

Primary care

Factors associated with difference in prevalence of asthma in children from three cities in China: multicentre epidemiological survey

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Abstract

Objective To determine the factors associated with difference in prevalence of asthma in children in different regions of China.

Design Multicentre epidemiological survey.

Setting Three cities in china.

Participants 10 902 schoolchildren aged 10 years.

Main outcome measures Asthma and atopic symptoms, atopic sensitisation, and early and current exposure to environmental factors.

Results Children from Hong Kong had a significantly higher prevalence of wheeze in the past year than those from Guangzhou and Beijing (odds ratio 1.64, 95% confidence interval 1.35 to 1.99). Factors during the first year of life and currently that were significantly associated with wheeze were cooking with gas (odds ratio 2.04, 1.34 to 3.13), foam pillows (2.58, 1.66 to 3.99), and damp housing (1.89, 1.26 to 2.83). Factors protecting against wheeze were cotton quilts and the consumption of fruit and raw vegetables.

Conclusion Environmental factors and diet may explain the differences in prevalence of asthma between children living in different regions of China.

Introduction

The factors related to the increasing prevalence of asthma are largely unknown, probably because they are so widespread that it is difficult for epidemiological studies to identify them. In China the prevalence of asthma seems to be lower than in the West.¹ Children aged 13 and 14 years in Hong Kong were found to have a higher prevalence of wheeze over one year than children in mainland China.² Using the phase II protocol from the international study of asthma and allergies in childhood, we compared the environmental and lifestyle factors related to asthma in children from Hong Kong and "mainland China" (areas of China not in the special administrative region of Hong Kong).³

Methods

Our study took place in three Chinese cities: Hong Kong and Guangzhou, which have a subtropical

climate, and Beijing, located in the temperate zone. The participants and methods are reported elsewhere.⁴ Briefly, we randomly selected primary schools from the three cities and recruited children aged 10 years. A questionnaire was completed by the parents or guardians of each child.

We randomly selected subgroups of children from each city to undergo a skin prick test for sensitivity to eight common aeroallergens (see bmj.com).⁵ Children with one or more positive reactions were considered atopic. We classified symptoms as current if they occurred in the past year. Asthma was defined as asthma ever if diagnosed sometime by a doctor and current asthma if current wheeze occurred in addition to asthma ever.

Exposures analysed in the participants' first year of life and currently were cooking with gas, foam pillows, cotton quilts, damp housing (mould on ceiling or walls), pets, and contact with cats, dogs, or farm animals. We also considered the consumption of fruit and raw vegetables.

We created a propensity score ("mainland propensity score") for children from Guangzhou and Beijing to reduce the chance of bias from differences in distribution of factors between the cities.⁶ We evaluated the associations between current wheeze and environmental factors and diet by using multiple logistic regression analyses adjusted for this score and sex. Identified factors were included in a multiple logistic regression model, adjusted for propensity score and sex. We also used a step by step modelling approach to investigate the "protective mainland effect"; initially we estimated an unadjusted mainland effect then we adjusted for the propensity score. In each subsequent model we added the environmental or dietary factor that led to the highest reduction in the Akaike's criterion at that particular step.⁷

Results

Overall, 10 902 of 11 608 (93.9%) children took part in the survey, of whom 3483 underwent a skin prick test.



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Table 1 Prevalence of asthma symptoms and atopic sensitisation in schoolchildren from three cities in China

Characteristic	Hong Kong (n=3110)		Beijing (n=4227)		Guangzhou (n=3565)	
	No of children	Prevalence (95% CI)	No of children	Prevalence (95% CI)	No of children	Prevalence (95% CI)
Mean (SD) age (years)		10.3 (0.7)		10.4 (0.6)		10.1 (0.4)
No (%) boys		1648 (52.9)		2156 (51.0)		1783 (50.0)
Symptoms in past year:						
Wheeze:	179	5.8 (4.9 to 6.6)	159	3.8 (3.2 to 4.3)	121	3.4 (2.8 to 4.0)
≥4 attacks	40	1.3 (0.9 to 1.7)	33	0.8 (0.5 to 1.1)	18	0.5 (0.3 to 0.7)
Speech limiting	54	1.7 (1.3 to 2.2)	20	0.5 (0.3 to 0.7)	16	0.4 (0.2 to 0.7)
Exercise induced	239	7.7 (6.7 to 8.6)	193	4.6 (3.9 to 5.2)	109	3.1 (2.5 to 3.6)
Current asthma	104	3.3 (2.7 to 4.0)	98	2.3 (1.9 to 2.8)	75	2.1 (1.6 to 2.6)
Skin prick test*:						
Atopic†	552	41.2 (38.5 to 43.8)	249	23.9 (21.3 to 26.4)	337	30.8 (28.1 to 33.5)
<i>Dermatophagoides pteronyssinus</i>	457	34.1 (31.5 to 36.6)	78	7.5 (5.9 to 9.1)	219	20.0 (17.6 to 22.4)
<i>Dermatophagoides farinae</i>	347	25.9 (23.5 to 28.2)	59	5.7 (4.3 to 7.1)	196	17.9 (15.6 to 20.2)
Cat	50	3.7 (2.7 to 4.7)	58	5.6 (4.2 to 6.9)	47	4.3 (3.1 to 5.5)
Cockroach	154	11.5 (9.8 to 13.2)	139	13.3 (11.3 to 15.4)	186	17.0 (14.8 to 19.2)

*Sensitivities <3% not shown.

†One or more positive test results.

Table 1 summarises the prevalence of asthma symptoms and atopic sensitisation in the study populations. The prevalence of wheeze in the past year was significantly higher in children from Hong Kong (odds ratio 1.64, 95% confidence interval 1.35 to 1.99). Other symptoms, such as exercise induced wheeze, were also significantly more common in children from Hong Kong. After adjustment for the propensity score, six factors were related to current wheeze: cooking by gas, foam pillows, cotton quilts, damp housing, consumption of fruit more than once a day, and consumption of raw vegetables once or more a week (table 2). Foam pillows and cooking with gas were associated with the highest risk for current wheeze.

After adjustment for the propensity score and sex, factors that remained significantly associated with current wheeze were cooking with gas, foam pillows, damp housing, and consumption of fruit. The association between cotton quilts and current wheeze was of borderline significance. Living in Guangzhou or Beijing was associated with a significantly reduced risk of current wheeze (odds ratio 0.61, 95% confidence interval 0.49 to 0.77; see [bmj.com](#)).

Discussion

Environmental factors and diet can explain the difference in prevalence of asthma in children living in

Table 2 Associations of environmental and dietary exposure factors and current wheeze in Chinese schoolchildren, adjusted for mainland propensity score (see text) and sex

Exposure factor	Univariate model			Multivariate model		
	Unadjusted prevalence of current wheeze	Adjusted odds ratio (95% CI)	P value	Unadjusted prevalence of current wheeze	Adjusted odds ratio (95% CI)	P value
Cooking with gas:						
None	24/1142 (2.1)	1.0		24/1058 (2.3)	1.0	
During first year but not at present	9/207 (4.3)	2.11 (0.97 to 4.61)	0.001	6/186 (3.2)	1.53 (0.61 to 3.80)	0.004
At present only	71/1957 (3.6)	1.44 (0.89 to 2.33)		55/1609 (3.4)	1.40 (0.85 to 2.31)	
At present and during first year	298/6316 (4.7)	2.04 (1.34 to 3.13)		255/5470 (4.7)	2.00 (1.29 to 3.09)	
Foam pillow:						
None	329/847 (3.9)	1.0		287/7571 (3.8)	1.0	
During first year but not at present	1/25 (4.0)	1.04 (0.14 to 7.71)	<0.001	1/21 (4.8)	1.43 (0.19 to 10.85)	0.002
At present only	39/681 (5.7)	1.24 (0.87 to 1.79)		27/529 (5.1)	1.04 (0.67 to 1.61)	
At present and during first year	26/236 (11.0)	2.58 (1.66 to 3.99)		25/202 (12.4)	2.49 (1.55 to 3.98)	
Cotton quilt:						
None	75/1167 (6.4)	1.0		60/939 (6.4)	1.0	
During first year but not at present	29/895 (3.2)	0.58 (0.37 to 0.91)	0.036	22/793 (2.8)	0.51 (0.31 to 0.86)	0.062
At present only	23/531 (4.3)	0.61 (0.38 to 0.98)		14/392 (3.6)	0.64 (0.35 to 1.18)	
At present and during first year	273/7016 (3.9)	0.72 (0.54 to 0.97)		244/6199 (3.9)	0.82 (0.59 to 1.14)	
Damp housing:						
None	294/7774 (3.8)	1.0		255/6788 (3.8)	1.0	
During first year but not at present	31/664 (4.7)	1.31 (0.90 to 1.92)	<0.001	29/616 (4.7)	1.41 (0.94 to 2.09)	0.012
At present only	43/641 (6.7)	1.67 (1.19 to 2.33)		32/556 (5.8)	1.44 (0.98 to 2.12)	
At present and during first year	28/400 (7.0)	1.89 (1.26 to 2.83)		24/363 (7.0)	1.78 (1.15 to 2.75)	
Fruit more than once daily:						
No	285/6203 (4.6)	1.0		247/5436 (4.5)	1.0	
Yes	116/3442 (3.4)	0.71 (0.57 to 0.89)	0.003	93/2887 (3.2)	0.70 (0.54 to 0.89)	0.004
Raw vegetables once or more a week:						
No	208/4458 (4.7)	1.0		196/4228 (4.6)	1.0	
Yes	162/4696 (3.4)	0.80 (0.65 to 1.00)	0.048	144/4095 (3.5)	0.81 (0.64 to 1.03)	0.082

Hong Kong and mainland China (Beijing and Guangzhou). Asthma is more common in developed countries. Because of economic improvements in mainland China, many of its cities are at different stages of modernisation. As the participants had the same genetic background, the differences in prevalence of asthma are likely to be due to exposure to different environmental factors.

Our large scale study used the standardised phase II protocol of the international study of asthma and allergies in childhood to evaluate environmental and lifestyle factors associated with asthma in schoolchildren recruited from three Chinese cities.³ Asthmatic symptoms occurring in the past year were up to three times more common in children from Hong Kong than in those from the other two cities. To avoid bias from differences in the distribution of factors associated with living in mainland China, we created a propensity score from 13 variables identified by logistic regression, and we adjusted for this score. Six factors were significantly associated with current wheeze and current asthma: cooking with gas, foam pillows, cotton quilts, damp housing, consumption of fruit more than once a day, and consumption of raw vegetables once or more a week. Of these, only foam pillows and the consumption of raw vegetables were associated with a positive skin prick test result.

It is unlikely that missing data would have led to major bias. Although questionnaires were returned for 10 902 participants, we included only 8323 (76.3%) in our multivariate analysis with all six factors in one model and 9154 to 9645 (83.9% to 88.5%) in the univariate analyses. The results for both models were consistent. Furthermore, the prevalence of asthma symptoms not included in the risk factor analyses was similar to the prevalence of those included in the multivariate analysis.

Cooking with gas was strongly associated with current wheeze. Studies in England and Canada have reported a higher prevalence of asthma in young people exposed to cooking with gas at home.⁸⁻¹⁰ A recent study also found an association between cooking with gas at home and sensitisation to house dust mite and reduction of lung function in children.¹¹ It should be noted that homes in China are generally smaller than those in England and Canada. The possible effects of cooking with gas are therefore likely to be less pronounced in British and Canadian homes.

Foam pillows were strongly associated with current wheeze. Traditionally, cotton has been the most common material used for pillows and bedding in China. Several studies have shown an association between synthetic bedding and asthma in children.¹²⁻¹³ Studies of asthma in both children and adults have shown an association with damp housing.¹⁴⁻¹⁵ In our survey, damp housing was more common in Hong Kong than in mainland China (17.0% v 8.3%).

Frequent consumption of fruit and raw vegetables was associated with a reduced risk of wheezing. A case-control study of 1471 adults in south London and a recent study of young adults in Australia found that the consumption of fruit or vegetables was associated with a lower prevalence of asthma.¹⁶⁻¹⁷ Our final analysis showed that children living in Guangzhou and Beijing had a 40% lower risk of current wheeze than children in Hong Kong.

What is already known on this topic

The prevalence of asthma has increased over the past three decades in many countries

This prevalence differs widely between developing and developed countries

No studies have identified the factors associated with this difference

What this study adds

The prevalence of asthma and atopic symptoms is higher in children in Hong Kong than those in mainland China

Factors related to the environment and diet could explain this difference

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- 1 International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema. *Lancet* 1998;351:1125-32.
- 2 Leung R, Wong G, Lau J, Ho A, Chan JK, Choy D, et al. Prevalence of asthma and allergy in Hong Kong schoolchildren: an ISAAC study. *Eur Respir J* 1997;10:354-60.
- 3 International study of asthma and allergies in childhood. isaac.auckland.ac.nz/Phasetwo/Modules/ModFrame.html (accessed 14 Aug 2004).
- 4 Wong GWK, Hui DSC, Chan HH, Fok TF, Leung R, Zhong NS, et al. Prevalence of respiratory and atopic disorders in Chinese schoolchildren. *Clin Exp Allergy* 2001;31:1225-31.
- 5 Wong GW, Li ST, Hui DS, Fok TF, Zhong NS, Chen YZ, et al. Individual allergens as risk factors for asthma and bronchial hyperresponsiveness in Chinese children. *Eur Respir J* 2002;19:288-93.
- 6 D'Agostino RB Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. *Stat Med* 1998;17:2265-81.
- 7 Greenland S. In: Rothman KJ, Greenland S, eds. *Modern epidemiology*. 2nd ed. New York: Lippincott, Williams, Wilkins, 1998.
- 8 Dekker C, Dales R, Bartlett S, Brunekreef B, Zwanenburg H. Childhood asthma and the indoor environment. *Chest* 1991;100:922-6.
- 9 Jarvis D, Chinn S, Luczynska C, Burney P. Association of respiratory symptoms and lung function in young adults with use of domestic gas appliances. *Lancet* 1996;347:426-31.
- 10 Burr ML, Anderson HR, Austin JB, Harkins LS, Kaur B, Strachan DP, et al. Respiratory symptoms and home environment in children: a national survey. *Thorax* 1999;54:27-32.
- 11 Ponsionby AL, Dwyer T, Kemp A, Couper D, Cochrane J, Carmichael A. A prospective study of the association between home gas appliance use during infancy and subsequent dust mite sensitization and lung function in childhood. *Clin Exp Allergy* 2001;31:1544-52.
- 12 Strachan DP, Carey IM. Home environment and severe asthma in adolescence: a population based case-control study. *BMJ* 1995;311:1053-6.
- 13 Strachan DP, Carey IM. Reduced risk of wheezing in children using feather pillows is confirmed. *BMJ* 1997;314:518.
- 14 Andrae S, Axelson O, Bjorksten B, Fredriksson M, Kjellman NI. Symptoms of bronchial hyperreactivity and asthma in relation to environmental factors. *Arch Dis Child* 1988;63:473-8.
- 15 Brunekreef B, Dockery DW, Speizer FE, Ware JH, Spengler JD, Ferris BG. Home dampness and respiratory morbidity in children. *Am Rev Respir Dis* 1989;140:1363-7.
- 16 Shaheen SO, Sterne JA, Thompson RL, Songhurst CE, Margetts BM, Burney PG. Dietary antioxidants and asthma in adults: population-based case-control study. *Am J Respir Crit Care Med* 2001;164:1823-8.
- 17 Woods RK, Walters EH, Raven JM, Wolfe R, Ireland PD, Thien FC, et al. Food and nutrient intakes and asthma risk in young adults. *Am J Clin Nutr* 2003;78:414-21.

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