

## ORIGINAL ARTICLE

## The prevalence of asthma and allergies in Singapore; data from two ISAAC surveys seven years apart

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*Arch Dis Child* 2004;**89**:423–426. doi: 10.1136/adc.2003.031112

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Accepted 26 August 2003

**Background and Aims:** Over the past few decades, the prevalence of asthma has been increasing in the industrialised world. Despite the suggestion of a similar increase in Singapore, the 12 month prevalence of wheeze among schoolchildren in 1994 was 2.5-fold less than that reported in western populations. It was hypothesised that with increasing affluence in Singapore, the asthma prevalence would further increase and approach Western figures. A second ISAAC survey was carried out seven years later to evaluate this hypothesis.

**Methods:** The cross-sectional data from two ISAAC questionnaire based surveys conducted in 1994 (n=6238) and in 2001 (n=9363) on two groups of schoolchildren aged 6–7 and 12–15 years were compared. The instruments used were identical and the procedures standardised in both surveys.

**Results:** Comparing data from both studies, the change in the prevalence of current wheeze occurred in opposing directions in both age groups—decreasing in the 6–7 year age group (16.6% to 10.2%) but increasing to a small extent in the 12–15 year age group (9.9% to 11.9%). The 12 month prevalence of rhinitis did not change; there was an increase in the current eczema symptoms in both age groups.

**Conclusion:** The prevalence of current wheeze, a surrogate measure of asthma prevalence, has decreased significantly in the 6–7 year age group. Eczema was the only allergic disease that showed a modest increase in prevalence in both age groups.

In recent decades, the increasing prevalence of childhood asthma and atopy has been supported by studies including objectively measured asthma related parameters.<sup>1–5</sup> This increase has been observed in different age groups in different populations over the past several decades. It has been hypothesised that environmental rather than genetic causes were responsible for this and that with increasing westernisation, less developed communities would follow this trend.<sup>6</sup> Recently, however, several studies in western populations have reported that this increase seems to have slowed down or plateaued,<sup>7–8</sup> suggesting that the environmental influences that promote asthma have reached their maximum effect on a susceptible genetic background.

In the 1990s, the results of phase one of the ISAAC survey involving about half a million schoolchildren internationally showed wide ranging differences (up to 20-fold) in the 12 month prevalence of wheeze between communities (1.6–36.8%).<sup>9</sup> Compared with data from around the world, the 12 month prevalence of asthma, rhinoconjunctivitis, and eczema in Singapore was around the middle of the range of reported values. In this study, we evaluated the changes in prevalence of symptoms of asthma and allergies by comparing the data from phase one and phase three of the ISAAC surveys conducted in Singapore seven years apart.

## METHODS

### Design and subjects

This study was a comparison of cross-sectional data from ISAAC written questionnaire surveys conducted in 1994 and 2001. The cluster sampling method was identical in both surveys: schools were sampled randomly from the lists of all primary and secondary schools in Singapore. Students in the sampled schools at the ages of interest (6–7 and 12–15 years old) were all invited to complete the questionnaire.

### Questionnaire and data collection

Standard ISAAC core questions for wheezing, rhinitis, and eczema were used. In both surveys, socioeconomic status of

the respondents was assessed by including questions on type of residence (public or private housing), which was shown in our ISAAC phase one study to be a reliable indicator.<sup>10</sup> In the 2001 survey, additional questions related to environmental factors were included in the questionnaire. The data from this additional section will not be presented in this paper.

The method of data collection, described in our previous paper,<sup>10</sup> was identical between the two surveys. In brief, the questionnaires were completed by the parents for the 6–7 year age group, and by the students themselves in the 12–15 year age group. Both surveys were conducted over the same months of the year (March to November). Only one of the randomly selected primary schools in 1994, had its counterpart secondary school selected in the 2001 survey. Thus the likelihood of surveying the same children—6–7 years in 1994 and 12–15 years in 2001 was small (estimated at not more than 5%—that is, 250 students—of the latter cohort).

### Data analysis

In order to accommodate the cluster sampling survey design, the Survey Data Analysis software (SUDAAN 8.02, RTI, Research Triangle Park, NC) was used. Data were weighted for the selection probability of schools and the response probabilities, which were estimated using response rate at school level and at subject level. Design of sampling without replacement was chosen due to the large sampling fraction from all primary sampling units (PSU). Weighted logistic models were used for adjusting age, gender, race, and socioeconomic status (type of housing) in prevalence comparison between the two surveys. All analyses have taken a p value of <0.05 to represent statistical significance.

Taking into account cluster sampling, the estimated design effect for “wheezing in the past year” was 1.14 based on our survey. At the outset of the survey, a sample size of about 3700 for each age group was estimated to be sufficient to detect an increase of 2% in the prevalence of asthma symptoms from 1994 with 95% statistical power. A sample

**Table 1** Demographic and socioeconomic characteristics of the survey respondents

	6–7 year age group: n (%)			12–15 year age group: n (%)		
	1994	2001	p value*	1994	2001	p value*
Total subjects surveyed	2030	5305	–	4208	4058	–
Total schools sampled	10	21	–	12	15	–
Sex						
Female	45.7	47.7		43.5	57.8	
Male	51.6	50.7	0.257	53.8	41.4	<0.001
Not stated	2.7	1.6		2.7	0.8	
Race						
Chinese	83.5	69.9		76.0	75.0	
Malay	8.7	19.1		14.1	12.3	
Indian	3.1	7.8	<0.001	5.0	8.2	<0.001
Other/not stated	4.7	3.2		4.9	4.5	
Type of housing						
Public housing	59.5	86.0		80.9	68.8	
Private condominium	13.5	8.1		7.6	15.3	
Landed property	21.2	3.6	<0.001	9.0	14.2	<0.001
Not stated	5.8	2.3		2.5	1.7	

\*"Not stated" was excluded from the  $\chi^2$  comparison.

size of 4000 for each age group was chosen. All analyses have taken a p value of <0.05 to represent statistical significance.

## RESULTS

There were 6238 and 9363 responses in the surveys of 1994<sup>10</sup> and 2001, respectively. The response rates were 90% in 1994 and 91% in 2001. Table 1 shows the demographic characteristics of the respondents from two surveys. Due to the significant differences in demographic make up between the surveys and the influence of these factors on prevalence rates, statistical adjustment for these factors were made for comparative analyses.

Table 2 presents the prevalence rates of symptoms of asthma, rhinitis, and eczema for both studies and their comparison. A reduction in asthma symptom prevalence was seen in the 6–7 year age group, with a 6.4% decrease in 12 month wheeze. In the 12–15 year age group, there was however, a small (2%) increase in 12 month wheeze (9.9–11.9%). Only the symptom of nocturnal cough showed a consistent significant increase in both age groups. Symptoms of rhinoconjunctivitis did not show significant change in

either age group. Symptoms of eczema (chronic itchy rash with typical distribution) were significantly increased in both age groups.

When changes in the severity of symptoms of asthma, rhinitis, and eczema were examined (table 3), little change was observed for asthma and eczema symptoms, although there was a reduction in the number of wheeze episodes in the 6–7 year olds and wheeze limiting speech in 13–14 year olds. Rhinitis, however, showed a change towards increasing severity of symptoms in both age groups.

In terms of the prevalence of doctor diagnosed asthma, hay fever, and eczema, there was an increase for all three disorders (table 2), suggesting an improved awareness of these diseases in our population.

## DISCUSSION

The increase of asthma and atopic disease prevalence around the world has been described as an epidemic.<sup>11</sup> Data from the United States,<sup>12</sup> Central America,<sup>13</sup> Asia,<sup>14</sup> and Europe<sup>15 16</sup> have shown increases up to and including the past decade. In Singapore, we reported an increase in cumulative asthma

**Table 2** Positive response (%) for each of the asthma, rhinitis, and eczema symptoms, with percentage change, in the overall population and different age groups for the 1994 and 2001 surveys

	6–7 year age group				12–15 year age group			
	1994	2001	Change	p value†	1994	2001	Change	p value†
<b>Asthma</b>								
Ever wheezed	28.6 (1.0)	21.5 (0.6)	–7.1 (1.2)	<b>0.044</b>	18.6 (0.6)	25.1 (0.7)	6.5 (0.9)	< <b>0.001</b>
Wheeze in past year	16.6 (0.8)	10.2 (0.4)	–6.4 (0.9)	< <b>0.001</b>	9.9 (0.5)	11.9 (0.5)	2.0 (0.7)	<b>0.015</b>
Wheeze with exercise in past year	8.4 (0.6)	4.4 (0.3)	–4.0 (0.7)	< <b>0.001</b>	13.2 (0.5)	14.7 (0.6)	1.5 (0.8)	0.072
Nocturnal cough in past year	14.9 (0.8)	19.5 (0.6)	4.6 (1.0)	< <b>0.001</b>	11.4 (0.5)	21.2 (0.7)	9.7 (0.8)	< <b>0.001</b>
Ever diagnosed asthma	18.5 (0.9)	16.3 (0.5)	–2.2 (1.0)	0.464	20.7 (0.6)	27.4 (0.7)	6.7 (0.9)	< <b>0.001</b>
<b>Rhinitis</b>								
Ever had rhinitis	30.8 (1.0)	29.3 (0.6)	–1.5 (1.2)	0.061	50.9 (0.8)	49.8 (0.8)	–1.2 (1.1)	0.707
Rhinitis in past year	27.7 (1.0)	25.5 (0.6)	–2.2 (1.2)	0.194	41.8 (0.8)	42.1 (0.8)	0.3 (1.1)	0.401
Associated itchy eye in past year	9.3 (0.7)	9.3 (0.4)	0.0 (0.8)	0.097	17.1 (0.6)	19.0 (0.6)	1.9 (0.9)	0.378
Ever diagnosed hay fever	6.3 (0.6)	8.3 (0.4)	2.0 (0.7)	<b>0.003</b>	3.7 (0.3)	3.1 (0.3)	–0.6 (0.4)	0.207
<b>Eczema</b>								
Chronic rash	10.5 (1.2)	12.5 (0.5)	2.0 (1.3)	0.194	12.3 (0.5)	14.9 (0.6)	2.6 (0.8)	0.056
Chronic rash in past year	8.9 (1.1)	11.0 (0.4)	2.1 (1.2)	0.155	9.5 (0.5)	11.6 (0.5)	2.1 (0.7)	<b>0.034</b>
Chronic rash with typical dist	6.1 (0.9)	9.8 (0.4)	3.7 (1.0)	<b>0.028</b>	7.0 (0.4)	10.2 (0.5)	3.2 (0.6)	< <b>0.001</b>
Ever diagnosed eczema	3.0 (0.7)	8.8 (0.4)	5.8 (0.8)	< <b>0.001</b>	4.1 (0.3)	5.8 (0.4)	1.7 (0.5)	0.810

Values in parentheses are standard errors (SE).

†Adjusted for sex, race, and housing type.

**Table 3** Respondents (%) with each of the following reported symptoms indicating severity of asthma, rhinitis, and eczema, in the overall population and different age groups for the 1994 and 2001 surveys

	6-7 year age group		p value†	12-15 year age group		p value†
	1994	2001		1994	2001	
<b>Wheeze in past year (n)</b>	316	543		407	472	
No. of wheezing episodes						
1-3	76.8	83.8		78.6	77.7	
4-12	18.8	13.9		14.8	15.5	
>12	4.4	2.3	<b>0.008</b>	6.6	6.8	0.468
Woken by wheeze						
Never	59.2	60.2		58.7	60.9	
<1 per week	30.4	30.5		29.5	27.3	
>1 per week	10.4	9.3	0.111	11.8	11.8	0.147
Wheezing attack limiting speech	9.2	8.6	0.140	23.6	18.5	<b>0.035</b>
<b>Rhinitis in past year (n)</b>	535	1361		1723	1683	
Interfering with daily activity						
Not at all	42.4	31.0		35.8	23.2	
Little	44.3	54.8		50.5	57.4	
Moderate	11.8	11.3		9.9	15.1	
A lot	1.5	2.9	<b>0.003</b>	3.8	4.3	< <b>0.001</b>
<b>Rash in past year (n)</b>	58	658		394	472	
Persistent rash without clearing	46.6	43.6	<b>0.888</b>	41.6	35.2	0.092
Kept awake by rash						
Never	53.4	60.1		59.1	51.1	
<1 per week	36.2	28.6		29.4	29.6	
>1 per week	10.3	11.3	<b>0.479</b>	11.5	19.3	<b>0.005</b>

†Adjusted for sex, race, and housing type.

prevalence from 5.5% in 1967<sup>17</sup> to 13.7% in 1987<sup>18</sup> and 20.0% in 1994.<sup>10</sup> Although the survey methodologies were different in these studies, this increase in prevalence was borne out by the high morbidity reflected in a report on healthcare utilisation in Singapore; In children up to 14 years of age, asthma ranked second highest among hospital discharge diagnoses, and it was the sixth commonest condition seen at the primary healthcare level in the late 1980s and early 1990s.<sup>19</sup>

In 1994, the prevalence of wheeze in the past 12 months in Singapore was intermediate in comparison with international data.<sup>9</sup> It was anticipated that this would increase with rising affluence and urbanisation.<sup>20</sup> Unexpectedly, we did not observe a consistent increase in prevalence of asthma symptoms. In fact, there was a decrease in most of the indices in the 6-7 year age group, except for the symptom of nocturnal cough. This result is in keeping with some recent studies, which suggest that the asthma burden may be plateauing.<sup>8, 21</sup> Reasons that have been suggested are an improvement in intervention and prevention efforts. Another possible reason is that the environmental factors that have resulted in this epidemic have "recruited" all genetically susceptible individuals and hence the prevalence of asthma has stabilised.<sup>7</sup> The environmental factors that may predispose to asthma include pollution, microbial exposure, dietary change, decrease in childhood infections, and small family size.<sup>22</sup> In this regard, exposure to passive smoke and animal allergens do not appear to be important factors in Singapore due to their low prevalence.<sup>23</sup>

The reason for the lack of substantial increase in asthma symptoms prevalence in Singapore may also be due to a combination of both improved diagnosis and management of asthma. Although not conclusive, this is suggested by the increase in doctor diagnosed asthma but decrease in 12 month asthma symptoms and severity.

The consistent increase in nocturnal cough in both age groups could possibly be related to an improved awareness of asthma symptoms. A recent ISAAC survey in Sheffield, England showed that the increase in 12 month symptoms of

asthma was confined to mild symptoms. The authors also argued that improved therapy could have affected the severity profile of asthma symptoms, leading to an increase in the reporting of less severe symptoms.<sup>16</sup>

Eczema was the only allergic disorder with a consistent increase in symptom prevalence in both age groups. There was also a suggestion of increased severity of symptoms in the 12-15 year age group. Other studies have reported an increase in eczema prevalence, usually in parallel with increases in other atopic disease.<sup>1, 15</sup> This was also seen in a recent German report which also compared ISAAC phase one and three surveys.<sup>24</sup> This has also been substantiated by a recent cross-sectional epidemiology study in Singapore where the one year prevalence of eczema was 20.8%.<sup>25</sup> This study involved over 12 000 (7, 12, and 16 year age groups) and the results were validated by cutaneous examination of all subjects. The prevalence data and the suggestion of increasing severity of eczema may necessitate the need for improved management of this disorder as we have seen with asthma.<sup>26</sup> This observed digression in trends between asthma and eczema may also be explained by the suggestion that the genetic susceptibility to eczema may involve unique candidate genes which are not common with those for respiratory allergies.<sup>23</sup>

In conclusion, this comparative study of two ISAAC surveys has provided us with important information. It supports the notion that the "epidemic" of asthma may be beginning to plateau. Further work is necessary to verify that these results are at least in part due to the efforts put into improved diagnosis and management, as this would impact our management of other allergic diseases.

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## IMAGE IN PAEDIATRICS

## Choroid plexus cyst: comparison of new ultrasound technique with old histological finding

In histological examinations Shuangshoti and Netsky found choroid plexus cysts with multiple tubules lined by simple cuboidal epithelium in the wall.<sup>1</sup> The proposed mechanism of formation of tubules and cysts was folding of the epithelium into the stroma to enlarge the surface of the choroid plexus. The epithelium can produce cerebrospinal fluid so that tubules and cysts can grow.

When we examined choroid plexus cysts of the lateral ventricle by means of a high resolution ultrasound system (HDI 5000 and 12–5 MHz-Linear-Broadband-Scanhead from Advanced Technology Laboratories, Washington, USA) we found spherical cysts with a double wall (fig 1).

We propose that the spherical form of the choroid plexus cyst is the result of secretion of cerebrospinal fluid by the epithelium into the cyst. The double wall seems to be the result of multiple tubules in the wall of the cyst which Shuangshoti and Netsky found in histological examinations of choroid plexus cysts in 1966.<sup>1</sup>



**Figure 1** Coronal ultrasound section shows spherical cyst with double wall.

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doi: 10.1136/adc.2003.031245



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*Arch Dis Child* 2004 89: 423-426  
doi: 10.1136/adc.2003.031112

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