Prevalence and severity of asthma among school children in Hong Kong

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A B S T R A C T

Introduction: This study presents contemporary epidemiological data regarding the prevalence and severity of asthma and wheezing among children in Hong Kong, which provides an update to the results of the International Study of Asthma and Allergies in Childhood (ISAAC) conducted in 1994-1995 and 2001-2003.

Methods: This cross-sectional investigation was based on the ISAAC study protocol. Responses from 1100 children aged 6 to 7 years (Primary 1-2) and 1048 children aged 13 to 14 years (Secondary 2-3) in Hong Kong between September 2020 and August 2021 were analysed. Sex differences within each age-group were assessed using Chi squared and independent *t* tests. Demographic information was entered into hierarchical logistic regression models to identify potential predictive factors associated with asthma severity. Annual change in prevalence was calculated via division of the prevalence by the number of years between surveys. Logistic regression modelling was conducted to identify risk factors associated with asthma severity.

Results: The prevalences of current wheezing were 6.19% and 4.97% in the primary and secondary school groups, respectively. The prevalences of asthma ever were 5.55% and 6.12%, whereas those of wheezing ever were 20.38% and 12.05%, in the primary and secondary school groups, respectively.

Conclusion: Asthma severity and prevalence have decreased in Hong Kong since 1994-1995. A follow-up study will explore the protective and risk factors contributing to these trends.

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New knowledge added by this study

- Epidemiological data for asthma and wheezing among Hong Kong children have not been updated in 25 years.
- Our cross-sectional study, based on the International Study of Asthma and Allergies in Childhood protocol, showed that the prevalences of asthma ever were 5.55% and 6.12% in the primary and secondary school groups, respectively; the corresponding prevalences of current wheezing were 6.19% and 4.97%.
- This study revealed decreases in asthma severity and prevalence among Hong Kong children since 1994-1995.

Implications for clinical practice or policy

- These findings provide essential epidemiological data for research and policy-making in Hong Kong and Asia.
- Understanding the prevalence and severity of asthma will help estimate the associated budget for taking care of this group of patients.

Introduction

The International Study of Asthma and Allergies in Childhood (ISAAC) is considered a landmark international investigation of the global burden of three major atopic diseases—asthma, allergic rhinitis, and eczema[1-4]—utilising standardised methodology to enable accurate estimation of prevalence trends in allergic diseases. Phase One examined the prevalence and severity of the three diseases in 1994-1995, Phase Two investigated the corresponding risk factors, and Phase Three constituted a follow-up study examining global prevalence and severity trends in 2001-2003.[1,2,4] The Global Asthma Network updated global burden information using data from 27 Global Asthma Network Centres in 14 countries in 2017-2020,[3] but Hong Kong data were excluded from that study.

Asthma remains a major medical burden

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香港學童哮喘患病率和嚴重程度

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引言：本研究旨在收集香港學童哮喘和哮鳴流行病學的最新數據，了解他們的患病率和嚴重程度，以更新1994-1995年度和2001-2003年度的「國際兒童哮喘和過敏症研究」結果。

方法：此項橫斷面研究依照「國際兒童哮喘和過敏症研究」計劃進行。在2020年9月至2021年8月期間，研究團隊招募了1100名6至7歲（小一、小二）和1048名13至14歲（中二、中三）香港學童參與問卷調查，並分析他們的回應。我們使用卡方檢定及獨立樣本t檢定分析每個年齡組別的性別差異，以及分層邏輯迴歸模型分析人口統計資料來找出與哮喘嚴重程度相關的潛在預測因素。我們把患病率除以各個調查相隔的年度數目，得出患病率的年度變化。另外，我們使用邏輯迴歸模型找出與哮喘嚴重程度相關的風險因素。

結果：小學生和中學生哮鳴現發率分別為6.19%和4.97%，曾患哮喘的患病率分別為5.55%和6.12%，而曾患哮鳴的患病率則分別為20.38%和12.05%。

結論：自1994-1995年度以來，香港學童哮喘嚴重程度和患病率有所下降。未來研究可探討導致下降趨勢的保護和風險因素。

responsible for nearly 500 000 deaths in 2017[5] and substantial direct, indirect, and intangible costs,[6] ranging from mortality and hospitalisations to school- or work-related loss (in the form of absenteeism from school or loss of working days), and quality of life impairments. Thus, accurate and current asthma prevalence data are essential for guiding public health initiatives and formulating healthcare policies. Recent estimates suggest global asthma prevalences of 9.1% in children, 11.0% in adolescents, and 6.6% in adults[7]; asthma is often cited as the most common chronic disease in children.[6]

Trends regarding the three major atopic diseases have considerably varied among countries and regions since 1994-1995. Asthma has shown the greatest variation, peaking in some countries but continuing to increase in others, especially developing countries.[2-6,8-16] Most studies of asthma prevalence were conducted before the coronavirus disease 2019 (COVID-19) pandemic, and statistics considerably differ even within the same region. In 2019, a large-scale study examining the global adult and paediatric prevalences of asthma in >200 territories showed a 24% decrease in age-standardised point prevalence in most countries[5]; however, increases were observed in Oman, Saudi Arabia, and Vietnam.[5] This discrepancy highlights the need for further investigation of the risk and protective factors for asthma in modern societies.

Hong Kong is an urban-centric port city in southeast China with a unique blend of Chinese and international influences, which have led to trends that considerably differ from those of neighbouring regions.[17] Cultural practices[17-19] and urbanisation (eg, cooking methods, joss stick burning, and high population density in urban areas)[9,17,20,21] increase the complexity involved in estimating asthma prevalence within Hong Kong based on data from neighbouring regions. This study presents contemporary epidemiological data regarding the prevalence and severity of asthma and wheezing among children in Hong Kong, which provides an update to the results of the ISAAC conducted in 1994-1995 and 2001-2003.

Methods

Study design

This cross-sectional study, based on the ISAAC study protocol,[2] was performed using traditional Chinese versions of the validated ISSAC measurements.[22]

Participants

In total, 2148 children aged 6 to 7 years or 13 to 14 years residing in Hong Kong were recruited from primary and secondary schools between September 2020 and August 2021. Inclusion criteria for children were enrolment in Primary 1-2 (Grades 1-2) or Secondary 2-3 (Grades 8-9) in Hong Kong and parental provision of informed consent to participate. The primary caregiver of the student (for the primary school group) or the student himself/herself (for the secondary school group) was asked to complete questionnaires in accordance with the ISAAC protocol. Only written questionnaires were used, considering reports of high agreement with their video counterparts.[23,24] Inclusion criteria for parents were: (1) being either the father or mother of the child, (2) bearing primary responsibility for the child's care for ≥6 months, and (3) provision of informed consent to participate. Exclusion criteria for parents and children were the presence of a learning disability or organic disorder that would impair the ability to understand and respond to the questionnaires, and inability to understand Chinese. Additionally, children attending Special Educational Needs schools were excluded.

Sampling

All schools in Hong Kong (n=900) were invited by phone and mail to participate in the survey. Contact persons were identified in each school. The investigators made at least three attempts per school (by phone, mail and/or email) to obtain responses from participating students. A target sample size of 1000 to 3000 participants was established, in accordance with the ISAAC study protocol.[2]

Measurements

Questions were adopted from the ISAAC study protocol, and disease definitions were based on the original ISAAC Phase Three questionnaire and handbook.[2] 'Current severe asthma' was defined as affirmative responses to one or more of the following items in the past 12 months: (1) ≥4 wheezing episodes, (2) woken from sleep by wheezing ≥1 night per week, or (3) limitation of speech during wheezing. Other questions and their definitions adhered to the standardised ISAAC Coding and Data Transfer Manual[2,22] to ensure comparability with previous studies utilising the ISAAC protocol.

Statistical analysis

Descriptive statistics, including means and standard deviations, were used for continuous variables; frequency distributions were used for categorical variables. Sex differences within each age-group were assessed using Chi squared and independent *t* tests. Demographic information was entered into hierarchical logistic regression models to identify potential predictive factors associated with asthma severity. Annual change in prevalence was calculated via division of the prevalence by the number of years between surveys. Logistic regression modelling was conducted to identify risk factors associated with asthma severity. Potential risk factors included parent gender, parent education, and household monthly income. All analyses were performed using SPSS software (Windows version 26.0; IBM Corp, Armonk [NY], United States). P values <0.05 were considered statistically significant.

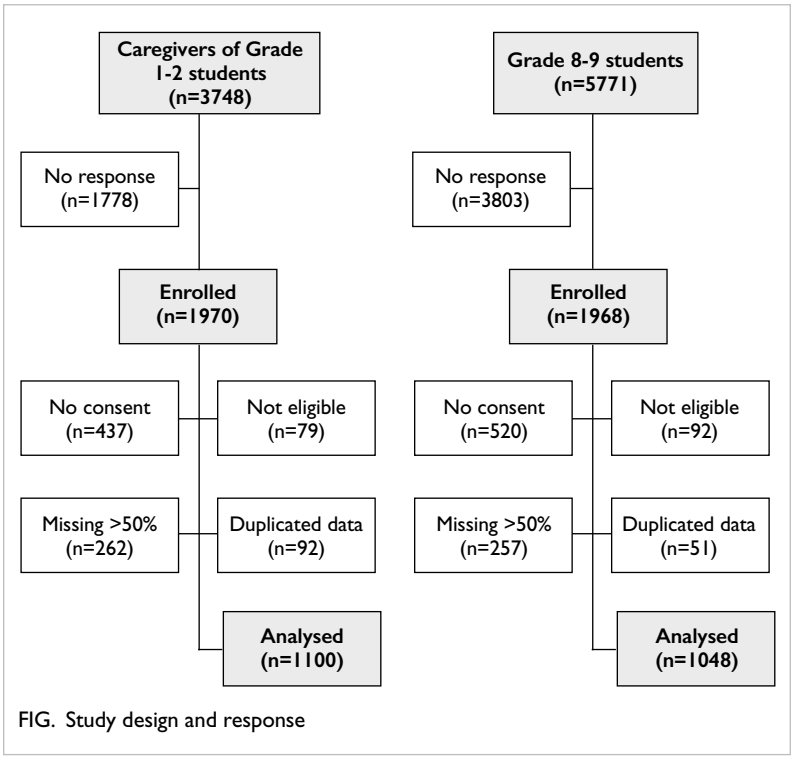

FIG. Study design and response

Results

Demographic characteristics

Nineteen primary schools and 25 secondary schools accepted the invitation to participate, representing 3748 and 5771 eligible students in the respective groups. Overall, 1970 (52.6%) questionnaires were returned for the primary school group, whereas 1968 (34.1%) questionnaires were returned for the secondary school group; 1100 and 1048 questionnaires were analysed in the respective groups after exclusion due to invalid consent, incomplete data, or ineligibility (Fig). Boys comprised 62.51% and 42.64% of the primary and secondary school groups, respectively (Tables 1 and 2). The mean ages were 7.02 years (standard deviation [SD]=0.76) in the primary school group and 14.09 years (SD=0.89) in the secondary school group.

Asthma symptoms

The estimated prevalences of current wheezing were 6.19% and 4.97% in the primary school and secondary school groups, respectively. The respective prevalences of exercise-induced wheezing and night cough were 7.46% and 16.74% in the primary school group and 17.88% and 10.61% in the secondary school group (Tables 1 and 2).

The prevalences of asthma ever were 5.55% and 6.12% in the primary school and secondary school groups, respectively; significantly more boys reported asthma ever in the secondary school group. The prevalences of bronchial hypersensitivity ever were 33.03% and 11.09% in the primary and secondary school groups, respectively (Tables 1-3). In total, 85.25% and 78.13% of primary and secondary school participants with asthma exhibited comorbid eczema and/or allergic rhinitis, respectively (Table 4).

Indicators of severe asthma were also examined. The incidences of ≥4 wheezing episodes in the past year were 2.18% (boys vs girls: 3.20% vs 0.49%) in the primary school group and 1.91% (boys vs girls: 2.24% vs 1.67%) in the secondary school group. Severe wheezing that limited speech in the past year was reported by 0.64% and 1.43% of participants in the primary and secondary school groups, respectively. Waking from sleep due to wheezing in the past year occurred in 2.82% and 1.24% of participants in the primary and secondary school groups, respectively. Hospitalisation due to shortness of breath was reported by 7.37% (boys vs girls: 8.30% vs 5.83%) and 4.30% (boys vs girls: 4.93% vs 3.83%) of participants in the primary and secondary school

TABLE 1. Overall and gender-specific prevalences of wheezing symptoms among primary school children*

	Boys	Girls	Total	OR† (95% CI)	P value
No.	687 (62.51%)	412 (37.49%)	1099‡ (100%)		
Wheezing ever	159 (23.14%)	65 (15.78%)	224 (20.38%)	1.61 (1.17-2.21)	0.003
Wheezing in past year	56 (8.15%)	12 (2.91%)	68 (6.19%)	2.425 (1.20-4.91)	0.012
Wheezing episodes ≥4 in past year	22 (3.20%)	2 (0.49%)	24 (2.18%)	1.44 (0.08-26.23)§	0.803
Woken by wheezing in past year	27 (3.93%)	4 (0.97%)	31 (2.82%)	0.857¶ (N/A)	0.483
Limitation of speech during wheezing in past year	5 (0.73%)	2 (0.49%)	7 (0.64%)	0.49 (0.08-2.89)	0.423
Asthma ever	43 (6.26%)	18 (4.37%)	61 (5.55%)	1.458 (0.83-2.56)	0.188
Has your child ever been diagnosed with bronchial hypersensitivity?	250 (36.39%)	113 (27.43%)	363 (33.03%)	1.51 (1.16-1.97)	0.002
Has your child ever been hospitalised due to shortness of breath?	57 (8.30%)	24 (5.83%)	81 (7.37%)	1.46 (0.89-2.39)	0.13
Has your child ever been hospitalised due to lung problems other than shortness of breath?	56 (8.15%)	27 (6.55%)	83 (7.55%)	1.259 (0.78-2.03)	0.343
Has your child ever taken any medication?	213 (31.00%)	86 (20.87%)	299 (27.21%)	1.697 (1.27-2.26)	<0.001
Has your child taken any medication in the past year?	66 (9.61%)	19 (4.61%)	85 (7.73%)	2.19 (1.29-3.70)	0.003
Exercise-induced wheezing in past year	52 (7.57%)	30 (7.28%)	82 (7.46%)	1.037 (0.65-1.66)	0.878
Has your child experienced wheezing due to exposure to chlorine in swimming pools in the past year?	5 (0.73%)	1 (0.24%)	6 (0.55%)	2.758 (0.32-23.73)	0.335
Has your child experienced wheezing while swimming in the past year?	3 (0.44%)	2 (0.49%)	5 (0.45%)	0.836 (0.14-5.03)	0.845
Nocturnal cough in past year	123 (17.90%)	61 (14.81%)	184 (16.74%)	1.248 (0.89-1.74)	0.194

Abbreviations: 95% CI = 95% confidence interval; N/A = not applicable; OR = odds ratio

* Data are shown as No. (%), unless otherwise specified

† ORs of participants exhibiting that symptom compared with participants without that symptom

‡ The total is not 1100 as there was one missing datum

§ OR and 95% CI of participants who reported <4 times compared with those who reported ≥4 times

¶ OR of boys only

groups, respectively (Tables 1 and 2). The mean ages of wheezing onset in the primary and secondary school groups were 2.37 years (SD=1.52) and 7.16 years (SD=4.38), respectively.

Comparison with the 1994-1995 and 2000-2001 data in Hong Kong

Compared with the previous Hong Kong ISAAC data,[1,25-27] the prevalence of wheezing ever increased from 16.80%[26] in 1994-1995 to 20.38% in the primary school group but decreased from 20%[25] to 12.05% in the secondary school group. Conversely, the prevalence of asthma ever decreased from 7.80%[26] to 5.55% in the primary school group and from 11%[26] to 6.12% in the secondary school group. The prevalence of wheezing in the past year decreased from 9.20% in 1994-1995[26] and 9.40% in 2000-2001[27] to 6.19% in our study (2020-2021) in the primary school group; it decreased from 12% in 1994-1995 to 4.97% in our study in the secondary school group. The annual changes in wheezing prevalence were -0.16% and -0.27% in the primary and secondary school groups, respectively. The aforementioned indicators of severe asthma, including ≥4 wheezing episodes in the past year and severe wheezing that limited speech in the past year, decreased in prevalence compared with the 1994-1995 figures. However, the prevalence of waking from sleep due to wheezing in the past year decreased in the primary group and increased in the secondary school group (Table 5).

Overall, both the prevalence and severity of asthma declined compared with the 1994-1995 data. We observed a statistically significant male predominance for wheezing ever (P=0.003), current wheezing (P=0.012), and bronchial hypersensitivity diagnosis (P=0.002) in the primary school group (Table 1), as well as for asthma ever in the secondary school group (P=0.005) [Table 2].

In the logistic regression model, demographic characteristics, including parent gender, household income, and parent education, were not significantly predictive of wheezing episodes in the past year. Hierarchical logistic regression using demographic characteristics along with concomitant current eczema and rhinitis also did not show significantly predictive effects for wheezing episodes in the past year.

TABLE 2. Overall and gender-specific prevalences of wheezing symptoms among secondary school children*

	Boys	Girls	Total	OR† (95% CI)	P value
No.	446 (42.64%)	600 (57.36%)	1046‡ (100%)		
Wheezing ever	59 (13.23%)	67 (11.17%)	126 (12.05%)	1.21 (0.84-1.76)	0.311
Wheezing in past year	26 (5.83%)	26 (4.33%)	52 (4.97%)	1.21 (0.59-2.45)	0.604
Wheezing episodes ≥4 in past year	10 (2.24%)	10 (1.67%)	20 (1.91%)	0.64 (0.10-4.10)§	0.639
Woken by wheezing in past year	6 (1.35%)	7 (1.17%)	13 (1.24%)	0.333 (0.02-5.03)¶	0.416
Limitation of speech during wheezing in past year	8 (1.79%)	7 (1.17%)	15 (1.43%)	1.21 (0.36-4.01)	0.76
Asthma ever	38 (8.52%)	26 (4.33%)	64 (6.12%)	2.065 (1.23-3.46)	0.005
Has your child ever been diagnosed with bronchial hypersensitivity?	53 (11.88%)	63 (10.50%)	116 (11.09%)	1.15 (0.78-1.69)	0.489
Has your child ever been hospitalised due to shortness of breath?	22 (4.93%)	23 (3.83%)	45 (4.30%)	1.29 (0.71-2.34)	0.409
Has your child ever been hospitalised due to lung problems other than shortness of breath?	22 (4.93%)	27 (4.50%)	49 (4.68%)	1.093 (0.61-1.95)	0.761
Has your child ever taken any medication?	58 (13.00%)	54 (9.00%)	112 (10.71%)	1.5 (1.01-2.22)	0.042
Has your child taken any medication in the past year?	13 (2.91%)	15 (2.50%)	28 (2.68%)	1.16 (0.55-2.47)	0.694
Exercise-induced wheezing in past year	75 (16.82%)	112 (18.67%)	187 (17.88%)	0.872 (0.63-1.20)	0.404
Has your child experienced wheezing due to exposure to chlorine in swimming pools in the past year?	7 (1.57%)	8 (1.33%)	15 (1.43%)	1.015 (0.36-2.83)	0.977
Has your child experienced wheezing while swimming in the past year?	13 (2.91%)	10 (1.67%)	23 (2.20%)	1.502 (0.65-3.47)	0.338
Nocturnal cough in past year	43 (9.64%)	68 (11.33%)	111 (10.61%)	0.828 (0.55-1.24)	0.360

Abbreviations: 95% CI = 95% confidence interval; OR = odds ratio

* Data are shown as No. (%), unless otherwise specified

† ORs of participants exhibiting that symptom compared with participants without that symptom

‡ The total is not 1048 as there were two missing data

§ OR and 95% CI of participants who reported <4 times compared with those who reported ≥4 times

¶ OR and 95% CI of participants who reported <1 night compared with those who reported ≥1 night

Discussion

This is the first study since 2001 to investigate trends in asthma prevalence and severity among school children in Hong Kong. The global variability in these trends is complicated by the lack of consensus regarding exact definitions of asthma entities, the heterogeneity of the disease itself, changes in community awareness, the absence of a 'gold standard' diagnostic test, and the non-specific nature of symptoms shared with other diagnoses.[13] This study showed a decrease in asthma prevalence, consistent with findings from the neighbouring region of Taiwan.[11]

Global trends in asthma prevalence and severity

The 2020 study by Asher et al[4] investigating international symptom trends showed annual current asthma prevalence increases of 0.06% in the secondary school group (from 13.2% to 13.7%) and 0.13% in the primary school group (from 11.1% to 11.6%), and increases in the prevalence of asthma ever by 0.18% and 0.28% in the primary and secondary school groups, respectively. However, trends varied across regions; in general, asthma prevalence decreased in higher-income regions but increased in low- and middle-income regions. Considering that Hong Kong exhibits higher levels of income and gross domestic product per capita, it is unsurprising that the local asthma prevalences showed a decreasing trend.

A decrease in asthma severity was also observed in most regions, reflected by the three indicators of severe asthma in our study and parameters such as asthma-related hospital admissions and mortality. These findings suggest that, regardless of overall asthma trends, milder forms of asthma have become more prevalent in recent years.[7,28] Our study revealed similar trends in terms of fewer severe asthmatic exacerbations and flares. However, according to the ISAAC protocol, centres with 1000 to 2999 participants are considered appropriate for comparisons of prevalence, but not severity, with centres in other regions.[2]

TABLE 3. Comparison of asthma symptom prevalences between primary school children and secondary school children*

	Primary	Secondary	Total	OR (95% CI)	P value
No.	1099† (51.24%)	1046‡ (48.76%)	2145 (100%)		
Wheezing ever	224 (20.38%)	126 (12.05%)	350 (16.32%)	1.87 (1.48-2.37)	<0.001
Wheezing in past year	68 (6.19%)	52 (4.97%)	120 (5.59%)	0.63 (0.40-1.00)	0.048
Wheezing episode in past year	24 (2.18%)	20 (1.91%)	44 (2.05%)	0.75 (0.22-2.57)	0.651
Woken by wheezing in past year	31 (2.82%)	13 (1.24%)	44 (2.05%)	2.80 (0.48-16.20)	0.237
Limitation of speech during wheezing in past year	7 (0.64%)	15 (1.43%)	22 (1.03%)	0.28 (0.11-0.76)	0.009
Asthma ever	61 (5.55%)	64 (6.12%)	125 (5.83%)	0.90 (0.63-1.30)	0.578
Has your child ever been diagnosed with bronchial hypersensitivity?	363 (33.03%)	116 (11.09%)	479 (22.33%)	3.94 (3.13-4.96)	<0.001
Has your child ever been hospitalised due to shortness of breath?	81 (7.37%)	45 (4.30%)	126 (5.87%)	1.76 (1.21-2.56)	0.003
Has your child ever been hospitalised due to lung problems other than shortness of breath?	83 (7.55%)	49 (4.68%)	132 (6.15%)	1.66 (1.15-2.39)	0.006
Has your child ever taken any medication?	299 (27.21%)	112 (10.71%)	411 (19.16%)	3.12 (2.46-3.95)	<0.001
Has your child taken any medication in the past year?	85 (7.73%)	28 (2.68%)	113 (5.27%)	3.04 (1.97-4.70)	<0.001
Exercise-induced wheezing in past year	82 (7.46%)	187 (17.88%)	269 (12.54%)	0.37 (0.28-0.49)	<0.001
Has your child experienced wheezing due to exposure to chlorine in swimming pools in the past year?	6 (0.55%)	15 (1.43%)	21 (0.98%)	0.38 (0.15-0.99)	0.039
Has your child experienced wheezing while swimming in the past year?	5 (0.45%)	23 (2.20%)	28 (1.31%)	0.21 (0.08-0.54)	<0.001
Nocturnal cough in past year	184 (16.74%)	111 (10.61%)	295 (13.75%)	1.69 (1.31-2.18)	<0.001

Abbreviations: 95% CI = 95% confidence interval; OR = odds ratio

* Data are shown as No. (%), unless otherwise specified

† The total is not 1100 as there was one missing datum

‡ The total is not 1048 as there were two missing data

TABLE 4. Comorbid atopic diseases in primary and secondary school children with asthma

	Primary		Secondary	
	No.	% of participants in group (% of asthma participants)	No.	% of participants in group (% of asthma participants)
Total participants	1100	100%	1048	100%
Asthma with or without co-morbidities	61	5.55%	64	6.11%
Asthma with co-morbidities	52	4.73% (85.25%)	50	4.77% (78.13%)
Asthma only	9	0.82% (14.75%)	14	1.34% (21.88%)
Asthma + eczema	11	1.00% (18.03%)	5	0.48% (7.81%)
Asthma + AR	9	0.82% (14.75%)	20	1.91% (31.25%)
Asthma + eczema + AR	32	2.91% (52.46%)	25	2.39% (39.06%)

Abbreviation: AR = allergic rhinitis

Age

Safiri et al[5] identified the highest asthma prevalence among 5- to 9-year-olds, which then decreased and remained stable until adulthood. A proportion of young children with wheezing may have 'transient wheezing' that does not progress to asthma.[4] This notion is consistent with our finding of less frequent symptoms in the past year among older children.[5] The prevailing view is that approximately 50% of preschool children with wheezing will progress to asthma by the time of primary school entry.[4] The prevalences of 12.05% and 6.12% for wheezing ever and asthma ever observed in our secondary school group are consistent with this view.

Sex

Our results showed a male predominance for asthma and wheezing in the primary school group, consistent

TABLE 5. Trends in prevalence and severity of asthma symptoms among primary and secondary school children

	2021 Primary (the current study)	2001 Primary (Lee et al[27])	1995 Primary (Lau and Karlberg[26])	2021 Secondary (the current study)	1995 Secondary (Leung et al[25])
Total No.	1099*	4448	3618	1046†	4665
Wheezing ever	20.38%	17.20%	16.80%	12.05%	20%
Wheezing in past year	6.19%	9.40%	9.20%	4.97%	12%
Wheezing episode in past year	2.18%	2.30%	2.30%	1.91%	4.40%
Woken by wheezing in past year	2.82%	4.00%	2.90%	1.24%	0.50%
Limitation of speech during wheezing in past year	0.64%	1.00%	0.80%	1.43%	2.40%
Asthma ever	5.55%	7.90%	7.80%	6.12%	11%
Exercise-induced wheezing in past year	7.46%	7.70%	7.10%	17.88%	29%
Nocturnal cough in past year	16.74%	26.00%	22.10%	10.61%	28%

* The total is not 1100 as there was one missing datum

† The total is not 1048 as there were two missing data

with existing literature.[29] Various mechanisms have been proposed to explain the post-pubertal shift towards female predominance due to sex hormone changes, genetic and epigenetic differences, co-morbidities, and socio-economic factors.[14] The significantly older age of wheezing onset reported in the secondary school group, along with the lower prevalence of wheezing ever in the secondary school group, may be attributable to recall bias due to the use of questionnaires, a limitation noted in other studies.[30]

Co-morbidities and exposure

Co-morbidities with other atopic diseases were common among our asthma participants; most participants in both groups had concomitant atopic dermatitis, allergic rhinitis, and asthma, consistent with previous reports.[8,16] Otherwise, our study did not identify relevant demographic characteristics or risk factors through statistical analysis that could predict wheezing episodes. Many studies have investigated various factors potentially associated with asthma diagnosis, wheezing, exercise-induced symptoms, and nocturnal cough. These factors include, but are not limited to, family history, recurrent respiratory infections, early-life severe respiratory syncytial virus infection, exposure to cigarette smoke, exposure to pets, incense burning, maternal education level, sex, race, vaccination rates, humidity, air pollution index (particulate matter) and exposure (particularly nitrogen dioxide and sulphur dioxide), exposure to indoor mould, farm residence, exposure to indoor endotoxins, socio-economic status, obesity, open fire cooking, nutritional levels, neonatal antibiotic use, delivery mode, urban living environment, psychosocial environment (including maternal stress), current paracetamol use, maternal antibiotic use during pregnancy, maternal vitamin D consumption during pregnancy, maternal weight gain during pregnancy, maternal paracetamol use during pregnancy, proton-pump inhibitor and H2-receptor antagonist use, and new immigrant status.[2-6,8-15,29] The next phase of our study will examine these predictive or protective factors; it will also explore risk factors unique to our population, including cultural perceptions,[18] feeding and weaning practices,[19,31] joss stick burning,[15] and exposure to traditional Chinese herbal medicine.[32,33]

Strengths and limitations

Study design and population demographics

Due to its survey approach, this study has limitations of recall bias and cross-sectional design. The estimations of symptom prevalence also lack objective confirmation through medical assessments and objective tests, which could lead to over- or underestimation of the asthmatic population; this aspect is further complicated by diagnostic discrepancies among medical professionals across regions and time periods.[4,34] Although our study population exceeded 1000 students per group, it was smaller than the original Hong Kong ISAAC studies, which included >3000[26] and 4000[25] participants, respectively. The paediatric population size has also significantly changed, according to the Hong Kong Population Census data: 86 000 13- to 14-year-olds in 1994 compared with 61 800 in 2021.[35] The male-to-female ratio of 1.67 and 0.74 in the primary and secondary school groups, respectively, differed from the 2021 census figures (1.063 and 1.067, respectively)[35]; therefore, our findings may not reflect the true prevalence and severity of asthma in the Hong Kong paediatric population, which represents a key limitation of the study. Although the ISAAC protocol acknowledges the impracticality of video questionnaires due to logistic or technical factors,[2]

exclusive use of the written questionnaire may have impacted our results; notably, a study has shown that video and written questionnaires are comparable.[23] The relatively large population size and the use of validated and standardised questionnaires may partially mitigate these limitations.

Response rates

In this study, response rates were lower than in the previous ISAAC studies (where rates >80% for most centres),[36] likely due to 'survey fatigue' and challenges in motivating participants during the COVID-19 pandemic. Similarly low response rates were observed in studies requesting parental completion of home questionnaires.[37] Although no significant differences in airway disease or symptom prevalences have been identified between non-responders and responders,[38] the lower response rates may have introduced selection bias into our study.

Physician practices

The increased prevalence of wheezing ever in the primary school group, decreased prevalence of wheezing ever in the secondary school group, decreased prevalences of asthma ever in both groups, and decreased symptom severity all reflect enhanced awareness and modified diagnostic practices among the general population and medical professionals.[4,11,13] Doctors are less likely to classify patients as 'asthmatic' without collecting a thorough clinical history and performing diagnostic testing, leading to a larger difference in the prevalences of wheezing and asthma.[11,13]

Coronavirus disease 2019 policies

The local COVID-19 policy, commonly known as the mask mandate, along with social isolation, increased awareness of infection control, changes in drug compliance, and enhanced hygiene practices, may have significantly reduced triggers for infectious and allergic airway diseases.[39,40] However, mechanisms linking COVID-19 to severe asthma risk have also been proposed.[41] These policies and social practices may explain the overall decreases in asthma prevalence and severity observed in our study. The timing of the study coincided with the COVID-19 pandemic, where the modified local health practices may have influenced trends concerning current asthma and airway symptoms.

Conclusion

This study provides an essential update regarding the prevalences of asthma and other respiratory symptoms among school children in Hong Kong. Our findings indicate overall decreasing trends in asthma severity and prevalence. A follow-up study will explore the protective and risk factors contributing to these trends.

Author contributions

Concept or design: JWCH Cheng, YP Tsang, YY Lam, AKY Chu, CHY Chan, YL Fung, PSY Chau, DCK Luk.
Acquisition of data: All authors.
Analysis or interpretation of data: All authors.
Drafting of the manuscript: JWCH Cheng, CSY Ng.
Critical revision of the manuscript for important intellectual content: JWCH Cheng, CSY Ng, CHY Chan, YL Fung.

All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have disclosed no conflicts of interest.

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Ethics approval

This research was approved by the Human Research Ethics Committee of The University of Hong Kong, Hong Kong (Ref No.: EA2002007). All study participants provided written consent for publication of their data which were de-identified in this article.

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