Urbanization and Health

URBANIZATION AND HEALTH

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URBANIZATION AND HEALTH

ABSTRACT

There has been rapid urbanization in China, the largest developing country in the world, which brings major changes to people's lives. In addition to the change of socioeconomic status, most people also experience dramatic shifts in lifestyles and the residential environment. On one hand, people have more access to better resources, including healthcare, education, job opportunities, etc. In the meantime, however, the prevalence of some "Western symptoms", including obesity and asthma, has been on the rise over the past few decades. Since the pace of urbanization is still fast and is likely to last, it is a critical time point to identify the factors that are connected to these diseases, which can provide evidence for individuals, companies and policy makers to make informed decisions in the future. Among the large number of factors that possibly affect people's health, in this thesis we prioritize and discuss about three of them which are closely related to urbanization, and on which people make effective changes to avoid or reduce the negative impact.

The first aim is to study the association between migration status and respiratory symptoms. With the rapid urbanization in China, significant migration from rural to urban areas and between urban areas has been observed, and the difference from local urban population in lifestyles has not been filled yet. The migration trend is accompanied by a significant increase in the prevalence of asthma. In this aim, we contrast the health conditions between domestically

migrating population and long-term residents and their children with a focus on asthma and allergic symptoms. It is found that children from migrant families have lower prevalence of asthma and other respiratory disease compared to the local families within our study population.

The finding of the first aim led us to explore further on the early life exposure factors. In aim 2, we investigated the effect of cesarean section (C-section) on childhood asthma and obesity. The C-section rate has increased dramatically in the past 20 years. With more access to better healthcare facilities, more mothers choose delivery by C-section without medical necessity. While many studies have focused on the increased cost burden for the healthcare system, there is insufficient attention on the possible health consequences of elevated C-section rate. Our results indicated that C-section is a strong and consistent risk factor for developing asthma and allergic symptoms, as well as being overweight and obese.

For the third aim, a different angle is taken to explore the effect of neighborhood greenness and asthma/allergic diseases. Although green spaces are built with the intention of promoting physical activity and creating recreational facilities, there exists mixed evidence on how greenness is associated with respiratory health. We conducted a comprehensive evaluation of residential greenness by using different measures of greenness, including the normalized difference vegetation index (NDVI) and distance to the closest park. Different measures yielded different results, which suggests more information needs to be collected on the specific type of greenness in order to tackle this complexity.

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ACKNOWLEDGMENTS

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CHAPTER 1 Thesis Overview

For the first time in history, more than 50% of the world's population lives in an urban area. By 2050, 70% of the world's population will be living in towns and cities. The effect on health of urbanization is two-edged. On the one hand, there are the benefits of ready access to healthcare, sanitation, and secure nutrition, whilst on the other there are the evils of overcrowding, pollution, social deprivation, crime, and stress-related illness. In less developed countries, urbanization also opens the door to 'western' diseases, including hypertension, heart disease, obesity, diabetes and asthma.

As a result of the rapid economic growth for the two decades since the initiation of economic reforms in 1978, China has been experiencing rapid urbanization created by the history's largest flow of rural–urban migration in the world. In the last few decades China has been experiencing rapid urbanization substantially with over one sixth of the total population moving from rural areas to mega-cities. On the other hand, however, with China's longstanding bifurcated household registration system, or Hukou system, a gap had been created between rural and urban populations. The migration trend occurred at such a high speed that the gap still exists in various aspects of life among the migrant population and the original urban population. This presents a natural epidemiological exposure for exploring the effect of numerous environmental and behavioral factors on people's health. Also, the urban infrastructure is not uniform across different areas in the fast developing cities, so it is also important to study the variation of some public spaces and facilities and how they are connected to health outcomes.

This project is designed to investigate the associations between attributes of urbanization and resident behaviors, perceptions and health of families, by collecting detailed information in a middle-sized diverse city with different urban areas (i.e., "Ancient City", industrial park, suburban area); different living environments, lifestyles and health conditions (including symptoms of chronic diseases); and using statistical approaches to analyze the associations. The findings and insights from this study will provide guidance to individuals towards a healthier lifestyle. In addition, the results will add a public health perspective to zoning decisions, help frame urban master plans and housing designs, and give context to a myriad of other decisions made by municipalities that impact the collective "health" of their communities.

From October 2014 to January 2015, we initiated a health cohort in Suzhou, China. Suzhou consists of an Ancient City (urban core), two new satellite districts (industrial parks), and two suburban districts (Figure 1.1). In the Ancient City, there are over two hundred traditional houses dating back to the Ming and Qing dynasties. The site of the Ancient City continues to be used for residential and retail purposes. The newer industrial park communities were built to permit modernization, expand the traditional city, and reduce the urban density in the Ancient City. The rapid improvement of the existing city infrastructure, with a more modern infrastructure and increased land for newer industries, is the centerpiece of Suzhou's strong economic base. The two suburban areas are a mix of residential use, ecological agriculture, and traditional industry. Modernization of this historic city offers a variety of housing types and neighborhood infrastructures for studying the relationships among health and aspects of the built environment.

We successfully recruited 8000 families, for information on 13,000 individuals, including parents of middle school students and kindergarten children from across the metropolitan area. Detailed information on home environment (materials, building age, renovation, ventilation. etc.), neighborhood environment (walkability, neighborhood surroundings, and access to service), commuting pattern, physical activity, social relations, migration history, and life satisfaction among other variables were collected (Figure 1.2) through questionnaire. The questionnaire was adapted from validated questionnaire designed by the International Study of Asthma and Allergies in Childhood (ISAAC), China, Children, Home and Health study (CCHH) and The Nurses' Health Study. A full version of the questionnaire can be found in Appendix A. This database provides a unique opportunity to explore key questions at the intersection of urban planning, the built environment and health.

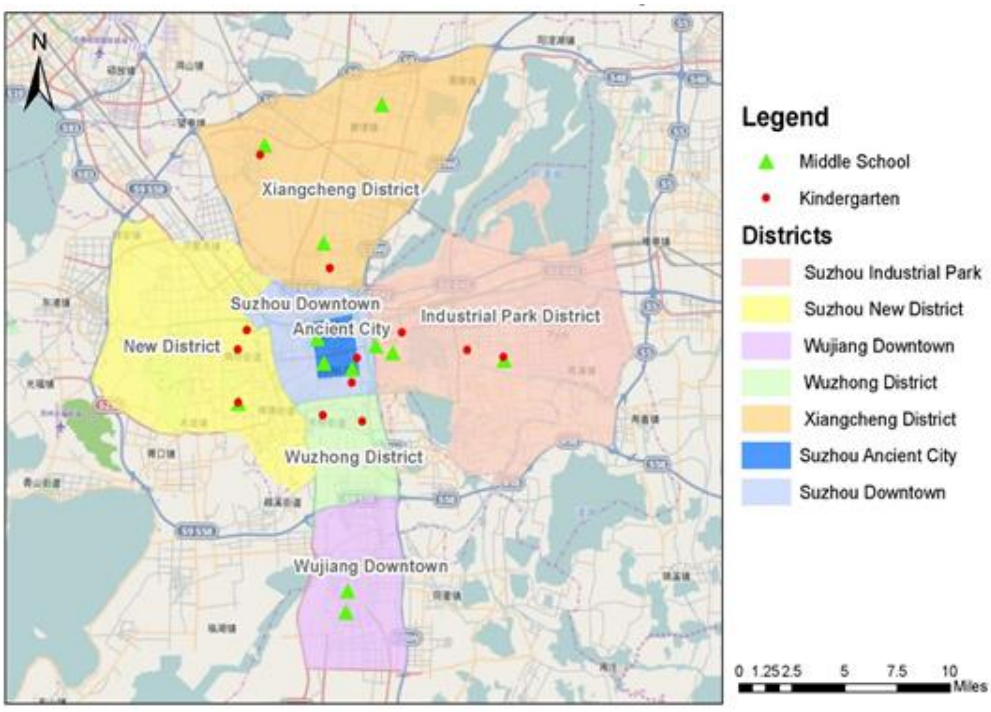

Figure 1.1. School distribution in the Suzhou study

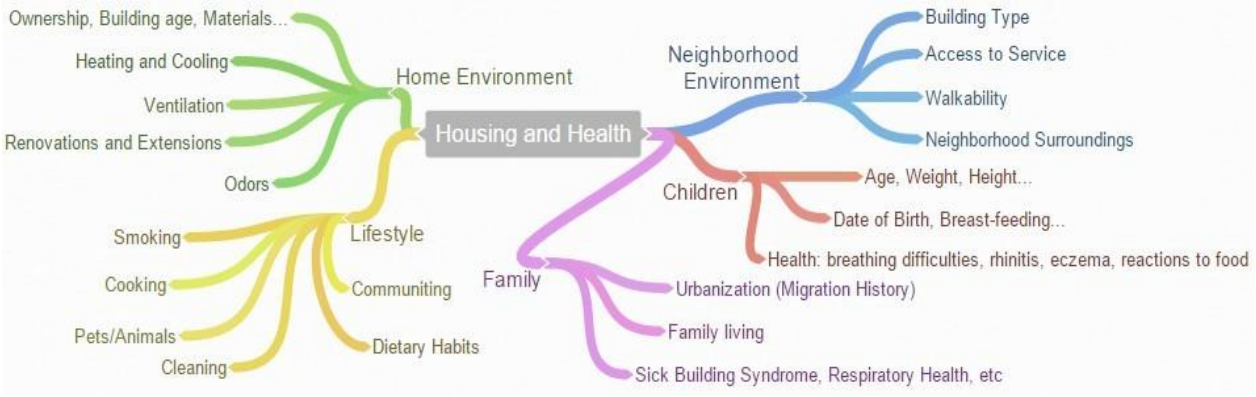

Figure 1.2. Detailed information on each household

Based on the address information we collected from the questionnaire, we were able to geocode the homes of the participants and perform detailed exposure assessment using information from Geological Information System. Figure 1.3 plots the proximity to nearest roadway of all home addresses as a measurement for air pollution. Figure 1.4 shows the Normalized Difference Vegetation Index (NDVI) values as a measure for residential greenness.

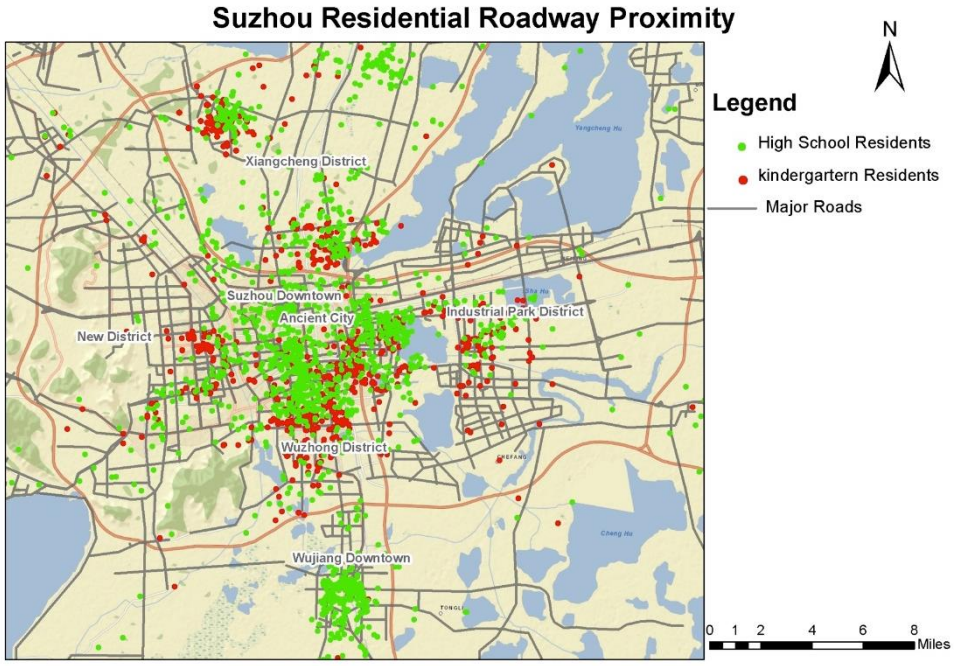

Figure 1.3. Estimating roadway proximity using GIS based tools

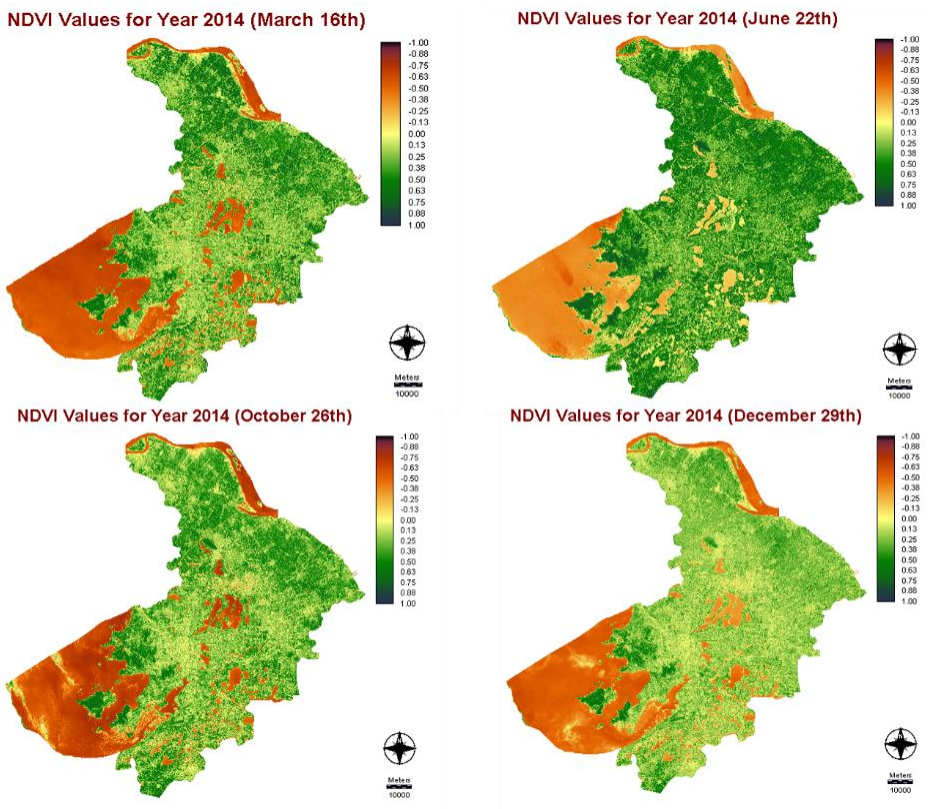

Figure 1.4. Normalized difference vegetation index (NDVI) distribution in Suzhou for four seasons in 2014

The specific aims investigated in this thesis is as follows:

Paper 1	*Prevalence of Asthma and Allergic Conditions in Suzhou, China: Trends by Domestic Migrant Status*
Aim 1	To compare the health status between local population vs. domestic migrant population.
Paper 2	*Risks of Cesarean Birth on Childhood Asthma, Allergic Symptoms and Obesity in a Chinese City and Its Effect Modification on breastfeeding*
Aim 2	To analyze the risks of cesarean birth on childhood asthma and obesity
Paper 3	*Effect of Residential Greenness on Respiratory and Allergic Diseases among Children in a Chinese City*
Aim 3	To analyze the effect of residential greenness on resident's respiratory and allergic diseases

CHAPTER 2 - Prevalence of Asthma and Allergic Conditions in Suzhou, China: Trends by Domestic Migrant Status

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Abstract

Background: During rapid urbanization in developing countries, significant migration from rural to urban areas and between urban areas has been observed, which presents a natural epidemiological model to better understand prevalence of asthma and allergy without being confounded by genetic factors.

Objective: The aim of this study is to investigate domestic migration and its effect on asthma and allergic symptoms.

Methods: This work was conducted from November 2014 to January 2015 in Suzhou, China as a cross-sectional study to contrast the health conditions between domestically migrating population and long-term residents and their children with a focus on asthma and allergic symptoms.

Results: The odds ratios for children in migrant families compared to long-term resident citizens of Suzhou, China for the doctor-diagnosed asthma, pneumonia, rhinitis and eczema are 0.56 (95% CI: 0.42.0.73) , 0.60 (95% CI: 0.49, 0.72), 0.63 (95% CI:0.52, 0.77) and 0.73 (95% CI: 0.60, 0.89) from multivariate logistic regression model.

Conclusion: A rapid rising trend of asthma prevalence in China was observed. Children from migrant families have lower prevalence of asthma and other respiratory disease compared to the local families within our study population.

2.1 Introduction

In the past few decades, the prevalence of asthma and allergenic symptoms has increased globally, affecting quality of life and economic development (1,2). Among many other potential factors, a person's migration status has been found associated with development of these symptoms (3). Several studies have investigated the effect of international migration on asthma and allergic symptoms. Most results showed a "healthy migrant" effect (4-6). Immigrants going to a westernized country like Australia, Italy and Germany have lower rates of asthma and other respiratory symptoms as compared to native population (7-10). This "protective effect" attenuates the longer the immigrating person has been in the host country (8,11-15). However, there are a few studies that reported different results. Studies in United States and United Kingdom (16,17) found the proportion of patients allergic to specific agents in the immigrant population is similar to the native population. Some authors even reported more severe asthma among immigrants (18). The majority of studies suggest it is reasonable to attribute this difference in migrant population to environmental factors, while some hypothesized that it might be related to ethnicity of immigrants (18,19). Understanding factors associated with migration status could provide insight for mitigating or preventing asthma and allergic symptoms.

While most studies focus on international immigration, domestic/internal migration, also needs close attention, especially in China, where the longstanding bifurcated household registration system, or Hukou system has created a gap between rural and urban populations in various aspects of life. In the last few decades China has been experiencing rapid urbanization substantially with rural populations moving to mega-cities. The migrant population reached 236 million, exceeding one sixth of the total population in China by 2012 (20). This unprecedented mobility of large populations has interested social scientists and influenced both federal and local development and many policies. As recent as 2014 China's National

Development and Reform Commission announced a new urban policy in favor of new city formation rather than increasing the population of existing large cities (21). This population received broad public health attention and increasing research effort has been made to examine the effect of migrant status on migrants' health. Most of the current public health focus is on infectious diseases, reproductive health and mental health issues of migrating populations (22-25). However, little has been published on asthma and other respiratory symptoms. These diseases can have long-term negative effects on people's efficiency and productivity, and are becoming a growing public health burden; therefore studying the migrant population within the same ethnic group would therefore provide insights for understanding the causes and further generate guidance for the prevention and treatment of the disease.

This analysis examines difference in health conditions between migrant population and a native urban population and their next generations in Suzhou, China, with a focus on asthma and allergic symptoms. To our knowledge, this work is the first study to investigate asthma and allergic conditions by city resident status in a prefecture-level city in China.

2.2 Methods

Study design

The cross-sectional survey was conducted November 2014 through January 2015 in Suzhou, China. The survey was distributed through participating schools and was completed by parents and returned to teachers. Twelve middle schools across the city participated. Our survey had a questionnaire for parents/guardians and another for students. Items included demographic information (migration status), home and neighborhood location and environment, detailed questions regarding children and family health and satisfaction. Questions on diagnosis and

symptoms of asthma, pneumonia, rhinitis and eczema were based on ISSAC (26), and questions about Chinese-specific home characteristics were adapted from the *China, Children, Home and Health* study (27).

The study protocol was approved by Harvard T.H. Chan School Public Health ethics committee and the local ethics committees. Children's parents or trustee provided written informed consent. Permission for the study was granted by the school boards of participating schools.

Questionnaire

Specific health outcomes were defined as described below.

"Asthma (father)", "Rhinitis (father)" and "Eczema (father)" were defined based on the positive answers to the questions "Does the child's father have asthma? (Yes/No)", "Does the child's father have rhinitis? (Yes/No)" and "Does the child's father have eczema? (Yes/No)", respectively. Mothers' questions were the same as fathers'.

"Asthma (child)", "Pneumonia (child)", "Rhinitis (child)" and "Eczema (child)" were determined by positive answers to the questions: "Has the child ever been diagnosed with asthma by a doctor? (Yes/No)", "Has the child ever been diagnosed with pneumonia by a doctor? (Yes/No)", "Has the child been diagnosed with hay fever or allergic rhinitis by a doctor? (Yes/No)" and "Has the child been diagnosed with eczema by a doctor? (Yes/No)", respectively.

Symptoms of "current wheeze (child)" were determined by positive answers to the written question "Have you (has your child) had wheezing or whistling in the chest in the past 12 months?" Symptoms of "ever wheeze (child)" were determined by positive answers to the

written question ‘Have you (has your child) had wheezing or whistling in the chest at any time in the past?”

Symptoms of “current sneezing (child)” were determined by positive answers to the written question “Have you (has your child) had sneezing, or a runny, or a blocked nose when not have a cold or the flu in the past 12 months?” Symptoms of “ever sneezing (child)” were determined by positive answers to the written question ‘Have you (has your child) had sneezing, or a runny, or a blocked nose when not have a cold or the flu at any time in the past?”

Symptoms of “current itchy rash (child)” were determined by positive answers to the written question “Have you (has your child) had itchy rash at any time in the last 12 months?” Symptoms of “ever itchy rash (child)” were determined by positive answers to the written question ‘Have you (has your child) ever had an itchy rash, which was coming and going for at least 6 months?”

Participants were asked “Did the child’s mother grow up in Suzhou? (Yes/No)” and “Did the child’s father grow up in Suzhou (Yes/No)”. Four groups were created as “both local parents”, “only migrant mother”, “only migrant father” and “both migrant parents” to reflect different migrant status. Participants were also asked to report their residency status by answering to the question “Do the child’s parents currently have official Suzhou residency status (i.e. Hukou)?”

Statistical analysis

Kruskal–Wallis nonparametric test and analysis of variance (ANOVA) were used to test differences among groups. Univariate logistic regression and multivariable logistic regression were used to compare the prevalence of symptoms among different population groups and to evaluate the relation between symptoms of asthma and migrant status. Ages, gender, paternal education, exposure to environmental tobacco smoke and home ownership were adjusted as confounding factors (28-30). Results are presented as odds ratios (ORs) and 95% confidence intervals (CIs). All the computations were carried out using R version 3.2.3.

2.3 Results

A total of 5,891 middle school children and their parents/guardians participated in our study, with 201 child-parent surveys excluded from the analysis due to the lack of migrant status information. Of the children included 51.6% were male, and most of them were at age 13 (43.7%) and age 14 (40.2%). We classified them into 4 groups based on migrant status, with 2,213 children (37.6%) whose parents both grew up in Suzhou, 461 children with only father from Suzhou, 460 children with only mother from Suzhou and 2,556 children whose parents both identified as having migrated from other places. 67% of our study population had Suzhou residency while 33% did not. Both parents growing up in Suzhou was highly correlated with having Suzhou residency status (P-value <0.001 based on Pearson Chi-square test).

Detailed demographic and social-economic characteristics by four different migrant status groups were laid out in Table 2.1. When both parents were migrants to Suzhou they were more likely to have boys (55.5%), multiple children (22.1%), higher ETS exposure (54.3%) and lower educational attainment than when both parents came from Suzhou. A higher percentage rented

rather than owned their residence (43.6%). The prevalence of family asthma and allergic problems among their children was lower among migrant households (9.5%).

Table 2.1. Distribution of Demographic Characteristics by Migrant Status Group in Suzhou, China, 2014-2015

		Overall (N=5690)	Both local parents (N=2213)	Only migrant mother (N=461)	Only migrant father (N=460)	Both migrant parents (N=2556)	*P*-value
Children's gender	Male	51.6	48.0	47.7	51.0	55.5	<0.001
Children's age	12 and below	10.1	8.7	8.8	11.5	11.3	0.009
	13	43.8	44.2	49.6	44.6	42.3	
	14	40.3	44.9	38.2	40.5	36.4	
	15 and above	5.8	2.1	3.3	3.4	10	
Parental education	Primary school	6.0	1.4	3.8	3.1	10.8	<0.001
	Middle school	26.0	17.5	23.6	13.3	36.1	
	High school	24.5	29.7	29.9	14.2	21.0	
	College	37.3	46.7	37.8	52.4	26.3	
	Graduate	6.2	4.7	4.9	17.1	5.8	
Family asthma history [a]	Yes	12.8	15.1	14.9	17.9	9.5	<0.001
ETS at home	Yes	49.5	44.3	43.6	53.9	54.3	<0.001
Rent current residence	Yes	22.1	3.5	7.3	8.3	43.6	<0.001
Children living together	1	81.1	89.0	89.6	83.5	71.8	<0.001
	2 and above	15.0	8.7	6.9	15.3	22.1	

[a]: asthma or allergic problems exist in the family

Figure 2.1 illustrated the prevalence of asthma, rhinitis, and eczema for the children (second generation) and their parents' generation (first generation) in the "both local parents" and "both migrant parents" groups. We observed similar trends that prevalence of all these diagnoses were higher in children's generation compared to their parents'. The doctor-diagnosed asthma rates in local population for father and mother and migrant population for father and mother were 1.5%, 2.2%, 0.9%, 1.2%, respectively. The asthma rates for children in local and migrant population were 13.2% and 6.8%, respectively. For the same generation, the prevalence of all three diagnoses in the migrant population was lower compared to the local population.

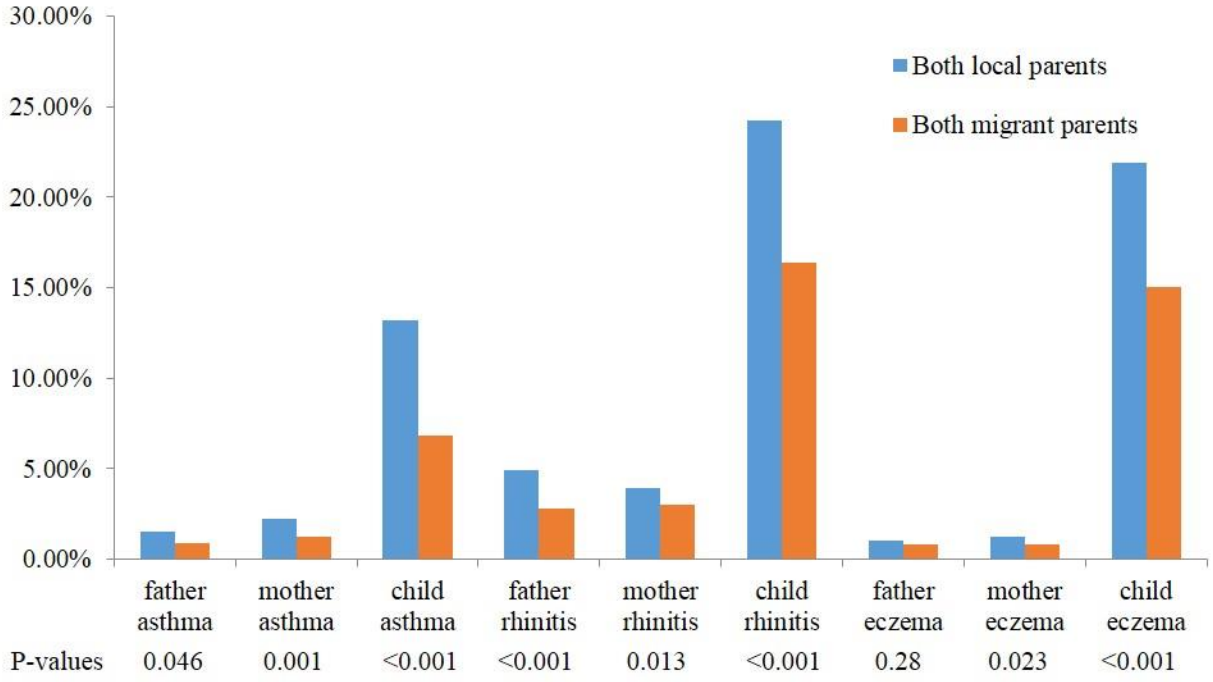

Figure 2.1. Comparison of Doctor-diagnosed Prevalence Between Children and Parent Generation in Suzhou, China, 2014-2015

Table 2.2 reported the doctor-diagnosed diseases and symptoms for children by four migrant status groups. The overall doctor-diagnosed asthma, pneumonia, rhinitis and eczema rates were 9.9%, 20.5%, 20.1 % and 18.3%, respectively. The prevalence of these four diseases was lower in children with both migrant parents than children with one or both local parents. For children with only one local parent, the reported doctor-diagnosed rhinitis and eczema rates were higher in children with only mother growing up in Suzhou, compared to those with only father from Suzhou, while there was similar prevalence of doctor-diagnosed asthma and pneumonia.

Table 2.2. Prevalence of Children's Asthma and Allergic Diseases and Symptoms by Parents' Migrant Status Groups in Suzhou, China, 2014-2015

Symptom	Overall	Both local parents	Only migrant mother	Only migrant father	Both migrant parents	*P*-value
	N=5690	N=2213	N=461	N=460	N=2556	
Doctor-diagnosed asthma	9.8	13.3	12.5	12.6	5.8	<0.001
Doctor-diagnosed pneumonia	20.5	26.9	23.3	22.6	14	<0.001
Doctor-diagnosed rhinitis	20.1	24.4	23.5	30.9	13.8	<0.001
Doctor-diagnosed eczema	18.2	23.0	16.7	23.5	13.4	<0.001
Current wheeze	8.8	10.2	8.1	7.5	7.8	0.096
Ever wheeze	13.2	17.8	17.1	14.1	8.1	<0.001
Current sneezing	63.3	67.0	66.9	65.4	58.6	<0.001
Ever Sneezing	45.8	49.6	50.4	52.7	40.2	<0.001
Current itchy rash	27.2	30.5	29.7	27.9	23.1	0.001
Ever itchy rash	28.5	32.8	32.8	34.8	22.7	<0.001

With respect to symptoms questions, there were positive associations between having both parents as migrants, and having a lower prevalence of "ever wheeze", 'current sneezing', "ever

sneezing", "current itchy rash" and "ever itchy rash". The associations persisted after fully adjusted for potential confounders (data not shown).

Multivariate logistic regression results for the associations between migrant group and local population (reference group as both local parents) for doctor-diagnosed diseases were shown in Table 2.3. There was no difference in the prevalence of doctor-diagnosed diseases between children with one migrant parent and local parents adjusting for gender and age, nor further controlling for other potential confounders. However, children with both migrant parents had positive associations with lower prevalence of all outcome variables when compared to children with both local parents. The associations were confirmed when adjusting for additional potential confounders. The odds ratios between the "both migrant parents" group and host population for doctor-diagnosed asthma, pneumonia, rhinitis and eczema in the full model were 0.56, 0.60, 0.63 and 0.73, respectively. The associations tested by family residency status showed the same trend, that children without city residency status have lower prevalence of all doctor-diagnosed asthma and allergic symptoms (Appendix B).

Table 2.3. Multivariate Logistic Regression Model for the Associations Between Migrant Group and Local Population (Reference Group as Both Local Parents) for Doctor-diagnosed Diseases in Suzhou, China, 2014-2015

	Asthma	Pneumonia	Rhinitis	Eczema
Both local parents	1	1	1	1
Only migrant mother	1.07 (0.74 , 1.50)	0.91 (0.70 , 1.19)	1.02 (0.77 , 1.35)	0.79 (0.59 , 1.07)
***P*-value**	0.724	0.511	0.875	0.132
Only migrant father	0.80 (0.55 , 1.14)	0.76 (0.58 , 0.99)	1.27 (0.97 , 1.65)	1.02 (0.77 , 1.33)
***P*-value**	0.22	0.048	0.081	0.907
Both migrant parents	0.56 (0.42 , 0.73)	0.60 (0.49 , 0.72)	0.63 (0.52 , 0.77)	0.73 (0.60 , 0.89)
***P*-value**	<0.001	<0.001	<0.001	0.002

Adjusted for children's gender, children's age, family asthma history, parental education level, environmental tobacco smoking at home, ownership status and interaction term between children's gender and age.

2.4 Discussion

Main findings and comparison with other studies

In the present study, we found substantial differences in the prevalence of asthma and allergic symptoms between recognized Suzhou citizens and those who have migrated to the city. Results are consistent when comparing answers to doctor-diagnosed questions and observation/symptom questions, and after further adjusting for number of children in the family. We also tested using parents' residency as indicator for migration status, and similar results were observed. Previously, similar effect was observed in studies of international immigrants to westernized countries. Grüber et al. studied children of Turkish origin living in Germany and found they had lower rates to suffer from atopic diseases, wheezing and itchy rash (10). An Italian survey study of extra-European immigrants to Milan revealed that 84.3% of patients claimed developing allergy/asthma symptoms after they arrive in Italy (9). Wang et al. found the prevalence of

asthma and wheezing higher in Canadian-born Chinese adolescents than Chinese immigrants (12). Our study indicates that domestic migration resembles international immigration in the trend of asthma and allergic symptoms. The "healthy migration" effect also applies to domestic migrants from rural to urban areas. Interestingly these differences persisted even though there was more ETS exposure at home and higher percentage of migrant families being renters with a lower social economic status as indicated by educational attainment.

The explanation for these findings remains uncertain. Ethnic heterogeneity is not easily ruled out in some international studies. The different epigenetic nature of respiratory symptoms might partially explain the difference in the international migrant population (18,19). However, since our study focused on domestic migrants, who are ethnically almost the same as recognized Suzhou residents, it suggests possible environmental or behavioral explanations. Differences in early life exposure (the hygiene hypothesis) are a possible explanation (31,32). This theory emphasizes the role of microbiota in the regulating normal immune responses to allergens. Factors that alter the natural colonization of the microbiota are believed to be associated with elevated risk for allergic symptoms. Identified factors include birth mode, prematurity, medication, hygiene measure, the type of infant feeding (breastfeeding or formula (33). Several studies supported this hypothesis, attributing the high prevalence of asthma symptoms in immigrants to changed microbial exposures and improved hygiene treatments (7,9,10,34). In our study we also observed differences in some of these factors between the two populations (Table 2.1), which might contribute to different asthma prevalence. Another explanation is the increased exposure to more polluted air in industrialized countries or cities. For example, the Milan study (9) pointed out that higher level of exposure to diesel exhaust could be a strong stimulant to

sensitization and development of allergy/asthma symptoms. To unravel the underlying mechanism requires further analysis of more detailed environmental/behavioral differences between the migrant and host populations.

Our results showed the asthma rate of the second generation of migrant population increased compared to the first generation. An increase of asthma prevalence was previously observed in many westernized countries over the past few decades. A repeated cross-sectional survey between 1985 and 2008 in the Northern part of Norway reported substantially increased prevalence of asthma and allergic rhinoconjunctivitis (AR) in a subarctic children population between 1985 and 2008 (2). Identical questionnaires were answered by parents of children aged 7-13 years to assess asthma and AR in 1985, 1995 and 2008. Asthma rate increased from 7.3% in 1985 to 17.6% in 2008, and AR increased by three folds over the same period. An Italian study showed from 1991 to 2010, the median prevalence of current asthma, wheezing and allergic rhinitis increased, the asthma prevalence had increased by over 35%, with prevalence of current asthma, allergic rhinitis being 6.6% and 25.8% in 2010, respectively (1). Another study of trends in asthma prevalence in Ontario, Canada reported 70.5% increase, from 8.5% in 1996 to 13.3% in 2005 (35). Our results indicated that with the rapid urbanization, China is also experiencing a dramatic increase in asthma prevalence. Asthma prevalence among the studied population in Suzhou is close to or even higher than westernized countries. This may be a key element of the health implications of urbanization, since families may be more exposed to many elements of modern urban lifestyles that, in concert, impart greater risk of asthma and allergy development. Future research is needed to understand these trends and develop strategies to mitigate these effects.

Strengths and limitations of this study

The main strength of this work is our study population represents a specific group - domestic migrants - in the largest developing country. It allows us to have the unique opportunity to observe changes in disease prevalence without being confounded by genetic difference. In the meantime, our domestic migrant population differs from the local ones in many key characteristics of environment and lifestyle. In addition, information gathered from both first and second generations represents a more complete model to assess the environmental and lifestyle impact on development of respiratory diseases at both earlier and later life stages.

One limitation of our study is the inherent limitation for cross-sectional studies. The analyses relied on self-reported data for both the exposure and outcome variables, which may cause a misclassification bias. However, these limitations would only bias the results toward the null as they are expected to lead to non-differential misclassifications of outcome. Information bias is not a problem for the exposure variable since it is not likely that people would misreport their migrant status. For the diagnostic information bias, as we used self-administrated surveys to obtain health status, migrant population having lower social-economic status may forgo healthcare service hence under report their doctor diagnoses conditions. However, the reported observation questions by parents were consistent with these doctor-diagnoses questions. Therefore, we are confident that our findings reasonably reflect the true trend.

2.5 Conclusion

This is the first study to examine a domestic migration population for their asthma and allergic problems. We found lower prevalence of asthma and other respiratory symptoms in migrant population compared to local population, supporting the "healthy migration effect" previously found in other studies. We also observed a rising trend of asthma prevalence in China, which calls for public attention to the prevention and treatment of this disease. Modernizing China presents a natural epidemiological model to better understanding of asthma causes and prevention, the findings suggest parental migration plays an important role in both parental and children's health. An explanation for this observation is still elusive but suggests the role of early life exposure and lifestyle differences.

CHAPTER 3 - Risks of Cesarean Birth on Childhood Asthma, Allergic Symptoms and Obesity in a Chinese City and Its Effect Modification on Breastfeeding

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Abstract

Objectives: The caesarean section (C-section) rate in large Chinese cities has increased dramatically over the past few decades, yet there is insufficient attention on the possible health consequences of elevated C-section rate. This study investigates the association between C-section and adverse health outcomes in middle school aged children.

Design: This work was conducted from November 2014 to January 2015 in Suzhou, China as a cross-sectional study.

Setting: Families were recruited from 12 middle schools in different parts of the city.

Participants: A total of 5891 families (response rate 82.9%) completed and returned the questionnaire.

Outcome measures: The adverse health outcomes studied include asthma, pneumonia, rhinitis, eczema, overweight and obesity,

Results: Multivariate logistic regression results showed C-section delivery to be a risk factor for most health outcomes studied, with the odds ratios being 1.24 (95% CI: 1.00, 1.52) , 1.28 (95% CI: 1.10, 1.49), 1.16 (95% CI: 0.99, 1.36) and 1.13 (95% CI: 0.96, 1.33) for doctor-diagnosed asthma, pneumonia, rhinitis, eczema, respectively, and 1.29 (95% CI:1.10, 1.51) and 1.44 (95% CI: 1.05, 1.99) for overweight and obesity, respectively. For effect modification test, the interaction term between breastfeeding and eczema has a statistically significant coefficient ($p=0.04$).

Conclusions: C-section is a strong and consistent risk factor for developing asthma and allergic symptoms, as well as being overweight and obese. It also alters the effect of breastfeeding on eczema.

Keywords: Deliver Mode, Respiratory Health, Asthma, Obesity, China

3.1 Introduction

In China, the C-section rate increased from about 5% in the 1960s to about 20% in the late 1980s and the early 1990s, and the C-section rate in urban areas of China has dramatically increased even further since the mid-1990's to 39.5 % in 2002. A global survey of the WHO showed that the C-section rate in China was 46.2 % in 2007– 2008, which was the highest in Asia and the second highest in the world (36). While a significant number of C-sections are performed for obstetrical indications (37), the increase in caesarean delivery on maternal request (CDMR) is particularly notable (38). Hu et al. (36) found that the number of unnecessary C-section in a Chinese cohort accounted for 71.5 % of all C-sections and for 41.8 % of all deliveries, and also that 34.9% of women undergoing caesarean section did not have any indications listed in the clinical guidelines (39).

Some researchers believe that the elevated C-section rate is partially responsible for the rapid increase of asthma prevalence, which has been dramatic over the past few decades (27). The pace of this increase has been much faster than the speed at which genetic constitution of any population can possibly shift (33), which suggests that environmental risk factors may be responsible. Other concerns have also been raised about possible associations between C-section and a number of adverse childhood health outcomes. For example, studies have reported that children born by cesarean delivery may have increased rates of respiratory illness in their first year of life (40-42) and beyond (43,44), and relationships have also been described with diabetes (45) and child overweight and obesity (46,47).

One theory that connects C-section with birth outcomes is the “hygiene hypothesis”, which poses that exposures to microbes and allergens in early life primes immune systems which is protective for development of asthma and allergic symptoms at a later life stage (33,48-52). Mode of delivery will influence a baby's first exposure to maternal vaginal and intestinal microflora (44,53,54). With cesarean delivery there is less chance of direct contact (37,54,55). Evidence suggests that the composition of the first human microbiota encountered could have enduring effects on the intestine of infants, especially for those who are breastfed (53). The WHO now recommends that C-sections should only be performed when medically necessary (56).

Here, we investigated the role of C-sections in children’s health, and also explored whether it might alter the health effect of breastfeeding in a large cross-sectional study of families living in Suzhou, China. Defining these modifiable risk factors can provide useful insight for healthcare providers and the general population.

3.2 Methods

Study design

A cross-sectional, descriptive epidemiological study was conducted in Suzhou, China between November 2014 and January 2015. Twelve out of 140 middle schools were selected from across the city to reflect different neighborhoods. The survey was distributed in schools, completed by parents and returned to teachers. The study protocol was approved by Harvard T.H. Chan School of Public Health ethics committee and the local ethics committees. Children’s parents or trustee provided written informed consent. Permission for the study was granted by the school boards of participating schools.

Outcome measures

Having "Doctor diagnosed asthma", "Doctor diagnosed pneumonia", "Doctor diagnosed rhinitis" and "Doctor diagnosed eczema" were determined by positive answers to the questions: "Has the child ever been diagnosed with asthma (*pneumonia, hay fever or allergic rhinitis, eczema*) by a doctor (Yes/No)"?, respectively.

Children's heights and weights reported by their parents/trustee were used to calculate body mass index (BMI) as weight/height squared. To determine the overweight and obese status for our study population, Li et al. (57) discussed multiple sets of standards for age- and gender-specific BMI cut-off points in Chinese population. From their paper, we adopted the WHO reference and used +1 standard deviation (SD) for overweight and +2 SD for obesity. Two binary variables - Obesity (reference: non-obesity) and overweight (reference: non-overweight) status - were used as indicators of body anthropometry.

Primary predictor and covariates selection

The child's deliver mode, whether by C-section or natural birth, was determined by answers to the question: "Was your child born by natural birth or C-section?"

A common set of covariates were selected using the following procedure. Clinically relevant variables (age and gender) as well as confounders were kept in the model as covariates, while collinear variables were kept out of model. We used backward selection first to choose variables that have p-value less than 0.1. Further, as almost all the collinear have been excluded after the step of automatic selection, we used 10% change rule to check for the remaining confounders. If variable causes 10% changed in exp(β) of primary predictor, it will be kept in the model as potential confounders. The final covariates in the model includes breastfeeding (Yes/No),

socioeconomic status, preterm birth and environmental tobacco smoke. Preterm delivery was determined by whether the child was born two weeks or more before the calculated due date. Socioeconomic status was presented by parents' education level (primary school, middle school, high school, college and above). Environmental tobacco smoke (ETS) was identified by whether there is a family member who smokes. (47,58,59)

Effect modification

In order to test whether deliver mode might modify the effect of breastfeeding on health outcomes, we added the interaction term into the multivariable model to test the hypothesis. Breastfeeding was a dummy coded variable with "never breastfed" as the reference group.

Analytical Approaches

Frequencies and percentages were calculated for each exposure and outcomes variable. We examined the relationship between socioeconomic statuses and deliver mode. Univariate and multivariable regression models were used to test the association between deliver mode and each health outcomes adjusted for covariates identified above (47,58,59). Interaction term between breastfeeding and delivery mode was added in the model to assess effect modification of breastfeeding by deliver mode. Results are presented as odds ratios (ORs) and 95% confidence intervals (CIs). P-values less than 0.05 were considered statistically significant. All the computations were carried out using R version 3.2.3.

3.3 Results

Participant characteristics and diseases prevalence

A total of 5891 children (response rate 82.9%) were included in our study, with 5584 participants who provided an answer to the delivery mode question. There were 3469 children born by natural delivery (62.1%) and 2115 by C-section. Basic demographic and descriptive statistics of study families were shown in Table 3.1. The participants with children born by cesarean reported less breastfeeding and more preterm birth.

Table 3.1. Distribution of demographic characteristics

		Overall (N=5584)	Natural Birth (N=3469)	C-section (N=2115)
Children's Gender	Male	51.6	51.6	51.6
Children's Age	12 and below	10.1	9	11.7
	13	43.7	41.8	47.3
	14	40.2	41.5	38.3
	15 and above	5.9	7.7	2.8
Breastfeeding	Yes	91.8	93	90.2
	No	8.2	7	9.8
Child delivery time	>2 weeks before due date	9.9	7.4	13.7
	1-2 weeks before	13.8	12.9	15.4
	Within ±1week	62.1	66.8	55.1
	1-2 weeks past	10.5	9.7	11.9
	>2 weeks past	3.6	3.3	4.0

In our study population, the overall prevalences of doctor-diagnosed asthma, pneumonia, rhinitis, and eczema are 9.8%, 20.7%, 20.3% and 18.4%, respectively. The overall prevalences of overweight and obesity are 19.8% and 4.1%, respectively. Children born via C-section have higher prevalences of all six outcomes compared to children by natural birth (Table 3.2).

Table 3.2. Prevalence of health outcomes by two deliver modes

	Overall (%)	C-section (%)	Natural birth (%)
Asthma	9.8	12.5	8.2
Pneumonia	20.7	25.3	17.9
Rhinitis	20.3	24.5	17.7
Eczema	18.4	21.7	16.4
Overweight	19.8	22.3	18.2
Obesity	4.1	4.9	3.6

Driver of mode of delivery

We observed a clear trend of the mode of delivery changing with increasing social economic status (Figure 3.1). Families with higher socioeconomic positions are more likely to choose C-section delivery. In the families with the highest education level (college and above), the C-section rate was nearly 50%, whereas for families with lowest education level (primary school) this rate was only 16.7%.

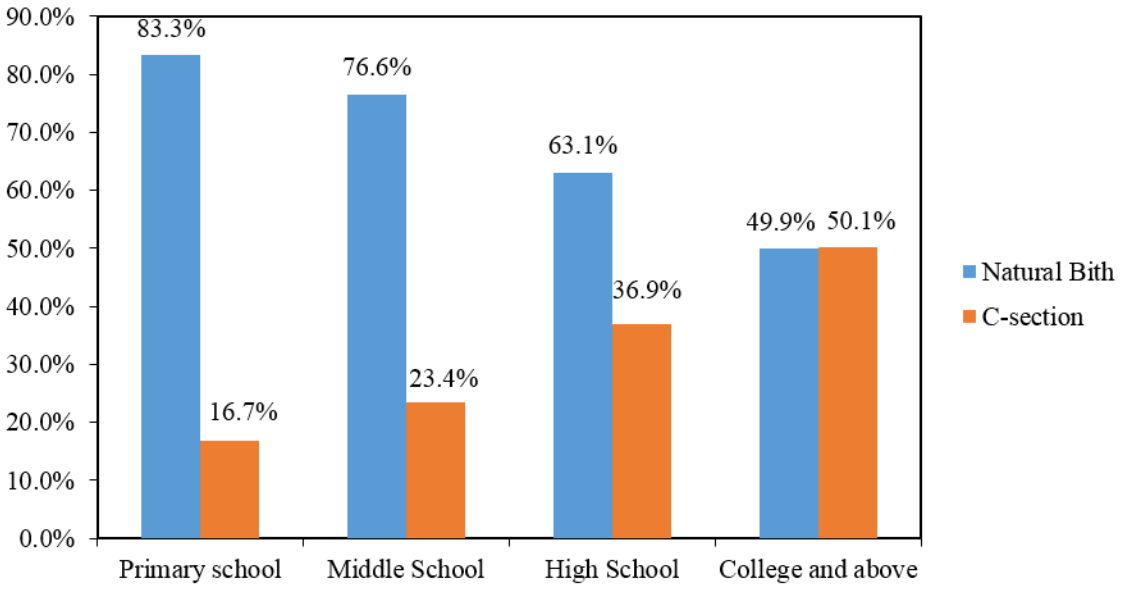

Figure 3.1. C-section rate by parental education level

Childhood health outcomes

Children's health outcomes associated with C-section delivery are shown in Table 3.3. Overall, we observed strong and consistent risk associations between C-section and health outcomes. In univariate models, C-section was statistically significantly associated with all health outcomes. In multivariable model after adjusting for covariates, C-section was statistically significantly associated with doctor-diagnosed asthma, doctor-diagnosed pneumonia, overweight and obesity. The odds ratios for children born by C-section vs natural birth were 1.24 (95% CI: 1.00, 1.52), 1.28 (95% CI: 1.10, 1.49), 1.16 (95% CI: 0.99, 1.36) and 1.13 (95% CI: 0.96, 1.33) for doctor-diagnosed asthma, pneumonia, rhinitis, eczema, respectively, and 1.29 (95% CI: 1.10, 1.51) and 1.44 (95% CI: 1.05, 1.99) for overweight and obesity, respectively.

Table 3. Univariate and multivariate logistic regression results for children born via cesarean delivery vs. natural birth

	Univariate Model	P-value	Full Model	P-value
Dr dx asthma	1.59 (1.33 , 1.90)*	<0.001	1.24 (1.00 , 1.52)*	0.046
Dr dx pneumonia	1.56 (1.36 , 1.78)*	<0.001	1.28 (1.10 , 1.49)*	0.001
Dr dx rhinitis	1.51 (1.32 , 1.73)*	<0.001	1.16 (0.99 , 1.36)	0.059
Dr dx eczema	1.41 (1.23 , 1.62)*	<0.001	1.13 (0.96 , 1.33)	0.128
Overweight	1.29 (1.12 , 1.49)*	0.002	1.29 (1.10 , 1.51)*	0.002
Obesity	1.39 (1.04 , 1.85)*	0.043	1.44 (1.05 , 1.99)*	0.024

*Full model adjusted for children's age and gender; socioeconomic status, breastfeeding, preterm birth, and ETS.

Effect Modification by delivery mode for the association between breastfeeding and health outcomes

We further tested the effect modification of breastfeeding by adding an interaction term between deliver mode and breastfeeding in the model. Only interaction term in the eczema model was statistically significant (p=0.04). After stratifying this analysis based on delivery mode, we observed statistical significance between breastfeeding and eczema in the children born by natural birth (OR=1.63, 95% CI (1.07, 2.61)), while almost null in the C-section group.

3.4 Discussion

C-section and asthma/allergic symptoms and potential mechanism

Our study observed that C-section is positively associated with asthma and allergic symptoms, overweight and obesity, with statistically significant results for asthma, pneumonia, overweight and obesity. Findings are consistent with other investigations of early life exposures. Several studies reported positive associations between C-section and asthma (53,58,60), and some others

reported positive associations between C-section and eczema/atopic dermatitis (61). The primary difference between the current study and previous studies is our focus on an older population (age 12-14) (44,59,60). For our targeted Chinese population, we were able to adjust for major demographic as well as environmental confounding variables (44,59,60). The effect of deliver mode may be explained by the different microbiota to which the infant is initially exposed. Infants born by C-section are primarily exposed to bacteria from the hospital environment (e.g. healthcare professionals), while naturally delivered infants are in contact with maternal and vaginal microbes. Penders et al. (52) investigated the intestinal microbiota establishment and found that delivery mode had a strong effect on the microbiota composition. C-section decreases the colonization rates of bacteroides and increases the prevalence of clostridia, causing an increased risk of developing atopic dermatitis. Grölund et al. (62) studied the fecal colonization of infants born by C-section and found that it was disturbed and delayed compared to vaginally delivered infants by up to six months. In a descriptive study, Azad et al. (63) found lower bacterial richness and diversity in C-section delivered infants.

C-section and overweight/obesity and potential mechanism

In addition to asthma and allergic symptoms, overweight and obesity has also gained more attention in the past few years. A review and meta-analysis by Kukle et al. (64) summarized the findings of 28 studies regarding C-section and obesity. Meta-analysis results showed a pooled risk ratio of 1.34 (95% CI 1.18–1.51). Of the studies they reviewed, nine showed a statistically significant positive association between C-section and obesity, while most others showed associations in the positive direction, though not statistically significant. The mechanism behind

the association is also related to the different microbiota development resulting from different deliver modes (54,65). The KOALA Birth Cohort Study in the Netherlands (66) showed that infants born through C-section have lower numbers of *bifidobacteria* and *Bacteroides* spp, which are believed to be a protective factor for overweight and obesity. Recently, there have been research efforts to restore maternal microbiota for C-section born infants, known as the microbial restoration procedure, or vaginal microbial transfer (67). Babies were exposed to maternal vaginal fluids by being swabbed with sterile gauze, which was earlier incubated in the vagina of mothers. Sampling of the bacterial communities through the first month suggested that vaginal microbes can be partially restored for C-section delivered babies through this procedure.

C-section trend with socioeconomic status

We also noted that in China C-section delivery is more common for people in higher socioeconomic positions, which is consistent with the trend found in some other studies (68,69). A large fraction of the C-sections are not performed because of medical necessity, but by maternal requests (36,38). Most of the medically unnecessary C-sections happen because mothers seek a specific date of birth or want to avoid the pain during natural delivery (70). As a result, the demand on C-section has been on rapid rise for the past few decades, outgrowing the capacity of medical services. Under this circumstance, those parents with higher socioeconomic status usually have better access to C-section, which explains why the C-section rate increases with parental education level. This finding suggests a need for further investigation – whether it is a lack of resources or access or that people have chosen near term convenience over an uncertain delayed outcome.

Effect modification on breastfeeding

We performed analysis that provided more insight into the relationship between the effects by C-section and breastfeeding. When we investigated the effect of breastfeeding stratified by delivery mode, it is found that breastfeeding is statistically significantly associated with eczema, but only in the natural birth group. Literature results are inconsistent regarding the effect of breastfeeding on eczema. Bergmann et al. (17) reported breastfeeding duration as a risk factor for eczema, with a 3% increase in the risk of developing eczema in the first seven years, for every one month increase in the length of breastfeeding. Purvis et al. (71) also identified breastfeeding as a risk factor for eczema and concluded breastfeeding should not be recommended for the prevention of eczema. On the contrary, Saarinen et al. observed a protective effect of breastfeeding against atopic eczema in a cohort study of 236 infants, following up until 17 years old (72). Our results indicated that the association between breastfeeding and risk of eczema might be different for infants with different delivery modes. This observation needs to be placed in context with other studies in various settings to confirm the observation and discern the underlying mechanisms.

Limitations

Our study has several limitations. Selection bias is possible in an observational study. However, the response rate among eligible children in our study is 82.9%, which is relatively high for such a study, and there is no evidence of differential participation by key variables. Another limitation of our study is the inherent limitation for cross-sectional studies. The analyses relied on self-reported data for both the exposure and outcome variables, which may cause misclassification

bias. Also, the information on whether C-section was performed based on medical necessity was not obtained, which limits the ability to further provide guidelines to reduce C-section. We did not separate between pre and postnatal ETS exposure, which limits our ability to further control this confounder.

3.5 Conclusions

For these middle-school-aged children in Suzhou, being born by C-section is a strong and consistent risk factor for developing asthma and allergic symptoms, as well as being overweight and obese. The C-section rate is found to be higher in families with higher socioeconomic status. Delivery mode is also seen to alter the effect on eczema by after-birth behaviors, as different effects are observed for breastfeeding in naturally delivered and C-section delivered children. Parents should be informed during pre-natal care of the possible adverse consequences of a C-section birth for their child. For unavoidable C-sections, vaginal microbial transfer might be useful to partially restore maternal microbiota and avoid adverse health consequences.

CHAPTER 4 - Effect of Residential Greenness on Respiratory and Allergic Diseases among Children in a Chinese City

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Abstract

BACKGROUND: Research on the impacts of natural environments, including greenness and green space, has mainly been conducted in the U.S. and in Europe, and a few studies have assessed associations with asthma and allergic diseases. The substantial differences in the urban form between China and western countries make it essential to understand the role of greenness in Chinese settings.

OBJECTIVES: Our objective was to investigate the relationship between neighborhood greenness and children's respiratory and allergic health in a Chinese city.

METHODS: Middle school students (n= 5,643) and their guardians from 12 schools in Suzhou, China were enrolled. Annual and seasonal average Normalized Difference Vegetation Index (NDVI) in four buffers (100, 200, 500, 1,000 m) and distance to the nearest park were calculated for each home address. Logistic regression was performed to test associations between each greenness measure and self-reported doctor diagnoses of asthma, pneumonia, rhinitis and eczema, after adjusting for age, sex, parental education, family history, and environmental tobacco smoke.

RESULTS: No statistically significant associations were observed with NDVI-based measures, however, living close to a park was associated with increased odds of asthma, pneumonia, rhinitis and eczema. Odds ratios for the furthest quartile of distance to a park compared to the closest were 0.68 (95% CI: 0.50, 0.92), 0.90 (95% CI: 0.73, 1.11), 0.93 (95% CI: 0.75, 1.17), 0.80 (95% CI: 0.64, 0.99) for asthma, pneumonia, rhinitis and eczema, respectively.

CONCLUSIONS: We observed living close to a park increases the odds of a number of respiratory and allergic outcomes, but did not observe associations with surrounding greenness. This suggests that the health effect of residential greenness may vary for different urban forms. This complexity needs to be understood when designing infrastructure for residential greenspace.

4.1 Introduction

As a component of infrastructure in modern cities, public greenspaces can offer opportunities for recreational and social interactions. Additionally, these public place might provide other amenities such as noise and air pollution mitigation, storm water management, enhancement of biodiversity and perhaps stress reduction (73-76). The primary focus for greenness studies have long been on its relationship with physical activity and obesity. Although inconsistent evidence exists in the literature, the majority of studies tend to support the hypothesis that greenness helps increase physical activity and reduce the risk of obesity (76-82).

A few recent studies have examined the potential adverse impacts of exposure to greenness as a source of allergic and respiratory irritants, with inconsistent results. Pilat et al. found no statistically significant results for NDVI, canopy cover and asthma (83). Dadvand et al. found living close to forests was positively associated with current allergic rhinoconjunctivitis, and proximity to parks was positively associated with current asthma and current allergic rhinoconjunctivitis. Fuertes et al. studied the association between greenness and allergies in two German areas, and found positive associations in the urban area but negative associations in the rural area (84). Another study by Fuertes et al. tested the association between residential NDVI and allergic disease and found different trends within seven birth cohorts based in Sweden (BAMSE), Australia (MACS), Netherland (PIAMA), Canada (CAPPS and SAGE), and Germany (GINIplus and LISAplus) (85). To date, most studies on greenness have been conducted in developed countries of Western Europe and North America. James et al. (2015) recommended studies of the impacts of greenness on health in developing countries, especially in Asia, where there are very few studies. The modern form of Chinese cities is characterized by

high residential density and intensively mixed land-use (86). Urban form is substantially different between China and western countries with ecological amenities only recently being recognized as an important element (87-89). National policy in now encouraging inclusion of more green spaces in urban development (90). Therefore, understanding the relationship between natural urban landscapes and health will be immediately relevant to urban planning in China.

4.2 Methods

Study population

As part of a larger study of the impacts of the environment on health, we identified 12 middle schools (out of 140) in 6 districts to represent different urban forms in the Chinese city of Suzhou. Between November 2014 and January 2015, 5,891 middle school students and their parents/guardians received questionnaires from their teachers, and were asked to return them within 1 week. The study protocol was approved by Harvard T.H. Chan School Public Health human subjects committee and local ethics committees. Children's parents or trustee provided written informed consent.

Exposure Assessment

NDVI and distance to the nearest park were used to assess residential greenness exposure. NDVI was captured from the National Aeronautics and Space Administration (NASA) Landsat satellite imagery of the earth's surface. NDVI measures the visible and near-infrared light reflected by vegetative growth and expressed as a vegetation density from -1 to +1 (91). We used the most cloud-free NDVI images within a season from Satellite Landsat 8 (grid size: 30 meters) to quantify the greenness exposure in the spring (March 16th), summer (June 22nd), fall (October

26th) and winter (December 29th) seasons. Average NDVI was calculated to represent the annual 2014 residential greenness exposure to correspond to the time period of questionnaire administration. As the specific spatial scale at which greenness may impact each of our selected outcomes is not known, we chose a range of commonly examined buffer sizes (100 meters, 200 meters, 500 meters and 1,000 meters) and calculated the average NDVI values within each buffer size (82,92-95). GIS-calculated distance from participants' home to the nearest park was used as another exposure variable (81,96), and was categorized based on quartiles.

Outcome Assessment

Questions on diagnosis of asthma, pneumonia, rhinitis and eczema were based on the previously validated International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire (26). "Doctor diagnosed asthma", "Doctor diagnosed Pneumonia", "Doctor diagnosed Rhinitis" and "Doctor diagnosed Eczema" were determined by positive answers to the questions: "Has the child ever been diagnosed with asthma *(pneumonia, allergic rhinitis, eczema)* by a doctor? (Yes/No)", respectively.

Statistical analysis

Logistic regression models were performed to test the associations between greenness and each of the outcomes identified above. Basic models adjusted for children's age and sex, and fully adjusted models were further adjusted for environmental tobacco smoking at home, parental education, and parental history of asthma. NDVI results are presented as odds ratios (ORs) and 95% confidence intervals (CIs) for an IQR increase in annual NDVI values after assessing deviations from linearity using splines. To identify whether there was any seasonal effect, NDVI

in four seasons were also separately examined. For distance to a park, ORs are presented compared to the quartile of participants living closest to a park. Effect modification by sex was tested by adding multiplicative interaction terms to the models. P-values less than 0.05 were considered as statistically significant. All the computations were carried out using R version 3.2.3.

4.3 Results

A total of 5,891 (response rate: 82.9%) middle school children and their parents/guardians participated in our study. Of these, 5,643 participants provided their home addresses. There was no statistically significant difference in outcome prevalence or key covariates between participants who provided residential addresses and those who did not. Demographic features of the participants included in the analyses are shown in Table 1. A majority of children (51.6%) were male and most were between age 12 and 15. The prevalence of doctor-diagnosed asthma, pneumonia, rhinitis and eczema were 9.8%, 20.7%, 20.2% and 18.5%, respectively.

Table 4.1. Distribution of demographic characteristics and prevalence of outcomes

		Overall % (N=5643)
Children's Sex	Male	51.6
Children's Age	12 and below	10.2
	13	43.8
	14	40.3
	15 and above	5.7
Parental education	Primary school	5.8

	Middle school	25.7
	High school	24.5
	College and above	44.0
Family asthma history	Yes	12.9
ETS at home	Yes	49.4

Overall and season-specific median NDVI values are shown in Table 4.2. The median NDVI values within the different buffer areas did not vary substantially. The median greenness value was highest in the summer, followed by spring and lowest in fall and winter. For distance from home to the nearest park, the median distance in our study was 903 meters, with the first quartile at 600 meter and third quartile at 1348 meters. Families in the first quartile had significant higher NDVI values in compared to other groups (data not shown).

Table 4.2. Overall and season-specific NDVI values

	Buffer 100m	**Buffer 200m**	**Buffer 500m**	**Buffer 1000m**
Overall median (IQR) NDVI	0.187 (0.101)	0.187 (0.088)	0.190 (0.073)	0.187 (0.055)
Spring median (IQR) NDVI	0.174	0.176	0.180	0.173
Summer median (IQR) NDVI	0.298	0.294	0.297	0.297
Fall median (IQR) NDVI	0.139	0.139	0.143	0.140
Winter median (IQR) NDVI	0.138	0.139	0.140	0.140

Table 4.3 shows the odds ratios from the basic and fully adjusted logistic regression models for associations between per interquartile increase residential annual average NDVI values and health outcomes. Results for the age and sex adjusted model and fully adjusted model were similar. There were no statistically significant associations observed for residential NDVI values and any of the examined outcomes. Similar patterns were observed in models using seasonal measures of NDVI, and sex did not appear to modify these associations (data not shown).

Table 4.3. Odds ratios of association between respiratory and allergic outcomes and NDVI IQR[a] in different buffer areas

		100-m buffer	200-m buffer	500-m buffer	1000-m buffer
Asthma	Basic	1.05 (0.97 , 1.15)	1.04 (0.92 , 1.18)	0.98 (0.85 , 1.14)	0.94 (0.84 , 1.07)
	Fully adjusted	1.02 (0.94 , 1.12)	1.01 (0.89 , 1.15)	0.95 (0.82 , 1.12)	0.94 (0.83 , 1.08)
Pneumonia	Basic	1.04 (0.98 , 1.10)	1.04 (0.96 , 1.14)	1.01 (0.91 , 1.12)	0.98 (0.90 , 1.08)
	Fully adjusted	1.02 (0.96 , 1.09)	1.02 (0.93 , 1.12)	0.99 (0.89 , 1.11)	0.99 (0.89 , 1.09)
Rhinitis	Basic	1.02 (0.96 , 1.08)	1.03 (0.94 , 1.12)	0.99 (0.89 , 1.11)	0.98 (0.89 , 1.07)
	Fully adjusted	0.98 (0.92 , 1.04)	0.97 (0.88 , 1.07)	0.95 (0.85 , 1.07)	0.96 (0.87 , 1.07)
Eczema	Basic	1.05 (0.99 , 1.12)	1.07 (0.97 , 1.17)	1.04 (0.93 , 1.17)	1.00 (0.91 , 1.11)
	Fully adjusted	1.02 (0.95 , 1.09)	1.02 (0.93 , 1.13)	1.03 (0.91 , 1.17)	1.02 (0.92 , 1.14)

[a]: the IQR for 100-m buffer, 200-m buffer, 500-m buffer and 1000-m buffer are 0.101, 0.088, 0.073 and 0.055, respectively.

[b]:fully adjusted model adjusted for child's age and sex, environmental tobacco smoking at home, parental education, and parental history of asthma

Table 4.4 presents the basic and fully-adjusted odds ratios assessing distance to the nearest park. In both basic and fully-adjusted models, we observed that living far from parks was associated with a lower OR for most of the allergic diseases. The odds ratios for people in the quartile living farthest from parks compared to those living closest to parks were 0.68 (95% CI: 0.50, 0.92), 0.90 (95% CI: 0.73, 1.11), 0.93 (95% CI: 0.75, 1.17), 0.80 (95% CI: 0.64, 0.99) for doctor-diagnosed asthma, pneumonia, rhinitis and eczema, respectively

Table 4.4. Basic and fully-adjusted ORs (95% CIs) of targeted outcomes associated with quartiles of distance from a park

		1st quartile (<600m)	2nd quartile (600-903m)	3rd quartile (903m-1348m)	4th quartile (>1348m)
Asthma	Basic	Reference	0.96 (0.75 , 1.24)	0.88 (0.68 , 1.14)	0.57 (0.42 , 0.75)*
	Fully adjusted	Reference	1.02 (0.78 , 1.34)	0.92 (0.70 , 1.21)	0.68 (0.50 , 0.92)*
Pneumonia	Basic	Reference	0.93 (0.77 , 1.12)	0.85 (0.70 , 1.03)	0.74 (0.61 , 0.90)*
	Fully adjusted	Reference	0.96 (0.79 , 1.18)	0.91 (0.74 , 1.12)	0.90 (0.73 , 1.11)

Rhinitis	Basic	Reference	1.13 (0.93 , 1.37)	0.99 (0.81 , 1.20)	0.73 (0.60 , 0.90)*
	Fully adjusted	Reference	1.14 (0.92 , 1.41)	1.10 (0.89 , 1.36)	0.93 (0.75 , 1.17)
Eczema	Basic	Reference	0.93 (0.77 , 1.14)	0.82 (0.67 , 1.01)	0.66 (0.54 , 0.81)*
	Fully adjusted	Reference	0.94 (0.76 , 1.16)	0.88 (0.71 , 1.09)	0.80 (0.64 , 0.99)*

[a] adjusted for child's age and sex, environmental tobacco smoking at home, parental education, and parental history of asthma

4.4 Discussion

As the first study in Asia to study the effect of greenness on respiratory and allergic diseases, we had several findings. While most studies in developed countries have observed increasing levels of average NDVI within larger buffer areas, the median values of our data stayed the same within different areas, which may indicate Chinese residential greenness is more evenly distributed compared to developed countries (81). Our study included a wide variety of neighborhoods in Suzhou. In these neighborhoods, most families live in apartments in urban areas, with the main form of greenness being disseminated trees and small parks, compared to developed countries where it may be more common for families to live in single-family homes or townhouses in suburban areas with access to larger and more concentrated green spaces.

We did not observe associations between of NDVI-based greenness on any of our outcomes. This is consistent with the findings of other studies conducted in Europe. Pilat et al. observed no association between NDVI and asthma (83) in Texas, USA, which they attributed to a small sample size and the spatial scale of the exposure measures used. Dadvand et al. (81) also observed no association between asthma and NDVI in a Barcelona-based cohort, even with a more spatially resolved measure. A study in Portugal done by Ayres-Sampaio, however, showed that low NDVI is associated with increased asthma hospitalizations (97). They attributed this to the fact that low NDVI areas are concentrated in highly urbanized areas and are usually correlated with high levels of air pollution. Since the Chinese urban form is different from

Portugal, i.e., air pollution is not necessarily linked with poor vegetation, to elucidate this relationship further investigation on the level of air pollutant is needed. A Canadian study by Sbihi et al. (98) have reported that traffic pollution increased the chance of chronic asthma while greenness showed no association. We found living close to a park to be a risk factor for most of the health outcomes explored. This result was similar to the Spain study that found that living close to a park was associated with increased doctor-diagnosed asthma (81). As NDVI is a measure of various types of greenness, using more specific measures such as parks may be helpful to identify the mechanism of how this type of greenness affects respiratory health.

The exact mechanisms behind the associations between greenness and asthma and allergic outcomes remain to be elucidated (84). One explanation is that living close to park elevated asthma rates due to pollen production. Exposure to tree pollen was found to be associated with increased IgE response, which could lead to allergic symptoms. (99) Codispoti et al. reported being born in tree or grass season increased the risk of allergic symptoms by a factor of 3, which also may also suggest an adverse effect due pollen exposure (100). This suggests that parks, an important urban amenity for many reasons, have some complexity which needs to be closely investigated and understood to maximize its benefit to the built environment.

This study has a number of limitations. Like other cross-sectional studies, we are unable to determine the causal relationship between our exposures and health outcomes. We also cannot rule out the possibility of self-selection bias. It is possible that parents of children diagnosed with respiratory or allergic diseases may move to an area closer to parks due to their perceived health benefits. Another limitation is that we were only able to examine the impacts of NDVI and

distance to parks in the year of the questionnaire, which by definition was after the time of diagnosis for each child. This may not be the etiologically relevant time period of exposure for these outcomes, which may partially explain our findings. Studies with exposures over longer time periods would be needed to clarify these issues. A commonly cited issue with the use of NDVI and distance to parks is that neither measure is able to take into account the quality or accessibility of the greenness. Also, we did not take the size of park into consideration, which may potentially lead to inaccuracy of exposure assessment. Lastly, the study areas of our study and previous studies are heterogeneous in terms of vegetation types, urbanization, and geography, and there is little information available on what specific type of tree or pollen might be the primary cause. Our results may be shaped by unmeasured co-incident urban environmental exposures or characteristics of the population under study that determine the risk of allergic or respiratory outcomes. Another limitation is due to cultural study limitations, we were not able to obtain data on family income but only use parental education as the surrogate for SES, which might lead to residual confounding.

Our study also has a number of strengths. We were able, for the first time in China, to explore the impacts of NDVI and distance to parks on respiratory and allergic outcomes in children. Our large sample size, geographically diverse sample, and validated outcomes made for a robust study of these associations, with control for a number of potentially important confounders. Lastly, we were able to examine the impacts of multiple measures of exposure.

4.5 Conclusions

We conducted the first study in China that explores the relationship between exposure to neighborhood greenness and various allergic outcomes. We found that, compared to Western

countries, NDVI values are more evenly distributed across the urban area. However, we did not observe association between NVDI and respiratory and allergic outcomes. Living closer to parks appeared to be a risk factor for asthma and allergic diseases. Our results suggest that the health effect of residential greenness may vary for different urban forms. Urban planners need to take this complexity into account when designing infrastructure for residential greenspace.

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CHAPTER 5. Summary and Future Research Directions

In this thesis, a large epidemiological study has been described that aims at elucidating the health impact of urbanization. Three important attributes associated with urbanization were studied regarding their effects on respiratory health and obesity. First, the gap between migrant population and local population was investigated. Second, C-section was selected as an example of early life exposure factors. Third, the effect of neighborhood greenness was studied.

A sharp rising trend for asthma and allergic symptoms has been observed in China. It was hypothesized that migrating from rural to urbanized areas is a major contributor to these diseases. As the first study to examine a domestic migration population for their asthma and allergic problems, we found lower prevalence of asthma and other respiratory symptoms in migrant population compared to local population, supporting the "healthy migration effect" previously found in other studies. Our findings suggest that parental migration plays an important role in both parental and children's health. The cause of this association needs further exploration, but it is possibly due to the difference in lifestyle, particularly some early life exposures.

Among all the early life exposure factors, C-section determines the very first microbiota that an infant is exposed to during birth and thus is believed to be linked to the developmental outcomes of the children. Our results showed that for these middle school age teenagers in Suzhou, being born by C-section is a strong and consistent risk factor for developing asthma and allergic symptoms, as well as being overweight and obese. The C-section rate was found to be higher in families with higher socioeconomic status, possible explanation being they have better access to medical services. Delivery mode is also seen to alter the effect on eczema by after-birth

behaviors, as different effects are observed for breastfeeding in naturally delivered and C-section delivered children. In order to reduce the asthma risk associated with C-section, parents should be informed during pre-natal care of the possible adverse consequences of a C-section birth for their child. For unavoidable C-sections, vaginal microbial transfer might be used to partially restore maternal microbiota and avoid adverse health consequences.

Third, our study was the first study in China that explores the relationship between exposure to neighborhood greenness and various allergic outcomes. We found that, compared to Western countries, NDVI values are more evenly distributed across the urban area. However, we did not observe association between NVDI and respiratory and allergic outcomes. Living closer to parks appeared to be a risk factor for asthma and allergic diseases. Our results suggest that the health effect of residential greenness may vary for different urban forms. Urban planners need to take this complexity into account when designing infrastructure for residential greenspace. While building more green spaces to encourage physical activities, it is important to limit the amount of pollen that is released to the surrounding air in order to control the prevalence of asthma.

Our research findings suggest several important future research directions. First, further comparison between the migrant and local population can be performed to reveal the effect of other early life exposure factors, including breastfeeding, siblings, antibiotics etc. Second, more detailed analysis of the ambient environment can be performed, including airborne allergens and air pollutants, in order to better identify the risk factors for asthma and allergic symptoms. Third, indoor environment can also be evaluated. Factors like cooking behavior, smoking, heating and

building materials can be studied to shed light on how to improve indoor air quality and reduce risks for respiratory symptoms.

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Appendix

Appendix A. Full questionnaire used in the Suzhou study

HAPI Health And Places Initiative

Suzhou Survey

Parents (Of 7th and 8th graders)

School Name: _____ School Grade: _____

Team Member: _____ Date: _____

About the study

Harvard School of Public Health is excited to be working in Suzhou with partners from Soochow University and Tsinghua University on a new research study, The Health and Places Initiative (HAPI). We hope to learn about how our homes and neighborhoods impact our behaviors and our health. The information may also help inform the building or development of healthy cities in China and worldwide in the future. We will collect information across multiple districts in Suzhou by reaching out to families through selected kindergarten and middle schools. We expect to enroll 6,000 families in the study.

Invitation to participate and consent

Your child's school and class of 7th & 8th graders have been selected to participate. As a parent, please consider you and your child's participation in the study, which would include both of you completing a survey with questions about your home, neighborhood, health and the environment. Also, we will ask you for your street name and number and use that and your child's school address to provide an estimate of your families proximity to traffic, green space and other public areas from home and school. Alternatively, if the parents of the child are not available, a grandparent or adult primary caregiver that lives in the home with the child can give consent and participate. Participating in the survey would serve as consent for you and the child.

Participating in the study

If your household agrees to participate, it will involve a one-time survey. We estimate the parent's survey will take about 40-60 minutes and the youth survey about 20-30 minutes to complete. Participation in the study is voluntary and does not involve any risk. It is YOUR choice whether or not you wish to join the study. You can even decide to take part and later change your mind. You can refuse, skip, or quit at any time without penalties of any kind or loss of any benefits you are otherwise entitled. You may choose not to answer all of the questions if something makes you feel uncomfortable. Your decision to participate or not participate will in no way affect your present or future relationship with
the child's teacher or school. You are not likely to have any direct benefit from being in this research study.

Your privacy

There are some questions that can identify your participation in the survey (like home address or the child's date of birth), however your privacy will be protected because we will assign a unique identification number to each survey. Only research team members will have access to your data. All surveys will be kept in a secure location

and data entered into a computer which will be passcode protected.

Raffle entry

There are no costs to participate in this research. Each family that completes the two surveys can choose to enter into a raffle with 7 prizes at each participating school (we plan to recruit about 25 schools to participate). One raffle entry can be submitted per household. The prizes include: a $100 & $50 gift card, and 5 Harvard University souvenirs (valued at approximates $10 each). A raffle entry form is attached to the end of this survey and if you decide to compete it, you will be entered into the raffle. The form will be separated from the survey and in no way linked to your survey responses. The raffle will be conducted by study staff once the study packets are collected and you will be contacted if you are a winner.

Returning completed packets

If you choose to participate in the study and have completed the surveys, please return your study packet sealed in the envelope provided. We ask that you complete the survey within one week of receiving it. There will be a box in the child's classroom where you or the child can place the study packet once completed. We will pick up the surveys at the school approximately one week after the surveys are at home.

Other details

An extra copy of the first two pages explaining the study details and with study contact information has been included in this packet. Please keep it for your information. The results of this study may be published or presented, but nothing that might identify you personally would be used. Your responses will be combined with those from all participants.

Dr. Gary Adamkiewicz is in charge of this research study. He is an Assistant Professor at Harvard School of Public Health in Boston, MA, USA. If you have any questions, concerns, or complaints about this research study, please contact Ms. Linyan Li (+86 139 0620 7278) and she will be able to help you or relay information as necessary directly to Dr. Adamkiewicz.

The Following Survey Includes 8 sections:

1 – About You 

2 – About Your Home 

3 – About Your Lifestyle 

4 – About Your Child 

5 – About You and Your family 

6 – About Your Neighborhood

7 – About Your Environment 

8 – Future Research

I. About You

1. Who is completing this questionnaire?

1 ☐ Mother
2 ☐ Father
3 ☐ Grandmother
4 ☐ Grandfather
5 ☐ Other _____

2. What is your birth year? _____

3. This survey is completed on: (year) _____ (month) _____ (day) _____

4. Please provide your current address:

_____ street name

_____ street number

_____ district

II. About Your Home

A. Basic Characteristics *(ownership, building age, materials, etc.)*

Questions in this section concern the child's main residence, i.e. where the child lives the majority of the time. If child lives with grandparents or another primary caregiver, please answer the residential condition of his/her grandparents or primary caregiver.

5. Has the child lived at the present residence the whole of his/her life?

1 ☐ Yes
2 ☐ No, lived here since _____

6. Is the child living more than 10 days per month at another residence?

1 ☐ Yes
2 ☐ No

6a. If Yes, whom does child live with? _____

Questions concerning the surrounding of the present residence

7. If the residence near (within 200 meters) a highway or main road?

1 ☐ Yes
2 ☐ No

8. Is the residence near (within 200 meters) to a farm/property where cattle are kept?
(E.g. cows, pigs, horses)

1 ☐ Yes
2 ☐ No

Questions concerning the present residence
9. In which kind of house is the child living in at the moment?

1 ☐ Flat roof Pingfang (bungalow)
2 ☐ Sloping roof Pingfang
3 ☐ Low-rise apartment (≤7 floors)
4 ☐ High-rise apartment (> 7 floors)
5 ☐ Villa or row house

9a. What floor do you and the child live on right now? _____# of floor

9b. How many floors in total are there in your building? _____total #

10. Approximate size of your residence:

1 ☐ Smaller than 40 m^2 (square meters)
2 ☐ 41-60 m^2
3 ☐ 61-75 m^2
4 ☐ 76-100 m^2
5 ☐ 101-150 m^2
6 ☐ Larger than 150 m^2

11. What was the construction year of your residence? _____ year (If you answer here, skip to Q12)

11a. If you can't remember, check the approximate age of the residence from the answers below?

1 ☐ Less than 5 years
2 ☐ Less than 10 years
3 ☐ 10-20 years
4 ☐ 20-30 years
5 ☐ 30-40 years
6 ☐ 40-50 years
7 ☐ More than 50 years
8 ☐ Don't know

12. Do you own or rent your current residence?

1 ☐ own
2 ☐ rent

13. Does your building have an elevator?

1 ☐ Yes
2 ☐ No

Questions concerning the child's sleep patterns *(Child's room means child has most activities here day & night)*

14. In which room does the child spend most of his/her sleeping time? (Choose only one answer)

1 ☐ The child's own room
2 ☐ Sharing bed room with siblings (brothers and sisters)
3 ☐ Sleeping with parents
4 ☐ Sleeping with grandparents
5 ☐ Others_____

Questions concerning the construction and material of the present residence

15. What kinds of flooring materials are in different rooms in the residence? (Check all that apply for each room)

	Linoleum	PVC floor	Wood	Laminated wood	Bamboo	Stones/ tiles	Cement	Carpets	Other/ Don't know
a. Childs room	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐
b. Your room	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐

16. Which kind of surface layer is on the walls in the child's room? (Check all that apply)

1 ☐ Oil based paint
2 ☐ Latex paint
3 ☐ Wall paper
4 ☐ Vinyl Wall paper
5 ☐ Unfinished
6 ☐ Don't Know
7 ☐ Other _____

16a. What kinds of windows exist in the child's room?

1 ☐ Wooden framed
2 ☐ Aluminium framed
3 ☐ PVC framed
4 ☐ Don't know

16b. What kind of glass is in the child's room window frames?

1 ☐ Single pane
2 ☐ Double pane
3 ☐ Double pane gas filled
4 ☐ Don't know

B. Heating and Cooling

Questions concerning heating and ventilation in the present residence

17. Which type of heating is there in the residence?

1 ☐ Electric (heating) radiator
2 ☐ Hot water (heating) radiator
3 ☐ Underfloor heating
4 ☐ Warm air (central) heating
5 ☐ Coal
6 ☐ Wood stove
7 ☐ Kang
8 ☐ Firewall
9 ☐ Other _____ (specify)
10 ☐ No heating
11 ☐ Don't know

18. During the winter, how comfortable is the temperature in your home?

1 ☐ About right
2 ☐ Too hot
3 ☐ Too cold

19. Which kind of cooling system is there in your residence? (Check all that apply)

1 ☐ Air conditioning unit
2 ☐ Electric fans
3 ☐ Opening windows
4 ☐ Other

20. During the summer, how comfortable is the temperature in your home?

1 ☐ About right
2 ☐ Too hot
3 ☐ Too cold

C. Ventilation

21. Which kind of ventilation system is there in the residence?

1 ☐ Natural ventilation without fans
2 ☐ Natural ventilation with fans in kitchen
3 ☐ Natural ventilation with fans in bathroom
4 ☐ Natural ventilation with fans in bedroom
5 ☐ Mechanical ventilation
6 ☐ Others

22. How often do you open a window for ventilation? (Select one answer for each season.)

	Everyday	Approximately twice a week	Once a week	Every second week	Once a month	Less frequent
a. Winter	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
b. Spring	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
c. Summer	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
d. Autumn	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

23. During the last 7 days, in your residence, how many days did you…

	Number of days
a. Open your windows	_____ (0-7 days)
b. Use an air conditioner for cooling	_____ (0-7 days)
c. Use a portable heater for heating	_____ (0-7 days)
d. Smell cigarette smoke from outside your residence	_____ (0-7 days)

D. Dampness related problems

Questions concerning dampness problems, if any, in the present residence

24. Have you noticed any visible mold on the floor, walls, or ceiling in any of the rooms stated below?

	Yes	No	Don't Know
a. Child's room	1 ☐	2 ☐	3 ☐
b. Your room	1 ☐	2 ☐	3 ☐
c. Bathroom	1 ☐	2 ☐	3 ☐
d. Other room(s)	1 ☐	2 ☐	3 ☐

25. Have you noticed any <u>visible damp stains</u> on the floor, walls, or ceiling in any of the rooms stated below?

	Yes	No	Don't Know
a. Child's room	1 ☐	2 ☐	3 ☐
b. Your room	1 ☐	2 ☐	3 ☐
c. Bathroom	1 ☐	2 ☐	3 ☐
d. Other room(s)	1 ☐	2 ☐	3 ☐

26. Do you suspect any humidity/mold problem on the floor, walls or ceiling, which are not visible on the inside of the residence?

1 ☐ Yes
2 ☐ No
3 ☐ Don't know

27. In the winter, does condensation or moisture occur on the inside, at the bottom of windows (window panes) in any of the rooms stated below?

	No, Never	Yes, less than 5 centimeters	Yes, 5-25 centimeters	Yes, more than 25 centimeters	Don't know
a. Child's room	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. Your room	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. Living room	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

Questions concerning odor in the present residence

28. Have you, during the last 3 months been bothered by any (one or more) of the conditions stated below, in your residence?

	Yes, Frequently (weekly)	Yes, Sometimes	No, Never
a. Tobacco smoke (in residence)	1 ☐	2 ☐	3 ☐
b. Tobacco smoke (elsewhere in building)	1 ☐	2 ☐	3 ☐
c. Cooking odors (in residence)	1 ☐	2 ☐	3 ☐
d. Cooking odors (elsewhere in	1 ☐	2 ☐	3 ☐

building)			
e. Dry air	1 ☐	2 ☐	3 ☐
f. Humid air	1 ☐	2 ☐	3 ☐
g. Exhaust fumes from outside	1 ☐	2 ☐	3 ☐
h. Stuffy odor	1 ☐	2 ☐	3 ☐
i. Moldy/earthy odor	1 ☐	2 ☐	3 ☐

Question concerning the child's residence at birth
If you did not move since the child was born, please skip to question 30.

29. In the child's birth residence, what kind of floor covering is used? (Check all that apply)

1 ☐ Linoleum
2 ☐ PVC floor
3 ☐ Wood
4 ☐ Laminated wood
5 ☐ Bamboo
6 ☐ Stones/tiles
7 ☐ Cement
8 ☐ Carpets
9 ☐ Other
10 ☐ Don't know

E. Renovations and extensions done to the present building and unit

30. Have any major renovations or extensions been done to your unit?

1 ☐ Yes
2 ☐ No (If NO, go to question 26)
3 ☐ Don't know (If don't know, go to question 26)

30a. If yes, when was the most recent unit rebuild/renovation?

1 ☐ 1-2 years ago
2 ☐ 3-4 years ago
3 ☐ 5-6 years ago
4 ☐ 7-8 years ago
5 ☐ 9-10 years ago

30b. If yes, was the action taken due to problems with damp and mold in the building?

1 ☐ Yes
2 ☐ No

3 ☐ Don't know

31. Have any major renovations or extensions been done to the building?

1 ☐ Yes
2 ☐ No (If NO, go to question 32)
3 ☐ Don't know (If don't know, go to question 32)

31a. If yes, when was the most recent building rebuild/renovation?

1 ☐ 1-2 years ago
2 ☐ 3-4 years ago
3 ☐ 5-6 years ago
4 ☐ 7-8 years ago
5 ☐ 9-10 years ago

31b. If Yes, was the action taken due to problems with damp and mold in the building?

1 ☐ Yes
2 ☐ No
3 ☐ Don't know

32. What was the status of your building when you moved in?

1 ☐ Finished without renovation
2 ☐ Renovated

33. Were any of the rooms, stated below, repainted during the child's mother's pregnancy?

	During your pregnancy			
	Yes	No	Don't Know	If yes, please specify what kind of paint was used?
a. Child's room	a1 ☐	a2 ☐	a3 ☐	a4 ☐ Oil based paint a5 ☐ Latex paint
b. Your room	b1 ☐	b2 ☐	b3 ☐	b4 ☐ Oil based paint b5 ☐ Latex paint
c. Other room(s)	c1 ☐	c2 ☐	c3 ☐	c4 ☐ Oil based paint c5 ☐ Latex paint

34. Were any of the rooms, stated below, repainted during the first year of the child's life?

	During the first year of the child's life			
	Yes	No	Don't Know	If yes, please specify what kind of paint was used?

a. Child's room	a1 ☐	a2 ☐	a3 ☐	a4 ☐ Oil based paint a5 ☐ Latex paint
b. Your room	b1 ☐	b2 ☐	b3 ☐	b4 ☐ Oil based paint b5 ☐ Latex paint
c. Other room(s)	c1 ☐	c2 ☐	c3 ☐	c4 ☐ Oil based paint c5 ☐ Latex paint

III. About Your Lifestyle

A. Smoking habits

Questions about cigarette smoking

35. Do you now smoke cigarettes?

1 ☐ Yes
2 ☐ No, not at all (If no, skip to Question 37)

36. On average, how many cigarettes did you usually smoke each day? *(*If you are not sure, take your best guess.)

_____ # of cigarettes (1 pack = 20 cigarettes)

37. Have you smoked at least 100 cigarettes (5 packs) in your entire life? (If you are not sure, take your best guess.)

1 ☐ Yes
2 ☐ No

38. Who in your home smokes? (Check all that apply)

1 ☐ Mother
2 ☐ Father
3 ☐ Siblings
4 ☐ Other
5 ☐ No one

39. Which statement best describes your family's rules about smoking in your home?

1 ☐ No one is allowed to smoke anywhere at any time
2 ☐ Smoking is permitted in some places or at some times
3 ☐ Smoking is permitted anywhere, anytime

40. Do visitors to your home ever smoke in your home?

1 ☐ Yes
2 ☐ No (If NO skip to Question 42)

41. What is the approximate total number of cigarettes smoked in your home on a typical day? (If you are not sure, take your best guess.)

1 ☐ Less than 10 per day
2 ☐ 10-20 per day
3 ☐ More than 20 per day
4 ☐ Don't know

42. Did any of the parents smoke during the child's first year of life?

1 ☐ No
2 ☐ Yes, mother
3 ☐ Yes, father

43. Did any of the parents smoke during the pregnancy?

1 ☐ No
2 ☐ Yes, mother
3 ☐ Yes, father

44. Did any other members of the household smoke during the pregnancy?

1 ☐ Yes
2 ☐ No

44a. If yes, please specify? _____

45. Do you or anyone in your household smoke e-cigarettes?

1 ☐ Yes
2 ☐ No
3 ☐ Don't know

B. <u>Pets/Animals</u>

Questions concerning furred animals

46. Do you have any furred animals / pets in your present residence?

1 ☐ Yes
2 ☐ No (if NO, skip to question 47)

46a. If yes, what kind and how many?

1 ☐ Cat (If yes, how many? _____)
2 ☐ Dog (If yes, how many? _____)

3 ☐ Rodent (rabbit, hamster, rats, guinea pig, etc.) (If yes, how many? _____)
4 ☐ Chickens or ducks (If yes, how many? _____)
5 ☐ Birds (If yes, how many? _____)
6 ☐ Aquarium fishes, reptiles, etc. (If yes, how many? _____)
7 ☐ Other furred animals (If yes, how many? _____)

47. Were there any furred animals / pets in the residence during the child's first years, i.e. in the child's birth residence?

1 ☐ Yes
2 ☐ No (if NO, skip to question 48)

47a. If yes, what kind and how many?

1 ☐ Cat (If yes, how many? _____)
2 ☐ Dog (If yes, how many? _____)
3 ☐ Rodent (rabbit, hamster, rats, guinea pig, etc.) (If yes, how many? _____)
4 ☐ Birds (If yes, how many? _____)
5 ☐ Aquarium fishes, reptiles, etc. (If yes, how many? _____)
6 ☐ Other furred animals (If yes, how many? _____)

48. Have you gotten rid of any furred animals / pets due to allergic illnesses in the family?

1 ☐ Yes
2 ☐ No

49. Have you refrained from procuring any furred animals / pets due to allergic illnesses in the family?

1 ☐ Yes
2 ☐ No

C. <u>Cooking habits</u>

50. Is there a live poultry market in your neighbourhood?

1 ☐ Yes
2 ☐ No (If NO, skip to Q51)

50a. If yes, is that where you buy your poultry?

1 ☐ Yes
2 ☐ No

51. What type of fuel do you primarily use for cooking?

1 ☐ Gas
2 ☐ Electric (including induction stoves)
3 ☐ Coal
4 ☐ Wood
5 ☐ Other _____

51a. Does your family use an induction stove?

1 ☐ Almost
2 ☐ Sometimes
3 ☐ Rarely
4 ☐ Never

52. Where do you usually get your food?

1 ☐ Fresh market
2 ☐ Small grocery store
3 ☐ Supermarket

52a. How long does it take to get there?

1 ☐ 1-5 minutes
2 ☐ 6-10 minutes
3 ☐ 11-15 minutes
4 ☐ 16-20 minutes
5 ☐ 21-25 minutes
6 ☐ 26-30 minutes
7 ☐ 31+ minutes

53. During the last 7 days, how many meals were prepared and eaten in your home?

	No of meals
a. Monday – Friday	_____ (0-15 meals)
b. Saturday and Sunday	_____ (0-6 meals)

54. On a typical **weekday** (Monday through Friday), what is the total amount of time the stovetop and/or oven is used?

1 ☐ The stovetop and/or oven is not used on a typical weekday (0 minutes)
2 ☐ Less than 15 minutes
3 ☐ More than 15, but less than 30 minutes
4 ☐ More than 30, but less than 60 minutes
5 ☐ More than 60, but less than 120 minutes
6 ☐ More than 120 minutes, but less than 180 minutes
7 ☐ More than 180 minutes

55. On a typical **weekend** (Saturday and Sunday), what is the total amount of time that the stovetop and/or oven is used?

1 ☐ The stovetop and/or oven is not used on a typical weekday (0 minutes)
2 ☐ Less than 15 minutes
3 ☐ More than 15, but less than 30 minutes
4 ☐ More than 30, but less than 60 minutes
5 ☐ More than 60, but less than 120 minutes
6 ☐ More than 120 minutes, but less than 180 minutes
7 ☐ More than 180 minutes

56. Do you have a fan above your stove?

1 ☐ Yes
2 ☐ No (If no, skip to 57)

56a. If yes, does the fan exhaust to the outside?

1 ☐ Yes
2 ☐ No

56b. If yes, when someone cooks in your apartment with the stovetop or oven, how often, if ever, do you/they use the exhaust fan?

1 ☐ Always
2 ☐ Only when odor or humidity seems to be an issue
3 ☐ Sometimes
4 ☐ Rarely
5 ☐ Never

D. <u>Cleaning habits (vacuum, cleaning products, electronic devices, etc.)</u>

Questions concerning cleaning routines, etc. in the residence

57. How often do you clean the floor in the child's room?

1 ☐ Everyday
2 ☐ Approximately twice a week
3 ☐ Once a week
4 ☐ Every second week
5 ☐ Once a month
6 ☐ Less frequent

58. Have your cleaning routines changed due to allergies in the family?

1 ☐ Yes

2 ☐ No
3 ☐ Don't know

59. Which of these methods has been used to clean the floor in the child's room? (Check all that apply)

1 ☐ Broom or dry mop
2 ☐ Wet mop (only water)
3 ☐ Wet mop (with water & detergent)
4 ☐ Vacuum
5 ☐ Other _____

60. How often do you sun-cure bed sheets?

1 ☐ Often
2 ☐ Sometimes
3 ☐ Never

61. Do you use a clothes dryer at home?

1 ☐ Yes
2 ☐ No

62. On average how often do you or your family members use the following…

EQUIMENT IN THE HOME	Never	Less than a few times per year	A few times per year	A few times per month	A few times per week	Every day
a. Humidifier	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
b. Ionizer	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
c. Ozone generator	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
d. Air cleaner/purifier unit	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

COMMERCIAL PRODUCTS WITH CHEMICALS	Never	Less than a few times per year	A few times per year	A few times per month	A few times per week	Every day
e. Fresher/room deodorizer	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
f. Spray-on surface or glass cleaner	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
g. Toilet, tub, or tile cleaner	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
h. Bleach such as Clorox (used for laundry or surfaces)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
i. Furniture polish	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

j. Floor cleaner	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
k. Carpet cleaner	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
l. Bug or insect spray	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

OTHER PRODUCTS	Never	Less than a few times per year	A few times per year	A few times per month	A few times per week	Every day
m. Candles	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
n. Incense (a substance that releases fragrant smoke when burned)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
o. mosquito-repellent incense	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

E. Dietary Habits

In media it is often indicated that our modern lifestyle cause allergy. No-one has yet been able to explain what is actually meant with this conception (term). For this reason we would like to make an attempt to get an understanding of how our modern lifestyles are related to our eating habits.

63. How often on average do you have the following food or drinks in a typical week?

Food or drinks	Never	1-3 days	4-6 days	Everyday
a. Fruits and vegetables	1 ☐	2 ☐	3 ☐	4 ☐
b. White rice, or other refined grain product	1 ☐	2 ☐	3 ☐	4 ☐
c. Brown rice or other coarse food grain (e.g. maize, millet, etc.)	1 ☐	2 ☐	3 ☐	4 ☐
d. Artificially-sweetened drinks (coke and juice)	1 ☐	2 ☐	3 ☐	4 ☐
e. Salt-preserved food (e.g. pickled vegetables)	1 ☐	2 ☐	3 ☐	4 ☐
f. Fast food (like McDonald's or KFC)	1 ☐	2 ☐	3 ☐	4 ☐
g. Milk	1 ☐	2 ☐	3 ☐	4 ☐
h. Eggs	1 ☐	2 ☐	3 ☐	4 ☐
i. Beef	1 ☐	2 ☐	3 ☐	4 ☐
j. Pork	1 ☐	2 ☐	3 ☐	4 ☐
k. Lamb	1 ☐	2 ☐	3 ☐	4 ☐
l. Chicken	1 ☐	2 ☐	3 ☐	4 ☐
m. Fish	1 ☐	2 ☐	3 ☐	4 ☐
n. Shellfish	1 ☐	2 ☐	3 ☐	4 ☐
o. Beer	1 ☐	2 ☐	3 ☐	4 ☐
p. Wine	1 ☐	2 ☐	3 ☐	4 ☐
q. Liquor	1 ☐	2 ☐	3 ☐	4 ☐

64. How often on average do you have the following eating habit in a typical week?

Eating habit	Never	1-3 days	4-6 days	Everyday
a. Eating breakfast	1 ☐	2 ☐	3 ☐	4 ☐
b. Eating out of your home from a street vendor	1 ☐	2 ☐	3 ☐	4 ☐
c. Eating out of your home from a fast food restaurant	1 ☐	2 ☐	3 ☐	4 ☐
d. Eating instant noodles	1 ☐	2 ☐	3 ☐	4 ☐

65. How often on average do you use the following cooking method in a typical week?

Cooking method	Never	1-3 days	4-6 days	Everyday
a. Deep fry	1 ☐	2 ☐	3 ☐	4 ☐
b. Pan fry	1 ☐	2 ☐	3 ☐	4 ☐
c. Steam/boil	1 ☐	2 ☐	3 ☐	4 ☐
d. Roast/bake/toast	1 ☐	2 ☐	3 ☐	4 ☐

66. What kind of cooking oil do you usually use? (Check all that apply)

1 ☐ Animal fat/lard
2 ☐ Soybean oil
3 ☐ Peanut oil
4 ☐ Corn oil
5 ☐ Canola oil
6 ☐ Olive oil
7 ☐ Other, specify _____

F. Commuting

67. Do you work at a job outside of the home?

1 ☐ Yes
2 ☐ No (If no, skip to Q70)

68. How do you commute to your job? (Check all that apply)

1 ☐ Car
2 ☐ Public transportation (bus or train)
3 ☐ Traditional bicycle
4 ☐ Electric bicycle
5 ☐ Walking
6 ☐ Scooter
7 ☐ Other _____

68a. If you take public transportation, how long does it take to get to the stop or station?

1 ☐ 1-5 minutes
2 ☐ 6-10 minutes
3 ☐ 11-15 minutes
4 ☐ 16-20 minutes
5 ☐ 21-25 minutes
6 ☐ 26-30 minutes
7 ☐ 31+ minutes

69. How much time in total does it take you to commute to your job and back home **(roundtrip)** each day?

_____ minutes

69a. Of the time it takes you to commute each day, how much of that time is spent sitting?

_____ minutes

70. Do you own a car?

1 ☐ Yes
2 ☐ No (if no, skip to 72)

71. How often do you drive?

1 ☐ Never
2 ☐ Occasional (1-2 days/week)
3 ☐ Moderate (3-4 days/week)
4 ☐ Frequent (5-7 days/week)

72. Do you own a traditional bicycle (non-electric)?

1 ☐ Yes
2 ☐ No

73. Do you own an electrically powered bicycle?

1 ☐ Yes
2 ☐ No

74. How often do you ride a traditional bicycle?

1 ☐ Never
2 ☐ Occasional (1-2 days/week)

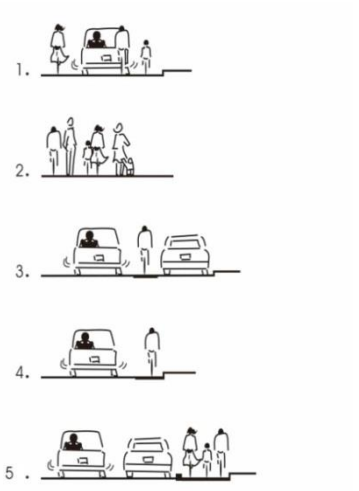
3 ☐ Moderate (3-4 days/week)
4 ☐ Frequent (5-7 days/week)

75. How much time on average do you spend bicycling on a traditional bicycle each day of the week?

1 ☐ Never
2 ☐ 5-15 minutes
3 ☐ 16-30 minutes
4 ☐ 31-59 minutes
5 ☐ 1 to 2 hours
6 ☐ More than 2 hours

G. Bicycle Environment

76. (Skip to question 77 if you do not bicycle.) If you bicycle, what's the percentage of your riding on different types of bicycle routes?



1._____% Road shared (bicyclists share with vehicle drivers)

2._____% Shared-use path (bicyclists share with walkers on a path)

3._____% Painted-line separated bicycle-exclusive path beside the cars (with parallel parked cars)

4._____% Painted-line separated bicycle-exclusive path beside the sidewalk (without parallel parked cars).

5._____% Barrier-separated bicycle-exclusive cycle track.

_____% Total (Total should be 100%)

77. If you do or do not bicycle, please check the following about your perceptions that refer to picture #5 above (barrier-protected bicycle-exclusive path beside a sidewalk).

	Strongly agree	Agree	Unknown/ no opinion	Disagree	Strongly Disagree
a. No street lights exist over the cycle tracks	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. Cars park on the cycle tracks	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. Cars drive on the cycle tracks	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d. Buses arrive and depart on the cycle tracks	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
e. My bicycle parking is a covered and locked shed	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
f. Traffic signals exist for bicyclists (e.g. count down with red and green bicycles)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

78. If you do or do not bicycle, please check the answer that best fits your perception of biking in your community.

	Strongly agree	Agree	Unknown/ no opinion	Disagree	Strongly disagree
a. Covered and locked bicycle parking is readily available	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. Traffic signals exist for bicyclists (e.g. count down with red and green bicycles)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. Bicycling is enjoyable with the beautiful surrounding environment (e.g. plants, trees)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d. My neighborhood has a high rate of bicycle theft	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

79. Do you currently use Suzhou's public bicycle rental system?

1 ☐ Yes
2 ☐ No

80. Does anyone in your family currently use Suzhou's public bicycle rental system?

1 ☐ Yes
2 ☐ No

H. Physical Activity

81. During the past year, what was your average time per week spent at each of the following **recreational** activities?

	Zero	1-4 min	5-19 min	20-59 min	One hour	1-1.5 hrs.	2-3 hrs.	4-6 hrs.	7-10 hrs.	11+ hrs.
a. Walking for exercise	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
b. Walking to work	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
c. Jogging (slower than 10min/mile)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
d. Running (10min/ mile or faster)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
e. Bicycling (includes stationary machine)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
f. Tennis, squash, racquet ball	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
g. Lap swimming	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐

h. Other aerobic exercise (aerobics, dance, guangchang dance, ski, or stair machine)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
i. Lower intensity exercise (yoga, tai chi, stretching, toning)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
j. Other vigorous activities (e.g. lawn mowing)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
k. Weight training or resistance exercises: ARMS (include free weights or machines such as Nautilis)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐
k. Weight training or resistance exercises: LEGS (include free weights or machines such as Nautilis)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐

82. This question is about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

82a. During the last 7 days, how much time did you usually spend sitting on a weekday?

_____ hours per day

82b. During the last 7 days, how much time did you usually spend sitting on a weekend?
_____ hours per day

IV. About Your Child

A. Core Questions

83. Child's gender: _____

84. Childs's date of birth: (year) _____ (month) _____ (date) _____

85. Child current weight _____Jin

86. Child current height _____cm

87. Child's weight at birth _____ Jin

88. Child's length at birth _____cm

B. Background Information of the child

Questions concerning the date of birth of the child and the breast-feeding routines

89. Was the child born within 1 weeks of the calculated date of birth?

1 ☐ Yes
2 ☐ No, more than 1 but less than 2 weeks early
3 ☐ No, more than 2 but less than 3 weeks early
4 ☐ No, more than 3 weeks early
5 ☐ No, more than 1 but less than 2 weeks late
6 ☐ No, more than 2 but less than 3 weeks late
7 ☐ No, more than 3 weeks late
8 ☐ Don't know

90. Where the child was born? (province) _____ (city) _____ (district) _____

91. How was the child delivered?

1 ☐ Natural delivery
2 ☐ Caesarean section

92. Was the child ever breast-fed totally or partly?

1 ☐ Yes, totally
2 ☐ Yes, partly
3 ☐ No (If NO, skip to 93)

92a. If yes, for how long?

1 ☐ Less than 3 months
2 ☐ 3–6 months
3 ☐ 6-12 months
4 ☐ More than one year

92b. If yes, for how long was the child breast fed without adding other foods or juices?

1 ☐ Less than 2 months
2 ☐ 2–4 months
3 ☐ 5-6 months
4 ☐ More than 6 months

93. What kind of diaper was most commonly used for the child?

1 ☐ Cloth diaper
2 ☐ Disposable diaper
3 ☐ Other: _____

94. What kind of milk bottle did the child use? (Check all that apply)

1 ☐ Stainless steel
2 ☐ Ceramics
3 ☐ Glass
4 ☐ Plastics
5 ☐ Other_____

95. Did the child use a pacifier?

1 ☐ Yes
2 ☐ No (If NO, skip to 96)

95a. If yes, when pacifier dropped down on the floor or was polluted by dust, how do you clean it?

1 ☐ Parent, grandparent, or primary caregiver sucking pacifier in mouth
2 ☐ Wipe by paper or cloth
3 ☐ Rinse by clean water
4 ☐ Boiling it
5 ☐ Clean by cleaning product
6 ☐ Other_____

96. Before the child attended elementary school, did the child stay at home or attend daycare?

1 ☐ Attended daycare, >20 hours per week
2 ☐ Attended daycare, 10-20 hours per week
3 ☐ Attended daycare, <10 hours per week
4 ☐ Stayed at home with parents (Skip to Q119)
5 ☐ Stayed at home with grandparents (Skip to Q119)
6 ☐ Taken care of by nanny or others at home (Skip to Q119)

96a. If the child attended daycare, at what age did the child start to attend?

1 ☐ Younger than 1 year
2 ☐ 1-2 years of age
3 ☐ 2-3 years of age
4 ☐ 3-4 years of age
5 ☐ Older than 4 years of age

96b. What kind of daycare did the child attend?

1 ☐ Private daycare

2 ☐ Public daycare

96c. How many children total were taken care of at daycare your child attended?

1 ☐ <10 children
2 ☐ 10-30 children
3 ☐ >30 children

C. Child's Health

Questions concerning breathing difficulties for the child

97. Has the child ever had wheezing or whistling in the chest at any time in the past?

1 ☐ Yes
1 ☐ No (If NO, skip to question 102)

97a. If yes, at what age did the problem first occur?

1 ☐ Prior to 1 year of age
2 ☐ At 1-2 years of age
3 ☐ At 3-4 years of age
4 ☐ At 5-6 years of age
5 ☐ Past 6 years of age

98. Has the child had wheezing or whistling in the chest in the past 12 months?

1 ☐ Yes
2 ☐ No (If No), skip to question 102)

98a. If Yes, under which circumstances? (Check all that apply)

1 ☐ When having a cold
2 ☐ During exercise
3 ☐ When laughing or weeping
4 ☐ When playing or being outdoors
5 ☐ In contact with furred animals
6 ☐ Others_____

99. In the past 12 months, how many attacks of wheezing have the child had?

1 ☐ Never
2 ☐ 1-3 times
3 ☐ 4-12 times
4 ☐ > 12 times

100. In the past 12 months, how often, on average, has the child's sleep been disturbed due to wheezing?

1 ☐ Never woken with wheezing

2 ☐ Less than one night per week
3 ☐ One or more nights per week

101. In the past 12 months, has wheezing ever been severe enough to limit the child's speech to only one or two words at a time between breaths?

1 ☐ Yes
2 ☐ No

102 In the past 12 months, has the child had a dry cough at night for more than two weeks, apart from a cough associated with a cold or chest infection?

1 ☐ Yes
2 ☐ No

103. Has the child ever been taken to a doctor due to wheezing or dry cough problem?

1 ☐ Yes
2 ☐ No

104. Has the child ever been diagnosed with asthma by a doctor?

1 ☐ Yes
2 ☐ No

105. Has the child ever had croup?

1 ☐ Yes
2 ☐ No

106. Has the child ever been diagnosed tuberculosis?

1 ☐ Yes
2 ☐ No

107. Has the child ever been diagnosed with pneumonia by a doctor?

1 ☐ Yes
2 ☐ No (If NO, skip to question 108)

107a. If Yes, the 1st diagnosed at age ____

107b. If Yes, it has occurred

1 ☐ Only once
2 ☐ 2-3 times
3 ☐ 4 or more

Questions concerning rhinitis or eye irritations for the child

108. Has the child ever had a problem with sneezing, or a runny, or a blocked nose when he / she did not have a cold or flu?

1 ☐Yes
2 ☐ No (If NO, skip to question 112)

108a. If yes, at what age did the problems first occur?

1 ☐ Prior to 1 year of age
2 ☐ At 1-2 years of age
3 ☐ At 3-4 years of age
4 ☐ At 5-6 years of age
5 ☐ Past 6 years of age

109. In the past 12 months, has the child had a problem with sneezing, or a runny, or a blocked nose when he/she did not have a cold or the flu?

1 ☐ Yes
2 ☐ No (If No), skip to question 112)

109a. During which of the past 12 months, did this nose problem occur? (Check any that apply)

1 ☐ January
2 ☐ February
3 ☐ March
4 ☐ April
5 ☐ May
6 ☐ June
7 ☐ July
8 ☐ August
9 ☐ September
10 ☐ October
11 ☐ November
12 ☐ December

110. In the past 12 months, how much did this nose problem interfere with the child's daily activities?

1 ☐ Not at all
2 ☐ A little
3 ☐ A moderate amount
4 ☐ A lot

111. In the past 12 months, has this nose problem been accompanied by *itchy-watery eyes*?

1 ☐ Yes
2 ☐ No

112. Has the child ever been diagnosed with hay fever or allergic rhinitis by a doctor?

1 ☐ Yes
2 ☐ No

113. In the past 12 months, how many times has the child had a cold?

1 ☐ None (If NONE, skip to 114)
2 ☐ 1-2 times
3 ☐ 3-5 times
4 ☐ 6 – 10 times
5 ☐ More than 10 times
6 ☐ Don't know

113a. Which season does the child usually have a common cold? (Select only one)

1 ☐ Spring
2 ☐ Summer
3 ☐ Autumn
4 ☐ Winter

113b. How long does usually a cold last?

1 ☐ Less than 2 weeks
2 ☐ 2 – 4 weeks
3 ☐ More than 4 weeks

114. Has the child ever had inflammations of the ears?

1 ☐ No
2 ☐ Yes, 1 – 2 times
3 ☐ Yes, 3 – 5 times
4 ☐ Yes, more than 5 times

Questions concerning eczema for the child

115. Has the child ever had an itchy rash, which was coming and going for at least 6 months?

1 ☐ Yes
2 ☐ No (If NO, skip to 117)

115a. If yes, at what age did the problem first occur?

1 ☐ Prior to 1 year of age
2 ☐ At 1-2 years of age
3 ☐ At 3-4 years of age
4 ☐ At 5-6 years of age
5 ☐ Past 6 years of age

115b. Has this itchy rash at any time affected any of the following places: the fold of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears or eyes?

1 ☐ Yes
2 ☐ No

116. Has the child had this itchy rash at any time in the last 12 months?

1 ☐ Yes
2 ☐ No (If NO, skip to 117)

116a. In the last 12 months, how often, on average, has the child been kept awake at night by this itchy rash?

1 ☐ Never
2 ☐ Less than one night per week
3 ☐ One or more nights per week

117. Has the child been diagnosed with eczema by a doctor?

1 ☐ Yes
2 ☐ No

Questions about food the child eats and drinks

118. In the past 12 months, how often, on average, did the child eat or drink the following?

Food or drinks	Never	1-3 days	4-7 days	Everyday
a. Fruits and vegetables	1 ☐	2 ☐	3 ☐	4 ☐
b. White rice, or other refined grain product	1 ☐	2 ☐	3 ☐	4 ☐
c. Brown rice or other coarse food grain (e.g. maize, millet, etc.)	1 ☐	2 ☐	3 ☐	4 ☐
d. Artificially-sweetened drinks (coke and juice)	1 ☐	2 ☐	3 ☐	4 ☐
e. Salt-preserved food (e.g. pickled vegetables)	1 ☐	2 ☐	3 ☐	4 ☐
f. Fast food (like McDonald's or KFC)	1 ☐	2 ☐	3 ☐	4 ☐
g. Milk	1 ☐	2 ☐	3 ☐	4 ☐
h. Eggs	1 ☐	2 ☐	3 ☐	4 ☐
i. Beef	1 ☐	2 ☐	3 ☐	4 ☐
j. Pork	1 ☐	2 ☐	3 ☐	4 ☐
k. Lamb	1 ☐	2 ☐	3 ☐	4 ☐
l. Chicken	1 ☐	2 ☐	3 ☐	4 ☐
m. Fish	1 ☐	2 ☐	3 ☐	4 ☐
n. Shellfish	1 ☐	2 ☐	3 ☐	4 ☐

Questions concerning reactions to food

119. Has **the child** ever had an allergic irritation to food , such as eczema, nettle-rash, diarrhoea, swollen lips or eyes?

1 ☐ Yes
2 ☐ No (skip to Q120)
3 ☐ Don't know

119a. If Yes, what foods is the child allergic to?

1 ☐ Milk or dairy products
2 ☐ Eggs
3 ☐ Fish
4 ☐ Peanuts
5 ☐ Nuts, almond
6 ☐ Seafood, e.g. crab
7 ☐ Vegetables, e.g. tomatoes, carrots
8 ☐ Flour (wheat, barley, rye, oat)
9 ☐ Soya, peas, beans

Questions concerning antibiotic treatment of the child

120. Did the child take medicines with antibiotic, e.g. penicillin, during the following periods of his/her life? (Check any that apply)

1 ☐ No, never (skip to 122)
2 ☐ Yes, when 0 – 12 months old
3 ☐ Yes, when 12 – 24 months old
4 ☐ Yes, after 24 months old

120a. If Yes, the antibiotic was used for_____

121. If the child was taking antibiotic when 0–12 months old, how many treatments did he / she receive?

1 ☐ 1 treatment
2 ☐ 2 treatments
3 ☐ 3 or more treatments

Questions concerning chronic "modern" disease of the child

122. Has the child had any of the following disease/disorders diagnosed?

	Doctor diagnosed?		Use of medicine		When diagnosed?
	Yes	No	Yes	No	
a. Diabetes					

b. ADHD (Attention Deficit Hyperactivity Disorder)					
c. Autism					
d. Asperger					
e. Tourette's syndrome					
f. Cryptorchidism and hypospadias					

D. Student Performance

123. How much time does the child spend on homework/school assignments every day?

1 ☐ Less than 30 minutes
2 ☐ 30 – 60 minutes
3 ☐ 1 – 2 hours
4 ☐ 2 – 3 hours
5 ☐ More than 3 hours

124. How would your rate the child's overall physical ability (e.g. sports and exercise)?

1 ☐ Excellent
2 ☐ Very good
3 ☐ Good
4 ☐ Fair
5 ☐ Poor

125. In the past academic year, did the child receive a "five excellence" honor?

1 ☐ Yes, 125a.If yes, which? _____
2 ☐ No

E. Child's Physical Activity

126. How often, on average, does the child participate in physical activities?

1 ☐ 0-1 times per week
2 ☐ 2-3 times per week
3 ☐ 4-5 times per week
4 ☐ 6-7 times per week

127. During a normal week, how many hours a day (24 hours) does the child watch television/?

1 ☐ Less than 1 hour
2 ☐ 1-3 hours
3 ☐ 3-5 hours
4 ☐ 5 hours or more

128. Do you own a computer/tablet?

1 ☐ Yes
2 ☐ No

129. During a normal week, how many hours a day (24 hours) does the child play on computer/tablet?

1 ☐ Less than 1 hour
2 ☐ 1-3 hours
3 ☐ 3-5 hours
4 ☐ 5 hours or more

130. Does the child have a mobile phone of his/her own?

1 ☐ Yes
2 ☐ No

130a. If yes, how long does he/she use it every day on average (including making phone calls, texting, and playing?

1 ☐ Less than 30 minutes
2 ☐ 30 – 60 minutes
3 ☐ 1 – 2 hours
4 ☐ 2 – 3 hours
5 ☐ More than 3 hours

131. What time does the child typically get up? _____ (example: 7:00am)

132. What time does the child typically go to sleep? _____ (example: 11:00pm)

V. About You and Your Family

A. Urbanization

133. Did the child's mother grow up in Suzhou?

1 ☐ Yes
2 ☐ No

134. Did the child's father grow up in Suzhou?

1 ☐ Yes
2 ☐ No

135. Did any of the child's grandparents grow up in Suzhou?

1 ☐ Yes
2 ☐ No

136. Do both parents currently have Suzhou residency?

1 ☐ Yes
2 ☐ No

B. Family living with you

137. How many children, who have not yet turned 9, are permanently living at home (including the investigated one)?

1 ☐ 1 child
2 ☐ 2 children
3 ☐ 3 children
4 ☐ 4 or more children

138. How many children / adolescents, age 9 to 18, are permanently living at home?

1 ☐ None
2 ☐ 1 person
3 ☐ 2 persons
4 ☐ 3 persons
5 ☐ 4 or more persons

139. How many persons, above the age 18, are permanently living at home? (Include yourself)

1 ☐ 1 adult
2 ☐ 2 adults
3 ☐ 3 adults
4 ☐ 4 or more adults

C. Education, Work, & Social Ties

140. Education level of:

	Primary school	Junior middle school	Senior middle school	Bachelor	Masters	PhD
a. Mother	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
b. Father	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
c. *You/Yourself [*only answer if	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

person answering is not a parent]						

141. Occupation of:

	Agriculture	Industry	Commercial & business	Education	Service	Other (specify below)
a. Mother	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐ _____
b. Father	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐ _____
c. *Your/Yourself [*only answer if person answering is not a parent]	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐ _____

142. How many hours each week do you participate in any groups such as a social or work group, church-connected group, self-help group, charity, public service or community group?

1 ☐ None
2 ☐ 1 to 2 hours
3 ☐ 3 to 5 hours
4 ☐ 6-10 hours
5 ☐ 11-15 hours
6 ☐ 16 or more hours

143. How many close friends do you have?

1 ☐ None
2 ☐ 1 to 2
3 ☐ 3 to 5
4 ☐ 6-9
5 ☐ 10 or more

144. Can you count on anyone to provide you with emotional support (talking over problems or helping you make a difficult decision)?

1 ☐ None of the time
2 ☐ A little of the time
3 ☐ Some of the time
4 ☐ Most of the time
5 ☐ All of the time

145. What is your gender?

1 ☐ Female
2 ☐ Male

146. What is your current weight _____ Jin

147. What is your current height _____ cm

C. Your family's health

Questions concerning the health of the rest of the family

148. Do asthma or allergic problems exist in the family?

1 ☐ Yes
2 ☐ No (If NO, skip to 149)

1483a. If yes, which kind of problems and for whom?

	Asthma	Allergic nose or eye problems	Eczema
a. Biological mother	1 ☐	2 ☐	3 ☐
b. Biological father	1 ☐	2 ☐	3 ☐
c. Siblings	1 ☐	2 ☐	3 ☐
d. Grandparent	1 ☐	2 ☐	3 ☐

149. How many times have you had colds in your household the past year?

	None	1-2 times	3-4 times	5 or more times	Don't know/ does not apply
a. Mother	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. Father	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. Siblings (include any cold experienced by any sibling)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d. Grandparents or Primary caregiver	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

D. Your Health

150. During the last 3 months, have you had any (one or more) of the following symptoms? (Answer every question even if you have not had any symptoms!)

	During the last 3 months, have you had any (one or more) of the following symptoms?			**If YES**, do you believe it is due to your home environment?	
	Yes, often (every week)	Yes, sometimes	No, Never	Yes	No
a. Fatigue	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
b. Feeling heavy-headed	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
c. Headache	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
d. Nausea/dizziness	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
e. Difficulties concentrating	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
f. Itching, burning or irritation of the eyes	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
g. Itching, stuffy or runny nose	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
h. Hoarse, dry throat	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
i. Cough	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
j. Dry or flushed facial skin	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
k. Scaling/itching scalp or ears	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐
l. Hands dry, itching, red skin	1a. ☐	1b. ☐	2a ☐	1c ☐	2b ☐

151. In general, would you say your health is?

1 ☐ Excellent
2 ☐ Very good
3 ☐ Good
4 ☐ Fair
5 ☐ Poor

Questions concerning reactions to food

152. Have **you** ever had an allergic irritation to food , such as eczema, nettle-rash, diarrhoea, swollen lips or eyes?

1 ☐ Yes
2 ☐ No
3 ☐ Don't know

152a. If Yes, what foods are you allergic to?

1 ☐ Milk or dairy products

2 ☐ Eggs
3 ☐ Fish
4 ☐ Peanuts
5 ☐ Nuts, almond
6 ☐ Seafood, e.g. crab
7 ☐ Vegetables, e.g. tomatoes, carrots
8 ☐ Flour (wheat, barley, rye, oat)
9 ☐ Soya, peas, beans

153. Has any health professional ever told you that you had the following?

	Yes	No
a. High blood pressure	☐	☐
b. Heart disease	☐	☐
c. Diabetes	☐	☐
d. Cancer or any malignancy	☐	☐
e. Obesity	☐	☐
f. Overweight	☐	☐
g. Asthma	☐	☐

E. Respiratory Health

The following questions are about your chest. Please answer YES or NO if possible. If a question does not appear to be applicable to you, check the "does not apply" space. If you are unsure if your answer is yes or no, record no.

COUGH

154. Do you usually have a cough? (Count a cough with first smoke or on first going out-of-doors. Exclude clearing of throat.)

1 ☐ Yes
2 ☐ No (If NO, skip to Q154b)

154a. Do you usually cough as much as 4 to 6 times a day, 4 or more days out of the week?

1 ☐ Yes
2 ☐ No
3 ☐ Does not apply

154b. Do you usually cough at all on getting up, or first thing in the morning?

1 ☐ Yes
2 ☐ No

154c. Do you usually cough at all during the rest of the day or at night?

1 ☐ Yes
2 ☐ No

If NO to all the above, go to Q155
If YES to any of the above (154-154c), please answer the following:

154d. Do you usually cough like this on most days for 3 consecutive months or more during the year?

1 ☐ Yes
2 ☐ No
3 ☐ Does not apply

PHLEGM
155. Do you usually bring up phlegm from your chest? (Count phlegm with the first smoke or on first going out-of-doors. Exclude phlegm from the nose. Count swallowed phlegm.)

1 ☐ Yes
2 ☐ No (If NO, skip to Q155b)

155a. Do you usually bring up phlegm like this as much as twice a day, 4 or more days of the week?

1 ☐ Yes
2 ☐ No
3 ☐ Does not apply

155b. Do you usually bring up phlegm at all on getting up, or first thing in the morning?

1 ☐ Yes
2 ☐ No

155c. Do you usually bring up phlegm at all during the rest of the day or at night?

1 ☐ Yes
2 ☐ No

If NO to all the above, go to Q156.
If YES to any of the above (155-155c), please answer the following:

155d. Do you bring up phlegm like this on most days for 3 consecutive months or more during the year?

1 ☐ Yes
2 ☐ No

3 ☐ Does not apply

WHEEZING

156. Does your chest ever sound wheezy or whistling:

	Yes	No
a. When you have a cold?	1 ☐	2 ☐
b. Occasionally apart from colds?	1 ☐	2 ☐
c. Most days or nights?	1 ☐	2 ☐
d. On exercise or exertion?	1 ☐	2 ☐
e. When you are exposed to pollen?	1 ☐	2 ☐
f. When you are exposed to dust?	1 ☐	2 ☐

F. Sleep

157. What time do you typically get up? _____ (example: 7:00am)

158. What time do you typically go to sleep? _____ (example: 11:00pm)

159. How would you rate the quality of your sleep?

1 ☐ Very Good
2 ☐ Good
3 ☐ Fair
4 ☐ Poor
5 ☐ Very Poor

160. How rested or refreshed do you feel when you wake up for the day?

1 ☐ Very well-rested
2 ☐ Well-rested
3 ☐ Somewhat rested
4 ☐ Slightly rested
5 ☐ Not at all rested

161. In the last 30 days, have any conditions made it difficult for you to fall asleep?

1 ☐ Yes
2 ☐ No (If no, skip to Q162)

161a. If yes, check all that apply:

1 ☐ Too hot
2 ☐ Too cold
3 ☐ Too noisy
4 ☐ Too bright
5 ☐ None of the above

6 ☐ Other (please specify: _____)

162. In the last 30 days, have conditions disturbed your ability to sleep during the night?

1 ☐ Yes
2 ☐ No (If no, skip toQ163)

162a. If yes, check any conditions that apply:

1 ☐ Too hot
2 ☐ Too cold
3 ☐ Too noisy
4 ☐ Too bright
5 ☐ None of the above
6 ☐ Other (please specify: _____)

VI. About Your Neighborhood

A. Types of residences in your neighborhood

163. Do you currently live in a gated community?

1 ☐ Yes
2 ☐ No

164. How common are the following types of residences in your immediate neighborhood?

	None	A few	Some	Most	All
a. detached single-family residence	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. townhouses or row houses of 1-3 stories	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. apartments or condos of 1-6 stories	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d. apartments or condos of 7 or more stories	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

165. About how long would it take to get from your home to the nearest businesses or facilities listed below if you walked to them?

	Please check mark only one category for each business or facility in this section. **NEXT →**						166. Is each business/ facility listed below ALSO the one you use the most?
	1-5 min	6-10 min	11-20 min	20-30 min	30+ min	Don't know	
a. convenience/small grocery store	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
b. supermarket	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
c. fruit/vegetable market	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
d. mall/shopping center	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
e. the child's school	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
f. fast food restaurants	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
g. bank/credit union	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
h. non-fast food restaurants	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
i. pharmacy or drug store	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
j. your job or school **(check here ☐ if does not apply)**	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
k. bus or train stop	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
l. park	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
m. community center	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No
n. community health center	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	1 ☐ Yes 2 ☐ No

B. Access to services

167. Please place a check mark next to the answer that best applies to you and your neighborhood. Both local and within walking distance mean within a 10-15 minute walk from your home.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
a. Stores are within easy walking distance of my home.	1 ☐	2 ☐	3 ☐	4 ☐
b. Parking is difficult in local shopping areas.	1 ☐	2 ☐	3 ☐	4 ☐
c. There are many places to go within easy walking distance of my home.	1 ☐	2 ☐	3 ☐	4 ☐
d. It is easy to walk to a transit stop (bus, train) from my home.	1 ☐	2 ☐	3 ☐	4 ☐
e. The streets in my neighborhood are hilly, making my neighborhood difficult to walk in.	1 ☐	2 ☐	3 ☐	4 ☐
f. There are major barriers to walking in my local area that make it hard to get from place to place (for example: freeways, railway lines, rivers).	1 ☐	2 ☐	3 ☐	4 ☐

C. Streets in my neighborhood & Places for walking and cycling

168. Please place a check mark next to the answer that best applies to you and your neighborhood.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
a. The distance between intersections in my neighborhood is usually short (100 meters or less; about the length of a soccer field or less).	1 ☐	2 ☐	3 ☐	4 ☐
b. There are sidewalks on most of the streets in my neighborhood.	1 ☐	2 ☐	3 ☐	4 ☐

D. Neighborhood surroundings

169. Please place a check mark next to the answer that best applies to you and your neighborhood. Your neighborhood is defined as a 10-15 minute walk from your home.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
a. There are trees along the streets in my neighborhood.	1 ☐	2 ☐	3 ☐	4 ☐
b. There are many attractive natural sights in my neighborhood (such as landscaping and views).	1 ☐	2 ☐	3 ☐	4 ☐

VII. About Your Environment

A. Climate Change Perception

170. Are you aware of global climate change?

1 ☐ Yes
2 ☐ No

171. On a scale from -3 (very bad) to +3 (very good), do you think global warming is a bad thing or a good thing? Place a check mark in the box under your answer.

Very bad -3	-2	-1	+1	+2	+3	unaware of climate change	No answer

172. Which one of these statements describes your level of concern about climate change?

1 ☐ I am not worried about climate change
2 ☐ Climate change is a future concern for me.
3 ☐ Climate change is an immediate concern for me.

173. If you believe climate change is occurring, is it mostly human caused, or do you think it is due mostly to natural changes in the environment?

1 ☐ I believe that climate change is mostly human caused
2 ☐ I believe that climate change is mostly due to natural changes in the environment

B. Outdoor Air Pollution

174. How would you rate the quality of your outdoor air in your city?

1 ☐ Very bad
2 ☐ Poor

3 ☐ Good
4 ☐ Excellent

175. Have you ever felt physical irritation by outdoor air pollution in your city?

1 ☐ Almost always
2 ☐ Frequently
3 ☐ Occasionally
4 ☐ Rarely or never

176. Are there any street snack vendors near your home or neighbourhood?

1 ☐ Yes
2 ☐ No

C. Indoor Air Pollution

177. How would you rate the quality of the indoor air in your home?

1 ☐ Very bad
2 ☐ Poor
3 ☐ Good
4 ☐ Excellent

178. The quality of the air inside my home is better than the quality of the outdoor air.

1 ☐ Strongly disagree
2 ☐ Somewhat disagree
3 ☐ Somewhat agree
4 ☐ Strongly agree
5 ☐ Don't know/no opinion

D. Water Perception

179. What is the source of water at your home? (Check all that apply)

	Bottled water	Tap water (plain)	Tap water (boiled)	Tap water (filtered)	Ground water (wells)	Surface water (e.g. rivers, lakes) (untreated)	Other (specify)	Don't know
179a. Drinking	1 ☐	2 ☐	3 ☐	4 ☐	4 ☐	5 ☐	6 ☐ _____	7 ☐
179b. Cooking	1 ☐	2 ☐	3 ☐	4 ☐	4 ☐	5 ☐	6 ☐ _____	7 ☐

180. How easily can you get to water bodies (e.g. rivers, lakes, ponds, bays) for the following activities?

	Very easily	Easily	Somewhat easily	Not easily at all	Does not apply
a. Fishing	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. Swimming	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. Taking a walk	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d. Social gathering	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

181. How would you rate the overall water quality of water bodies (e.g. rivers, lakes, ponds, bays) in your neighborhood?

1 ☐ Very good
2 ☐ Good
3 ☐ Neither good nor bad
4 ☐ Bad
5 ☐ Very bad
6 ☐ I don't know
7 ☐ Does not apply

182. Does your access to water bodies (e.g. rivers, lakes, ponds, bays) improve your level of happiness?

1 ☐ Yes
2 ☐ No
3 ☐ Does not apply

E. Satisfaction with current living environment

183. Currently, how satisfied are you with your life as a whole? On a scale of 0 to 10 where 0 = not at all satisfied and 10 = very satisfied.

_____ (Please write in a number from the scale of 0-10)

184. Think about the last 12 months. Are you satisfied with the following domains of your life?

	strongly dissatisfied	somewhat dissatisfied	neither satisfied nor dissatisfied	somewhat satisfied	strongly satisfied
a. Leisure	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. Family relationships	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. Relationships with friends	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d. Your economic situation	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
e. The environment (air, water, noise, etc.) where you live	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
f. Your work	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
g. Your health in general	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

Below are things about your neighborhood with which you may or may not be satisfied.

185. How satisfied are you with…

	strongly dissatisfied	somewhat dissatisfied	neither satisfied nor dissatisfied	somewhat satisfied	strongly satisfied
a. highway access from home?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. access to public transportation in your neighborhood	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. your commuting time to school/work?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d. access to shopping in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
e. the friends you have in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
f. how easy and pleasant it is to walk in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
g. the crosswalks and pedestrian signals to help walkers cross busy streets in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
h. the amount of exhaust fumes when walking in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
i. how easy and pleasant it is to bicycle in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
j. access to entertainment in your neighborhood (restaurants, movies, clubs, etc.)?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
k. the safety from the threat of crime in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
l. the lighting of the streets in my neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
m. the amount of speed of traffic in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
n. the noise from traffic in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
o. the number of quality food stores in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

p. the number and quality of restaurants in your neighborhood?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
q. your neighborhood as a good place to raise children?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
r. your neighborhood as a good place to live?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
s. your access to financial institution or banks?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

VIII. Future Research

To further investigate the influence of indoor environment on a child's health, we may conduct future research. If you may be interested in participating in a future study, please share your contact information with us below.

This section is optional and does not have to be completed if you would not like future contact.

186. Mobile phone: _____

187. Home phone: _____

188. E-mail: _____

189. Any comments:

_____

_____

_____

Thank you for your participation!

Appendix B. Age-gender-adjusted and fully-adjusted ORs (95% CIs) of asthma and allergic outcomes associated with family not having Suzhou residency

Outcome	Basic	Full
Doctor-diagnosed asthma	0.28 (0.21 , 0.37)*	0.59 (0.41 , 0.84)*
Doctor-diagnosed pneumonia	0.32 (0.26 , 0.38)*	0.44 (0.34 , 0.57)*
Doctor-diagnosed rhinitis	0.32 (0.26 , 0.38)*	0.53 (0.41 , 0.69)*
Doctor-diagnosed eczema	0.30 (0.25 , 0.37)*	0.51 (0.38 , 0.67)*
Current wheeze	0.97 (0.65 , 1.42)	1.13 (0.64 , 1.92)
Ever wheeze	0.29 (0.22 , 0.36)*	0.54 (0.38 , 0.74)*
Current sneezing	0.60 (0.51 , 0.71)*	0.74 (0.58 , 0.94)*
Ever Sneezing	0.64 (0.56 , 0.73)*	0.71 (0.59 , 0.86)*
Current itchy rash	0.62 (0.48 , 0.79)*	0.64 (0.44 , 0.92)*
Ever itchy rash	0.43 (0.37 , 0.50)*	0.63 (0.50 , 0.77)*

Adjusted for children's gender, children's age, family asthma history, parental education level, environmental tobacco smoking at home, ownership status and interaction term between children's gender and age.

*: p-value <0.05