

Increasing the hospitalization of asthma in children not in adults – from a national survey in Taiwan 1996–2002

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Prevalence of asthma has risen gradually in past 30 yr in Taiwan, but less is known about the trend of asthma hospitalization and different hospitalization patterns between children and adult groups in the Chinese population. The implementation of National Health Insurance (NHI) in Taiwan was in 1995, and it covered health care for >96% of the population. Using NHI data from 1996 to 2002, we investigated the admission rate, length of stay, cost and the readmission rate of hospitalization with primary diagnosis of asthma in this period. We also compare the difference between the children group (<18 yr old) and adult group (≥18 yr old). The average incidence of hospitalization in the age group below 18 was 105.0 cases per 100,000 children, and was 116.7 per 100,000 population in the adult group during that period. It increased by 6.5% annually in the children group, though it was 0.1% annually in the adult group. The hospitalization days were 3.6 ± 2.4 days in the children group, and were 8.2 ± 8.9 days of those age ≥18 ($p < 0.0001$). The hospitalization cost was $\$288.7 \pm \$292.9$ and $\$717.5 \pm \$1409.4$, respectively ($p < 0.0001$). Autumn was the most frequent admission season in the children group, but the winter season was the most common in the adult group. The average readmission rate in this period was 20.4%. It was 13.0% in the children group, and was 22.6% in the adult group ($p < 0.0001$). The general hospitalization rate of asthma in the children group was lower than the adult group. It increased significantly in the children group from 1996 to 2002, but the admission cost rose prominently in the adult group during the same period. The hospitalization days, admission cost, and readmission rate were also significantly lower in the children group.

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Asthma is a common chronic inflammatory lung disease, and is a major public health problem in Taiwan. The prevalence of asthma has increased gradually in several countries (1–3). According to the International Study of Asthma and Allergies in Childhood study in Taiwan, the prevalence of asthma increased from 1.3% in 1974 to 14.7% in 2002 in Taiwan (2). This trend cannot be ascribed to one specific reason.

Taiwan is located on the east coast of Asia in the Western Pacific, which is noted for its subtropical climate. There are 22.7 million people, and the

land area is 36,188 km²; therefore, the population density is 627/km². The average monthly temperature in the lowlands is 16°C in the winter and ranges between 24 and 30°C the rest of the year. There are 23 academic medical centers, 80 regional hospitals, 435 district hospitals, and 18,650 local clinics. The gross national product (GNP) per person increased from \$13,527 in 1996 to \$14,271 in 2002. The implementation of National Health Insurance (NHI) in Taiwan started in 1995, its databases containing healthcare data from >95% of all the hospitals in Taiwan, and >96% of the

population was covered by this national health-care system (4).

In addition to the increasing prevalence, different patterns of hospital admission rates for childhood asthma have also been reported in many countries (5–9). However, these studies and results were limited in time duration or were from selected hospitals in a local city. The objective of this study was to assess in asthma-related hospitalization patterns based on the NHI database in Taiwan, and to compare the different patterns between children and adults groups. The objective of this study was to assess in asthma-related hospitalization patterns based on the NHI database in Taiwan, and to compare the different patterns including incidence of annual hospital admission, length of hospital stay, and hospitalization costs between children and adult groups. The clinical features were not totally similar between children and adult groups. This is the first survey of asthma hospitalization in a developing country in a subtropical region. As such, documenting the epidemiologic features of asthma hospitalization in a Chinese population has proven valuable.

Methods

Hospitalization healthcare records were collected from NHI databases from 1996 to 2002. The NHI databases contained healthcare data from >95% of all the hospitals in Taiwan and >96% of the population receiving health care (4). From this database, we selected all hospitalized patients on the basis of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code for asthma (493.xx) listed as the major diagnosis. The variables included date of hospital admission and discharge, gender, and total cost of each admission. We analyzed patterns of asthma hospitalizations by different age groups, gender, month and year of admission, length of stay, hospitalization, and cost. The readmission rates of hospitalizations were also analyzed.

The general population data were obtained from census data from the Department of Ministry of the Interior. The annual incidence of asthma was calculated by dividing the number of asthma hospitalizations by the population with the same age as reported between 1996 and 2002 from Taiwan census data. The children group was defined as age below 18 yr; the adult group consisted of patients of age above 18. The annual incidence of asthma was expressed as the number of hospitalizations per 100,000 population. Readmission was defined as the second, or

admission of the higher order, that occurred within 365 days and at least 1 wk apart between each admission. Throughout the study, spring was defined as March to May, summer was defined as June to August, autumn was defined as September to November, and winter was defined as December through February.

Statistics

We analyzed the data with SAS statistical software (Version 8.2; SAS Institute, Cary, NC, USA). Data were expressed as mean (s.d.), median (range), or percentage (number). Annual incidence of asthma used age-matched census population as the denominator. The change of differences among continuous variables was measured by a trend test. The difference in annual incidence among different age groups and the difference in seasonal distribution were measured with a chi-squared test. $p < 0.05$ indicated statistical significance.

Results

Generally, the average annual admission numbers per year were 31,295 among 25,041 persons from 1996 to 2002. The average hospitalization rate was 113.4 per 100,000 population in this period. It increased from 105.1 in 1996 to 122.4 per 100,000 population in 1999, then decreased to approximately 115.0 per 100,000 population, maintaining until 2002. The average annual hospitalization rate was 1.24 times higher for males (121.3 per 100,000 population) than females (98.3 per 100,000 population). The hospitalization stay was 7.2 ± 8.2 days per admission. The annual cost of asthma hospitalization increased from 15.8 to 23.5 million during the study period with an increasing rate of 7% annually. The average annual cost was \$19.6 millions, and was $\$623.0 \pm \$1266.1$ in each admission.

The admission rate in the children group increased from 83.9 per 100,000 population in 1996 to 120.3 per 100,000 population in 2002. The average admission rate was 105.0 per 100,000 population. It increased by 6.5% annually in the children group. In the adult group, the admission rate was from the lowest 113.3 to the highest 124.8 per 100,000 population in this period, though the increase rate was 0.1%. It was apparent that the admission rate was significantly lower in the children group than in the adult group ($p < 0.001$). The admission rate increased gradually in both groups, although an annual increasing rate was prominent in the children

group (trend test $p < 0.001$) (Fig. 1). Male preponderance was more significant in the children group. The male/female ratio was 1.6 in the children group, and it was 1.2 in the adult group.

The average hospitalization days of each admission in the children group was 3.6 ± 2.4 days, while it was 8.2 ± 8.9 day in the adult group. It was significantly different in each year ($p < 0.0001$) in the study period. The cost in each admission was from \$279.5 to \$297.6 in children during this period. The average cost of each admission was $\$293.2 \pm \$297.4$. However, in the adult group, it was from \$621.6 to \$842.9, and it showed an increasing trend. The average cost of each admission in the adult group was $\$728.7 \pm \$1431.4$. In the children group, the hospitalization cost per day per admission was \$79.8 without a prominent increase in during this period. In the adult group, its cost was \$75.6 in 1996, increasing by 4.3% per year. Up to 2002, its cost was \$97.4 per day per admission (Fig. 2).

The readmission rate in the children group was 13.0%, and was 22.6% in the adult group. It demonstrated a significant difference each year, although it did not show any changes in trend during this period. There was no prominent difference between each sex except in 2002 in the children group. However, in the adult group, it was 1.3 times higher for males than for females readmitted because of asthma within 1 year (Table 1).

The distribution of asthma-related hospitalization by month is shown in Fig. 3. The admission rate was 9.6 and 12.0 per 100,000 population per

month in the children and adult groups, respectively. There were two peaks in a year, one from autumn to winter (12.5 per 100,000 population), the other in early spring (9.9 per 100,000 population). It had only one peak occurring in late winter in the adult group (14.5 per 100,000 population).

Discussion

In our study, the general admission rate increased from 105.3 in 1996 to 122.4 per 100,000 population in 1999, and then slightly decreasing to a range of 112.2 to 118.3 per 100,000 population in following 3 yr. Furthermore, if it was divided into different age groups, it produced a different trend. The annual admission rate increased by 6.5% each year in the children group; however, it was only 0.1% in the adult group, which even demonstrated a decreasing pattern since 2000. In Singapore, the average rate of 17.1 hospital admissions per 10,000 persons is higher than our data. 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) (10). In Scotland, the overall hospital admission rate increased by 122% (from 106.7 to 236.7 per 100,000 population) from 1981 to 1997; however, the declining pattern occurred in children younger than 15 yr old after 1992, although adult admissions continued to rise (11). These findings were contrary to our study. In New Zealand, both children and the young adult group had hospitalizations peaking in 1986, later

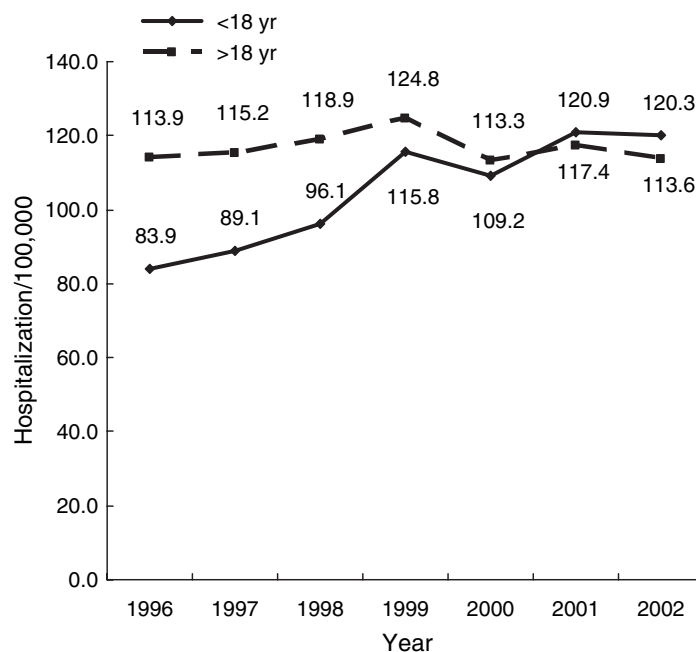


Fig. 1. The hospitalization rate increased gradually in the age group below 18 yr, but it remained stable in the age group above 18 yr during this period.

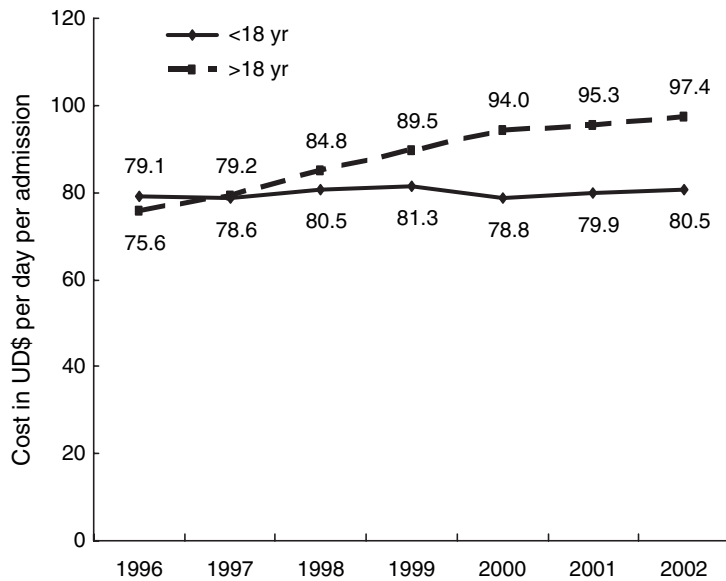


Fig. 2. The average cost of each hospitalization was $\$288.7 \pm \$292.9$ in the children group and $\$717.5 \pm \$1409.4$ in the adult group, respectively ($p < 0.0001$). Its cost was $\$79.8$ per day per admission in the children group. It was $\$88.0$ in the adult group, and the hospitalization cost increased gradually from 1996 to 2002.

Table 1. Annual readmission rate for different sexes. There was no sex difference in the children group from 1996 to 2001, although male adults were readmitted more prominently than females during the study period

	Children group (<18 yr)			Adult group (≥18 yr)		
	Male	Female	p-value	Male	Female	p-value
1996	9.0	9.0	0.97	19.5	14.4	<0.0001
1997	13.6	13.8	0.80	27.0	19.1	<0.0001
1998	12.2	12.6	0.68	26.7	20.2	<0.0001
1999	13.2	14.5	0.14	26.6	19.4	<0.0001
2000	13.6	13.2	0.69	25.4	21.1	<0.0001
2001	13.6	14.6	0.24	25.4	21.1	<0.0001
2002	15.5	13.6	0.04	25.9	22.0	<0.0001

falling by 18.7% by 1993 (12). However, in our survey, the hospitalization rate in the children group increased prominently than in the adult group. In Finland, the number of children admitted for asthma increased 2.8-fold during 1976 to 1995 (8). In Athens, Greece, the hospitalization rate of asthma among children 0–14 yr from 1998 to 2000 rose by 271% (5). In the USA, the asthma hospitalization rate in children increased by an average of 1.4% annually during the period between 1980 and 1999 (1), although the hospitalization rate decreased in both white and black populations, and a narrowing of the black to white disparity in asthma hospitalization rate was noted for the young children group between 1995 and 2002 (13).

Hospitalization rates may reflect the level of asthma control in primary care settings. Lack of a high level of care in primary care may result in high admission rates. In developed countries, the admission rate has declined or remained steady

in past decades. In our data, the increasing admission rate probably reflects a lack of asthma knowledge or good care in general practice settings, partly explained by increasing awareness of asthma symptoms in the children group. It has been surveyed that 90.4% of specialists indicate that they follow the guidelines in treating asthma patients, whereas only 63.8% of general practitioners practice such guidelines. Asthma specialists also seem to be significantly more competent than general practitioners regarding asthma knowledge, instruction of inhalation techniques, use of peak flow meters to monitor symptoms, and making an action plan (14). The data relied on database mining with data of a discharge diagnosis of asthma, which did not include severity information of the patients. As such, it was hard to know what level of severity would have caused the risk for admission or readmission.

The length of stay of admission may reflect the efficiency of hospital-based asthma management. In Nordic countries, it was around 2.2–3.2 days in different age groups at the age below 14 (9). In Finland, the median duration of admission was 2.0 days in children (15). In South Australia, it was around 2.8 days for patients 1–49 yr with asthma from 1989 to 1996 (16). In our data, it was 4.4 days in the children group and 2.6 times higher in the adult group. Overall cost per bed day was from \$304 to \$581 in Nordic countries. However, the cost is much lower (\$79.8) in our county. Although the GNP in Taiwan per person was around \$14,000, which is 2.7-fold lower than Nordic countries, 2.5-fold lower than Finland and 2.2-fold lower than Australia. However, it is

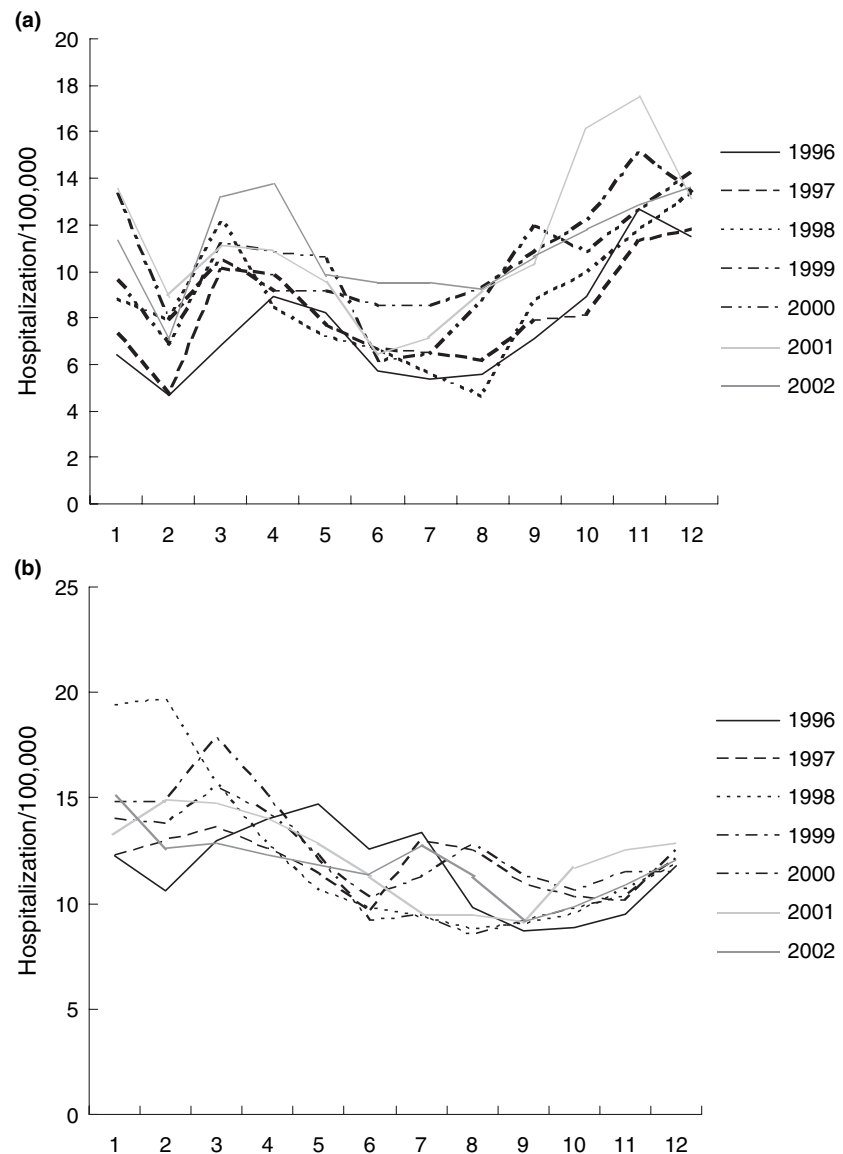


Fig. 3. (a) Seasonal variations of asthma hospitalization in the children group. There are two peaks, one in October through December, and the other from March through April. (b) Seasonal variations of asthma hospitalization in the adult group. Only one peak appeared from January to March.

almost five times lower in the hospitalization cost per bed day in Taiwan. This represents that it is more cost-effective to manage the disease during hospitalization.

The readmission rate was used as a measure of the efficiency and quality of asthma management, although it partly reflected the severity of the disease. One of the treatment goals of asthma is to reduce the readmission rate. In Denmark, the relative risk of readmission in children decreased gradually from 1978 to 1993 (17). The readmission rate declined in Oslo, Norway during the period of 1980 to 1995 as well (18). In Australia, there was also a significant decline in readmission of 17% in the 1990s (16). On the contrary, in Athens, the readmission rate among children 0–14 yr increased from 15.3% to 23.3%, and there were no significant differences between the

younger and older groups (5). Even in the young children group, it produced the same trend. In Canada, the readmission rate was 23.3% in children and young adults over a 4-yr study period, and females had a higher rate in the young adult group (19). In our survey, the overall readmission rate was 20.3%. However, it was only 13.0% in children with an age below 18. In the children group, the readmission rate had a slight increase but did not produce a declining trend as in other countries. Furthermore, there was no sex difference. The readmission rate was more significant in the adult group, and male adults had higher readmission rates than female adults.

In developed countries, the prevalence of the admission of asthma has remained stable or has declined in recent years. However, in Taiwan,

a developing country in Asia, both sets of data have significantly increased over the past decade. The issue of quality of asthma care, including asthma education, should be emphasized much more. The prominent increasing incidence rate and readmission rate in the children group should reflect that they should have much more attention paid to them concerning asthma care. The patients who were readmitted because of asthma should be treated more aggressively and need better asthma care and education. To reduce the increasing asthma hospitalization rates and readmission rates, significant education programs enhancing efficient care should be implemented (18). We have developed a 1-day national education program for school and community nurses over the past 7 years. It includes asthma knowledge, treatment medication and inhalation techniques, and peak flow meter monitoring, etc. The majority of participants increase their knowledge and efficacy on asthma care after this program (21). Asthma education should be continued and extended to other healthcare providers.

In a previous study of a medical center in Taiwan, seasonal admission rates revealed a statistically significant increase during the October–December period, peaking in November or December of each calendar year in children (3). In our study, the same pattern was revealed in the young age group; the other peak was noted from March and April. Pollen is not a major allergen leading to the seasonal variation in Taiwan. It can be explained in part because of high humidity during these two seasons, and partly due to high viral infection because of the beginning of academic semesters (22). Another explanation for this phenomenon could be ascribed to poor adherence to inhaled corticosteroids. It has been surveyed that only 17.4% of asthmatic children would continue using inhaled corticosteroids, even if prescribed by doctors (23). During the summer period, the symptoms usually appear less severe, and the patients feel well. Therefore, they do not continue to use maintenance medication if there is no adequate education provided to them. It has been reported that an increase in using inhaled corticosteroids could reduce admission risk (7). Unlike the children group, winter is the high season in adult asthma hospitalization but without a prominent nadir in the summer period. This admission pattern was correlated with air pollution and climate factors (24). In the USA, the majority of asthma-related hospitalizations occurred in the winter months and a nadir in the summer months above the age of 35 during calendar years 2000–

2001 (25). Furthermore, in New Zealand in the southern hemisphere, elderly people above age of 45 demonstrated asthma hospitalization rates peaking in the winter months (July/August) as well (26).

Some studies in Western countries have stated the decline in admission and readmission rates in recent years. However, regarding our national survey results, more emphasis should be placed on the importance of the recent trend of asthma hospitalization in children, which is significantly different from the adult group; and on longer admission days than other countries' results. The severity of asthma of children might not be as much as asthmatic adults, but it should be treated more aggressively to reduce the increasing trend and ongoing disease process. Moreover, for asthmatic children, more attention in asthma education to care givers should be given to decrease the readmission rate and to prevent the high peak admission incidence for specific seasons.

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