Temporal trends and ethnic variations in asthma mortality in Singapore, 1976–1995

T P Ng, Wan C Tan

Abstract

***Background*—A study was undertaken to examine temporal trends and ethnic differences in the asthma mortality rate in Singapore.**

***Methods*—Asthma mortality rates in Singapore were estimated from vital data for the years from 1976 to 1995. Trends in sex and age specific (5–14, 15–34, 35–59, 60+ years) rates were obtained for four periods (1976–80, 1981–85, 1986–90, 1991–95) and for Chinese, Malay, and Indian subjects for the years when these data were available (1989–95).**

***Results*—An increase in asthma mortality was observed in children aged 5–14 years from 0.21 per 100 000 person years in 1976–80 to 0.72 per 100 000 person years in 1991–95. No increases were noted in the other age groups but a small decrease was observed in the 1991–95 period for the 35–59 year age group. Marked ethnic differences in mortality rates were observed. In the group aged 5–34 years the asthma mortality rates were 0.5 per 100 000 in Chinese subjects, 1.3 per 100 000 in Indians, and 2.5 per 100 000 in Malay subjects. Similar 2–4 fold differences were observed in all other age groups.**

***Conclusions*—Apart from genetic factors, environmental exposures and medical care factors which influence asthma prevalence and severity are most likely to be the causes of the observed temporal trends and ethnic differences in the asthma mortality rate in Singapore, but further studies are needed to elucidate these more fully.**

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Keywords: asthma; mortality; ethnicity; race

Department of Community, Occupational and Family Medicine
T P Ng

Department of Medicine
W C Tan

National University of Singapore, Lower Kent Ridge Road, Singapore 119260

Correspondence to:
Dr T P Ng.

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

	5–14 y		*15–34 y*		*5–34 y*		*35–59 y*		*60+ y*	
	No.	*Rate*	*No.*	*Rate*	*No.*	*Rate*	*No.*	*Rate*	*No.*	*Rate*
Males										
1976–80	1	0.08	23	0.95	24	0.65	106	7.83	157	41.0
1981–85	5	0.46	29	1.11	34	0.92	89	6.09	172	39.3
1986–90	3	0.29	39	1.47	42	1.14	113	6.17	169	31.9
1991–95	10	0.93	27	1.05	37	1.02	100	4.29	260	40.8
Females										
1976–80	4	0.32	27	1.07	31	0.88	68	5.09	105	23.0
1981–85	5	0.50	17	0.68	22	0.63	68	4.75	108	21.5
1986–90	7	0.72	26	1.03	33	0.94	107	5.93	137	22.6
1991–95	5	0.50	21	0.84	26	0.74	84	3.69	167	22.7
Total										
1976–80	5	0.21	50	1.08	55	0.76	174	6.32	262	30.4
1981–85	10	0.48	46	0.90	56	0.78	157	5.42	280	29.8
1986–90	10	0.50	65	1.25	75	1.04	220	6.05	306	26.9
1991–95	15	0.72	48	0.95	63	0.88	184	3.99	427	31.1

Rising trends in mortality from asthma in the 1970s and 1980s have been reported in a number of countries including New Zealand,[1] England and Wales,[2] France,[3] Italy,[4] and the United States.[5 6] In Asia an increase in asthma deaths from 1976 to 1985 has also been reported for Hong Kong.[7] In these countries the sharpest increase has been observed in young people in the 5–34 year age group. Ethnic differences in the asthma mortality rate have also been reported in a number of countries including New Zealand,[8] the United States,[9] and South Africa.[10] Higher mortality rates have been observed in Polynesian, black, and coloured subjects (Africans, Asians, and other non-white subjects) than in the white population. These variations in asthma deaths may be related to variations in the incidence, prevalence, or severity of asthma as a result of changing or differing patterns of environmental exposures, access, and effectiveness of care.

In Singapore (population 3.1 million) the temporal trends in asthma mortality have not been reported to date in the international literature. Given the ethnic diversity of the population (75% Chinese, 14% Malays, 7% Indians), it is interesting to compare the rates of asthma mortality in the different racial groups. We have previously reported ethnic differences in the prevalence of asthma with Malays and Indians having higher rates of asthma morbidity than Chinese subjects.[11] However, ethnic differences in asthma mortality have not been examined. In this report we present this additional information and attempt to explain the observed trends and variations in asthma deaths in Singapore.

Methods

Annual numbers of deaths from asthma (ICD-8: 493, ICD-9: 493, ICD-10: J45, J46) were obtained for the period from 1976 to 1995 separately for each sex and in five year age groups from 0–4, 5–9, etc up to 85+. These data were obtained from two relevant government departments responsible for keeping vital statistics: the Department of Statistics from 1976 to 1988 and the National Registration Department thereafter from 1989 to 1995. As the numbers of asthma deaths by ethnic groups were not compiled by the Department of Statistics, these data were not available for the period from 1976 to 1988, but the National Registration Department was able to provide them for the period from 1989 to 1995. Mid-year population estimates for the same sex, ethnic and five year age groups were obtained from the Department of Statistics which conducts a population census every 10 years and regular bi-censuses in between.

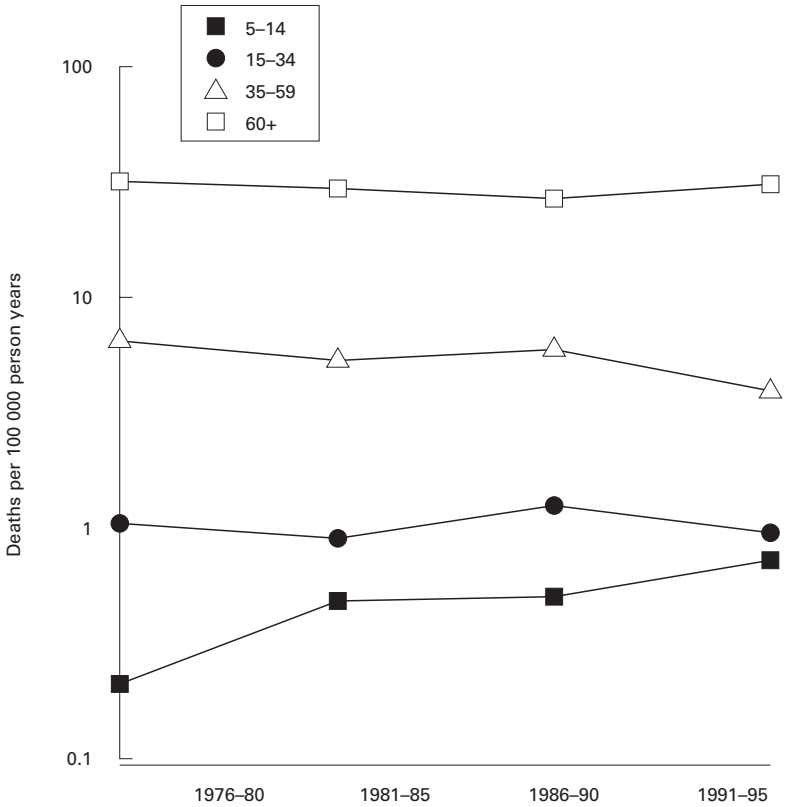

Figure 1 Asthma mortality rates in Singapore, 1976–95.

Table 2 Poisson regression analysis of asthma mortality trends from 1976 to 1995 by age groups

Age group	*Period*	*Mortality ratio (95% CI)*	*χ^2 (1 df)*	*p value*
5–14	1976–80	1.00	—	—
	1981–85	2.33 (0.80 to 6.81)	2.38	0.123
	1986–90	2.41 (0.82 to 7.06)	2.59	0.108
	1991–95	3.50 (1.27 to 9.64)	5.89	0.015
15–34	1976–80	1.00	—	—
	1981–85	0.86 (0.57 to 1.27)	0.58	0.447
	1986–90	1.19 (0.83 to 1.73)	0.90	0.342
	1991–95	0.90 (0.61 to 1.34)	0.26	0.611
35–59	1976–80	1.00	—	—
	1981–85	0.82 (0.66 to 1.02)	3.24	0.072
	1986–90	0.91 (0.75 to 1.11)	0.77	0.380
	1991–95	0.60 (0.49 to 0.74)	22.81	0.001
60+	1976–80	1.00	—	—
	1981–85	0.93 (0.78 to 1.10)	0.72	0.395
	1986–90	0.84 (0.71 to 0.99)	4.23	0.040
	1991–95	0.97 (0.83 to 1.13)	0.13	0.714

We calculated sex and age specific death rates during four time periods (1976–80, 1981–85, 1986–90, and 1991–95) for the clinically relevant age groups: 0–4, 5–14, 15–34, 35–59, and 60+ years. In those under the age of five years the numbers of deaths per year were very small (less than two) and the diagnosis is rather less certain as it may be confused with bronchiolitis. For this reason the death rate in this age group is not included. The primary interest of the analysis was the age groups 5–14 and 15–34 years in which the diagnostic labelling and coding are subject to fewer errors. In order to allow for direct comparison with other countries, the rates were also reported for these two age groups combined (5–34 years). In older subjects and in the elderly asthma may coexist with or be confused with chronic obstructive airways diseases and emphysema. However, most of the deaths from asthma are in these older age groups. Hence, the rates for these groups are presented for necessary perspectives, with the usual caution in interpretation.

For ethnic comparison, age specific rates were calculated for each ethnic group separately for males and females for the period 1989–95. Directly age standardised rates were calculated for each of the three ethnic groups and for both sexes using the age distribution of the general Singapore population in 1992 as the standard population. Poisson regression techniques using the GENMOD procedure in the SAS package of statistical programs were used for adjusted risk estimation and significance testing.

Results

There were a total of 2165 deaths from asthma during the 20 year period from 1976 to 1995. Most of the deaths (66%) were in the oldest age group (60+ years). There were 39 deaths in the 5–14 year age group and 200 deaths in the 15–34 year age group. Mortality rates for the different age groups were 1.5–2 times higher in male subjects than in females.

The mortality rates were higher in older age groups and varied little during the period under study (table 1, fig 1). The highest rates of asthma, which occurred in the oldest age group (60+ years), remained stable at 27–31 per 100 000. Both elderly men and women showed a similar lack of trends. In the group aged 35–59 years the mortality rates appeared to have reached their lowest levels during the most recent five year period (1991–95) at about four per 100 000. This improvement was more apparent in men, showing a downward trend from 7.5 per 100 000 in 1976–80 to 4.3 per 100 000 in 1991–95. No increase in mortality rates was noted for the younger group aged 15–34 years, the rates staying constant at about one per 100 000. However, in the youngest age group (5–14 years) the mortality rates showed a statistically significant increase from 0.21 per 100 000 in 1976–80 (five cases) to 0.72 per 100 000 in 1991–95 (15 cases). Males in this age group showed a sharper increase than females, although this was not statistically significant, given the smaller number of cases. Poisson regression

Table 3 Age specific and standardised asthma mortality rates per 100 000 person years in Chinese, Malay, and Indian subjects in Singapore, 1989–95

	Male					*Female*					*Male*	*Female*
	5–14 y	*15–34 y*	*5–34 y*	*35–59 y*	*60+ y*	*5–14 y*	*15–34 y*	*5–34 y*	*35–59 y*	*60+ y*	*Age standardised rate*	
Chinese	0.55 (6)	0.86 (24)	0.8 (30)	3.2 (81)	40.5 (184)	0.20 (2)	0.26 (7)	0.2 (9)	3.1 (76)	23.7 (133)	4.5 (295)	2.8 (218)
Malay	0.78 (2)	2.92 (16)	2.2 (18)	10.6 (36)	104.8 (92)	0.83 (2)	3.66 (19)	2.8 (21)	11.8 (41)	82.8 (63)	13.9 (146)	12.4 (125)
Indian	0.00 (0)	1.57 (4)	1.1 (4)	9.7 (21)	45.4 (38)	1.00 (1)	1.63 (4)	1.4 (5)	7.1 (14)	45.1 (14)	7.7 (63)	6.8 (33)

Numbers of subjects are shown in parentheses.
Mortality rates were directly standardised to the age distribution of the general Singapore population in 1992.

Table 4 Poisson regression analysis of asthma mortality by ethnicity controlling for sex and age, Singapore, 1989–95

	Mortality ratio (95% CI)	*χ^2 (1 df)*	*p value*
Sex			
Female	1.00		
Male	1.31 (14 to 1.49)	15.19	0.0001
Age			
5–14	1.00	—	—
15–34	2.36 (1.31 to 4.26)	8.19	0.0042
35–59	10.67 (6.11 to 18.62)	69.42	0.0001
60+	94.51 (54.49 to 163.90)	262.30	0.0001
Ethnicity			
Chinese	1.00	—	—
Malay	3.32 (2.86 to 3.84)	253.73	0.0001
Indian	1.76 (1.42 to 2.20)	25.67	0.0001

analysis of asthma mortality trends from 1976 to 1995 by age is shown in table 2.

There were pronounced differences in mortality rates among the three ethnic groups. Chinese subjects had the lowest rates of mortality from asthma, Indians had about twice their rate, while Malay subjects had 3–4 times the rate of the Chinese (table 3). In the 5–34 age group the asthma mortality rates were 0.5 per 100 000 in Chinese subjects, 1.3 per 100 000 in Indian subjects, and 2.5 per 100 000 in Malay subjects. The ethnic differences in risks of asthma mortality, adjusting for sex and age, were statistically significant (table 4).

Discussion

We observed a gradual upward trend in asthma mortality from 1976 to 1995 in Singapore in the youngest age group (5–14 years). In other age groups, however, the rates appeared to be mostly stable during this period. However, there appeared to be a small decrease in asthma mortality in the most recent five year period (1991–95) in the 35–59 year age group.

In 1979, when the change from the ICD-8 to ICD-9 revisions was effected, primary causes of death on death certificates in which asthma was mentioned concomitantly with bronchitis, bronchiolitis or emphysema were coded as asthma rather than one of the other respiratory conditions. This might be expected to have caused a steep increase in death certification of asthma. However, this was not observed in the data in Singapore when they were analysed for single years from 1978 through 1979 and up to 1995. We therefore believe that the change in ICD coding in 1979 is unlikely to explain the observed changes in mortality rates during this period. Other investigators have also found little evidence to conclude that this coding change could explain much of the observed trends in other countries.[12 13]

The observed trends cover two decades in the 1970s to 1990s during which much attention had been focused on the striking increase in asthma mortality rates in many countries. This has been observed commonly in the 1970s through the 1980s, especially among young asthmatic subjects. However, recent studies have reported decreasing mortality trends from the mid 1980s into the 1990s.[14–18] In England and Wales[14] deaths in the 5–14 year age group showed an irregular downward trend from 1983 to 1996, as did other age groups after 1989. This may have been the result of increased use of prophylactic steroid treatment. In Italy[4] the mortality rates from asthma also appeared to stabilise during 1986–88 after increasing sharply from 1979 to 1985 and this was also attributed to an increase in the use of anti-inflammatory drugs. In Singapore an increased awareness of worldwide trends in asthma mortality has led to greater attention being paid to the adequate and appropriate treatment of asthma in the 1990s. However, we do not have data to conclude confidently that improved care and greater use of anti-inflammatory drugs have contributed to improving the trends in asthma mortality. The mortality reduction in the 35–59 year age group in the most recent five years from 1991 to 1995 may suggest this, but the gradual upward trends in mortality rates in the youngest 5–14 year age group suggest the contrary. Data from prevalence studies indicate that the proportion of children under 14 diagnosed with asthma have increased from 5% in 1967 to 20% in 1994.[19 20] It is therefore possible that the prevalence or severity of childhood asthma might have increased over the past 30 years in Singapore, but greater diagnostic awareness and lack of standardised diagnostic criteria could also explain the apparent increase.

Ethnic differences in asthma mortality have been reported from New Zealand,[8] the USA,[9] and South Africa.[10] In these countries asthma mortality rates are higher in black Americans, coloured South Africans, and Maoris and Pacific Islanders than in Caucasians. In the present study we have also observed marked differences in mortality rates among Chinese, Indian and Malay subjects in Singapore. The different magnitudes of the mortality rates in the three ethnic groups in Singapore is appreciated in better perspective by comparing them with those in other countries. Such comparisons are often best done by looking at mortality rates in the 5–34 year age group in which the diagnosis of asthma is most likely to be correctly assigned.

The asthma mortality rate in the 5–34 year age group (both sexes combined) among Chinese subjects in Singapore (0.5 per 100 000 person years) is very similar to that observed among Chinese subjects in Hong Kong.[7] It is also similar to the rates observed in England and Wales, and among white subjects in the USA and South Africa, all of which have rates well below one per 100 000. The rates in Indians in this age group (1.3 per 100 000) are higher than these and, in fact, are higher than those of black subjects in the USA.[9] The rates for Malays (2.5 per 100 000) are as high as those reported for the coloured population in South Africa[10] and for New Zealand in the 1980s, which was known to have probably the highest rate of asthma deaths in the world. Although the rates in Malays are not as high as those of Maoris and the Pacific Islanders in New Zealand, it is interesting to note that Malays are an ethnic group closely related to Polynesians.

It should be noted that the ethnic differences in asthma mortality rates were also observed in the adult and elderly age groups (35–59 years and 60+ years), and at higher orders of magnitude, thus accounting for larger numbers of deaths. In the older age groups diagnostic accuracy is likely to be lower because of misclassification errors due to competing causes. Smoking rates are higher in Malay subjects (but not in Indians), so it is possible that the certification of asthma might be inflated in Malay subjects by concomitant asthma and other chronic obstructive airway diseases. However, we have also shown in an earlier study that there were, indeed, marked ethnic differences in the prevalence and severity of asthma among Chinese, Malay and Indian adults in Singapore.[11] The one year prevalence rates of asthma in Chinese subjects is estimated at 0.9% compared with 4.5% in Indians and 3.3% in Malays. The observation of higher mortality rates from asthma in non-Chinese (Indians and Malays) is therefore supported by the fact that they also have a higher prevalence of asthma. A similar pattern of ethnic differences in the prevalence and morbidity of asthma has also been reported among Chinese, Malay, and Indian subjects in Malaysia.[21 22]

However, it is interesting to note that, when Indian and Malay subjects are compared, although Malays have been noted to have higher rates of mortality from asthma, they do not have a higher prevalence of the disease. The prevalence rate of asthma in Indians is, in fact, slightly higher than that in Malays. It is possible that a cultural bias in self-reporting of symptoms among Indian subjects could result in higher rates of asthma without any increase in disease morbidity. It may also be postulated that more morbid disease and poorer management of near fatal asthma attacks in Malay subjects could increase their risk of dying. There is some evidence for this from previous studies of asthma morbidity in adult patients.[23 24] Asthma symptoms are more frequent in Malays than in either Indian or Chinese subjects. In particular, nocturnal exacerbations of asthma, which are widely recognised as a marker of asthma severity, are most frequent in Malay subjects. Despite this, they make use of the emergency room services for acute exacerbations of asthma less frequently than Indians, and hence are not admitted to hospital as frequently as would be warranted by their help-seeking behaviour. On the other hand, Indians make use of emergency room services more frequently and, by the same token, increase their likelihood of being admitted to hospital. These findings therefore strongly suggest that Malay asthmatic patients suffer more from their disease but generally make use of health services and receive less medical attention.

There are also clear differences in socioeconomic status among the races, with Indian and Malay subjects having lower incomes than the Chinese. In Singapore there are no financial barriers to access to health care since the Ministry of Health outpatient services provide highly subsidised care for all. Access to emergency care is also not a problem given the short distances and ready availability of public and ambulance transport. It is possible that, despite this, the level of utilisation of health care services by Malay subjects is lower because they have higher thresholds of symptom recognition and are less ready to seek medical attention. Other aspects of quality of medical care may well explain higher asthma severity and case fatality. There are good reasons to believe that personal behavioural factors in therapeutic self-management play an important role, as the lower level of understanding and self-efficacy in Malay and Indian subjects could well increase their risk of a fatal outcome.[25 26] Among Malay patients who received continuing care at the government primary care clinics, asthma knowledge scores were poorer than those of Indian or Chinese patients, as were their scores on inhaler techniques.[24] Language barriers could well be an important factor in the communications process influencing the effectiveness of patient education.

Based on the results of our previous studies,[11 24] there are also good reasons to believe that certain lifestyle factors that predispose to greater allergenic exposures, which were more common in Malay and Indian subjects, could partly explain the higher prevalence and severity of asthma in these ethnic groups. These include the keeping of pets, use of rugs and carpets, domestic exposures to cockroaches, and occupational exposures. Allergic disorders such as allergic rhinitis are also known to be more common in Indian and Malay subjects.[27 28] Smoking can only partly explain these ethnic differences as Indian subjects do not have higher smoking rates than Chinese.

Although these ethnic differences in the prevalence and severity of asthma might be explained by differences in environmental exposures and medical care, genetic factors are also likely to play an important part. However, we do not have much useful comparative data to allow us to examine ethnic differences in biological susceptibility to asthma.

Recent studies have focused interest on sex differences in asthma mortality and morbidity. In the 5–14 year age group the asthma mortality rates tended to be lower in females than in males, but in the 15–34 year age group the mortality was higher in females than in males.[29] In the latter age group there is also more morbidity and higher admission rates to hospital in women.[30] However, these sex differences in asthma mortality rates are not consistently observed in other countries. As in Switzerland[16] and Columbia,[18] women in Singapore do not have higher rates of asthma mortality, they do not have a higher prevalence rate of asthma,[11] nor do they experience greater morbidity from asthma.[23]

In conclusion, in Singapore there has been an increase in asthma mortality from 1976 to 1995 in the 5–14 year age group, and a suggestion of a recent decline in mortality from 1986–90 to 1991–95 in the 35–59 year age group. Marked ethnic differences exist with

Malay and Indian subjects having higher asthma mortality rates than Chinese subjects. Males have a higher asthma mortality rate than females. More studies will need to be conducted to understand better the changing trends and ethnic and sex variations in asthma outcomes and to improve the care of asthmatic patients.

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