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Increasing prevalence of asthma and allergy in Beijing pre-school children: Is exclusive breastfeeding for more than 6 months protective?

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This study evaluated the prevalence and risk factors for asthma, allergy and related symptoms; and breastfeeding patterns and durations for 5479 Beijing children aged 3–6. Parents of children in randomly selected kindergartens wrote responses to a questionnaire used previously. The study aimed to evaluate trends in the prevalence of asthma and related illnesses, and to determine whether "more" breastfeeding, defined as exclusive, > 6 months, was associated with reduced prevalence. Asthma has increased in this age group between 1990 and 2011, with the steepest increase in the last 2–3 years. Of the total, 14.2% (779) children were breastfed exclusively for > 6 months. The efficacy of "more" breastfeeding was tested in a subset with two strong risk factors, positive family history (for asthma and/or allergy) and male gender. "More" breastfeeding was found to be significantly protective (aOR 0.42, $P < 0.05$) for this subset against Doctor-diagnosed asthma (D-asthma). Protection that did not reach statistical significance was also found for this subset against Wheeze ever, Cough at night, Rhinitis ever, Doctor-diagnosed rhinitis (D-rhinitis) and Eczema. The greatest protective effects were found for girls with no family history of asthma or allergy, reaching statistical significance for Wheeze ever (aOR 0.48, $P < 0.01$), Cough at night (aOR 0.47, $P < 0.01$), D-asthma (aOR 0.14, $P < 0.01$) and Rhinitis ever (aOR 0.67, $P < 0.05$). "More" breastfeeding was not consistently associated with either a protective or risk effect for Eczema.

family history, urbanization, epigenetics, wheeze, rhinitis, eczema

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Asthma is the most common chronic disease of childhood [1], and is a challenge to public health systems and health care providers throughout the world [2]. Surveys by International Study of Asthma and Allergies in Childhood (ISAAC) research teams in over 120 countries have shown that the prevalences of asthma in the combined age groups 6–7 and 13–14 vary widely from country to country [3–8]. In 2007, prevalences ranged from 2%–4% in Indonesia, Albania and Romania to 30%–32% in New Zealand, the United Kingdom and Costa Rica [7]. The most recently reported global prevalences of asthma in the widely studied 6–7 and 13–14-year old groups averaged 14.1% and 11.7%, respectively ($N = 1200000$) [9]. Asthma prevalences in China have been relatively low but are increasing. A national survey of 438000 children from 0 to 14 years old in 43 cities in 2000 indicated that the average level of physician-diagnosed asthma was 1.97% [10], which is a 64% increase over what had been reported in a 1990 survey conducted in the same manner. In Beijing, surveys performed in 1990 [11], 2000 [12] and 2008 [13] found the prevalences of physician-diagnosed asthma to be 0.78%, 2.05% and 3.15%, respectively, in children aged 0–14 years old.

Personal and environmental factors have been shown to be risk factors for asthma and allergic symptoms in children. Personal factors include age, gender, and a history of family allergic disease. Environmental factors include environmental tobacco smoke, dampness in the home, pet-keeping,

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living close to a high traffic road [14,15], home wood floors, and prenatal home redecoration. Environmental factors have been studied more in western than in Asian populations, but a 2002 study of Beijing children identified risk factors for children in Beijing including gender, environmental tobacco smoke, coal for heating, unventilated cooking with coal, observable mold or fungi in the home, cockroaches or rats in the home, and pet-keeping [16].

Numerous studies, listed in a review by Kramer and Kakuma [17], have demonstrated that breastfeeding is beneficial for children's health. Exclusive breastfeeding has been found to be protective against infection [18,19] including pneumonia [20,21]. Whether breastfeeding protects against asthma, a non-infectious illness with a genetic component [22], and associated allergic symptoms, remains uncertain. Gdalevich et al.'s [23] and Matheson et al.'s [24] reviews include studies which showed protective effects, studies which showed no effects, and studies which showed increased risk. These authors describe inherent methodological difficulties, chief of which is the impossibility of a random controlled trial. However, by dividing children into groups according to family history of atopy, Van Odijk et al.'s review [25] found that breastfeeding protects against atopic disease in all children, especially in children whose family history was positive for atopic disease.

The World Health Organization (WHO) recommends that mothers exclusively breastfeed for 6 months, and continue breastfeeding thereafter while introducing complementary foods [26]. Yet the rate of exclusive breastfeeding remains very low, especially in more wealthy, higher income countries [27]. In the United States less than 14% of children are exclusively breastfed at age 6 months [28]. In China, where healthy mothers of healthy babies are typically granted 90 days of work-leave following a birth, the government has recommended 4 months of exclusive breastfeeding. The most recent data show that between 1998 and 2002, 15.1% of Beijing children were exclusively breastfed for 4 months [27]. Xu et al. [29] assembled reports on breastfeeding practices in 21 Chinese cities from approximately 1989 to 2008. Breastfeeding practices varied widely from city to city. In 2006, 82.7% of 657 Beijing babies received at least some breastfeeding, and 17.5% were exclusively breastfed for 6 months [30].

The aims of the present study are firstly to estimate the prevalence of asthma and asthma-related symptoms in Beijing children 3 to 6 years old; secondly to survey Beijing breastfeeding durations and patterns; thirdly to ascertain the impact of gender and family allergic history on the prevalence of childhood asthma and related symptoms; and finally to assess whether "more" breastfeeding (exclusive, longer duration) might reduce childhood asthma/allergies in high risk 3–6 years old children. Our findings on asthma prevalence and breastfeeding durations/patterns will be compared with those of earlier studies.

1 Materials and methods

1.1 Questionnaire

The present study is a cross-sectional study of Beijing children 1–8 years old that is part of the national study China, Children, Homes, Health (CCHH). The ISAAC study core questions were used to evaluate the prevalences of asthma and asthma/allergy-related symptoms [31]. An additional set of questions was added in the CCHH survey to address home environmental factors. This set of questions was similar to those used in the Dampness in Buildings and Health (DBH) studies performed in Sweden, Bulgaria, and Texas, USA. [32–35], but adapted to Chinese housing characteristics.

1.2 Questions on children's asthma, allergy and related symptoms

In this study, we focused on Doctor-diagnosed asthma (D-asthma), and asthma/allergy-related symptoms. A "yes" response by children's parents or guardian to Question (iii) was recorded as D-asthma; "yes" responses to the remaining core questions were recorded as the relevant specific asthma and asthma/allergy-related symptoms. The core questions were:

(i) Has your child ever had wheezing or whistling in the chest at any time in the past? (Wheeze ever)

(ii) In the last 12 months, has your child had a dry cough at night for more than two weeks, apart from a cough associated with a cold or chest infection? (Cough at night)

(iii) Has your child been diagnosed with asthma by a doctor? (D-asthma)

(iv) Has your child ever had a problem with sneezing, or runny, or a blocked nose when he/she did not have a cold or a flu? (Rhinitis ever)

(v) Has your child been diagnosed with hay fever or allergic rhinitis by a doctor? (D-rhinitis)

(vi) Has your child ever had an itch of skin that lasted more than 6 months? (Eczema)

1.3 Subject selection

This study was performed in 11 of the 16 administrative districts in Beijing (Figure 1): Dongcheng, Xicheng, Chaoyang, Fengtai, Haidian, Shijingshan, Tongzhou, Changping, Daxing, Mentougou and Fangshan. The headmaster or responsible person of every kindergarten in the 11 districts was contacted by telephone, and the survey and intended use of questionnaire responses in research explained. The kindergartens which expressed interest in participating were visited. Some headmasters self-selected to not further participate. The parents of all children in participating kindergartens were invited to take part in the survey. Teachers distributed questionnaires to parents or legal guardians via children and children returned completed questionnaires to teachers. The survey was completed between January and

Figure 1 Sketch of administrative districts in Beijing. The questionnaire surveys were performed in the colored areas. There are 11 districts (Dongcheng, Xicheng, Chaoyang, Fengtai, Haidian, Shijingshan, Tongzhou, Changping, Daxing, Mentougou and Fangshan).

May, 2011.

1.4 Definition of exclusive and partial breastfeeding

WHO has established criteria for infant feeding patterns [36]. The WHO criterion for exclusive breastfeeding is that no other food, drink or milk, not even water, is given. Partial breastfeeding refers to the combined use of breast milk and any other solid or fluid food for reasons that might include work, social commitments and/or the inability to effectively express breast milk. "More" breastfeeding in the present study is defined as exclusive breastfeeding for > 6 months. It follows that any partial breastfeeding, or any breastfeeding for less than 6 months, is "less" breastfeeding. The database for exclusive and partial breastfeeding was obtained from the following questions:

(i) Until what age did you breast-feed your child totally or partly? (No breastfeeding/Younger than 1 months/1–2 months/3–6 months/Older than 6 months)

(ii) At what age was the child first given infant formula, gruel or porridge? (Younger than 3 months/3–6 months/Older than 6 months)

(iii) At what age was the child first given tasters (samples) of food, e.g. fruit purees, mashed root vegetables (e.g. potatoes)? (Younger than 3 months/3–6 months/Older than 6 months)

1.5 Statistical analysis

Multivariate logistic regression was applied to estimate the adjusted odds ratios (aOR) after adjusting for potential confounders. All statistical analysis was performed with PASW (Predictive Analytics Suite Workstation) (version 18.0 SPSS Inc., USA, 2009). All models were adjusted for age, gender and family history. Adjustment for possible confounding factors, including smoking by anyone in the family and present animal or pet-keeping, did not appreciably change risk for all other children outcomes' categories (not shown). We present only aOR with 95% confidence intervals (95% CI). The aOR was set at 1.00 for durations and patterns that represent "less" breastfeeding, that is, for duration less than 6 months, for partial breastfeeding, for the combination of exclusive breastfeeding less than 6 months, and for the combination of partial breastfeeding less than 6 months. In all tables and figures, N is the total number of subjects, and n is the number of subjects in the particular subgroup under discussion. Statistical significance was defined by a two-sided alpha level of 0.1%, 1% and 5%, and represented with ***, ** and *, respectively. All statistically significant findings and their 95% CI's are presented in boldface. Questionnaires missing any data required for the present study were excluded from analysis.

2 Results

A total of 5876 complete questionnaires was returned for a response rate of 65.0%. The questionnaires were filled out by mothers (72.7%), fathers (20.3%) or others (7.0%) including grandmothers or grandfathers.

Figure 2 shows that the percentages of children in each age group from 1 to 8 years old were 0.42%, 2.16%, 24.1%, 28.7%, 26.3%, 16.3%, 1.41% and 0.61%, respectively, for 1, 2, 3, 4, 5, 6, 7 and 8 years old. Because children aged 1, 2, 7 and 8 were represented in small numbers, they were excluded from analyses. Thus, the study is of 5479 children between 3–6 years old.

Figure 3 shows that the relative numbers of responses from suburban and rural districts were small. Urban respondents outnumbered suburban respondents by factors of

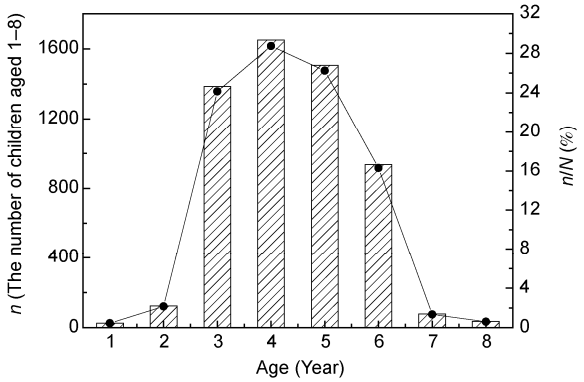

Figure 2 Age distribution of children for whom completed questionnaires were received (Left axis and bars represent n, number of children for each age. Right axis and points represent n/N, % of total represented by each age).

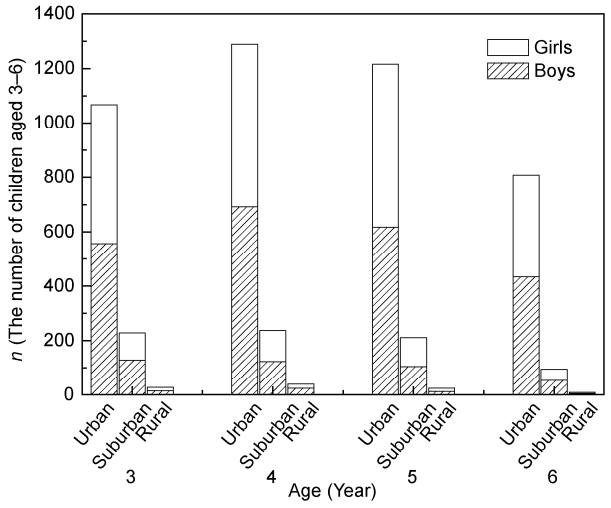

Figure 3 Distribution of gender, age and residency in children 3–6 years old.

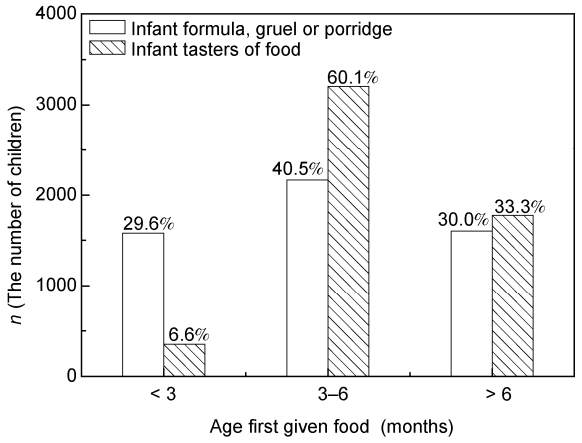

Figure 5 Percentage by age for when children were first given infant formula, gruel or porridge.

4.7, 5.4, 5.8 and 8.5 for ages 3, 4, 5 and 6, respectively; suburban respondents in turn outnumbered rural respondents by factors of about 8.4, 5.9, 8.8 and 10.6 for ages 3, 4, 5 and 6, respectively. The number of boys was a little higher than that of girls, whether urban, suburban or rural.

Figures 4 and 5 present breast-feeding demographics for 5479 Beijing children 3–6 years old, including duration of breastfeeding, the age at which the child was first given infant formula, gruel or porridge, and the age at which the child was first given infant tasters of food, e.g. fruit purées, mashed root vegetables. Figure 4 shows that 8.5% (461) received no breastfeeding. Of these, 12.5% (671) were breastfed for some time but less than 3 months; this includes the small number of infants breastfed for less than one month, or breastfed for 1–2 months. Another 22.1% (1191) were breastfed for 3–6 months, and 56.9% (3068) for greater than 6 months. In order to have sufficiently large numbers for analyses, we divided the total group into breastfed for less than 6 months and breastfed for more than 6 months. The fraction 14.2% was exclusively breastfed for more than

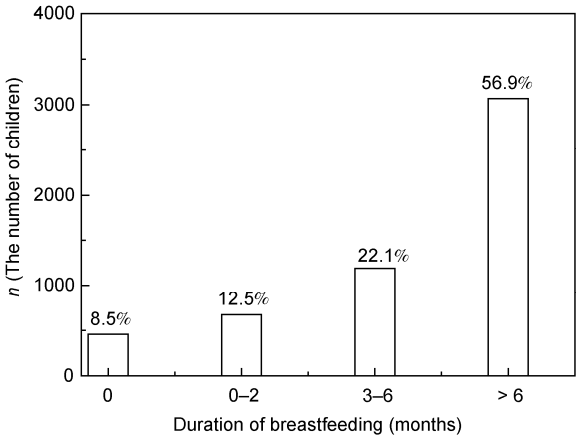

Figure 4 Duration of breastfeeding among children.

6 months. Infant formula, gruel and/or porridge were introduced to 29.6% of infants within 3 months of birth, and to 70.0% of all children by 6 months of age. Tastes of food were introduced somewhat later, to only 6.6% by 3 months but to 67.0% by 6 months (Figure 5).

Table 1 summarizes Beijing breastfeeding practices over the past 23 years. Breastfeeding trends in Beijing show considerable changes during that time, reflecting the nadir of breastfeeding in the late 1980's and a resurgence of breastfeeding following the government's 1990 National Program of Action for Child Development in China. By the 1993–1994 survey, over 80% of China's babies were receiving at least some breastfeeding. The present survey found that 90% of Beijing babies were breastfed in the years 2005–2008. With respect to exclusive breastfeeding for more than 6 months, a survey of breastfeeding in 2006 reported the combined average for Beijing, Tianjin and Qingdao to be 17.5%, whereas the present study found this average to be 14.2% for Beijing alone in the years from 2005 to 2008. The duration of breastfeeding, whether partial or exclusive, was reported to be greater than 6 months for a combined average of 50% in Guangzhou and Beijing during the years 1998–2002 [37], and 56.9% for Beijing alone in the present study.

Table 2 shows that the prevalence of self-reported D-asthma (by a parent or guardian of a child) has increased for all age groups except 1-year-olds in Beijing from 1990 to 2011. The 1990, 2000, 2008 and present cross-sectional surveys all used the ISAAC group's questionnaire for asthma and related symptoms [31]. Surveys in 1990 [11], 2000 [12], 2008 [13] and 2011 (Table 2) found asthma rates of 0.78%, 2.05%, 3.15% and 6.30% in Beijing, respectively. Figure 6 shows the parallel increasing trends for 3–6 year old children ($R^2 = 0.96$) and 6 year old children ($R^2 = 0.87$). Childhood asthma increased at a greater rate between 2008 and 2011 than in the previous 20 years.

Table 3 shows morbidity and co-morbidity rates for asthma and allergies in Beijing's 3–6 year old children in

Table 1 Beijing breastfeeding practices from 1989 to 2008

Breastfed years	Refs	*N*	Breastfed ever (%)	Breastfed > 6 months (or ⩾ 4 months) (%)	Exclusive > 4 months (%)	Exclusive > 6 months (%)
1989–1992	[38]	282	31.2	–	–	–
1993–1994	[38]	157	49.7	–	–	–
1993–1994	[39]	100	–	37.0 (4 months)	–	–
1998–2002	[27]	4214	48.7	30.8	15.1	–
1999–2001	[40]	400	–	39.2 (4 months)	–	–
2006	[30]	657	82.7 (6 months)	–	–	17.5 (6 months)
2005–2008	Present study	5479	90.0	56.9	–	14.2

Table 2 Prevalences (%) of asthma in Beijing children aged 2–7 from 1990 to 2011

	Year			
	1990	2000	2008	2011
Number of children	10947	10163	10372	5876
Study period	1990	June–October 2000	October 2008–March 2009	January–May 2011
Age				
2	0.80	1.24	1.76	1.61
3	1.21	1.86	4.47	4.83
4	1.61	2.18	4.33	6.04
5	1.37	2.63	5.00	6.40
6	1.26	1.51	4.86	7.44
7	1.00	2.55	3.93	6.49
Refs	[12]	[12]	[13]	Present study

Table 3 Morbidity and co-morbidity of asthma and allergies in Beijing children

Morbidity and co-morbidity	2011 Present study *N* = 5497 3–6 years old (%)	2008 Zhou et al. [13] *N* = 10372 0–14 years old (%)
Asthma	6.1	3.2
Wheeze, last 12 months	16.5	5.5
Cough at night, last 12 months	18.9	8.7
Rhinitis ever	55.0	14.5
Rhinitis ever + D-asthma	82.0 [a)]	49.5 [a)]
Wheeze ever + D-asthma	74.8 [a)]	–
Rhinitis ever + Wheeze ever + D-asthma	62.2 [a)]	–

a) Those children with asthma who also have the co-morbidity.

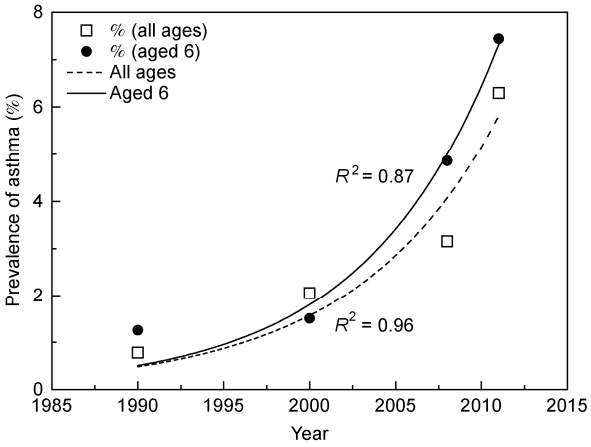

Figure 6 Percent prevalence (%) of children's asthma versus year in Beijing.

2011 and in 0–14 year old children in 2008–2009. All morbidity rates are more than twice as high in the 2011 children than in the 2008–2009 children. The co-morbidity rate for rhinitis (ever) in 2011 D-asthmatic children was also much higher than for children 2008–2009.

Tables 4–6 list the illnesses and symptoms analyzed and show their percent associations with durations and patterns of breastfeeding for all children. "More" breastfeeding is associated with significantly reduced prevalences in all children of wheeze ever, cough at night, D-asthma and rhinitis ($P < 0.05$). The effect is stronger for girls than for boys, for whom only the prevalence of D-asthma was significantly reduced. The protective effect is strongest for girls with negative family history. "More" breastfeeding was not associated in any consistent way with change in the prevalence of eczema.

Table 4 Percentage (*n*, %) of patterns and durations of breastfeeding and prevalence (*n*, %) of asthma and allergies in total children[a)]

Total children		All		Wheeze ever		Cough at night		D-asthma		Rhinitis ever		D-rhinitis		Eczema	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Duration of breastfeeding (months)	⩽6	2326	43.1	514	22.7	484	**21.5***	152	6.7	1357	**60.5***	191	8.5	618	27.7
	>6	3068	56.9	653	21.8	549	**18.4***	180	6.0	1620	**55.3***	212	7.2	875	29.5
	Total	5394	100	1167	22.2	1033	19.7	332	6.3	2977	57.5	403	7.8	1493	28.7
Breastfeeding patterns	Exclusive	1294	23.6	270	21.3	236	18.9	79	6.3	699	56.0	96	7.7	346	**28.0***
	Partial	3640	66.4	798	22.0	719	19.9	231	6.4	2073	57.7	282	7.9	1070	**29.7***
Duration of exclusive breastfeeding (months)	⩽6	515	39.8	127	**24.9***	120	**23.7***	42	**8.3***	305	**60.3***	47	9.3	139	28.1
	>6	779	60.2	143	**18.9***	116	**15.6***	37	**5.0***	394	**53.0***	49	6.6	207	27.9
Duration of partial breastfeeding (months)	⩽6	1351	37.1	280	21.3	281	21.6	87	6.6	793	**60.8***	113	8.7	375	28.9
	>6	2289	62.9	506	22.6	433	19.4	143	6.4	1242	**56.3***	163	7.4	668	30.0

a) Differences between categorical variables were tested with Pearson's χ^2 test (Yes or No), * $P \leqslant 0.05$.

Table 5 Percentage (*n*, %) of patterns and durations of breastfeeding and prevalence (*n*, %) of asthma and allergies in girls[a)]

Girls		All		Wheeze ever		Cough at night		D-asthma		Rhinitis ever		D-rhinitis		Eczema	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Duration of breastfeeding (months)	⩽6	1124	44.2	220	20.0	237	**21.7***	59	5.4	643	**59.3***	79	**7.3***	282	26.0
	>6	1421	55.8	252	18.2	243	**17.5***	57	4.1	699	**51.5***	73	**5.3***	365	26.4
	Total	2545	100	472	19.0	480	19.4	116	4.7	1342	54.9	152	6.2	647	26.3
Breastfeeding patterns	Exclusive	605	23.3	106	17.9	102	17.5	25	4.3	305	52.5	25	4.3	148	25.6
	Partial	1733	66.9	327	18.8	350	20.2	88	5.1	955	55.4	118	6.9	473	27.4
Duration of exclusive breastfeeding (months)	⩽6	239	39.5	50	21.2	55	**23.6***	16	**6.9***	139	**59.4***	15	**6.5***	62	27.0
	>6	366	60.5	56	15.7	47	**13.4***	9	**2.6***	166	**47.8***	10	**2.9***	86	24.7
Duration of partial breastfeeding (months)	⩽6	678	39.1	128	19.3	151	**23.1***	39	5.9	392	**59.6***	51	7.8	178	27.3
	>6	1055	60.9	194	18.8	196	**18.9***	48	4.6	542	**53.1***	63	6.2	279	27.0

a) Differences between categorical variables were tested with Pearson's χ^2 test (Yes or No), * $P \leqslant 0.05$.

Table 6 Percentage (*n*, %) of patterns and durations of breastfeeding and prevalence (*n*, %) of asthma and allergies in boys[a)]

Boys		All		Wheeze ever		Cough at night		D-asthma		Rhinitis ever		D-rhinitis		Eczema	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Duration of breastfeeding (months)	⩽6	1202	42.2	294	25.2	247	21.2	93	8.0	714	61.7	112	9.6	336	29.2
	>6	1647	57.8	401	25.0	306	19.2	123	7.7	921	58.5	139	8.8	510	32.1
	Total	2849	100	695	25.1	553	20.1	216	7.8	1635	59.9	251	9.2	846	30.9
Breastfeeding patterns	Exclusive	689	23.9	164	24.3	134	20.1	54	8.1	394	59.0	71	10.6	198	30.0
	Partial	1907	66.0	471	24.9	369	19.6	143	7.6	1118	59.9	164	8.8	597	31.9
Duration of exclusive breastfeeding (months)	⩽6	276	40.1	77	28.0	65	**23.8***	26	9.6	166	61.0	32	11.8	77	29.2
	>6	413	59.9	87	21.7	69	**17.5***	28	7.1	228	57.6	39	9.9	121	30.6
Duration of partial breastfeeding (months)	⩽6	673	35.3	152	23.4	130	20.1	48	7.4	401	62.0	62	9.6	197	30.5
	>6	1234	64.7	312	25.9	237	19.8	95	7.9	700	59.1	100	8.5	389	32.6

a) Differences between categorical variables were tested with Pearson's χ^2 test (Yes or No), * $P \leqslant 0.05$.

Tables 7–9 show percent associations of breastfeeding with illnesses as a function of both gender and family history. Durations and patterns of breastfeeding had more of an impact on asthma prevalence in girls than in boys. For both girls and boys, "more" breastfeeding was mainly protective.

Table 10 compares breastfeeding practices according to family history and gender. These comparisons were performed because positive family history and male gender were found to be strong risk factors for D-asthma, with crude OR of 3.94 and 1.77, respectively (not shown). 1256 children (672 boys and 584 girls) had a positive family history for asthma, allergy or related symptoms. 115 boys with positive family history had D-asthma (Table 9). Table 10 shows that breastfeeding practices did not differ as a function of family history: children with positive family history were not breastfed for longer duration, nor were they more

Table 7 Percentage (*n*, %) of patterns and durations of breastfeeding and prevalence (*n*, %) of asthma and allergies in total children with or without family history[a)]

Total children		Wheeze ever				Cough at night				D-asthma				Rhinitis ever				D-rhinitis				Eczema			
		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Duration of breastfeeding (months)	⩽6	162	31.2	336	19.9	159	30.2	315	**18.6***	73	13.8	77	4.5	369	69.9	967	**57.7***	104	**19.9***	84	5.0	189	36.9	418	24.9
	>6	235	33.5	399	18.0	193	27.5	348	**15.6***	99	14.1	80	3.6	465	66.8	1129	**51.6***	103	**14.9***	107	4.8	288	41.1	572	25.8
Breastfeeding patterns	Exclusive	86	29.6	177	18.8	86	29.4	147	15.6	38	13.1	40	4.2	203	69.5	489	**52.1***	53	18.3	43	4.6	118	42.0	220	**23.5***
	Partial	289	33.6	485	18.2	245	28.4	460	17.1	123	14.2	106	3.9	589	68.0	1445	**54.4***	138	16.3	139	5.2	339	39.4	713	**26.7***
Duration of exclusive breastfeeding (months)	⩽6	42	29.4	84	**23.5***	45	31.0	74	**20.8***	22	15.4	20	5.6	105	72.4	199	55.9	28	19.7	19	5.4	59	43.4	78	22.2
	>6	44	29.7	93	**15.9***	41	27.7	73	**12.5***	16	11.0	20	3.4	98	66.7	290	49.7	25	16.9	24	4.1	59	40.7	142	24.3
Duration of partial breastfeeding (months)	⩽6	97	32.4	170	17.5	91	30.3	182	18.6	40	13.2	45	4.6	210	69.5	566	**58.1***	58	19.5	52	5.3	105	35.6	262	27.0
	>6	192	34.7	303	18.6	152	27.4	275	16.7	83	14.9	60	3.7	373	67.2	848	**52.5***	78	14.4	83	5.1	229	41.2	430	26.3

a) Differences between categorical variables were tested with Pearson's χ^2 test (Yes or No). Positive refers to positive family history for asthma or allergy. * $P \leqslant 0.05$.

Table 8 Percentage (*n*, %) of patterns and durations of breastfeeding and prevalence (*n*, %) of asthma and allergies in girls with or without family history [a)]

Girls		Wheeze ever				Cough at night				D-asthma				Rhinitis ever				D-rhinitis				Eczema			
		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Duration of breastfeeding (months)	⩽6	52	**19.9***	159	**19.7***	74	28.0	156	**19.4***	22	8.4	36	**4.4***	180	69.0	448	**56.0***	46	**17.7***	31	3.9	83	**31.8***	191	24.0
	>6	91	**29.4***	155	**14.8***	74	23.8	165	**15.7***	35	11.3	22	**2.1***	193	62.9	498	**48.3***	34	**11.1***	38	3.6	131	**42.1***	229	21.9
Breastfeeding patterns	Exclusive	27	20.1	76	17.3	34	25.2	65	14.8	10	7.5	15	3.4	93	68.9	210	48.1	14	10.4	11	2.5	58	43.3	85	19.6
	Partial	108	26.7	208	16.1	109	26.7	233	18.0	46	11.2	41	3.2	265	65.3	672	52.4	58	14.5	57	4.4	150	36.9	316	24.6
Duration of exclusive breastfeeding (months)	⩽6	11	15.9	39	**24.1***	20	28.6	34	**21.1***	4	5.8	12	**7.5***	51	72.9	88	**54.3***	9	13.0	6	3.8	32	45.7	28	17.8
	>6	16	24.6	37	**13.4***	14	21.5	31	**11.2***	6	9.4	3	**1.1***	42	64.6	122	**44.4***	5	7.7	5	1.8	26	40.6	57	20.6
Duration of partial breastfeeding (months)	⩽6	34	21.8	86	17.8	48	30.6	97	20.2	17	10.8	21	4.3	109	69.9	271	**56.1***	28	18.2	21	4.3	43	**27.7***	130	**27.3***
	>6	74	30.3	117	15.2	60	24.4	134	17.3	29	11.7	19	2.5	154	62.9	382	**50.1***	29	12.0	33	4.3	105	**42.5***	172	**22.3***

a) Differences between categorical variables were tested with Pearson's χ^2 test (Yes or No). Positive refers to positive family history for asthma or allergy. * $P \leqslant 0.05$.

Table 9 Percentage (*n*, %) of patterns and durations of breastfeeding and prevalence (*n*, %) of asthma and allergies in boys with or without family history[a)]

Boys		Wheeze ever				Cough at night				D-asthma				Rhinitis ever				D-rhinitis				Eczema			
		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive		Negative	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Duration of breastfeeding (months)	⩽6	110	42.6	177	20.0	85	32.3	159	17.9	51	19.2	41	4.6	189	70.8	519	**59.2***	58	22.1	53	6.0	106	42.2	227	25.6
	>6	144	36.8	244	20.9	119	30.4	183	15.6	64	16.4	58	4.9	272	69.9	631	**54.5***	69	17.9	69	5.9	157	40.3	343	29.3
Breastfeeding patterns	Exclusive	59	37.6	101	20.1	52	32.9	82	16.3	28	17.9	25	5.0	110	70.1	279	55.6	39	25.0	32	6.3	60	40.8	135	26.9
	Partial	181	39.6	277	20.1	136	29.9	227	16.3	77	16.8	65	4.7	324	70.4	773	56.3	80	17.8	82	6.0	189	41.7	397	28.6
Duration of exclusive breastfeeding (months)	⩽6	31	41.9	45	23.1	25	33.3	40	**20.5***	18	**24.3***	8	4.1	54	72.0	111	57.2	19	26.0	13	6.7	27	40.9	50	25.8
	>6	28	33.7	56	18.2	27	32.5	42	**13.7***	10	**12.2***	17	5.5	56	68.3	168	54.5	20	24.1	19	6.1	33	40.7	85	27.6
Duration of partial breastfeeding (months)	⩽6	63	44.1	84	**17.1***	43	30.1	85	17.1	23	15.8	24	4.8	101	69.2	295	60.0	30	21.0	31	6.3	62	44.3	132	26.7
	>6	118	38.1	186	**21.7***	92	29.9	141	16.2	54	17.5	41	4.7	219	70.6	466	54.7	49	16.2	50	5.9	124	40.1	258	30.0

a) Differences between categorical variables were tested with Pearson's χ^2 test (Yes or No). Positive refers to positive family history for asthma or allergy. * $P \leqslant 0.05$.

likely to be breastfed exclusively. The one exception is that a larger percentage of boys with positive family history were partially breastfed for > 6 months than boys with negative family history.

Tables 11–13 present breastfeeding's associations with illness prevalence as a function of both family history and gender. For the greatest risk subset, boys with positive family history, "more" breastfeeding was significantly protective against D-asthma (aOR 0.42, $P < 0.05$). "More" breastfeeding was also non-significantly protective for this group against wheeze ever, cough at night, rhinitis ever and D-rhinitis. "More" breastfeeding was non-significantly associated with increased risk in boys with negative family history for D-asthma, but was non-significantly protective for boys with negative family history against all other symptoms except eczema. "More" breastfeeding had mixed and non-significant associations with illness for girls with positive family history; it was protective against cough at night, rhinitis ever and D-rhinitis, but associated with increased risk for wheeze (ever) and D-asthma. "More" breastfeeding for girls with negative family history was strongly protective for wheeze (ever) (aOR 0.48, $P < 0.01$), cough (at night) (aOR 0.47, $P < 0.01$), D-asthma (aOR 0.14, $P < 0.01$) and rhinitis (ever) (aOR 0.67, $P < 0.05$). For all groups, the aOR's for partial breastfeeding for > 6 months are randomly divided between protection and risk, with no apparent trend. The overall greatest effect is a protective effect against rhinitis ever. The overall smallest effect,

Table 10 Percentage (n, %) for patterns and durations of breastfeeding and family history in total/girls/boys[a)]

Total (N = 5479)		Positive		Negative	
		n	%	n	%
Duration of breastfeeding (months)	> 6	701	57.5	2213	56.7
Breastfeeding patterns	Exclusive	291	23.9	941	24.1
Duration of exclusive breastfeeding (months)	> 6	148	12.1	584	15
Duration of partial breastfeeding (months)	> 6	554	45.4	1626	41.7
Girls (N = 2592)		Positive		Negative	
		n	%	n	%
Duration of breastfeeding (months)	> 6	310	53.1	1047	54.7
Breastfeeding patterns	Exclusive	134	22.9	439	22.9
Duration of exclusive breastfeeding (months)	> 6	65	11.1	277	14.5
Duration of partial breastfeeding (months)	> 6	244	41.8	769	40.2
Boys (N = 2887)		Positive		Negative	
		n	%	n	%
Duration of breastfeeding (months)	> 6	391	58.2	1166	55.1
Breastfeeding patterns	Exclusive	157	23.4	502	23.7
Duration of exclusive breastfeeding (months)	> 6	83	12.4	307	14.5
Duration of partial breastfeeding (months)	> 6	310	46.1	857	40.5

a) Positive refers to positive family history for asthma or allergy.

Table 11 Associations of patterns and durations of breastfeeding and asthma and allergies in total children[a)]

Total children		Wheeze ever	Cough at night	D-asthma	Rhinitis ever	D-rhinitis	Eczema
		aOR					
		Lower-upper					
Duration of breastfeeding (months)	> 6	0.94	**0.83****	0.88	**0.80*****	0.82	1.09
		0.82–1.08	**0.72–0.95**	0.70–1.10	**0.71–0.89**	0.66–1.01	0.96–1.23
Breastfeeding patterns	Exclusive	0.95	0.95	0.997	0.92	0.99	0.94
		0.81–1.11	0.81–1.12	0.76–1.30	0.81–1.05	0.77–1.26	0.82–1.09
Duration of exclusive breastfeeding (months)	> 6	**0.71***	**0.64****	**0.61***	**0.78***	0.76	1.05
		0.54–0.94	**0.47–0.85**	**0.38–0.98**	**0.61–0.98**	0.49–1.18	0.81–1.36
Duration of partial breastfeeding (months)	> 6	1.07	0.88	0.93	**0.82****	0.81	1.04
		0.91–1.28	0.74–1.04	0.70–1.24	**0.71–0.94**	0.63–1.05	0.89–1.21

a) Adjusted odds ratios (aOR) with 95% confidence intervals (95% CI) were estimated by logistic regression adjusting for age, gender and family history. The aOR was set at 1.00 for durations and patterns that represent "less" breastfeeding, that is, for duration less than 6 months, for partial breastfeeding, for the combination exclusive breastfeeding less than 6 months and for the combination of partial breastfeeding less than 6 months. Positive refers to positive family history for asthma or allergy. * $0.01 < P \leqslant 0.05$; ** $0.001 < P \leqslant 0.01$; *** $P \leqslant 0.001$.

Table 12 Associations of patterns and durations of breastfeeding and asthma and allergies in girls with or without family history[a)]

Girls		Wheeze ever			Cough at night			D-asthma			Rhinitis ever			D-Rhinitis			Eczema		
		All	Positive	Negative	All	Positive	Negative	All	Positive	Negative	All	Positive	Negative	All	Positive	Negative	All	Positive	Negative
		aOR			aOR			aOR			aOR			aOR			aOR		
		lower-upper			lower-upper			lower-upper			lower-upper			lower-upper			lower-upper		
Duration of breastfeeding (months)	> 6	0.91	**1.67****	**0.71****	**0.78***	0.80	**0.77***	0.78	1.40	**0.46****	**0.74*****	0.76	**0.74*****	0.73	**0.58***	0.94	1.05	**1.56***	0.89
		0.74–1.11	**1.13–2.47**	**0.56–0.90**	**0.64–0.96**	0.55–1.17	**0.61–0.98**	0.53–1.14	0.80–2.45	**0.27–0.78**	**0.63–0.87**	0.54–1.08	**0.61–0.89**	0.52–1.03	**0.36–0.93**	0.58–1.52	0.87–1.26	**1.11–2.21**	0.71–1.11
Breastfeeding patterns	Exclusive	0.94	0.71	1.05	0.85	0.97	0.81	0.92	0.70	1.14	0.89	1.21	0.82	0.62*	0.65	0.59	0.92	1.37	0.77
		0.74–1.20	0.44–1.14	0.79–1.40	0.67–1.09	0.62–1.50	0.60–1.08	0.58–1.45	0.34–1.42	0.63–2.07	0.74–1.07	0.80–1.83	0.66–1.02	0.40–0.97	0.35–1.20	0.31–1.33	0.74–1.14	0.92–2.03	0.59–1.00
Duration of exclusive breastfeeding (months)	> 6	0.67	1.74	**0.48****	**0.53****	0.69	**0.47****	**0.39***	1.67	**0.14****	**0.67***	0.69	**0.67***	0.48	0.52	0.46	1.05	0.83	1.20
		0.43–1.03	0.74–4.10	**0.29–0.80**	**0.34–0.82**	0.32–1.52	**0.27–0.79**	**0.17–0.91**	0.45–6.21	**0.04–0.49**	**0.48–0.95**	0.33–1.43	**0.45–0.99**	0.21–1.12	0.16–1.66	0.14–1.54	0.70–1.58	0.42–1.65	0.73–1.98
Duration of partial breastfeeding (months)	> 6	1.01	1.60	0.84	0.80	0.73	0.83	0.79	1.12	0.55	0.77*	0.74	**0.79***	0.79	0.62	0.99	0.99	**1.89****	**0.77***
		0.78–1.30	1.00–2.56	0.62–1.14	0.63–1.02	0.47–1.15	0.62–1.11	0.50–1.22	0.59–2.13	0.30–1.14	0.63–0.95	0.48–1.14	**0.63–1.00**	0.53–1.17	0.36–1.10	0.57–1.73	0.79–1.24	**1.23–2.92**	**0.59–1.00**

a) Adjusted odds ratios (aOR) with 95% confidence intervals (95% CI) were estimated by logistic regression adjusting for age. The aOR was set at 1.00 for durations and patterns that represent "less" breastfeeding, that is, for duration less than 6 months, for partial breastfeeding, for the combination exclusive breastfeeding less than 6 months and for the combination of partial breastfeeding less than 6 months. Positive refers to positive family history for asthma or allergy. * $0.01< P \leqslant 0.05$; ** $0.001< P \leqslant 0.01$; *** $P \leqslant 0.001$.

Table 13 Associations of patterns and durations of breastfeeding and asthma and allergies in boys with or without family history[a)]

Boys		Wheeze ever			Cough at night			D-asthma			Rhinitis ever			D-Rhinitis			Eczema		
		All	Positive	Negative	All	Positive	Negative	All	Positive	Negative	All	Positive	Negative	All	Positive	Negative	All	Positive	Negative
		aOR			aOR			aOR			aOR			aOR			aOR		
		lower-upper			lower-upper			lower-upper			lower-upper			lower-upper			lower-upper		
Duration of breastfeeding (months)	> 6	0.96	0.78	1.06	0.87	0.92	0.85	0.94	0.82	1.07	**0.85***	0.96	**0.82***	0.88	0.77	0.99	1.12	0.92	1.21
		0.81–1.15	0.60–1.08	0.85–1.32	0.72–1.05	0.65–1.28	0.67–1.07	0.70–1.25	0.55–1.24	0.71–1.61	**0.73–1.00**	0.68–1.35	**0.69–0.98**	0.67–1.15	0.52–1.14	0.68–1.43	0.95–1.33	0.67–1.27	0.99–1.47
Breastfeeding patterns	Exclusive	0.95	0.90	0.98	1.04	1.12	1.01	1.05	1.03	1.06	0.95	0.96	0.94	1.26	1.50	1.09	0.96	0.98	0.95
		0.78–1.17	0.62–1.30	0.76–1.26	0.84–1.30	0.76–1.64	0.77–1.32	0.75–1.46	0.64–1.64	0.67–1.69	0.79–1.13	0.65–1.42	0.77–1.16	0.94–1.70	0.97–2.30	0.72–1.65	0.79–1.17	0.68–1.43	0.76–1.19
Duration of exclusive breastfeeding (months)	> 6	0.73	0.70	0.74	0.73	0.98	0.63	0.75	**0.42***	1.33	0.88	0.84	0.89	0.91	0.90	0.91	1.07	0.99	1.10
		0.50–1.05	0.36–1.34	0.48–1.15	0.49–1.07	0.50–1.90	0.39–1.01	0.42–1.33	**0.18–0.99**	0.56–3.14	0.64–1.21	0.42–1.68	0.62–1.27	0.54–1.51	0.43–1.86	0.44–1.89	0.75–1.51	0.51–1.92	0.73–1.65
Duration of partial breastfeeding (months)	> 6	1.13	0.78	**1.35***	0.95	0.99	0.94	1.05	1.14	0.98	0.86	1.08	0.81	0.84	0.74	0.92	1.08	0.84	1.18
		0.89–1.42	0.52–1.16	**1.01–1.80**	0.75–1.22	0.64–1.53	0.70–1.26	0.73–1.52	0.67–1.94	0.58–1.64	0.70–1.05	0.70–1.66	0.64–1.01	0.59–1.18	0.44–1.23	0.58–1.47	0.87–1.33	0.56–1.26	0.92–1.51

a) Adjusted odds ratios (aOR) with 95% confidence intervals (95% CI) were estimated by logistic regression adjusting for age. The aOR was set at 1.00 for durations and patterns that represent "less" breastfeeding, that is, for duration less than 6 months, for partial breastfeeding, for the combination exclusive breastfeeding less than 6 months and for the combination of partial breastfeeding less than 6 months. Positive refers to positive family history for asthma or allergy. * $0.01< P \leqslant 0.05$; ** $0.001< P \leqslant 0.01$; *** $P \leqslant 0.001$.

either protective or for increased risk, is for eczema.

3 Discussion

3.1 Prevalence of childhood asthma in Beijing

Data from surveys in 1990, 2000, 2008 and the present, which all used the same ISAAC core questions [31], demonstrate that the prevalence of asthma in Beijing has increased over the past 22 years (Figure 6). Self-reported asthma (by a parent or guardian of a child) in Beijing increased from 0.78% for mixed age groups of children in 1990 to 6.30% in 2011 for children aged 1–8 (Table 2, Figure 6). The present study shows a steeper increase in the last 3 year period than in the previous 20 years. Importantly, the trend for 6-year-olds, in whom asthma is more reliably diagnosed than in small children [41,42], parallels that for all pre-school children, increasing from 1.26% to 7.44% in the same 3 year period.

The prevalences of "asthma ever" in 6–7 year old children vary widely in countries surveyed in the ISAAC study, from a high of about 27% in Costa Rica, Australia and New Zealand to a low of about 2% in Lithuania and Russia [7]. By comparison, the 2008 prevalence in Beijing was approximately 5% and 4% in 6 and 7 year old children respectively. World trends are not clear [7,9], although countries with low prevalences in ISAAC Phase I (1998) [3] have shown increased prevalences in ISAAC Phase III [7]. Meanwhile, "high prevalence" countries of ISAAC Phase I may be experiencing a leveling out of prevalences [7].

The rate of increase per year of Beijing asthma prevalence is readily calculated from Table 2 data. From 1990 to 2008, asthma prevalence increased 0.20%/year, consistent with 0.24%/year reported for the total ISAAC group of Guangzhou and Beijing children (6–7 and 13–14 years old) for the years 1998 to 2005 [3]. However, the rate of increase from 2008 to 2012 was an alarming 0.86%. We can speculate that asthma prevalence follows a sigmoid curve with time, and that the Beijing prevalence is in the steeply ascending region of the curve. If so, the present period is ideally suited for intense study of environmental factors which, if changed, could slow the increase in asthma prevalence, and result in a lower level steady state.

The overall prevalence of asthma was higher by a factor of 1.7 in boys (7.80%) than in girls (4.70%), consistent with worldwide reports [43] for children up to age 8. The present study also found that the gender ratio decreased with age. Decreasing gender ratios have similarly been found in some studies [44–46] but increasing ratios have been found in others [47,48]. The 2012 ISAAC summary reported Asia-Pacific prevalences for 6–7 year old children to be 10.8% in boys and 8.2% girls [9]. Generally, until the age of 13–14 years, boys' asthma prevalence is greater than that of girls [49,50].

The increases in morbidity and co-morbidity of asthma and related symptoms from the time of Zhao et al.'s study (2008–2009) [13] to 2011 are striking (Table 3). It should be noted that while the same questions were used for both studies, Zhao et al. obtained responses from interviews with parents. Data for eczema were not included because the reliability of responses to eczema questions in the translated ISAAC questionnaire is uncertain [51]. These increases merit analysis beyond the scope of the present paper, but it should be noted that the pace of urbanization and modernization in China in general and Beijing in particular are unprecedented [52]. Factors associated with such urbanization undoubtedly contribute to the observed increases in morbidity [52]. These factors include exposure to increasing levels of outdoor pollution [52–54], and indoor exposure to the man-made chemicals that are associated with modernization and construction of new buildings [55]. Traffic-related air pollution has been found to be associated with the development of asthma and allergies during the first 8 years of life [52,56]. Another possible contributory factor is the increased percentage of births by Cesarean delivery in China [57], which may be associated with increased risk of asthma and allergy rates [58].

The present study's findings for co-morbidity combinations (Table 3) are comparable to those for some western countries, in which 30%–90% of patients with asthma also have allergic rhinitis [59,60]. The prevalence of both asthma and co-morbidities may reflect growing awareness of asthma in medical professionals and the public, and may therefore be confounded by over-diagnosis. On the other hand, during a time of less awareness, there may have been under-diagnosis.

3.2 Beijing breastfeeding practices

The present study found that while 56.0% (3068/5479) of Beijing's children aged 3 to 6 were breastfed for more than 6 months, only 14.2% of Beijing's children aged 3 to 6 had been exclusively breastfed for more than 6 months. A 2009 WHO survey found that world-wide, about one-third of the world's children were meeting the WHO and UNICEF recommendations (http://www.unicef.org/nutrition/index_24824.html) of exclusive breastfeeding for 6 months. Children in our group were born when mothers received 90 days leave from work. The current Chinese recommendation is for 4 months exclusive breastfeeding [40]. A 2007 questionnaire survey for 657 children 6–12 months old in Beijing, Tianjin and Qingdao reported 17.5% combined exclusive, > 6 month breastfeeding [30] in Beijing. We found no difference between boys and girls in either patterns or durations of breastfeeding (Tables 4–6).

3.3 Is breastfeeding protective against asthma, allergy, and related symptoms?

It remains undecided whether breastfeeding is protective against asthma, allergy and related symptoms [23,24]. To

contribute to the resolution of this issue, we tested breastfeeding's efficacy in the face of strong risk factors for asthma. If breastfeeding is truly protective, then "more" breastfeeding, here defined as exclusive for > 6 months, should be associated with lower aOR for asthma, allergy and related symptoms. The risk factors chosen were positive family history and male gender, both of which included large subsets of the total group. For D-asthma, the overall crude OR for positive family history was 3.94 and the subset size 1256/5479; the crude OR for male gender was 1.77 and subset size 2887/5479. Thus, the 672 boys with positive family history provided a stringent test of breastfeeding's protective effects. For this subset (Table 13), the aOR for D-asthma of "more" breastfeeding was 0.42 (95% CI 0.18–0.99), for a subset of 28. Also, boys with positive family history who were exclusively breastfed for > 6 months also showed non-significant aOR<1.00 for all other asthma-related symptoms (reference value 1.00 for ⩽ 6 months partial breastfeeding), suggesting that breastfeeding may have been protective.

We studied children grouped by gender and family history. A recent study of 206453 children, aged 6–7 years, ungrouped according to family history and divided only between "any" and "no" breastfeeding did not see any "consistent relation" between breastfeeding and the symptoms wheezing, rhinocunjunctivitis or eczema [61]. We observed that "more" breastfeeding was protective for girls with negative family history. Thus, our findings suggest that breastfeeding can be protective at least for a defined group, but also suggest that a genetic predisposition for asthma and allergy can outweigh any protective effect of breastfeeding. Nonetheless, "more" breastfeeding was associated with decreased aOR for D-asthma in boys with positive family history and moreover, the protective effect persisted non-significantly for other symptoms in this group. This finding is consistent with the conclusion of a 2003 review which found breastfeeding to be more protective against the development of atopic disease in children with positive family history than in children with negative family history [25].

Our finding of very little association, either protective or risk, between breastfeeding and eczema is consistent with that of a recent international ISAAC study [27]. However, we note that symptoms related to eczema have been difficult to translate [51].

The etiology of asthma is both genetic and environmental [22]. Asthma can also be initiated by epigenetic changes in previously quiet, apparently inactive genetic material [62]. The genetic etiology is attributable to a number of possible variations in each of a number of genes [22,63] and therefore can vary greatly in strength. It has been demonstrated that the strength of a genetic predisposition to asthma influences whether breastfeeding can effectively protect against asthma and allergy [63].

3.4 Reverse causation

We found partial breastfeeding > 6 months to be associated with both increased and decreased risks, and in no apparent pattern. A possible explanation for the observed increased risk associated with more breastfeeding is the *post facto* effect known as Reverse Causation [24,64]. Regardless of family history, mothers whose babies have early and frequent illness might prolong breastfeeding in the hopes of mitigating their babies' illness, whereas mothers whose babies are robustly healthy discontinue breastfeeding earlier [64]. The most definitive way to discern a Reverse Causation effect is by prospective study, or a study which records the specific ages for the child's illness [65,66]. However, it should be noted that only a finding of increased risk associated with breastfeeding, and not a finding that breastfeeding is protective, can be logically associated with Reverse Causation.

In the present study, families with positive and negative family history showed similar breastfeeding durations and patterns, suggesting that a positive family history did not create a bias towards "more" breastfeeding. However, Table 10 does show a higher percentage of mothers with positive family history who extend partial breastfeeding especially for boys for more than 6 months, than mothers with negative family history. This effect is particularly evident for specific symptoms (Table 10). This suggests that in future studies, analysis for Reverse Causation should be carefully considered [65].

3.5 Limitations

The present study is retrospective, and as such, subject to recall bias. However, several studies have found that maternal recall of breastfeeding is reliable [67,68], even 20 years after the time of breastfeeding [69]. Another limitation is our inability to thoroughly evaluate the possible role of Reverse Causation.

4 Conclusions

This study has found that the prevalence of asthma, allergy and related symptoms in Beijing children aged 3 to 6 continues to increase, and has increased dramatically in the past 2–3 years. Exclusive breastfeeding for more than 6 months may be helpful in preventing these illnesses even in the high risk group of males with positive family history. Exclusive breastfeeding for more than 6 months appears to have a stronger protective effect in females with negative family history. Overall, "more" breastfeeding appears to be protective against asthma and related symptoms.

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