

Utilization of Healthcare Resources for Asthma in Singapore: Demographic Features and Trends

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The current emphasis on asthma in research and the healthcare communities has been associated with reports of rising trends in asthma prevalence figures and increasing rates of asthma related hospitalization, healthcare utilization and mortality. These increases have occurred despite a better understanding of asthma, and the availability of better medication and management for its treatment and control. These rising figures have prompted the formation of numerous initiatives, such as the National Heart, Lung, and Blood Institute (NHLBI)-World Health Organization Global Initiative for Asthma, the Task Force set up by the New Zealand Medical Research Council, the National Asthma Education and Prevention Program in the United States, and numerous international workshops and conferences on the etiology of asthma.¹ These organizations were aimed at improving asthma awareness and heightening priority for asthma research.

In this study, the utilization

SUMMARY This study examined the healthcare utilization patterns for asthma in Singapore, a tropical island city-state, between 1986 and 1993. Asthma was ranked fifth among principal conditions with the highest number of discharges in Singapore (2.4 discharges per 1,000 population per annum). Among the 0-14 year-olds, asthma was ranked second, only after accidents and injuries, as the condition with the highest number of discharges (5.2 per 1,000). It was estimated that there were approximately 20,000 accident and emergency (A & E) room visits for asthma per annum (7.0 visits per 1,000 population per annum). There were, however, no significant changes in the number of hospitalized or emergency room cases for asthma over the period of analysis. In the primary healthcare setting, asthma ranked 6th among the leading conditions seen by the general practitioners and government polyclinics (15 visits per 100 population per annum). Among under 15 year olds, asthma (37 visits per 100 age-adjusted population per annum) ranked as the second leading condition behind upper respiratory tract infections. This study has shown that asthma causes a significant amount of morbidity in the Singapore community.

patterns of medical resources used for the treatment and management of asthma in Singapore (hospitalization, emergency room visits, visits to general practitioners and government primary health care clinics) were evaluated. The elucidation of these trends would provide insights into the utilization patterns and distribution of healthcare resources used for asthma in a country which has experienced rapid social and economic development in the last two decades.

Asthma is a chronic condition characterized by acute and episodic attacks, and health care statistics reflect this dichotomous nature, measuring both chronicity and acute morbidity. Outpatient statistics (visits to general practitioners and government primary health care clinics) are more indicative of chronicity or

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the ongoing management of asthma, while hospital based encounters (hospitalization and emergency room visits) are more reflective of acute exacerbation events. In this study, the figures were aggregated, based on the encounters (ie. Frequency of encounters), and therefore addressed the issue of trends in disease occurrence. It does not evaluate the pattern of disease management (which would require the aggregation of more details of the encounters such as the length of stay, or type of treatment). The aim of this study was to evaluate asthma morbidity in Singapore and to examine recent trends.

MATERIALS AND METHODS

Source of data

Inpatient hospitalization

The annual number of hospitalized inpatients for asthma in Singapore between 1986 and 1993 were collated from the Research and Epidemiology Department, Ministry of Health. This data represents the utilization profile for all public and private sector hospitals in Singapore. This data was tabulated in accordance with the 57 broad causes with morbidity adapted from the ninth revision of the International Classification of Diseases.² In this listing, asthma together with bronchitis (chronic and unspecified) and emphysema (ICD 490-493), were grouped under one disease category (number 39 of List B). Nevertheless, further data from the Ministry showed that asthma (ICD 493) made-up between 91-94% of all hospitalization within this disease category annually.

Emergency room visits

Data on the number of vis-

its to emergency units of general hospitals for asthma were not available from the Ministry of Health. In Singapore, the government hospitals had been restructured in stages since 1985 and data on the principal conditions seen at the emergency units were no longer collated. For this study, data were obtained from two large general hospitals in Singapore (National University Hospital [NUH] and Singapore General Hospital [SGH]), which in combination accounted for approximately 50% of the total number of emergency room visits to all hospitals each year. At the point of collation, data on the number of A & E visits for asthma (ICD 493) from these two hospitals were only available from 1990 onwards. These data were then extrapolated to represent Singapore, based on the total number of A & E visits (all cases) per annum and the baseline population estimates obtained from the annual Yearbook of Statistics.³

The only 'hospital-based' data unavailable during the time of collation were that of the Specialist Outpatient Clinics (SOC). This data was unavailable as records of SOC attendances captured in most hospitals do not include diagnostic information. As such it was not possible to obtain the proportion of SOC attendances used for the management of asthma.

Primary health care services

The utilization pattern of primary health care services and general practitioners for the treatment and management of asthma was estimated from two Outpatient Morbidity Surveys conducted by the Ministry of Health in 1988 and 1993.^{4,5} The detailed data for asthma and bronchitis were extracted

from these surveys and collated by the Research and Epidemiology Department, Ministry of Health.

RESULTS

Inpatient hospitalization

Table 1 shows the leading causes of hospitalization in Singapore (tabulated by the number of discharges and bed-days) in 1993. Based on the number of discharges, asthma (together with bronchitis and emphysema) was ranked the fifth highest. Asthma-ICD 493 alone, accounted for 6,358 discharges [90.9%] within this disease category, translating to a hospital discharge rate of approximately 2.4 per 1,000 population and 3.6 bed-days per discharge). Among 0-14 year-olds, asthma alone (ranked 4th by bed-days and second only to accidents and injuries by discharges) accounted for 3,185 of discharges (or 93.0% within the asthma-bronchitis-emphysema category), translating to an age-adjusted hospitalization rate of approximately 5.2 per 1,000 and an average length of stay of 3.0 bed-days per admission.

Fig. 1 shows the annual hospitalization rates for asthma by the number of bed-days and number of discharges between 1986 and 1993. The overall rates fluctuated between 8.7 - 10.6 bed-days per 1,000 population and 2.4 - 2.9 discharges per 1,000 population over this period. No significant change in the proportion of bed-days utilized for asthma over the period of analysis was observed (χ^2 for trends = 3.12; $p > 0.05$). However, a slightly increasing trend was observed among Malays when the data were tabulated according to racial groups (Fig. 2). When analyzed by the number of discharges,

Table 1 The leading causes of hospitalization in all hospitals with the highest number of discharges and bed-days in Singapore in 1993

Disease condition*	n	%	rates‡	Disease condition*	n	%	rates‡
<u>All ages</u>				<u>Below 15 years</u>			
Leading causes of hospitalization with the highest number of discharges							
Total	337,926†	100	11,759	Total	61,449†	100	9,268
Accidents and injuries	30,445	9.0	1,059	Accidents and injuries	3,872	6.3	584
Heart diseases	18,024	5.3	627	Bronchitis, emphysema, asthma	3,426	5.6	517
Cancer	16,754	5.0	583	Congenital anomalies	3,121	5.1	470
Pregnancy related complications	12,124	3.6	422	Intestinal infections	2,658	4.3	401
Bronchitis, emphysema, asthma	6,991	2.1	243	Other perinatal conditions	2,590	4.2	391
Pneumonia	6,179	1.8	215	Acute bronchitis and bronchiolitis	2,313	3.8	349
Cerebrovascular diseases	5,751	1.7	200	Acute upper respiratory tract infections	2,146	3.5	324
Benign neoplasms	5,738	1.7	200	Pneumonia	2,134	3.5	322
Intestinal infections	5,170	1.5	180	Non-infective enteritis and colitis	1,874	3.0	283
Congenital anomalies	4,478	1.3	156	Non-specific viral infections	1,647	2.7	248
<u>All ages</u>				<u>Below 15 years</u>			
Leading causes of hospitalization with the highest number of bed-days							
Total	2,126,620†	100		Total	250,474†	100	
Schizophrenia	272,408	12.8		Congenital anomalies	19,816	7.9	
Cancer	163,104	7.7		Other perinatal conditions	11,277	4.5	
Accidents and injuries	161,500	7.6		Accidents and injuries	11,213	4.5	
Heart diseases	131,743	6.2		Bronchitis, emphysema, asthma	10,395	4.2	
Cerebrovascular diseases	91,879	4.3		Pneumonia	10,391	4.1	
Pneumonia	46,632	2.2		Hypoxia, birth asphyxia and other respiratory conditions	10,256	4.1	
Pregnancy related complications	40,153	1.9		Acute bronchitis and bronchiolitis	9,525	3.8	
Diabetes mellitus	31,498	1.5		Intestinal infections	8,359	3.3	
Congenital anomalies	28,392	1.3		Cancer	6,393	2.6	
Benign anomalies	28,272	1.3		Acute upper respiratory tract infections	5,709	2.3	
Bronchitis, emphysema, asthma ranked 11th	25,079	1.2					

*Excludes ill-defined and non-disease entities such as legally induced abortion, normal and assisted delivery, prematurity, physiological jaundice in the newborn and contact with health services.

†Excluding unknown disease conditions.

‡per 100,000 population (age adjusted rates for those below 15 year olds).

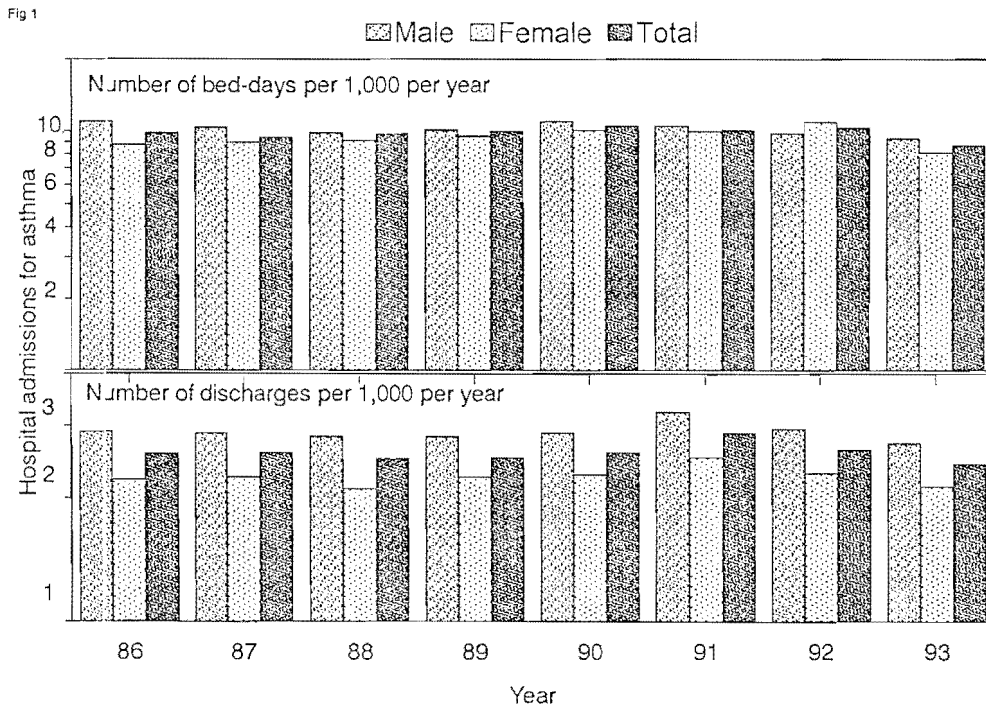


Fig. 1 Annual hospitalization rates for asthma by the number of bed-days (per 1,000 population) and by the number of discharges (per 1,000) between 1986 and 1993 tabulated according to sex. No significant change in the proportion of bed-days utilized for asthma or by the number of discharges over the period of analysis was observed.

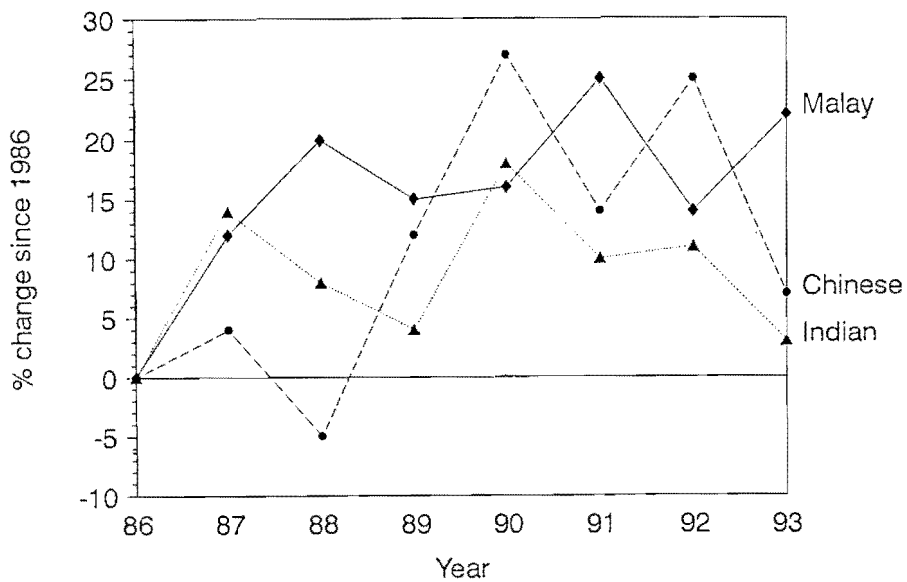


Fig. 2 Percent change in the annual hospitalization rates for asthma (racially adjusted) by the number of bed-days (per 1,000) compared with the 1986 baseline figure according to the three main racial groups in Singapore.

Table 2 Hospitalization rates (by the number of bed-days or discharges) per 100 current asthmatic per year

	Asthma hospitalization rates (per 1,000 population)*	Current prevalence	Calculation	Hospitalization rates per 100 current asthmatic per annum	Adult:child difference
Number of bed-days					
Children	mean 18 per 1,000	11.6%†	$\frac{(18/1,000) \times 100}{(11.6/100)}$	15.5 bed-days per 100 current asthmatic per year	
Adults	mean 7.4 per 1,000	2.2%‡	$\frac{(7.4/1,000) \times 100}{(2.2/100)}$	33.6 bed-days per 100 current asthmatic per year	2.2 x
Number of discharges					
Children	mean 5.7 per 1,000	11.6%†	$\frac{(5.8/1,000) \times 100}{(11.6/100)}$	4.9 discharges per 100 current asthmatic per year	
Adults	mean 1.7 per 1,000	2.2%‡	$\frac{(1.7/1,000) \times 100}{(2.2/100)}$	7.7 discharges per 100 current asthmatic per year	1.6 x

*mean hospitalization rates for asthma between 1990-1993.

†Based on the adult survey by Ng *et al.*, 1994 (6).

‡Based on the childhood survey by Goh *et al.*, 1996 (7).

Table 3 Crude comparison between asthma prevalence and hospitalization rates (by the number of discharges) in a representative five countries from different regions with the rates in Singapore

Country	Current prevalence	Hospitalization rate (per 1,000 population)	Calculations	Estimated hospitalization rate (per 1,000 current asthmatic)
Fiji	20.6% current wheeze for both Fijian and Indian children aged 5-14 years ⁸	1.68 (Indian children) and 0.56 (Fijian children) in 1993 ⁸	cur. $(1.68/20.6) \times 100$ for Indian children; and cur. $(0.56/20.6) \times 100$ for Fijian children	8.2 for Indian children 2.7 for Fijian children
Hong Kong	15.3% among young adults (16-26 years old) in 1989 ¹⁰	0.967 (males) and 0.693 (females) in 1985 ¹¹ (mean = cur. 0.83 per 1,000)	cur. $(0.83/15.3) \times 100$	5.4
US	5.26% among 5-34 year-olds in 1992 ¹²	1.25 in 1992 ¹²	cur. $(1.25/5.26) \times 100$	23.8
Denmark	3.2 whole population in 1979 ¹³	1.6 in 1979 ¹³	cur. $(1.6/3.2) \times 100$	50.0
Singapore	11.6% among children in 1994 ⁶ and 2.2% among adults in 1992 ⁷	5.7 (children) and 1.7 (adults) in 1993 (current study)	cur. $(5.7/11.6) \times 100$ for children; and cur. $(1.7/2.2) \times 100$ for adults.	49.1 for children 77.3 for adults.
Canada	3.3% (children) in British Columbia and 7.4% (children) in Nova Scotia and Prince Edward Island, 1993 ¹⁴	3.96 (children) in British Columbia and 8.0 (children) in Nova Scotia and Prince Edward Island, 1993 ¹⁴	cur. $(3.96/3.3) \times 100$ in British Columbia; and cur. $(8.0/7.4) \times 100$ in Nova Scotia and Prince Edward Island	120.0 in British Columbia 108.1 in Nova Scotia and Prince Edward Island

Table 4 Hospitalization rates (by the number of bed-days or discharges) per 100 current asthmatic per year tabulated by sex

	Asthma hospitalization rates per 1,000 population*	M:F	Current prevalence	Calculation	Hospitalization rates per 100 current asthmatic per annum	M:F
Number of discharges						
Male	2.9 per 1,000	1.26 x	(12.8%† x 0.3†) + (2.4%** x 0.7†) = 5.5%	$\frac{(2.9/1,000) \times 100}{(5.5/100)}$	5.27 discharges per 100 current asthmatic per year	1.03 x
Female	2.3 per 1,000		(10.2%† x 0.3†) + (2.0%** x 0.7†) = 4.5%	$\frac{(2.3/1,000) \times 100}{(4.5/100)}$	5.11 discharges per 100 current asthmatic per year	
Number of bed-days						
Male	0.2 per 1,000	1.06x	5.5%	$\frac{(0.2/1,000) \times 100}{(5.5/100)}$	18.55 bed-days per 100 current asthmatic per year	0.87x
Female	9.6 per 1,000		4.5%	$\frac{(9.6/1,000) \times 100}{(4.5/100)}$	21.33 bed-days per 100 current asthmatic per year	

*mean hospitalization rates for asthma between 1990-1993.

†Based on the Census of Population, 1990 when 70% of the population is aged 20 years old or above.

‡Based on the childhood survey by Goh *et al.*, 1996 (7).

**Based on the adult survey by Ng *et al.*, 1994 (6).

however, no significant change in the annual hospitalization rates was observed. When hospitalization figures were tabulated by the major ethnic groups in Singapore, asthma ranked higher in Malays and Indians compared with Chinese (comparative data not shown). Among the Chinese, asthma comprised between 0.8-1% of the total number of bed-days utilized annually. In contrast, this disease made up between 2.0-2.6% of the total number of bed-days utilized annually among the Malays and Indian, and has constantly ranked among the top 10 leading cause of hospitalization with the highest number of bed-days.

Hospitalization rates per current asthmatic

Table 2 shows the hospitalization rates (by number of bed-

days and discharges) per 100 current asthmatic per annum. Based on the hospitalization rates obtained and current prevalence figures for children⁶ and adults,⁷ it was calculated that current adult asthmatics utilized approximately 2.2 times more bed-days per asthmatic individual than childhood asthmatics. Similarly, there were 1.6 times more hospital discharges for asthma per current adult asthmatic compared to child asthmatics. This suggests that current adult asthmatics have a higher rate of hospitalization for their condition per asthmatic individual compared with child asthmatics. The data also suggests that adult asthmatics stay hospitalized longer per admission (or discharge). The figures, 7.7 discharges per 100 adult asthmatic per year and 33.6 bed-days per 100 adult

asthmatic per year, would translate crudely to 4.4 bed-days per adult asthma hospital admission. In comparison, the childhood figures translated to 3.2 bed-days per child admission.

Table 3 shows the hospitalization rates for asthma of six representative countries from different regions around the world compared with Singapore. Singapore was found to have comparatively high hospitalization rates, whether expressed as per 1,000 population or per 1,000 current asthmatic.

Table 4 compares the hospitalization rates between the two sexes (see column 2). The results showed that males have 1.26 times higher asthma admissions rate (per 1,000 population) than females. This difference may be due to the

Table 5 Leading disease conditions seen in private general practitioner clinics and government primary health care clinics in Singapore in 1988 and 1993

<u>All ages</u>			<u>Below 15 years*</u>		
<u>Disease condition</u>	<u>n†</u>	<u>%</u>	<u>Disease condition</u>	<u>n†</u>	<u>%</u>
1988			1988		
Total (in 1,000s)	11,827‡	100	Total (in 1,000s)	2,818‡	100
Upper respiratory tract infections	3,742	31.6	Upper respiratory tract infections	1,888	51.3
Hypertension	743	6.3	Asthma and bronchitis	286	7.8
Arthritis conditions and rheumatism	678	5.7	Diarrheal diseases	230	6.2
Skin disorders	629	5.3	Skin disorders	174	4.7
Diarrheal diseases	559	4.7	Chicken pox	40	1.1
Asthma and bronchitis	468	4.0			
Diabetes mellitus	359	3.0			
Gastritis	280	2.4			
Conditions of female genital tract	253	2.1			
Conjunctivitis	172	1.5			
1993			1993		
Total (in 1,000s)	14,884‡	100	Total (in 1,000s)	3,680‡	100
Upper respiratory tract infections	5,397	36.3	Upper respiratory tract infections	1,940	52.7
Hypertension	885	5.9	Asthma and bronchitis	292	7.9
Arthritis conditions and rheumatism	808	5.4	Diarrheal diseases	204	5.5
Skin disorders	798	5.4	Skin disorders	162	4.4
Diarrheal diseases	794	5.3	Chicken pox	62	1.7
Asthma and bronchitis	532	3.6			
Diabetes mellitus	473	3.2			
Gastritis	342	2.3			
Conditions of female genital tract	270	1.8			
Conjunctivitis	203	1.4			

*For the under 14 year old, only the top five conditions are shown.

†Figures in 1,000s.

‡Figures exclude non-morbid conditions.

underlying prevalence as the rate of asthma hospitalization per 100 current asthmatic seems to be the same for both sexes (Table 4, column 6). In a different context, it was noted that although the admission figures for asthma seem slightly higher among males, the data indicated that female asthmatics had utilized a slightly higher number of bed-days per current asthmatic. If this index (utilization of hospital bed-days) could be used as a rough surrogate indicating severity, then female asthmatics seem to have more severe attacks requiring longer hospitalization. The rate for females was approximately 1.15 times

greater than males. Similarly, the data showed that female asthmatics stayed an average of 4.17 bed-days per hospital admission (discharge) per annum (21.3 bed-days/5.11 discharges) compared to 3.52 bed-days per asthma admission among male asthmatics (18.55 bed-days/5.27 discharges).

Emergency room visits

The principal conditions seen at the emergency units of general hospitals were not ranked as the data were not collated according to disease conditions. Nevertheless, data from NUH and SGH showed

that there were more than 9,000 asthma-related emergency room visits in total annually at these two general hospitals (approximately 4% of the total number of A & E visits per annum). When extrapolated to represent the whole of Singapore, it was estimated that there were approximately 20,000 A & E visits for asthma in 1993, translating to an overall rate of close to 7.0 visits per 1,000 population.

Fig. 3 shows the estimated annual emergency room visit rates for asthma (per 1,000 population) between 1990-1994. Over the 5

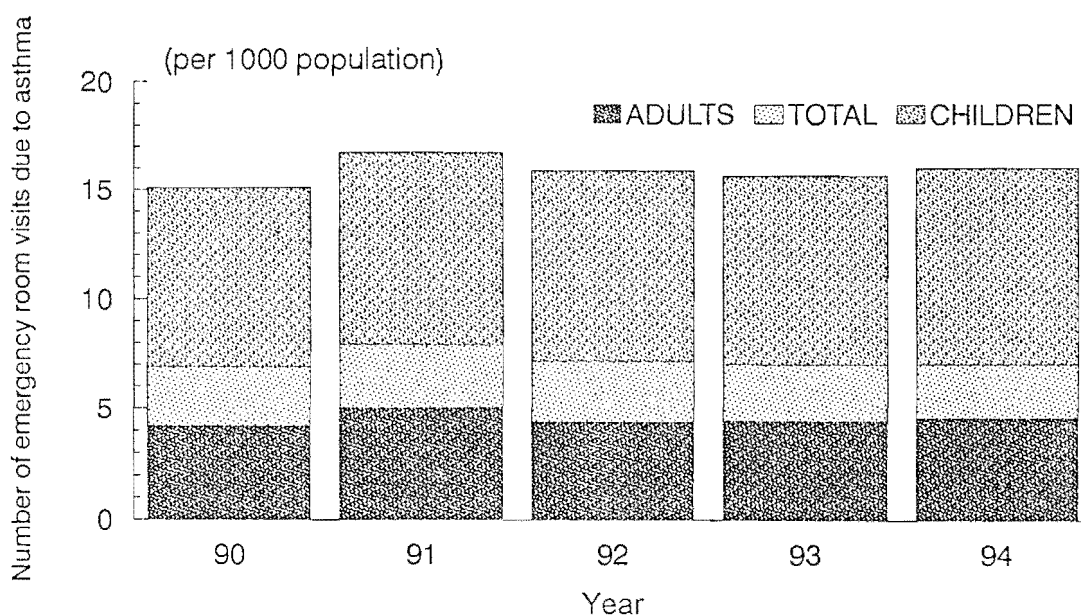


Fig. 3 Estimated annual emergency room visit rates for asthma (per 1,000) between 1990-1994. No significant change in the annual number of emergency room visits was observed.

years of analysis, the A & E visit rates averaged approximately 4.6 visits per 1,000 population for adults and 15.8 per 1,000 for children 14 years old and below. No significant change in the annual number of emergency room visits was observed.

Primary health care services

The leading disease conditions seen in private general practitioner and government primary healthcare clinics based on the Morbidity Survey of Outpatients, in 1988 and 1993^{4,5} are shown in Table 5. 'Asthma and bronchitis' as a disease category ranked 6th in both surveys. Among the under-15 year-olds, 'asthma and bronchitis' ranked second behind upper respiratory tract infections in both surveys. Asthma (ICD 493) alone accounted for approximately 431,000 outpatient visits overall (81.0% of the total within the asthma-bronchitis

category) and 244,000 visits within the under 15 year-old age group (83.6% of the disease category). This would translate to an outpatient attendance rate of approximately 15 visits per 100 population overall in 1993 and an age-adjusted rate of 37 visits per 100 population for the 0-14 year olds.

When tabulated by sex and age, both surveys also showed that there were higher rates of outpatient attendances for asthma among males than females (comparative data not shown). Similarly, when analyzed by ethnic group, asthma was ranked lower, in proportion to other disease conditions, among Chinese compared with Malays and Indians. Further, the proportion of outpatient attendances for asthma among Chinese and Indians fell between 1988 and 1993 (3.9% vs 3.2% and 6.7% vs 4.8%, respectively) but there was an increase in

the proportion among Malays (4.1% vs 5.1%).

DISCUSSION

Asthma has consistently ranked as the fifth or sixth principal condition with the highest number of discharges in Singapore, and second or third among children (0-14 years old). Higher hospitalization rates and outpatient attendances were observed among children compared with adults, suggesting that higher morbidity and a greater need for disease management exist among children. These figures however probably reflect more closely higher prevalence rates among children rather than greater morbidity.^{6,7,15} Although the indices of morbidity per thousand population were higher among children, the data showed that adult asthmatics *per se* suffering higher frequencies of acute exacerbations per asthmatic individual.

Various studies following cohorts of asthmatics into adulthood reported that approximately half the children with asthma may cease to have any symptoms by the time they reach adolescence.¹⁶⁻¹⁸ However, others have also shown that about a fifth of these may develop other allergic problems¹⁹ or a relapse of symptoms may occur particularly in severe cases.²⁰ One probable reason why current adult asthmatics may have higher morbidity per asthmatic individual compared to children, is that adult asthmatics with persistent symptoms since childhood are usually those with other concurrent atopic conditions²¹ and this has been shown to be associated with increased morbidity.²² Similarly, those with severe asthma during childhood or those who have frequent attacks, chronic bronchitis, and impaired lung function have been shown in other studies to be the ones more likely to have symptoms persisting into adulthood.²³ Studies have also shown that these same circumstances are the risk factors for increased severity of symptoms in adult asthma.^{22,24}

Male asthmatics were found to have a 1.3 times higher asthma admissions rate (per 1,000 population) than females. This difference was also reflected in the number of outpatient attendances for asthma. These differences, however, may again just be due to the underlying prevalence rates, as the rates of asthma hospitalization per 100 current asthmatic seem to be the same for both sexes. All three childhood asthma surveys in Singapore showed that male children had higher prevalence rates compared with females.^{6,25-26} Various studies have shown that childhood asthma tends to occur more frequently

in boys than girls, with the male:female ratio approaching 2:1 particularly in younger children.^{27,28} This trend however gradually changes, the prevalence in girls tends to equal or exceed boys during adolescence and this sex difference is usually not seen in adulthood.²⁹ In Singapore, a similar natural history may be occurring with respect to the discordance in asthma prevalence rates between sexes, as no significant difference was found between the prevalence of asthma in male and female adult in both adults surveys 25 years apart.^{7,26}

On the other hand, this current study also showed that adult female asthmatics utilized a slightly higher number of bed-days per current asthmatic than their male counterparts. Female asthmatics seem to have more severe attacks requiring longer hospitalization. In most studies in asthmatic adults, the male:female ratio skews toward the females. Hospitalization and morbidity rates in adults, particularly among those aged 40 years and above are significantly higher in women than in men. Further, studies elsewhere have shown that the proportion of women with current complaint and greater symptom scores in adulthood is higher than in men, and the prognosis for women is usually worse than it is for men.³⁰⁻³² The reasons for the differences between the sexes is surprisingly still unknown but various hypotheses have been postulated, such as, hormonal differences,³³ differences in the rate of lung growth or rate of pulmonary function deterioration, and airway diameter, parenchymal and lung size differences between the sexes.³⁴

If hospital admission rates could be used as indices for asthma

severity, then the data suggest that the Malay and Indian ethnic groups have more frequent severe asthma compared to Chinese as reflected in the higher hospital admission rates. Asthma has also consistently been ranked as the 4th leading condition among Malays and Indians with the highest number hospital discharges compared to the 6th - 8th position among Chinese. Within these two ethnic groups also, the proportion of asthma admissions (ICD 493) to emphysema and bronchitis admission figures seems to be higher than that of the Chinese (data not shown). These two ethnic groups also exhibited higher outpatient attendance rates for the management of asthma. The data suggest that these higher admission rates may be a result of higher prevalence figures among these racial groups. Epidemiological surveys have shown that Malays and Indians had a significantly higher prevalence of asthma compared to the Chinese.⁷ On the other hand, our data among children⁶ showed that Indians and Malays had more severe asthma compared to Chinese, in terms of the frequency of attacks and the presence of speech limiting symptoms. This suggests that their increased hospitalization rates may reflect this increased severity and not just higher prevalence.

Poverty and socio-economic factors have been attributed as possible reasons for racial differences in both disease morbidity and prevalence rates. Many countries have reported that higher morbidity and mortality rates tend to cluster in poorer communities³⁵ and racial differences in many instances could be explained or nullified if one controls for income levels or socio-economic status.³⁶ Nevertheless, some studies

have attributed other reasons, such as a difference in health care utilization patterns and access among races³⁷ and different lung capacity³⁸ as possible explanations for these racial variations. In Singapore, previous work has shown that Malay and Indian children inherently have smaller airways and this may play a role in the racial asthma prevalence and severity differences.³⁹

Other lifestyle and behavioral risk factors have also been associated with increased asthma morbidity. In Singapore, several lifestyle/behavioral risk factors have also been identified.⁴⁰⁻⁴² These include the keeping of pets (cats, dogs and birds), the use of rugs and carpets, smoking and high risk occupations. The 1992 adult asthma prevalence study reported that these environmental factors, in particular smoking and rearing of pets, were in-part responsible for ethnic differences in the prevalence of asthma.⁷

Asthma hospitalization has been reported to have increased between threefold to ten-fold over the last one or two decades in some countries.^{43,44} In Singapore, however, there was no significant increase in the number of bed-days utilized for asthma or the number of discharges in the last one decade. There was also no significant increase in the overall annual rates of emergency room visits over the period of analysis. The number of outpatient attendances for asthma however increased by 24% in five years. Taken together, the data suggest that the severity of the disease may not have increased markedly in Singapore over the past 10 years, despite an increase in prevalence. Except for occasional increases

in hospitalization and emergency room visits experienced at particular points of time, for example, during the incidence of 'haze' and air pollution,^{45,46} the annual hospital admission figures for asthma in Singapore remained relatively stable during the period of analysis.

Hospital admission figures for asthma have been reported to have increased despite the increase in use of anti-asthmatic medication.⁴⁷ This suggests either that such therapy is ineffective or may even have compounded the problem, or that asthma has increased in severity for other reasons. The use of asthma medication in Singapore was also observed to have increased over the same period.⁴⁸ We have previously reported that there was a diminishing use of theophyllines in Singapore and this was in accordance with trends elsewhere. This was likely to have arisen from concerns about the adverse effects and clinical efficacy of theophylline.⁴⁹ There is, however, a recent trend towards the reintroduction of theophylline into the therapeutic plan for additional control of symptoms when aerosol therapy with beta₂-agonists and corticosteroids are insufficient⁵⁰ and this was again reflected in the most recent drug usage trends (unpublished). However, despite increased asthma drug usage, reflecting increased management, our hospitalization rates have remained relatively high.

In summary, asthma causes a significant amount of morbidity in the Singapore community and has been ranked among the leading causes of hospitalization, particularly among children. It is also among the principal conditions, with the highest number of outpatient

attendances. The evidence collected over the last few years, however, suggests that asthma severity, as judged by the hospital admission data, may not have increased markedly in Singapore, despite an increase in prevalence, unlike the manifold increases reported elsewhere. Nevertheless, although our overall hospitalization rates may have remained relatively stable, they were relatively higher compared with most other nations. A closer look at our asthma management system and also elucidation of the risk factors for increased morbidity and the trigger factors of acute exacerbations may help reduce the burden caused by this disease.

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