# RISK FACTORS ASSOCIATED WITH CURRENT ASTHMA AND WHEEZE IN SCHOOL CHILDREN ALONG AN URBAN-RURAL GRADIENT IN SASKATCHEWAN

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# Abstract

**Background:** The prevalence of childhood asthma varies geographically with a lower prevalence of asthma reported among rural compared to urban dwelling children. Although several explanations have been proposed, evidence is required to determine which of these explanations is most plausible. The purpose of this study was to identify the risk factors associated with current childhood asthma and wheeze and to determine which risk factors best explain the variations of asthma prevalence between urban and rural settings

**Methods:** In 2013, we conducted a cross-sectional survey of 3,420 school children (aged 5-14 years) from three regions of Saskatchewan representing a large urban, small urban, and rural area (Regina, Prince Albert and the rural area around Prince Albert, respectively). Self-reported questionnaires were used and information was collected on lung and general health, indoor environment, health behaviors, and socio-demographics.

**Results:** A lower prevalence of current asthma was observed in the rural area (11.5%) compared to the large urban (14.6%) and small urban areas (15.9%) but after adjustment for a large number of variables, this association was not statistically significant (OR=0.80, 95%CI=0.47-1.36). Risk factors for both current wheeze and current asthma included children with any allergy (OR=4.50, 95%CI=3.25-6.23; OR=5.00, 95%CI=3.53-7.01), parental history of asthma and allergies (OR=1.62, 95%CI=1.17-2.25; OR=2.21, 95%CI=1.56-3.12), home dampness (OR=1.91, 95%CI=1.27-2.87; OR=1.70, 95%CI=1.10-2.62), seafood consumption in the past 12 months (OR=1.64, 95%CI=1.17-2.29; OR=1.61, 95%CI=1.12-2.30). Age was a risk factor for current wheeze (OR=0.67, 95%CI=0.48-0.94) and sex showed an inverse association for current asthma (OR=0.70, 95%CI=0.50-0.99). The association between urban-rural status with current wheeze

and current asthma were affected by type of fuel used for heating the home and consumption of nuts in the past 12 months although true mediation was not seen. Significant effect modification between personal and environmental risk factors with geographical location was found for both current wheeze and current asthma.

**Conclusions:** The prevalence of asthma was lower among children living in rural areas. However, the association was not entirely consistent and mediation by various risk factors was not fully observed. Also, while there were some consistent associations with current asthma and wheeze, the association between some personal and environmental risk factors with asthma and wheeze were modified by geographic location.

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# Dedication

This dissertation is dedicated to:

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ii) My husband who supported me all the way a long journey during my study period.

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# Chapter 1: Introduction

## 1.1 Background

Asthma has emerged as an important contributor to morbidity worldwide including in Canada. In recent decades, the prevalence of asthma has risen in many countries (1). This increased trend of asthma prevalence has also been observed in Canada over the last 20 years (2). Although the etiology of asthma has not been well-established, the potential risk factors associated with asthma are age, gender, genetic (inherited), indoor and outdoor environmental triggers, predisposing conditions such as atopy, and the indoor environment. It is one of the most common chronic diseases among children (3,4) and it has a large impact on society. The prevalence of childhood asthma varies geographically and a lower prevalence of asthma has been reported among rural compared to urban dwelling children but the reasons for this remain uncertain. (5). Differences in access to health care utilization, geographical variations in exposure to environmental factors, differences in individual health practices, and personal factors could play a role in explaining the differences across an urban-rural gradient among pediatric populations. However, there are few studies available to determine what could explain the geographic variations of childhood asthma (5).

## 1.2 Rationale

Asthma is a chronic respiratory condition that is one of the most common diseases among pediatric populations (3,4). Many previous studies have observed that children in rural environments report a lower prevalence of asthma and asthma-like symptoms (wheeze) compared to urban children (6–8). Although several explanations have been proposed to explain

this phenomenon, evidence is required to prove which of these explanations is most plausible. Limitations of previous studies investigating this problem include how characteristics of geographic variability. Lack of geographic variability means that sometimes rural farm and non-farm populations are exposed to similar risk factors i.e. children living in town may have been regularly exposed to allergens and irritants commonly experienced in children who living on farms and so comparison to other areas is warranted. My study will help advance the current state of knowledge by providing evidence around the etiology of asthma along an urban-rural gradient in Saskatchewan.

## 1.3 Objectives and research questions

The main objective of this thesis was to identify the risk factors associated with childhood asthma and to determine which risk factors best explain the variations of asthma prevalence between urban and rural settings in Saskatchewan. More specifically, the specific research questions were:

1. *What are the risk factors associated with the prevalence of current asthma and wheeze in pediatric populations in Saskatchewan and specifically, is location of residence associated with asthma and wheeze after adjustment for confounders?*

2. *Which risk factors best explain the variations of current asthma and wheeze prevalence in Saskatchewan?*
3. *Are the risk factors of current asthma and wheeze, as identified in Research question #1, modified by area of residence?*

This thesis is based on data collected from a previous study. The original study was cross-sectional and conducted to look at the differences in the prevalence of childhood conditions, with a focus on respiratory health, across an urban-rural gradient. The research questions for this thesis were developed to help more fully investigate those of the original study by conducting a more thorough assessment of risk factors for asthma and wheeze.

## 1.4 Thesis organization and outline

The main purpose of this thesis was to identify the risk factors associated with childhood asthma and to examine the variations of asthma prevalence between urban and rural settings. This thesis followed a traditional style approach and explored which risk factors may explain the differences in observed asthma prevalence among pediatric populations in three regions representing a large urban, small urban, and rural area (Regina, Prince Albert and the rural area around Prince Albert, respectively) of Saskatchewan.

This thesis involved a number of different experiences consistent with the aims of a Master's thesis in the field of epidemiology. This included: design of hypothesis, preparation of a literature review, data cleaning, data management, planning and completion of the analysis, presentation and interpretation of results, and traditional thesis preparation and submission for the requirements of my degree.

A literature review is presented in Chapter 2. It describes asthma and its burden, the prevalence of asthma, the risk factors associated with childhood asthma and wheeze, and evidence for four explanations that may underlie geographic variations in asthma prevalence among pediatric populations. Chapter 3 describes the methodology of the thesis. Chapter 4

describes the main results of the analysis. Chapter 5 summarizes the key findings of the results in the context of the literature review and highlighted areas of future work.

# Chapter 2: Literature Review

## 2.1 Scope of literature review

The aim of this literature review was to discuss the previous literature that has described the risk factors associated with asthma and wheeze among children. In addition, how these risk factors influence the geographic variations in the prevalence of asthma, especially those at school age. The main geographic differences under study are urban and rural dwellers as well as children from farming and non-farming homes. This literature review will also discuss existing explanations that may account for the variations in asthma outcome prevalence by location of residence.

## 2.2 Methodology of the literature review

The literature review was started in December 2013 and included articles up to September 2018. Some common search engines were used including Pubmed and Google Scholar at the University of Saskatchewan's University Library. Also, additional relevant scientific articles were considered if they appeared in the reference section of a reviewed article. A filter used in the search limited the articles to those published after the year of 1990 and available in English. Research terms included combinations of the words "asthma", "wheeze", "pediatric", "risk factors", "school age children", "urban-rural", "farming exposure", "access to health care", "prevalence", and combinations of these.

## 2.3 Rural living and farming in Canada and Saskatchewan

In 2016, the total population of Canada was over 35 million and the rural population was

over 6 million, which was 19% of the total population (9). Among the total population, the largest proportions living in rural area were in the Atlantic provinces (44.9%) with Saskatchewan (32.8%) being the second largest (10). People who live in rural area may also live on farms. In the same time period, 9.5% of the total rural Canadian population lived on rural farms with the largest proportion being in Saskatchewan (27.8%) and the smallest in the Atlantic provinces (2.4%) (10). According to the 2016 Census of Agriculture, the total number of farms in Canada had decreased 5.9% from 2011 (205,730) to 2016 (193,492) and this rate of decline was the lowest in the last 20 years (11,12). Despite the number of farms decreasing in Canada, the average land per farm has increased from 2011 (779 acres) to 2016 (820 acres) (11). According to the 2016 Census of Agriculture, the total number of farms had decreased 6.6% in the province of Saskatchewan compared to the 2011 census (16.6%) (13).

The largest proportion of Canadian farms were field crop farms (39.8%) followed by beef cattle farms (26.6%) (14). In 2016, Saskatchewan was the largest crop-producing province in Canada representing more than two-fifths (46.8%) of the national total field crop acreage which was more than Alberta (26.8%) and Manitoba (12.7%) combined (13). Although cattle farming had decreased by 2.1% from the 2011 census, Saskatchewan continued to report the second largest cattle herds in Canada after Alberta (13).

A significant proportion (19%) of Canadians live in rural area making rural health an important field to study. According to The Rural Health and Northern Health Research Initiative (2004), the study of rural population health was also a national research priority (15,16). In addition, research focused on rural pediatric health, specifically respiratory health, is an important area to improve rural dwellers' health and identify the risk factors of those who are

exposed to farming environments.

## 2.4 Symptoms and natural history of asthma and wheeze

"Asthma is a chronic inflammatory disorder of the airways associated with airway hyperresponsiveness which is characterized by episodes of wheezing, shortness of breath, chest tightness, and coughing, particularly at night or in the early morning" (17). Triggering factors for asthma includes exposure to allergens and irritants (fumes, gases), exercise, viral respiratory infections such as cold (18). Understanding of the natural history of asthma is complex due to its heterogeneity (19). Children who have asthma symptoms such as wheeze in their early life may increase the possibility of asthma later in life (20,21). Many studies have examined the natural history of asthma and wheeze and identified several phenotypes. Based on analysis of data from a population-based Tucson birth cohort study in Arizona, USA, wheeze during the first 6 years of life could be categorized into never wheeze (51.5%), transient early wheezing {(19.9%) where symptoms began during the first 3 years of life and disappeared at 6 years of age}, persistent wheeze {(15%) where symptoms began during the first 3 years of life and continued at 6 years of age}, and late-onset wheeze {(13.7%) where symptoms began after the age of 3 years and continued at 6 years of age) (20,22). The majority of the children with transient early wheezing had diminished lung function and did not have an increased risk of asthma and allergies later in life (20). Children with persistent wheezing were associated with lower lung function and more likely to have asthma later in life (20,21,23). The researchers found that 23% of children with late onset wheezing and 46% of children with persistent wheezing had been given a diagnosis of asthma by the age of 6 years (20).

Asthma consists of several other phenotypes (20,24,25). Based on the presence or absence of skin prick tests to common allergens or specific IgE antibodies against common allergens, the most commonly identified asthma phenotypes include allergic (atopic) and non-allergic (non-atopic) asthma (24–26). Allergic asthma often begins in childhood and is associated with a past and/or family history of allergic diseases including eczema, allergic rhinitis, or food or drug allergy and non-allergic asthma is defined as those who have asthma that is not associated with allergy (27–29). Although a personal history of allergic rhinitis or eczema, or a family history of asthma or allergy increases the possibility of developing asthma, not all children with these features are atopic and most children with atopy do not develop asthma (25,27).

## 2.5 Asthma and its burden

Asthma is a chronic health condition affecting a considerable proportion of children and adults worldwide (18). Asthma contributes to a societal burden accounting for a high proportion of hospitalization, visiting emergency rooms, and having multiple physician visit each year (18). According to results from the National Population Health Survey (NPHS), 43% of people with asthma made an unscheduled visit to their physicians for asthma and 18% of patients with asthma visited the emergency department in the previous 12 months (18). Ten percent of total hospital admissions for children in the age group of 5 to 14 years were due to asthma (18). Asthma can also result in activity limitation, school absenteeism, and in rare cases death (18,30).

Asthma conveys a large impact on health care utilization and the economic burden of the disease is also very high in Canada. Direct costs include respiratory-related visits to healthcare providers, emergency rooms, hospital admissions, pulmonary function tests, prescription

medications, devices, and out-of-pocket expenses; indirect costs were parents' absences from work/usual activities and travel and waiting time (31). In a prospective study of asthma costs in children from Ontario, Unger et al found that hospital admissions due to asthma were the highest component of total costs (43%), followed by medications (31%), and parent productivity losses (12%) (31). This was confirmed in a systematic review of the economic impact of asthma where it was found that the high direct costs were due to hospitalizations and medications; and high indirect costs were due to work absenteeism (32). In a cohort study of British Columbia, asthma related direct health care costs were over $41 million annually and $331 per patient-year (33). Medication costs contributed to a major part (63.9%) of the total direct costs followed by physician visits (18.3%) and hospitalizations /emergency visits (17.8%) (33). From a systematic review, the researchers found high economic burden on asthma where direct costs were $366 to $647 per patient annually and the annual population-level costs were $46 million in British Columbia and $141 million in Ontario (34). The estimated total costs of asthma in Canada were $2.1 billion annually including direct costs (hospitalization, healthcare professional services and medication) and indirect costs (decreased productivity) (35).

## 2.6 Prevalence of asthma

Worldwide, 300 million people are affected by asthma with an increasing prevalence of childhood asthma (32,36,37). 'Western lifestyle' and urbanization have been suggested as reasons for increasing asthma prevalence in developed countries compared to developing countries (38). International studies have been conducted to examine the prevalence of childhood asthma. The International Study of Asthma and Allergies in Childhood (ISAAC) Phase 1 was conducted to assess the worldwide prevalence of asthma symptoms in 155 centres in 56 countries

among children aged 13-14 years and in 91 centres in 38 countries among children aged 6-7 years old (39). Low prevalence rates (2%–4%) of childhood asthma have been observed in Asian countries (especially China and India) and high prevalence rates (15%–20%) in the United Kingdom, Canada, Australia, New Zealand and other developed countries (36,40,41). In Phase 3 of the ISAAC study, Phase 1 was repeated with the two age groups of school children, aged 6-7 years from 66 centres in 37 countries and aged 13-14 years from 106 centres in 56 countries to examine changes of asthma prevalence over time. The results of this study showed that in the younger age group (6-7 years), the prevalence of asthma symptoms changed by 1 standard error (SE) or more in most centres (59%); of the 39 centres with changes, the prevalence increased in 25 and decreased in 14 centres (36). In addition, in the older age group (13-14 years), the prevalence of asthma symptoms changed by 1 SE or more in most centres (77%); of the 82 centres with changes, almost equal numbers of centres showed an increase (42) and decrease (40) in asthma prevalence (36). Therefore, the rise in prevalence of asthma symptoms in the younger age group in many centres is concerning, though changes in the older age group do not appear to show as consistent a pattern.

In Canada, approximately 13% of children have been diagnosed with asthma (37). In an earlier study (1988), Dales et al examined asthma prevalence among children aged 5 to 8 years old in several regions across Canada (42). They found that the overall prevalence of current asthma in Canada was 4.7% (unadjusted) with the highest prevalence (7.4%, unadjusted) in the Maritimes and the lowest prevalence (2.3%, unadjusted) in British Columbia (42). In Ontario, a population-based cohort study was conducted to estimate asthma prevalence from 1996 to 2005 both in children and adults. The age- and sex-standardized asthma prevalence increased from 8.5% in 1996 to 13.3% in 2005, a relative increase of 55.1% ($P < 0.0001$) (43).

In Saskatchewan, during the ten year period from 2001/2002 to 2010/2011, the overall prevalence of asthma among children and adolescents has increased by 3969 cases per year to a total more than 113,000 cases (44). Among children in the age groups 5-9 years and 10-14 years, asthma prevalence was 16% and 21%, respectively (44). In both age groups, asthma prevalence was more pronounced in males than in females (18.9% vs. 13% for 5-9 years old and 24.1% vs. 16.7% for 10-14 years old) (44). In a previous cross sectional study of Saskatchewan, researchers found that the prevalence of asthma has increased in children and adults from 1981 to1990, and the prevalence was higher in the pediatric population compared to the adult population (45). An higher asthma prevalence was also observed in school-going children aged 5 to 14 years between 1991 and 1995 but began to stabilize or decrease between 1996 and 1998 (46). During the study period, the researchers found similar or lower asthma prevalence among the rural populations in comparison to the rates for the urban populations in all age groups. Differences in the distribution of asthma prevalence have been found within regions. In a study of 2 Saskatchewan communities in 2000, Rennie et al found that in Estevan, the asthma prevalence in children in grades 1 to 6 was higher compared to asthma prevalence in Swift Current (21.4% and 16.2% respectively) (47).

## 2.7 Risk factors for pediatric asthma

Numerous risk factors associated with childhood asthma have been identified. The risk factors can be categorized into personal factors such as age, sex, ethnic background, family history of asthma and allergy; environmental factors such as environmental tobacco smoking, home dampness or mould, house dust mite, pets and heating mechanisms; behavioural factors such as diet, physical activity and screen time.

Personal factors are well established as important risk factors for pediatric asthma. Age and sex are considered important personal risk factors. Several previous studies consistently found that the prevalence of asthma is higher in pediatric populations than adult groups (45,48). Boys are more often diagnosed with asthma than girls in early life but the opposite trend is observed in adult life (18,46,49). A genetic component is one of the most important contributing factors of childhood asthma. It is well known that asthma and atopy are associated with a family history of asthma or allergy (50). Many studies have investigated the influence of genetic effects on the development of asthma and allergic susceptibility in offspring (51).

Due to industrialization, people spend much of their leisure time at home. For this reason, the investigators have focused their research on indoor environmental factors in relation to asthma, with some inconsistent findings. Environmental tobacco smoking is one of the risk factors with more consistent results. It is an established risk factor for pediatric asthma and has a great effect on respiratory health (5,52,53). According to the World Health Organization (WHO), approximately half of the children in the world are exposed to ETS, mostly in their homes (54,55). Maternal smoking, specifically, is an important risk factor associated with asthma and wheeze, particularly in primary school children. In 1990, in a previous study of the United States, Weitzman et al. observed a positive association of maternal smoking with higher rates of asthma; children whose mothers used to smoke were two times more likely to have asthma and were at four times increased likelihood to use asthma medications in their earlier life than those mothers who did not smoke (56). High exposures to indoor environments such as pets, dust mites, cockroach, mouse, fungi (mold) and bacteria (endotoxin) have been identified as potential risk factors to develop asthma(18,57,58).Some studies reported that endotoxin may act as a protective factor for asthma and asthma like symptoms in children.

Although more controversial, a large number of studies have reported a positive association between asthma and obesity including lack of physical activity (59,60). Inconsistent findings have been reported in some studies of diet in relation to asthma and wheeze. Some foods rich in antioxidants, omega-3 fatty acids, and dietary fibres (fruits, vegetables, rice, fish, pulses, cereals, potatoes), appear to be protective (38). while other kinds of food common in modern lifestyle such as fast food may aggravate the risk of asthma or wheeze (61–65).

## 2.8 Geographical variation (urban-rural) of asthma

### 2.8.1 Prevalence of asthma and wheeze among children in urban-rural settings

Many epidemiological studies have shown that children who grow up on farms have a lower prevalence of asthma despite higher exposure to pollen and other common allergens (66). Some recent studies also found that children dwelling in a farming environment have protective effects on asthma and wheeze (38,67,68). Very few studies were located that examined a rural urban gradient. **Table 2.1** summarizes several studies conducted in North America and Europe examining the prevalence of asthma and wheeze among children living in urban vs. rural vs. farm settings. Most of the studies were cross sectional in design.

In Canada, from a recent cross-sectional survey, Lawson et al. found a lower risk of asthma among school children in rural area compared to urban children (69). In the WHO sponsored Health Behavior in School-Aged Children (HBSC) study, Lawson et al found the lower prevalence of asthma among young people (grades 6-10) in rural regions (14.8%) compared to metro (17.7%) and non-metro-adjacent (15.6%) regions (5). In this study, the lower risk of asthma was associated with rural region (adjusted odd ratio OR = 0.76, 95% CI = 0.61-0.95) and living in non-metro-adjacent regions (adjusted OR = 0.81, 95% CI =0.65-1.01) (5). As

the HBSC survey was designed to provide information about health and health behaviors of youth not specifically for respiratory disease, this study was unable to assess other existing hypotheses such as environmental factors and health care access through which the relationship between geographic regions and asthma was operating.

There were several studies that examined rural/non-rural differences in asthma prevalence. In a recent study of rural Saskatchewan, Barry et al found that asthma and wheeze prevalence were not significantly different between farm and rural small town area (current asthma: 16% vs. 13% respectively; current wheeze: 27% vs. 21% respectively) (70). The reason this study failed to find differences in childhood asthma between farm and small town status might be due to the similar characteristics of populations and lack of geographic variability between groups. The protective effect of living in a farming environment has also been observed for the incidence of asthma in both children with or without parental history of asthma in a longitudinal survey across Canada conducted over a period of 2 years (68). In this survey, the researchers found that children living on farms had a lower incidence of asthma compared to rural non-farming children (OR = 0.39, 95% CI = 0.24-0.65) (68). Children living on farms with livestock had a lower prevalence of asthma. Dimich-Ward et al found that in British Columbia among 4-H club youth (aged 8-20 years), those living on farms with livestock were at a reduced risk of having asthma (OR = 0.49, 95% CI = 0.27-0.89) or wheeze (OR = 0.74 (95% CI: 0.41-1.33) compared with members living in a rural area without livestock (66). Within the United States, in a large population based survey conducted solely in a rural context among school children, Adler et al found a lower prevalence of asthma and wheeze among farm reared children compared to rural non-farm children (asthma: 22% vs. 26% respectively; wheeze: 28% vs. 34% respectively) (71). This is the first large cross sectional study of asthma prevalence among a non-

urban population in the US but this study did not address several important factors such as parental allergic disease, housing conditions, heating fuels, dietary factors, or socioeconomic status that have been found in many previous studies to affect the prevalence of asthma (71). In a study of rural Iowa school children, Chrischilles et al found that farm children were less likely to have physician diagnosed asthma (OR = 0.80, 95% CI: 0.61-1.06) and current wheeze (OR = 0.77, 95% CI: 0.69-0.98) compared to town children (72). In Iowa state, as a whole, 87% of the land mass is farmland. Therefore, many farm and non-farm children have been exposed to similar allergens and irritants. In a recent study in the Republic of Macedonia, Vlaski et al found a lower prevalence of current wheeze and ever-diagnosed asthma in rural compared to urban dwelling adolescents (4.9% vs. 7.2% and 1.2% vs. 1.9% respectively) but the associations were not statistically significant (wheeze: OR = 0.74, 95% CI: 0.46-1.21; asthma: OR = 0.97, 95% CI: 0.38-2.46) (38). An issue with this study is that under-diagnosis of asthma was highly suspected. In a study of rural Austria, findings suggested that children who lived on farms had a lower prevalence of asthma (1.1% vs. 3.9%), and a lower prevalence of positive skin prick reactions (18.8 vs. 32.7%) compared to children from an urban environment (73). An objective measure of allergic disease (I.e. skin prick test including standardized questionnaire) was used in this study among children aged 8-10 years old. Children who lived on a farm had a lower prevalence of asthma and a lower prevalence of positive skin prick reactions may be due to selection bias because this study did not rule out whether atopic children or atopic parents have been leaving the farms for generations leading to a protective mechanism of farming environment.

**Table 2.1: Difference between urban-rural residences of asthma and wheeze prevalence among children**

| Lead author (Year published) | Place/ Country | Study population (n = Sample size) | Study design | Major findings (OR; 95% CI) | Comment/Summary |
|---|---|---|---|---|---|
| Lawson et al. (2017) (69) | Saskatchewan, Canada | 5-14 years<br><br>(n = 3509) | Cross-sectional | Rural vs. urban:<br><br>Ever asthma: 15.1% vs. 20.7% (p = 0.003); OR = 0.57 (95% CI: 0.44-0.75)<br><br>Current asthma: 10.9% vs. 14.9% (p = 0.03); OR = 0.58 (95% CI: 0.42-0.99)<br><br>Ever wheeze: 27.4% vs. 27.2% (p = 0.16); OR = 2.93 (95% CI: 1.25-6.86)<br><br>Current wheeze: 13.1% vs. 14.0% (p = 0.83); OR = 1.25 (95% CI: 0.74-2.10) | Data were collected from proxy (parents/guardians) completed questionnaire which can cause recall bias. However, this survey was conducted during Spring when outdoor allergens such as pollens and seasonal allergies (hay fever) were most common that can cause asthma symptoms. Therefore, in the questionnaire participants reported asthma symptoms more accurately than recall in the past 12 months when seasonal exposures and asthma symptoms were low. |

| Lead author (Year published) | Place/ Country | Study population (n = Sample size) | Study design | Major findings (OR; 95% CI) | Comment/Summary |
|---|---|---|---|---|---|
| Vlaski et al. (2014) (38) | Republic of Macedonia (8 cities and adjacent villages) | 12-16 years<br>(n = 5,507) | Cross sectional | Rural vs. urban living:<br>Asthma:1.2% vs. 1.9% (p = 0.26); OR = 0.97 (95% CI: 0.38-2.46)<br>Wheeze: 4.9% vs. 7.2% (p = 0.03); OR = 0.74, (95% CI: 0.46-1.21) | Under-diagnosis of asthma and a lack of information if the urban respondents had a previous rural dwelling experience might be the reason to report lower prevalence of asthma in this study among rural dwelling young adolescents in Macedonia. |
| Barry et al. (2012) (70) | Saskatchewan, Canada | 6-13 years<br>(n = 842) | Cross sectional | Farm vs. small town:<br>Ever asthma: 20% vs. 19% (p = 0.94)<br>Current asthma: 16% vs. 13% (p = 0.48)<br>Ever wheeze: 30% vs. 28% (p = 0.74)<br>Current wheeze: 27% vs. 21% (p = 0.28) | This study failed to find differences in childhood asthma by farm and small town status might be due to the population and area size of Estevan are relatively small compared a more urban centre and lack of geographic variability between groups. |
| Lawson et al. (2011) (5) | Canadian component of | 11-15 years | Cross sectional | Rural vs. non-metro-adjacent vs. metro | As HBSC survey was designed to provide information about |

| Lead author (Year published) | Place/ Country | Study population (n = Sample size) | Study design | Major findings (OR; 95% CI) | Comment/Summary |
|---|---|---|---|---|---|
| | the 2001-02 Health Behavior in School-Aged Children (HBSC) | (n = 4,726) | | living:<br><br>Asthma: 14.8% vs. 15.6% vs. 17.7% (p = 0.04); OR = 0.76 (95% CI: (0.61-0.95) and OR = 0.81 (95% CI: 0.65-1.01) Metro reference category) | health and health behaviors of youth not specifically for respiratory disease, this study was unable to assess other existing hypothesis such as environmental factors and health care access facility through the relationship between geographic regions and asthma operating. |
| Midodzi et al. (2007) (68) | Canada across all ten provinces (excluding territories) | 0-11 years<br><br>(n = 13524) | Cohort study | Farming vs. rural non-farming vs. non-rural:<br><br>Asthma: cumulative incidence of asthma: 2.3% vs. 5.3% vs. 5.7%; OR = 0.39 (95% CI: 0.24-0.65) | In this study, children living on a farm had a reduced risk of asthma compared to rural non-farming children may be due to selection bias because interviewers made subjective judgement regarding location of residence (farming vs. rural non-farming). Another possibility might be children remained in the same dwelling centres during follow up. |
| Dimich-Ward et al. (2006) (66) | British Columbia, Canada | 8-20 years<br><br>(n = 1158) | Cross sectional | Farm vs. rural with livestock vs. rural without livestock vs. urban:<br><br>Ever asthma: 12% | Children living on farms with livestock had lower prevalence of asthma might be due to recall bias particularly for those who retrospectively assessed exposures before age 2 and |

| Lead author (Year published) | Place/ Country | Study population (n = Sample size) | Study design | Major findings (OR; 95% CI) | Comment/Summary |
|---|---|---|---|---|---|
| | | | | vs. 15.7% vs. 21.6% vs. 18.1%; OR = 0.49 (95% CI: 0.27-0.89)<br><br>Wheeze (past year): 12.6% vs. 15.4% vs. 19.7% vs. 14.6%; OR = 0.74 (95% CI: 0.41-1.33) | another reason might be designation of location of residence based on participants' interpretation without written definition. |
| Adler et al. (2005) (71) | United States (Wisconsin) | Kindergarten to grade 12th<br><br>(n = 4152) | Cross sectional | Farming vs. non-farming:<br><br>Asthma: 22% vs. 26% (p = <.002)<br><br>Wheeze: 28% vs. 34% (p = <.300); OR = 0.08 (95% CI: 0.66-0.98) | This is the first large cross sectional study of asthma prevalence among a non-urban population in the US but this study did not address several important factors such as parental allergic disease, housing conditions, heating fuels, dietary factors, or socioeconomic status that have been found in many previous studies to affect the prevalence of asthma. |
| Chrischillies et al. (2004) (72) | United States (Two rural counties in Iowa) | 6-14 years<br><br>(n = 3090) | Cross sectional | Farming vs. non-farming:<br><br>Asthma: OR = 0.80 (95% CI: 0.61-1.06); | In Iowa state, as a whole, 87% of the land mass is farmland. Therefore, many farm and non-farm children have been exposed to similar allergens and |

| Lead author (Year published) | Place/ Country | Study population (n = Sample size) | Study design | Major findings (OR; 95% CI) | Comment/Summary |
|---|---|---|---|---|---|
| | | | | wheeze: OR = 0.77 (95% CI: 0.69-0.98) | irritants. |
| Riedler et al. (2000) (73) | Austria (rural area) | 8-10 years<br>(n = 2283) | Cross sectional | Farm vs. non-farm: Asthma:<br>1.1% vs. 3.9%; positive skin prick reaction: 18.8 vs. 32.7% | Children who live on farm have a lower prevalence of asthma and a lower prevalence of positive skin prick reactions may be due to selection bias because this study didn't rule out whether atopic children or atopic parents have been leaving the farms for generations and protective mechanism of farming environment. |

As observed in Table 2.1, the prevalence of asthma among children differs depending on the location of their home. Most of the studies in this table show a lower prevalence of asthma in rural children compared to urban children. However, Lawson et al. found that symptoms suggestive of asthma, among those with asthma, were higher among children living in rural area compared to urban children (69). He found 24.8% of rural children with asthma had severe asthma symptoms (>3 episodes of wheeze in the past 12 months) compared to 12.3% of urban children with asthma. Multiple factors can explain the variations in asthma prevalence along an urban-rural gradient and are described in the section below (69).

## 2.8.2 Explanations for Differences by Location of Residence

The common notion is that urban residence has become a recognized risk factor for asthma prevalence. Although the exact etiology of asthma prevalence by place of residence remains unknown. 'Western lifestyle' and urbanization could help explain the observed global geographic variations (38,74). There are several potential explanations that might account for the lower rates of childhood asthma observed in rural populations compared to urban area. The possible theories that underpin the variations in asthma prevalence observed between urban and rural populations include: (1) Personal factors, (2) Environmental exposures, (3) Diet and health risk behaviors, and (4) Health care access indicators (70,75).

### *2.8.2.1 Personal risk factors explanation*

It is well documented that a family history of asthma and personal history of allergy are strongly associated with childhood asthma (18,51,68). Therefore, variations in personal factors between urban and rural children may explain the observed differences of asthma prevalence.

For example, children who live on farms may be less likely to have parents with asthma because parents with asthma were more likely to move away from the farm environment in order to decrease symptoms. In a Canada wide population based study of the Canadian National Longitudinal Survey of Children and Youth (NLSCY), the researchers found that living in a farming environment was protective for asthma in both children with or without parental history of asthma (68). In contrast, children living in urban area were more susceptible to develop asthma, but only among those children who have a family history of asthma (68). A lower prevalence of asthma has been observed among farm reared younger children compared to adolescents (71). Early exposure to the farming environment during the first 5 years, but not later, was associated with decreased rates of ever asthma (71). In a recent study of Saskatchewan, Barry et al found a similar association of childhood asthma among children with a positive family history of asthma and personal history of allergy between groups of children who live in farm versus small town residential settings (75). A limitation to this previous study is that these findings may be due to lack of geographic variability e.g. children living in town may have been regularly exposed to similar allergens and irritants as children living on farms (70,75).

#### *2.8.2.2 Environmental risk factors explanation*

The environment has been the most common mechanism used to explain the relationship between geographic region and childhood asthma (5). Variations in environmental exposures may alter the human immune system that responds inappropriately to innoxious substances, this is called the hygiene hypothesis (76)**.** The hygiene hypothesis postulates that early exposure to bacterial and viral pathogens during the first year of life influence the body's immune system and results in lower risk of allergy and other allergic diseases such as asthma (76). Children growing up on a farm are more likely to be exposed to a wider range of microbial agent such as

endotoxin early in life compared to children who live in urban areas (77)**.** Endotoxins are cell wall components of the outer membrane of gram-negative bacteria and consist of a family of molecules called lipopolysaccharides (LPS) (78,79). Early childhood infections and exposure to bacterial products such as endotoxin in homes and on farms may increase production of T helper type 1 cells, and decrease production of T helper type 2 cells involved in allergy (79,80). In many epidemiological studies, inconsistent findings have been reported on the role of endotoxin, related to the presence of pets at home and in farm environment. Early exposures to endotoxin among farm dwellers are thought to have a protective role on asthma in young children, although there is a reported increased risk of asthma severity and wheeze in school children associated with endotoxin (38,81,82).

Exposure to environmental tobacco smoking is a well-known risk factor associated with childhood asthma (52,53,83). In a previous study, Martinez et al found that children who wheezed early in life and continued at the age of 6 years were more likely to have mothers who smoked (20). In a cross sectional study from Saskatchewan, the association between environmental tobacco smoking from mother and asthma differed two regions, with no association in Swift Current while there was an inverse association found in Estevan (84). Also, in another cross sectional study from Saskatchewan, Lawson et al. did not find any positive association between current asthma and parental smoking while there was a positive association observed between current asthma and exposure to best friend's smoking (OR=1.77, $p<0.01$) (5). Inconsistent findings from these studies suggesting that parents were trying to quit smoking to reduce the risk factors associated with asthma (85).

Living in a home that is damp has increased the chance of negative respiratory health

outcomes such as wheeze and asthma (75,84,86,87)**.** Mold or dampness in the home or some farm specific environmental risk factors for asthma and wheeze, including both farm activities (feeding livestock, filling grain bins, cleaning or playing in the barn and in pens, riding horses), and farm type (living on a grain and livestock farm) may be the reason to explain the differences of childhood asthma by urban-rural status. Children living on farms were more likely to have homes with dampness (32.0% vs. 24.6%, $p < 0.001$), and mold or mildew (24.0% vs. 15.6%, $p < 0.001$) than those children living in town (75). In a study of pediatric asthma of rural Saskatchewan, Barry et al found an inverse association among cleaning or playing in the barn and pens, riding horses, filling grain bins, and living on a grain farms with ever asthma in children(75). Also, cleaning or playing in pens and living on a livestock farm tended to be protective for current asthma (75). In contrast, feeding livestock was identified as a risk factor for wheeze while filling grain bins was associated with decreased presence of ever wheeze (75). Therefore, it is possible that some of these environmental factors might contribute to make differences in asthma prevalence among pediatric populations along an urban-rural gradient in Saskatchewan.

#### *2.8.2.3 Diet and health risk behavior explanation*

Less physical activity and sedentary lifestyles such as television viewing, are associated with obesity and the latter with asthma, indeed there are complex relationships that have been reported between each of them and asthma (5,38,88). In a study of 'Health Behavior in School-aged Children', Bruner et al. examined the variations in overweight and obesity by urban-rural geographic status, and they found that rural Canadian adolescents are more likely to be obese than urban adolescents (OR = 1.56, 95% CI: 0.95 to 2.57 for rural regions) (85). Physically active children can be more likely to be diagnosed with asthma because active children exert

themselves enough to have shortness of breath, prompting the child to visit a physician (5,89). Different patterns have been observed between diet and urban-rural children with some associations seen with asthma and wheeze. (38). Rural dwellers usually rely more on locally produced fresh foods and are less likely to eat processed foods or fast foods compared to urban dwellers (65). Due to the modern life style, changes have been observed where there has been a decreased consumption of fresh fruits, vegetables, fish and milk, as well as an increased intake of fast foods rich in fats (65). If there have been changed in diet, this led to differences in urban-rural gradient of asthma may be associated with the changes in food habits. To support this, in a cross-sectional study from the Republic of Macedonia, Vlaski et al found that the association between urban-rural status and current wheeze or asthma was mediated by diet (38). However, in an earlier Canadian study, Lawson et al found that the association between asthma and an urban-rural geographic status was not mediated by health behaviors or obesity (5).

#### *2.8.2.4 Health care access explanation*

The lower prevalence of asthma observed in rural area may be due to under diagnosis of asthma (90,91) or under-presentation of rural children to a physician. Rural patients have increased difficulty obtaining health care in general and may receive improper management for asthma (91). In a study of rural Iowa school children, less than half of children with frequent symptoms, and less than three-quarters of children with severe symptoms of asthma reported ever diagnosis of asthma by a physician (72). In another study of Kentucky children with Medicaid health insurance in 1995, Yawn, et al. found that urban children with asthma were twice as likely as rural children with asthma to visit an asthma specialist, 2.7 times as likely to receive asthma care in the emergency department, and 1.4 times as likely to receive oral steroid medication to control asthma symptoms (30). In a study of Health Behavior in School-Aged

Children (HBSC) 2001-2002 from the Canadian component, Lawson et al observed that the prevalence of asthma progressively became lower as the degree of rurality increased: metro (17.7%); non-metro-adjacent (15.6%); rural (14.8%) with a statistically significant difference between rural and metro regions ($p = .04$) (5). They also found that report of wheeze and access to medical care for wheeze (doctor's visits, hospitalization, emergency room visits) were similar between regions (5). In a study of Saskatchewan children, Barry et al found that farm children reported longer distance to health care services compared to small town children (75). To support this finding, in a previous study, Rennie et al also found an inverse relationship between distance to health care facilities and prevalence of more severe pediatric asthma symptoms in a rural population of children living in Saskatchewan (92). These findings suggest that the potential number of undetected cases in rural populations, due to lack of access to health care utilization, might account for differences in asthma prevalence between rural and urban children.

### 2.8.3: Summary of literature review:

Asthma is a heterogenous disease. It is the most common chronic condition among pediatric population and approximately 13% of children have been diagnosed with asthma in Canada. It attributes a large impact on health care utilization within the country. Geographic location plays an important role in variations of asthma prevalence. Many studies from different countries have investigated the relationship between asthma and geographic location. Children living in rural area appear to have a lower prevalence of asthma compared to urban children. Although the exact reasons of asthma prevalence by geographic location is not well-known, personal risk factors, environmental exposures, health risk behaviors and healthcare access indicators may help explain this variation.

Based on this information and the rational (Section 1.2), as a refresher, The main objective of this thesis was to identify the risk factors associated with childhood asthma and wheeze and to determine which risk factors best explain the variations of asthma prevalence between urban and rural settings in Saskatchewan. More specifically, the specific research questions were:

1. *What are the risk factors associated with the prevalence of current asthma and wheeze in pediatric populations in Saskatchewan and specifically, is location of residence associated with asthma and wheeze after adjustment for confounders?*

2. *Which risk factors best explain the variations of current asthma prevalence and wheeze in Saskatchewan?*

3. *Are the risk factors of current asthma and wheeze, as identified in Research Question #1, modified by area of residence?*

# Chapter 3: Methodology

## 3.1 Study Location

Data were collected from within the province of Saskatchewan, Canada where children were recruited from three regions of the province (Regina, Prince Albert and the rural area around Prince Albert). Schools in Regina were randomly selected. All schools in the Saskatchewan River School District in Prince Albert and the surrounding area were selected.

## 3.2 Study Design and Study Population

The study was a cross-sectional survey that was completed in spring 2013. Approvals to conduct the survey were obtained from the school district boards and school principals prior to data collection. In addition to this, ethical approval from the University of Saskatchewan was obtained. Any child attending one of the selected schools from Kindergarten to Grade 8 (ages 5-14 years) was eligible to participate in the survey. The total sample size was 3,509 and the participation rate was approximately 28% overall (large urban=26%; small urban=23%; rural=38%) (69). The current analysis was based on 3,420 children. There were 89 children not included in the current analysis due to missing information on home location.

## 3.3 Data collection

The study team prepared packages that included an information letter and questionnaire. Questionnaires (Appendix 1) were distributed through the schools to parents of children attending the school. The parents completed the questionnaires on behalf of the children and returned the questionnaire to the school where they were collected by research assistants.

Questionnaires were based on standardized questionnaires including the International Study of Asthma and Allergies in Childhood (ISAAC) (41) questionnaire and the American Thoracic Society's (ATS) Division of Lung Diseases questionnaire for children (93) as well as questionnaires used previously in Saskatchewan lung health studies (94). Information was collected on lung and general health, indoor environment, health behaviors, and socio-demographics.

## 3.4 Variables considered in the study

### *3.4.1 Outcome variables*

The outcome variables of this study were current wheeze and current asthma. Asthma and wheeze were operationally defined based upon standard definitions (47).

- Current asthma - a positive response to ever asthma as well as a positive response to wheeze, health care utilization for asthma, asthma episodes or breathing medication use in the past 12 months. Ever asthma was defined as "Has this child ever been diagnosed as having asthma by a doctor?"

- Current wheeze – Ever wheeze along with a positive response to "Has this child had wheezing or whistling in the chest in the past 12 months?" Ever wheeze was defined as "Has this child ever had wheeze or whistling in the chest in the past?"

### *3.4.2 Independent Variables*

The primary exposure was the child's location of residence determined by the question: "Where is your child currently living? (farm, acreage, in town, or reserve)". This variable was

recoded as large urban (Regina, population approximately 200,000), small urban (Prince Albert, population approximately 35,000), and rural (towns around Prince Albert; <2,500 or people living on a farm or acreage around Prince Albert). Children who lived on a reserve were excluded from the study because of the small number of participants who lived on a reserve (n=18).

In the United States, the Beale code system is used to classify counties first on the basis of whether they belonged to a metropolitan area and then on the basis of the population of the metropolitan area (95). In non-metropolitan areas, counties are classified according to their location relative to metropolitan regions (i.e., adjacent or non-adjacent to a metropolitan region). This system has been adapted to be compatible within the Canadian context using census divisions (95). The system for Canada uses only six categories. The Beale classification system identifies Census Divisions (CDs) as being major metro areas or part of their fringes, a medium sized metro area, a small metro area, or part of a rural region based on proximity to, and the population size of, Census Metropolitan Areas (CMAs) and Census Agglomerations (CAs) (95).

The regions in the current study align with categories of the modified version of the Beale urban-rural coding system of Canada (95). In Canada, the modified Beale code regions are based on the following geographic categories (1) *Metropolitan regions* (large urban), which are considered to be highly urbanized CDs containing, within or partially within a CMAs/CAs, a population greater than 50,000 (in our study, Regina); (2) *Non-metropolitan regions* (small urban) population less than 50,000 (20,000-49,999 people); (in our study, Prince Albert); (3) *Predominantly rural* (rural) population less than <2,500; (in our study, this is the region around Prince Albert) . (96)

In addition to the region of interest, the following independent variables were considered:

*Personal factors*: Age, sex, ethnic background, low birth weight, premature birth, history of allergy, history of breast feeding, birth order, parental history of asthma and allergies, day care attendance, family size, parent's education, and family income were identified as personal factors by questionnaire. Age groups were classified as younger (ages 5 to 9) and older (ages 10 to 14). A child was considered low birth weight if parents reported a weight of less than 2.5 kg at birth. Premature birth was defined as being born more than 2 weeks before the expected birth date. History of respiratory allergies was considered present if there was a positive response to the question "Has this child ever had an allergy (e.g. hives, runny nose, sneezing and/or wheezing) to any of the following: house dust, grain dust, pollen, trees, grasses, mold or mildew, dog, cat, birds/feathers, farm animals and foods?" Parents' educational attainment was determined by the question "What is the highest level of education completed by the child's father/mother?" and was categorized as high school or less vs. any postsecondary education. Birth order was defined based on the asking question "Is this child a first born child?" on the basis of binary (yes/no) responses. Family size was assessed using a continuous variable describing the number of children in a family.

*Environmental factors*: Environmental factors were explored as potential risk factors including passive smoking, house dampness, mold or mildew, pets, modern or old home, home crowding, type of housing units, type of fuel using at home, presence of home fireplaces and dehumidifier, frequency of truck passing through the residential street, and presence of carpet on the classroom floor at school. Passive smoking exposure was defined based on the parental smoking and child's friends' smoking status and if the child was exposed to smoke in a car or in

a bus. The child was considered exposed to passive smoking if there was a positive response to any of the following 4 questions: “Does this child’s father currently smoke?”, “Does this child’s mother currently smoke?”, “Do any of the friends of this child smoke?”, “Is this child exposed to smoke in a car or in a bus?” House dampness was considered present if there was a positive response to the question “Does your house have any damage caused by dampness (e.g. wet spots on walls, floors)?” House mold was considered present if there was a positive response to the question “Are there signs of mold or mildew in any living areas in your home?” Children were considered to have pets present if there was a positive response to the question “In the past 12 months, have you had any of the following pets living in your home? cat/dog/bird” Age of the home was based on the question “When was your home built?” and was categorized into modern (between 1980-present) and old (before 1980) home categories. Home crowding was defined using a continuous variable describing the number of people in the home divided by the number of rooms in the home. Type of housing unit was defined as single family dwelling or other dwelling. The presence of home fireplaces and dehumidifiers were based on self-report of currently having one in the house (i.e. binary yes/no responses). Frequency of truck passing through the residential street was defined based on the question “How often do trucks pass through the street where you live, on weekdays?” and was categorized into never/seldom and frequently/almost whole day categories. Finally, presence of carpet on the classroom floor at school was defined by asking the question “Is this child’s classroom floor at school carpeted?” and then assessed as high risk (fully covered), low risk (partly covered) and no risk (no) categories.

*Diet and behavioural factors*: Diet, physical activity, and screen time were considered as potential risk factors for asthma. *Diet.* Participants were asked how often during the past 12

months they usually ate or drank different dietary products (meat, seafood, fruits, vegetables, pulses, cereal, pasta, rice, margarine, milk, fast food) and responses for each food type were classified into low (never or occasionally), moderate (once or twice a week) and high (three or more times a week) categories. *Physical activity.* Participants were provided with a definition (activity that increases heart rate and makes them get out of breath some of the time) and examples of some physical activities (e.g. sports, school activities, playing with friends or walking to school) and then asked two questions: (1) "Over the past 7 days, on how many days was this child physically active for a total of least 60 minutes per day?" and (2) "Over a typical or usual week, on how many days was this child physically active for a total of at least 60 minutes per day?" Physical activity participation was based on the average of these 2 questions. Participants were classified into either low (1 day or less a week), moderate (2-4 days a week), or high (5 or more days a week) physical activity categories. *Screen time.* Screen time was defined based on the question "During a normal week, how many hours a day (24 hour) does your child watch TV or play video games?" Responses were classified as less than 1 hour, 1 hour but <3 hours, 3 hours but < 5 hours and 5 hours or more.

In addition to the above variables, health care access indicators were investigated descriptively to provide contextual information for issues that may affect diagnoses or management. Traveling time for a routine check-up and 24 hour emergency health care services, place of receiving medical care, difficulties getting routine or on-going health care services, and being unable to get prescription medications were considered as health care access indicators assessed by questionnaire. Traveling time was determined using a continuous variable to measure how many minutes need to travel (in one direction) to receive routine or on-going

medical care and 24 hours emergency health care services for the child. The most common place of receiving medical care was assessed based on self-report of taking services from the emergency department, regular family physician, hospital or medi-clinic, walk-in clinic, minor emergency clinic, or ambulatory clinic by asking the question "Where does this child receive most of their medical care?" We categorized this variable into family physician (regular family physician) and not family physician (emergency department, hospital, or medi-clinic, walk-in clinic, minor emergency clinic, ambulatory clinic). Difficulties getting routine or on-going health care services and being unable to get prescription medications in the past 12 months were assessed on the basis of binary (yes/no) responses.

Regarding farm activities, participants were asked about in the past 12 months, how often they spent 1 hour in different types of farm activities: haying or moving or playing with hay bales; feeding livestock; cleaning or playing in barns; emptying or filling grain bins; cleaning or playing in pens or corrals; riding horses, and pesticides. Responses for each type of farm activities were categorized into irregular (never or less than once a month) and regular (everyday or at least once a week or at least once a month)

## 3.5 Statistical Analysis

Analyses were completed using the Statistical Package for the Social Sciences (SPSS) software version 21.

*Analysis for Research Question #1. (What are the risk factors associated with the prevalence of current asthma and wheeze in pediatric populations in Saskatchewan and specifically is location of residence associated with asthma and wheeze after adjusted for confounders?)* The outcomes

for this analysis were current wheeze and current asthma. These two outcomes were considered independently. Descriptive statistics were calculated for outcome variables and compared using the chi-squared tests for categorical and independent samples *t*-tests for continuous variables. Multiple logistic regression analyses were conducted to identify potential risk factors such as personal factors, environmental factors, diet and behavioural factors for each outcome. The strength of association was assessed by the odds ratio (OR) and corresponding 95% confidence intervals (CI). Variables were selected to the model with consideration of statistical significance as well as clinical or biological importance based on the scientific literature in the selection of covariates. For the initial bivariate analysis, variables with a p value <0.25 were considered candidates for a full multiple logistic regression model. After fitting the full regression model, only statistically significant variables based on a p <0.05 were kept in the reduced model. Following this, potential confounders were identified. For confounding assessment, I included variables in the final main effect models if their addition to the models changed a beta estimate of an already included variable by >15%. Location of residence was fitted at each stage regardless of statistical significance. Initially, baseline models were fitted with fewer variables (see research question 2). The same variables were included in the model for each outcome. Following this, a second fully adjusted model was fitted including a larger number of variables. This was conducted to investigate mediation analysis. The following potential confounders were considered: location, age, sex, ethnicity, money left at the end of the month, children born premature, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, home dampness from rain or flood in the past 12 months, signs of mold or mildew, fuel used for heating in home, homes with wood fireplace, consumption of unpasteurized milk in the past 12 months, current paternal smoking,

current maternal smoking, consumption of seafood in the past 12 months, consumption of pasta in the past 12 months, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance, dog ownership in the past 12 months, home with mice or pests, egg consumption in the past 12 months, nuts consumption in the past 12 months, wild meat consumption in the past 12 months, soda consumption in the past 12 months, milk consumption in the past 12 months, fast food consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in the past 12 months, live on a farm during first year of life, first born child, home damage caused by dampness, cat ownership in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of chips in the past 12 months, community support, homes with humidifier, carpet on classroom, physical activity, consumption of fruit in the past 12 months, consumption of bread in the past 12 months.

*Analysis for Research Question #2. (Which risk factors best explain the variations of current asthma and current wheeze prevalence in Saskatchewan?)* A mediation analysis was performed for both current asthma and current wheeze. A fully adjusted model was fitted which included location of residence (urban-rural status) and each of the variables that were selected based on research question 1. Then a base adjusted model was fitted with a minimum set of predictor variables which included location of residence, age, sex, ethnicity and statistically significant variables based on a $p<0.05$ and each of the variables that were selected based on confounding assessment. Following this, potential mediator variables were added one at a time to the base adjusted model to assess the impact on the association between urban-rural status and each outcome. For mediation to occur, a statistically significant association between the primary

exposure (urban-rural status) and the outcome must be smaller and no longer statistically significant when the mediator was included (97). The percentage change for the association of urban-rural status from the adjusted baseline model was calculated for each variable or groups of variables added. A 5% change was considered a meaningful change. Only those variables that fit the criteria for a mediator were presented in the results.

*Analysis for Research Question #3. (Are the risk factors of current asthma and current wheeze, as identified in Research Question #1, modified by area of residence?)* The main effect models used was based on that fitted for research question #1 using multiple logistic regression. After fitting the fully adjusted models for current wheeze and current asthma, effect modification was assessed. This was completed to determine whether the magnitude of an independent variable's association with an outcome depends on a third variable. Multiple regression analyses were conducted for the dependent variables of current asthma and current wheeze in children. An interaction term between the area of residence indicator variable and other variables of interest from research question # 1 were included in the models. Other clinically important interaction terms such as sex*smoking were considered. In the final results of effect modification analysis, a p value <0.05 was considered for statistical significance of the interaction term.

## 3.6 Statistical power calculation

Statistical power (P) was calculated by using G*Power 3.1 and was defined as: $P = 1- \beta$. Statistical power is conventionally set at 0.80 or 80% i.e. there is a 20% chance of accepting the null hypothesis in error, i.e. beta is 0.20 or 20% (98). Here, I used the statistical test of logistic regression for binary outcomes and post hoc power analysis (for a z-test) to determine the level of statistical power achieved for a given sample size (n=3420), odds ratio (0.5) and alpha level ($\alpha$

= 0.05 for a two-tailed test). A study will be able to detect an association between a predictor and an outcome variable depends on the actual magnitude of that association in the target population.

In Figure 3.1, the plotted graph shows that when the odds ratio = 0.75, this would result in a power of 80%, which would also result from an odds ratio of 1.3. If we consider a stronger odds ratio to be 0.5 or 2.0 representing values on each side of the null value, respectively, we would experience a statistical power of approximately 99%.

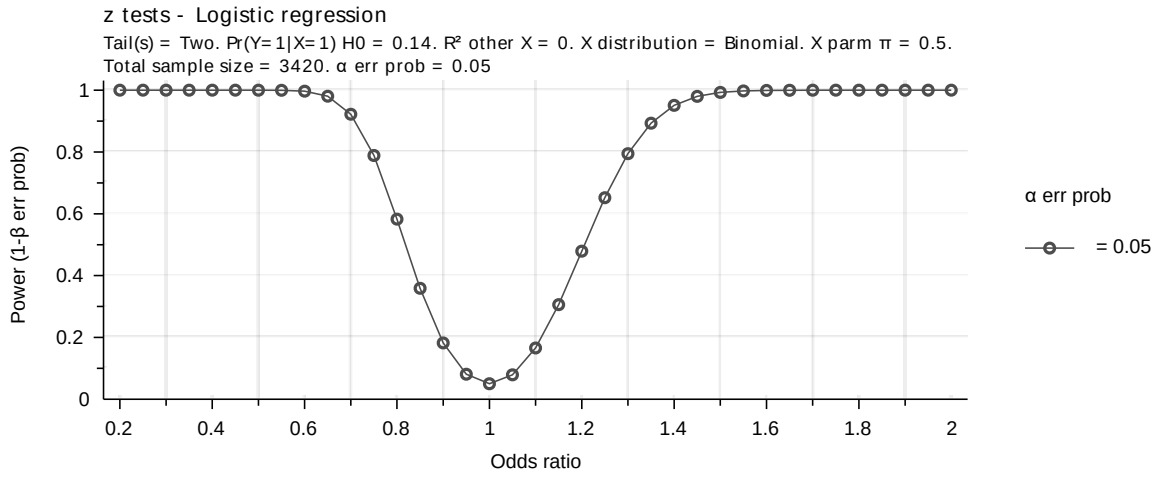


**Figure 3.1: Statistical power justification by odds ratios (OR)**

# Chapter 4: Results

## 4.1 Descriptive comparison by location of residence

### 4.1.1 Distribution of personal characteristics by geographic location

A descriptive analysis of personal characteristics by geographic location (large vs. small urban; large urban vs. rural area and small urban vs. rural area) is presented in Table 4.1. Compared to those who live in the small urban area, children from a large urban dwelling were more likely to be young, Caucasian, born premature, breastfed for more than 6 months, to have an allergy, more likely to participate in the community's events, have a higher proportion of fathers and mothers with postsecondary education, have parents who had some money left over at the end of the month, and have fathers with a history of asthma and allergies. A lower proportion of children living in the large urban center struggled to meet the basic living requirements in the past 12 months or lived on a farm during the first year of life compared to small urban children.

When comparing large urban children to rural children (Table 4.1), children from the large urban center were more likely to be young, born premature, attend day care, and participate in the community's events, as well as have a higher proportion of fathers with postsecondary education. Compared to rural children, large urban children were less likely to be Caucasian and or live on a farm during the first year of life.

Finally, compared to small urban children (Table 4.1), rural children were more likely to be male, Caucasian, have mothers with postsecondary education, have parents with some money

left over at the end of the month, be born premature, have a father with a history of asthma and allergies, and live on a farm during the first year of life. A lower proportion of children living in the rural area struggled to meet the basic living requirements and attend daycare than those who lived in the small urban center.

**Table 4.1: Distribution of personal characteristics by geographic location**

| | Overall (n=3420) % | Large urban (n=2317) %[a] | Small urban (n=400) %[a] | Rural area (n=703) %[a] |
|---|---|---|---|---|
| *Sex* | | | | |
| Male | 1686 (49.5) | 1134 (49.1) | 181 (45.6‡) | 371 (53.2) |
| Female | 1720 (50.5) | 1177 (50.9) | 216 (54.4) | 327 (46.8) |
| Missing | 14 (0.4) | | | |
| *Age Group* | | | | |
| 5-9 years (younger) | 1813 (53.0) | 1273 (54.9*†) | 198 (49.5) | 342 (48.6) |
| 10- 14 years (older) | 1607 (47.0) | 1044 (45.1) | 202 (50.5) | 361 (51.4) |
| Missing | 0 (0.0) | | | |
| *Ethnicity* | | | | |
| Caucasian | 2179 (65.3) | 149566.2*† | 156 (39.9‡) | 528 (76.7) |
| First Nation | 524 (15.7) | 202 (8.9) | 196 (50.1) | 126 (18.3) |
| Other | 635 (19.0) | 562 (24.9) | 39 (10.0) | 34 (4.9) |
| Missing | 82 (2.4) | | | |
| *Father's education* | | | | |
| High school or less | 955 (30.0) | 540 (24.6*†) | 150 (44.4) | 265 (40.7) |
| Postsecondary | 2225 (70.0) | 1651 (75.4) | 188 (55.6) | 386 (59.3) |
| Missing | 240 (7.0) | | | |
| *Mother's education* | | | | |
| High school or less | 779 (23.5) | 475 (21.0*) | 141 (37.6‡) | 163 (24.0) |
| Postsecondary | 2540 (76.5) | 1790 (79.0) | 234 (62.4) | 516 (76.0) |
| Missing | 101 (3.0) | | | |
| *Money left over at the end of the month* | | | | |
| Some money | 2069 (63.6) | 1408 (64.0*) | 213 (55.8‡) | 448 (66.6) |
| Just enough money | 826 (25.4) | 555 (25.2) | 107 (28.0) | 164 (24.4) |
| Not enough money | 360 (11.1) | 237 (10.8) | 62 (16.2) | 61 (9.1) |
| Missing | 165 (4.8) | | | |
| *In the past 12 months, struggled to meet the basic living requirements* | | | | |
| No | 2787 (83.7) | 1923 (85.4*) | 269 (68.8‡) | 595 (86.6) |
| Yes | 16.3 | 330 (14.6) | 122 (31.2) | 92 (13.4) |
| Missing | 89 (2.6) | | | |

| | Overall (n=3420) % | Large urban (n=2317) %[a] | Small urban (n=400) %[a] | Rural area (n=703) %[a] |
|---|---|---|---|---|
| *Participation in community's events* | | | | |
| Never | 271 (8.2) | 187 (8.3*†) | 39 (10.3‡) | 45 (6.6) |
| Rarely | 547 (16.5) | 283 (12.5) | 68 (18.0) | 196 (28.8) |
| Sometimes | 1976 (59.5) | 1404 (62.1) | 200 (53.1) | 372 (54.7) |
| Always | 101 (15.8) | 388 (17.2) | 70 (18.6) | 67 (9.9) |
| Missing | 101 (3.0) | | | |
| *Community support, mean (standard deviation) mm on VAS* | 61.6 (24.7) | 61.9 (24.5)*† | 54.6 (26.8) ‡ | 64.7 (23.6) |
| *Children born premature* | | | | |
| No | 2210 (68.1) | 1490 (67.1*) | 265 (74.0‡) | 455 (68.0) |
| Yes | 1037 (31.9) | 730 (32.9) | 93 (26.0) | 214 (32.0) |
| Missing | 173 (5.1) | | | |
| *First born child* | | | | |
| No | 1861 (55.0) | 1208 (52.7†) | 227 (57.5) | 426 (61.2) |
| Yes | 1523 (45.0) | 1085 (47.3) | 168 (42.5) | 270 (38.8) |
| Missing | 36 (1.1) | | | |
| *Children breastfed* | | | | |
| Never | 498 (15.0) | 319 (14.1*) | 81 (21.2‡) | 98 (14.3) |
| 0-4 weeks | 482 (14.5) | 330 (14.6) | 64 (16.8) | 88 (12.9) |
| 4 weeks to 6 months | 933 (28.1) | 637 (28.2) | 91 (23.8) | 205 (23.8) |
| More than 6 months | 1412 (42.5) | 973 (43.1) | 146 (38.2) | 293 (42.8) |
| Missing | 95 (2.8) | | | |
| *Day care attendance* | | | | |
| No | 1398 (41.5) | 899 (39.3†) | 155 (40.2‡) | 344 (49.6) |
| Yes | 1970 (58.5) | 1390 (60.7) | 231 (59.8) | 349 (50.0) |
| Missing | 52 (1.5) | | | |
| *Children with any allergy* | | | | |
| No | 2292 (67.0) | 1522 (65.7*) | 285 (71.3) | 485 (69.0) |
| Yes | 1128 (33.0) | 795 (34.3) | 115 (28.8) | 218 (31.0) |
| Missing | 0 (0.0) | | | |
| *Father with history of asthma and allergies* | | | | |
| No | 2422 (70.8) | 1598 (69.0*) | 325 (81.3‡) | 499 (71.0) |
| Yes | 998 (29.2) | 719 (31.0) | 75 (18.8) | 204 (29.0) |
| Missing | 0 (0.0) | | | |
| *Mother with history of asthma and allergies* | | | | |
| No | 2172 (63.5) | 1469 (63.4) | 264 (66.0) | 439 (62.4) |
| Yes | 1248 (36.5) | 848 (36.6) | 136 (34.0) | 264 (37.6) |
| Missing | 0 (0.0) | | | |

| | Overall (n=3420) % | Large urban (n=2317) %[a] | Small urban (n=400) %[a] | Rural area (n=703) %[a] |
|---|---|---|---|---|
| *Consumption of unpasteurized milk in first year of life* | | | | |
| No | 3128 (95.3) | 2113 (95.2) | 354 (95.4) | 661 (95.7) |
| Yes | 154 (4.7) | 107 (4.8) | 17 (4.6) | 30 (4.3) |
| Missing | 138 (4.0) | | | |
| *Live on a farm during the first year of life* | | | | |
| No | 3117 (93.7) | 2230 (98.9 *†) | 371 (97.1‡) | 516 (74.8) |
| Yes | 209 (6.3) | 24 (1.1) | 11 (2.9) | 174 (25.2) |
| Missing | 94 (2.7) | | | |

[a]Proportions are based on valid sample sizes include those with non-missing data in the row variable. There were no missing values in the large urban-small urban-rural status variable
∗p<0.05 between the large urban and small urban groups using the Pearson Chi-square test
†p<0.05 between the large urban and rural area groups using the Pearson Chi-square test
‡p<0.05 between the small urban and rural area groups using the Pearson Chi-square test

### 4.1.2 Distribution of environmental factors by geographic location

Table 4.2 presents the descriptive analysis of environmental factors by geographic location**.** Compared to the small urban center, children living in the large urban area were less likely to have a mother, a father, and friends who smoked currently, to be exposed to smoke in a car or bus, to be exposed to smoke from alternate caregivers, to live in a home with damage caused by dampness (wet spots), to live in a home with dampness from rain or flooding in the past 12 months, to live in a home with mildew odor or musty smell, to live in a home with signs of mold or mildew, to live in a home with cat and bird in the past 12 months, to frequently have trucks passing close to home, or to have a classroom fully covered with carpet. Children living in the large urban center were more likely to have a home which was built in 1980 or later, to live in a crowded home, to live in a single family unit, to live in a home with an air conditioner, to

live in a home with an air filter, to live in a home with a humidifier, to live in a home with a wood fireplace, or to live in a home with a recovery ventilator compared to small urban center.

Compared to children from large urban area, children from the rural area (Table 4.2) were more likely to have a mother or father who smoked currently, to be exposed to smoke in a car or bus, to live in a home with dampness from rain or flooding in the past 12 months, to live in a home with a mildew odor or musty smell, to live in a home with dog or cat in the past 12 months, to live in a crowded home, to live in a home with a dehumidifier, to live in a home with a wood fireplace, to frequently have trucks passing close to the home, or to have classroom fully covered with carpet. Children who lived in the rural area had a lower proportion of children living in a home that used natural gas for heating, a home with an air conditioner, a home with an air filter, a home with a humidifier, or a home with a heating recovery ventilator than the children living in the large urban area.

Finally, compared to rural children, small urban children (Table 4.2) were more likely to have a mother or father who smoked currently, to be expose to smoke from alternate caregivers, to have a home with mold or mildew, to have a home that used natural gas for heating. Children living in the small urban center were less likely to live in a home with dog or cat in the past 12 months, to have a home with mice or pests, to have a home which was built in 1980 or later, to have a crowded home, to have single family housing unit, to have a home with a dehumidifier, to have a home with a wood fireplace, or to have a home with a heating recovery ventilator compared to rural children.

**Table 4.2: Distribution of environmental factors by geographic location**

| | Overall (n=3420) % | Large urban (n= 2317) %[a] | Small urban (n=400) %[a] | Rural area (n=703) %[a] |
|---|---|---|---|---|
| *Current maternal smoking* | | | | |
| No | 2800 (82.7) | 1996 (86.7*†) | 237 (61.2‡) | 567 (81.3) |
| Yes | 585 (17.3) | 305 (13.3) | 150 (38.8) | 130 (18.7) |
| Missing | 35 (1.0) | | | |
| *Current paternal smoking* | | | | |
| No | 2529 (76.7) | 1825 (80.9*†) | 197 (54.4‡) | 507 (74.7) |
| Yes | 769 (23.3) | 432 (19.1) | 165 (45.6) | 172 (25.3) |
| Missing | 122 (3.6) | | | |
| *Child's friends' smoking* | | | | |
| No | 3121 (95.9) | 2161 (97.3*†) | 324 (91.0) | 636 (94.1) |
| Yes | 133 (4.1) | 61 (2.7) | 32 (9.0) | 40 (5.9) |
| Missing | 166 (4.9) | | | |
| *Child exposed to smoke in a car or bus* | | | | |
| No | 3203 (95.1) | 2215 (96.8*†) | 343 (89.3‡) | 645 (92.8) |
| Yes | 164 (4.9) | 73 (3.2) | 41 (10.7) | 50 (7.2) |
| Missing | 53 (1.5) | | | |
| *Child exposed to smoke from alternate caregivers* | | | | |
| No | 2954 (88.8) | 2045 (90.7*†) | 307 (80.0‡) | 602 (87.4) |
| Yes | 371 (11.2) | 209 (9.3) | 75 (19.6) | 87 (12.6) |
| Missing | 95 (2.8) | | | |
| *Home damage caused by dampness (wet spots)* | | | | |
| No | 2642 (83.8) | 1864 (85.0*) | 260 (78.1) | 518 (82.7) |
| Yes | 509 (16.2) | 328 (15.0) | 73 (21.9) | 108 (17.3) |
| Missing | 269 (7.9) | | | |
| *In the past 12 month, any home dampness from rain or flood* | | | | |
| No | 2488 (74.8) | 1733 (77.0*†) | 258 (68.1) | 497 (71.5) |
| Yes | 836 (25.2) | 517 (23.0) | 121 (31.9) | 198 (28.5) |
| Missing | 96 (2.8) | | | |
| *Mildew odor or musty smell* | | | | |
| No | 2881 (84.7) | 2025 (87.8*†) | 297 (75.4) | 559 (79.7) |
| Yes | 521 (15.3) | 282 (12.2) | 97 (24.6) | 142 (20.3) |
| Missing | 18 (0.5) | | | |

| | Overall (n=3420) % | Large urban (n=2317) % [a] | Small urban (n= 400) % [a] | Rural area (n=703) % [a] |
|---|---|---|---|---|
| *Signs of mold or mildew* | | | | |
| No | 2845 (88.2) | 1940 (89.1*) | 299 (81.0‡) | 606 (89.2) |
| Yes | 381 (11.8) | 238 (10.9) | 70 (19.0) | 73 (10.8) |
| Missing | 194 (5.7) | | | |
| *Dog living in your home in the past 12 months* | | | | |
| No | 2036 (59.9) | 1435 (62.3†) | 239 (60.2‡) | 362 (51.6) |
| Yes | 1365 (40.1) | 867 (37.7) | 158 (39.8) | 340 (48.4) |
| Missing | 19 (0.6) | | | |
| *Cat living in your home in the past 12 months* | | | | |
| No | 2545 (74.8) | 1804 (78.4*†) | 288 (72.5‡) | 453 (64.5) |
| Yes | 856 (25.2) | 498 (21.6) | 109 (27.5) | 249 (35.5) |
| Missing | 19 (0.6) | | | |
| *Bird living in your home in the past 12 months* | | | | |
| No | 3307 (97.2) | 2245 (97.5*) | 379 (95.5) | 683 (97.3) |
| Yes | 94 (2.8) | 57 (2.5) | 18 (4.5) | 19 (2.7) |
| Missing | 19 (0.6) | | | |
| *Home with mice or pests* | | | | |
| No | 3059 (90.9) | 2067 (90.8*) | 368 (94.1‡) | 624 (89.7) |
| Yes | 305 (9.1) | 210 (9.2) | 23 (5.9) | 72 (10.3) |
| Missing | 56 (1.6) | | | |
| *Home built years* | | | | |
| Between 1980-present | 1528 (53.2) | 1049 (54.3*) | 99 (35.9‡) | 380 (57.1) |
| Before 1980 | 1346 (46.8) | 883 (45.7) | 177 (64.1) | 286 (42.9) |
| Missing | 546 (16.0) | | | |
| *Fuel used for heating in home* | | | | |
| Natural gas | 2774 (85.2) | 1986 (90.0†) | 312 (86.4‡) | 476 (69.1) |
| Electricity | 302 (9.3) | 196 (8.9) | 43 (11.9) | 63 (9.1) |
| Others | 181 (5.6) | 25 (1.1) | 6 (1.7) | 150 (21.8) |
| Missing | 163 (4.8) | | | |
| *Home crowding (persons/rooms)* | | | | |
| <=1 | 2526 (74.9) | 1670 (73.2*†) | 263 (66.8‡) | 593 (85.0) |
| >1 | 846 (25.1) | 610 (26.8) | 131 (33.2) | 105 (15.0) |
| Missing | 48 (1.4) | | | |

| | Overall (n=3420) % | Large urban (n=2317) % [a] | Small urban (n= 400) % [a] | Rural area (n=703) % [a] |
|---|---|---|---|---|
| *Type of housing unit* | | | | |
| For single family | 3051 (90.0) | 2039 (88.8*†) | 332 (83.4‡) | 680 (98.0) |
| Others | 338 (10.0) | 258 (11.2) | 66 (16.6) | 14 (2.0) |
| Missing | 31 (0.9) | | | |
| *Homes with air conditioners* | 999 (29.6) | 437 (19.1*†) | 200 (51.8) | 362 (51.9) |
| No | 2375 (70.4) | 1853 (80.9) | 186 (48.2) | 336 (48.1) |
| Yes | 46 (1.3) | | | |
| Missing | | | | |
| Homes with air filter | | | | |
| No | 1453 (43.1) | 865 (37.8*†) | 221 (57.3) | 367 (52.6) |
| Yes | 1921 (56.9) | 1425 (62.2) | 165 (42.7) | 331 (47.4) |
| Missing | 46 (1.3) | | | |
| *Homes with humidifier* | | | | |
| No | 2242 (66.4) | 1435 (62.7*†) | 283 (73.3) | 524 (75.1) |
| Yes | 1132 (33.6) | 855 (37.3) | 103 (26.7) | 174 (24.9) |
| Missing | 46 (1.3) | | | |
| *Homes with dehumidifier* | | | | |
| No | 2435 (72.2) | 1717 (75.0†) | 300 (77.7‡) | 418 (59.9) |
| Yes | 939 (27.8) | 573 (25.0) | 86 (22.3) | 280 (40.1) |
| Missing | 46 (1.3) | | | |
| *Homes with wood fireplace* | | | | |
| No | 2828 (83.8) | 1936 (84.5*†) | 343 (88.9‡) | 549 (78.7) |
| Yes | 546 (16.2) | 354 (15.5) | 43 (11.1) | 149 (21.3) |
| Missing | 46 (1.3) | | | |
| *Homes with heating recovery ventilator* | | | | |
| No | 2856 (84.6) | 1897 (82.8*†) | 357 (92.5‡) | 602 (86.2) |
| Yes | 518 (15.4) | 393 (17.2) | 29 (7.5) | 96 (13.8) |
| Missing | 46 (1.3) | | | |
| *Frequency of truck passing* | | | | |
| Never/seldom | 1665 (60.3) | 1274 (66.5*†) | 143 (44.8) | 248 (47.1) |
| Frequently | 1097 (39.7) | 643 (33.5) | 176 (55.2) | 278 (52.9) |
| Missing | 658 (19.2) | | | |
| *Carpet on classroom floor* | | | | |
| No | 2809 (84.0) | 1958 (86.3*†) | 289 (75.7) | 562 (81.1) |
| Partly covered | 66 (2.0) | 49 (2.2) | 6 (1.6) | 11 (1.6) |
| Fully covered | 469 (14.0) | 262 (11.5) | 87 (22.8) | 120 (17.3) |
| Missing | 76 (2.2) | | | |

[a]Proportions are based on valid sample sizes include those with non-missing data in the row variable. There were no missing values in the large urban-small urban-rural status variable

*p<0.05 between the large urban and small urban groups using the Pearson Chi-square tests
†p<0.05 between the large urban and rural area groups using the Pearson Chi-square tests
‡p<0.05 between the small urban and rural area groups using the Pearson Chi-square tests

### 4.1.3 Distribution of diet and behavioral factors by geographic location

Table 4.3 presents the descriptive analysis of diet and behavioral factors by geographic location. Compared to small urban children, children from the large urban center were more likely to eat meat, seafood, fruit and milk 3 or more times per week. Children from the large urban center were less likely to eat pasta, wild meat, soda, or fast food 3 or more times per week compared to the small urban children. Compared to large urban children, rural children were more likely to eat meat, bread or cereal, or wild meat 3 or more times per week; however, rural children were less likely to eat seafood and unpasteurized milk 3 or more times per week. Finally, compared to the small urban area, a higher proportion of children from the rural area ate meat, fruit, bread or cereal, or wild meat 3 or more times per week. In the rural area, a lower proportion of children ate unpasteurized milk and soda 3 or more times per week than children living in small urban area.

**Table 4.3: Distribution of diet and behavioral factors by geographic location**

| | Overall (n=3420) % | Large urban (n= 2317) %[a] | Small urban (n=400) %[a] | Rural area (n=703) %[a] |
|---|---|---|---|---|
| *Meat* | | | | |
| Never/occasionally | 83 (2.5) | 49 (2.2*†) | 27 (7.0‡) | 7 (1.0) |
| 1 or 2 times/wk | 659 (19.8) | 479 (21.2) | 71 (18.4) | 109 (15.9) |
| 3 or more times/wk | 2591 (77.7) | 1735 (76.7) | 288 (74.6) | 568 (83.0) |
| Missing | 87 (2.5) | | | |
| *Seafood* | | | | |
| Never/occasionally | 1926 (58.2) | 1189 (52.8*†) | 271 (71.5) | 466 (68.7) |
| 1 or 2 times/wk | 1197 (36.2) | 914 (40.6) | 92 (24.3) | 191 (28.2) |
| 3 or more times/wk | 187 (5.6) | 150 (6.7) | 16 (4.2) | 21 (3.1) |
| Missing | 110 (3.2) | | | |
| *Fruit* | | | | |
| Never/occasionally | 61 (1.8) | 48 (2.1*) | 4 (1.0‡) | 9 (1.3) |
| 1 or 2 times/wk | 368 (11.0) | 236 (10.4) | 64 (16.5) | 68 (9.9) |
| 3 or more times/wk | 2909 (87.1) | 1981 (87.5) | 319 (82.4) | 609 (88.8) |
| Missing | 82 (2.4) | | | |
| *Bread or cereal* | | | | |
| Never/occasionally) | 41 (1.2) | 32 (1.4†) | 5 (1.3‡) | 4 (0.6) |
| 1 or 2 times/wk | 328 (9.8) | 230 (10.2) | 49 (12.6) | 49 (7.2) |
| 3 or more times/wk | 2964 (88.9) | 1999 (88.4) | 334 (86.1) | 631 (92.3) |
| Missing | 87 (2.5) | | | |
| *Milk* | | | | |
| Never/occasionally | 177 (5.4) | 106 (4.8*) | 29 (7.6) | 42 (6.2) |
| 1 or 2 times/wk | 334 (10.2) | 220 (10.0) | 48 (12.6) | 66 (9.8) |
| 3 or more times/wk | 2751 (84.8) | 1880 (85.2) | 305 (79.8) | 566 (84.0) |
| Missing | 158 (4.6) | | | |
| *Unpasteurized milk* | | | | |
| Never/occasionally | 2983 (94.1) | 2009 (93.6†) | 337 (92.6‡) | 637 (96.7) |
| 1 or 2 times/wk) | 115 (3.6) | 84 (3.9) | 16 (4.4) | 15 (2.3) |
| 3 or more times/wk | 71 (2.2) | 53 (2.5) | 11 (3.0) | 7 (1.1) |
| Missing | 251 (7.3) | | | |
| *Pasta* | | | | |
| Never/occasionally | 52 (1.6) | 31 (1.4*) | 12 (3.1) | 9 (1.3) |
| 1 or 2 times/wk | 585 (17.6) | 419 (18.6) | 58 (14.9) | 108 (15.8) |
| 3 or more times/wk | 2690 (80.9) | 1806 (80.1) | 319 (82.0) | 565 (82.8) |
| Missing | 93 (2.7) | | | |

| | Overall (n=3420) % | Large urban (n=2317) % [a] | Small urban (n= 400) % [a] | Rural area (n=703) % [a] |
|---|---|---|---|---|
| *Eggs* | | | | |
| Never/occasionally | 608 (18.4) | 400 (17.9) | 73 (19.1) | 135 (19.8) |
| 1 or 2 times/wk | 1936 (58.6) | 1328 (59.4) | 229 (59.8) | 379 (55.6) |
| 3 or more times/wk) | 757 (22.9) | 508 (22.7) | 81 (21.8) | 168 (24.6) |
| Missing | 119 (3.5) | | | |
| *Nuts* | | | | |
| Never/occasionally | 1531 (47.0) | 1009 (45.8) | 192 (50.8) | 330 (48.9) |
| 1 or 2 times/wk | 1385 (42.5) | 969 (44.0) | 146 (38.6) | 270 (40.0) |
| 3 or more times/wk | 339 (10.4) | 224 (10.2) | 40 (10.6) | 75 (11.1) |
| Missing | 165 (4.8) | | | |
| *Wild meat* | | | | |
| Never/occasionally | 2866 (87.4) | 2050 (92.2*†) | 302 (79.7‡) | 514 (75.9) |
| 1 or 2 times/wk | 312 (9.5) | 144 (6.5) | 62 (16.4) | 106 (15.7) |
| 3 or more times/wk | 102 (3.1) | 30 (1.3) | 15 (4.0) | 57 (8.4) |
| Missing | 140 (4.1) | | | |
| *Chips* | | | | |
| Never/occasionally | 507 (15.3) | 342 (15.3) | 67 (17.4) | 98 (14.4) |
| 1 or 2 times/wk | 1951 (59.0) | 1338 (59.7) | 217 (56.5) | 396 (58.1) |
| 3 or more times/wk | 848 (25.7) | 561 (25.0) | 100 (26.0) | 187 (27.5) |
| Missing | 114 (3.3) | | | |
| *Soda* | | | | |
| Never/occasionally | 1370 (41.9) | 975 (44.0*) | 121 (31.7‡) | 274 (40.7) |
| 1 or 2 times/wk | 1544 (47.2) | 1029 (46.4) | 197 (51.6) | 318 (47.3) |
| 3 or more times/wk | 358 (10.9) | 213 (9.6) | 64 (16.8) | 81 (12.0) |
| Missing | 148 (4.3) | | | |
| *Fast food* | | | | |
| Never/occasionally | 1317 (39.8) | 887 (39.3*) | 131 (34.7‡) | 299 (44.3) |
| 1 or 2 times/wk | 1754 (53.0) | 1225 (54.3) | 198 (52.5) | 331 (49.0) |
| 3 or more times/wk | 236 (7.1) | 143 (6.3) | 48 (12.7) | 45 (6.7) |
| Missing | 113 (3.3) | | | |
| *Physical activity* | | | | |
| 1 day or < a week | 52 (1.8) | 35 (1.8) | 6 (1.9) | 11 (1.8) |
| 2-4 days a week | 735 (25.3) | 506 (25.5) | 85 (26.5) | 144 (23.9) |
| 5 or more days a week | 2122 (72.9) | 1444 (72.7) | 230 (71.7) | 448 (74.3) |
| Missing | 511 (14.9) | | | |
| *Screen time* | | | | |
| Less than 1 hour | 297 (9.7) | 212 (10.2) | 21 (6.0) | 64 (10.3) |
| 1 hours but <3 hours | 1559 (51.0) | 1049 (50.3) | 180 (51.7) | 330 (53.1) |
| ≤3 hours but <5 hours | 768 (25.1) | 514 (24.7) | 96 (27.6) | 158 (25.4) |
| ≤5 hours or more | 430 (14.1) | 309 (14.8) | 51 (14.7) | 70 (11.3) |
| Missing | 366 (10.7) | | | |

[a]Proportions are based on valid sample sizes include those with non-missing data in the row variable. There were no missing values in the large urban-small urban-rural status variable
∗p<0.05 between the large urban and small urban groups using the Pearson Chi-square tests
†p<0.05 between the large urban and rural area groups using the Pearson Chi-square tests
‡p<0.05 between the small urban and rural area groups using the Pearson Chi-square tests

### 4.1.4 Distribution of health care access indicators by geographic location

Table 4.4 presents the descriptive analysis of health care access indicators by geographic location. Compared to the small urban center, children from the large urban center were more likely to receive regular medical care from a family physician. Children from the large urban center were less likely to be unable to get prescription medications than the small urban children. Compared to those in the rural area, children living in a large urban centre were less likely to travel more than 30 minutes for both routine care and emergency care. Children from the large urban center were more likely to receive regular medical care from a family physician than the rural children. Finally, compared to small urban children, rural children were more likely to travel more than 30 minutes for both routine care and emergency care. A lower portion of rural children received medical care from a family physician than the children from small urban center.

**Table 4.4: Distribution of health care access indicators by geographic location**

| | Overall (n=3420) % | Large urban (n= 2317) %[a] | Small urban (n=400) %[a] | Rural area (n=703) %[a] |
|---|---|---|---|---|
| *Travelling time for routine care* | | | | |
| 0-15 minutes | 1760 (56.4) | 1301 (62.5*†) | 294 (82.4‡) | 165 (24.2) |
| >15-30 minutes | 1156 (37.1) | 749 (36.0) | 52 (14.6) | 355 (52.1) |
| >30 minutes | 204 (6.5) | 31 (1.5) | 11 (3.1) | 162 (23.8) |
| Missing | 300 (8.8) | | | |
| *Travelling time for emergency care* | | | | |
| 0-15 minutes | 1617 (52.4) | 1219 (59.4*†) | 285 (80.5‡) | 113 (16.6) |
| >15-30 minutes | 1243 (40.3) | 820 (39.9) | 60 (16.9) | 363 (53.5) |
| >30 minutes | 226 (7.3) | 14 (0.7) | 9 (2.5) | 203 (29.9) |
| Missing | 334 (9.8) | | | |
| *Place of receiving medical care* | | | | |
| Family physician | 2382 (69.6) | 1714 (74.0*†) | 223 (55.8‡) | 445 (63.3) |
| Not family physician | 1038 (30.4) | 603 (26.0) | 177 (44.3) | 258 (36.7) |
| Missing | 0. 0 | | | |
| *Difficulties getting health care services* | | | | |
| No | 3094 (92.2) | 2096 (92.4) | 365 (93.6) | 633 (90.9) |
| Yes | 261 (7.8) | 173 (7.6) | 25 (6.4) | 63 (9.1) |
| Missing | 65 (1.9) | | | |
| *Unable to get prescription medications* | | | | |
| No | 3273 (96.7) | 2240 (97.5*) | 361 (92.6‡) | 672 (96.3) |
| Yes | 112 (3.3) | 57 (2.5) | 29 (7.4) | 26 (3.7) |
| Missing | 35 (1.0) | | | |

[a]Proportions are based on valid sample sizes include those with non-missing data in the row variable. There were no missing values in the large urban-small urban-rural status variable

∗p<0.05 between the large urban and small urban groups using the Pearson Chi-square tests

†p<0.05 between the large urban and rural area groups using the Pearson Chi-square tests

‡p<0.05 between the small urban and rural area groups using the Pearson Chi-square tests

### 4.1.5 Distribution of farm activities by geographic location

Descriptive analysis of farm activities by geographic location is presented in Table 4.5. Compared to children living in a small urban area, children living in a large urban center were less likely to spend their time regularly haying or moving or playing with hay bales, feeding livestock, or cleaning or playing in the pens or corrals in the past 12 months. Children living in a rural area were more likely to spend their time regularly haying or moving or playing with hay bales, feeding livestock, cleaning or playing in barns, emptying or filling grain bins, and being close to pesticides in the past 12 months compared to those living in the large urban area. Children living in the rural area were more likely to spend their time regularly participating in all farm activities in the past 12 months compared to children living in the small urban area.

**Table 4.5: Distribution of farm activities by geographic location**

| | Overall (n=3420) % | Large urban (n= 2317) % | Small urban (n=400) % | Rural area (n=703) % |
|---|---|---|---|---|
| *Haying or moving or playing with hay bales* | | | | |
| Irregular | 3212 (94.9) | 2284 (98.6*†) | 388 (97.0‡) | 540 (80.8) |
| Regular | 173 (5.1) | 33 (1.4) | 12 (3.0) | 128 (19.2) |
| Missing | 35 (1.3) | | | |
| *Feeding livestock* | | | | |
| Irregular | 3212 (94.9) | 2294 (99.0*†) | 390 (97.5‡) | 528 (79.0) |
| Regular | 173 (5.1) | 23 (1.0) | 10 (2.5) | 140 (21.0) |
| Missing | 35 (1.3) | | | |
| *Cleaning or playing in barns* | | | | |
| Irregular | 3228 (95.7) | 2283 (98.5†) | 389 (97.3‡) | 566 (84.7) |
| Regular | 147 (4.3) | 34 (1.5) | 11 (2.8) | 102 (15.3) |
| Missing | 35 (1.3) | | | |
| *Emptying or filling grain bins* | | | | |
| Irregular | 3339 (98.6) | 2313 (99.8†) | 399 (99.8‡) | 627 (93.9) |
| Regular | 46 (1.4) | 4 (0.2) | 1 (0.3) | 41 (6.1) |
| Missing | 35 (1.3) | | | |
| *Cleaning or playing in pens or corrals* | | | | |
| Irregular | 3239 (95.7) | 2288 (98.7*) | 389 (97.3‡) | 562 (84.1) |
| Regular | 146 (4.3) | 29 (1.3) | 11 (2.8) | 106 (15.9) |
| Missing | 35 (1.3 ) | | | |
| *Riding horses* | | | | |
| Irregular | 3266 (96.5) | 2290 (98.8†) | 392 (98.0‡) | 584 (87.4) |
| Regular | 119 (3.5) | 27 (1.2) | 8 (2.0) | 84 (12.6) |
| Missing | 35 (1.3) | | | |
| *Pesticides* | | | | |
| Irregular | 3360 (99.3) | 2310 (99.7†) | 398 (99.5‡) | 652 (97.6) |
| Regular | 25 (0.7) | 7 (0.3) | 2 (0.5) | 16 (2.4) |
| Missing | 35 (1.3) | | | |

aProportions are based on valid sample sizes include those with non-missing data in the row variable. There were no missing values in the large urban-small urban-rural status variable

*p<0.05 between the large urban and small urban groups using the Pearson Chi-square tests

†p<0.05 between the large urban and rural area groups using the Pearson Chi-square tests

‡p<0.05 between the small urban and rural area groups using the Pearson Chi-square tests

### 4.1.6 Distribution of prevalence of ever wheeze and ever asthma by geographic location

The prevalence of ever asthma and ever wheeze by geographic location are presented in Figure 4.1. The overall prevalence of ever asthma and ever wheeze were 19.6% and 28%, respectively. P values for trend of both ever asthma and ever wheeze were (p=0.003) and (p=0.834) respectively. There was a statistically significant linear trend observed by geographic location with the highest prevalence of ever asthma in small urban children (21.4%) and lowest prevalence in rural children (15.1%) ($p<0.05$). However, no statistically significant differences were found between geographic locations in the prevalence of ever wheeze among children ($p>0.05$).

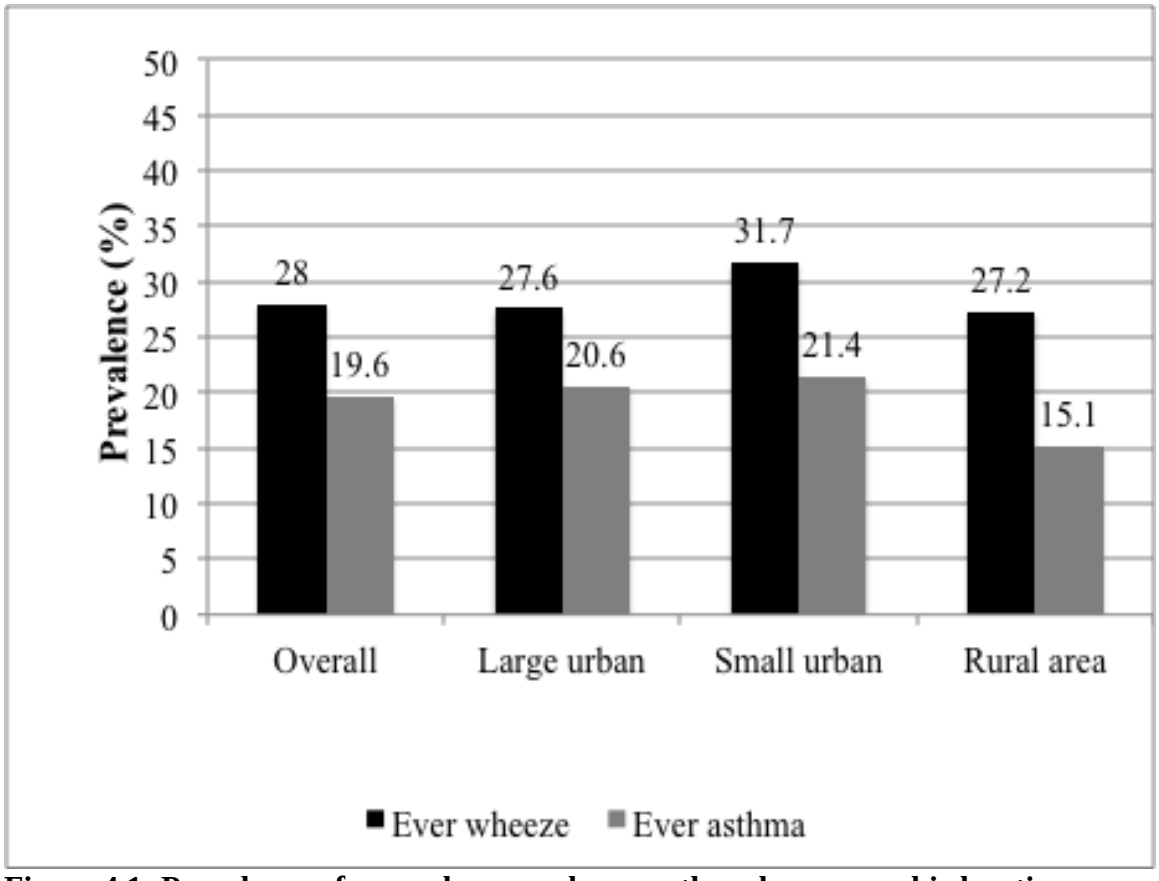


**Figure 4.1: Prevalence of ever wheeze and ever asthma by geographic location**

### 4.1.7 Distribution of prevalence of current wheeze and current asthma by geographic location

The prevalence of current asthma and current wheeze by geographic location is presented in Figure 4.2. The overall prevalence of current asthma and current wheeze were 14.1% and 14.5%, respectively. P values for trend of both current asthma and current wheeze were (p=0.086) and (p=0.0.405) respectively. A lower prevalence of current asthma was observed in the rural area (11.5%) compared to the large urban (14.6%) and small urban areas (15.9%). However, this association was not statistically significant (p>0.05). There were no statistically significant differences in current wheeze prevalence by geographic location (p>0.05).

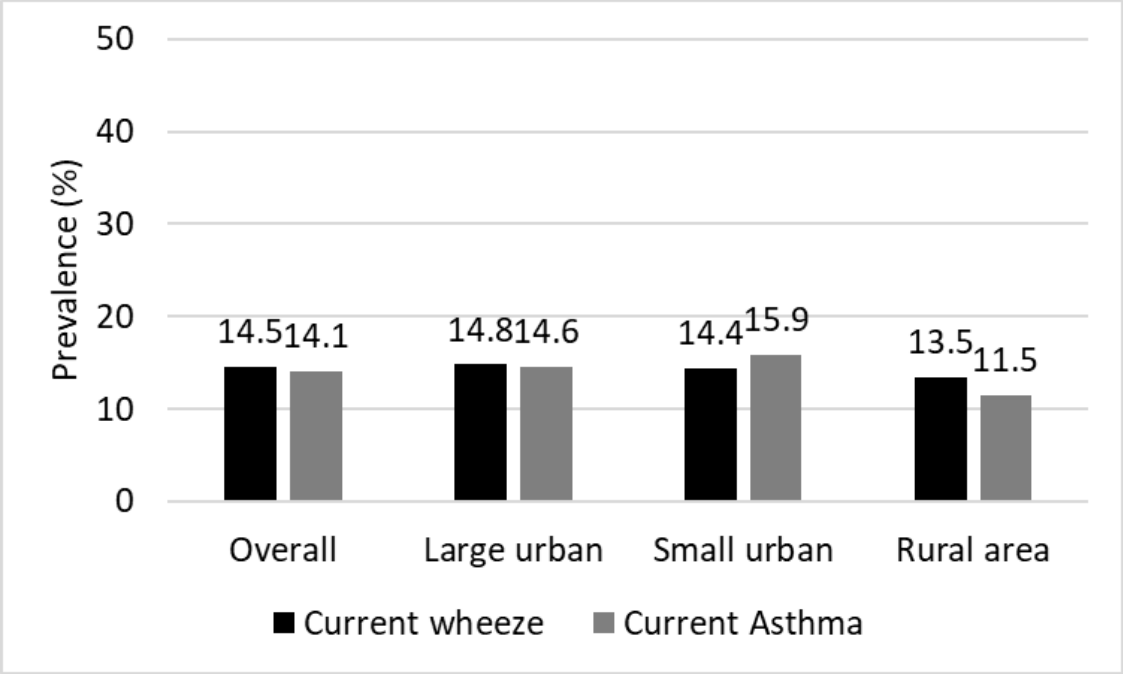


**Figure 4.2: Prevalence of current wheeze and current asthma by geographic location**

## 4.2 Results for Research Question 1 *What are the risk factors associated with the prevalence of current asthma and wheeze in pediatric populations in Saskatchewan and specifically, is location of residence associated with asthma and wheeze after adjusted for confounders?*

Descriptive statistics of personal factors, environmental factors, diet and behavioral factors, and health care access indicators by current wheeze and current asthma are presented in Table 4.6.

**Table 4.6: Descriptive statistics of personal factors, environmental factors, diet and behavioral factors, and health care access indicators by outcome variables current wheeze and current asthma**

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| Location | | | | | | |
| Large urban | 1911 (85.2%) | 333 (14.8%) | 0.405 | 1937 (85.4%) | 330 (14.6%) | 0.086 |
| Small urban | 327 (85.6%) | 55 (14.4%) | | 318 (84.1%) | 60 (15.9%) | |
| Rural area | 587 (86.5%) | 92 (13.5%) | | 605 (88.5%) | 79 (11.5%) | |
| Personal factors | | | | | | |
| *Sex* | | | | | | |
| Male | 1356 (48.2) | 282 (58.9) | <0.001 | 1364 (47.9) | 273 (58.6) | <0.001 |
| Female | 1458 (51.8) | 197 (41.1) | | 1485 (52.1) | 193 (41.4) | |
| *Age Group* | | | | | | |
| 5-9 years (younger) | 1453 (51.4) | 291 (60.6) | <0.001 | 1513 (52.9) | 254 (54.2) | 0.325 |
| 10-14 years (older) | 1372 (48.6) | 189 (39.4) | | 1347 (47.1) | 215 (45.8) | |
| *Ethnicity* | | | | | | |
| Caucasian | 1786 (64.9) | 334 (70.5) | <0.001 | 1826 (65.4) | 308 (67.2) | 0.073 |
| First Nation | 412 (15.0) | 86 (18.1) | | 422 (15.1) | 80 (17.5) | |
| Other | 552 (20.1) | 54 (11.4) | | 543 (19.5) | 70 (15.3) | |
| *Father's education* | | | | | | |
| High school or less | 792 (30.0) | 134 (30.2) | 0.493 | 798 (29.8) | 127 (29.9) | 0.508 |
| Postsecondary | 1846 (70.0) | 310 (69.8) | | 1879 (70.2) | 298 (70.1) | |
| *Mother's education* | | | | | | |
| High school or less | 635 (23.1) | 107 (22.9) | 0.485 | 641 (23.0) | 110 (24.6) | 0.246 |
| Postsecondary | 2110 (76.9) | 360 (77.1) | | 2151 (77.0) | 338 (75.4) | |

| Covariates | Current wheeze No (n=2825) % | Yes (n=480) % | P value | Current asthma No (n=2860) % | Yes (n=469) % | P value |
|---|---|---|---|---|---|---|
| *Money left over at the end of the month* | | | | | | |
| Some money | 1728 (64.2) | 280 (61.5) | 0.171 | 1770 (64.8) | 254 (57.7) | 0.009 |
| Just enough money | 677 (25.1) | 113 (24.8) | | 675 (24.7) | 124 (28.2) | |
| Not enough money | 287 (10.7) | 62 (13.6) | | 285 (10.4) | 62 (14.1) | |
| *In the past 12 months, struggled to meet the basic living requirements* | | | | | | |
| No | 2339 (85.0) | 366 (77.9) | <0.001 | 2371 (85.0) | 350 (76.9) | <0.001 |
| Yes | 413 (15.0) | 104 (22.1) | | 419 (15.0) | 105 (23.1) | |
| *Participation in community's events* | | | | | | |
| Never | 230 (8.4) | 28 (6.0) | 0.244 | 218 (7.9) | 254 (7.9) | 0.563 |
| Rarely | 441 (16.1) | 86 (18.5) | | 462 (16.6) | 64 (14.1) | |
| Sometimes | 1641 (59.8) | 279 (59.9) | | 1654 (59.6) | 283 (62.2) | |
| Always | 430 (15.7) | 73 (15.7) | | 443 (16.0) | 72 (15.8) | |
| *Community support* mean (standard deviation) mm on VAS | 61.9 (24.5) | 60.9 (25.3) | 0.425 | 62.1 (24.5) | 58.7 (25.7) | 0.009 |
| *Children born premature* | | | | | | |
| No | 1853 (69.0) | 287 (62.7) | 0.004 | 1882 (69.1) | 278 (62.1) | 0.002 |
| Yes | 287 (31.0) | 171 (37.3) | | 840 (30.9) | 170 (37.9) | |
| *First born child* | | | | | | |
| No | 1541 (55.1) | 260 (54.5) | 0.419 | 1565 (55.3) | 245 (52.8) | 0.172 |
| Yes | 1254 (44.9) | 217 (45.5) | | 1266 (44.7) | 219 (47.2) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Children breastfed* | | | | | | |
| Never | 400 (14.6) | 85 (18.2) | <0.001 | 404 (14.5) | 80 (17.4) | 0.012 |
| 0-4 weeks | 361 (13.1) | 94 (20.1) | | 387 (13.9) | 85 (18.5) | |
| 4 weeks to 6 months | 786 (28.6) | 124 (26.5) | | 800 (28.7) | 117 (25.4) | |
| More than 6 months | 1202 (43.7) | 165 (35.3) | | 1193 (42.9) | 178 (38.7) | |
| *Day care attendance* | | | | | | |
| No | 1178 (42.3) | 173 (36.6) | 0.010 | 1171 (41.5) | 176 (38.3) | 0.105 |
| Yes | 1604 (57.7) | 300 (63.4) | | 1652 (58.5) | 284 (61.7) | |
| *Child has any allergy* | | | | | | |
| No | 2051 (72.6) | 171 (35.6) | <0.001 | 2094 (73.2) | 140 (29.9) | <0.001 |
| Yes | 774 (27.4) | 309 (64.4) | | 766 (26.8) | 329 (70.1) | |
| *Father with history of asthma and allergies* | | | | | | |
| No | 2050 (72.6) | 281 (58.5) | <0.001 | 2084 (72.9) | 264 (56.3) | <0.001 |
| Yes | 775 (27.4) | 199 (41.5) | | 776 (27.1) | 205 (43.7) | |
| *Mother with history of asthma and allergies* | | | | | | |
| No | 1878 (66.5) | 220 (45.8) | <0.001 | 1902 (66.5) | 204 (43.5) | <0.001 |
| Yes | 947 (33.5) | 260 (54.2) | | 958 (33.5) | 265 (56.5) | |
| *Consumption of unpasteurized milk in first year of life* | | | | | | |
| No | 2585 (95.4) | 446 (95.7) | 0.423 | 2628 (95.4) | 426 (95.3) | 0.492 |
| Yes | 126 (4.6) | 20 (4.3) | | 126 (4.6) | 21 (4.7) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Live on a farm during first year of life* | | | | | | |
| No | 2583 (93.8) | 433 (92.9) | 0.266 | 2613 (93.6) | 425 (94.4) | 0.283 |
| Yes | 171 (6.2) | 33 (7.1) | | 179 (6.4) | 25 (5.6) | |
| Environmental factors | | | | | | |
| *Current maternal smoking* | | | | | | |
| No | 2331 (83.4) | 376 (78.7) | 0.008 | 2349 (82.9) | 380 (81.5) | 0.248 |
| Yes | 464 (16.6) | 102 (21.3) | | 483 (17.1) | 86 (18.5) | |
| *Current paternal smoking* | | | | | | |
| No | 2113 (77.5) | 340 (73.8) | 0.046 | 2142 (77.5) | 330 (73.3) | 0.030 |
| Yes | 614 (22.5) | 121 (26.2) | | 621 (22.5) | 120 (26.7) | |
| *Child's friends' smoking* | | | | | | |
| No | 2587 (96.1) | 429 (94.5) | 0.070 | 2621 (96.0) | 421 (95.0) | 0.192 |
| Yes | 104 (3.9) | 25 (5.5) | | 108 (4.0) | 22 (5.0) | |
| *Child exposed to smoke in a car or bus* | | | | | | |
| No | 2649 (95.3) | 448 (94.9) | 0.411 | 2689 (95.3) | 435 (95.0) | 0.435 |
| Yes | 132 (4.7) | 24 (5.1) | | 134 (4.7) | 23 (5.0) | |
| *Child exposed to smoke from alternate caregivers* | | | | | | |
| No | 2470 (89.7) | 394 (84.7) | 0.001 | 2500 (89.5) | 377 (84.5) | 0.002 |
| Yes | 283 (10.3) | 71 (15.3) | | 294 (10.5) | 69 (15.5) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Home damage caused by dampness (wet spots)* | | | | | | |
| No | 2199 (84.3) | 362 (82.1) | 0.130 | 2222 (84.2) | 354 (82.1) | 0.152 |
| Yes | 408 (15.7) | 79 (17.9) | | 416 (15.8) | 77 (17.9) | |
| *In the past 12 month, any home dampness from rain or flood* | | | | | | |
| No | 2092 (76.1) | 321 (68.6) | <0.001 | 2121 (76.2) | 309 (68.1) | <0.001 |
| Yes | 656 (23.9) | 147 (31.4) | | 661 (23.8) | 145 (31.9) | |
| *Mildew odor or musty smell* | | | | | | |
| No | 2401 (85.5) | 388 (81.2) | 0.010 | 2435 (85.5) | 375 (80.6) | 0.005 |
| Yes | 408 (14.5) | 90 (18.8) | | 413 (14.5) | 90 (19.4) | |
| *Signs of mold or mildew* | | | | | | |
| No | 2363 (88.8) | 392 (85.6) | 0.033 | 2405 (89.0) | 374 (84.4) | 0.004 |
| Yes | 299 (11.2) | 66 (14.4) | | 297 (11.0) | 69 (15.6) | |
| *Dog living in your home in the past 12 months* | | | | | | |
| No | 1691 (60.2) | 272 (56.9) | 0.097 | 1714 (60.3) | 265 (56.7) | 0.082 |
| Yes | 1119 (39.8) | 206 (43.1) | | 1129 (39.7) | 202 (43.3) | |
| *Cat living in your home in the past 12 months* | 2118 (75.4) | 348 (72.8) | 0.127 | 2123 (74.7) | 350 (74.9) | 0.476 |
| No | 692 (24.6) | 130 (27.2) | | 720 (25.3) | 117 (25.1) | |
| Yes | | | | | | |
| *Bird living in your home in the past 12 months* | | | | | | |
| No | 2734 (97.3) | 463 (96.3) | 0.340 | 2765 (97.3) | 453 (97.0) | 0.424 |
| Yes | 76 (2.7) | 15 (3.1) | | 78 (2.7) | 14 (3.0) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Home with mice or pests* | | | | | | |
| No | 2545 (91.5) | 420 (87.9) | 0.007 | 2570 (91.4) | 413 (89.0) | 0.063 |
| Yes | 235 (8.5) | 58 (12.1) | | 243 (8.6) | 51 (11.0) | |
| *Home built years* | | | | | | |
| Between 1980 present | 1255 (53.0) | 231 (54.7) | 0.272 | 1285 (53.5) | 211 (52.6) | 0.392 |
| Before 1980) | 1113 (47.0) | 191 (45.3) | | 1117 (46.5) | 190 (47.4) | |
| *Fuel used for heating in home* | | | | | | |
| Natural gas | 2280 (84.9) | 399 (86.2) | 0.457 | 2319 (84.9) | 391 (88.1) | 0.139 |
| Electricity | 256 (9.5) | 36 (7.8) | | 263 (9.6) | 30 (6.8) | |
| Others | 149 (5.5) | 28 (6.0) | | 151 (5.5) | 23 (5.2) | |
| *Home crowding (persons/rooms)* | | | | | | |
| <=1 | 2087 (75.0) | 365 (77.0) | 0.186 | 2111 (74.8) | 355 (76.8) | 0.193 |
| >1 | 697 (25.0) | 109 (23.0) | | 710 (25.2) | 107 (23.2) | |
| *Type of housing units* | | | | | | |
| For Single family | 2533 (90.4) | 422 (88.7) | 0.142 | 2553 (90.1) | 419 (89.7) | 0.422 |
| Others | 270 (9.6) | 54 (11.3) | | 280 (9.9) | 48 (10.3) | |
| *Homes with air conditioners* | | | | | | |
| No | 830 (29.8) | 133 (28.0) | 0.233 | 840 (29.8) | 129 (27.7) | 0.192 |
| Yes | 1957 (70.2) | 342 (72.0) | | 1979 (70.2) | 337 (72.3) | |
| *Homes with air filter* | | | | | | |
| No | 1200 (43.1) | 201 (42.3) | 0.401 | 1228 (43.6) | 188 (40.3) | 0.401 |
| Yes | 1587 (56.9) | 274 (57.7) | | 1591 (56.4) | 278 (59.7) | |
| *Homes with humidifier* | | | | | | |
| No | 1891 (67.9) | 279 (58.7) | <0.001 | 1899 (67.4) | 284 (60.9) | 0.004 |
| Yes | 896 (32.1) | 196 (41.3) | | 920 (32.6) | 182 (39.1) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Homes with dehumidifier* | | | | | | |
| No | 2029 (72.8) | 327 (68.8) | 0.043 | 2043 (72.5) | 333 (71.5) | 0.344 |
| Yes | 758 (27.2) | 148 (31.2) | | 776 (27.5) | 133 (28.5) | |
| *Homes with wood fireplace* | | | | | | |
| No | 2325 (83.4) | 412 (86.7) | 0.038 | 2346 (83.2) | 409 (87.8) | 0.007 |
| Yes | 462 (16.6) | 63 (13.3) | | 473 (16.8) | 57 (12.2) | |
| *Homes with heating recovery ventilator* | | | | | | |
| No | 2358 (84.6) | 406 (85.5) | 0.342 | 2383 (84.5) | 397 (85.2) | 0.388 |
| Yes | 429 (15.4) | 69 (14.5) | | 436 (15.5) | 69 (14.8) | |
| *Frequency of truck passing* | | | | | | |
| Never/seldom | 1400 (61.6) | 220 (54.3) | 0.004 | 1402 (61.0) | 219 (56.4) | 0.051 |
| Frequently | 873 (38.4) | 185 (45.7) | | 897 (39.0) | 169 (43.6) | |
| *Carpet on classroom floor* | | | | | | |
| No | 2346 (84.9) | 375 (79.4) | 0.003 | 2361 (84.5) | 379 (82.6) | 0.320 |
| Partly covered | 57 (2.1) | 8 (1.7) | | 52 (1.9) | 13 (2.8) | |
| Fully covered | 359 (13.0) | 89 (18.9) | | 382 (13.7) | 67 (14.6) | |
| Diet and behavioral factors | | | | | | |
| *Meat* | | | | | | |
| Never/occasionally | 66 (2.4) | 11 (2.3) | 0.711 | 68 (2.4) | 13 (2.9) | 0.532 |
| 1 or 2 times/wk | 551 (20.0) | 87 (18.4) | | 561(20.1) | 82 (18.0) | |
| 3 or more times/wk | 2133 (77.6) | 374 (79.2) | | 2163 (77.5) | 360 (79.1) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Seafood* | | | | | | |
| Never/occasionally | 1584 (58.0) | 276 (59.0) | 0.587 | 1614 (58.2) | 261 (58.1) | 0.996 |
| 1 or 2 times/wk | 986 (36.1) | 170 (36.3) | | 1004 (36.2) | 163 (36.3) | |
| 3 or more times/wk | 161 (5.9) | 22 (4.7) | | 157 (5.7) | 25 (5.6) | |
| *Fruit* | | | | | | |
| Never/occasionally | 54 (2.0) | 6 (1.3) | 0.529 | 48 (1.7) | 12 (2.6) | 0.018 |
| 1 or 2 times/wk | 299 (10.8) | 55 (11.7) | | 292 (10.4) | 65 (14.3) | |
| 3 or more times/wk | 2404 (87.2) | 409 (87.0) | | 2455 (87.8) | 378 (83.1) | |
| *Bread or cereal* | | | | | | |
| Never/occasionally) | 35 (1.3) | 4 (0.8) | 0.087 | 37 (1.3) | 3 (0.7) | 0.389 |
| 1 or 2 times/wk | 281 (10.2) | 34 (7.2) | | 278 (10.0) | 41(9.0) | |
| 3 or more times/wk | 2434 (88.5) | 434 (91.9) | | 2475 (88.7) | 411 (90.3) | |
| *Milk* | | | | | | |
| Never/occasionally | 143 (5.3) | 26 (5.6) | 0.963 | 146 (5.3) | 26 (5.9) | 0.715 |
| 1 or 2 times/wk | 273 (10.1) | 47 (10.2) | | 274 (10.0) | 49 (11.0) | |
| 3 or more times/wk | 2278 (84.6) | 390 (84.2) | | 2312 (84.6) | 369 (83.1) | |
| *Unpasteurized milk* | | | | | | |
| Never/occasionally | 2449 (93.8) | 437 (96.0) | 0.162 | 2487 (94.0) | 419 (95.9) | 0.246 |
| 1 or 2 times/wk) | 100 (3.8) | 11 (2.4) | | 100 (3.8) | 10 (2.3) | |
| 3 or more times/wk | 63 (2.4) | 7 (1.5) | | 60 (2.3) | 8 (1.8) | |
| *Pasta* | | | | | | |
| Never/occasionally | 46 (1.7) | 4 (0.9) | 0.401 | 48 (1.7) | 3 (0.7) | 0.171 |
| 1 or 2 times/wk | 48 (17.5) | 85 (18.1) | | 484 (17.4) | 87 (19.2) | |
| 3 or more times/wk | 2220 (80.8) | 381 (81.1) | | 2253 (80.9) | 364 (80.2) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Eggs* | | | | | | |
| Never/occasionally | 490 (18.0) | 97 (21.0) | 0.074 | 499 (18.0) | 95 (21.3) | 0.085 |
| 1 or 2 times/wk | 1597 (58.5) | 277 (59.8) | | 1619 (58.5) | 263 (59.1) | |
| 3 or more times/wk) | 641 (23.5) | 89 (19.2) | | 651 923.5) | 87 (19.6) | |
| *Nuts* | | | | | | |
| Never/occasionally | 1246 (46.3) | 235 (51.4) | 0.131 | 1267 (46.4) | 231 (52.4) | 0.024 |
| 1 or 2 times/wk | 1160 (43.1) | 179 (39.2) | | 1167 (42.8) | 177 (40.1) | |
| 3 or more times/wk | 283 (10.5) | 43 (9.4) | | 294 (10.8) | 33 (7.5) | |
| *Wild meat* | | | | | | |
| Never/occasionally | 2359 (87.1) | 411 (88.4) | 0.575 | 2410 (87.7) | 389 (87.2) | 0.234 |
| 1 or 2 times/wk | 262 (9.7) | 38 (8.2) | | 259 (9.4) | 38 (8.5) | |
| 3 or more times/wk | 86 (3.2) | 16 (3.4) | | 78 (2.8) | 19 (4.3) | |
| *Chips* | | | | | | |
| Never/occasionally | 416 (15.2) | 76 (16.3) | 0.757 | 419 (15.1) | 75 (16.6) | 0.525 |
| 1 or 2 times/wk | 1606 (58.8) | 275 (59.0) | | 1632 (59.0) | 269 (59.6) | |
| 3 or more times/wk | 709 (26.0) | 115 (24.7) | | 716 (25.9) | 107 (23.7) | |
| *Soda* | | | | | | |
| Never/occasionally | 1135 (42.0) | 202 (43.3) | 0.862 | 1154 (42.2) | 179 (39.8) | 0.348 |
| 1 or 2 times/wk | 1266 (46.9) | 216 (46.3) | | 1281 ((46.8) | 227 (50.4) | |
| 3 or more times/wk | 299 (11.1) | 49 (10.5) | | 300 (11.0) | 44 (9.8) | |
| *Fast food* | | | | | | |
| Never/occasionally | 1106 (40.5) | 177 (37.9) | 0.572 | 1136 (41.0) | 156 (34.7) | 0.030 |
| 1 or 2 times/wk | 1433 (52.5) | 255 (54.6) | | 1449 (52.3) | 255 (56.8) | |
| 3 or more times/wk | 193 (7.1) | 35 (7.5) | | 185 (6.7) | 38 (8.5) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Physical activity* | | | | | | |
| 1 day or < a week | 45 (1.9) | 7 (1.7) | 0.939 | 41 (1.7) | 6 (1.5) | 0.118 |
| 2-4 days a week | 605 (25.2) | 107 (25.8) | | 600 (24.7) | 120 (29.5) | |
| 5 or more days a week | 1753 (73.0) | 301 (72.5) | | 1790 (73.6) | 281 (69.0) | |
| *Screen time* | | | | | | |
| Less than 1 hour | 254 (10.1) | 31 (7.2) | 0.155 | 249 (9.8) | 42 (9.9) | 0.969 |
| 1 hours but <3 hours | 1279 (50.7) | 235 (54.7) | | 1302 (51.0) | 219 (51.7) | |
| ≤3 hours but <5 hours | 641 (25.4) | 100 (23.3) | | 643 (25.2) | 102 (24.1) | |
| ≤5 hours or more | 347 (13.8) | 64 (14.9) | | 359 (14.1) | 61 (14.4) | |
| | | | | | | |
| Health care access indicators | | | | | | |
| *Travelling time for routine care* | | | | | | |
| 0-15 minutes | 1487 (57.7) | 228 (50.9) | 0.026 | 1491 (57.3) | 227 (51.7) | 0.086 |
| >15-30 minutes | 924 (35.9) | 188 (42.0) | | 944 (36.3) | 182 (41.5) | |
| >30 minutes | 165 (6.4) | 32 (7.1) | | 167 (6.4) | 30 (6.8) | |
| *Travelling time for emergency care* | | | | | | |
| 0-15 minutes | 1338 (52.6) | 232 (52.3) | 0.652 | 1348 (52.4) | 227 (52.2) | 0.412 |
| >15-30 minutes | 1018 (40.0) | 184 (41.4) | | 1035 (40.2) | 183 (41.1) | |
| >30 minutes | 189 (7.4) | 28 (6.3) | | 191 (7.4) | 25 (5.7) | |
| *Place of receiving medical care* | | | | | | |
| Family physician | 1959 (69.3) | 350 (72.9) | 0.063 | 1974 (69.0) | 346 (73.8) | 0.021 |
| Not family physician | 866 (30.7) | 130 (27.1) | | 886 (31.0) | 123 (26.2) | |
| *Difficulties getting health care services* | | | | | | |
| No | 2600 (93.6) | 394 (83.7) | <0.001 | 2617 (93.2) | 394 (85.7) | <0.001 |
| Yes | 177 (6.4) | 77 (16.3) | | 191 (6.8) | 66 (14.3) | |

| Covariates | Current wheeze | | P value | Current asthma | | P value |
|---|---|---|---|---|---|---|
| | No (n=2825) % | Yes (n=480) % | | No (n=2860) % | Yes (n=469) % | |
| *Unable to get prescription medications* | | | | | | |
| No | 2721 (97.2) | 444 (93.7) | <0.001 | 2755 (97.3) | 429 (92.1) | <0.001 |
| Yes | 79 (2.8) | 30 (6.3) | | 75 (2.7) | 37 (7.9) | |

With regard to personal risk factors and current asthma, being male and children from homes where there was not enough money left over at the end of the month, children who struggled to meet the basic living requirements in the past 12 months, were born premature, never breastfed, attended daycare, had a history of allergy, had parents with a history of asthma and allergies were significantly more likely to have current asthma. With regard to environmental risk factors and current asthma, children who had a father who smoked currently, children exposed to smoke from alternate caregivers, children who lived with any home dampness from rain or flooding, lived in a home with mildew odor or musty smell, lived in a home with signs of mold or mildew, lived in a home with a humidifier, or lived in a home with a wood fireplace were more likely to have current asthma. With regard to diet and health risk behaviours, children who ate fruit and nuts 3 or more times per week were less likely to have current asthma while children who ate fast food 3 or more times per week were more likely to have current asthma. With regard to health care access indicators and current asthma, children who visited a family physician or had difficulties getting health care services, or were unable to get prescription medications were more likely to have current asthma.

With regard to personal risk factors and current wheeze, males, younger children, Caucasian children, those children who struggled to meet the basic living requirements in the past 12 months or children who were born premature, never breastfed, attended daycare, had a personal history of allergy, and had parents with history of asthma and allergies were more likely to have current wheeze. With regard to environmental risk factors and current wheeze, children who had parents who smoked currently or who were exposed to smoke from alternate caregivers, had home dampness from rain or flooding,

or who lived in a home with a mildew odor or musty smell, in a home with signs of mold or mildew, in a home with a humidifier, in a home with a wood fireplace, in a home with mice or pests, in a home with frequent truck passing through the street close to their homes, or who had a classroom floor fully covered with carpet were more likely to report current wheeze. With regard to health care access indicators and current wheeze, children with more than 30 minutes travelling time for routine care, children who had difficulties getting health care services and were unable to get prescription medications were more likely to have current wheeze.

Multivariate analysis results, after adjustment for potential confounders, for each outcome are reported in Table 4.7. Adjusted results in Table 4.7 show that there were no statistically significant associations between current asthma and current wheeze with geographic status (large urban vs. small urban vs. rural town).

**Table 4.7: Multiple logistic regression analysis of current wheeze and current asthma as the outcomes:**

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted‡ Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| *Location* | | | | | | |
| *Large urban* | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| *Small urban* | 0.97 (0.71-1.31) | 0.96 (0.57-1.64) | 1.13 (0.56-2.30) | 1.11 (0.82-1.49) | 1.52 (0.90-2.55) | 1.40 (0.69-2.83) |
| *Rural area* | 0.90 (0.70-1.15) | 0.77 (0.51-1.15) | 1.05 (0.65-1.70) | 0.77 (0.59-1.00) | 0.67 (0.43-1.03) | 0.80 (0.47-1.36) |
| *Sex* | | | | | | |
| Male | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Female | 0.65 (0.53-0.79) | 0.82 (0.63-1.07) | 0.78 (0.56-1.07) | 0.65 (0.53-0.79) | 0.74 (0.56-0.98) | 0.71 (0.50-0.99) |
| *Age Group* | | | | | | |
| 5-9 years (younger) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 10-14 years (older) | 0.69 (0.57-0.84) | 0.69 (0.52-0.92) | 0.67 (0.48-0.94) | 0.95 (0.78-1.16) | 0.91 (0.68-1.21) | 0.90 (0.64-1.28) |
| *Ethnicity* | | | | | | |
| Caucasians | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| First Nations | 1.12 (0.86-1.45) | 0.87 (0.55-1.38) | 0.72 (0.40-1.31) | 1.12 (0.86-1.47) | 1.15 (0.70-1.88) | 1.11 (0.60-2.07) |
| Others | 0.52 (0.39-0.71) | 0.66 (0.40-1.08) | 0.57 (0.31-1.08) | 0.76 (0.58-1.01) | 1.04 (0.64-1.69) | 0.91 (0.50-1.68) |
| *Money left over at the end of the month* | | | | | | |
| Some money | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Just enough money | 1.03 (0.81-1.30) | | 1.14(0.76-1.70) | 1.28 (1.02-1.62) | | 1.45 (0.96-2.18) |
| Not enough money | 1.33 (0.99-1.80) | | 0.97 (0.51-1.84) | 1.52 (1.12-2.06) | | 0.99 (0.50-1.95) |

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted‡ Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| In past 12 months struggled meeting basic requirements | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.61 (1.26-2.05) | 1.45 (0.98-2.14) | 1.29 (0.75-2.23) | 1.70 (1.33-2.16) | 1.46 (0.97-2.20) | 1.01 (0.62-1.93) |
| *Child has any allergy* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 4.79 (3.90-5.87) | 4.09 (3.11-5.36) | 4.50 (3.25-6.23 | 6.42 (5.18-7.96) | 5.15 (3.85-6.90) | 5.00 (3.53-7.01) |
| *Father with history of asthma and allergies* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.87 (1.53-2.29) | 1.49 (1.13-1.96) | 1.36 (0.98-1.89) | 2.09 (1.71-2.55) | 1.67 (1.25-2.24) | 1.94 (1.37-2.73) |
| *Mother with history of asthma and allergies* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 2.34 (1.93-2.85) | 1.69 (1.29-2.21) | 1.62 (1.17-2.25) | 2.58 (2.12-3.15) | 2.01 (1.51-2.67) | 2.21 (1.56-3.12) |
| *Participation in community's events* | | | | | | |
| Never | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Rarely | 1.60 (1.02-2.53) | 1.27 (0.65-2.47) | 0.90 (0.40-2.07) | 0.84 (0.54-1.30) | 0.71 (0.36-1.40) | 0.61 (0.26-1.43) |
| Sometimes | 1.40 (0.93-2.11) | 0.83(0.45-1.52) | 0.58 (0.72-1.25) | 1.04 (0.71-1.51) | 0.67 (0.37-1.22) | 0.50 (0.26-1.08) |
| Always | 1.40 (0.88-2.22) | 0.99 (0.51-1.92) | 0.66 (0.29-1.53) | 0.98 (0.64-1.52) | 0.78 (0.49-1.52) | 0.62 (0.27-1.42) |
| *Community support* mean | 1.00 (0.99-1.00) | 1.00 (1.00-1.01) | 1.00 (1.00-1.01) | 1.00 (0.99-1.00) | 1.00 (0.99-1.01) | 1.00 (0.99-1.01) |

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted‡ Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| *Children born premature* | | | | | | |
| No | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Yes | 1.33 (1.08-1.63) | | 1.21 (0.87-1.68) | 1.37 (1.11-1.69) | | 1.44 (1.02-2.03) |
| First born child | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.03 (0.80-1.25) | 0.96 (0.74-1.25) | 0.90 (0.66-1.24) | 1.11 (0.91-1.36) | 1.09 (0.82-1.44) | 1.14 (0.82-1.60) |
| *Children breastfed* | | | | | | |
| Never | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 0-4 weeks | 1.23 (0.88-1.70) | 1.12 (0.70-1.79) | 1.34 (0.75-2.39) | 1.11 (0.79-1.55) | 1.15(0.68-1.94) | 1.36 (0.72-2.58) |
| 4 weeks to 6 months | 0.74 (0.55-1.00) | 0.72 (0.46-1.11) | 0.67 (0.38-1.17) | 0.74 (0.54-1.01) | 0.91 (0.56-1.47) | 0.77 (0.42-1.43) |
| More than 6 months | 0.65 (0.49-0.846) | 0.72 (0.47-1.08) | 0.88 (0.53-1.48) | 0.75 (0.57-1.00) | 1.09 (0.69-1.72) | 1.19 (0.68-2.11) |
| *Day care attendance* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.27 (1.04-1.56) | 1.14 (0.86-1.51) | 1.17 (0.83-1.64) | 1.14 (0.93-1.40) | 0.97 (0.72-1.30) | 0.90 (0.63-1.28) |
| *Consumption of unpasteurized milk in first year of life* | | | | | | |
| *No* | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| *Yes* | 0.92 (0.57-1.49) | 0.99 (0.43-2.25) | 1.41 (0.45-4.45) | 1.03 (0.64-1.65) | 0.87 (0.37-2.05) | 0.90 (0.63-1.28) |

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted‡ Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| *Live on a farm during the first year of life* | | | | | | |
| *No* | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| *Yes* | 1.51 (0.78-1.69) | 1.33 (0.74-2.39) | 1.14 (0.55-2.37) | 0.86 (0.56-1.32) | 1.67 (0.89-3.14) | 1.30 (0.59-2.86) |
| *Current maternal smoking* | | | | | | |
| No | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Yes | 1.36 (1.07-1.73) | | 1.55 (0.95-2.51) | 1.10 (0.85-1.42) | | 0.94 (0.55-1.60) |
| Current maternal smoking | | | | | | |
| No | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Yes | 1.23 (0.98-1.54) | | 0.96 (0.62-1.48) | 1.25 (1.00-1.57) | | 1.32 (0.85-2.07) |
| *Child's friends' smoking* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.45 (0.93-2.27) | 1.79 (0.97-3.33) | 1.16 (0.50-2.67) | 1.27 (0.79-2.03) | 1.37 (0.70-2.68) | 1.14 (0.49-2.65) |
| *Child exposed to smoke from alternate caregivers* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.57 (1.19-2.02) | 0.94 (0.61-1.44) | 1.24 (0.74-2.07) | 1.56 (1.17-2.07) | 1.34 (0.88-2.05) | 1.30 (0.77-2.21) |

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted‡ Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| *Home damage caused by dampness (wet spots)* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.18 (0.90-1.53) | 1.09 (0.72-1.64) | 1.00 (0.58-1.74) | 1.16 (0.89-1.52) | 0.82 (0.52-1.28) | 0.78 (0.43-1.42) |
| *In the past 12 month, any home dampness from rain or flood* | | | | | | |
| No | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Yes | 1.46 (1.18-1.81) | | 1.91 (1.27-2.87) | 1.51 (1.21-1.87) | | 1.70 (1.10-2.62) |
| *Mildew odor or musty smell* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.37 (1.06-1.76) | 1.10 (0.72-1.70) | 1.02 (0.59-1.75) | 1.42 (1.10-1.82) | 1.23 (0.78-1.94) | 1.07 (0.60-1.91) |
| *Signs of mold or mildew* | 1 | | | | | |
| No | .00 | | 1.00 | 1.00 | | 1.00 |
| Yes | 1.33 (1.00-1.77) | | 0.59 (0.33-1.05) | 1.49 (1.13-1.98) | | 0.59 (0.32-1.07) |
| *Dog living in your home in the past 12 months* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.14 (0.94-1.39) | 0.93 (0.71-1.22) | 0.78 (0.56-1.08)) | 1.16 (0.95-1.41) | 0.95 (0.71-1.26) | 0.89 (0.63-1.27) |

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted‡ Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| *Cat living in your home in the past 12 months* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.14 (0.92-1.42) | 1.05 (0.77-1.42) | 0.99 (0.69-1.42) | 0.99 (0.79-1.24) | 1.01 (0.73-1.39) | 0.90 (0.61-1.33) |
| *Home with mice or pests* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.50 (1.10-2.03) | 1.42 (0.90-2.25) | 1.47 (0.85-2.55) | 1.31 (0.95-1.80) | 1.37 (0.82-2.27) | 1.17 (0.63-2.16) |
| *Fuel used for heating in home* | | | | | | |
| Natural gas | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Electricity | 0.80 (0.56-1.16) | | 0.34 (0.15-0.80) | 0.68 (0.46-1.00) | | 0.42 (0.19-0.94) |
| Others | 1.07 (0.71-1.63) | | 0.65 (0.28-1.51) | | | 0.61 (0.24-1.53) |
| *Home crowding (persons/rooms)* | | | | | | |
| <=1 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| >1 | 0.89 (0.71-1.13) | 1.28 (0.87-1.89) | 1.61 (0.99-2.63) | 0.90 (0.71-1.13) | 1.02 (0.68-1.52) | 1.31 (0.79-2.16) |
| *Type of housing units* | | | | | | |
| For Single family | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Others | 1.20 (0.88-1.64) | 1.18 (0.70-1.99) | 1.43 (0.73-2.80) | 1.05 (0.76-1.44) | 0.95 (0.55-1.65) | 1.00 (0.49-2.06) |
| *Homes with air filter* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.03 (0.85-1.26) | 0.92 (0.69-1.22) | 1.05 (0.74-1.47) | 1.14 (0.94-1.39) | 1.30 (0.96-1.76) | 1.15 (0.80-1.65) |

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted‡ Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| *Homes with humidifier* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.48 (1.26-1.81) | 1.13 (0.86-1.49) | 1.15 (0.83-1.60) | 1.32 (1.08-1.62) | 1.09 (0.81-1.46) | 0.97 (0.68-1.37) |
| *Homes with dehumidifier* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.212 (0.98-1.50) | 0.99 (0.73-1.33) | 1.11 (0.78-1.57) | 1.05 (0.85-1.31) | 0.85 (0.62-1.17) | 0.92 (0.63-1.34) |
| *Homes with wood fireplace* | | | | | | |
| No | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Yes | 0.77 (0.58-1.02) | | 0.61 (0.38-0.98) | 0.69 (0.52-0.93) | | 0.74 (0.46-1.20) |
| *Homes with heating recovery ventilator* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 0.93 (0.71-1.23) | 1.26 (0.87-1.83) | 1.11 (0.71-1.73) | 0.95 (0.72-1.25) | 1.26 (0.86-1.84) | 0.86 (0.53-1.38) |
| *Carpet on classroom floor* | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Partly covered | 0.88 (0.42-1.86) | 0.72(0.20-2.50) | 0.47 (0.06-3.99) | 1.56 (0.84-2.89) | 2.49 (0.95-6.52) | 2.74 (0.68-11.1) |
| Fully covered | 1.55 (1.20-2.00) | 1.24 (0.86-1.80) | 1.08 (0.68-1.70) | 1.09 (0.83-1.45) | 1.04 (0.69-1.58) | 0.70 (0.41-1.20) |
| *Seafood* | | | | | | |
| Never/occasionally | 1.00 | | 1.00 | 1.00 | | 1.00 |
| 1 or 2 times/wk | 0.99 (0.81-1.22) | | 1.64 (1.17-2.29) | 1.00 (0.81-1.24) | | 1.61 (1.12-2.30) |
| 3 or more times/wk | 0.78 (0.49-1.25) | | 0.96 (0.36-2.56) | 0.99 (0.63-1.53) | | 1.63 (0.65-4.10) |

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted[†] Odds ratio (95% CI) | Fully adjusted[‡] Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted[†] Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| *Fruit* | | | | | | |
| Never/occasionally | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 or 2times/wk | 1.66 (0.68-4.04) | 1.43 (0.43-4.73) | 0.67 (0.18-2.56) | 0.89 (0.45-1.77) | 1.30 (0.41-4.11) | 0.78 (0.20-3.10) |
| 3 or more times/wk | 1.53 (0.66-3.58) | 1.45 (0.47-4.49) | 0.78 (0.23-2.66) | 0.62 (0.32-1.17) | 1.21 (0.41-3.54) | 1.19 (0.34-4.20) |
| *Bread or cereal* | | | | | | |
| Never/occasionally | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 or 2 times/wk | 1.06 (0.36-3.16) | 0.74 (0.18-3.15) | 0.62 (0.09-4.04) | 1.82 (0.54-6.17) | 1.62 (0.29-8.93) | 0.89 (0.13-6.29) |
| 3 or more times/wk | 1.56 (0.55-4.41) | 1.13 (0.29-4.38) | 1.04 (0.18-5.99) | 2.05 (0.63-6.67) | 2.95 (0.58-14.1) | 1.73 (0.28-10.6) |
| *Milk* | | | | | | |
| Never/occasionally | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 or 2times/wk | 0.95 (0.56-1.59) | 1.34 (0.63-2.86) | 1.38 (0.53-3.60) | 1.00 (0.60-1.68) | 1.18 (0.55-2.51) | 1.40 (0.57-3.45) |
| 3 or more times/wk | 0.94 (0.61-1.45) | 1.19 (0.63-2.26) | 1.44 (0.64-3.21) | 0.90 (0.58-1.38) | 1.08 (0.57-2.02) | 1.11 (0.52-2.38) |
| *Unpasteurized milk* | | | | | | |
| Never/occasionally | 1.00 | | 1.00 | 1.00 | | 1.00 |
| 1 or 2times/wk) | 0.62 (0.33-1.16) | | 0.76 (0.15-3.72) | 0.59 (0.31-1.5) | | 0.91 (0.19-4.37) |
| 3 or more times/wk | 0.62 (0.28-1.37) | | 0.29 (0.03-2.79) | 0.79 (0.38-1.67) | | 0.28 (0.03-2.67) |
| *Eggs* | | | | | | |
| Never/occasionally | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 or 2times/wk | 0.88 (0.68-1.13) | 1.19 (0.84-1.69) | 1.20 (0.79-1.83) | 0.85 (0.66-1.10) | 1.06 (0.74-1.53) | 1.02 (0.66-1.59) |
| 3 or more times/wk) | 0.70 (0.51-0.96) | 1.04 (0.67-1.60) | 0.86 (0.50-1.50) | 0.70 (0.51-0.96) | 0.87 (0.55-1.36) | 0.90 (0.51-1.59) |
| *Nuts* | | | | | | |
| Never/occasionally | 1.00 | | 1.00 | 1.00 | | 1.00 |
| 1 or 2times/wk | 0.82 (0.66-1.01) | | 0.57 (0.40-0.81) | 0.8 (0.67-1.03) | | 0.76 (0.53-1.10) |
| 3 or more times/wk | 0.81 (0.57-1.14) | | 0.99 (0.57-1.73) | 0.62 (0.42-0.91) | | 0.68 (0.36-1.28) |

| Covariates | Current wheeze | | | Current asthma | | |
|---|---|---|---|---|---|---|
| | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted‡ Odds ratio (95% CI) | Crude odds ratio (95% CI) | Base adjusted† Odds ratio (95% CI) | Fully adjusted Odds ratio (95% CI) |
| *Wild meat* | | | | | | |
| Never/occasionally | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 or 2times/wk | 0.83 (0.58-1.19) | 0.96 (0.59-1.54) | 1.07 (0.59-1.94) | 0.91 (0.64-1.30) | 1.26 (0.77-2.05) | 1.06 (0.57-1.99) |
| 3 or more times/wk | 1.70 (0.62-1.84) | 0.33 (0.11-0.99) | 0.44 (0.13-1.44) | 1.51 (0.90-2.52) | 0.73 (0.30-1.80) | 0.67 (0.23-2.00) |
| *Chips* | | | | | | |
| Never/occasionally | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 or 2times/wk | 0.94 (0.71-1.24) | 1.03 (0.71-1.50) | 1.12 (0.69-1.83) | 0.92 (0.70-1.22) | 0.89 (0.61-1.01) | 0.69 (0.42-1.14) |
| 3 or more times/wk | 0.89 (0.65-1.22) | 1.10 (0.73-1.68) | 0.97 (0.56-1.69) | 0.84 (0.61-1.15) | 0.93 (0.61-1.44) | 0.64 (0.36-1.13) |
| *Soda* | | | | | | |
| Never/occasionally | 1.00 | | 1.00 | 1.00 | | 1.00 |
| 1 or 2times/wk | 0.96 (0.78-1.18) | | 0.96 (0.66-1.40) | 1.14 (0.93-1.41) | | 1.42 (0.96-2.10) |
| 3 or more times/wk | 0.92 (0.66-1.29) | | 1.20 (0.60-2.40) | 0.95 (0.66-1.35) | | 0.69 (0.31-1.55) |
| *Fast food* | | | | | | |
| Never/occasionally | 1.00 | | 1.00 | 1.00 | | 1.00 |
| 1 or 2times/wk | 1.11 (0.90-1.37) | | 0.99 (0.69-1.41) | 1.28 (1.04-1.59) | | 1.29 (0.88-1.90) |
| 3 or more times/wk | 1.13 (0.77-1.68) | | 1.18 (0.53-2.64) | 1.50 (1.02-2.20) | | 2.67 (1.20-5.97) |
| *Physical activity* | | | | | | |
| 1 day or < a week | 1.00 | | 1.00 | 1.00 | | 1.00 |
| 2-4 days a week | 1.14 (0.50-2.59) | | 0.68 (0.21-2.20) | 1.37 (0.57-3.29) | | 1.53 (0.37-6.34) |
| 5 or more days a week | 1.10 (0.49-2.47) | | 0.60 (0.19-1.89) | 1.07 (0.45-2.55) | | 1.14 (0.28-4.65) |

† Adjusted for location, age, sex, ethnicity, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance, dog living in your home in the past 12 months, home with mice or pests, egg consumption in the past 12 months, wild meat consumption in the past 12 months, milk consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in first

year of life, live on a farm during first year of life, first born child, home damage caused by dampness, cat living in your home in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of chips in the 12 months, community support, homes with humidifier, carpet on classroom floor, consumption of fruit in the past 12 months, consumption of bread in the past 12 months., consumption of bread in the past 12 months.

‡Adjusted for location, age, sex, ethnicity, money left at the end of the month, children born premature, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, home dampness from rain or flood in the past 12 months, signs of mold or mildew, fuel used for heating in home, homes with wood fireplace, consumption of unpasteurized milk in the past 12 months, current paternal smoking, current maternal smoking, consumption of seafood in the past 12 months, consumption of pasta in the past 12 months, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance, dog living in your home in the past 12 months, home with mice or pests, egg consumption in the past 12 months, nuts consumption in the past 12 months, wild meat consumption in the past 12 months, soda consumption in the past 12 months, milk consumption in the past 12 months, fast food consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in the past 12 months, live on a farm during first year of life, first born child, home damage caused by dampness, cat living in your home in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of chips in the past 12 months, community support, homes with humidifier, carpet on classroom, physical activity, consumption of fruit in the past 12 months, consumption of bread in the past 12 months..

Females were less likely to have current asthma than males. Children who reported a personal history of allergy, a paternal history of asthma and allergies, or a maternal history of asthma and allergies were more likely to have current asthma. Children living with any home dampness from rain or flooding in the past 12 months or living in homes with electricity used for heating the home were more likely to have current asthma. Children who ate seafood 1 or 2 times per week in the past 12 months or fast food 3 or more times per week in the past 12 months were more likely to report current asthma.

An older age group (10-14 years) of children were less likely to have current wheeze. Children who reported a personal history of allergy or who had a mother with a history of asthma and allergies were more likely to have current wheeze. Children who lived in a home with any home dampness from rain or flooding in the past 12 months were more likely to report current wheeze. Children living in a home that used electricity for heating or a home with a wood fireplace were less likely to have current wheeze. Children who ate seafood 1 or 2 times per week in the past 12 months were more likely to have current wheeze than those who did not. Also, children who ate nuts 1 or 2 times per week in the past 12 months were less likely to report current wheeze than those who did not.

A summary of the multivariate analysis results, after adjustment for potential confounders, for each outcome is presented in Table 4.8. Variables that were statistically significant for either outcome are presented in Table 4.8 with a description of their association.

**Table 4.8: Summary of multiple logistic regression analysis of current wheeze and current asthma as the outcomes**

| Covariates | Current wheeze | Current asthma |
|---|---|---|
| Location | | ↓ed risk |
| Female | | ↓ed risk |
| Age | | ↓ed risk |
| Child with history of allergies | ↑ed risk | ↑ed risk |
| Father with history of asthma and allergies | | ↑ed risk |
| Mother with history of asthma and allergies | ↑ed risk | ↑ed risk |
| Children born premature | | ↑ed risk |
| Fuel used for heating in home | ↓ed risk | |
| Homes with wood fireplace | ↓ed risk | |
| Home dampness from rain or flood in the past 12 months | ↑ed risk | ↑ed risk |
| Consumption of seafood in the past 12 months | | ↑ed risk |
| Consumption of fast food in the past 12 months | | ↑ed risk |

↓ed risk indicated odds ratio (OR) <1 and ↑ed risk indicated odds ratio (OR) > 1

## 4.3 Results for Research Question 2 *Which risk factors best explain the variations of current asthma prevalence in Saskatchewan?*

The mediation analysis of location with current asthma is presented in Table 4.9. The association between location and current asthma changed by more than 5% towards the null when father's smoking, physical activity by the child, fast food and nuts consumption in the past 12 months were included variables in the model.

Table 4.9: Adjusted association between location and current asthma with the addition of each factor to explore potential mediation.

| | Urban (reference category) | Small urban odds ratio (95%CI) | % change from base adjusted model | Rural area odds ratio (95%CI) | % change from base adjusted model |
|---|---|---|---|---|---|
| Base model (Crude association) | 1.00 | 1.11 (0.82-1.49) | | 0.77 (0.59-1.00) | |
| Base model (Adjusted) | 1.00 | 1.52 (0.90-2.55) | | 0.67 (0.43-1.03) | |
| Basic model (adjusted) with the following added one group at a time | | | | | |
| Children born premature | 1.00 | 1.49 (0.87-2.54) | -2.1 | 0.62 (0.39-0.96) | -7.9 |
| Money left over at the end of the month | 1.00 | 1.53 (0.91-2.57) | 0.6 | 0.64 (0.41-1.00) | -4.6 |
| Father's smoking | 1.00 | 1.32 (0.76-2.30) | -12.9 | 0.63 (0.40-0.99) | -5.5 |
| Fuel used for heating | 1.00 | 1.50 (0.87-2.57) | -1.1 | 0.75 (0.47-1.17) | -11.5 |
| Physical activity | 1.00 | 1.65 (0.96-2.86) | 9.0 | 0.74 (0.47-1.16) | 11.1 |
| Fast food consumption | 1.00 | 1.52 (0.90-2.57) | 0.2 | 0.71 (0.45-1.10) | 12.5 |
| Nuts consumption | 1.00 | 1.41 (0.83-2.39) | -6.9 | 0.65 (0.42-1.01) | -2.5 |
| Fully adjusted model | 1.00 | 1.40 (0.69-2.83) | | 0.80 (0.47-1.36) | |

a Adjusted for location, age, sex, ethnicity, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance, dog living in your home in the past 12 months, home with mice or pests, egg consumption in the past 12 months, wild meat consumption in the past 12 months, milk consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in first year of life, live on a farm during first year of life, first born child, home damage caused by dampness, cat living in your home in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of

chips in first year of life, community support, homes with humidifier, carpet on classroom floor, consumption of fruit in first year of life, consumption of bread in first year of life.

b Adjusted for location, age, sex, ethnicity,  struggled to meet the basic living requirements, children born premature, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, home dampness from rain or flood in the past 12 months, signs of mold or mildew, fuel used for heating in home, homes with wood fireplace, consumption of unpasteurized milk in the past 12 months, current paternal smoking, current maternal smoking, consumption of seafood in the past 12 months, consumption of pasta in the past 12 months, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance, dog living in your in the past 12 months, home with mice or pests, egg consumption in the past 12 months, nuts consumption in the past 12 months, wild meat consumption in the past 12 months, soda consumption in the past 12 months, milk consumption in the past 12 months, fast food consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in first year of life, live on a farm during first year of life, first born child, home damage caused by dampness, cat living in your in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of chips in first year of life, community support, homes with humidifier, carpet on classroom, physical activity, consumption of fruit in first year of life.

The mediation analysis of location with current wheeze is present in Table 4.10. The association between location and current wheeze changed by more than 5% towards the null when following variables were included in the model: parents with money left over at the end of the month, fuel used for heating in the home, physical activity by the child.

Table 4.10: Adjusted association between location and current wheeze with the addition of each factor to explore potential mediation

| | Urban (reference category) | Small urban odds ratio (95%CI) | % change from base adjusted model | Rural area odds ratio (95%CI) | % change from base adjusted model |
|---|---|---|---|---|---|
| Base model (Crude association) | 1.00 | 0.97 (0.71-1.31) | | 0.90 (0.70-1.15) | |
| Base model (Adjusted)[a] | 1.00 | 0.97 (0.57-1.64) | | 0.77 (0.51-1.15) | |
| Basic model (Adjusted) with the following added one at a time | | | | | |
| Children born premature | 1.00 | 0.98 (0.57-1.69) | 1.3 | 0.74 (0.49-1.12) | -3.3 |
| Money left over at the end of the month | 1.00 | 1.01 (0.59-1.73) | 5.1 | 0.82 (0.56-1.23) | 6.5 |
| Father's smoking | 1.00 | 0.82 (0.46-1.47) | -14.8 | 0.77 (0.51-1.16) | 0.0 |
| Fuel used for heating | 1.00 | 0.89 (0.51-1.55) | -7.7 | 0.81 (0.54-1.23) | 5.7 |
| Physical activity | 1.00 | 1.08 (0.62-1.88) | 11.9 | 0.82 (0.54-1.24) | 6.6 |
| Fast food consumption | 1.00 | 0.96 (0.57-1.64) | -0.1 | 0.79 (0.53-1.18) | 2.5 |
| Nuts consumption | 1.00 | 0.91 (0.53-1.56) | -5.9 | 0.76 (0.50-1.14) | -1.6 |
| Fully adjusted model[b] | 1.00 | 1.13 (0.56-2.30) | | 1.05 (0.65-1.70) | |

a Adjusted for location, age, sex, ethnicity, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance, dog ownership in the past 12 months, home with mice or pests, egg consumption in the past 12 months, wild meat consumption in the past 12 months, milk consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in first year of life, live on a farm during first year of life, first born child, home damage caused by dampness, cat ownership in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of chips in first year of life, community support, homes with humidifier, carpet on classroom floor, consumption of fruit in first year of life, consumption of bread in first year of life.

b Adjusted for location, age, sex, ethnicity,  struggled to meet the basic living requirements, children born premature, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, home dampness from rain or flood in the past 12 months, signs of mold or mildew, fuel used for heating in home, homes with wood fireplace, consumption of unpasteurized milk in the past 12 months, current paternal smoking, current maternal smoking, consumption of seafood in the past 12 months, consumption of pasta in the past 12 months, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance,  dog ownership in the past 12 months, home with mice or pests, egg consumption in the past 12 months, nuts consumption in the past 12 months, wild meat consumption in the past 12 months, soda consumption in the past 12 months, milk consumption in the past 12 months, fast food consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in first year of life, live on a farm during first year of life, first born child, home damage caused by dampness, cat ownership in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of chips in first year of life, community support, homes with humidifier, carpet on classroom, physical activity, consumption of fruit in first year of life.

## 4.4 Results for Research Question 3 *Are the risk factors of current asthma and wheeze, as identified in Research Question #1, modified by area of residence?*

The interaction terms for current asthma were statistically significant for location*sex, location*mother with history of asthma and allergies, location*home dampness from rain or flood in the past 12 months. Stratified analysis by location of residence for current asthma is presented in Figure 4.3. In the large urban and small urban areas, there were statistically significant associations found between sex and current asthma where females were less likely to have current asthma. This association was not seen in the rural group. In all areas, there were statistically significant associations found between mother with a history of asthma and allergies and current asthma where children who had a mother with history of asthma and allergies were more likely to have current asthma. In the rural area, there was a statistically significant association found between any home dampness from rain or flooding in the past 12 months variable and current asthma where children living in a home with dampness from rain or flood were more likely associated with current asthma. This association was not observed in either large or small urban areas.

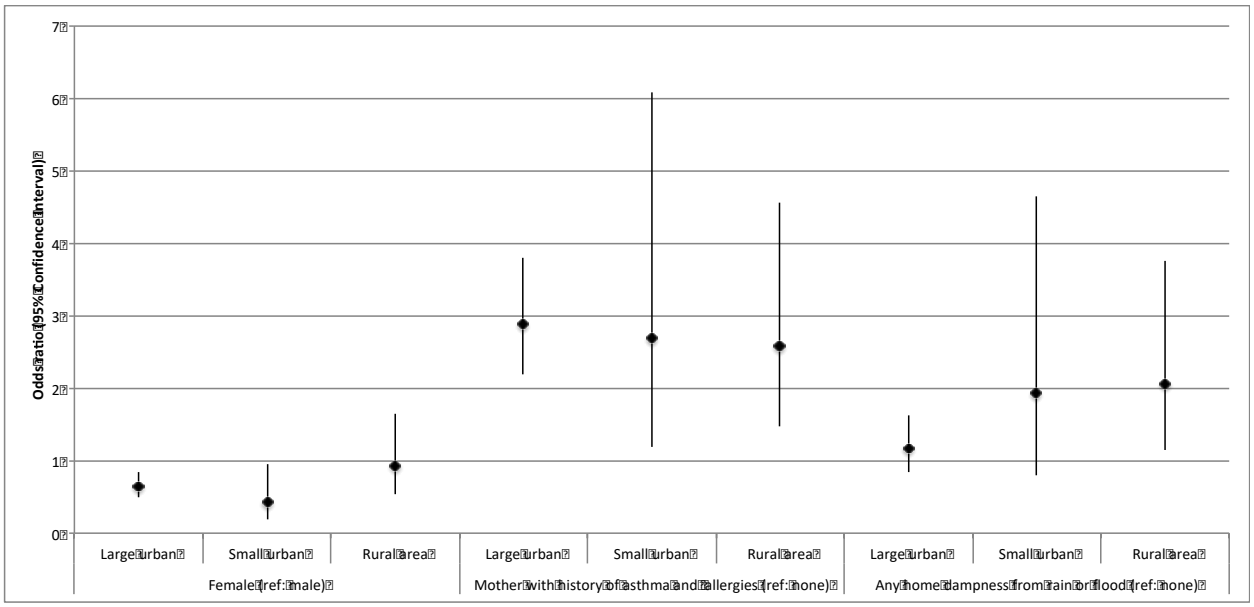


Figure 4.3: Stratified analysis of location with current asthma as the outcome

Adjusted for location, age, sex, ethnicity, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance, dog ownership in the past 12 months, home with mice or pests, egg consumption in the past 12 months, wild meat consumption in the past 12 months, milk consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in first year of life, live on a farm during first year of life, first born child, home damage caused by dampness, cat ownership in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of chips in the past 12 months, community support, homes with humidifier, carpet on classroom floor, consumption of fruit in the past 12 months, consumption of bread in in the past 12 months.

†.The results of signs of mold or mildew variable were not included because of small cell sizes.

The interaction terms with current wheeze were statistically significant for location*sex, location*mother with history of asthma and allergies, location*participation in community events, location*current maternal smoking, location*home dampness from rain or flood, and location*homes with dehumidifier. Stratified analysis by location of

residence when looking at current wheeze is presented in Figure 4.4. In the large urban and small urban areas, there were statistically significant associations found between sex and current wheeze where being female was less likely associated with current wheeze. This association was not seen in the rural area. In the large urban and rural areas, there were statistically significant associations observed between mother with history of asthma and allergies variable and current wheeze where children who had a mother with history of asthma and allergies were more likely to have current wheeze. This association was not observed in the small urban area. In the large urban and rural areas, there was a statistically significant association found between participation in community events and current wheeze. In the large urban area, children who rarely participated in a community's events were more likely to have current wheeze. Children living in the rural area who sometimes participated in a community's events were less likely to have current wheeze. This association was not seen in the small urban area. In the rural group, there was a statistically significant association found between current maternal smoking and current wheeze where children living in the rural area who had a mother with a history of current smoking were more likely to have current wheeze. This association was not observed in either large or small urban areas. There was a statistically significant association found between any home dampness from rain or flooding in the past 12 months variable and current wheeze where rural children living in a home with dampness from rain or flood were more likely associated with current wheeze. This association was not seen in either large or small urban area. In small urban and rural areas, there were statistically significant associations found between homes with a dehumidifier and

current wheeze where children who lived in a home with a dehumidifier were more likely associated with current wheeze. This association was not seen in the large urban area.

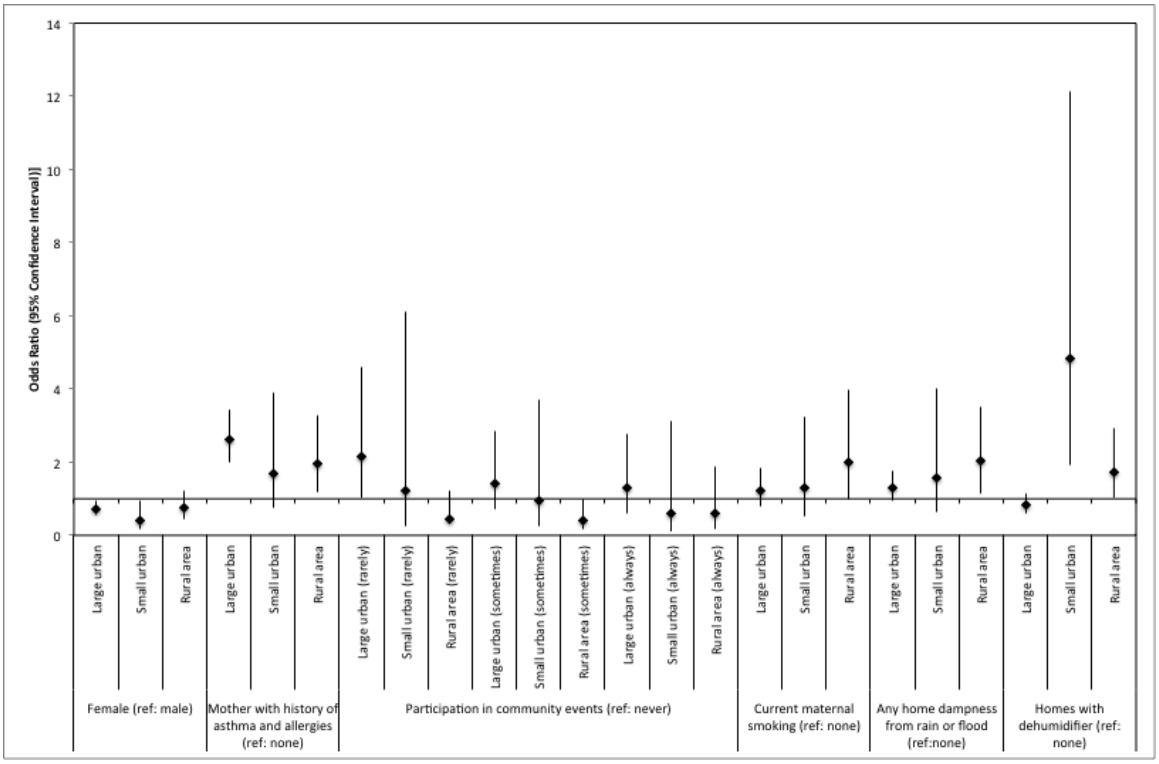


Figure 4.4: Stratified analysis of location with current wheeze as the outcome

Adjusted for location, age, sex, ethnicity, children breastfed, children with any allergy, mother with history of asthma and allergies, father with history of asthma and allergies, struggled to meet the basic living requirements, mildew odor or musty smell, child exposed to smoke from alternate caregivers, day care attendance, dog ownership in the past 12 months, home with mice or pests, egg consumption in the past 12 months, wild meat consumption in the past 12 months, milk consumption in the past 12 months, participation in the community's events, child's friends' smoking, homes with air filter, consumption of unpasteurized milk in first year of life, live on a farm during first year of life, first born child, home damage caused by dampness, cat ownership in the past 12 months, home crowding, type of housing units, homes with dehumidifier, homes with recovery ventilator, consumption of chips in the past 12 months, community support, homes with humidifier, carpet on classroom floor, consumption of fruit in the past 12 months, consumption of bread in the past 12 months.

# Chapter 5: Discussion

The purpose of this study was to examine the risk factors associated with childhood asthma, specifically regarding the location of residence in the province of Saskatchewan. This study also investigated which risk factors best explained the variations of asthma and wheeze prevalence along an urban-rural gradient in Saskatchewan and which of these risk factors were modified by area of residence. This chapter interprets the findings of each research question and makes comparisons with the existing literature. Finally, it also discusses internal and external validity of the study, other limitations and strengths, conclusions, and future directions.

## 5.1 Summary of study findings

- A lower prevalence of asthma was observed in rural areas compared to urban areas, but after adjustment for a large number of variables, this association was not statistically significant.

- Certain personal characteristics (age, sex, personal history of allergy, parental history of asthma and allergies), environmental factors (home dampness from rain or flooding in the past 12 months, children living in a home that used electricity for heating, children living in a home with wood fireplaces), and dietary factors (consumption of seafood, nuts and fast food in the past 12 months) were associated with current wheeze and current asthma.

- Father's smoking, physical activity by the child, fast food consumption and nuts consumption in the past 12 months mediated the association between geographic location and current asthma. However, mediation can be questioned since the original baseline adjusted association was not statistically significant.

- Parents with money left over at the end of the month, fuel used for heating in the home, and physical activity by the child mediated the association between geographic location and current wheeze. However, mediation can be questioned since the original baseline adjusted association was not statistically significant.

- There was significant effect modification between personal (sex, mother with history of asthma and allergies and participation of the community events) and environmental risk factors (home dampness from rain or flooding in the past 12 months, current maternal smoking and children living in home a with dehumidifier) with geographic location observed for both current wheeze and current asthma among school children.

## 5.2 Interpretation of results and comparisons with the existing literature

### 5.2.1 Research Question 1: *What are the risk factors associated with the prevalence of current asthma and wheeze in pediatric populations in Saskatchewan and specifically, is a location of residence associated with asthma and wheeze after adjustment for confounders?*

While there was a lower risk of asthma in the rural areas compared to both urban areas observed in the current study, this association was not statistically significant after

adjustment for a large number of confounders. Also, a lower prevalence of current wheeze was observed in rural areas (13.5%) compared to large urban (14.8%) and small urban (14.4%) areas although this was also not statistically significant and relatively small. Many previous studies have investigated geographic variations (urban-rural) in relation to asthma and wheeze (69,99). Findings from these previous studies have shown a lower prevalence of asthma in rural children compared to urban children (5,73). Considering a gradient of urban to rural might increase the variation in exposures and help provide a better understanding about the etiology of asthma and wheeze.

In an earlier study looking at the Canadian portion of the Health Behavior in School-Aged Children (HBSC), which included children aged 11-15 years, Lawson et al. found an urban-rural gradient of asthma prevalence with a lower risk of current asthma in rural areas while the prevalence of current wheeze was similar across locations (5). As the HBSC survey was designed to provide information about health and health behaviors of youth and did not focus specifically on respiratory disease, this study was unable to assess other confounders or respiratory disease specific information. In a cross-sectional study conducted in a national sample of Macedonian adolescents (aged 12-16 years), Vlaski et al. found a lower prevalence of asthma as well as current wheeze in rural children compared to urban children (38). However, after adjustment for potential confounders, the associations remained protective but no longer statistically significant for current wheeze (38). Results from a population based birth cohort study among a pediatric Medicaid population (birth cohort through 6$^{th}$ year of life) from Tennessee, USA suggested a statistically significant increased asthma prevalence in rural and suburban children compared to urban children (100). Another study among school

children (aged 4-17 years) from Arkansas, USA found no differences of asthma prevalence between rural and urban children where rural children had an increased report of asthma-related respiratory symptoms compared to urban children (101). Another separate study among school children from Austria (mean age 8.4 years) found that the prevalence of doctor-diagnosed-asthma was similar among town, rural, and farm children (102). However, farm children who were regularly exposed with animal shed, hay lofts, or farm milk had a reported lower prevalence of asthma as well as current wheeze (102). Results from The Belarus Ukraine Poland Asthma Study (BUPAS) among school children (aged 7-13 years) found statistically non-significant differences in asthma prevalence between urban and rural children while it differed significantly by country for both urban and rural children with the highest prevalence consistently in Poland followed by Ukraine and Belarus (103). A cross-sectional study in Chile among school children (aged 13-14 years) found statistically non-significant differences in asthma prevalence between urban, semi-urban or rural children while there was a significant gradient found in the prevalence of current asthma symptoms (wheeze) with the highest prevalence in urban children and lowest in rural children (104). As seen when comparing the current study results to the scientific literature, there are some similarities as well as some differences. Reasons for these differences in results between studies could be due to differences in study populations as well as exposures and health behaviours between them.

The current study also confirmed that personal characteristics, environmental factors, and dietary factors were associated with current asthma and current wheeze. Below, we consider our results in relation to the literature.

#### 5.2.1.1 Personal factors

In the BUPAS study, involving children aged 7-13 years old, Brozek et al. found that increasing age was associated with reduced risk of wheeze in the past 12 months but an increased risk of diagnosed asthma (103). It is well known that male children are more often diagnosed with asthma compared to female children earlier in life with a sex reversal in the teens and an opposite trend observed in adult life (18,49,105). A personal history of allergy or parental history of asthma and allergies are well established risk factors to develop asthma in childhood (18,51,68). In our study, we found a statistically significant positive association of having a personal history of allergy or a parental history of asthma and allergies with current wheeze and current asthma. In a recent study from Saskatchewan, Barry et al. found that children with a personal history of allergy and parental history of asthma were more likely to report current wheeze and current asthma (75). In the BUPAS study, Brozek et al. also found an increased risk of asthma and wheeze in the past 12 months among children who have parents with a history of allergic disease (103). In a study of Southern California among school children, Burke et al. found that family history of asthma and allergies was strongly associated with the risk of early-onset persistent asthma (106). In addition, London et al. found that family history of asthma and allergies among first degree relatives was a strong predictor of having asthma in children (107)**.** Thus, the current study confirms the well-established personal characteristics associated with asthma and wheeze.

#### 5.2.1.2 Environmental factor

Environmental factors such as any home dampness from rain or flood in the past 12 months were strongly associated with current wheeze and current asthma in the current study. More children from small urban and rural areas compared to large urban areas lived in a home with dampness. Many other studies have reported home dampness as a risk factor for wheeze and asthma (84,86,87). Based on results from a recent study of the Belarus Ukraine Poland Asthma Study (BUPAS), Brozek et al. found an increased risk of asthma and wheeze with home dampness (103). Results from another cross-sectional study in Saskatchewan by Barry et al. also found a strong association with home dampness and wheeze and asthma (70,84,86,108). Children living in a home that used electricity for heating were less likely to have current wheeze and current asthma. In contrast, in a cross-sectional survey among children (aged 13-14 years old), Madani et al. did not find any association between electricity used for heating at home and current wheeze and asthma (109). In the current study, more children living in rural areas lived in a home with wood fireplaces than urban children. Children living in a home with a wood fireplace were less likely to be associated with current wheeze.

#### 5.2.1.3 Dietary factors

The role of dietary factors in the development of asthma has been debated (65). Several studies have investigated the relationship between diet and childhood asthma and wheeze (38,65,109,110). In the current study, there were statistically significant associations found between diet (seafood, nuts, and fast food) and current wheeze and current asthma. Children eating seafood including fish 1 or 2 times per week in the past 12 months were more likely have current wheeze and current asthma. In a study from

Italy, Farchi et al. found that children who ate fish less than 1 time per week in the past 12 months were less likely to have current wheeze (65). The current study found an inverse association of nuts with current wheeze among children who ate nuts 1 or 2 times per week in the past 12 months. Several other studies also found an association of nuts with asthma and wheeze (65,109). There was a strong positive association found between consumption of fast food and current asthma. Children living in a large urban area were more likely to eat fast food 1 or 2 times per week in the past 12 months than children in small urban and rural children. Due to urbanization, marked changes have been observed in western diet with decreased consumption of fresh fruits, vegetables, fish and milk, and the increase intake of fast foods (65).

### 5.2.2 Research Question 2: *Which risk factors best explain the variations of current asthma and wheeze prevalence in Saskatchewan?*

There have been very few studies that have looked at mediation analysis, trying to explain childhood asthma in relation to urban and rural differences in asthma and wheeze. Several mediator variables were examined in the current study. Four of these mediators were identified to affect the relationship between geographic location and current asthma, and three mediators were determined to affect the relationship between geographic location and current wheeze. These variables were shown to adjust the association between location of residence and asthma or wheeze by more than 5 percent and were, therefore, investigated more fully. The association between geographic location and current asthma was mediated by the father's smoking, physical activity, fast food consumption, and nuts consumption in the past 12 months. Money left over at the end of

the month, fuel used for heating in the home, and physical activity by the child mediated the association between geographic location and current wheeze.

Mediation criteria include: i) the predictor variable is significantly associated with the outcome variable; ii) the predictor variable is related to the mediator variable; iii) the mediator variable is related to the outcome variable; and iv) when a mediator variable is added to the model, the strength of the association between the mediator and outcome variable is significantly reduced. Since the association between location of residence and wheeze and asthma were not statistically significant, we are unable to say that mediation occurred. Also, most of the mediator variables that we investigated in the relationship between location of dwelling and current wheeze and current asthma did not meet the mediation criteria. Even after excluding criteria #1, few variables were shown to mediate the association between location of dwelling and current asthma and current wheeze. Some differences that might help explain these findings include rural children were more likely to use electricity as a fuel for heating in a home compared to urban children. Children living in a home where electricity was used as a fuel for heating were less likely to have current asthma and current wheeze The relationship between location of dwelling and current asthma and current wheeze were protective {OR = 0.67 (0.43-1.03) and OR=0.77 (0.51-1.15) respectively} but became weaker after fuel used for heating in home were added to the mediation models {OR = 0.75 (0.47-1.17) and OR=0.81 (0.54-1.23)}.

Dietary factors mediated the association between geographic location and current wheeze. Rural children were more likely to eat nuts 3 or more times per week compared

to urban children. Consumption of nuts 1 or 2 times per week in the last 12 months influenced the association between location of residence and current wheeze where initially, the association had an OR=0.77 (95% CI: 0.51-1.15) but the became weaker when consumption of nuts in the past 12 months was added to the mediation model {OR = 0.91 (0.53-1.56)}. To support our study, Vlaski et al. also found that the association between location and asthma was mediated by diet (38).

### 5.2.3 Research Question 3: Are the risk factors of current asthma and wheeze, as identified in research question #1, modified by area of residence?

The present study investigated geographic location as an effect modifier in the relationship between personal and environmental risk factors with current wheeze and current asthma. This study found significant effect modification of personal factors including sex, mother with history of asthma and allergies, and participation in the community's events with geographic location when considering both current wheeze and current asthma as the outcomes. This study also found significant effect modification between location of residence and environmental exposures, including home dampness from rain or flooding in the past 12 months when considering current wheeze and current asthma as the outcomes. In addition, significant effect modification was found between location of residence and environmental exposures, including current maternal smoking and homes with a dehumidifier when considering current wheeze as the outcome.

In the present study, in large and small urban areas, female children were less likely to have current wheeze and current asthma, while this association was not seen for rural areas. In a recent study conducted in 3 eastern European countries (BUPAS),

Brozek et al also found a statistically significant effect modification between location (Belarus, Ukraine, Poland) and sex when considering asthma as the outcome where female children living in Belarus and Poland were less likely to report of diagnosed asthma compared to those living in Ukraine (103).

In large urban and rural areas, children who have a mother with a history of asthma and allergies were more likely to have current wheeze while this association was statistically non-significant for the small urban area. Children who have a mother with a history of asthma and allergies were more likely to have current asthma in all three areas (large urban, small urban, and rural areas). A parental history of asthma and allergic diseases suggests a strong genetic component, which is an important contributing factor to develop atopic diseases such as asthma and other allergic diseases (50,90). There is 50% chance of being atopic among children if both their parents are atopic and 25% if one of the parents is atopic (111).

In large urban and rural areas, there was a statistically significant association found between participation in community's events and current wheeze. Children living in a large urban area who rarely participated in the community's events were more likely to have current wheeze while this association was not observed in small urban and rural areas. Also, children living in rural area who sometimes participated in community's events were less likely to have current wheeze while this association was not seen for either the large or small urban areas. In the questionnaire, there was no information regarding types of community's events in which children participated. Therefore, it is

difficult to explain why we found associations with participation in community's events in some areas but not other areas.

In small urban and rural areas, children who lived in a home with dehumidifier were more likely to have current wheeze while this association was not seen in large urban area and rural areas, children living in a home with mould or dampness were more likely to have current wheeze and current asthma while this association was statistically non-significant for either the large or small urban areas. Similar to this, Brozek et al. also found a statistically significant effect modification between location (countries) and presence of home mould or dampness when considering both asthma and wheeze as the outcomes (103). For each outcome, associations in Belarus and Poland showed statistically significant increased risks while in Ukraine, a non-significant inverse association was observed. In a previous Canadian study, a significant effect modification was found between two South Saskatchewan regions and presence of home mould or dampness (84). In Estevan, the presence of mould or home dampness was associated with increased risk of asthma while this association was not seen in Swift Current (84). Reasons for these differences were not investigated but were thought to be a result of housing modifications made in response to outdoor sources of air pollution that differed between communities.

In the rural area, children who had a mother with a history of current smoking showed increased risk of current wheeze while this association was not observed in children living in the large and small urban areas. Reasons for this difference may be due to mothers of children living in urban areas who either quit smoking or smoked outside of

their child's environment. Similar to this, in a study from Saskatchewan, associations between current ETS exposure from the mother and asthma differed between communities, with no association in Swift Current and an inverse association in Estevan (84), suggesting a healthy smoker effect.

## 5.3 Internal validity

### 5.3.1 Selection bias

Selection bias should be considered in our study. During the recruitment, some participants may be more or less likely to enter the study than others. It has been shown that those with a disease are often more likely than those without a disease to take part in a study. For our study, this means that parents of children with wheeze or asthma may be more likely to complete the questionnaire than parents of children without these conditions that can lead to inflation of absolute prevalence for asthma. In our study, we found a moderate overall participation rate that was higher in the rural population. Because of this, we cannot exclude the potential of response bias in our study.

### 5.3.2 Information bias

Information bias may occur due to incorrect measurement of exposure or outcome or both and result in misclassification. Data were collected from a proxy (parent or guardian)-completed questionnaire. This may result in the parent not actually being aware of what the correct response is, or there may also be a chance of classic recall bias as the parent or guardian may not always remember accurately.

In our study, the primary exposure was geographic location (urban-rural status,) and it was defined according to the child's current residency. There was no information in the questionnaire about whether children residing in urban areas had previous exposure to rural areas other than living on a farm in the first year of life and this may affect the results since exposure during earlier life can be a risk factor for developing asthma later in life (38). Also, we did not look at objective measures of environmental exposures (e.g., home dampness, pet exposure, dust) in our study as only self-report was included. This could result in an overestimate or underestimate of environmental exposures. However, to minimise bias, we used a standardized questionnaire in our study. Regarding the outcome measures (current wheeze and current asthma), as there is no gold standard for the diagnosis of asthma, we used questionnaire report of a doctor’s diagnosis of asthma. This has been shown to be a relatively accurate indicator of asthma presence in epidemiological studies (112–114). In addition to this, we used wheeze as a method of investigation that does not require a diagnostic label.

### 5.3.3 Confounding

Multivariate analysis was conducted to adjust for a large number of potential confounders. As the present study was focused on respiratory health and related conditions, the common and known important risk factors and confounders were considered based on literature, clinical importance, and statistical significance. We did not include other potential confounding factors such as heath care access indicators, parents' education, age at which asthma was diagnosed, living on a farm during first year of life in our analysis due to insignificant association with the outcomes. In addition, we

excluded another potential confounding variable (obesity) due to a large amount of missing information in our data set about body height and weight of the children.

As mentioned earlier, we adjusted for a large number of potential confounders in our regression analysis; therefore, there was a possibility of over-adjustment bias in our study. In the epidemiologic literature, regarding the concept of "overadjustment" has been given little attention and it's definition is not clearly understood (115). According to the Dictionary of Epidemiology "Overadjustment is said to occur when adjustment is inadvertently carried out for a variable that is either in the causal pathway between the exposure and the outcome (thus being an intermediate cause) or so strongly related to either the exposure or outcome that their true relationship is distorted (116,117)**."** Therefore, overadjustment could hide the true effect between the relationship of exposures and outcomes or create an obvious effect when none exist (116). A more common problem with overadjustment is that the statistical power will be reduced.

### 5.4 External validity

In our study, we used the definition of urban-rural gradient according to Statistics Canada's definition based on modified Beale Codes, and this definition can be used in other provinces of Canada among school-age children. The findings of our study may not be generalizable to non-Caucasian children due to a large number of Caucasian children who participated in our study (65.3%). We need to be careful when we generalize our study findings to populations of different countries where environmental exposures, dietary habits, and health care access may differ from Canada.

### 5.5 Other limitations and strengths

### 5.5.1 Limitations

One important limitation was that we collected data by using a cross-sectional study design. As exposure and outcome data were collected at the same time point, this study design was unable to determine the causal relationship between exposures and outcomes due to lack of temporality despite the association being present in the study. Due to its practical considerations such as low cost and less time required as well as its usefulness at determining prevalence and hypothesis generating, this study design is common for epidemiological studies.

There can be difficulties in defining asthma in many epidemiological studies. There is no single test that defines the presence or absence of asthma. As no gold standard exists for the diagnosis of asthma, we used questionnaire report of doctors' diagnosis of asthma. In our study, we used the definition of current asthma (a previous diagnosis of asthma as well as asthma activity in the past 12 months) to report our results since it was more relevant, and the results were similar between current and ever. This definition has been frequently used in epidemiological studies to examine asthma prevalence (112). Many epidemiological studies have used wheeze as the most important symptom for the identification of asthma. However, wheezing can occur in other conditions such as the common cold, which is a limitation. However, as no gold standard of asthma diagnosis exists and there is the potential for misdiagnosis or misreporting on the questionnaire, we still considered wheeze as an outcome as a method of considering an asthma indicator without the need for a diagnostic label. Wheeze has been used in a number of studies of childhood asthma.

In our study, we found a difference between asthma and wheeze prevalence (ever asthma: 19.6%; current asthma: 14.1%; ever wheeze: 28.0%; current wheeze: 14.5%). The reason for the variation between these outcomes may be due to a true lack of asthma diagnosis or diagnostic labeling issues. We used questionnaire report of a doctors' diagnosis of asthma and self-reported "yes/no" questions about wheeze. Considering both can be an advantage as their use allows us to remove the effect of labeling.

Prince Albert and the rural area around it is located near the centre of Saskatchewan while Regina is situated in the southern part of the Saskatchewan. Variations of weather between these two regions may confound the relationship between location and outcomes. Another difference between these two regions could be variations in farming exposures. School Districts in Regina were randomly selected and in Prince Albert, all schools in the Saskatchewan River School District and the surrounding area were selected. There may have been some sampling error in Regina School District.

Due to the smaller sample size of rural residents, we did not categorize this group into farm and non-farm dwellers. Therefore, we were unable to make a hypothesis about the difference in prevalence of asthma or wheeze between these two groups. However, in previous Saskatchewan studies, these two groups have been found to be similar (69,70,75).

Seasonal variation could be another limitation of our study. We collected data in spring when outdoor and seasonal allergies were most common.

### 5.5.2 Strengths

A strength of our study was its relatively large sample size and that the data were collected from three different regions of Saskatchewan along an urban-rural gradient. We calculated the statistical power of our study for the investigation of potential risk factors associated with asthma along an urban-rural gradient, and we found an adequate statistical power (99%) when we considered a stronger odds ratio to be 0.5 or 2.0 from the null value on each side of the plotted graph in figure 3.1. In our study, we used a standardized questionnaire, which was based on ISAAC, ATS, and the Division of Lung Diseases questionnaire for children and also questionnaire previously used in Saskatchewan Lung Health studies.

## 5.6 Significance of the research

Results obtained from this study will help to understand the factors that are associated with pediatric asthma and wheeze. The results from this study will also be useful to residents of Regina, Prince Albert, and the surrounding area by identifying the risk factors for asthma and its burden to take action as a public health measure in this population. While some previous studies have been completed regarding risk factors associated with asthma in relation to geographic variation of asthma prevalence in other parts of Saskatchewan, the findings of those studies were limited due to lack of geographic variability. Our study has also improved the exposure assessment by including more questions on urban-rural exposures as well as to try and identify explanations of geographic variations of pediatric asthma. Results from this study will help address which explanations best describe geographic differences in childhood asthma.

## 5.7 Future Research Directions

While this study was good at hypothesis generating, because of the survey based cross-sectional study design, it is hard to infer causal associations between risk factors and asthma. There are several potential research directions we could consider in the future. These include:

1. Use a stronger study design, such as a longitudinal study for examining associations between asthma and exposure.

2. Address the issue of potential misclassification bias potentially observed in our study by completing a further clinical investigation such as objective lung health measures (lung function test such as spirometry and consideration of FEV1/FVC).

3. Assess exposures to risk factors associated with asthma such as mold, home dampness, house dust mites, and pet dander, by using objective measures of things such as endotoxin and ETS biomarkers such as cotinine from hair or saliva.

4. Validate the findings of our study by completing similar studies in other provinces of Canada among more ethnically diverse populations as well as internationally.

## 5.8 Conclusions

In conclusion, a lower prevalence of asthma was observed among children in a rural area compared to large urban and small urban areas although the association was not statistically significant after adjusting for a large number of risk factors. The current

study also confirmed that the association between personal and environmental risk factors with asthma and wheeze can be modified by geographic location.

## References


1. Nunes C, Pereira AM, Morais-Almeida M. Asthma costs and social impact. Asthma Res Pract [Internet]. 2017;3(1):1–11. Available from: http://dx.doi.org/10.1186/s40733-016-0029-3

2. Asthma Society of Canada. Asthma Facts & Statistics. 2011;1–5. Available from: http://www.asthma.ca/corp/newsroom/pdf/asthmastats.pdf

3. Malveaux FJ. The State of Childhood Asthma: Introduction. Pediatrics. 2009;123(Supplement 3):S129–30.

4. Mannino DM, Buist AS. Global burden of COPD: risk factors, prevalence, and future trends. Lancet [Internet]. 2007;370(9589):765–73. Available from: http://dx.doi.org/10.1016/S0140-6736(07)61380-4

5. Lawson JA, Janssen I, Bruner MW, Madani K, Pickett W. Urban–rural differences in asthma prevalence among young people in Canada: the roles of health behaviors and obesity. Ann Allergy, Asthma Immunol. 2011;107(3):220–8.

6. Wong GWK CC. Childhood asthma epidemiology: Insights from comparative studies of rural and urban populations. Pediatr Pulmonol. 2008;43(2):107–16.

7. Ege MJ, Frei R, Bieli C, Schram-Bijkerk D, Waser M, Benz MR, et al. Not all farming environments protect against the development of asthma and wheeze in children. J Allergy Clin Immunol. 2007;119(5):1140–7.

8. Riedler J, Braun-Fahrländer C, Eder W, Schreuer M, Waser M, Maisch S, et al. Exposure to farming in early life and development of asthma and allergy: A cross-sectional survey. Lancet. 2001;358(9288):1129–33.

9. Canada S, Statistics Canada. Table 17-10-0122-01 Census indicator profile based on the 2016 Census short-form questionnaire, Canada, provinces and territories, and health regions (2017 boundaries) [Internet]. Available from: https://www150.statcan.gc.ca/t1/tb%7C1/en/tv.action?pid=1710012201

10. Statistics Canada. 2011 Census of Agriculture: Highlights and analysis [Internet]. Available from: https://www.statcan.gc.ca/eng/ca2011/ha?fbclid=IwAR2d2ILzlRN0RvrT3q5vhaGm3XNuVm8KXkMS2hWrmR5QtthXrW7x2VLrBvQ#a1-1-3

11. Statistics Canada. Farm and farm operator data: 2016 Census of Agriculture [Internet]. Available from: https://www150.statcan.gc.ca/n1/pub/95-640-x/95-640-x2016001-eng.htm?fbclid=IwAR0w65_-4ASbX0o1uX-zOVULc0yWdmcvSdhHm5-5I6DsEhbgT-2Knec30SI

12. Statistics Canada. Farms classified by farm type [Internet]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210040301

13. Statistics Canada. Saskatchewan remains the breadbasket of Canada. 2017;(95). Available from: http://www.statcan.gc.ca/pub/95-640-x/2016001/article/14807-eng.pdf

14. Canada S. Canada at a Glance 2009. Vol. 2015. 2008.

15. Research H. Investing in Canada's Future 2004-2005. Vol. 2015. 2006.

16. for Health Research CI. Rural Health and Northern Health Research Initiative. Vol. 2015. 2004.

17. Bateman ED, Hurd SS, Barnes PJ, Bousquet J, Drazen JM, FitzGeralde M, et al. Global strategy for asthma management and prevention: GINA executive summary. Eur Respir J. 2008;31(1):143–78.

18. Canada H. Respiratory disease in Canada. 2001.

19. Bisgaard H, Bonnelykke K. Long-term studies of the natural history of asthma in childhood. J Allergy Clin Immunol [Internet]. 2010;126(2):187–97. Available from: http://dx.doi.org/10.1016/j.jaci.2010.07.011

20. Martinez FD, Wright AL, Taussig LM, Holberg CJ, Halonen M, Morgan WJ. Asthma and wheezing in the first six years of life. N Engl J Med. 1995;332(3):133–8.

21. Wayne J, Debra A, Duane L. Outcome of Asthma and Wheezing in the First 6 Years of Life : Follow-up through Adolescence. 2005;

22. Brand PL, Baraldi E, Bisgaard H, Boner AL, Castro-Rodriguez JA, Custovic A, et al. Definition, assessment and treatment of wheezing disorders in preschool children: an evidence-based approach. Eur Respir J. 2008 Oct;32(4):1096–110.

23. La L, Simpson A, Woodcock A, Respir AJ. Wheeze Phenotypes and Lung Function in Preschool Children Kricia P . Palmer , Scott D . Nash and Larry W . Williams. 2006;

24. Sally E Wenzel. Asthma: defining of the persistent adult phenotypes. Lancet. 2006;368:1–32.

25. Pekkanen J, Lampi J, Genuneit J, Hartikainen AL, Järvelin MR. Analyzing atopic and non-atopic asthma. Eur J Epidemiol. 2012;27(4):281–6.

26. Charpin D, Magnan A, Lanteaume A, Vervloet D. Original article Allergic vs nonallergic asthma : what makes the difference ? Clin Immunol. 2002;(10):607–13.

27. (GINA) GI for A. Gina Strategy for Asthma 2018. Available from: http://search.ebscohost.com/login.aspx?direct=true&db=cin20&AN=118972966&site=ehost-live

28. Bel EH. Clinical phenotypes of asthma. 2004;44–50.

29. Moore WC, Meyers DA, Wenzel SE, Teague WG, Li H, Li X, et al. Identification of asthma phenotypes using cluster analysis in the Severe Asthma Research Program. Am J Respir Crit Care Med [Internet]. 2010;181(4):315–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19892860%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC2822971

30. Yawn BP, III GMA, Love MM, Hueston W. Do rural and urban children have

comparable asthma care utilization? J Rural Heal. 2001;17(1):32–9.

31. Ungar WJ, Coyte PC. Prospective study of the patient-level cost of asthma care in children*. Pediatr Pulmonol. 2001;32(2):101–8.

32. Bahadori K, Doyle-Waters MM, Marra C, Lynd L, Alasaly K, Swiston J, et al. Economic burden of asthma: a systematic review. BMC Pulm Med. 2009;9(1):24.

33. Mhsc MS, Lynd L, Pharmd CM, Carleton B, Mb WCT, Sullivan S, et al. Direct health care costs associated with asthma in British Columbia. 2010;17(2).

34. Ismaila AS, Sayani AP, Marin M, Su Z. Clinical , economic , and humanistic burden of asthma in Canada : a systematic review. 2013;

35. Hermus G, Stonebridge C, Goldfarb D, Thériault L, Bounajm F. Cost Risk Analysis for Chronic Lung Disease in Canada. 2012;(February).

36. Asher MI, Montefort S, Björkstén B, Lai CKW, Strachan DP, Weiland SK, et al. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC Phases One and Three repeat multicountry cross-sectional surveys. Lancet. 2006;368(9537):733–43.

37. Garner R, Kohen D. Changes in the prevalence of asthma among Canadian children. Heal reports. 2008 Jun;19(2):45–50.

38. Vlaski E, Lawson JA. Urban rural differences in asthma prevalence among young adolescents: The role of behavioural and environmental factors. Allergol

Immunopathol (Madr). 2014;

39. N P, N A-K, R B, J M, U K, E M, et al. Worldwide trends in the prevalence of asthma symptoms: phase III of the International Study of Asthma and Allergies in Childhood (ISAAC). Thorax [Internet]. 2007 Sep;62(9):758–66. Available from: http://sfx.usask.ca/usask?sid=OVID:medline&isbn=&issn=0040-6376&volume=62&issue=9&pages=758-66&date=2007&atitle=Worldwide+trends+in+the+prevalence+of+asthma+symptoms%3A+phase+III+of+the+International+Study+of+Asthma+and+Allergies+in+Childhood+%28ISAAC%29.

40. Lawson JA, Senthilselvan A. Asthma epidemiology: has the crisis passed? Curr Opin Pulm Med. 2005;11(1):79–84.

41. Asher MI, Anderson HR, Stewart AW, Crane J, Ait-Khaled N, Anabwani G, et al. Worldwide variations in the prevalence of asthma symptoms: the International Study of Asthma and Allergies in Childhood (ISAAC). Eur Respir J. 1998;12(2):315–35.

42. RE D, M R, el-Saadany S, J B, R B. Prevalence of childhood asthma across Canada. Int J Epidemiol [Internet]. 1994 Aug;23(4):775–81. Available from: http://sfx.usask.ca/usask?sid=OVID:medline&isbn=&issn=0300-5771&volume=23&issue=4&pages=775-81&date=1994&atitle=Prevalence+of+childhood+asthma+across+Canada.&title=International+Journal+of+Epidemiology&aulast=Dales+RE&spage=775&epage=8

1&pid=AN:8002192

43. AS G, J G, C W, T T. Trends in asthma prevalence and incidence in Ontario, Canada, 1996-2005: a population study. Am J Epidemiol [Internet]. 2010 Sep;172(6):728–36. Available from: http://sfx.usask.ca/usask?sid=OVID:medline&isbn=&issn=0002-9262&volume=172&issue=6&pages=728-36&date=2010&atitle=Trends+in+asthma+prevalence+and+incidence+in+Ontario%2C+Canada%2C+1996-2005%3A+a+population+study.&title=American+Journal+of+Epidemiology&aula

44. Ministry S. Prevalence Trends and Co-morbidity. 2013;(May):1–6.

45. Senthilselvan A. Prevalence of physician-diagnosed asthma in Saskatchewan, 1981 to 1990. CHEST J. 1998;114(2):388–92.

46. Senthilselvan A, Lawson J, Rennie DC, Dosman JA. Stabilization of an increasing trend in physician-diagnosed asthma prevalence in Saskatchewan, 1991 to 1998. CHEST J. 2003;124(2):438–48.

47. Rennie DC, Lawson JA, Cockcroft DW, Senthilselvan A, McDuffie HH. Differences in respiratory symptoms and pulmonary function in children in 2 Saskatchewan communities. Ann Allergy, Asthma Immunol. 2004;92(1):52–9.

48. Manfreda J, Becker AB, Wang P-Z, Roos LL, Anthonisen NR. Trends in physician-diagnosed asthma prevalence in Manitoba between 1980 and 1990.

CHEST J. 1993;103(1):151–7.

49. Midodzi WK, Rowe BH, Majaesic CM, Saunders LD, Senthilselvan A. Predictors for wheezing phenotypes in the first decade of life. Respirology. 2008;13(4):537–45.

50. Ober C. Do genetics play a role in the pathogenesis of asthma? J Allergy Clin Immunol. 1998;101(2):S417–20.

51. Raby BA, Steen K Van, Celedón JC, Litonjua AA, Lange C, Weiss ST. Paternal history of asthma and airway responsiveness in children with asthma. Am J Respir Crit Care Med. 2005;172(5):552–8.

52. Cook DG, Strachan DP, Carey IM. Health effects of passive smoking. 9. Parental smoking and spirometric indices in children. Thorax. 1998 Oct;53(10):884–93.

53. Cook DG, Strachan DP. Health effects of passive smoking. 3. Parental smoking and prevalence of respiratory symptoms and asthma in school age children. Thorax. 1997 Dec;52(12):1081–94.

54. Tsai C-H, Huang J-H, Hwang B-F, Lee YL. Household environmental tobacco smoke and risks of asthma, wheeze and bronchitic symptoms among children in Taiwan. Respir Res. 2010;11(11):10.1186.

55. Beasley R, Crane J, Lai CKW, Pearce N. Prevalence and etiology of asthma. J Allergy Clin Immunol. 2000;105(2):S466–72.

56. Weitzman M, Gortmaker S, Walker DK, Sobol A. Maternal smoking and childhood asthma. Pediatrics. 1990 Apr;85(4):505–11.

57. Kanchongkittiphon W, Mendell MJ, Gaffin JM, Wang G, Phipatanakul W. Indoor environmental exposures and exacerbation of asthma: An update to the 2000 review by the institute of medicine. Environ Health Perspect. 2015;123(1):6–20.

58. Gent JF, Belanger K, Triche EW, Bracken MB, Beckett WS, Leaderer BP. Association of pediatric asthma severity with exposure to common household dust allergens. Environ Res [Internet]. 2009;109(6):768–74. Available from: http://dx.doi.org/10.1016/j.envres.2009.04.010

59. Shore SA, Johnston RA. Obesity and asthma. Pharmacol Ther. 2006;110(1):83–102.

60. Chen Y, Dales R, Krewski D, Breithaupt K. Increased effects of smoking and obesity on asthma among female Canadians: the National Population Health Survey, 1994-1995. Am J Epidemiol. 1999 Aug;150(3):255–62.

61. McKeever TM, Britton J. Diet and asthma. Am J Respir Crit Care Med. 2004;170(7):725–9.

62. Wickens K, Barry D, Friezema A, Rhodius R, Bone N, Purdie G, et al. Fast foods–are they a risk factor for asthma? Allergy. 2005;60(12):1537–41.

63. Garcia-Marcos L, Canflanca IM, Garrido JB, Varela AL, Garcia-Hernandez G, Grima FG, et al. Relationship of asthma and rhinoconjunctivitis with obesity,

exercise and Mediterranean diet in Spanish schoolchildren. Thorax. 2007 Jun;62(6):503–8.

64. Ellwood P, Asher MI, Garcia-Marcos L, Williams H, Keil U, Robertson C, et al. Do fast foods cause asthma, rhinoconjunctivitis and eczema? Global findings from the International Study of Asthma and Allergies in Childhood (ISAAC) phase three. Thorax. 2013 Apr;68(4):351–60.

65. Farchi S, Forastiere F, Agabiti N, Corbo G, Pistelli R, Fortes C, et al. Dietary factors associated with wheezing and allergic rhinitis in children. Eur Respir J. 2003 Nov;22(5):772–80.

66. H D-W, Y C, J C, C T. Contact with livestock--a protective effect against allergies and asthma?. Clin Exp Allergy [Internet]. 2006 Sep;36(9):1122–9. Available from: http://sfx.usask.ca/usask?sid=OVID:medline&isbn=&issn=0954-7894&volume=36&issue=9&pages=1122-9&date=2006&atitle=Contact+with+livestock--a+protective+effect+against+allergies+and+asthma%3F.&title=Clinical+%26+Experimental+Allergy&aulast=Dimich-Ward+H&spage

67. of Health information CI. Health Care in Canada 2011: A focus on Seniors and Aging. Vol. 2015.

68. Midodzi WK, Rowe BH, Majaesic CM, Senthilselvan A. Reduced risk of physician-diagnosed asthma among children dwelling in a farming environment. Respirology. 2007;12(5):692–9.

69. Lawson JA, Rennie DC, Cockcroft DW, Dyck R, Afanasieva A, Oluwole O, et al. Childhood asthma, asthma severity indicators, and related conditions along an urban-rural gradient: a cross-sectional study. BMC Pulm Med. 2017;17(1):4.

70. Barry RJ, Pickett W, Rennie DC, Senthilselvan A, Cockcroft DW, Lawson JA. Factors contributing to risks for pediatric asthma in rural Saskatchewan. Ann Allergy, Asthma Immunol. 2012;109(4):255–9.

71. Adler A, Tager I, Quintero DR. Decreased prevalence of asthma among farm-reared children compared with those who are rural but not farm-reared. J Allergy Clin Immunol. 2005;115(1):67–73.

72. Chrischilles E, Ahrens R, Kuehl A, Kelly K, Thorne P, Burmeister L, et al. Asthma prevalence and morbidity among rural Iowa schoolchildren. J Allergy Clin Immunol. 2004;113(1):66–71.

73. Riedler J, Eder W, Oberfeld G, Schreuer M, J R, W E, et al. Austrian children living on a farm have less hay fever, asthma and allergic sensitization. Clin Exp Allergy [Internet]. 2000 Feb;30(2):194–200. Available from: http://sfx.usask.ca/usask?sid=OVID:medline&isbn=&issn=0954-7894&volume=30&issue=2&pages=194-200&date=2000&atitle=Austrian+children+living+on+a+farm+have+less+hay+fever%2C+asthma+and+allergic+sensitization.&title=Clinical+%26+Experimental+Allergy&aulast=Ri

74. Masoli M, Fabian D, Holt S, Beasley R. The global burden of asthma: executive

summary of the GINA Dissemination Committee report. Allergy. 2004;59(5):469–78.

75. Barry RJ, Pickett W, Rennie DC, Dosman J a, Pahwa P, Hagel L, et al. The role of farm operational and rural environments as potential risk factors for pediatric asthma in rural saskatchewan. Pediatr Pulmonol [Internet]. 2013 Oct 25 [cited 2014 Apr 2]; Available from: http://www.ncbi.nlm.nih.gov/pubmed/24167097

76. Yazdanbakhsh M, Kremsner PG, van Ree R. Allergy, parasites, and the hygiene hypothesis. Science. 2002 Apr;296(5567):490–4.

77. Ege MJ, Mayer M, Normand A-C, Genuneit J, Cookson WOCM, Braun-Fahrländer C, et al. Exposure to environmental microorganisms and childhood asthma. N Engl J Med. 2011;364(8):701–9.

78. Gehring U, Strikwold M, Schram-Bijkerk D, Weinmayr G, Genuneit J, Nagel G, et al. Asthma and allergic symptoms in relation to house dust endotoxin: Phase Two of the International Study on Asthma and Allergies in Childhood (ISAAC II). Clin Exp Allergy. 2008;38(12):1911–20.

79. Mutius V. Exposure to endotoxin or other bacterial components might protect against the development of atopy. Clin Exp Allergy. 2000;30(9):1230–4.

80. Wright RJ, Subramanian S V. Advancing a multilevel framework for epidemiologic research on asthma disparities. CHEST J [Internet]. 2007 Nov [cited 2014 Mar 19];132(5_suppl):757S–769S. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/17998340

81. Rennie DC, Lawson JA, Senthilselvan A, Willson PJ, Dosman JA. Domestic endotoxin exposure and asthma in children: epidemiological studies. Front Biosci (Elite Ed). 2012 Jan;4:56–73.

82. Braun-Fahrländer C, Riedler J, Herz U, Eder W, Waser M, Grize L, et al. Environmental exposure to endotoxin and its relation to asthma in school-age children. N Engl J Med. 2002;347(12):869–77.

83. Strachan DP, Cook DG. Health effects of passive smoking. 6. Parental smoking and childhood asthma: longitudinal and case-control studies. Thorax. 1998 Mar;53(3):204–12.

84. Lawson JA, Rennie DC, Senthilselvan A, Cockcroft DW, McDuffie HH. Regional variations in risk factors for asthma in school children. Can Respir J. 2005;12(6):321–6.

85. Bruner MW, Lawson J, Pickett W, Boyce W, Janssen I. Rural Canadian adolescents are more likely to be obese compared with urban adolescents. Int J Pediatr Obes. 2008;3(4):205–11.

86. Rennie DC, Lawson JA, Kirychuk SP, Paterson C, Willson PJ, Senthilselvan A, et al. Assessment of endotoxin levels in the home and current asthma and wheeze in school-age children. Indoor Air. 2008;18(6):447–53.

87. Farthing P, Rennie D, Pahwa P, Janzen B, Dosman J. The association between

farming activities and respiratory health in rural school age children. J Agromedicine. 2009;14(2):256–62.

88. Mitchell EA, Beasley R, Björkstén B, Crane J, García-Marcos L, Keil U. The association between BMI, vigorous physical activity and television viewing and the risk of symptoms of asthma, rhinoconjunctivitis and eczema in children and adolescents: ISAAC Phase Three. Clin Exp Allergy. 2013;43(1):73–84.

89. Ownby DR, Peterson EL, Nelson D, Joseph CCL, Williams LK, Johnson CC. The relationship of physical activity and percentage of body fat to the risk of asthma in 8-to 10-year-old children. J Asthma. 2007;44(10):885–9.

90. Guner SN, Gokturk B, Kilic M, Ozkiraz S. The prevalences of allergic diseases in rural and urban areas are similar. Allergol Immunopathol (Madr). 2011;39(3):140–4.

91. Valet RS, Perry TT, Hartert T V. Rural health disparities in asthma care and outcomes. J Allergy Clin Immunol. 2009;123(6):1220–5.

92. Rennie DC, Dosman JA. Distance to health care and the prevalence of asthma in school age children. J Agric Saf Health. 1999;

93. Ferris BG. Epidemiology Standardization Project (American Thoracic Society). Am Rev Respir Dis. 1978 Dec;118(6 Pt 2):1–120.

94. Lawson JA, Dosman JA, Rennie DC, Beach J, Newman SC, Senthilselvan A. Relationship between indoor environment and asthma and wheeze severity among

rural children and adolescents. J Agromedicine. 2009;14(2):277–85.

95. Vinodrai T. A Tale of Three Cities: The Dynamics of Manufacturing in Toronto, Montreal and Vancouver, 1976-1997. Analytical Studies Branch, Statistics Canada; 2001.

96. Plessis V Du, Beshiri R, Bollman RD, Clemenson H. No Title. Defin of" Rural. 2002;

97. Frazier PA, Tix AP, Barron KE. Testing Moderator and Mediator Effects in Counseling Psychology Research. J Couns Psychol [Internet]. 51(1):115–34. Available from: http://sfx.usask.ca/usask?sid=OVID:psycdb&isbn=&issn=0022-0167&volume=51&issue=1&pages=115-134&date=2004&atitle=Testing+Moderator+and+Mediator+Effects+in+Counseling+Psychology+Research.&title=Journal+of+Counseling+Psychology&aulast=Frazier%2C+Patricia+A&s

98. Prajapati B, Dunne M, Armstrong R. Sample size estimation statistical power analyses. Optom Today. 2010;16(7).

99. Iversen L, Hannaford PC, Price DB, Godden DJ. Is living in a rural area good for your respiratory health?: Results from a cross-sectional study in Scotland. CHEST J. 2005;128(4):2059–67.

100. Valet RS, Gebretsadik T, Carroll KN, Wu P, Dupont WD, Mitchel EF, et al. High asthma prevalence and increased morbidity among rural children in a Medicaid

cohort. Ann Allergy, Asthma Immunol. 2011;106(6):467–73.

101. Pesek RD, Vargas PA, Halterman JS, Jones SM, McCracken A, Perry TT. A comparison of asthma prevalence and morbidity between rural and urban schoolchildren in Arkansas. Ann Allergy, Asthma Immunol [Internet]. 2010;104(2):125–31. Available from: http://dx.doi.org/10.1016/j.anai.2009.11.038

102. Horak E, Morass B, Ulmer H, Genuneit J, Braun-Fahrländer C, von Mutius E. Prevalence of wheezing and atopic diseases in Austrian schoolchildren in conjunction with urban, rural or farm residencePrävalenz von Wheezing und atopischen Erkrankungen bei österreichischen Schulkindern im städtischen, ländlichen oder bäuerlichen Umfeld. Wien Klin Wochenschr. 2014;126(17–18):532–6.

103. Brozek G, Lawson J, Shpakou A, Fedortsiv O, Grishchuk LA, Rennie D, et al. Childhood asthma prevalence and risk factors in three Eastern European countries - the Belarus, Ukraine, Poland Asthma Study (BUPAS): An international prevalence study. BMC Pulm Med [Internet]. 2016;16(1):1–11. Available from: http://dx.doi.org/10.1186/s12890-016-0172-x

104. Kausel L, Boneberger A, Calvo M, Radon K. Childhood Asthma and Allergies in Urban, Semiurban, and Rural Residential Sectors in Chile. Sci World J. 2013;2013:1–4.

105. Gilliland FD, Berhane K, Islam T, Wenten M, Rappaport E, Avol E, et al. Environmental tobacco smoke and absenteeism related to respiratory illness in

schoolchildren. Am J Epidemiol. 2003 May;157(10):861–9.

106. Burke W, Fesinmeyer M, Reed K, Hampson L, Carlsten C. Family history as a predictor of asthma risk. Am J Prev Med. 2003;24(2):160–9.

107. London SJ, Gauderman WJ, Avol E, Rappaport EB, Peters JM, London SJ, et al. Family History and the Risk of Early-Onset Persistent , Early ' Onset Transient , and Late ^ Onset Asthma. 2019;12(5):577–83.

108. Oluwole O, Kirychuk SP, Lawson JA, Karunanayake C, Cockcroft DW, Willson PJ, et al. Indoor mold levels and current asthma among school-aged children in Saskatchewan, Canada. Indoor Air. 2017;27(2):311–9.

109. Madani K, Vlaski E, Rennie DC, Sears M, Lawson JA. An international comparison of risk factors between two regions with distinct differences in asthma prevalence. Allergol Immunopathol (Madr) [Internet]. 2018;46(4):341–53. Available from: https://doi.org/10.1016/j.aller.2018.01.002

110. Hijazi NA, Abalkhail BA, Seaton A. Diet and childhood asthma in a society in transition. Am J Epidemiol. 2001;153(11, S):S170.

111. Postma DS, Koppelman GH, Meyers DA. The genetics of atopy and airway hyperresponsiveness. Am J Respir Crit Care Med. 2000;162(3 II):118–23.

112. Kemp T, Pearce N, Crane J, Beasley R. Problems of measuring asthma prevalence. Respirology. 1996;1(3):183–8.

113. Hedman L, Lindgren B, Perzanowski M, Rönmark E. Agreement between parental and self-completed questionnaires about asthma in teenagers. In: Pediatric Allergy and Immunology. 2005. p. 176–81.

114. Yang CL, To T, Foty RG, Stieb DM, Dell SD. Verifying a questionnaire diagnosis of asthma in children using health claims data. BMC Pulm Med. 2011;11.

115. Manuscript A, Bias O, Studies E. Overadjustment Bias and Unnecessary Adjustment in Epidemiologic Studies. Epidemiology. 2009;20(4):488–95.

116. Moyses S, F. Javier N. Epidemiology Beyond the Basics. Fourth. Burlington, Massachusetts: Jones & Bartlett Learning; 2019.

117. Last JM. A Dictionary of Epidemiology. Vol 1.4th ed. New York: Oxford University Press, Inc; 2001. 2001.

# Appendix 1

## Lung Health Study Questionnaire

**LUNG HEALTH STUDY**

UNIVERSITY OF SASKATCHEWAN

**Dear Parents or Guardians,**

Researchers at the University of Saskatchewan are conducting a study to learn more about the lung health of children in your region. We hope to learn more about how much lung disease there is in children and why children may get lung disease.

This survey has 4 parts. Please try to answer all of the questions, but remember you don't have to answer any questions if you choose not to. All information will be kept confidential and used only to group your responses with the survey responses of other parents.

**Part One** asks about your child's health.

**Part Two** asks about your child's lifestyle and environment.

**Part Three** asks questions about child's personal and family history.

**Part Four** asks about your child's contact information.

**The questionnaire can be answered by checking the best answer or by filling in the blank with number or words.**

**Please complete ONE questionnaire PER child.**

**The person MOST familiar with this child's health should complete the questionnaire.**

**When you have finished, please place the questionnaire in the envelope, seal the envelope, and return it to the school, even if you did not complete the questionnaire.**

**THANK YOU VERY MUCH FOR YOUR PARTICIPATION!**
**WE APPRECIATE YOUR TIME.**

**Supported by a grant from the *Saskatchewan Health Research Foundation***

## PART ONE – HEALTH OF THIS CHILD

**Breathing symptoms**

1. Has your child had a dry cough at night apart from a cough associated with a cold or chest infection? *Tick all that apply*

   ☐ Yes, past 12 months

   ☐ Yes, before the last 12 months

   ☐ No

2. Has this child woken up because of a cough? *Tick all that apply*

   ☐ Yes, past 12 months

   ☐ Yes, before the last 12 months

   ☐ No

3. Does this child usually have congestion in the chest or bring up phlegm or mucus apart from colds?

   ☐ Yes

   ☐ No

   ☐ Don't know

   If **NO**, GO TO **QUESTION 4**.

   If **YES**, has this congestion or phlegm been present for as much as 3 months in a row out of the year? *Tick all that apply*

   ☐ Yes, past 12 months

   ☐ Yes, before last 12 months

   ☐ No

4. Has this child ever had wheeze or whistling in the chest at any time in the past?

   ☐ Yes

   ☐ No

   ☐ Don't know

   If **NO**, SKIP TO **QUESTION 10**

   If **YES**, at what age did this child first start to wheeze? ____ years

5. Has this child had wheezing or whistling in the chest **in the past 12 months**?

   ☐ Yes

   ☐ No

   ☐ Don't know

   IF **YES,** CONTINUE TO **QUESTION 6**

   IF **NO,** at what age did this child stop wheezing?

   ___ years GO TO **QUESTION 10**

6. Does the wheezing or whistling in the chest occur:

   ☐ apart from colds?

   ☐ with colds?

   ☐ both apart from colds and with colds?

7. How many attacks of wheezing has this child had **in the past 12 months**?

   ☐ none

   ☐ 1-3

   ☐ 4-12

   ☐ more than 12

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

☐ Never woken with wheezing

☐ Less than one night per week

☐ One or more nights per week

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

☐ Yes

☐ No

10. Has your child's chest ever sounded wheezy during or after exercise/sports? *Tick all that apply.*

☐ Yes, past 12 months

☐ Yes, before last 12 months

☐ No

11. Has this child ever been diagnosed as having asthma by a doctor?

☐ Yes

☐ No

☐ Don't know

**IF NO or DON'T KNOW,** Please go to **QUESTION 14**

**IF YES,** At what age was the asthma diagnosed? ___ years

12. **In the past 12 months,** how many times has this child required health care for asthma from the following places:

Hospital inpatient _____
Emergency room _____
Doctor's office _____

13. **In the past 12 months**, how many asthma episodes (e.g. attacks, symptoms such as cough or wheeze or shortness of breath) has your child had?

☐ none

☐ 1-3

☐ 4-12

☐ more than 12

14. How often has your child's sleep been disturbed by breathing problems **in the past 12 months**:

☐ Never in the past 12 months

☐ At least once in the past 12 months

☐ At least once per month

☐ At least once per week

☐ Every day or nearly every day

15. **In the past 12 months** have you or another family member missed work because of your child's chest illness?

☐ Yes

☐ No

☐ Don't know

16. **In the past 12 months** how many days of school has your child missed because of breathing problems?

___ days ☐ Don't know

17. **In the past 12 months**, has this child's parents' sleep been disturbed because of this child's breathing problems?

☐ Yes

☐ No

☐ Don't know

18. Has this child had a prescription of antibiotics for respiratory infections (chest, ears, or throat) **in the past 12 months**?

☐ Yes If **YES**, how many? _____

☐ No

19. **In the past 12 months**, has this child taken medicine that your doctor prescribed for a breathing problem?

☐ Yes

☐ No

If **NO**, GO TO **QUESTION 20**.
If **YES**, please list the medication and how often it is used on average:

| Medicine | Daily | Sometimes (as needed) | Rarely |
|---|---|---|---|
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |

20. Has a doctor ever said this child had any of the following illnesses (*check all that apply*)

| | Before age 3 | Age 3 or older |
|---|---|---|
| Chronic bronchitis | ☐ | ☐ |
| Spastic bronchitis | ☐ | ☐ |
| Hay fever | ☐ | ☐ |
| Eczema | ☐ | ☐ |
| Pneumonia | ☐ | ☐ |
| Sinus trouble | ☐ | ☐ |
| Croup | ☐ | ☐ |
| Whooping cough | ☐ | ☐ |
| Tonsillitis | ☐ | ☐ |
| Sleep apnea | ☐ | ☐ |
| Ear infections | ☐ | ☐ |
| Diabetes | ☐ | ☐ |
| Emotional, psychological, nervous difficulties or ADD/ADHD | ☐ | ☐ |

21. **In the past 12 months**, has your child ever had a problem with sneezing, or a runny, or a blocked nose when he/she did **NOT** have a cold or the flu?

☐ Yes

☐ No

22. Has this child ever had an allergy (e.g. hives, runny nose, sneezing and/or wheezing) to any of the following:

House dust No ☐ Yes ☐

Grain dust No ☐ Yes ☐

Pollen No ☐ Yes ☐

Trees No ☐ Yes ☐

Grasses No ☐ Yes ☐

Mold or mildew No ☐ Yes ☐

Dog No ☐ Yes ☐

Cat No ☐ Yes ☐

Birds/feathers No ☐ Yes ☐

Farm animals No ☐ Yes ☐

Foods No ☐ Yes ☐

If **YES**, what food(s)? _____

If **YES** to any allergies listed in **QUESTION 22** were they diagnosed by a doctor?

☐ Yes

☐ No

☐ Don't know

23. Is this child's immunization status up to date?

☐ Yes

☐ No

☐ Don't know

24. Do you need more information on how to manage your child's breathing problems?

☐ Yes

☐ No

☐ Not applicable

25. Has this child ever been hospitalized for breathing problems?

☐ Yes

☐ No

☐ Don't know

If **YES**, please list the age and the reason:

| | Age | Reason |
|---|---|---|
| 1. | | |
| 2. | | |

26. Does this child snore?

☐ Yes

☐ No

☐ Don't know

27. Has this child had an operation to remove their tonsils or adenoids?

☐ Yes

☐ No

☐ Don't know

28. **During the past twelve months** has your child visited a dentist for dental care?

☐ Yes

☐ No

29. How long do you travel (in one direction) to receive routine and on-going medical care for this child? ____ minutes

30. How long do you travel (in one direction) to receive 24 hour emergency health care services for this child? ____ minutes

31. Where does this child receive **MOST** of their medical care?

☐ Emergency department

☐ Regular family physician

☐ Hospital

☐ Medi-clinic, walk-in clinic, minor emergency clinic, ambulatory clinic

32. **In the past 12 months**, did you ever experience any difficulties getting routine or on-going healthcare for this child?

☐ Yes

☐ No

☐ Don't know

33. In the **past 12 months**, were you ever unable to get prescription medications this child was supposed to take?

☐ Yes

☐ No

34. **In the past 12 months**, has this child had acetaminophen/paracetamol (e.g. Tylenol)?

☐ Yes

☐ No

☐ Don't know

35. **In the past 12 months**, has this child used any holistic or traditional medicine for breathing problems (e.g. homeopathic, herbal, rat root, etc.)?

☐ Yes

☐ No

☐ Don't know

## PART TWO – LIFESTYLE & ENVIRONMENT

36. How long has your child lived in your current home? ____ years

37. **In the past 12 months**, how many times did this child change where they were living? ____ times

38. Which best describes the type of housing unit in which you live?

☐ One family house

☐ A building for 2 or more families

☐ Other, please specify: _____

39. How many rooms are there in your home (not including bathrooms, porches, balconies, halls, or entrance ways)? _____ number

40. How many people live in your home? _____ number

41. When was your home built?

☐ Between 1980-present

☐ Before 1980

☐ Don't know

42. In your house, what fuel is usually used for heating?

☐ Natural gas/central heating

☐ Electricity

☐ Coal

☐ Wood

☐ Don't know

☐ Other, specify _____

43. Does your house have any damage caused by dampness (e.g. wet spots on walls, floors)?

☐ Yes

☐ No

☐ Don't know

44. **During the past 12 months**, has there been water or dampness in your home from broken pipes, leaks, heavy rain, or floods?

☐ Yes

☐ No

☐ Don't know

45. Does your home (including basement) frequently have a mildew odor or musty smell?

☐ Yes

☐ No

46. Are there signs of mold or mildew in any living areas in your home?

☐ Yes

☐ No

☐ Don't know

47. Where is your child currently living?

☐ Farm

☐ Acreage

☐ In town

☐ Reserve

**If this child lives on a "FARM"**, what is **produced for sale** on your farm or ranch? (*Check all that apply*).

☐ Grain

☐ Cattle (beef)

☐ Cattle (dairy)

☐ Pigs

☐ Poultry

☐ Vegetable/fruit

☐ Other: Please specify: _____

☐ Nothing for sale

48. **In the past 12 months**, on average, how often has this child spent 1 hour near or in the following activities

| | Everyday | At least once a week | At least once a month | Less than once a month | Never |
|---|---|---|---|---|---|
| Haying or moving or playing with hay bales | | | | | |
| Feeding livestock | | | | | |
| Cleaning or playing in barns | | | | | |
| Emptying or filling grain bins | | | | | |
| Cleaning or playing in pens or corrals | | | | | |
| Riding horses | | | | | |
| Pesticides | | | | | |

49. Do you have any of the following in your home?

Air conditioners No ☐ Yes ☐

Air filter No ☐ Yes ☐

Humidifier No ☐ Yes ☐

Dehumidifier No ☐ Yes ☐

Wood fireplace No ☐ Yes ☐

Heat recovery ventilator (HRV) No ☐ Yes ☐

50. **In the past 12 months**, have you had any of the following pets living in your home?

Cat ☐ No ☐ Yes

Dog ☐ No ☐ Yes

Bird ☐ No ☐ Yes

51. **In the past 12 months**, have you had any problems with mice or pests in your home?

☐ Yes

☐ No

☐ Don't know

52. Does any person currently smoke **inside** the house?

☐ Yes

☐ No

53. Does this child's father currently smoke?

☐ Yes

☐ No

☐ Don't know

54. Does this child's mother currently smoke?

☐ Yes

☐ No

☐ Don't know

55. Is this child exposed to smoke in a car or in a bus?

☐ Yes

☐ No

☐ Don't know

56. Do any of the friends of this child smoke?

☐ Yes

☐ No

☐ Don't know

57. Has this child ever smoked tobacco? (At least one cigarette, cigar, or pipe)

☐ Yes

☐ No

☐ Don't know

58. Is this child exposed to tobacco smoke from alternate caregivers?

☐ Yes

☐ No

☐ Don't know

59. Is this child's classroom floor at school carpeted?

☐ Yes, fully

☐ Yes, partly

☐ No

60. Do any of the following animals live in the child's classroom at school: turtle, fish, furred animals, bird?

☐ Yes

☐ No

61. How often do trucks pass through the street where you live, on weekdays?

☐ Never

☐ Seldom

☐ Frequently through the day

☐ Almost the whole day

62. During a normal week, how many hours a day (24 hours) does your child watch TV or play video games?

☐ Less than 1 hour

☐ 1 hour but less than 3 hours

☐ 3 hours but less than 5 hours

☐ 5 hours or more

Physical activity is any activity that increases your heart rate and makes you get out of breath some of the time. Physical activity can be done in sports, school activities, playing with friends, or walking to school. For these next two questions, add up all the time this child spends in physical activity each day.

63. **Over the past 7 days**, on how many days was this child physically active for a total of at least 60 minutes per day? ____ days

64. Over a **typical or usual** week, on how many days was this child physically active for a total of at least 60 minutes per day?
____ days

65. In the past 12 months, how often, on average, did your child eat or drink the following? (please check)

| | Never/ Occasionally | Once or twice per week | Three or more times per week |
|---|---|---|---|
| Meat (beef, lamb, chicken, pork, etc.) | | | |
| Seafood (including fish) | | | |
| Fruit | | | |
| Vegetables | | | |
| Bread or cereal | | | |
| Pasta, rice, or potatoes | | | |
| Milk | | | |
| Unpasteurized milk (raw milk) | | | |
| Eggs | | | |
| Nuts | | | |
| Wild meat or bird (e.g. deer, elk, rabbit, duck) | | | |
| Potato chips or sweets (including chocolate) | | | |
| Soft drinks or pop | | | |
| Fast foods or foods including hamburgers, chicken nuggets, deep dried foods, or French fries | | | |

## PART THREE – THIS CHILD, THE FAMILY, AND EARLY LIFE EXPOSURES

66. Child's sex: Male ☐ Female ☐

67. Date of Birth: ___ ___ ___
Mo Day Yr.

68. Child's age: ____

69. How tall is this child? (*For best results please use a tape measure against a wall*)
_____ feet, ____ inches OR ___ cm

70. How much does this child weigh? (*For best results please use a scale*)
____ pounds OR ___ kg

71. Did this child consume unpasteurized milk (e.g. raw milk, farm milk, etc.) regularly **in the first year of life**?

☐ Yes

☐ No

☐ Don't know

72. Did this child live on a farm during the **first year of life**?

☐ Yes, **If Yes**, what type of farm?
(*Check all that apply*)

☐ Grain

☐ Livestock

☐ Other: Please specify: _____

☐ No

☐ Don't know

73. What was the child's weight at birth?
___ pounds, ___ ounces OR ___ g

74. Was this child born before mother's due date?

☐ Yes, how many weeks early? ___ wks

☐ No

☐ Don't know

75. Was this child delivered by Caesarean section?

☐ Yes

☐ No

☐ Don't know

76. Was this child breastfed?

☐ Never

☐ 0-4 weeks

☐ 4 weeks to 6 months

☐ More than 6 months

☐ Don't know

77. Is this child a first born child?

☐ Yes

☐ No

☐ Don't know

78. Did this child's **birth** mother smoke during the pregnancy?

☐ Yes

☐ No

☐ Don't know

79. Do the child's **birth** parents have any of the following conditions? *Tick any that apply*

| | Mother | Father |
|---|---|---|
| Asthma | ☐ | ☐ |
| Hay fever | ☐ | ☐ |
| Allergies | ☐ | ☐ |
| Eczema | ☐ | ☐ |
| Don't know | ☐ | ☐ |
| None | ☐ | ☐ |

80. Did this child's **birth** mother have diabetes while she was pregnant with this child?

☐ Yes

☐ No

☐ Don't know

81. Did this child ever go to daycare?

☐ Yes If **YES**, Age started: ____

☐ No

☐ Don't know

82. How many brothers or sisters does this child have? _____

83. What is the highest level of education of this child's mother?

☐ Grade school

☐ Completed Grade 12

☐ Some technical school or university

☐ Completed Technical school or University degree

☐ Don't know

84. What is the highest level of education of this child's father?

☐ Grade school

☐ Completed Grade 12

☐ Some technical school or university

☐ Completed Technical school or University degree

☐ Don't know

85. At the end of the month, how much money do you have left over?

☐ Some money

☐ Just enough money

☐ Not enough money

86. Type of household

☐ Single parent home

☐ Two parent /partner home

87. In the past 12 months, has this family ever struggled to meet the basic living requirements (i.e. food, housing, power, heating, water, clothing, school supplies, fees for school events, etc.)?

☐ Yes

☐ No

88. What is this child's ethnicity?

☐ Caucasian

☐ First Nation

☐ Metis

☐ African, African-American

☐ Asian, Southeast Asian

☐ Other Please specify_____

89. Do members of this household take part in your local community's events?

☐ Always / almost always

☐ Sometimes

☐ Rarely

☐ Never

90. How well do you feel like you are generally supported (socially, emotionally, medically, etc.) by your community (please mark on the line)?

**No support** **Extremely supported**

## PART FOUR – CONTACT INFORMATION

**After we receive the completed survey, <u>this information will be detached from the questionnaire by research staff</u> to maintain confidentiality.**

**This information is important to collect so we may contact you about this project if necessary.**

91. Name of School _____

92. Grade _____

93. Child's First Name _____

94. Last Name _____

95. Street Address or land location _____

96. PO Box _____

97. Telephone No. _____

98. Person completing questionnaire:

Mother ☐

Father ☐

Other ☐ Relationship to child _____

**98. Would you be willing to have your child participate in the next part of this research project, which could include clinical testing (e.g. lung function testing) or home environmental testing?**

☐ **YES**

☐ **NO**

**THE END**
**THANK YOU for completing the questionnaire. This study could not be successful without your participation.**
**Please make any comments you wish to make on the back of this page.**