

Declining asthma prevalence in Hong Kong Chinese schoolchildren

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Summary

Background Many studies have reported an increase in the prevalence of asthma and related atopic disorders. The lack of standardized methodologies and 'objective' measurements make reliable comparison and monitoring of trends of asthma very difficult.

Methods In this study, a total of 3321 schoolchildren aged 13–14 years were recruited for study using the Phase III Protocol of the International Study of Asthma and Allergic disease in Childhood (ISAAC). The results were compared with those obtained in the Phase I ISAAC study (1994–95), which used the identical and validated core questionnaires.

Results The prevalence rates of physicians' diagnosis of asthma were similar in the two surveys (11.2% and 10.2%), but the prevalence rates of wheeze (written questionnaire) in the past year have decreased from 12.4% in 1994–95 to 8.7% in 2002 ($P < 0.001$). For the video questionnaire, all asthmatic symptoms in the preceding 12 months were significantly lower in 2002 when compared with those in 1994–95. Among the subjects with diagnosed asthma, the prevalence rates of wheeze in the past 12 months (written questionnaire) has decreased from 39.1% to 27.6% ($P < 0.001$). The prevalence rates of having wheezing attack at least once per month (video questionnaire) has decreased from 10.5% to 5.6% ($P = 0.013$).

Conclusion Using the same standardized and validated ISAAC questionnaire, the prevalence rates of asthma symptoms in Hong Kong Chinese schoolchildren have decreased since 1994. The exact reasons for such trend remain to be explored.

Keywords asthma, children, Chinese, ISAAC, prevalence

Submitted 26 January 2004; revised 26 March 2004; accepted 8 June 2004

Introduction

Asthma is one of the most common chronic disorders in childhood. The prevalence rates of asthma and related atopic disorders have been reported to increase steadily in many countries over the past few decades [1–7]. However, the absence of a precise definition of asthma and the lack of standardized methodologies make reliable comparison and monitoring of trends of asthma prevalence very difficult. Furthermore, only a few articles report the secular changes of the prevalence of asthma and allergies using objective markers, such as IgE measurements, skin prick tests (SPTs) or the measurement of bronchial hyper-responsiveness (BHR) [8].

Phase I of the International Study of Asthma and Allergic disease in Childhood (ISAAC) developed simple standardized methods for measuring prevalence of childhood asthma, allergic rhinitis (AR) and atopic eczema for international comparison [9]. It also provides data of baseline measures for assessment of future trends in the prevalence and severity of these diseases. Representative samples of schoolchildren of

two different age groups (6–7 and 13–14 years) from centres in many regions of the world were studied. The use of video questionnaire in the 13–14-year olds has a further advantage of minimizing the linguistic problems associated with the interpretation and translation of some terms such as 'wheeze' which does not have an equivalent term in some languages [10]. Previous epidemiological studies in Hong Kong using written questionnaires suggested that the prevalence rates of wheeze in the past 12 months in secondary schoolchildren had increased from 3.7% in 1992 to 12.4% in 1995 [4]. Increased awareness of asthma in the community might have contributed to such dramatic increase in a short period of time. In order to determine whether there are secular changes in the prevalence rates of asthma and allergies, a cross-sectional study of secondary schoolchildren aged 13–14 years using the ISAAC Phase III protocol was conducted in 2002. The results were compared with those in Phase I using the same ISAAC core questionnaires performed in 1994–95 [4].

Methods

Study population

Schoolchildren aged 13–14 years were targeted for this study following the ISAAC Phase III protocol [11]. In participating schools, 2 school years (second and third year of secondary

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school) with the highest proportion of children aged 13–14 years were recruited for the study. All children in the school class belonging to the respective school years were invited for survey. There were a total of about 420 secondary schools with approximately 105 000 schoolchildren of the target age range in Hong Kong. Similar to Phase I, schools were individually allocated a number, and by computer randomization, a list of 20 schools was generated. Each school was invited to take part in the study in descending order down the list. Ten out of the first 13 schools agreed to participate and were able to provide 3339 schoolchildren as potential subjects. These schools were randomly distributed throughout Hong Kong. Informed parental consent was obtained from parents or guardians and 3321 agreed to enroll their children in the study, representing a response rate of 99%.

Questionnaires

Each subject was given an ISAAC Phase III written questionnaire to complete, followed by the video questionnaire at the same session in school. The written questionnaire was translated into Chinese following the ISAAC protocol as described previously [4]. 'Current' symptoms referred to symptoms in the past 12 months; 'asthma ever' was defined as having been diagnosed with asthma by a physician in the subject's lifetime; 'rhinoconjunctivitis' was defined as sneezing or having a runny nose or blocked nose accompanied by itchy–watery eyes when the subject did not have an upper respiratory tract infection; 'flexural eczema' was defined as an itchy rash which was coming and going for at least 6 months affecting the folds of elbows, behind the knees, in front of the ankles, under the buttocks or around the neck, ears or eyes. In addition, two questions on the place of birth and the age of migration to Hong Kong were asked if the subjects were not born in Hong Kong. The ISAAC video questionnaire consisted of five scenes displaying young persons of different races with wheezing at rest, wheeze after exercise, night waking with wheeze, night waking with cough and severe asthma attack. The study was conducted between April and June 2002, the same season as that of the Phase I study. The study protocol was approved by the Ethics Committee of the Chinese University of Hong Kong and informed consent was obtained from children's parents or guardians.

Analysis of data

All data were entered into a computer twice by two independent persons. Data were categorized and analysed using Statistical Package for the Social Sciences (SPSS) for Windows Release 10.0 (Maija J Norusis/SPSS Inc., 1999). The χ^2 test was used to compare prevalence rates obtained from the two surveys and between subgroups of recruited subjects. The results are presented as odds ratios (ORs) and 95% confidence intervals (95% CIs) where appropriate. A *P*-value of <0.05 was considered to be significant.

Results

The age and sex distributions of participating children in the Phase I and Phase III studies are shown in Table 1. The response rates were 97% and 99%, respectively. The age and

Table 1. Demographic data of recruited subjects in Phase I (1994–1995) and Phase III (2002)

	Phase I	Phase III
<i>N</i>	4667	3321
Sex, (%)		
Boys	2329 (50)	1661 (50)
Girls	2339 (50)	1660 (50)
Age group, <i>N</i> (%)		
≤ 12 years	344 (7)	164 (5)
13–14 years	2994 (64)	2131 (64)
≤ 15 years	1329 (28)	1026 (31)
Response rate (%)	97	99

sex distributions were similar in the two surveys. Table 2 shows the responses to various questions on atopic symptoms in the two surveys. The prevalence rates of physicians' diagnosis of asthma ('asthma ever') were similar (11.2% and 10.2%). The prevalence rate of current wheeze has decreased from 12.4% in 1994–95 to 8.7% in 2002 as documented by the written questionnaire (*P* < 0.001). With the exception of 'current flexural eczema', all other responses obtained from the written questionnaire on asthma and atopic symptoms were significantly less in 2002 when compared with those in 1994–95. Similarly, all current symptoms documented by the video questionnaire were significantly lower in 2002 than those rates in 1994–95. Wheezing at rest in the past 12 months (video questionnaire) has decreased significantly from 10.1% to 6.2%.

Table 3 shows the responses among the subjects with a physician diagnostic label of asthma. Among these subjects, the prevalence rates of current rhinoconjunctivitis and current flexural eczema were similar in the two surveys. However, the prevalence rates of current wheeze has decreased significantly from 39.1% to 27.6% (*P* < 0.001) as documented by the written questionnaire. Furthermore, the severity of asthma has also decreased significantly. The prevalence of having wheezing attack at least once per month (video questionnaire) has decreased from 10.5% to 5.6% (*P* = 0.013). With the exception of night waking with cough, all current symptoms related to asthma as documented by the video questionnaires were found to have decreased significantly in 2002 compared with those in 1994–95.

Among the 3321 recruited subjects, 2612 were born and raised in Hong Kong, while 616 were born in Mainland China and subsequently emigrated to Hong Kong. The remaining 93 subjects were born in other countries. For the 616 subjects born in Mainland China, their median age of migration to Hong Kong was 9 years. The majority of them (87%) migrated to Hong Kong after their third birthday. Table 4 shows the differences of responses to the questionnaires between children born in Hong Kong and in Mainland China. Most parameters of atopic symptoms were significantly more common in children born in Hong Kong than the children born in Mainland China. As documented by the video questionnaire, wheeze at rest in the past 12 months was 7.0% for those born in Hong Kong compared with only 3.4% for children born in Mainland China. Children born in Hong Kong were two times (OR = 2.12) more likely to report wheeze at rest in the past 12 months when compared with children born in Mainland China. The proportions of

Table 2. Responses to written and video questionnaires: comparison of two surveys

	Phase I % (95% CI)	Phase III % (95% CI)	P
Written questionnaire			
Wheeze ever	19.5 (18.4–20.7)	16.2 (14.9–17.4)	<0.001
Asthma ever	11.2 (10.3–12.1)	10.2 (9.2–11.2)	0.12
Current wheeze	12.4 (11.5–13.4)	8.7 (7.8–9.7)	<0.001
Wheeze attack past year			
1–3 episodes	8.6 (7.8–9.4)	6.4 (5.6–7.3)	<0.001
4–12 episodes	2.8 (2.4–3.4)	1.7 (1.3–2.2)	<0.001
> 12 episodes	1.5 (1.2–1.9)	0.7 (0.4–1.0)	<0.001
Current speech limiting wheeze	2.4 (2.0–2.9)	1.4 (1.0–1.8)	0.001
Current exercise-induced wheeze	29.1 (27.8–30.5)	19.9 (18.5–21.3)	<0.001
Current rhinoconjunctivitis	26.4 (25.2–27.7)	23.8 (22.4–25.2)	0.009
Current flexural eczema	3.3 (2.8–3.9)	3.6 (3.0–4.3)	0.56
Video questionnaire: current symptoms			
Wheeze at rest	10.1 (9.2–11.0)	6.2 (5.4–7.0)	<0.001
Wheeze at rest ≥ 1 per month	3.7 (3.2–4.3)	1.4 (1.0–1.8)	<0.001
Wheeze after exercise	15.3 (14.3–16.4)	6.4 (5.6–7.3)	<0.001
Night waking with wheeze	3.8 (3.3–4.4)	1.7 (1.3–2.2)	<0.001
Night waking with cough	24.6 (23.4–25.8)	21.8 (20.4–23.2)	0.004
Severe asthma attack	6.9 (6.2–7.7)	5.6 (4.9–6.4)	0.02

CI: confidence interval.

Table 3. Responses among subjects with a physicians' label of asthma in the two surveys

	Phase I % (95% CI)	Phase III % (95% CI)	P
N	524	337	
Written questionnaire			
Current wheeze	39.1 (35.0–43.5)	27.6 (22.9–32.7)	<0.001
Wheeze attack past year			
1–3 episodes	26.3 (22.6–30.3)	19.0 (14.9–23.7)	0.013
4–12 episodes	9.4 (7.0–12.2)	5.6 (3.4–8.7)	0.05
> 12 episodes	5.2 (3.4–7.4)	3.3 (1.6–5.8)	0.19
Current speech limiting wheeze	9.7 (7.3–12.6)	4.7 (2.7–7.6)	0.007
Current exercise induced wheeze	44.3 (40.0–48.6)	30.3 (25.4–35.5)	<0.001
Current rhinoconjunctivitis	35.7 (31.6–40.0)	35.9 (30.8–41.3)	0.95
Current flexural eczema	7.1 (5.0–9.6)	6.5 (4.1–9.7)	0.76
Video questionnaire: current symptoms			
Wheeze at rest	31.9 (27.9–36.1)	21.1 (16.8–25.8)	<0.001
Wheeze at rest ≥ 1 per month	10.5 (8.0–13.4)	5.6 (3.4–8.7)	0.013
Wheeze after exercise	30.3 (26.5–34.5)	15.4 (11.8–19.8)	<0.001
Night waking with wheeze	21.2 (17.8–24.9)	9.5 (6.6–13.1)	<0.001
Night waking with cough	30.5 (26.6–34.7)	27.9 (23.2–33.0)	0.41
Severe asthma attack	23.1 (19.6–26.9)	16.6 (12.8–21.1)	0.02

CI: confidence interval.

Mainland migrants in the two surveys were 16.2% and 18.6%, respectively. In order to eliminate the potential influence of the difference in the proportion of Chinese Mainland migrants on the results, an analysis restricted to those born in Hong Kong was performed. As shown in Table 5, the prevalence rates of most asthma symptoms were significantly lower in the Phase III survey. These changes were similar to those comparing the whole group as shown in Table 2.

Discussion

The two cross-sectional surveys carried out in Hong Kong used the same ISAAC protocol including both written and

video questionnaires. This study shows that the prevalence rates of asthma symptoms in Hong Kong secondary schoolchildren have decreased significantly in 2002 when compared with those in 1994–95. However, the prevalence rates of physicians' diagnosis of asthma remain unchanged.

Over the past two decades, there have been many epidemiological studies in different parts of the world showing an apparent increasing trend of asthma prevalence [1–7]. Data from Hong Kong also suggested an increasing prevalence of asthma among schoolchildren [4]. Most of these studies were carried out using non-standardized written questionnaires without validation against more 'objective' markers such as BHR testing. Increased community awareness of asthma among the general population and medical

Table 4. Comparison of responses among children born in Hong Kong and in Mainland China: Phase III results

	Hong Kong <i>n</i> = 2612 % (95% CI)	Mainland China <i>n</i> = 616 % (95% CI)	OR*
Written questionnaire			
Wheeze ever	17.2 (15.8–18.7)	11.4 (9.0–14.2)	1.62
Asthma ever	11.9 (10.7–13.2)	2.4 (1.4–4.0)	5.44
Current wheeze	9.0 (8.0–10.2)	6.3 (4.5–8.5)	1.47
Current rhinoconjunctivitis	24.9 (23.2–26.6)	20.1 (17.1–23.5)	1.31
Current flexural eczema	3.8 (3.1–4.6)	2.4 (1.4–4.0)	NS
Eczema ever	13.4 (12.1–14.7)	11.5 (9.1–14.3)	NS
Video questionnaire: current symptoms			
Wheeze at rest	7.0 (6.0–8.0)	3.4 (2.1–5.2)	2.12
Wheeze after exercise	6.4 (5.5–7.4)	6.3 (4.5–8.5)	NS
Night waking with wheeze	1.9 (1.4–2.5)	0.8 (0.3–1.9)	†
Night waking with cough	22.6 (21.0–24.3)	17.9 (14.9–21.2)	1.34
Severe asthma attack	6.2 (5.3–7.2)	3.6 (2.3–5.3)	1.79

NS = Not significantly different.

*All were statistically significantly different ($P < 0.05$) unless otherwise stated.† $P = 0.06$; OR = 2.38.**Table 5.** Comparison of responses among children born in Hong Kong in the two surveys

	Phase I <i>n</i> = 3752 % (95% CI)	Phase III <i>n</i> = 2612 % (95% CI)	<i>P</i>
Written questionnaire			
Wheeze ever	20.3 (19.1–21.7)	17.2 (15.8–18.7)	<0.001
Asthma ever	12.9 (11.8–14.0)	11.9 (10.7–13.2)	0.24
Current wheeze	12.8 (11.7–13.9)	9.0 (8.0–10.2)	<0.001
Current rhinoconjunctivitis	25.9 (24.5–27.3)	24.9 (23.2–26.6)	0.38
Current flexural eczema	3.9 (3.3–4.6)	3.8 (3.1–4.6)	0.89
Eczema ever	14.9 (13.8–16.1)	13.4 (12.1–14.7)	0.10
Video questionnaire: current symptoms			
Wheeze at rest	10.6 (9.6–11.6)	7.0 (6.0–8.0)	<0.001
Wheeze after exercise	15.8 (14.7–17.0)	6.4 (5.5–7.4)	<0.001
Night waking with wheeze	4.1 (3.5–4.8)	1.9 (1.4–2.5)	<0.001
Night waking with cough	24.3 (22.9–25.7)	22.6 (21.0–24.3)	0.11
Severe asthma attack	7.0 (6.2–7.9)	6.2 (5.3–7.2)	0.22

CI: confidence interval.

personnel are likely to contribute to the apparent increase in asthma documented by these studies. A recent review by Wieringa et al. [8] concluded that the increase in the occurrence of asthma is supported by only a few studies with 'more objective measurements'. One of these studies was from Australia showing continued increase of asthma and atopy in children aged 8–11 years [6]. In contrast, a recent study from the United Kingdom showed a decrease in the incidence of asthma episodes presenting to general practitioners since 1993 [12]. In addition, an epidemiological study of schoolchildren in Italy also showed no increase of the prevalence of asthma from 1992 to 1998 [13]. It is conceivable that some of the increase of asthma prevalence documented by previous studies such as those from Hong Kong might have been because of methodological differences and increased community awareness of asthma.

The two surveys conducted in Hong Kong used identical and validated methodology in studying randomly recruited secondary schoolchildren. The response rates of both surveys were extremely high (97% and 99%). Both written and video questionnaires were used and the results were consistent. Validation study of the ISAAC questionnaire has been

carried out in Hong Kong schoolchildren [14]. Both written and video questionnaires were found to have similar sensitivity and specificity in predicting asthma-associated BHR. Having a physician diagnostic label of asthma had a sensitivity of 0.88 and specificity of 0.90 in predicting BHR. The current study showed that the prevalence rates of having a physician diagnostic label of asthma remain unchanged whereas the prevalence rates of wheeze have decreased. Among those with a physician label of asthma, their severity of asthma (frequency of wheezing attack, exercise-induced symptoms, nocturnal symptoms) has decreased significantly when the results in 2002 were compared with those in 1994–95. Similar trend of decrease was found among those subjects without a physician diagnostic label of asthma (data not shown).

The exact reasons for the decrease in the prevalence of asthma symptoms are not clear. Over the past two decades in Hong Kong, there has been steady economic improvement resulting in a three fold increase in the per capita gross domestic product [15]. Such economic advance is usually associated with increase in asthma prevalence. In 1990, the Hong Kong Government introduced a legislation to reduce the use of sulphur-containing fuel [16]. Such restriction

resulted in marked reduction (up to 80%) of the ambient SO₂ level [17]. No significant changes on the other ambient air pollutants were noted. During the transition period, a cross-sectional study was carried out recruiting schoolchildren aged 9–12 years before and 1–2 years after the introduction of the legislation. It showed a significant reduction in the prevalence of BHR in the subjects suggesting a beneficial effect on airway sensitivity when the ambient SO₂ level was reduced [18]. The cohort of children studied in the Phase I of ISAAC study was born before the legislation was imposed. Exposure to higher level of ambient SO₂ in the first 8–10 years of life might have affected their propensity to develop airway symptoms later on in life. For the cohort of children in the Phase III study, less than half of the children were exposed to higher level of SO₂ for 2 years or more in their early childhood period. Therefore, the reduction of asthma severity might have been associated with reducing ambient pollutant exposure. Although details of asthma therapy of subjects in the first survey were not available, indirect evidence suggested that there have been changes of asthma care among the patients. A recent study from Hong Kong has demonstrated the increasing use of inhaled corticosteroid over the past decade along with declining asthma mortality in our locality [19]. It is reasonable to speculate that the decrease in the severity of symptoms among the asthmatic subjects documented in this study might have been partly because of improved asthma care.

Environmental factors in early life have been thought to be important in determining subsequent development of asthma. Children who migrated from Mainland China to Hong Kong have been exposed to the environment in the Mainland for their early years before migration. As 18% of the subjects in the 2002 survey were born in the Mainland, we were thus able to compare the prevalence rates of various atopic symptoms of children born in the Mainland with those of children born in Hong Kong. The results of both written and video questionnaires clearly demonstrated that the prevalence rates of diagnosed asthma and current asthma symptoms were significantly lower in the group of children born in Mainland China (Table 4). Since all of our subjects should be genetically similar and those children born in Mainland China had been exposed to the living environment in the Mainland during their early years, the differences in the prevalence rates of asthma symptoms highlight the importance of early environmental exposure in the subsequent development of asthma. These results are in line with our previous study showing that children born in the Mainland have lower rates of atopic sensitization documented by SPT [20]. Our results are similar to those documented in the former East and West Germany. The prevalence rates of atopy, asthma, and BHR were significantly higher in children from West Germany when compared with those in East Germany [21]. The lifestyle factors in the former East Germany might be protective against the development of asthma. Comparative studies of genetically similar populations living in different environments may reveal important factors influencing the development of asthma and related atopic diseases.

As the prevalence rates of asthma symptoms were markedly lower in the Mainland migrants, difference in the proportion of Mainland migrants can potentially affect the results. The influx of young immigrants from Mainland China to Hong

Kong has remained stable in the past decade as it is strictly controlled by the Immigration Department of the Hong Kong Government. The proportions of Mainland migrants in the two surveys were similar (16.2% and 18.6%). As shown in Table 5 with the analysis restricted to those children born in Hong Kong only, the pattern of decrease was similar to the analysis comparing the whole group of children in the two surveys (Table 2). Therefore, the significant reduction in prevalence of symptoms was unrelated to the proportions of Mainland migrants in the two surveys.

In conclusion, we have used the same standardized and validated ISAAC questionnaire to study the prevalence of asthma symptoms in Hong Kong Chinese schoolchildren in 1994–95 and 2002. The prevalence rates of asthma symptoms have decreased significantly in 2002 when compared with the previous survey. Improvement of the air quality and increased use of inhaled corticosteroid might have been the contributing factors for such changes. Our findings on the children born in Mainland China and subsequently migrated to Hong Kong support the importance of early environmental exposure in the subsequent development of asthma. Further studies are necessary to reveal the exact reasons that may explain the secular trend of asthma prevalence in Hong Kong.

Acknowledgements

The study was supported by Research Grant Council Earmarked Grant, No. CUHK 4165/02M. The authors wish to thank E. Yung and C. Au for their technical support, and the children, parents and staff of the schools for their participation in the survey.

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