental factors or genetic influences are likely to account for residual differences in the prevalence of asthma.

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