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Prevalence of Asthma and Comorbid Allergy Symptoms in Singaporean Preschoolers

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SUMMARY The cross-sectional prevalence of wheeze, rhinitis and eczema in 7,549 randomly selected Singaporean preschoolers aged 4 to 6 years old is reported in this study. Cumulative and past 12 months ('current') prevalence of wheeze was 27.5% and 16.0%, respectively. 'Asthma' was reported by 11.7%. Current rhinitis prevalence was 25.3% and rhinoconjunctivitis, 7.6%. Current chronic rash affected 13.5% of subjects while 9.9% reported chronic rash with flexural distribution. After multivariate analysis, the main risk factors for 'current wheeze' and self-reported asthma, respectively, were family history of allergy (adjusted odds ratio [aOR]3.22 [2.79-3.71], aOR3.93 [3.34-4.63]); concurrent rhinoconjunctivitis (aOR4.04 [3.31-4.92], aOR3.02 [2.43-3.76]); concurrent chronic flexural rash (aOR2.56[2.13-3.08], aOR2.95[2.41-3.62]) and previous respiratory infection (aOR4.80[4.17-5.53], aOR3.28 [2.80-3.85]). Thus, these allergy-associated symptoms already affect a considerable portion of children by the preschool years, supporting the need for allergy education and intervention program in this age group.

Epidemiological studies on pediatric asthma are mostly focused on children aged seven and above as the working definition of asthma as "wheezy symptoms" correlates well with the diagnosis of asthma in this age group.[1,2] Information on asthma in younger pre-school children remains inadequate since early life wheeze can be due to a variety of causes such as respiratory infections in addition to asthma.[3-5] Nevertheless, wheeze is a common source of morbidity in pre-school children regardless of cause and often treated with asthma medication.[3,6] Moreover, it has also been suggested that early recognition and intervention may improve the prognosis.[7,8] Concomitant presence of atopic disease such as allergic rhinitis and eczema was also shown to be associated with the presence of wheeze and poorer prognosis of asthma in children.[9-11] Since this age group is an important phase in the development of allergies in childhood, this paper documents for the first time asthma symptom prevalence and the associated risk factors in Singaporean preschoolers, adding to the limited data on allergy prevalence in the preschool age group in South East Asia.[12]

MATERIALS AND METHODS

Children born between 1994-1996, corresponding to 4-6 years of age, were recruited through randomly selected preschools. Participating preschools were responsible for distributing and collecting the completed questionnaires from the parents of the pre-schoolers during the months of January to May in year 2000.

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A standardized and validated questionnaire on asthma, rhinitis and eczema was adapted from the International Study of Asthma and Allergies in Childhood (ISAAC) core questionnaire.[1] Since asthma is not well defined in this preschool age group, respiratory symptoms such as wheezing, 'whistling sounds in the chest', dry nocturnal cough and exercise-induced wheeze were regarded only as 'asthma-like' while the question 'has your child ever had asthma' was used to infer doctor-diagnosed asthma as per the ISAAC definition. Rhinitis as a symptom was indicated by the presence of 'sneezing or a runny or blocked nose in the absence of a cold or a flu'; allergic rhinitis was defined as rhinitis accompanied by itchy-watery eyes (rhinoconjunctivitis). Eczema was defined as a chronic rash lasting at least 6 months and considered to be indicative of atopic eczema if this chronic rash appeared on 'the folds of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, cheeks, ears or eyes' (chronic flexural rash). 'Current' was defined as occurrence in the past 12 months. Questionnaires were also translated into Mandarin and Malay. Inconsistent response or null response to the stem questions for asthma, allergic rhinitis and eczema were excluded from analysis.

Demographic factors investigated included race (the three main ethnic groups in Singapore are Chinese, Malay and Indian); gender and age. Socio-economic status was categorized by total monthly family income grouped into < S$2,000, S$2,000-3,999 and > S$4,000 to approximate the bottom 25th centile, 25th-50th centile and top 50% centile according to national statistics at the time of the study.[13] Other parameters investigated include family size, birth order, number of fever episodes in the first three years of life, number of antibiotic courses in the first year of life, history of respiratory infection (bronchitis, bronchiolitis, croup and pneumonia), premature birth, parental smoking during the past 12 months and during child's first 18 months of life, whether child was breastfed, parental history of asthma, allergic rhinitis and atopic dermatitis (collectively analyzed as parental history of allergy). Bivariate analyses were performed using chi-square test or t-test where appropriate using PROC FREQ from SAS Statistical Package. Logistic regression analyses using PROC LOGISTIC were adjusted for age, gender, ethnic group and family's total monthly income.

RESULTS

The response rate was 72.56% (8,057/ 11,103), of which 7,594 children were aged between 4 to 6 years at time of study. The majority (96%) of questionnaires returned were in English. The prevalence of respiratory symptoms, self-reported asthma and indicators of respiratory morbidity are listed in Table 1. We further defined 'likely asthma' in this preschool age group as recurrent wheeze occurring more than three times in the past year and accompanied by another atopic symptom (rhinoconjunctivitis and/or chronic flexural rash); this was reported by 1.8% (n = 138/7,361). Additionally, rhinitis was reported by 25.3% (n = 1,857) of the respondents although only 7.6% (n = 555) reported concurrent itchy-eyes (rhinoconjunctivitis). Current chronic rash affected 13.5% (n = 1,026) of subjects while 9.9% (n = 709) reported chronic rash with flexural distribution.

Current wheeze and self-reported asthma are the outcomes of interest. Table 2 lists the prevalence of these symptoms by demography, socio-economic factors and other risk factors; Table 3 lists the crude and adjusted odds ratios after multivariate analysis. Younger children were significantly ($p < 0.05$) more prone to current wheeze in both bivariate and multivariate analyses. In the multivariate model, the 4 year olds remained significantly less likely to report asthma (adjusted odds ratio [aOR] 0.65, 95% CI: 0.53-0.79) than the 6 year olds. Boys and higher family income also remained as significant risk factors for current wheeze and self-reported asthma in the multivariate models. Self-reported asthma appears to be significantly associated with larger family size or birth order in the bivariate analyses (Table 2) which became insignificant in the multivariate model (Table 3). There is no significant relationship ($p > 0.05$) between self-reported asthma and ethnicity. Neither were there significant trends ($p > 0.05$) between current wheeze with family size or birth order, and in the multivariate model, ethnic groups (Table 3).

Table 1 Prevalence of respiratory symptoms, self-reported asthma, and indicators of morbidity in wheezy children

	Prevalence n (%)
Respiratory symptoms (n = 7,361)	
Ever wheezed	2,024 (27.5)
Current wheeze	1,177 (16.0)
Wheeze when exercising	355 (4.7)
Current persistent nocturnal cough	2,077 (28.2)
Self-reported asthma	858 (11.7)
Symptoms of respiratory morbidity in wheezy children	
Frequency of wheezy attacks in past 12 months (n =1,166)	
1-3 attacks	950 (81.5)
4-12 attacks	156 (13.4)
>12 attacks	23 (2.0)
Woken by wheeze (n=1,159)	
< 1 per week	351 (30.3)
> 1 per week	140 (12.1)
Limited speech during attack (n = 1,168)	81 (6.93)

Analyses on parental smoking were limited to fathers as a very small proportion of Singaporean mothers were current smokers (n = 189). Nearly 30% (n = 2,089) of the fathers were smokers since their child's birth and the great majority (n = 2,003) were still smoking in the past 12 months. An inverse significant relationship exists between paternal smoking with current wheeze and self-reported asthma (Table 2), which became insignificant after multivariate analysis (Table 3).

While breastfeeding appears to be a risk factor for wheezing (Table 2), this relationship holds only for children without a family history of allergy (results not shown). Therefore, in our population, breastfeeding has no influence, whether positive or negative, on wheeze in children with atopic parents. Moreover, in the group of children who were breastfed, length of breastfeeding (< 2 or ≥ 2 months) did not exert a significant influence ($p > 0.05$) on wheeze and self-reported asthma prevalence (results not shown).

The parameters which carry the greatest risks for both current wheeze and self-reported asthma are family history of allergy, concurrent rhinoconjunctivitis, concurrent eczema, previous respiratory infection, multiple fever episodes in the first three years of life and greater antibiotic consumption in the first year of life. Their influence was observed to be independent of demography and socioeconomic status; their odds ratios remained consistent even after adjustment.

DISCUSSION

Singapore's current wheeze prevalence in preschoolers is on par with that of African- and Hispanic-Americans (16.0%), the United Kingdom (13.0%) and Canada (13.0%).[6,14-15] However, a fair comparison between studies could not be done as the age range of preschoolers selected for each study were not identical although they did overlap. Also, the studies were carried out at different time points. Nevertheless, these figures ranked mid-way between a low of 4% with current wheeze reported for Norwegian 4/5 year olds, and the high of 21.1% and 26.9% reported by Brazilian and Australian preschoolers, respectively.[16-17]

Table 2 Bivariate comparison and prevalence of current wheeze and self-reported asthma

	Current wheeze				Self-reported asthma			
	N	(%)	%	*p*-value	N	(%)	%	*p*-value
Age (years)								
4	2,183	(29.8)	18.5	< 0.0001	2,085	(29.7)	9.6	< 0.0001
5	2,556	(34.9)	16.1		2,436	(34.7)	12.7	
6	2,591	(35.3)	14.0		2,496	(35.6)	13.9	
Sex								
Male	3,797	(52.2)	18.1	< 0.0001	3,628	(52.1)	14.1	< 0.0001
Female	3,479	(47.8)	13.9		3,337	(47.9)	10.2	
Race								
Chinese	5,773	(81.4)	16.5	0.049	5,583	(82.2)	12.0	0.9746
Malay	896	(12.6)	12.9		808	(11.9)	15.2	
Indian	420	(5.9)	15.2		400	(5.9)	9.3	
Family Income								
< $2,000/month	1,544	(21.5)	8.5	< 0.0001	1,440	(21)	11.3	0.0536
$2-4,000/month	2,056	(28.7)	12.8		1,955	(28.5)	11.0	
> $ 4,000/month	3,574	(49.8)	21.1		3,475	(50.6)	13.2	
Family size								
≤ 3 persons	764	(11.1)	16.6	0.3554	721	(10.9)	10.0	0.0195
4	2,194	(31.8)	15.2		2,093	(31.7)	11.4	
5	1,872	(27.2)	17.2		1,803	(27.3)	13.5	
≥ 6	2,061	(29.9)	16.7		1,983	(30)	12.9	
Birth order								
1st born	3,351	(46.1)	16.7	0.1455	3,218	(46.2)	11.5	0.0445
2nd born	2,573	(35.4)	15.9		2,478	(35.6)	12.5	
3rd born or higher	1,348	(18.5)	15.0		1,274	(18.3)	13.6	
Age when entering daycare								
≤ 2 years old	2,251	(30.7)	18.1	< 0.0001	2,150	(30.6)	12.0	0.6212
3 years old	2,876	(39.2)	17.1		2,778	(39.6)	13.0	
4 years old or older	2,203	(30.1)	12.6		2,089	(29.8)	11.5	
Ever breast-fed								
No	2,517	(34.9)	12.7	< 0.0001	2,420	(35)	11.8	0.464
Yes	4,694	(65.1)	17.9		4,486	(65)	12.4	
Ever had respiratory infection								
No	5,825	(79.5)	10.4	< 0.0001	5,563	(79.3)	8.9	< 0.0001
Yes	1,502	(20.5)	38.0		1,454	(20.7)	24.8	
Fever in first 3 years of life								
Never	1,989	(28.1)	12.4	< 0.0001	1,897	(27.9)	8.8	< 0.0001
1 time	3,548	(50.1)	16.1		3,404	(50.1)	12.7	
≥ 2 times	1,550	(21.9)	20.9		1,494	(22)	15.7	
Antibiotics in 1st year of life								
0 course	1,102	(15.8)	5.6	< 0.0001	1,045	(15.6)	7.1	< 0.0001
1 course	4,578	(65.6)	14.6		4,381	(65.5)	11.5	
> 1 course	1,300	(18.6)	31.5		1,267	(18.9)	19.3	
Father who smokes								
No	5,244	(71.5)	17.3	< 0.0001	5,038	(71.8)	12.4	0.0277
Yes	2,086	(28.5)	13.0		1,979	(28.2)	11.9	
Current rhinoconjunctivitis								
No	6,581	(92.5)	14.1	< 0.0001	6,302	(92.4)	10.8	< 0.0001
Yes	532	(7.5)	39.9		518	(7.6)	28.0	
Current chronic flexural rash								
No	6,312	(90.1)	14.0	< 0.0001	6,071	(90.2)	10.5	< 0.0001
Yes	695	(9.9)	30.8		662	(9.8)	25.4	
Family history of allergies								
No	4,960	(73.7)	11.0	< 0.0001	4,727	(73.3)	7.8	< 0.0001
Yes	1,767	(26.3)	30.1		1,720	(26.7)	24.4	

Table 3 Crude and adjusted odds ratios of multivariate analyses for current wheeze and self-reported asthma

	Current wheeze		Self-reported asthma	
	cOR*	aOR**	cOR*	aOR**
Sex				
Female	1.00	1.00	1.00	1.00
Male	1.36 (1.20-1.55)	1.35 (1.18-1.54)	1.44 (1.25-1.67)	1.48 (1.27-1.72)
Age				
4	1.39 (1.19-1.63)	1.36 (1.16-1.60)	0.66 (0.55-0.79)	0.65 (0.53-0.79)
5	1.18 (1.02-1.38)	1.20 (1.02-1.41)	0.90 (0.76-1.06)	0.92 (0.77-1.09)
6	1.00	1.00	1.00	1.00
Race				
Chinese	1.33 (1.08-1.64)	0.86 (0.68-1.07)	0.76 (0.62-0.94)	0.68 (0.54-0.85)
Malay	1.00	1.00	1.00	1.00
Indian	1.21 (0.87-1.68)	0.99 (0.70-1.39)	0.57 (0.39-0.84)	0.58 (0.39-0.87)
Family Income				
< $2,000/month	1.00	1.00	1.00	1.00
$2-4,000/month	1.57 (1.26-1.96)	1.57 (1.26-1.98)	0.97 (0.78-1.20)	1.06 (0.84-1.32)
> $4,000/month	2.87 (2.36-3.48)	2.97 (2.41-3.66)	1.19 (0.99-1.44)	1.35 (1.10-1.66)
Family history of allergy				
No	1.00	1.00	1.00	1.00
Yes	3.48 (3.04-3.98)	3.22 (2.79-3.71)	3.79 (3.26-4.42)	3.93 (3.34-4.63)
Current rhinoconjunctivitis				
No	1.00	1.00	1.00	1.00
Yes	4.04 (3.35-4.87)	4.04 (3.31-4.92)	3.20 (2.60-3.94)	3.02 (2.43-3.76)
Current chronic flexural rash				
No	1.00	1.00	1.00	1.00
Yes	2.73 (2.29-3.26)	2.56 (2.13-3.08)	2.90 (2.39-3.52)	2.95 (2.41-3.62)
Ever had respiratory infection				
No	1.00	1.00	1.00	1.00
Yes	5.29 (4.62-6.04)	4.80 (4.17-5.53)	3.37 (2.90-3.91)	3.28 (2.80-3.85)
Fever in first 3 years of life				
Never	1.00	1.00	1.00	1.00
1 time	1.36 (1.16-1.60)	1.30 (1.10-1.54)	1.51 (1.25-1.83)	1.50 (1.23-1.82)
≥ 2 times	1.87 (1.56-2.24)	1.78 (1.47-2.16)	1.93 (1.57-2.39)	1.91 (1.54-2.38)
Antibiotic courses in 1st year of life				
Never	1.00	1.00	1.00	1.00
1 time	2.86 (2.19-3.74)	2.69 (2.00-3.61)	1.71 (1.33-2.20)	1.81 (1.38-2.37)
2 or more times	7.73 (5.83-0.24)	6.61 (4.85-9.01)	3.15 (2.39-4.14)	3.37 (2.50-4.54)
Age when entering daycare				
≤ 2 years old	1.00	1.00	1.00	1.00
3 years old	1.54 (1.30-1.82)	1.13 (0.94-1.36)	1.05 (0.87-1.27)	1.13 (0.92-1.38)
≥ 4 years old	1.44 (1.22-1.68)	1.10 (0.93-1.31)	1.15 (0.96-1.37)	1.21 (1.00-1.46)
Family size				
≤ 3	1.00	1.00	1.00	1.00
4	0.90 (0.72-1.12)	0.91 (0.72-1.15)	1.16 (0.88-1.54)	1.13 (0.85-1.51)
5	1.04 (0.83-1.31)	1.00 (0.79-1.27)	1.40 (1.06-1.86)	1.29 (0.97-1.73)
≥ 6	1.01 (0.80-1.26)	0.94 (0.75-1.19)	1.33 (1.01-1.75)	1.27 (0.95-1.70)
Breast-feeding				
No	1.00	1.00	1.00	1.00
Yes	1.49 (1.30-1.72)	1.29 (1.11-1.51)	1.06 (0.91-1.24)	1.02 (0.86-1.20)
Father is a smoker				
No	1.00	1.00	1.00	1.00
Yes	0.72 (0.62-0.83)	0.87 (0.74-1.02)	096 (0.81-1.12)	0.97 (0.81-1.15)

*cOR, crude odds ratio; aOR**, adjusted odds ratio, is based on a basic multivariate model controlling for sex, age, race and family's total monthly income.

The prevalence of current wheeze appears to be higher in our preschool age group (16.0%) compared to the 6 to 7 year olds (10.2%) surveyed during Singapore's participation in Phase III of the International Study of Asthma and Allergy in Childhood (ISAAC) in year 2001.[18] Within the preschool age group, the four year olds have the highest likelihood of having current wheeze (aOR1.3) although 'asthma' as a diagnostic label was also most conservatively applied to them (aOR 0.65). Indeed, bronchitis, bronchiolitis, pneumonia and croup were observed to be most common in the first three years of life (results not shown) and were strongly associated with wheeze in our subjects, reflecting the heterogeneous origins of early life wheeze.[19] Nevertheless, this does not exclude the possibility that wheezy respiratory infections in the first years of life may eventually be diagnosed as asthma in a subset of susceptible children.[20-24]

Our results are also consistent with observations on school age children in ISAAC Phase I where self-reported asthma and symptom prevalence do not differ between ethnicity.[25] Interestingly, although Singapore and Malaysia are in close proximity to each other, the prevalence of current wheeze in Singaporean preschoolers (16%) was much higher than Malaysia's (6.2%),[12] a disparity consistently seen in the school age children surveyed in both ISAAC Phases I and III.[2,26] It might be argued that ethnicity is one of the influencing factors since the major ethnic group in Singapore is the Chinese (78.7% in this study) and in Malaysia, the Malays (99.1%) but this is an unlikely explanation.[27] The higher prevalence in Singapore compared to Malaysia is a real phenomenon since 12.9% of Singaporean Malay children reported wheeze, a proportion insignificantly different from the Chinese or Indians in Singapore (Tables 2 and 3). As Singapore and Malaysia are in close proximity geographically and share similar climate, other environmental or living conditions could be possible factors. These include the relatively more urbanized living condition and higher living density in Singapore. This follows the consistent trend of asthma, atopy and airway hyperresponsiveness being more common in urban than rural areas.[28-30]

Similar to observations made in previous local surveys as well as in other countries, affluence is an associated risk of wheeze and self-reported asthma in our preschoolers.[11,31-34] Environmental and lifestyle differences such as diet, pet-keeping and air-conditioned environment between the socio-economic groups are contending explanations of the higher risk associated with affluence but such multifactorial interaction is difficult to resolve. Our observations also support previous reports of asthma having a higher likelihood of occurring in males than in females during the preschool years.[35] The susceptibility of males to wheezing can be explained by the smaller airways found in males compared to females in early life, predisposing them to respiratory infections and poorer lung function.[36,37] Also, parental history of allergy and comorbid allergy symptoms (rhinoconjunctivitis and chronic flexural rash) are strongly associated with current wheeze and self-reported asthma, illustrating the role of genetics in asthma which has been indicated by familial clustering as well as co-presence of other allergies in the asthmatic.[9-11,16,38-40]

Meta-analyses have estimated that exclusive breastfeeding in the first months of life have a protective effective against asthma, with a greater effect in children with a family history of atopy.[41,42] However, our data adds to the accumulating evidence challenging this paradigm.[43,44] Adding to the confusion, studies which observed breastfeeding as a risk factor for wheeze, found either an independent or a dependent relationship with parental history.[45-47] More work is required to elucidate possible mechanisms to explain the relationship between breastfeeding and asthma.

Our findings showed that symptoms of asthma, allergic rhinitis and atopic dermatitis affect a significant proportion of preschoolers in Singapore. Although wheeze was commonly caused by respiratory infection especially in the younger preschoolers, wheeze in older preschoolers was more likely to be diagnosed as asthma. Thus, there is value in implementing allergy education and intervention program for children by the preschool years as early detection and intervention can promote better prognosis in later life.[7,8]

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