



ORIGINAL ARTICLE

Trends in childhood asthma hospitalisation in three Asia Pacific countries

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Aim: The study aims to examine recent childhood asthma hospitalisation rates in the Asia Pacific countries of Australia, Hong Kong and Singapore. On the background of reported decline in many countries with high asthma prevalence during late 1990s.

Methods: Annual asthma hospitalisation (ICD9-CM: 493 or ICD10-AM: J45-46)* and population data from 1994 to 2008, of children aged 0–14 years old, were obtained from the Australian National Hospital Morbidity Database, from the Hospital Authority in Hong Kong and from the Ministry of Health in Singapore. Data were stratified in two age groups: 0–4 and 5–14 years old, and also in different periods of calendar years. Time-series regression analyses were used to examine temporal trends. Diagnostic transfer was addressed by examining bronchitis hospitalisations.

Results: Significant decreases of up to 6.5% per annum in childhood asthma hospitalisation rates were found over the study period. However, the latter half of the study period showed increases in hospitalisation rates in all countries studied. No evidence of diagnostic transfer was found.

Conclusion: Although there has been a decrease in childhood asthma hospitalisation rates since the 1990s, a modest increase was observed from 2003 to 2008. Ongoing monitoring is required.

Key words: asthma; child; hospitalisation.

What is already known on this topic

- 1 Childhood asthma hospitalisations have been stabilising or declining in countries with high asthma prevalence since the 1990s.
- 2 Increase in the use of inhaled corticosteroids has contributed to the decline in hospitalisation rates.
- 3 Diagnosis of asthma can be challenging especially among pre-school children who present with wheeze due to incomplete understanding of the pathophysiology and ongoing revision of what asthma constitutes.

What this paper adds

- 1 Recent trends in childhood asthma hospitalisation in three urban communities in the Asia Pacific indicate a reversal, with a modest increase in the latter half of the study period (2003–2008).
- 2 Hospitalisation rates of all wheezing illnesses in children have not declined in recent years and may have reached a trough.
- 3 Asthma is still the most common diagnosis in hospitalisations of preschool children with wheeze; the terms “episodic viral wheeze” and “multiple trigger wheeze” appear to fall under the umbrella label of asthma in clinical practice.

Childhood asthma hospitalisation relates to its prevalence and severity, and also reflects appropriateness of its management. Significant decreases in asthma hospitalisation rates in children have been observed in the UK since 1988,¹ with similar trends reported in some Asia Pacific countries through the 1990s.^{2,3} Such improvements in childhood asthma outcomes have been

largely attributed to changes in management practices including more frequent use of controller medications,^{3,4} and improved Emergency Department management. A decade into this century, it is perhaps timely to examine recent childhood asthma hospitalisation rates. Therefore, this study aimed to examine childhood asthma hospitalisation rates in three Asia Pacific countries – Australia, Hong Kong and Singapore.

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*ICD9-CM: International Classification of Diseases 9th revision – Clinical Modification. ICD10-AM: International Statistical Classification of Diseases and Related Health Problems 10th Revision – Australian Modification.

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Materials and Methods

Annual asthma hospitalisation and population data from 1994 to 2008, of children aged 0–14 years old, were obtained from the Australian National Hospital Morbidity Database⁵ and the Australian Bureau of Statistics,^{6,7} the Hospital Authority – governing

body for public hospitals in Hong Kong – and the Ministry of Health in Singapore. Hospitalisation data were based on public and private hospital admissions with principal diagnosis of asthma coded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD9-CM: 493) or the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM: J45-46). Annual data from Australia were reported in mid-year to mid-year format. For simplicity, the 1-year data were taken to be the annual data for the end year of the 1-year period. For example, data for July 1993–June 1994 were regarded as data for 1994. Further, because of the ICD revision in Australia in 1999, a conversion factor was applied to asthma hospitalisation data prior to 1999.² In Hong Kong, the total numbers of hospital admissions (public and private) were extrapolated based on censor data on preference in the utilisation of health services and the number of admissions to public hospitals.

In addition, hospitalisation data for lower respiratory tract infections – the other major cause of episodic wheeze in children – were also sourced to identify any diagnostic shifts. Acute bronchitis and bronchiolitis were included in our analyses,^{8,9} and these data were obtained as per asthma hospitalisation data. Hospitalisation data were based on public and private hospital admissions with principal diagnosis of acute bronchitis, acute bronchiolitis and unspecified bronchitis, coded ICD9-CM: 466 and 490 or ICD-10-AM: J20-21 and J40. For the ease of discussion, these will be grouped under “bronchitis” in subsequent presentation of results and discussion.

Data were stratified in two age groups: 0 to 4 and 5 to 14-year-olds, and also in different periods of calendar years. Age-specific yearly hospitalisation rates were calculated. Negative binomial regression analysis was performed using SPSS 16.0 for Windows (SPSS Inc., Chicago IL) to estimate time trends in yearly asthma hospitalisation counts for each country (Appendix I). Population growth was accounted for by introducing an *offset* of log-transformed population variable into each regression model. Average annual percent change (AAPC) in asthma hospitalisation rates estimated from respective regression model was used to characterise trends over the various studied periods. Negative binomial regression analysis was also used to study the association between asthma hospitalisation rates and bronchitis hospitalisation rates in children in order to examine any possible diagnostic shift (Appendix I). Dummy variables were introduced in the analyses of Hong Kong and Singapore data to account for the effects because of the outbreak of severe acute respiratory syndrome (SARS) in these two countries.

Results

Over approximately the 15 years, declining trends were found in Australia and Singapore with AAPC ranging from –3.4 to –6.5%. Paradoxically, an increase of 3.7% was found among 0 to 4-year-olds in Hong Kong. In Australia, from 1994 to 2002, AAPC for both 0 to 4 and 5 to 14-year-olds significantly decreased by 5.2% (P -value <0.001) and 7.6% (<0.001), respectively. However, from 2003 to 2008, AAPC increased by 1.3% (0.172) in 0 to 4-year-olds and 0.7% (0.464) in 5 to 14-year-olds (Fig. 1).

Similar results were found for Singapore from 1994 to 2002, where AAPC significantly declined by 11.8% (<0.001) in 0 to 4-year-olds and 11.3% (<0.001) in 5 to 14-year-olds. The time trends reversed with AAPC of +1.1% (0.709) and +1.6% (0.670) observed in 0 to 4 and 5 to 14-year-olds, respectively, from 2003 to 2008.

For Hong Kong, from 1996 to 2002, AAPC in 0 to 4-year-olds actually increased by 3.6% (0.002), and this trend continued from 2003 to 2008, with a rise of 4.0% (0.027). AAPC in 5 to 14-year-olds showed changes of –2.2% (0.104) and +2.0% (0.346) over the same two periods.

No significant negative association between trends in asthma hospitalisation rates and bronchitis hospitalisation rates in children were found (Table 1). This would suggest a low probability of a diagnostic shift from bronchitis to asthma or vice versa.

Discussion

Asthma is increasingly recognised as a syndrome with a spectrum of phenotypes rather than a single disease entity.¹⁰ It commonly presents with wheeze but its array of symptoms overlap with a number of other diseases causing difficulty in diagnosis, especially among younger children. These complexities in asthma diagnosis in the younger age group may affect diagnostic accuracy, which may in turn confound the results of epidemiological studies. While diagnostic accuracy can never be completely accounted for, an attempt was made to address the issue of diagnostic shift by examining hospitalisations because of acute bronchitis and bronchiolitis, the other common causes of wheeze in children. An inverse relationship between asthma hospitalisation and bronchitis was not found but instead, the data seem to suggest that children hospitalisations because of these wheezing illnesses have been on the rise in recent years.

With a relatively short period of data analysed, we recognise that the increase observed could purely be a function of the time period selected. It may also be contended that the increase could be a result of changes in coding practices or admission policies. However, these changes would result in a step change in hospitalisation rates rather than a gradual increase. A quick search of the literature also did not find evidence of such changes. Further, it seems unlikely that three different geographical regions adopted new practices around the same period of time.

The recent (2003–2008) increases in childhood asthma hospitalisation rates contrast with earlier trends. Hospitalisation rates provide valuable indications of prevalence and severity of disease, as well as its management. While estimates from the International Study of Asthma and Allergies in Childhood surveys showed decreases in both prevalence and severity of asthma in children in Australia, Hong Kong and Singapore from 1994 to 2002,^{11,12} there has been a shortage of relevant data in recent years. Moreover, these data were gathered from 6 to 7-year-olds and 13 to 14-year-olds and may not give an accurate estimate of the burden of asthma in children under 15 years old. In particular, there is a paucity of data on both prevalence and severity of asthma in 0 to 4-year-olds, perhaps because the diagnosis of asthma in this age group remains contentious.

Distinct phenotypes of recurrent wheezing illnesses in preschool children have been identified through birth cohort studies.^{13–15} These classifications were intended to help

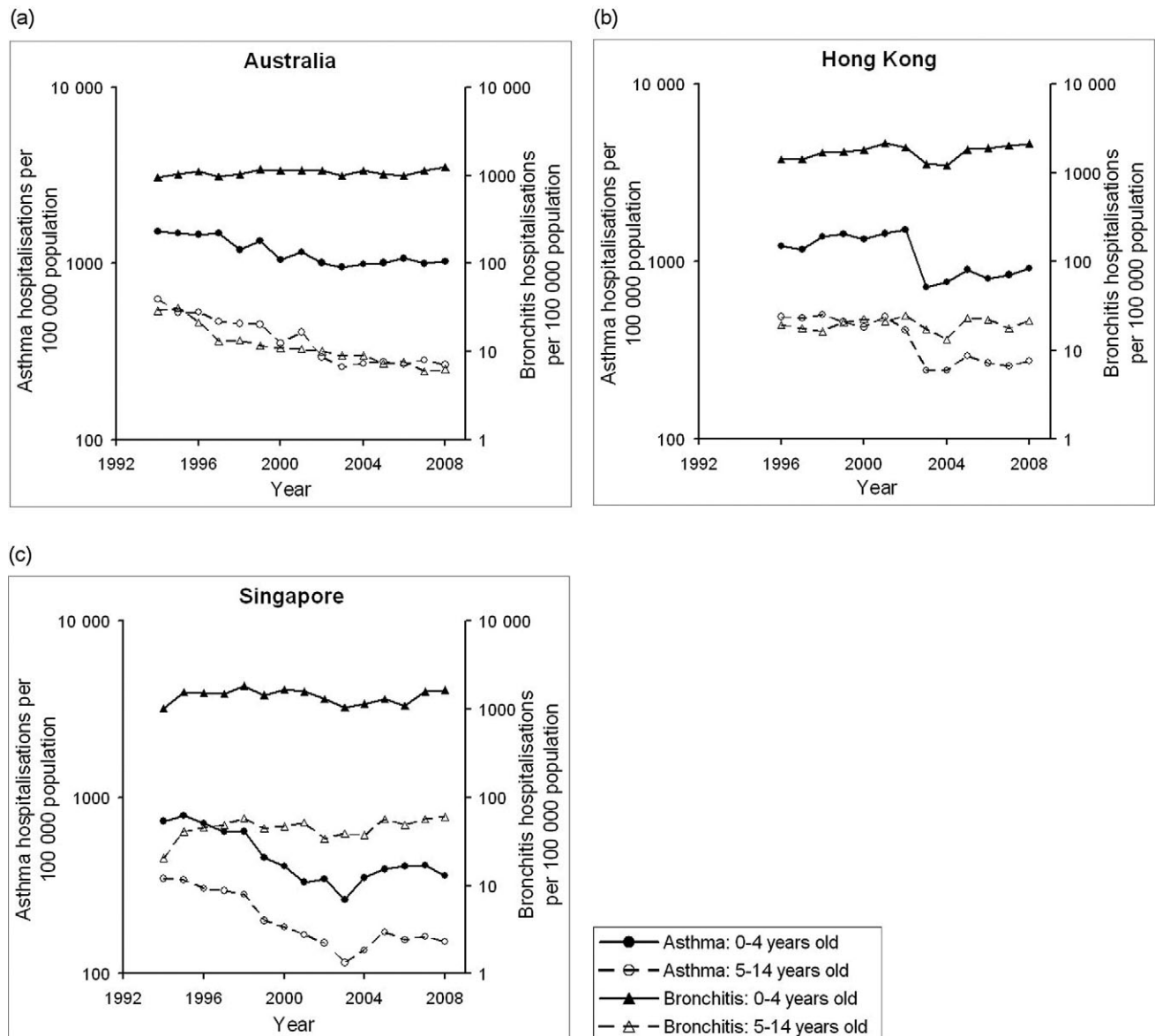


Fig. 1 Age-specific asthma and bronchitis hospitalisation rates in children in (a) Australia (b) Hong Kong and (c) Singapore from 1994 to 2008. Asthma hospitalisation rates decreased over the entire study period but from 2003, there is a slight upward trend. There is no apparent inverse relationship between asthma and bronchitis hospitalisation rates.

determine the cause and underlying disease process, tailor therapy and predict prognosis of separate disease entities if they exist.¹⁶ However, classifications based on subjective criteria have led to a gamut of phenotypes being described.¹⁶ Some phenotypes clearly show disparity, but others demonstrate degrees of similarity in clinical and pathological features, with classical atopic asthma seen in older children.^{13,17,18} Accordingly, for clinical pragmatism, the European Respiratory Society Task Force¹⁹ has recommended that preschool wheeze be labelled as either (i) episodic (viral) wheeze or (ii) multi-trigger wheeze. It is possible that terms such as these may have replaced the diagnosis of 'asthma' among 0 to 4-year-olds admitted with wheez-

ing illnesses, but our data suggest that asthma remains as the predominant diagnosis for such admissions and an expectant fall has not been observed. For the purpose of this study to examine and compare asthma trends in two different age groups, consistency in ICD code was chosen by the authors. At present, it would be appropriate to suggest based on the findings of this study that prevalence and/or severity of asthma in children may have been rising and this requires verification.

This study was not intended to examine the reasons behind recent trends in childhood asthma hospitalisations observed in Australia, Hong Kong and Singapore, but in considering hospitalisation rates as a reflection of asthma management, a possible

Table 1 Regression analyses examining association between time trends in childhood asthma and bronchitis hospitalisation rates in Australia, Hong Kong and Singapore from 1994 to 2008

Country	0–4 years old		5–14 years old	
	β_2	P-value	β_2	P-value
Australia				
1994–2002	0.308	0.604	–0.095	0.651
2003–2008	–0.272	0.251	–0.293	0.237
1994–2008	0.205	0.518	0.046	0.808
Hong Kong				
1996–2002	0.348	0.317	–0.469	0.057
2003–2008	0.179	0.695	0.301	0.044
1996–2008	0.105	0.414	0.041	0.822
Singapore				
1994–2002	0.488	0.004	0.201	0.019
2003–2008	–0.196	0.700	0.653	0.002
1994–2008	0.073	0.804	0.114	0.553

inference regarding pharmacotherapy is put forth. Inhaled corticosteroids have been established as a foundation of current asthma treatment. Some authors of this paper have described elsewhere rising sales of inhaled corticosteroids in the three countries studied,²⁰ but this increase was largely a result of combination drugs – inhaled corticosteroids and long-acting beta agonists (LABA) combined (data not shown). Although the national drug sales data may not represent prescription patterns for childhood asthma, there is concern that more children are using combination drugs despite a lack of studies investigating the safety of LABA in children. Off-label use of these combination drugs in the 1 to 4-year age group is also practised in Singapore and Hong Kong (clinical observation). A recent review found an approximate two times risk of hospital admission in children (although not statistically significant) with the addition of LABA to inhaled corticosteroids compared with a higher dose of inhaled corticosteroids alone.²¹ It is plausible that an increase in the use of LABA-containing drugs has contributed to worsening asthma outcomes but this has not been clearly established.

In Hong Kong and Singapore, a sharp decline in hospitalisation rates was observed in 2003, most likely because of the outbreak of SARS. A similar dip in hospitalisation rates was not observed in Australia which was not an epicentre of SARS. While hospitalisation rates rebounded the following year in Singapore, they remained low in Hong Kong. This may reflect the success in uptake of health-seeking behaviours and new public health measures in Hong Kong that reduced viral infections.²² Therefore, the increase in hospitalisation rates in Hong Kong from 2003 could represent a return to baseline with gradual waning of public health awareness.

Predominantly decreasing trends in childhood asthma hospitalisation rates have been observed in three Asia Pacific countries over approximately the 15 years. However, a possible recent inflection in these trends precludes assumptions that the burden of asthma will continue to decline or stabilise. More data

from other countries and the years following are needed to corroborate present findings. In the meantime, ongoing monitoring of asthma outcomes among children is required.

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Appendix I

Regression model for estimating time trend in annual hospitalisation rates:

$$\log(\text{expected number of age-specific asthma hospitalisations}) = \beta_0 + \log(\text{age-specific population}) + \beta_1 (\text{year}).$$

$\beta_1 \times 100\%$ is approximately the average annual percent change (AAPC) in asthma hospitalisation rates.

Regression model for estimating association between asthma and bronchitis hospitalisation rates:

$$\log(\text{expected number of age-specific asthma hospitalisations}) = \beta_0 + \log(\text{age-specific population}) + \beta_1 (\text{year}) + \beta_2 \log(\text{number of age-specific bronchitis hospitalisations}).$$

β_2 estimates the association between asthma and bronchitis hospitalisation rates. A positive value indicates a positive correlation and vice versa.