Chartbook

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Asthma Hospitalizations Among Children and Youth in Canada: Trends and Inequalities

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Please note that the analyses and conclusions in this chartbook do not necessarily reflect the views of the individuals mentioned above.

About this chartbook

The analysis includes data from the Hospital Morbidity Database (HMDB) housed at the Canadian Institute for Health Information (CIHI) for fiscal years 2006–2007 to 2015–2016 from all provinces and territories, as well as data from Statistics Canada's 2006–2007 to 2008–2009 Census–Discharge Abstract Database (DAD) linked data, which excludes Quebec.

Supplementary data tables provide additional results by province and territory.

Executive summary

Approximately 15% of children and youth in Canada were living with asthma in 2013–2014,[1] and asthma continues to be one of the leading causes of hospitalization among children and youth. Many of these hospitalizations are considered avoidable if appropriate treatment and management is provided at the primary care level.

Over the past decade, hospitalizations for asthma have declined significantly for both boys and girls, and across all age groups. In spite of this improvement, children and youth living in lower-income neighbourhoods continue to experience significantly higher rates of hospitalization than those living in higher-income neighbourhoods. These income-related inequalities are observed across different age groups and for boys and girls.

In this report, we also found large inequalities in asthma hospitalizations by household education level: children and youth living in households in which the highest level of education was less than high school were 2.3 times more likely to have been admitted to a hospital for asthma than children and youth living in a household in which the highest level of education was a master's degree or doctorate. This analysis of education-related inequalities was made possible through Statistics Canada's linkage of hospital data with Canada's long-form census. Linking administrative health and social data in Canada provides new opportunities to further advance the measurement of health inequalities across population subgroups.

Our analysis suggests that there are opportunities to improve asthma management for children and youth, particularly within lower-education and lower-income populations. Promising interventions include tailored patient/parent education and self-management plans, as well as school- and community-based interventions. Moving forward, the rich longitudinal data sets used for this report could be used to monitor interventions for improving asthma management, with a focus on vulnerable subgroups.

Introduction

Health equity is an important component of quality of care and overall health system performance, and it is a growing priority for health care systems in Canada. Measuring inequalities across population subgroups is an important first step in identifying differences that may be considered unfair or unjust and that can be acted on to improve health equity.[2, 3] In Canada, inequalities in health and health care are significant across a range of health indicators[4] and are generally persisting or worsening over time.[5] For example, a 2015 report showed that smoking rates declined over the period 2003 to 2013 for the population on average, yet the smoking rate among people in the lowest income group remained stable.[5] This highlights the importance of examining indicator rates across population subgroups because health improvements are not always equally distributed.

This chartbook examines inequalities in asthma hospitalization by age, sex, income, geographic location and education among children and youth (age 0 to 19) at the provincial/territorial and national levels, as well as patterns over time. This work leverages newly developed recommended definitions for a set of socio-demographic variables (i.e., equity stratifiers) for the measurement of health inequalities. For more information about these equity stratifiers, please see CIHI's report *In Pursuit of Health Equity: Defining Stratifiers for Measuring Health Inequality*. These definitions were developed by drawing on the support of a nationally representative expert working group and on standards developed by Statistics Canada.

Asthma is a chronic respiratory condition that is highly prevalent in Canadian children and youth: approximately 15% of those age 1 to 19 were living with asthma[i] in 2013–2014.[1] There are many possible risk factors for developing asthma, including genetic predisposition and exposure to airborne irritants and second-hand smoke.[7]

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i. The Chronic Disease and Injury Indicator Framework uses data from the Canadian Chronic Disease Surveillance System, which identifies prevalent asthma cases in children and youth based on having 1 or more hospitalizations ever or 2 or more physician claims within 2 years.[6]

Canadians living with asthma may be hospitalized when they experience a severe or life-threatening asthma exacerbation, including worsening coughing and wheezing, chest pain, drowsiness and confusion.[8] Many asthma hospitalizations are considered avoidable if appropriate treatment and management is provided at the primary care level.[9] Hospitalizations and emergency department (ED) visits for asthma are more common among children and youth than among adults; this may be related to the fact that the evidence for diagnosis and treatment is stronger for adults,[8, 10, 11] as well as to challenges associated with diagnosis and treatment for children younger than 6 in particular.[11, 12] Indeed, asthma continues to be a leading cause of hospitalization among children and youth, with more than 6,000 hospitalizations in 2015–2016. Moreover, for every hospitalization, there are approximately 8 ED visits for asthma among this age group.[13]

Effective asthma management includes medication adherence, avoiding asthma triggers and implementing an asthma action plan;[8, 14] however, only 1 in 3 Canadians are properly controlling their asthma.[15] Uncontrolled asthma in childhood is associated with decreased cardiovascular fitness,[16] missed school days and lower health-related quality of life for children.[17] Asthma is also associated with lower productivity and quality of life among caregivers of children with asthma.[17] The treatment and management of asthma, and the related avoidable hospitalizations, are also associated with significant health care costs:[18] in 2015–2016, the average cost per asthma hospitalization for children and youth was estimated to be approximately $2,718.[19] A study from British Columbia estimated that approximately 64% of patients age 5 to 55 had poorly controlled asthma, and these patients accounted for 94% of the direct health care costs of asthma (due to medications, hospitalizations and physician visits).[20] The burden of asthma on patients, caregivers and health care systems points to opportunities for improving patient care and reducing health system costs.

Leveraging linked health and social data to measure health inequalities

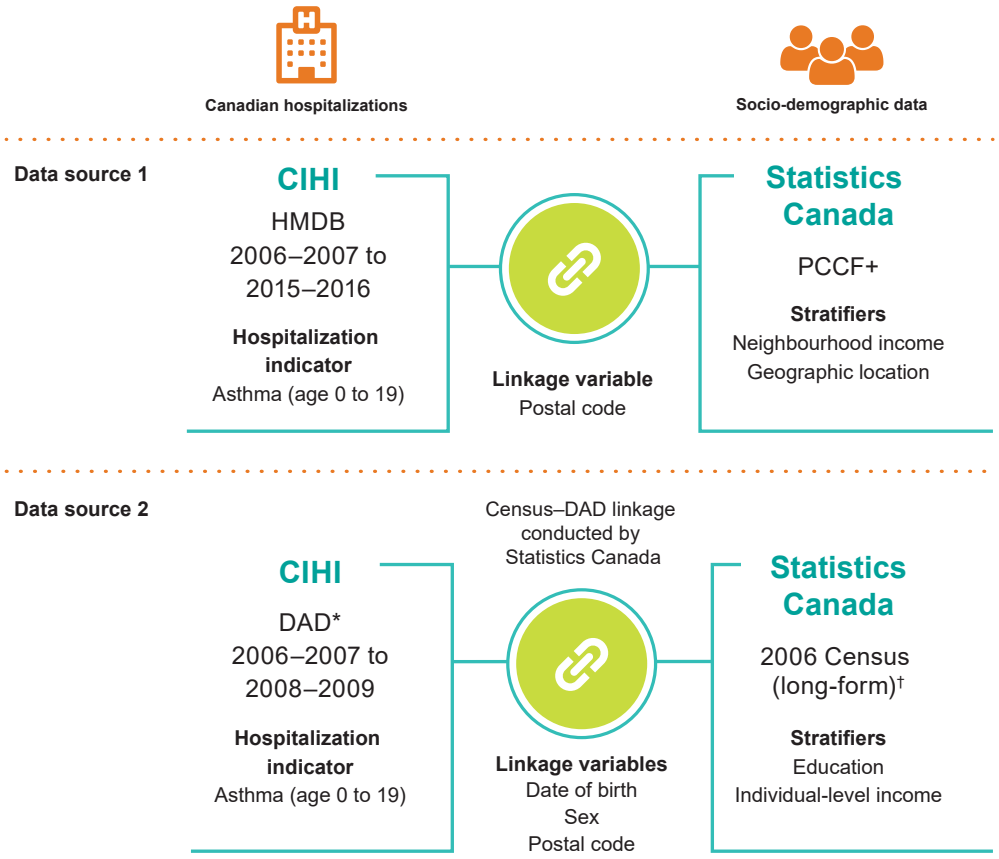
This chartbook contains analysis using 2 data sources (see Figure 1):

1. First, to examine overall asthma hospitalization rates stratified by age, sex, province/territory, neighbourhood income and geographic location (i.e., urban versus rural/remote status), we used the Hospital Morbidity Database (HMDB) housed at the Canadian Institute for Health Information (CIHI) for fiscal years 2006–2007 to 2015–2016. To examine trends by neighbourhood-level income and geographic location, we applied Statistics Canada's Postal Code[ii] Conversion File (PCCF+ Version 6D)[21] tool to assign measures of neighbourhood income and urban and rural/remote geographic location to the HMDB data.
2. To further examine asthma hospitalization rates stratified by educational attainment and individual-level income, we used Statistics Canada's 2006 Census (long-form) linked to the 2006–2007 to 2008–2009 Discharge Abstract Database (DAD);[22] this linkage does not include data from Quebec.

The Methodology section provides additional details about the data sources and linkage, as well as the asthma hospitalization case definition and age-standardized rate calculation. Provincial and territorial results for 2006–2007 to 2015–2016 are available in the supplementary data tables.

ii. Postal code is an official mark of Canada Post Corporation.

Figure 1: Data sources and linkages used in this chartbook



Notes

* Excludes Quebec.

† About 20% of the Canadian population received the long-form census (excluding those in institutions and those who entered Canada after Census Day).

HMDB: Hospital Morbidity Database.

PCCF+: Postal Code Conversion File Plus.

DAD: Discharge Abstract Database.

Sources

PCCF+: Statistics Canada. *Postal Code Conversion File Plus (PCCF+) Version 6C Reference Guide*. 2016.

Census–DAD linkage: Statistics Canada. *2006/2007 to 2008/2009 Census-linked Discharge Abstract Database (DAD)*.

Rotermann M, et al. Linking 2006 Census and hospital data in Canada. *Health Reports*. 2015.

How do asthma hospitalizations vary by age and sex?

Key messages

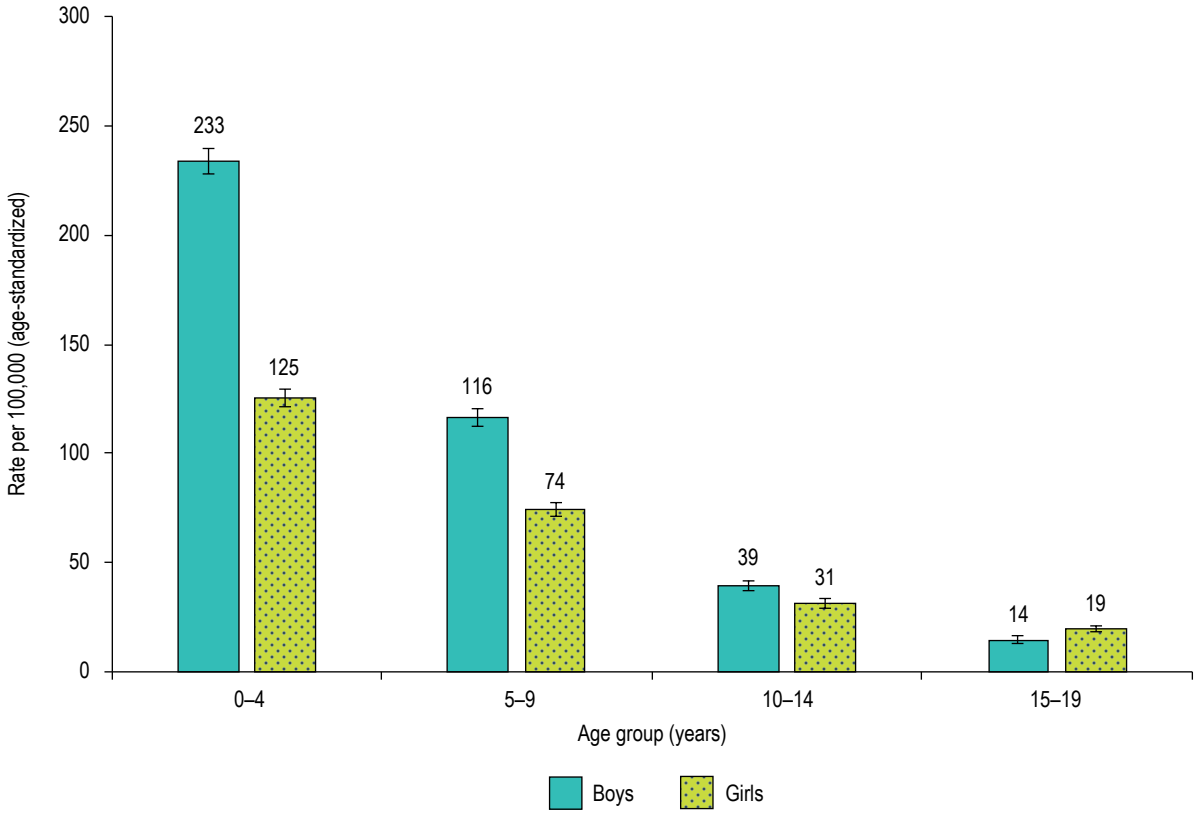
- Children age 0 to 4 had the highest hospitalization rates for asthma compared with older age groups (5 to 9, 10 to 14 and 15 to 19) (Figure 2).
- Higher rates were observed among boys for the younger age groups (0 to 4, 5 to 9 and 10 to 14) and among girls for the oldest age group (15 to 19) (Figure 2).

Discussion

The higher hospitalization rates observed among the youngest children may be related to difficulties diagnosing and treating asthma in this age group. For these younger patients, health care providers must rely on reports from family members or caregivers, rather than respiratory tests such as spirometry,[8] resulting in significant diagnostic and therapeutic uncertainty and higher morbidity.[11] Preschool-age children with asthma symptoms may be diagnosed with a range of conditions, including asthma, acute bronchitis, bronchiolitis, bronchospasms and reactive airway disease. This challenge leads to increased morbidity, delayed diagnosis and suboptimal management of asthma in primary care settings.[11]

The observed sex-related differences are consistent with clinical evidence suggesting that asthma is more prevalent and severe among young boys than girls. This pattern reverses during adolescence, with increased prevalence and severity of asthma symptoms in girls starting at puberty.[23] While sex hormones may modulate asthma pathways, there may also be gender differences in environmental exposures, the perception of asthma symptoms, knowledge of asthma self-management and likelihood of carrying asthma medication.[23, 24] Some research has suggested that asthma is more common among boys because they are born with smaller airways relative to their lung size or because they tend to have more allergies, predisposing them to asthma.[25]

Figure 2: Asthma hospitalization, by sex and age group, Canada, 2013–2014 to 2015–2016



Asthma hospitalization rates are higher among boys than girls for those age 0 to 14.

Note

Results are based on the pooled 3-year average for the most recent years (2013–2014 to 2015–2016). Similar patterns were observed for pooled data from 2006–2007 to 2008–2009 (data not shown).

Source

Hospital Morbidity Database, Canadian Institute for Health Information.

How have asthma hospitalizations changed over time?

Key messages

Asthma hospitalization rates in children and youth have declined by 50% over the past 10 years (Figure 3).

- Rates decreased for both boys and girls (Figure 3) and across all age groups (Figure 4), with the largest decrease among children younger than 5.
- Rates decreased significantly in all provinces and in Yukon, but there were variations between provinces (Figure 5).
- From 2013–2014 to 2015–2016, rates were significantly higher than the Canadian average in Prince Edward Island, Saskatchewan, Ontario and the Northwest Territories, and were lower than the average in New Brunswick, Quebec, Manitoba, Alberta, British Columbia and Yukon (Figure 5).

Discussion

The substantial decrease in asthma hospitalization rates among children and youth in Canada suggests that there have been improvements in the prevention and/or primary care treatment and management of this disease during the past decade, and that these improvements have affected rates across all age groups and among both boys and girls. These trends in hospitalizations were also noted in the United States and in many European countries.[26–28]

During this time period, hospital readmission rates attributed to asthma remained fairly stable, with a slight decrease in recent years — from 8.7% of all admissions in 2006–2007 to 7.6% in 2015–2016.[iii] This may further suggest improvements in disease management and primary care follow-up after an acute care episode. During this time period, there was also a change in the coding direction. Prior to 2009–2010, cases of reactive airway disease (RAD) were classified as *Asthma* (J45), but from 2009 onward these cases were classified as *Other specified respiratory disorders* (J98.8). Additional analysis shows that rates for combined asthma and RAD decreased to a similar extent as asthma alone between 2006–2007 and 2015–2016 (asthma alone: 52%; asthma and RAD: 45%).

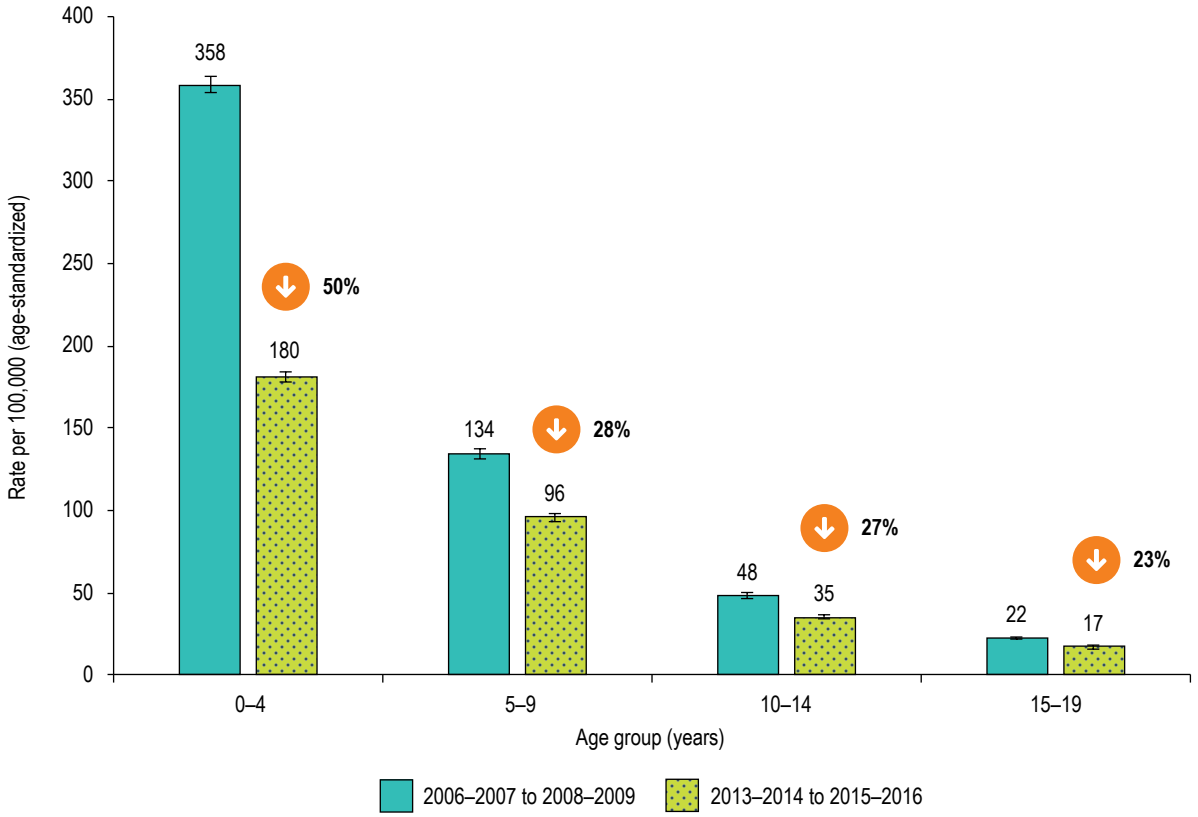
iii. For each fiscal year, readmissions were defined as admissions occurring more than 24 hours after an earlier discharge date.

Figure 3: Asthma hospitalization (age 0 to 19) by sex, Canada, 2006–2007 to 2015–2016

Asthma hospitalization rates decreased by 50% over the past decade, with 79 per 100,000 fewer cases in 2015–2016 than in 2006–2007.

Source
Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 4: Asthma hospitalization by age group, Canada, 2006–2007 to 2008–2009 versus 2013–2014 to 2015–2016



Asthma hospitalization rates decreased across all age groups, with the highest decrease among children younger than 5.

Notes

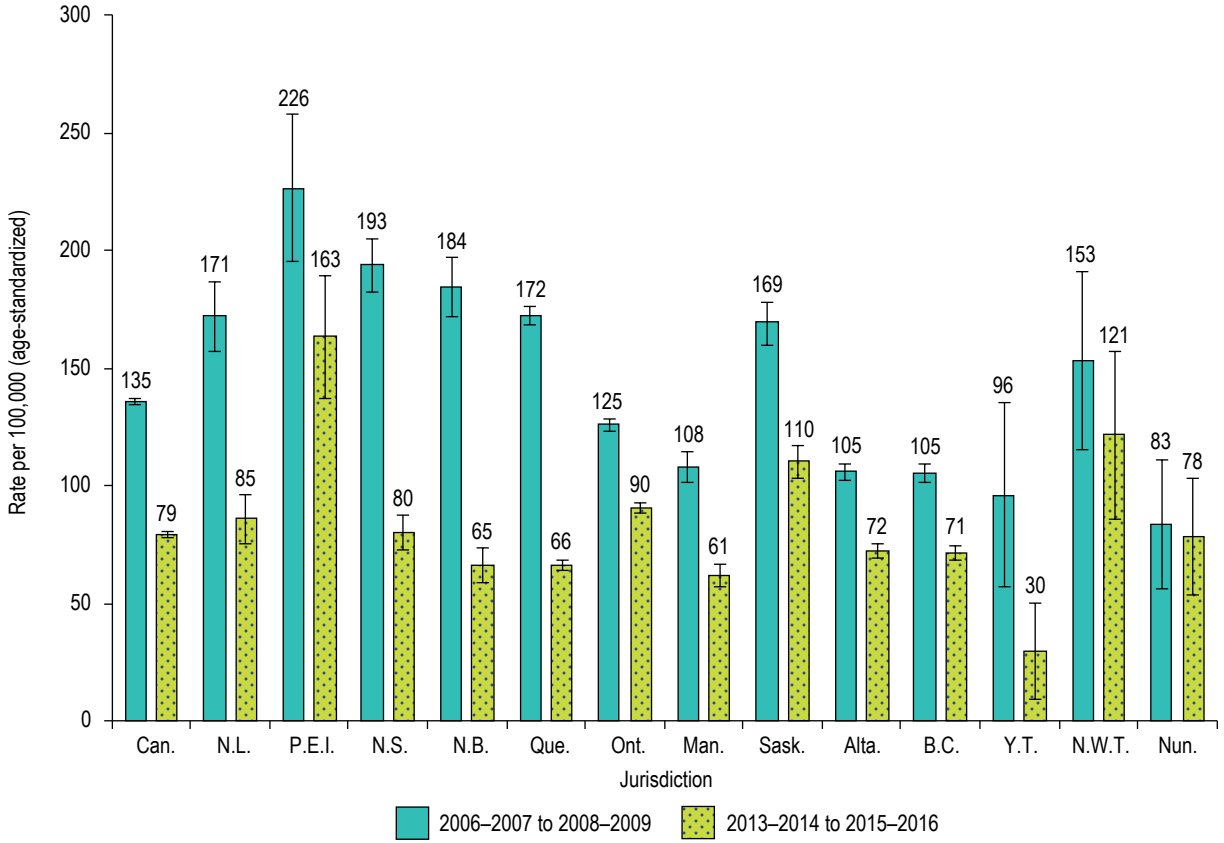
The percentage decrease was calculated by subtracting the later age-standardized hospitalization rate per 100,000 population from the earlier rate, dividing by the earlier rate and multiplying by 100%.

Results are based on the pooled 3-year average for the most recent years (2013–2014 to 2015–2016). Similar patterns were observed for pooled data from 2006–2007 to 2008–2009 (data not shown).

Source

Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 5: Asthma hospitalization (age 0 to 19) by province/territory, 2006–2007 to 2008–2009 versus 2013–2014 to 2015–2016



Asthma hospitalization rates decreased significantly over the past decade for all provinces and Yukon.

- From 2013–2014 to 2015–2016, rates were significantly higher than the Canadian average in Prince Edward Island, Ontario, Saskatchewan and the Northwest Territories.

Source
Hospital Morbidity Database, Canadian Institute for Health Information.

How do asthma hospitalizations vary by neighbourhood income, geographic location and household education?

Inequalities by income

The income-related inequalities presented in this section are based on neighbourhood income quintiles assigned to asthma hospitalization cases. Results based on individual-level income quintiles from the 2006 Census (long-form) linked to the 2006–2007 to 2008–2009 DAD show similar levels of inequality at the national level, and greater inequalities for certain provinces such as Saskatchewan. Individual-level income quintiles generally better reflect a person's material well-being, such as having the means to purchase goods and services, relative to other individuals; area-level income quintiles encompass the social and economic characteristics of neighbourhoods, including access to health care and other services and amenities, relative to other neighbourhoods. The results using individual-level income quintiles are available in the supplementary data tables.

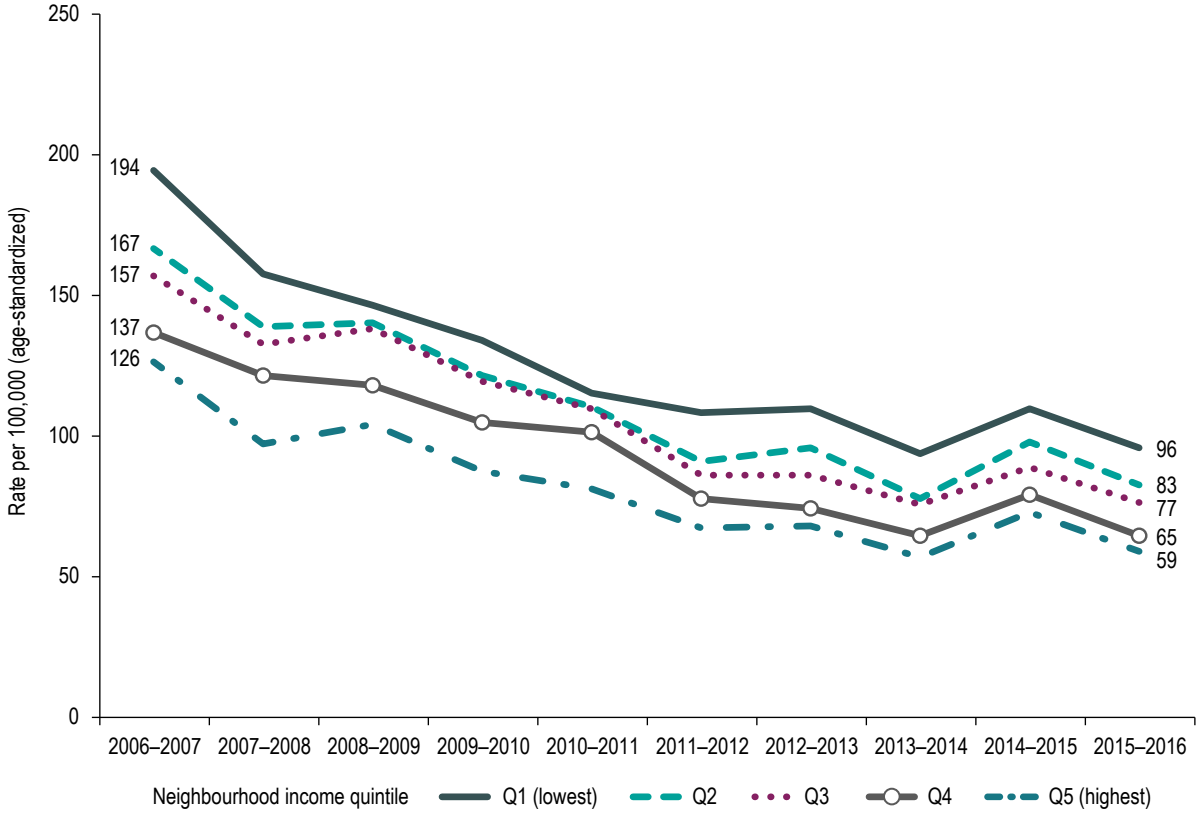
Key messages

- Inequalities by neighbourhood income have generally persisted over the past 10 years (Figure 6).
- Neighbourhood income–related inequalities are similar for both boys and girls (see supplementary data tables), and are significant for both children and youth (Figure 7).
- Neighbourhood income–related inequalities have persisted over time across all provinces, except in British Columbia (where they appear to have been eliminated). Provincial and territorial results are available in the supplementary data tables.

Discussion

The income-related inequalities observed here are in line with findings from the literature. A recent Ontario study found that asthma hospitalizations and ED visits were greater among children from low-income families and that these children were at higher risk of aggravating their asthma as the proportion of household income spent on out-of-pocket payments for asthma medication increased.[29] It is also known that children and youth from households with lower incomes are more likely to engage in earlier cigarette use[30, 31] or be exposed to second-hand smoke.[32, 33] Smoking or exposure to second-hand smoke are risk factors for asthma exacerbation, particularly in children.[7, 34] These income-associated environmental factors can lead to asthma hospitalizations or ED visits.[35] Poor housing conditions (e.g., poor housekeeping, disrepair), which are more common in lower-income populations, are also associated with increased exposure of children with asthma to indoor allergens and air pollution.[36–38] A recent study of 3 large Canadian cities (Montréal, Vancouver and Toronto) linked increased air traffic pollution (as measured by nitrogen dioxide concentrations) to lower income and suggested that this may in part contribute to the high incidence of air pollution–related diseases, such as asthma, in lower socio-economic status neighbourhoods.[39]

Figure 6: Asthma hospitalization (age 0 to 19) by neighbourhood income, Canada, 2006–2007 to 2015–2016



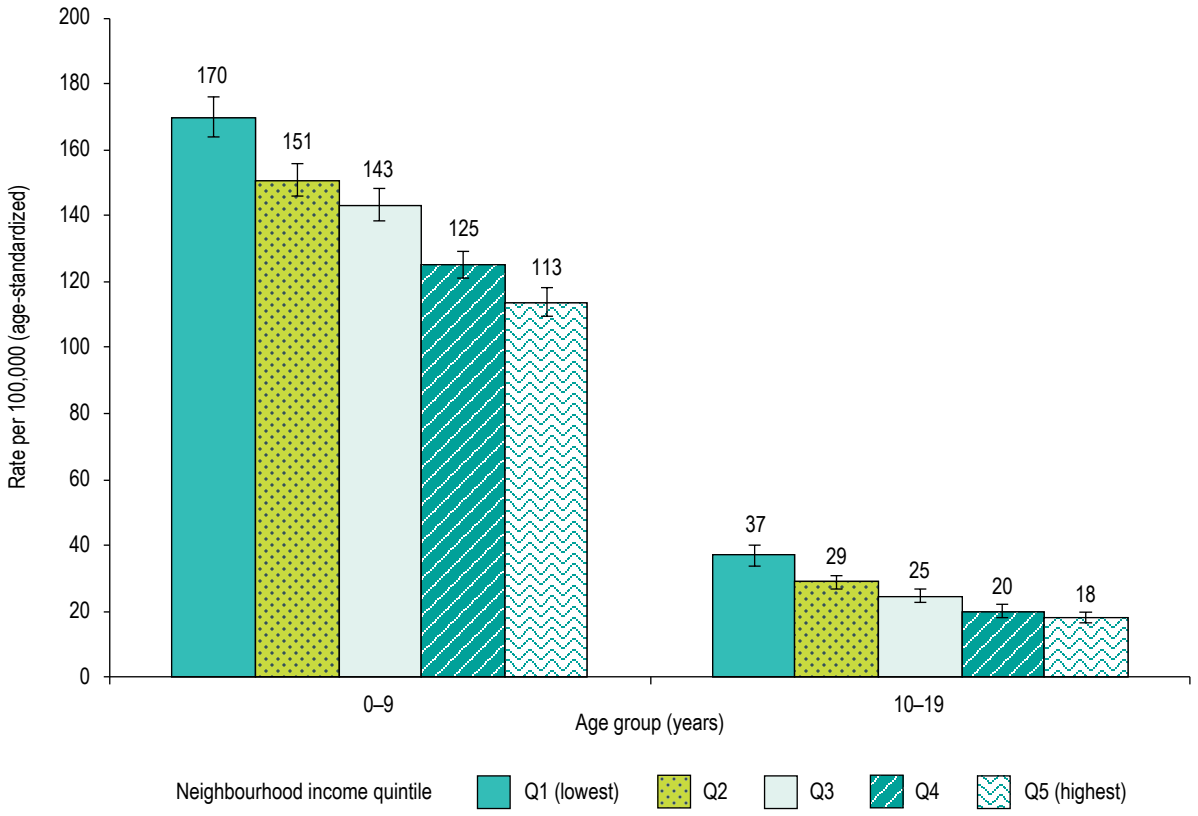
Note
Results are based on income defined at the neighbourhood level using Statistics Canada's PCCF+ tool. See the Methodology section for more information.

Source
Hospital Morbidity Database, Canadian Institute for Health Information.

Income-related inequalities have persisted over time on a relative scale, with asthma hospitalization rates remaining approximately 1.5 times higher in the lowest-income neighbourhoods compared with the highest-income neighbourhoods.

- In 2015–2016, there were **37 more hospitalizations per 100,000 population** in the lowest-income neighbourhoods compared with the highest-income neighbourhoods. As hospitalization rates decreased over time, so did the level of absolute inequality; in 2006, the rate difference was 68 cases per 100,000 between the lowest- and highest-income neighbourhoods.

Figure 7: Asthma hospitalization, by neighbourhood income and age group, Canada, 2013–2014 to 2015–2016



Note
Results are based on income defined at the neighbourhood level using Statistics Canada's PCCF+ tool. See the Methodology section for more information.

Source
Hospital Morbidity Database, Canadian Institute for Health Information.

There are income-related inequalities in asthma hospitalization rates for both children and youth.

- Among children age 0 to 9, hospitalization rates were **1.5 times higher (or 57 additional cases per 100,000)** in the lowest-income neighbourhoods compared with the highest-income neighbourhoods.
- Among youth age 10 to 19, hospitalization rates were **2.0 times higher (or 19 additional cases per 100,000)** in the lowest-income neighbourhoods compared with the highest-income neighbourhoods.

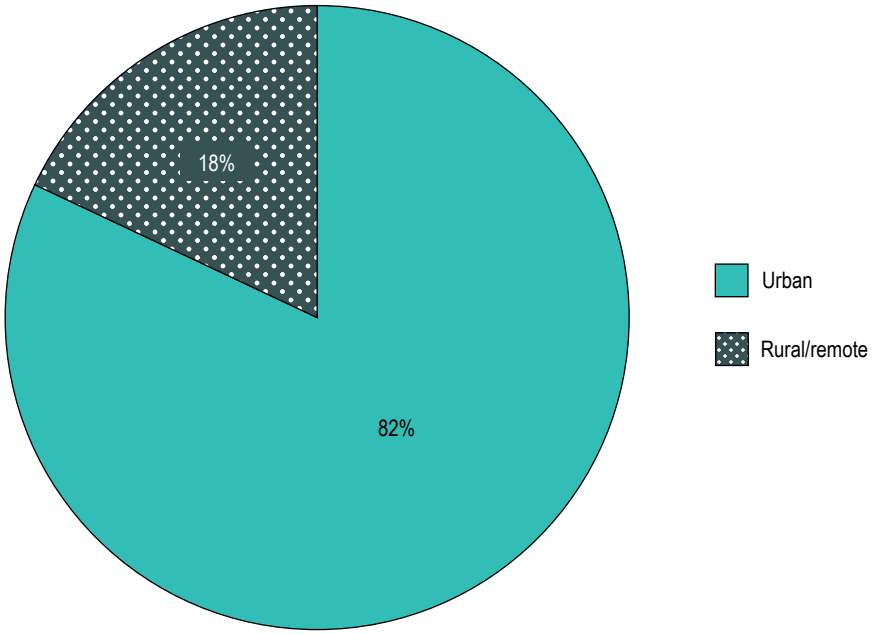
Inequalities by geographic location

Geography-related inequalities were calculated by dividing the population of children and youth in Canada into 2 groups based on their postal code, depending on whether they lived in an urban or rural/ remote setting.

Key message

- In Canada, asthma hospitalization rates are slightly higher in urban areas compared with rural/remote areas (Figure 9), with some variations across provinces and territories.

Figure 8: Geographic distribution of population (age 0 to 19), Canada, 2015–2016



Note

Geographic location was assigned based on Statistics Canada's Statistical Area Classification type (SACtype): SACtypes 1, 2 and 3 are urban, and SACtypes 4, 5, 6, 7 and 8 are rural/remote. This variable takes into account population size and commuting to large urban centres.[42]

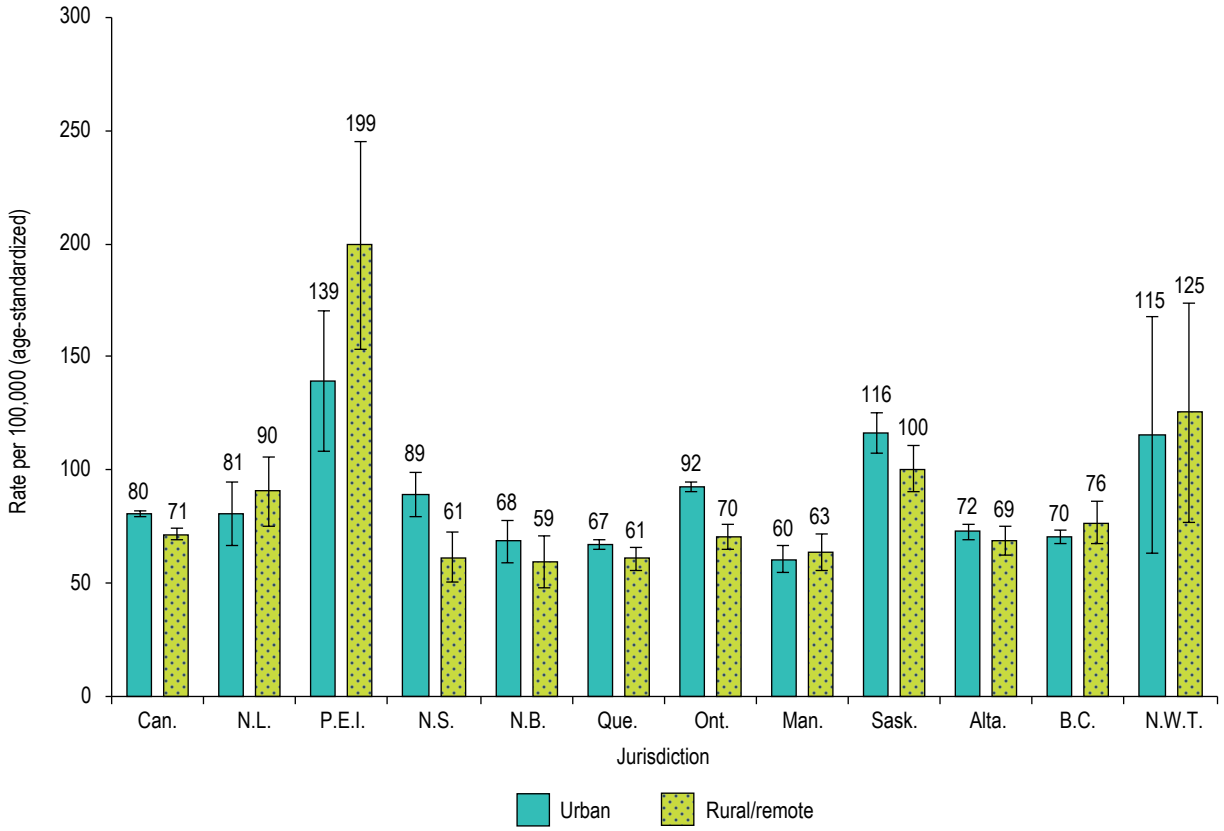
Source

Statistics Canada, Demography Division. Population estimates, 2015–2016.

Discussion

One reason asthma hospitalization rates may be slightly lower in rural and remote areas is because asthma appears to be less prevalent among children in rural than urban regions. This may be due in part to higher environmental exposures in rural and remote areas, which are believed to protect against the development of asthma.[40] On the other hand, children with asthma who lived in rural areas were more likely to have severe asthma symptoms than children living in urban areas, and they were less likely to visit a physician until their condition became severe.[40] The Canadian Thoracic Society and the Canadian Paediatric Society outline 5 recommendations for referral to asthma specialists, including for severe asthma and when frequent exacerbations persist despite treatment with a moderate dose of inhaled corticosteroids.[11] However, one study found that almost one-quarter of rural residents faced difficulty accessing specialist care services,[41] likely due to longer travel times to access health care.[40, 41]

Figure 9: Asthma hospitalization (age 0 to 19), by urban versus rural/remote geographic location, provinces/ territories, 2013–2014 to 2015–2016



In Nova Scotia and Ontario, asthma hospitalization rates are significantly higher in urban areas than in rural/remote areas.

- In Canada, urban areas experience slightly higher hospitalization rates than rural/remote areas.

Notes

Data for Yukon and Nunavut was suppressed due to small numbers.

Geographic location was assigned based on Statistics Canada's Statistical Area Classification type (SACtype): SACtypes 1, 2 and 3 are urban, and SACtypes 4, 5, 6, 7 and 8 are rural/remote. This variable takes into account population size and commuting to large urban centres.[42]

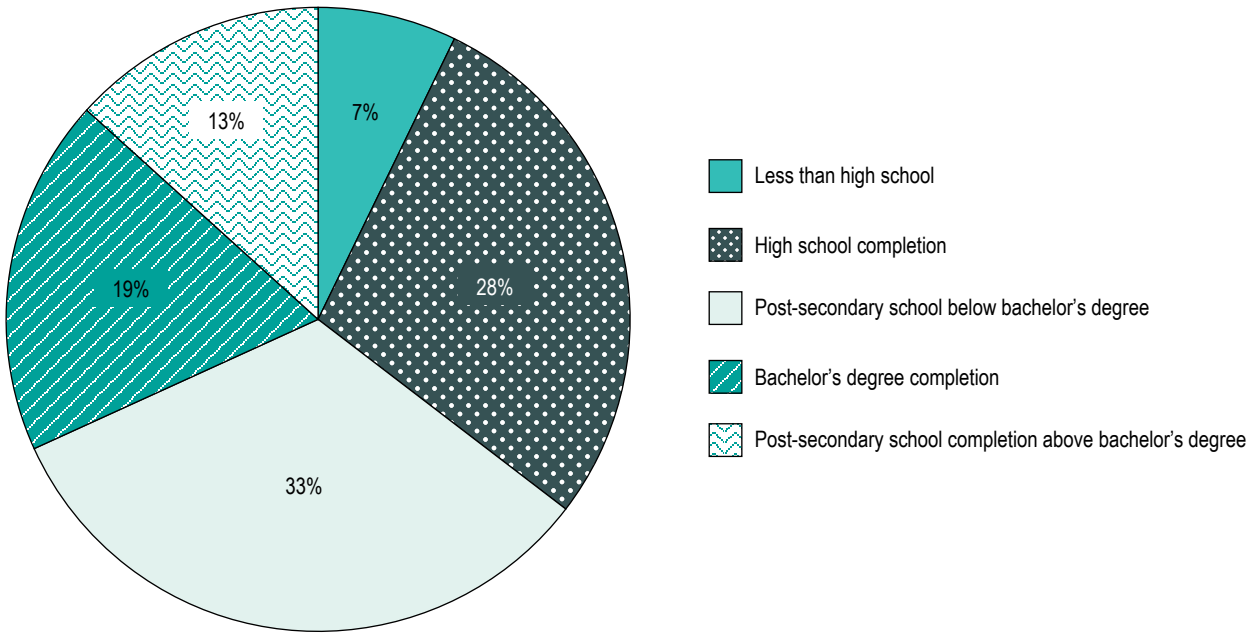
Source

Hospital Morbidity Database, Canadian Institute for Health Information.

Inequalities by educational attainment

Linking hospital and long-form census data facilitates the analysis of inequality. In this work, educational attainment refers to the highest level of schooling achieved by any member of the household.

Figure 10: Distribution of household educational attainment (age 0 to 19), Canada (excluding Quebec), 2006



Note
Distribution is based on the Canadian population age 0 to 19 (excluding Quebec), estimated using the weighted long-form census.
Source
2006 Census linked to 2006–2007 to 2008–2009 Discharge Abstract Database, Statistics Canada.

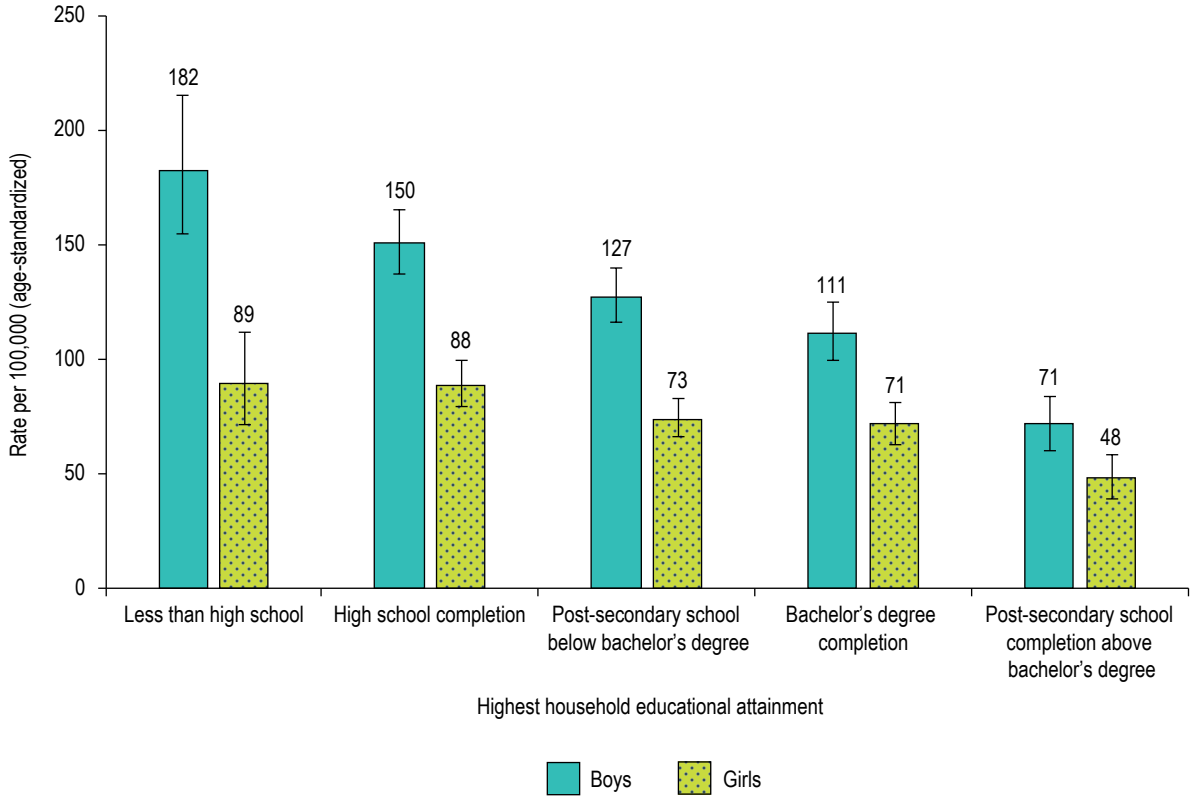
Key messages

- There are large education-related inequalities, especially among boys (Figure 11).
- Education-related inequalities are observed among both children age 0 to 9 and youth age 10 to 19 (Figure 12).

Discussion

Health literacy, defined as “the degree to which individuals have the capacity to obtain, process and understand basic health information and services to make appropriate health decisions,”[43] is correlated with educational attainment[44, 45] and has been linked to asthma outcomes. In particular, multiple studies reveal that lower levels of health literacy are associated with poorer asthma-related knowledge, management and health outcomes.[46–49] Lower levels of educational attainment are also associated with increased vulnerability to airborne allergens, as reflected by increased hospitalizations for asthma,[50] perhaps related to the association between lower education and poorer housing quality[51] or residential proximity to sources of air pollution.[52] As well, smoking and exposure to second-hand smoke represent significant risk factors for asthma exacerbations in children and youth, and individuals with lower educational attainment in Canada are more likely to smoke than those with higher levels of education.[34, 53]

Figure 11: Asthma hospitalization (age 0 to 19), by household educational attainment and sex, Canada (excluding Quebec), 2006–2007 to 2008–2009



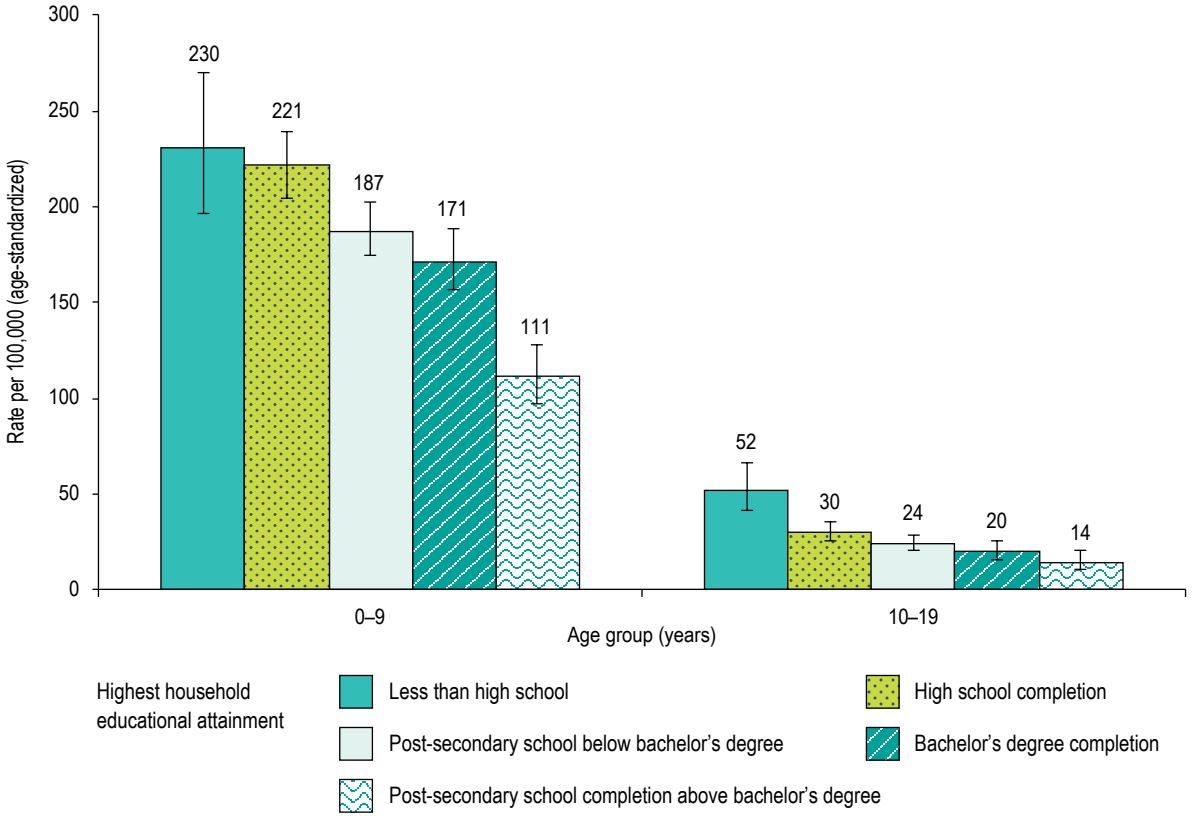
Source
2006 Census linked to 2006–2007 to 2008–2009 Discharge Abstract Database, Statistics Canada.

There are large education-related inequalities, especially among boys.

Compared with households in which the highest level of education was post-secondary school completion above a bachelor's degree,

- **Among boys**, hospitalization rates were **2.6 times higher (or 111 additional cases per 100,000)** for households in which the highest level of education was less than high school.
- **Among girls**, hospitalization rates were **1.9 times higher (or 41 additional cases per 100,000)** for households in which the highest level of education was less than high school.

Figure 12: Asthma hospitalization (age 0 to 19), by household educational attainment and age group, Canada (excluding Quebec), 2006–2007 to 2008–2009



Source
2006 Census linked to 2006–2007 to 2008–2009 Discharge Abstract Database, Statistics Canada.

Education-related inequalities were observed in both age groups.

Compared with households in which the highest level of education was post-secondary school completion above a bachelor's degree,

- Among children age 0 to 9, hospitalization rates were **2.1 times higher (or 119 additional cases per 100,000)** for households in which the highest level of education was less than high school.
- Among youth age 10 to 19, hospitalization rates were **3.7 times higher (or 38 additional cases per 100,000)** for households in which the highest level of education was less than high school.

Opportunities to address income- and education-related inequalities

The results of this study suggest that while overall asthma hospitalization rates are declining, there is a disproportionate burden of asthma hospitalizations among children living in lower-income and lower-educated households. Results also show higher rates of hospitalization in urban populations for Nova Scotia and Ontario.

Evidence suggests several opportunities to improve the management of asthma, with particular attention paid to families with lower education and lower income. Some promising interventions are listed below; however, there may be interest in further examining their effectiveness among these vulnerable subgroups.

1. **Self-management planning** includes a written asthma action plan and generally encompasses strategies to self-monitor symptoms, as well as knowledge of when to seek treatment by a health care provider.[8] In children, self-management plans have been shown to improve drug adherence and asthma outcomes in both acute care and non–acute care settings.[8, 54, 55] Educational tools should be adapted for those with low health literacy by removing unnecessary medical terms and including alternative methods of sharing information, such as through drawings or pictures.[8]

2. **A patient–provider partnership** is important for asthma management to elicit the patient's own goals regarding asthma, which may differ from conventional medical goals, as well as to address differences in patients' ability to self-manage.[8] Emerging evidence suggests verbal discussions around asthma management education should take priority over written action plans to ensure optimal health outcomes.[56] Clear communication between patients, caregivers and health providers that addresses expectations from all parties increases treatment adherence and may help to reduce the poorer asthma outcomes among children living in households with lower educational attainment.[57] It is suggested that patients and caregivers should be given a chance to voice concerns or questions surrounding proposed asthma management and treatment techniques, especially those related to factors (such as low income or distance from care facilities) that may impact their ability to sufficiently manage the condition and reduce health care utilization, including hospitalization.[58]

3. **School-based interventions**, such as Alberta's Roaring Adventures of Puff program[59] and the Cincinnati Children's Hospital Medical Center's Pursuing Perfection asthma improvement initiative,[60] that incorporate educational sessions and open discussions allow for the dissemination of information on successfully managing asthma to a wide audience, regardless of individual social factors. These and similar interventions undertaken at schools have been shown to have positive clinical and academic effects for their participants.[61]

4. **Community-based interventions**, such as programs targeting environmental asthma triggers like the Lowell Healthy Homes Program[62] and the Addressing Asthma in Englewood Project,[63] allow for the identification and management of widespread causes of asthma exacerbation, like outdoor allergens and mould, and can direct patients to medical and social agencies in their communities. Low socio-economic status, including low income and lower levels of educational attainment, is associated with poorer housing quality.[38, 51] As well, individuals from households with lower levels of educational attainment may be more likely to experience asthma hospitalization with exposure to airborne allergens, compared with those from households with higher levels of educational attainment.[50]

5. **Smoking cessation**, such as programs targeted to vulnerable populations, like the Yes! I Quit smoking cessation program for women with lower educational attainment, may be more effective in reducing smoking rates compared with traditional programs that are not tailored.[64] Smoking and exposure to second-hand smoke are risk factors for asthma hospitalization, particularly among children.[34] In Canada, lower socio-economic status, including lower levels of educational attainment and income, is associated with increased smoking prevalence,[65, 66] and these inequalities are widening over time.[5, 53]

6. **Drug coverage**, such as Quebec's Public Prescription Drug Insurance Plan[67] and Ontario's OHIP+: Children and Youth Pharmacare program,[68] for the costs of asthma medication for children and youth helps address the financial burden that low-income households may face when trying to properly manage asthma. A recent study from Ontario found that individuals younger than 65 who had drug coverage experienced 1.5 times greater odds of having used prescription drugs to treat asthma compared with those without coverage.[69]

Methodology

Data sources

Hospital Morbidity Database

The HMDB captures administrative, clinical and demographic information for all hospital discharges occurring within a fiscal year from acute inpatient facilities (and day surgery facilities in some provinces) for all provinces and territories. The analyses in this report are based on HMDB data for 2006–2007 to 2015–2016, including analyses based on pooled 3-year average data for 2006–2007 to 2008–2009 and for 2013–2014 to 2015–2016.

2006 Census linked to 2006–2007 to 2008–2009 Discharge Abstract Database

Statistics Canada's linkage of the 2006 Census (long-form) and the DAD brings together socio-demographic data (i.e., equity stratifiers) from the long-form 2006 Census of Population and hospital data from the DAD (2006–2007 to 2008–2009); this linkage is available for all provinces and territories except Quebec. As of 2006, CIHI sends annual DAD data to Statistics Canada.

Statistics Canada conducts the census of population every 5 years. Both short- and long-form censuses are conducted. Approximately 20% of households received the long-form census, which included 53 questions on topics such as education, ethnicity, immigration, income and employment.[70] In some regions, all households were asked to complete the long-form census: Nunavut, the Northwest Territories (excluding Yellowknife), Yukon (excluding Whitehorse) and other First Nations reserves and settlements. Because the long-form census was received by the Canadian household population, it does not include the institutionalized population (e.g., residents of long-term care facilities). To make inferences at the population level based on the long-form census, Statistics Canada used sampling weights to account for the survey design and under- or over-representation of certain groups.[71]

The linkage was conducted by Statistics Canada using a hierarchical deterministic approach based on date of birth, sex and postal code. In total, 94% of long-form census records were eligible for linkage to the DAD, and 80% of 2006–2007 DAD records were linked to the census (with similar results for 2007–2008 and 2008–2009). Coverage rates were calculated by dividing the number of hospitalizations among long-form census respondents (based on the linked census–DAD) by the number of hospitalizations in the unlinked DAD. The crude coverage rate was 17% and the weighted coverage rate was approximately 80%; there were variations by jurisdiction. Weighted coverage estimates were expected to be less than 100%, mainly due to differences in the populations covered and linkage error. For example, institutionalized populations, who are high users of hospital services, are represented in the DAD but not in the linked census–DAD data. More information regarding the methodology and validation of the data can be found elsewhere.[72]

Identifying asthma hospitalizations in children and youth

Asthma hospitalizations in children and youth were identified from the HMDB using the following case ascertainment approach. For the provincial/territorial analysis, cases were assigned to provinces/territories based on their residential postal code.

CIHI inclusions

1. Asthma hospitalization, defined as a most responsible diagnosis code of

   ICD-9/9-CM: 493 *Asthma*

   ICD-10-CA: J45 *Asthma*
2. Age at admission younger than 20
3. Sex recorded as male or female
4. Canadian resident (Canadian postal code)

CIHI exclusions

1. Records with discharge as death (Discharge Disposition Code = 07)
2. Newborn, stillbirth or cadaveric donor records (Admission Category = N, R or S)

Analytical approach

The following steps were taken to examine inequalities in asthma hospitalization by CIHI and Statistics Canada:

Step 1: Categorize the population by equity stratifiers.

Step 2: Calculate stratified rates.

Step 3: Quantify inequalities using summary measures.

Step 4: Identify key findings.

Step 1: Categorize the population by equity stratifiers

Data was categorized into population subgroups for 5 equity stratifiers (see Table 1): age, sex, household income (neighbourhood level and individual level), household education, and urban and rural/remote geographic location. For more information about these equity stratifiers, please see CIHI's report *In Pursuit of Health Equity: Defining Stratifiers for Measuring Health Inequality*. For income, both neighbourhood-level and individual-level household income were used, as they provide complementary information when measuring health inequalities.[73]

Table 1 Equity stratifiers

Stratifier	Defined as	Categories	Data source
Neighbourhood-level income quintiles	Neighbourhood income quintiles are a measure of average before-tax income per single-person equivalent in a dissemination area (DA), adjusted for household size (based on 2006 Census data).[42] The average income per person equivalent was used to rank DAs from lowest to highest in each census metropolitan area (CMA), census agglomeration (CA) or provincial residual area not in any CMA or CA. Finally, the population within each area was divided into approximate fifths (i.e., about 20% of DAs in each quintile) to create community-specific income quintiles.	Quintiles (based on distribution of before-tax income) Quintile 1 refers to the lowest income level, while quintile 5 refers to the highest income level.	HMDB-PCCF+: Statistics Canada's PCCF/PCCF+ Version 6D was used to assign individuals to neighbourhood income quintiles by linking HMDB postal codes to census geography. Note: Measure reflects income levels at the neighbourhood level in 2006.
Individual-level income quintiles	Within each CMA/CA, or the remainder of the DAs within the province/territory, 20th, 40th, 60th and 80th percentiles were constructed based on the total before-tax income of a household (which is the sum of the total incomes of all members of that household) divided by a scale that assigns a decreasing value to the second and subsequent household members. Finally, for each observation, we determined to which quintile the household income belongs, by comparing with the area-specific percentiles.	Quintiles (based on distribution of before-tax income) Quintile 1 refers to the lowest income level, while quintile 5 refers to the highest income level.	2006 Census linked to the 2006–2007 to 2008–2009 DAD

Stratifier	Defined as	Categories	Data source
Household-level educational attainment	Maximum value of self-reported education among all persons in the household.	Less than high school High school Post-secondary school below bachelor's degree Bachelor's degree Above bachelor's degree	2006 Census linked to the 2006–2007 to 2008–2009 DAD
Urban and rural/remote	Statistical Area Classification type (SACtype) identifies the type of statistical area classification in which the census subdivision is located.[42] There are 8 different SACtypes: SACtype 1: Census subdivision (CSD) within CMA SACtype 2: CSD within CA with at least one census tract SACtype 3: CSD within CA with no census tracts SACtype 4: CSD outside of CMA and CA with strong metropolitan influence (between 30% and <50% commuting flow) SACtype 5: CSD outside of CMA and CA with moderate metropolitan influence (between 5% and <30% commuting flow) SACtype 6: CSD outside of CMA and CA with weak metropolitan influence (between >0% and <5% commuting flow) SACtype 7: CSD outside of CMA and CA with no metropolitan influence SACtype 8: CSD in the territories, outside of a CA	SACtype 1, 2, 3 = urban SACtype 4, 5, 6, 7, 8 = rural/remote	HMDB-PCCF+: Statistics Canada's PCCF/PCCF+ Version 6D was used to link HMDB postal codes to census geographies that can be aggregated as urban and rural/remote.

Stratifier	Defined as	Categories	Data source
Age	Age in years	0 to 9 10 to 19	HMDB
Sex	Male or female sex	Male Female	HMDB

Step 2: Calculate stratified rates

Age-standardized asthma hospitalization rates per 100,000 population in a given year and for pooled years (2006–2007 to 2008–2009 or 2013–2014 to 2015–2016) were calculated by province/territory and for all equity stratifiers outlined in Table 1. The unit of analysis is a single hospital discharge; this means that individuals can be represented more than once in the numerator if they were hospitalized multiple times during the study period.

For analyses based on the HMDB at CIHI, either a pooled or yearly approach was used. For pooled analyses, the numerator is the sum of all asthma hospitalizations occurring from 2013–2014 to 2015–2016 pooled and/or from 2006–2007 to 2008–2009 pooled; yearly analyses examined 2006–2007 to 2015–2016 data. Denominators are based on population counts available from Statistics Canada.

For analyses based on the 2006 Census linked to the 2006–2007 to 2008–2009 DAD, the numerator is the sum of all linked asthma hospitalizations occurring from 2006–2007 to 2008–2009 pooled; pooling numerators follows the approach used in previous work to reduce the variation that can occur with small numbers.[74] All denominators were based on weighted person counts from the 2006 Census (long-form). For 2007–2008 and 2008–2009, Statistics Canada used an “aging” denominator approach such that in 2007–2008 it excluded everyone younger than 1 and in 2008–2009 it excluded all those younger than 2. The aging denominator approach was used because children born after April 1, 2006, will not be included in the numerator for the census–DAD linkage.

Age-standardization

Rates were age-standardized by the direct method of standardization, using the 2011 Canadian population (from the 2011 Census) as the standard population. Standardization was based on 5-year age groupings.

Age-standardized rate (ASHR) = [Sum over all age groups j of] (numerator_j ÷ denominator_j) × weight of standard population_j × 100,000

Measures of precision

Variance was calculated using the following formula:

Variance (ASHR) = [Sum over all age groups j of] (numerator_j ÷ denominator_j^2) × weight of standard population_j^2

The 95% confidence interval is given by the following:

Lower bound =

exp {log (ASHR) − 1.96 × sqrt[(1 ÷ (ASHR ÷ 100,000)^2) × sqrt(Variance(ASHR))]} × 100,000

Upper bound =

exp {log (ASHR) + 1.96 × sqrt[(1 ÷ (ASHR ÷ 100,000)^2) × sqrt(Variance(ASHR))]} × 100,000

Step 3: Quantify inequalities using summary measures

Inequalities between population subgroups were measured on both the absolute and relative scales because, taken together, they provide a more accurate and complete description of inequality than either measure alone.[75–77] Relative and absolute inequality measures may yield different or even opposing patterns, and relying on only one measure alone may result in different interpretations of inequality trends.[77–79]

Table 2 Inequality measures

Rate ratio	Rate difference
Captures the relative difference and is calculated by dividing the rate of the stratification category with the highest expected hospitalization rate by that with the lowest expected hospitalization rate. The categories used were the lowest income quintile and the highest income quintile (for neighbourhood- and individual-level income analyses), those living in urban areas and those living in rural/remote areas (for geographic location analyses) and education below high school completion and education above bachelor's degree completion (for educational attainment analyses). Example: Q1 ÷ Q5 = 750 per 100,000 ÷ 250 per 100,000 = 3 **Interpretation:** The rate of condition X is 3 times higher for Canadians in the lowest income quintile than for those in the highest income quintile.	Captures the absolute difference and is calculated by subtracting the rate of the stratification category with the highest expected hospitalization rate by that with the lowest expected hospitalization rate. The categories used were the same as those for calculating the rate ratio. Example: Q1 − Q5 = 750 per 100,000 − 250 per 100,000 = 500 per 100,000 **Interpretation:** 500 more Canadians per 100,000 have condition X in the lowest income quintile than in the highest income quintile.

Step 4: Identify key findings

Key findings were identified by examining statistically significant differences or inequality measures. Significant differences were defined as point estimates with non-overlapping 95% confidence intervals (CIs) between time periods or population groups. Significant inequality measures were defined as rate ratios and rate differences, whereby the 95% CIs did not include 1 or 0, respectively. Notably, this approach of highlighting only statistically significant key findings was taken to overcome the practical challenges of deriving key messages for a comprehensive report in a consistent fashion.

Appendix: Text and table alternatives for figures

Figure 1 Data sources and linkages used in this chartbook

This figure shows 2 data sources and how each was linked to obtain socio-demographic data (i.e., equity stratifiers) for measuring health inequalities in asthma hospitalization rates for children and youth age 0 to 19.

1. In data source 1, the Hospital Morbidity Database (HMDB) housed at CIHI for 2006–2007 to 2015–2016 was linked via postal code to Statistics Canada's Postal Code Conversion File Plus (PCCF+). PCCF+ links postal codes to standard census geographic areas. These standard geographies are used to assign individual asthma hospitalization cases to area-based socio-demographic categories, specifically neighbourhood income and geographic location.
2. In data source 2, Statistics Canada's 2006 Census (long-form) was linked to the 2006–2007 to 2008–2009 Discharge Abstract Database (DAD). The DAD does not include data from Quebec. Approximately 20% of the Canadian population received the long-form census (excluding those in institutions and those who entered Canada after Census Day). The census–DAD linkage was conducted by Statistics Canada based on 3 linkage variables: date of birth, sex and postal code. This linkage assigns household education and individual-level income data from the census to asthma hospitalization cases obtained from the DAD.

Sources

PCCF+: Statistics Canada. *Postal Code Conversion File Plus (PCCF+) Version 6C, Reference Guide*. 2016.
Census–DAD linkage: Statistics Canada. *2006/2007 to 2008/2009 Census-linked Discharge Abstract Database (DAD)*.
Rotermann M, et al. Linking 2006 Census and hospital data in Canada. *Health Reports*. 2015.

Figure 2 Asthma hospitalization, by sex and age group, Canada, 2013–2014 to 2015–2016

Age group	Hospitalization rate per 100,000 population: Girls	Lower 95% confidence limit: Girls	Upper 95% confidence limit: Girls	Hospitalization rate per 100,000 population: Boys	Lower 95% confidence limit: Boys	Upper 95% confidence limit: Boys
0 to 4	125	121	129	233	228	239
5 to 9	74	71	77	116	112	120
10 to 14	31	29	33	39	37	41
15 to 19	19	18	21	14	13	16

Note

Results are based on the pooled 3-year average for the most recent years (2013–2014 to 2015–2016). Similar patterns were observed for pooled data from 2006–2007 to 2008–2009 (data not shown).

Source

Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 3 Asthma hospitalization (age 0 to 19) by sex, Canada, 2006–2007 to 2015–2016

Sex	2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016
Girls	116	93	94	80	74	64	66	56	68	57
Boys	190	159	153	134	119	105	105	89	108	92
Both boys and girls	154	127	124	108	97	85	86	73	88	75

Source

Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 4 Asthma hospitalization by age group, Canada, 2006–2007 to 2008–2009 versus 2013–2014 to 2015–2016

Age group	Hospitalization rate (per 100,000 population): 2006–2007 to 2008–2009	Lower 95% confidence limit: 2006–2007 to 2008–2009	Upper 95% confidence limit: 2006–2007 to 2008–2009	Hospitalization rate (per 100,000 population): 2013–2014 to 2015–2016	Lower 95% confidence limit: 2013–2014 to 2015–2016	Upper 95% confidence limit: 2013–2014 to 2015–2016	Percentage decrease
0 to 4	358	353	363	180	177	184	50%
5 to 9	134	131	137	96	93	98	28%
10 to 14	48	46	49	35	33	36	27%
15 to 19	22	21	23	17	16	18	23%

Notes

The percentage decrease was calculated by subtracting the later age-standardized hospitalization rate per 100,000 population from the earlier rate, dividing by the earlier rate and multiplying by 100%.

Results are based on the pooled 3-year average for the most recent years (2013–2014 to 2015–2016). Similar patterns were observed for pooled data from 2006–2007 to 2008–2009 (data not shown).

Source

Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 5 Asthma hospitalization (age 0 to 19) by province/territory, 2006–2007 to 2008–2009 versus 2013–2014 to 2015–2016

Province/territory	Hospitalization rate per 100,000 population: 2006–2007 to 2008–2009	Lower 95% confidence limit: 2006–2007 to 2008–2009	Upper 95% confidence limit: 2006–2007 to 2008–2009	Hospitalization rate per 100,000 population: 2013–2014 to 2015–2016	Lower 95% confidence limit: 2013–2014 to 2015–2016	Upper 95% confidence limit: 2013–2014 to 2015–2016
Newfoundland and Labrador	171	157	186	85	75	96
Prince Edward Island	226	195	257	163	137	189
Nova Scotia	193	182	205	80	72	87
New Brunswick	184	172	196	65	58	73
Quebec	172	168	175	66	64	68
Ontario	125	123	128	90	88	92
Manitoba	108	101	114	61	56	66
Saskatchewan	169	160	178	110	103	117
Alberta	105	101	109	72	69	75
British Columbia	105	101	109	71	68	74
Yukon	96	57	135	30	9	50
Northwest Territories	153	115	191	121	86	157
Nunavut	83	56	111	78	53	103
Canada	135	134	137	79	78	80

Source
Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 6 Asthma hospitalization (age 0 to 19) by neighbourhood income, Canada, 2006–2007 to 2015–2016

Neighbourhood income quintile	2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016
Q1 (lowest)	194	158	147	134	116	109	110	94	110	96
Q2	167	139	141	122	111	91	96	78	98	83
Q3	157	133	138	120	110	86	86	76	89	77
Q4	137	122	119	105	102	78	75	65	79	65
Q5 (highest)	126	98	104	88	81	68	69	57	73	59

Note
Results are based on income defined at the neighbourhood level using Statistics Canada's PCCF+ tool. See the Methodology section for more information.
Source
Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 7 Asthma hospitalization, by neighbourhood income and age group, Canada, 2013–2014 to 2015–2016

Neighbourhood income quintile	Hospitalization rate per 100,000 population: Age 0 to 9	Lower 95% confidence limit: Age 0 to 9	Upper 95% confidence limit: Age 0 to 9	Hospitalization rate per 100,000 population: Age 10 to 19	Lower 95% confidence limit: Age 10 to 19	Upper 95% confidence limit: Age 10 to 19
Q1 (lowest)	170	164	175	37	34	40
Q2	151	145	156	29	27	31
Q3	143	138	148	25	23	27
Q4	125	121	129	20	18	22
Q5 (highest)	113	109	118	18	17	20

Note
Results are based on income defined at the neighbourhood level using Statistics Canada's PCCF+ tool. See the Methodology section for more information.
Source
Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 8 Geographic distribution of population (age 0 to 19), Canada, 2015–2016

In 2015–2016, 82% of the Canadian population age 0 to 19 lived in urban areas, and 18% lived in rural/remote areas.

Note
Geographic location was assigned based on Statistics Canada's Statistical Area Classification type (SACtype): SACtypes 1, 2 and 3 are urban, and SACtypes 4, 5, 6, 7 and 8 are rural/remote. This variable takes into account population size and commuting to large urban centres.[42]
Source
Statistics Canada, Demography Division. Population estimates, 2015–2016.

Figure 9 Asthma hospitalization (age 0 to 19), by urban versus rural/remote geographic location, provinces/territories, 2013–2014 to 2015–2016

Province/territory	Hospitalization rate per 100,000 population: Urban	Lower 95% confidence limit: Urban	Upper 95% confidence limit: Urban	Hospitalization rate per 100,000 population: Rural/remote	Lower 95% confidence limit: Rural/ remote	Upper 95% confidence limit: Rural/ remote
Newfoundland and Labrador	81	67	94	90	75	106
Prince Edward Island	139	108	170	199	153	245
Nova Scotia	89	79	98	61	49	72
New Brunswick	68	59	78	59	48	71
Quebec	67	64	69	61	56	65
Ontario	92	90	94	70	65	75
Manitoba	60	54	66	63	55	71
Saskatchewan	116	107	125	100	90	111
Alberta	72	69	76	69	62	75
British Columbia	70	67	74	76	67	86
Northwest Territories	115	63	168	125	77	173
Canada	80	79	81	71	69	74

Notes

Data for Yukon and Nunavut was suppressed due to small numbers.

Geographic location was assigned based on Statistics Canada's Statistical Area Classification type (SACtype): SACtypes 1, 2 and 3 are urban, and SACtypes 4, 5, 6, 7 and 8 are rural/remote. This variable takes into account population size and commuting to large urban centres.[42]

Source

Hospital Morbidity Database, Canadian Institute for Health Information.

Figure 10 Distribution of household educational attainment (age 0 to 19), Canada (excluding Quebec), 2006

In 2006, the highest level of household educational attainment among Canadian households with children and youth age 0 to 19 was as follows:

- Less than high school: 7%
- High school completion: 28%
- Post-secondary school completion below a bachelor's degree: 33%
- Bachelor's degree completion: 19%
- Post-secondary school completion above a bachelor's degree: 13%

Note
Distribution is based on the Canadian population (excluding Quebec) age 0 to 19, estimated using the weighted long-form census.
Source
2006 Census linked to 2006–2007 to 2008–2009 Discharge Abstract Database, Statistics Canada.

Figure 11 Asthma hospitalization (age 0 to 19), by household educational attainment and sex, Canada (excluding Quebec), 2006–2007 to 2008–2009

Highest household educational attainment	Hospitalization rate per 100,000 population: Girls	Lower 95% confidence limit: Girls	Upper 95% confidence limit: Girls	Hospitalization rate per 100,000 population: Boys	Lower 95% confidence limit: Boys	Upper 95% confidence limit: Boys
Less than high school	89	71	111	182	154	215
High school	88	79	99	150	137	165
Post-secondary school below bachelor's degree	73	66	82	127	116	139
Bachelor's degree	71	62	81	111	99	124
Above bachelor's degree	48	39	58	71	60	83

Source
2006 Census linked to 2006–2007 to 2008–2009 Discharge Abstract Database, Statistics Canada.

Figure 12 Asthma hospitalization (age 0 to 19), by household educational attainment and age group, Canada (excluding Quebec), 2006–2007 to 2008–2009

Highest household educational attainment	Hospitalization rate per 100,000 population: Age 0 to 9	Lower 95% confidence limit: Age 0 to 9	Upper 95% confidence limit: Age 0 to 9	Hospitalization rate per 100,000 population: Age 10 to 19	Lower 95% confidence limit: Age 10 to 19	Upper 95% confidence limit: Age 10 to 19
Less than high school	230	196	269	52	41	66
High school	221	204	239	30	25	35
Post-secondary school below bachelor's degree	187	174	202	24	20	28
Bachelor's degree	171	156	188	20	15	25
Above bachelor's degree	111	97	127	14	10	20

Source

2006 Census linked to 2006–2007 to 2008–2009 Discharge Abstract Database, Statistics Canada.

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