Prevalence and Influencing Factors of Wheezing and Asthma Among Preschool Children in Urumqi City: A Cross-sectional Survey

Tingting Wang (m18909929590_1@163.com)
School of Nursing & Health Management, Shanghai University of Medicine & Health Sciences
Haonan Shi
School of Public Health, Xinjiang Medical University
Guangshen Wan
School of Nursing & Health Management, Shanghai University of Medicine & Health Sciences
Zhuohui Zhao
Department of Environmental Health, School of Public Health, Fudan University
Dan Norback
Department of Medical Sciences, Occupational and Environmental Medicine, Uppsala University
Guiping Pu
School of Nursing & Health Management, Shanghai University of Medicine & Health Sciences
Shaowei Ma
School of Nursing & Health Management, Shanghai University of Medicine & Health Sciences
Huijuan Dong
School of Public Health, Xinjiang Medical University
Jian Yao
School of Public Health, Xinjiang Medical University
Junwen Lu
School of Public Health, Xinjiang Medical University
Yue Wang
School of Public Health, Xinjiang Medical University
Qi Yan
School of Public Health, Xinjiang Medical University
Huizhen Qi
Department of Neurology, The Fifth Affiliated Hospital of Xinjiang Medical University
Qi Ma
Xinjiang Key Laboratory of Metabolic Disease, Clinical Medical Research Institute, the First Affiliated Hospital of Xinjiang Medical University
Yufeng Shi
School of Nursing & Health Management, Shanghai University of Medicine & Health Sciences

Research Article

Keywords: Wheezing, asthma, indoor environment, preschool children

Posted Date: October 29th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-1021148/v1

Abstract

Background: To investigate the prevalence and indoor environmental influencing factors of wheezing and asthma among preschool children in Urumqi, Xinjiang, China to provide a strong basis for prevention and control.

Methods: In August 2019, a cross-sectional epidemiological study involving 8153 preschool children was conducted in 60 kindergartens in Urumqi. The mean age of the children who participated in the survey was 5.27 ± 1.10 years. Additionally, 51.9% were boys, 86.9% were Han Chinese, and an 81.53% survey response rate was observed. The childhood wheeze and asthma survey used was the ALLHOME-2 questionnaire, and the childhood home dwelling and living environment survey used was the DBH questionnaire. Partial adjustments were made according to the geographical environment of Urumqi and the living habits of the residents.

Results: The prevalence of wheezing and asthma in children was 4.7% and 2.0%, respectively. Multivariate unconditional logistic regression results suggested that ethnicity (odds ratio (*OR*)=1.39, 95% confidence interval (95%*CI*)=1.05–1.84), birth pattern (*OR*=1.24, 95%*CI*=1.00–1.53), family history of asthma (*OR*=5.00, 95%*CI*=3.36–7.44), carpet or floor bedding at home (*OR*=1.40, 95%*CI*=1.05–1.87), purchasing new furniture in the mother's residence during pregnancy (*OR*=1.58,95%*CI*=1.06–2.36), pet keeping in the residence at age 0–1 (*OR*=1.55, 95%*CI*=1.13–2.13), passive smoking in the child's residence (*OR*=1.35, 95%*CI*=1.01–1.80), and having mould or hygroma in the child's residence at age 0–1 (*OR*=1.72, 95%*CI*=1.12–2.64) were risk factors for wheezing. In addition, sex (*OR*=0.73, 95%*CI*=0.59-0.90) was a protective factor for wheezing. Birth pattern (*OR*=1.46, 95%*CI*=1.06–2.00), family history of asthma (*OR*=7.06,95%*CI*=4.33–11.53), carpet or floor bedding at home (*OR*=2.20, 95%*CI*=1.50–3.23), and pet keeping in the residence at age 0–1 (*OR*=1.64, 95%*CI*=1.04–1.83) were risk factors for asthma, whereas gender (*OR*=0.58, 95% CI=0.42–0.80) was a protective factor for asthma.

Conclusion: This survey indicates that preschool children in Urumqi have a higher risk of wheezing and asthma. Risk factors that may cause an elevated risk of wheezing or asthma have also been identified.

Background

Bronchial asthma, referred to as asthma, is a respiratory disease resulting from a variety of causes that often manifests with symptoms, such as wheezing, shortness of breath, chest tightness, and cough [1]. According to previous statistics, there are at least 300 million children with asthma worldwide, and the prevalence is still on the rise, a trend that is particularly marked in developing countries [2, 3]. In recent years, China has experienced rapid economic development. Furthermore, the tremendous changes that have occurred in people's living environments and ways, resulting in the prevalence of asthma, have increased each year. Asthma not only causes significant damage to the physical health of children and costs incurred during the course of prolonged treatment but also imposes a severe economic burden on the families of affected children.

Liu et al. [4] suggested an increasing trend of childhood asthma prevalence in China by comparing the prevalence of childhood asthma over a 20-year period in 16 cities in China. The prevalence was 0.96% in 1990, 1.66% in 2000, and 2.38% in 2010. Xinjiang is a multiethnic aggregation area with a hot and dry climate, and there are large differences in the lives, dietary habits, and residential environments of all ethnic people. In a survey of children from 10 cities in China during 2010–2012, Zhang et al. [5] concluded that the prevalence of asthma among children was 1.7–9.8%, with the highest prevalence in Shanghai. However, the prevalence of wheezing among children in Urumqi was the highest among these 10 cities. This result suggests a higher prevalence of respiratory disease among children in Urumqi city. This was also confirmed by Wang et al. [6], who investigated children in Urumqi in 2011 and reported a prevalence of asthma of 3.6%.

According to related studies, the incidence of asthma is strongly associated with genetics, ethnicity, and the quality of the indoor and outdoor environments [7]. However, in recent years, epidemiological surveys of asthma in children in Urumqi city have been scarce. To understand the latest prevalence and risk factors for childhood asthma in Urumqi, a study covering 8153 preschool children in the Xinshi district, Shayibake district, Tianshan district, Shuimogou district, Toutunhe district, and Midong district of Urumqi was conducted in association with the actual situation in August 2019. The prevalence of childhood asthma and indoor environmental risk factors in Urumqi city were investigated. This study aims to provide a theoretical basis and scientific guidance for the prevention and treatment of asthma in children in Urumqi and even nationwide.

Subjects And Methods

Subjects

A stratified cluster random sampling method was used in August 2019, with a total of 60 kindergartens randomly selected from eight to 12 kindergartens in each of six districts, Xinshi district, Shayibake district, Tianshan district, Shuimogou district, Toutunhe district, and Midong district, according to the administrative region of Urumqi city. A total of 10000 questionnaires were distributed, and 8153 valid questionnaires were returned, resulting in an 81.53% response rate. This study was approved by the ethics committee of Fudan University, and all parents of the investigated children gave written informed consent.

Questionnaire

Contact was made with the Education Bureau of Urumqi city and the kindergarten teachers, and uniform professional training was provided to the responsible teachers involved in the investigated classes before the survey. Questionnaires were administered uniformly to the parents of the children by the preschool teachers in the kindergartens, and the questionnaires were completed by the parents or other guardians of the children when they were taken home. They were asked to complete it within a week and return it to the responsible teacher in the preschool. Teachers returned the questionnaires to the kindergarten gardener. The gardener sent the questionnaire to the City Education Bureau of Urumqi after collecting all the questionnaires from the kindergartens where the gardener was located.

The contents of this questionnaire are referred to in ALLHOME-2 in the doctoral thesis of Naydenov [8] and the questionnaire used by Bornehag on the dampness in construction and health (DBH) survey study [9]. Some revisions were made based on the specific situation in China and Urumqi city. The survey included the following six sections: (1) demographic characteristics, including sex, ethnicity, educational level, home address, etc.; (2) feeding status, including whether they were only children, whether they were breastfed, duration of breastfeeding, and age at which the child attended kindergarten; (3) child and family member health, including wheezing, asthma, pneumonia, allergic rhinitis, and other related symptoms; (4) child's residential environment, including housing type, whether there was a renovation, whether furniture was newly purchased, ventilation, smoke evacuation, etc.; (5) lifestyle habits, including animals, plants, cleaning frequency, smoking in the residence of the child, etc.; and (6) dietary habits, including the type of eating, the number of times, etc. Questionnaires were completed by all parents of children, and all questionnaires, excluding ineligible ones, were reviewed by more than two trained subject team members.

In this study, the related outcomes were judged as follows: (1) wheezing: subjective judgement: the child has great difficulty breathing; objective judgement: the respiratory muscles of the child are all involved in breathing, and the respiratory rate of the child is faster than normal [10–11]; (2) asthma: parental report of a doctor to include ever having a doctor's definite diagnosis of asthma; (3) frequency of the child’s room cleaning where regular cleaning refers to cleaning at least 2 times in 1 week, occasional cleaning refers to cleaning fewer than 2 times in 1 week and more than 1 time in 2 weeks, rare cleaning refers to fewer than 1 cleaning in 2 weeks [7]. (4) passive smoking: weekly exposure of nonsmokers for at least 1 d to smoke emitted from ignited coils or smoke exhaled by smokers [12].

Data analysis

Epi Data 3.1 software was used to create the database. One-way χ^2 tests were performed using SPSS 25.0 software. Multivariate logistic regression models were used to analyse potential respiratory disease risk factors. Differences with $P < 0.05$ were considered statistically significant.

Results

General condition of the investigated subjects

A total of 8153 preschool children were investigated in this study, including 4235 boys (51.9%) and 3918 girls (48.1%). Among them, the youngest age was 2.00 years, and the oldest age was 7.83 years, with a mean age of 5.27 ± 1.10 years. Additionally, 7081 (86.9%) were Han Chinese, and 1072 (13.1%) were members of other ethnic groups.

Wheezing and asthma prevalence

Approximately 4.7% of children reported symptoms of previous wheezing, and the prevalence of physician-diagnosed asthma was 2.0% (Table 1). Among them, boys had higher rates of wheezing and asthma than girls ($P < 0.01$), other ethnic groups had higher rates of wheezing and asthma than Han Chinese ($P < 0.01$), and children born via caesarean section had higher rates of wheezing and asthma than cisgender children ($P < 0.01$).

Table 1
Comparison of wheezing and asthma among preschool children with different characteristics in Urumqi (n = 8153).

Characteristics		Number of individuals	Number of wheezing cases	Prevalence (%)	χ^2	P value	Number of asthma cases	Prevalence (%)	χ^2	P value
Sex	Boy	4235	227	5.4	8.30	<0.01	107	2.5	10.05	<0.01
	Girl	3918	157	4.0			60	1.5		
Nation	Han	7081	312	4.4	11.07	<0.01	131	1.9	10.56	<0.01
	Other	1072	72	6.7			36	3.4		
Age (Year)	2~	1033	46	4.5	0.22	0.90	23	2.2	0.37	0.83
	4~	4828	231	4.8			100	2.1		
	6~8	2292	107	4.7			44	1.9		
Mode of birth	Antepartum	4187	178	4.3	4.04	0.05	73	1.7	3.99	0.05
	Caesarean section	3966	206	5.2			94	2.4		
Only child	Yes	3584	169	4.7	0.00	0.98	69	1.9	0.48	0.49
	No	4569	215	4.7			98	2.1		
Total		8153	384	4.7			167	2.0		

Univariate analysis of wheezing and asthma with indoor environmental variables

The analyses revealed that children's wheezing was the main environmental factor associated with carpet or floor bedding at home, new furniture acquisition in the mother's prepregnancy residence, mould or damp phenomenon in the mother's prepregnancy residence, new furniture acquisition in the mother's prepregnancy residence, new furniture acquisition in the child's residence at age 0–1, grooming or dampness in the residence at 0–1 years of age, pet keeping in the residence at 0–1 years of age, passive smoking in the current residence, passive smoking in the residence at 0–1 years of age, and passive smoking by the mother in the residence during pregnancy (P < 0.05).

Carpets or floor bedding at home, grooming in the mother's prepregnancy residence, mouldy in the mother's prepregnancy residence, dampness in the mother's prepregnancy residence, addition of new furniture before pregnancy, home renovation before pregnancy, new furniture in the home at age 0–1, grooming in the child's prepregnancy residence at age 0–1, mouldy in the residence at 0–1 years of age, dampness in the residence at 0–1 years of age, pet keeping in the residence at 0–1 years of age, and passive smoking by the mother in the residence during pregnancy were the main environmental factors influencing the development of childhood asthma (P < 0.05). They are all shown in Table 2.

Table 2
Univariate analysis of wheezing and asthma with indoor environmental variables (n = 8153).

Factors	Wheezing				Asthma			
	Number of cases	%	χ^2	P value	Number of cases	%	χ^2	P value
Residence area								
<75m^2	99	5.0	0.47	0.50	43	2.2	0.19	0.66
≥75m^2	285	4.6			124	2.0		
Carpet or floor bedding at home								
Yes	66	6.9	11.37	<0.01	42	4.4	29.36	<0.01
No	318	4.4			125	1.7		
Addition of new furniture before pregnancy								
Yes	108	6.1	9.19	<0.01	43	2.4	1.49	0.22
No	276	4.3			124	1.9		
Home renovation before pregnancy								
Yes	83	6.9	15.27	<0.01	37	3.1	7.51	<0.01
No	301	4.3			130	1.9		
Mouldy or dampness before pregnancy								
Yes	63	7.2	13.47	<0.01	36	4.1	20.78	<0.01
No	321	4.4			131	1.8		
Addition of new furniture during pregnancy								
Yes	72	8.3	27.37	<0.01	31	3.6	11.05	<0.01
No	312	4.3			136	1.9		
Home renovation during pregnancy								
Yes	51	8.7	22.18	<0.01	21	3.6	7.33	<0.01
No	333	4.4			146	1.9		
Mouldy or dampness during pregnancy								
Yes	54	7.9	17.07	<0.01	29	4.3	18.02	<0.01
No	330	4.4			138	1.8		
Addition of new furniture at child's age 0–1 year								
Yes	52	7.1	10.47	<0.01	28	3.8	12.82	<0.01
No	332	4.5			139	1.9		
Home renovation at child's age 0–1 year								
Yes	35	7.2	7.15	<0.01	23	4.7	18.56	<0.01
No	349	4.6			144	1.9		
Mouldy or dampness at child's age 0–1 year								
Yes	56	9.2	29.07	<0.01	26	4.2	15.92	<0.01
No	328	4.3			141	1.9		
Use of air conditioning								

Factors	Wheezing				Asthma			
	Number of cases	%	χ^2	*P* value	Number of cases	%	χ^2	*P* value
Yes	115	4.5	0.36	0.55	50	2.0	0.16	0.69
No	269	4.8			117	2.1		
Pet in child’s residence								
Yes	63	4.6	1.62	0.20	32	2.8	3.46	0.06
No	321	5.4			135	1.9		
Flowering plants grown in the child's residence								
Yes	115	4.7	0.01	0.93	50	2.0	0.00	0.96
No	269	4.7			117	2.1		
Pet in the residence at child’s age 0–1 year								
Yes	50	7.6	13.14	<0.01	24	3.6	9.03	<0.01
No	334	4.5			143	1.9		
Flowering plants grown in the residence at child’s age 0–1 year								
Yes	97	5.2	1.27	0.26	35	1.9	0.36	0.55
No	287	4.6			132	2.1		
Passive smoking in the child's residence								
Yes	179	6.0	18.10	<0.01	72	2.4	3.30	0.07
No	205	4.0			95	1.8		
Passive smoking at child’s age 0–1 year								
Yes	150	6.1	15.03	<0.01	56	2.3	0.90	0.34
No	234	4.1			111	2.0		
Passive smoking during pregnancy								
Yes	128	6.2	13.98	<0.01	55	2.7	5.35	0.02
No	256	4.2			112	1.8		
Room cleaning frequency								
Often	316	4.5	4.07	0.13	135	1.9	5.41	0.07
Occasionally	63	5.9			28	0.3		
Very seldom	5	6.1			4	0.0		
Family history of asthma								
Yes	36	9.4	106.83	<0.01	23	13.7	115.80	<0.01
No	348	4.4			144	1.8		

Multivariate analysis of wheezing and indoor environmental variables

Wheezing illness was used as the dependent variable (0 = no; 1 = yes), variables significant in univariate analysis were introduced into the logistic regression model, and 9 variables from the final entry main effect model were associated with the incidence of wheezing. Among these, mode of birth, family history of asthma, carpet or floor bedding at home, acquisition of new furniture in the mother's residence during pregnancy, pet keeping in the child's residence at age 0–1 years, and passive smoking in the child's current residence at age 0–1 years were risk factors for wheezing. Sex was a protective factor for wheezing (Table 3).

Table 3
Multivariate logistic regression analysis of risk factors for wheezing among preschool children in Urumqi (n = 8153).

Factors	Reference	β	$S_{\cdot x}$	Waldχ^2 value	P value	OR	95%CI
Sex	Boy	-0.31	0.11	8.47	<0.01	0.73	0.59~0.90
Nation	Han	0.33	0.14	5.40	0.02	1.39	1.05~1.84
Mode of birth	Antepartum	0.21	0.11	4.01	0.05	1.24	1.00~1.53
Family history of asthma	No	1.61	0.20	63.11	<0.01	5.00	3.36~7.44
Carpet or floor bedding at home	No	0.34	0.15	5.12	0.02	1.40	1.05~1.87
Addition of new furniture during pregnancy	No	0.46	0.20	5.11	0.02	1.58	1.06~2.36
Pet in the residence at child's age 0–1 year	No	0.44	0.16	7.33	<0.01	1.55	1.13~2.13
Passive smoking in the child's residence	No	0.30	0.15	4.17	0.04	1.35	1.01~1.80
Mouldy or dampness at child's age 0–1 year	No	0.54	0.22	6.08	0.01	1.72	1.12~2.64

Multivariate analysis of asthma and indoor environmental variables

The presence or absence of asthma was used as the dependent variable (0 = no; 1 = yes), variables significant in univariate analysis were introduced together into the logistic regression model, and 5 variables from the final entry main effect model were associated with the incidence of asthma. Among these, mode of birth, family history of asthma, carpet or floor bedding at home, and child's age 0 to 1 year were risk factors for asthma when keeping a pet in the residence. Sex was a protective factor for asthma (Table 4).

Table 4
Multivariate logistic regression analysis of risk factors for asthma among preschool children in Urumqi (n = 8153).

Factors	Reference	β	$S_{\cdot x}$	Waldχ^2 Value	P value	OR	95%CI
Sex	Boy	-0.55	0.17	10.93	<0.01	0.58	0.42~0.80
Mode of birth	Antepartum	0.38	0.16	5.43	0.02	1.46	1.06~2.00
Family history of asthma	No	1.95	0.25	60.93	<0.01	7.06	4.33~11.53
Carpet or floor bedding at home	No	0.79	0.20	16.43	<0.01	2.20	1.50~3.23
Pet in the residence at child's age 0–1 year	No	0.50	0.23	4.49	0.03	1.64	1.04~1.83

Discussion

The results of this survey showed that the prevalence of wheezing (4.7%) and asthma (2.0%) among preschool children in Urumqi city is high. In addition to genetic factors, wheezing and the onset of asthma have extremely strong associations with indoor environmental factors.

Kim et al. [13] found a higher prevalence of asthma in boys than in girls, and children with a family history of asthma had a higher risk of developing asthma. Quite a few studies have found that the risk of asthma in minorities is greater than that in the Han population [7, 14]. This is consistent with the results of the present study. Genetic factors are one of the important contributors to the pathogenesis of asthma, and more than 100 candidate genes for asthma have been identified thus far. Among them, genes, such as ADRB2, interleukin 4, IL-13, and ormdl3, in the chromosome 5q region are more clearly associated with childhood asthma onset [15]. These factors may have contributed to the fact that sex, ethnicity, and family history of asthma are risk factors for the development of childhood asthma. In addition to genetic factors, differences in lifestyle habits and residential environments among different ethnic groups and sexs may also contribute to the predisposition of girls and ethnic minorities to asthma. For example, there is a strong desire to lay carpets and floor pads, all of which contribute to the breeding of bacteria and dust mites in the minority families of Xinjiang, which, combined with the fact that they are not easily cleaned, children are usually exposed to a large number of bacteria and dust mites inhaled into their bodies, resulting in an elevated incidence of respiratory diseases [6]. This survey similarly found carpet or floor mats lying at home to be a risk factor for wheezing and asthma. Boys are more mobile, have more opportunities for allergen exposure, and have differential hormone secretion than girls; thus, they have a higher prevalence of wheezing and asthma [16–18]. It was also found in the multivariate analysis

of this study. Additionally, mode of birth was found to be a risk factor for wheezing and asthma prevalence in this study. Studies have confirmed that mode of birth has a very important impact on the development and maturation of the neonatal immune system [19]. Caesarean delivery of newborns increases the risk of allergic diseases later in infancy due to a lack of exposure to the normal flora of the maternal vagina and gut; instead Escherichia coli and Fusobacterium enter the neonatal gastrointestinal tract at an early age [20–21]. Therefore, we considered that the prevalence of wheezing and asthma was higher in children who were delivered by caesarean section than in those who were delivered vaginally, and the reasons may be related to this.

Due to rapid economic development in recent years, people also have an increasing demand for indoor renovation and furniture. However, whether decorating materials or newly purchased furniture, which contains substances, such as formaldehyde, benzene, toluene, and xylene, children inhale such substances in excess and irritate their airways, increasing the risk of developing asthma [22]. Although indoor renovation and newly purchased furniture were not found to be associated with asthma incidence in children in this study, newly purchased furniture in mothers' gestational residence was found to result in an elevated risk of developing wheezing. This may be due to the ability of formaldehyde to transport across the placenta endangering the health of the foetus, and pregnant women have been in an environment containing substances, such as formaldehyde, for a long time, which can cause abnormal foetal development and even foetal malformations [23]. Indoor passive smoking has been confirmed to be closely associated with child health in many studies. A cohort study by Robison et al. [24] in Boston showed that passive smoking may affect foetal and infant lung development, resulting in impaired lung function from early in life and increasing the number of wheezing episodes in infants and young children. A meta-analysis of 79 cohort studies by Burke et al. [25] also suggested passive smoking as a risk factor for the development of wheezing in children. This conclusion was similarly reached in the present investigation.

Domestic pets are now very common in China, but many studies in the country and abroad have confirmed that pets increase the levels of endotoxin to allergens in the environment and induce asthma after inhalation in children [26–27]. The present study also identified pet keeping in the residence when the child was 0–1 years old as a risk factor for wheezing and the development of asthma. It is worth mentioning that there are still quite a few studies proposing that exposure to endotoxin early in life is a protective factor for asthma pathogenesis [28–29]. The reason for this difference may be due to the excessively dry climate in Xinjiang, which is suitable for the spread of dust mites, bacteria, and other substances, and the excessive amount of such substances inhaled by children through the respiratory tract. Therefore, keeping pets at home can lead to an elevated risk of wheezing and asthma. However, this survey also found that a wet environment was similarly a risk factor for the incidence of wheezing. A survey by Zhao et al. [30] in Taiyuan, Shanxi, showed that signs of dampness or indoor mould was positively associated with asthma and allergic disease in nearly all children. This may be related to the fact that the humid environment is prone to bacterial and dust mite breeding, so overly dry or humid shelter should be avoided.

Conclusion

Ethnicity, mode of birth, family history of asthma, carpet or floor bedding at home, acquisition of new furniture in the mother's home during pregnancy, keeping a pet in the residence when the child is 0–1 years old, passive smoking in the child's current residence when the child is 0–1 years old, and presence of mouldy or hygroscopic phenomena in the residence when the child is 0–1 years old are risk factors for wheezing, whereas sex is a protective factor for wheezing. Mode of birth, family history of asthma, carpet or floor bedding at home, and pet keeping in the home when the child is 0–1 years old are risk factors for asthma, whereas sex is protective for asthma. Further expansion of longitudinal studies and cohort studies could help to validate and gain insight into the influence of indoor environmental factors on wheezing and asthma in children.

Abbreviations

CI: confidence interval; *OR*: odds ratio

Declarations

Ethics approval and consent to participate

The study was conducted strictly in accordance with the Declaration of Helsinki and approved by the research ethics committee of Fudan University（protocol no. IRB00002408 & FWA00002399）, all parents and class teachers of the children under investigation have signed written informed consent.

Consent for publish

Not applicable

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due the data belongs to the School of Public Health of Fudan University but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

All phases of this study were supported by National Natural Science Foundation of China (grant no. 81860179 and 81861138005).

Authors Contributions

TW, HS and ZZ designed the study, participated in the field investigation phase, and wrote the airicle.

GW, DN QM and YS onceptualized and designed the study, and investigated and revised the manuscript.

GP, SM, HD, JY, JL, YW, QY and HQ participated in the field investigation phase.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Acknowledgements

Acknowledgement is given to National Natural Science Foundation of China (grant no. 81861138005) and National Natural Science Foundation of China (grant no. 81860179) for initiating the original research project. Researchers within the School of Public health of Xinjiang Medical University and Urumqi Education Bureau must also be acknowledged for assisting with data collection.

References

1. Hua W, Huang H Q, Shen H H. Interpretation of 2016 asthma management and prevention guideline. JOURNAL OF ZHEJIANG UNIVERSITY(MEDICAL SCIENCES, 2016,45(5):447–452. DOI: 10.3785/j.issn.1008-9292.2016.09.01.
2. Global Initiative for Asthma. Pocket guide for asthma management and prevention[EB/OL].(2012-12)[2021-10-26].
3. Global Initiative for Asthma. Global strategy for the diagnosis and management of asthma in children 5 years and younger[EB/OL]. 2009[2021-10-26].
4. Liu C H, Hong J G, Shang X Y, et al. Comparison of asthma prevalence in children from 16 cities of China in 20 years. Chinese Journal of Practical Pediatrics August, 2015,30(8):596–600. DOI: 10.7504/ek2015080609.
5. Zhang Y P, Li B Z, Huang C, et al. Ten cities cross-sectional questionnaire survey of children asthma and other allergies in China. Chinese Science Bulletin, 2013, 58(34): 4182–4189. DOI: 10.1007/s11434-013-5914-z.
6. Wang T T, Zhao Z H, Yao H, et al. Housing characteristics and indoor environment in relation to children's asthma, allergic diseases and pneumonia in Urumqi, China. Chinese Science Bulletin, 2013, 58(34): 4237–4244. DOI: 10.1007/s11434-013-5727-0.
7. Wang Q, Xu C Y, Xu D Q, et al. Risks on asthma among city chiidren in China:a nationwide case-control study. CHINESE JOURNAL OF EPIDEMIOLOGY, 2014, 35(3): 237–241. DOI: 10.3760/cma.j.issn.0254-6450.2014.03.004.
8. Naydenov K, Popov T, Mustakov T, et al. The association of pet keeping at home with symptoms in airways, nose and skin among Bulgarian children[J]. Pediatric allergy and immunology, 2008, 19(8): 702–708. DOI: 10.1111/j.1399-3038.2008.00721.x.

9. Bornehag C G, Sundell J, Sigsgaard T. Dampness in buildings and health (DBH): Report from an ongoing epidemiological investigation on the association between indoor environmental factors and health effects among children in Sweden. Indoor Air, 2004, 14(7): 59–66. DOI: 10.1111/j.1600-0668.2004.00274.x.
10. Wang B Y, Yuan Y. Diagnosis of dyspnea in children. Chinese Medical Journal, 2016, 51(11): 14–17. DOI: 10.3969/j.issn.1008-1070.2016.11.005.
11. Lian R, Zhang G Q. Clinical application of bedside ultrasound in acute dyspnea. Chinese Medical Journal, 2016, 51(9): 1–6. DOI: 10.3969/j.issn.1008-1070.2016.09.001.
12. Luo L F, Chen J W, Luo M H, et al. Exposure to second-hand smoke and its influencing factors among 15-69 years old residents in Guangzhou city. Chin J Public Health, 2019,35(8): 973–976. DOI: 10.11847/zgggws1120915.
13. Jin K, Duolikun M, Ma X P, et al. The prevalence and related factors of asthma in Urumgi. Clin Pediatr, 2012, 30(6): 559–561. DOI: 10.3969 / j.issn.1000-3606.2012.06.016.
14. Wang T T, Shi H N, Liu Q et al. Prevalence and influencing factors of asthma and wheezing among preschool children in Urumqi city: a cross-sectional survey[J]. Chin J Public Health, 2021, 37(2): 260–264. DOI: 10.11847/zgggws1125733.
15. Lin Y H, Yuan S H, Lu A P. New Research Development in Genetic Factors of Bronchial Asthma. Medical Recapitulate, 2010, 16(16): 2428–2430. DOI: 10.3969/j.issn.1006-2084.2010.16.010.
16. Bai J, Zhao J, Shen K L, et al. Prevalence of Childhood Asthma in Beijing, Chongqing, and Guangzhou. CHINESE JOURNAL OF ALLERGY & CLINICAL IMMUNOLOGY, 2010, 4(4): 280-285. DOI: 10.3969/j.issn.1673-8705.2010.04.007.
17. Shea K M, Truckner R T, Weber R W, et al. Climate change and allergic disease[J]. Journal of allergy and clinical immunology, 2008, 122(3): 443–453. DOI: 10.1016/j.jaci.2008.06.028.
18. Postma D S. Gender differences in asthma development and progression. Gender medicine, 2007, 4(Suppl. B): S133-S146. DOI: 10.1016/S1550-8579(07)80054-4.
19. Guan Y Z. The effect of delivery method on the development of the infant's early immune system. Chinese Journal of Perinatal Medicine, 2011, 14(1): 32–34. DOI: 10.3760/cma.j.issn.1007-9408.2011.01.010.
20. Gunderson E P, Hurston S R, Dewey K G, et al. The study of women, infant feeding and type 2 diabetes after GDM pregnancy and growth of their offspring (SWIFT Offspring study): prospective design, methodology and baseline characteristics. BMC pregnancy and childbirth, 2015, 15(1): 1–15. DOI: 10.1186/s12884-015-0587-z.
21. Dou H D, Zhang X F, Bai R H, et al. The occurrence of macrosomia and its influencing factors. Journal of Xi'an Jiaotong University(Medical Sciences), 2017, (6): 888–891. DOI: 10.7652/jdyxb201706020.
22. Zhang H L, He Y, He L F, et al. Effect of home renovation on children with asthma and asthma symptoms, Zhongshan city. Modern Preventive Medicine, 2018, 45(11): 29–33. DOI: CNKI:SUN:XDYF.0.2018-11-007.
23. Deng G X, Fan X Q, Yang Q X. Correlation between Fetal Malformation and Formaldehyde-Benzene Pollution in a Furniture Production Base. J Environ Occup Med, 2013, 30(9): 673–675. DOI: CNKI:SUN:LDYX.0.2013-09-007
24. Robison R G, Kumar R, Arguelles L M, et al. Maternal smoking during pregnancy, prematurity and recurrent wheezing in early childhood. Pediatric pulmonology, 2012, 47(7): 666–673. DOI: 10.1016/j.jaci.2010.12.382.
25. Burke H, Leonardi-Bee J, Hashim A, et al. Prenatal and passive smoke exposure and incidence of asthma and wheeze: systematic review and meta-analysis. Pediatrics, 2012, 129(4): 735–744. DOI: 10.1542/peds.2011-2196.
26. Hugg T T, Jaakkola M S, Ruotsalainen R, et al. Exposure to animals and the risk of allergic asthma: a population-based cross-sectional study in Finnish and Russian children. Environmental Health, 2008, 7(1): 1–8. DOI: 10.1186/1476-069X-7-28.
27. Dong G H, Ma Y N, Ding H L, et al. Pets keeping in home, parental atopy, asthma, and asthma-related symptoms in 12,910 elementary school children from northeast China. Indoor Air, 2008, 19(2): 166–173. DOI: 10.1111/j.1600-0668.2008.00576.x.
28. Kramer M S, Matush L, Bogdanovich N, et al. The low prevalence of allergic disease in Eastern Europe: are risk factors consistent with the hygiene hypothesis?. Clinical & Experimental Allergy, 2009, 39(5): 708–716. DOI: 10.1111/j.1365-2222.2009.03205.x.
29. Kerkhof M, Wijga A H, Brunekreef B, et al. Effects of pets on asthma development up to 8 years of age: the PIAMA study. Allergy, 2009, 64(8): 1202–1208. DOI: 10.1111/j.1398-9995.2009.02016.x.
30. Zhao Z H, Zhang X, Liu R R, et al. Prenatal and early life home environment exposure in relation to preschool children's asthma, allergic rhinitis and eczema in Taiyuan, China. Chinese Science Bulletin, 2013, 58(34): 4245–4251. DOI: 10.1007/s11434-013-5705-6.