
Trends and ethnic differences in asthma hospitalization rates in Singapore, 1991 to 1998

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Background: A few reports have indicated that asthma hospitalization rates in several countries have stopped rising or started falling in the 1990s.

Aim: To describe recent trends and ethnic differences in asthma hospitalization rates in Singapore from 1991 to 1998.

Methods: Asthma hospitalization rates in all hospitals were analyzed by age groups, sex, ethnicity, and individual years, using aggregated data for asthma (ICD-9 493 and ICD-10 J45, J46) from 1991 to 1998, when nationwide data from the Central Claims Processing System were available.

Results: Between 1991 and 1998 there were a total of 37,615 hospital admissions for asthma, giving an annual average rate of 17.1 hospital admissions per 10,000 persons. Overall, the rates of asthma hospitalization fell by 28% from 21.7 per 10,000 in 1991 to 15.4 per 10,000 in 1998 (3.5% annually). The trends were broadly based across all age, sex, and ethnic groups. Hospitalizations were more common in boys than in girls aged 0 to 4 (male/female ratio 1.69), but less common in men than women aged 35 to 64 (male/female ratio 0.81). Rates of asthma hospital admissions were higher in Malays (32.8 per 10,000) and Indians (40.8 per 10,000) than Chinese (11.9 per 10,000).

Conclusions: In line with findings from several countries, there have been recent declines in rates of hospital admissions for asthma in Singapore in the 1990s. The declines were broadly based across all population subgroups and parallel previously observed declines in mortality in adults. However, considerable ethnic differences in levels of asthma hospitalization still exist.

Ann Allergy Asthma Immunol 2003;90:51–55.

INTRODUCTION

Studies of asthma trends in the 1970s and 1980s have widely reported progressive increases in hospitalization and mortality, especially for childhood asthma.^{1–4} Concern about rising asthma morbidity and mortality in many countries has led to the consequent development and dissemination of practice guidelines to improve asthma care. However, the effect of population-based asthma control programs, typified by national asthma campaigns, is still uncertain.⁵ Reports of changing patterns of asthma hospitalizations in the 1990s are limited. These have indicated that hospital admission rates for asthma in several places, including Scotland,⁶ the Netherlands,⁷ New Zealand,⁸ and California,⁹ have stopped rising or started falling.

The prevalence of asthma in the multiethnic population of Singapore (3 million population, comprising Chinese 77%, Malays 14%, and Indians 8%) has been determined in previous studies. It is 20% in children (aged <15 years),¹⁰ and 2.2% in adults (2.4% in men and 2.0% in women¹¹) and varies greatly among the three ethnic groups. The reported *adult* prevalence is 0.9% in Chinese, 4.5% in Indians, and 3.3% in Malays. The ethnic differences in asthma prevalence are also reflected in differences in asthma mortality.¹² Previ-

ous data on asthma trends were limited to examining long-term mortality trends from 1976 to 1995¹³; these suggest that asthma mortality in children aged 5 to 14 years had risen from 0.21 per 100,000/year to 0.72 per 100,000/year. No increase in mortality were noted in the other age groups, but a dip in the most recent 5-year period, 1991 to 1995, was detected in adults in the 35-to-59-year-old age group. Asthma mortality, nevertheless, provides limited information to evaluate trends in asthma morbidity and quality of care, because mortality, especially in younger age groups, concerns relatively small number of deaths among the most severe asthma cases which may often be attributable to factors extrinsic to clinical care. There has been no previous report of hospitalization data to describe ethnic differences and recent trends in asthma morbidity in the 1990s. During this period, evidence-based practice guidelines were widely implemented for improving asthma care in the population.

We have examined nationwide data on asthma hospitalization in the multiethnic population of Singapore, and in this report, we describe recent trends and ethnic differences in asthma hospitalization rates from 1991 to 1998.

METHODS

Asthma hospitalization rates were calculated based on aggregated nationwide data on annual hospital admissions in Singapore from 1991 to 1998. The source of data was the national database of the Central Claims Processing System in the Ministry of Health, which began operation in 1991 to facilitate claims for hospital charges from all public and private hospitals. Diagnoses at discharge were coded using

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Received for publication February 4, 2002.

Accepted for publication in revised form April 8, 2002.

Table 1. Asthma Hospitalization Rates and Adjusted Rate Ratios, Singapore, 1991–1998

Characteristics	Number of asthma hospitalizations	Hospitalization rate/10,000/yr*	Rate ratio (95% CI)†
Overall	37,615	17.1	
Gender†			
Females	16,632	15.4	1.00
Males	20,983	18.7	1.21 (1.14–1.28)
Age groups			
<5 years	8,910	46.8	1.00
5–14 years	11,049	32.2	0.69 (0.64–0.74)
15–34 years	6,381	8.0	0.17 (0.16–0.19)
35–64 years	11,275	13.2	0.28 (0.26–0.31)
Ethnicity‡			
Chinese	19,811	11.9	1.00
Malays	11,151	32.8	2.68 (2.51–2.87)
Indians	6,653	40.8	3.39 (3.14–3.67)

* Annual age and sex standardized rates per 10,000-population.

† Adjusted for age, gender, and ethnicity in Poisson regression models.

‡ All statistically significant at $P < 0.01$.

CI, confidence interval.

the International Classification of Disease-Clinical Modification (ICD-9 CM, ICD-10CM). The extracted data for the population were aggregated by sex, ethnicity, and calendar years from 1991 to 1998. Annual numbers of hospital admissions for asthma (ICD-9:493, ICD-10:J45, J46) were obtained for the period from 1991 to 1999, separately for each sex, and in 5-year age groups from 0 to 4, 5 to 9, etc.

Midyear population estimates for the same sex, ethnic, and 5-year age groups were obtained from census data in the Department of Statistics.

We calculated sex and age-specific rates for the clinically relevant age groups: 0 to 4, 5 to 14, 15 to 34, and 35 to 64. The primary attention of the analysis are the age groups of 5 to 14 and 15 to 34 years, in which the diagnostic labeling and coding are subject to less errors. In those under the age of 5 years, the diagnosis is rather less certain as it may be confused with acute bronchiolitis. In older persons and in the elderly, asthma may coexist with or be confused with chronic obstructive airways diseases and emphysema. It has previously been shown that the accuracy of certification of asthma diagnosis was highest at 98.6% among persons aged 15 to 34 years, declining with increasing age, and was <70% in those aged 65 years or more.¹⁴

Rates were age-standardized by the direct method, using the 1991 population estimates as standard population. Percentage changes in asthma hospitalization rates were calculated using regression techniques. Rate ratios and 95% confidence intervals (CI), adjusted for sex, age, ethnicity, and calendar year, were calculated by Poisson regression modeling techniques, using generalized linear model (GENMOD) procedure in the SAS package of statistical programs (SAS, Cary, NC).

RESULTS

Between 1991 and 1998 there were a total of 37,615 hospital admissions for asthma in Singapore, giving an annual average rate of 17.1 hospital admissions per 10,000 population (Table 1). As expected, asthma hospital admission rates were greater (approximately 20%) in males than in females, although the male preponderance was greatest in children and reversed to a female preponderance in adults (Fig 1). The male/female ratio was 1.69 (95% CI 1.49 to 1.91) in children aged 0 to 4 years, and 0.81 (95% CI 0.73 to 0.90) in adults aged 35 to 64

Rates per 10000-population

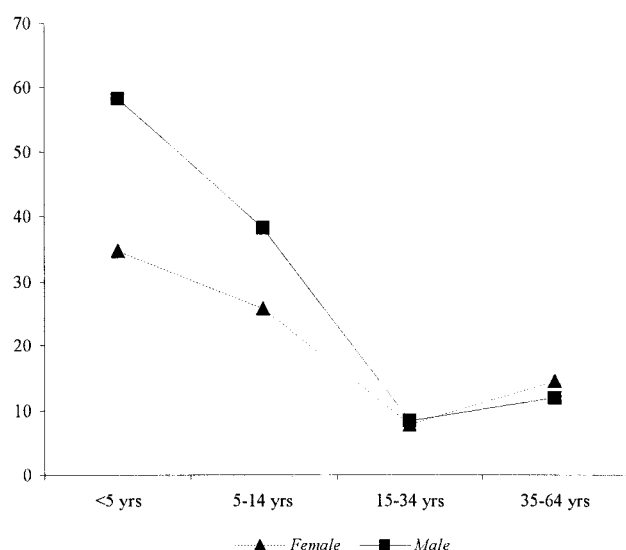


Figure 1. Asthma hospitalization rates by age groups and gender in Singapore, 1991 to 1998.

Table 2. Trends in Asthma Hospitalization Rates by Age Group, Gender, and Ethnicity, Singapore, 1991–1998

Characteristics	1991 hospitalization rate/10,000	1998 hospitalization rate/10,000	% change from 1991 to 1998*
Overall	21.7	15.4	–28.1
Gender†			
Females	19.1	14.2	–23.8
Males	24.2	16.6	–31.3
Age groups			
<5 years	63.0	42.2	–32.3
5–14 years	41.3	27.1	–33.6
15–34 years	9.0	7.5	–16.1
35–64 years	16.9	12.4	–25.7
Ethnicity‡			
Chinese	16.0	9.9	–35.9
Malays	38.3	32.0	–17.5
Indians	50.6	38.4	–26.0

* All statistically significant at $P < 0.01$; percentage changes were calculated from regression estimates.

† Adjusted for age, gender, and ethnicity in Poisson regression models.

‡ All statistically significant at $P < 0.01$.

Rates per 10000-population

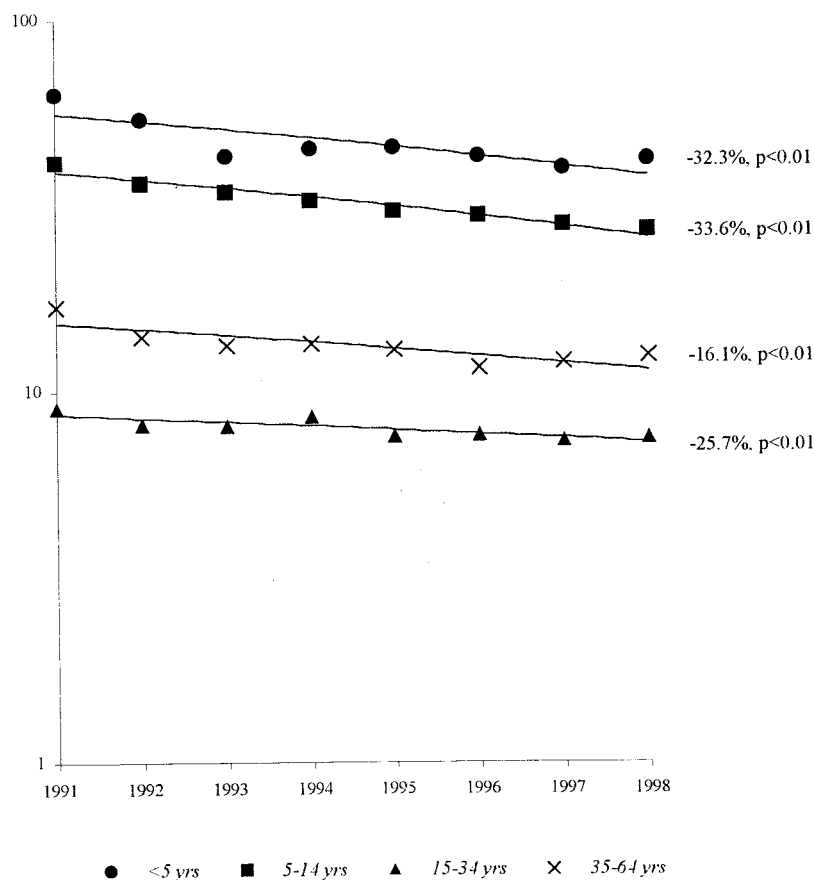


Figure 2. Trends in asthma hospitalization rates by age groups in Singapore from 1991 to 1998. Total percentage declines from 1991 to 1998 were calculated from regression estimates.

Total percentage decline from 1991 to 1998 were calculated from regression

years. Rates of hospital admission for asthma were greatest in children <5 years of age (46.8 per 10,000/year), and decreasing with increasing age to their lowest level in those aged 15 to 34 years (8.0 per 10,000/year).

There was a two- to fourfold difference in rates of asthma hospital admissions among the ethnic groups. The rates of asthma hospital admissions were higher in Malays (32.8 per 10,000/year) and Indians (40.8 per 10,000/year) than Chinese (11.9 per 10,000/year).

Overall, the rates of asthma hospitalization fell by 28% from 21.7 per 10,000 in 1991 to 15.4 per 10,000 in 1998 (3.5% annually; Table 2, Fig 2). The trends were broadly based across all population subgroups. The declines in asthma hospitalization, however, appeared to be greater in males and in children (Fig 2), groups showing higher levels of asthma hospitalization overall. However, Malays and Indians, who also had higher levels of hospitalization, did not

appear to show as much decline as their Chinese counterparts, who showed the greatest declines (36%; Fig 3).

DISCUSSION

The declining pattern of hospital admissions found elsewhere in several countries in the late 1980s and 1990s was also observed in Singapore in the 1990s. The patterns of changes, however, were not uniformly the same in different countries. In Scotland,⁶ the declines occurred only in children younger than 15 years old after 1992, whereas in adults, admissions have continued increasing. In the Netherlands,⁷ hospital admissions for asthma showed a decrease in all age groups except in children <5 years, and that rate continued to increase in the 1990s. In New Zealand,⁸ the declines were broadbased, including both children and young adults, and parallel similar falling rates in asthma mortality. National asthma surveillance data of the United States showed no

Rates* per 10000-population (Log scale)

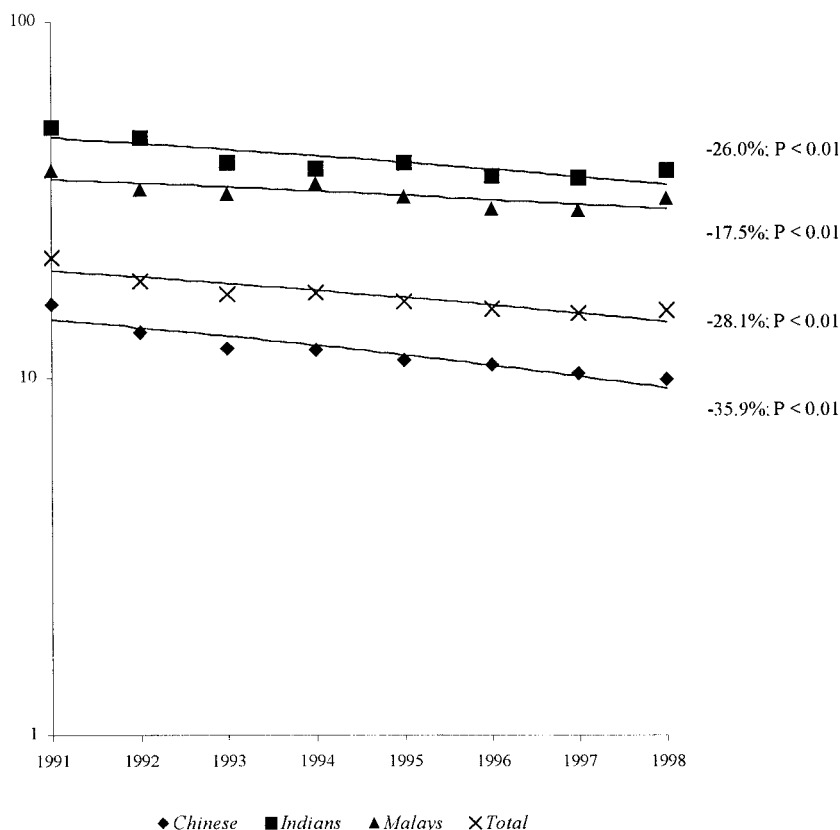


Figure 3. Trends in asthma hospitalization rates by ethnicity in Singapore from 1991 to 1998. Rates were standardized for gender and age. Total percentage declines from 1991 to 1998 were calculated from regression estimates.

*Rates were standardized for gender and age:
Total percentage decline from 1991 to 1998 were calculated from regression estimates

significant changes overall in asthma hospitalization rates between 1979 and 1994. However, the rates have increased in some regions and decreased in others.¹⁵ In California,⁹ the rates of hospitalization for Caucasian children decreased by one-third, whereas rates increased for Hispanics and Asians and remained the same for African-American children. In Singapore, as in New Zealand, the pattern of falling rates was also generally broadbased, involving all age and ethnic groups. They also parallel a preliminary observation of a decline in asthma mortality in adults reported in our previous study.¹³

In the present study, the trends for children aged 0 to 4 years need to be interpreted with some caution. There was a corresponding rise in hospitalization rates for acute bronchitis/bronchiolitis from 45.5 per 10,000 in 1991 to 100.4 per 10,000 in 1998. It is therefore possible that the fall in asthma hospitalizations in this age range is at least partly explained by diagnostic transfer. In contrast, the trends in the older age range from 5 to 64 years appear unlikely to be explained by diagnostic transfer.

Apart from this, whether the falling rates of asthma hospital admissions in Singapore can be attributed to the effects of population-based programs to improve asthma care is arguable. Hospital admissions include both first admissions and readmissions. Falling patterns of asthma admissions may reflect a change in the prevalence and severity of asthma and better primary preventive treatment, which reduces first admissions, or improved hospital management of severe asthma in reducing readmissions and changes in the delivery of care, including hospital admission and readmission policies. In our study, we were only able to analyze grouped hospitalization events rather than individual histories of first and subsequent readmissions. Using patient-linked hospital data to analyze separately trends for first admissions and readmissions may help to point toward the quality of primary preventive and hospital-based care, but more refined testing of these hypotheses requires detailed investigations and measurements of case severity and practice patterns. Such investigations are scarce, but a limited amount of evidence has ascribed stable

rates for asthma admissions in children to changes in admission thresholds in pediatric hospitals.¹⁶

Our results confirm previous findings that boys are almost twice as likely to be hospitalized for asthma as girls,² but women are more likely to be hospitalized than men.^{3,4} Paradoxically the prevalence of asthma is higher in men. This has also been observed in other studies.^{2,3,17}

Our findings of ethnic differences in asthma have also been observed elsewhere.⁴ They are also consistent with our previous observations of higher rates of asthma prevalence, morbidity, and mortality in Malays and Indians. The plausible causes have previously been discussed,¹² and they include greater exposures to airborne allergens from keeping rugs or carpets and pet cats, dogs, or birds. Although Malays had lower reported prevalence of asthma compared with Indians, they were more likely to experience greater severity of symptoms, but make less use of emergency room services, which may explain a lower rate of hospitalization but much higher mortality.¹² The converse seemed to be true for Indians. The slightly differing ethnic trends in asthma hospitalization suggest that groups in greatest need for asthma care were not benefiting more from asthma care programs and warrant further investigation.

CONCLUSION

In line with findings from several countries, there have been recent declines in rates of hospital admissions for asthma in Singapore in the 1990s. The declines were broadly based across all age and ethnic groups and parallel previously observed declines in mortality in adults. Considerable sex, age, and ethnic variations in levels of asthma hospitalization remain, and further investigations are required to understand influencing factors in clinical care.

ACKNOWLEDGMENT

This study was made possible by a research grant from the National Medical Research Council in Singapore.

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