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Abstract
Upper respiratory (nose and throat) infections, ear infections and asthma are common among young children. This article uses data from the National Longitudinal Survey of Children and Youth (NLSCY) to trace trends in the prevalence of these conditions among young children in Canada from 1994/1995 to 2008/2009. Gender, age and regional differences in the occurrence of these conditions are examined, and possible links with exposure to cigarette smoke are considered. The prevalence of upper respiratory infections among children aged 2 to 3 remained constant or declined in most regions of Canada between 1994/1995 and 2008/2009, but rose significantly in Quebec. Ear infections declined significantly in all regions. The prevalence of asthma among children aged 2 to 7 rose steadily until 2000/2001 and then declined. A wide range of environmental factors, including reduced exposure to cigarette smoke, may have contributed to these trends.

Keywords
common cold, ear diseases, otitis media, passive smoking, respiratory diseases, respiratory sounds

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Upper respiratory (nose and throat) infections, otitis media (ear infection and inflammation) and asthma affect large numbers of young children.[1-5] This article uses data from the National Longitudinal Survey of Children and Youth (NLSCY) to report trends from 1994/1995 to 2008/2009 in the prevalence of these conditions among children in Canada. Data on upper respiratory infections and ear infections are available for 2- to 3-year-olds, and data on asthma are available for children aged 2 to 7. Gender, age and regional differences in the occurrence of these conditions are examined. Possible links with exposure to cigarette smoke are considered.

Upper respiratory infections

Upper respiratory infections, including the common cold, are frequent among children, with 3 to 8 infections a year being typical.[6] In 1994/1995, 26% of Canadian children aged 2 to 3 years were reported by their parents as having upper respiratory infections "almost all the time," "often," or "from time to time" (Table 1). This percentage remained almost stable over the next 14 years: the 2008/2009 figure was 23%.

In 1994/1995, boys were more likely than girls to have frequent upper respiratory infections: 29% versus 23%. Thereafter, no male-female differences were apparent, because among boys (but not girls), the prevalence of frequent infections decreased.

Throughout the 1994/1995-to-2008/2009 period, the prevalence of frequent upper respiratory infections among 2- to 3-year-olds was lowest in the Atlantic provinces (Newfoundland and Labrador, Prince Edward Island, Nova Scotia, and New Brunswick), and highest in Quebec.

Table 1
Prevalence of "frequent" (almost all the time/often/from time to time) upper respiratory infections, by sex and region, household population aged 2 to 3, Canada excluding territories and Nunavut, 1994/1995 to 2008/2009

	1994/1995	2000/2001	2006/2007	2008/2009	Comparison between 1994/1995 and 2008/2009 (p-value)
			%		
Total	25.8	25.9	24.4	23.5	0.141
Sex					
Male	28.7*	26.7	24.2	23.1	0.010
Female†	22.7	25.0	24.6	24.0	0.571
Region					
Atlantic provinces	20.3	18.8*	17.6*	16.8*	0.153
Quebec†	28.0	36.8‡	41.1	38.9	0.003
Ontario	26.4	22.1*	19.7*	19.5*	0.013
Prairie provinces	24.3	22.4*	17.0*‡	19.3*	0.052
British Columbia	25.1	27.8*	25.6*	18.4*‡	0.081

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from estimate for previous survey cycle (p<0.05)
Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

In all provinces except Quebec, the prevalence of frequent upper respiratory infections declined over the 14 years. In Ontario, the percentage fell from 26% to 20%, and in the Prairie provinces (Manitoba, Saskatchewan and Alberta), from 24% to 19%. Declines in the Atlantic provinces and British Columbia did not reach statistical significance. By contrast, in Quebec, the percentage rose from 28% to 39%.

The significant increase in frequent upper respiratory infections in Quebec could partly reflect changes in child care funding in that province in 1997, which resulted in a substantial increase in the percentage of Quebec children in daycare centres.[7] Children in these settings have an increased risk of contracting colds and other infectious conditions, compared with children who are not in such centres.[6,8,9]

Otitis media

Otitis media (middle-ear infection or inflammation) is also common in childhood.[1,10] In 1994/1995, 67% of Canadian children aged 2 to 3 years had had at least one ear infection since birth (Table 2). The percentage with frequent (four or more) ear infections was 26%. However, by 2008/2009, the percentage who had had at least one ear infection had dropped to 50%, and the percentage who had had four or more had fallen to 13%.

Boys were more likely than girls to have had at least one (data not shown) or four or more ear infections (Table 2). From 1994/1995 to 2008/2009, the prevalence of at least one ear infection among boys declined from 70% to 53% (p<0.001), and among girls, from 64% to 47% (p<0.001). Similarly, the percentage of boys who had had frequent ear infections dropped from 30% to 14%; among girls, the decline was from 23% to 11%.

The Atlantic provinces and Quebec tended to have high ear infection rates, while in British Columbia, the rates tended to be low (Table 2). In all regions except Quebec, the prevalence of ear infections fell since 1994/1995. These variations may be linked to regional differences in upper respiratory infections, which increase the risk of ear infections.[3,4]

In fact, significant links were found between upper respiratory infections and ear infections in each of the four survey cycles (Figure 1). For example, in 1994/1995, 44% of children aged 2 to 3 with frequent upper respiratory infections were also reported to have had frequent ear infections since birth; this compared with 20% of children who rarely or never had upper respiratory infections (p<0.001). In 2008/2009, the prevalence of frequent ear infections was lower among both groups, but the difference between those who did and did not experience frequent upper respiratory infections remained significant, at 24% versus 9% (p<0.001).

Table 2
Prevalence of ear infections, by sex and region, household population aged 2 to 3, Canada excluding territories and Nunavut, 1994/1995 to 2008/2009

	1994/1995	2000/2001	2006/2007	2008/2009	Comparison between 1994/1995 and 2008/2009 (p-value)
			%		
At least one ear infection	66.9	62.6‡	51.5‡	50.2	<0.001
Frequent ear infections	26.3	19.8‡	14.2‡	12.6	<0.001
Sex					
Male	29.9*	21.2‡	16.2*‡	14.2*	<0.001
Female†	22.5	18.2‡	12.1‡	10.9	<0.001
Region					
Atlantic provinces	35.2*	22.6*‡	17.3*‡	16.0*	<0.001
Quebec	24.4	25.8*	22.0*	18.4*§	0.080
Ontario	25.3	19.7*‡	12.3‡	11.5*	<0.001
Prairie provinces	27.4	18.3*‡	11.5‡	10.5	<0.001
British Columbia†	25.8	9.6‡	9.2E	7.3E	<0.001

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from estimate for previous survey cycle (p<0.05)
§ significantly different from estimate for 2000/2001 (p<0.05)
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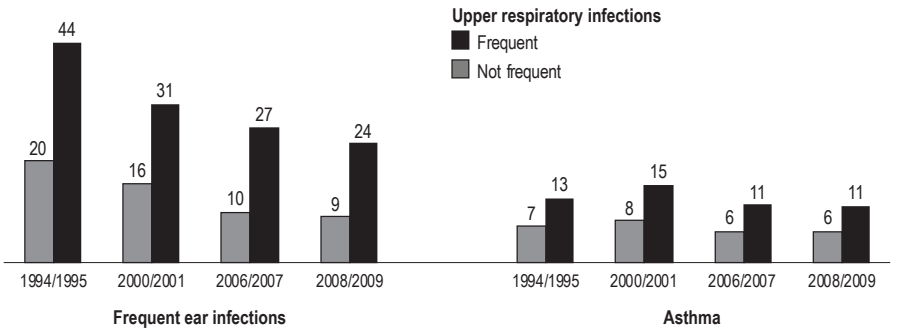
Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

Figure 1
Prevalence of frequent ear infections and of asthma among children aged 2 to 3, by frequency of upper respiratory infections (URIs), Canada excluding territories and Nunavut, 1994/1995 to 2008/2009



Note: "Frequent" upper respiratory infections occurred "almost all the time," "often" or "from time to time."
Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

Asthma

In Canada and many other western countries, the prevalence of asthma among children increased steadily for several decades, and then levelled off or even declined.[11-14] Echoing trends in an earlier report on Canadian children aged 0 to 11,[14] the present study found that the percentage of children aged 2 to 7 who had been diagnosed with asthma rose from 11% in 1994/1995 to 13% in 2000/2001, but by 2008/2009, had fallen to 10% (Table 3).

Because the lifetime prevalence of health conditions increases with age, it is not surprising that at each NLSCY cycle, a higher percentage of 6- to 7-year-olds than 2- to 3-year-olds were reported to have been diagnosed with asthma. For example, in 2006/2007, 15% of children aged 6 to 7 had been diagnosed with asthma, compared with 8% of those aged 2 to 3. The increase in prevalence rates to 2000/2001 and the subsequent drop occurred in all age groups.

A significantly higher percentage of boys than girls had been diagnosed with asthma at each NLSCY cycle (Table 3). Among both sexes, asthma prevalence followed the general trend, rising from

Table 3
Prevalence of asthma, by sex, age and region, household population aged 2 to 7, Canada excluding territories and Nunavut, 1994/1995 to 2008/2009

	1994/1995	2000/2001	2006/2007	2008/2009	Comparison between 1994/1995 and 2008/2009 (p-value)
		%			
Total	11.5	13.2‡	11.5‡	9.8‡§	0.008
Sex					
Male	14.2*	16.2*‡	13.5*‡	11.4*‡§	0.006
Female†	8.7	10.0	9.4	7.9§	0.364
Age					
2 to 3	8.8*	10.1*	7.6*‡	7.4*§	0.135
4 to 5	11.6*	13.5	12.7	10.1‡§	0.185
6 to 7†	14.2	15.7	14.9	12.4§	0.178
Region					
Atlantic provinces	14.2*	15.2*	12.5‡	10.8*§	0.004
Quebec	11.2	15.5*‡	13.2	10.6§	0.686
Ontario	12.1	13.7*	10.9‡	9.8§	0.052
Prairie provinces	10.3	10.9	11.7	9.6‡	0.489
British Columbia†	10.2	9.2	10.1	7.9	0.174

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from estimate for previous survey cycle (p<0.05)
§ significantly different from estimate for 2000/2001 (p<0.05)
Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

The data

The data are from the National Longitudinal Survey of Children and Youth (NLSCY), which has been conducted every two years since 1994/1995. This report examines trends from 1994/1995 to 2008/2009 in the prevalence of upper respiratory infections and otitis media among children aged 2 to 3 years, and in the prevalence of asthma among children aged 2 to 7 years.

The information used in this analysis was provided to the NLSCY by the person most knowledgeable about the child, usually the mother. The prevalence of health conditions was based on the parent's response to the following questions:

- *Upper respiratory infections*: How often does this child have nose or throat infections (almost all the time, often, from time to time, rarely, or never)?
- *Otitis media*: Since birth, has this child had an ear infection (otitis)? If yes, how many times?
- *Asthma and asthma symptoms*: Has this child ever had asthma that was diagnosed by a health professional? Has this child had an asthma attack in the past 12 months? Has this child had wheezing or whistling in the chest any time in the last 12 months? Does this child take any of the following prescribed medications on a regular basis: Ventolin, inhalers, puffers for asthma?

Income status was measured as the ratio of household income to the low-income cut-off for the size and location of the child's household.

Cross-sectional survey weights were used for the analyses. For statistical tests, the variances and standard errors of all estimates were calculated using the bootstrap weights developed by Statistics Canada for each of the cross-sectional samples.

1994/1995 to 2000/2001, and then declining.

Previous studies have reported regional variations in the prevalence of childhood asthma,[14,15] with British Columbia and the Prairie provinces having lower rates than other regions. However, this pattern has changed markedly. Since 2000/2001, the prevalence of asthma among 2- to 7-year-olds declined in the Atlantic provinces, Quebec and Ontario, but remained relatively stable in British Columbia and the Prairies (Table 3). As a result, in 2006/2007 and 2008/2009, no significant regional differences in asthma prevalence emerged.

During the 1994/1995-to-2008/2009 period, the percentage of children with asthma who had had an asthma *attack* in the past 12 months fell steadily from 53% to 36% (data not shown).

As expected, rates of *wheezing and whistling in the chest* were much higher for children who had been diagnosed with asthma than for children overall (data not shown). However, while the prevalence of such symptoms among the general population of children aged 2 to 7 did not change over time (ranging between 17% and 20%), it dropped significantly among those with asthma (from 70% to 61%).

In 1994/1995, about 50% of children with asthma used asthma medication regularly, a rate that did not change significantly over the 14 years (data not shown).

Although boys were more likely than girls to have asthma, the severity of the condition did not appear to differ by sex: no differences emerged in the percentage who had had an asthma attack or experienced wheezing or whistling in the chest in the past year, or in the percentage who used asthma medication regularly (data not shown).

Asthma and upper respiratory infections

Upper respiratory infections are major asthma inducers.[2,5,12] In the present study, significant links were found between upper respiratory infections and asthma (Figure 1). For example, in 1994/1995, 13% of children aged 2 to 3 who had frequent upper respiratory infections had been diagnosed with asthma; by contrast, 7% of children who rarely or never had these infections had asthma ($p<0.003$). In 2008/2009, the figures were 11% and 6% ($p<0.002$).

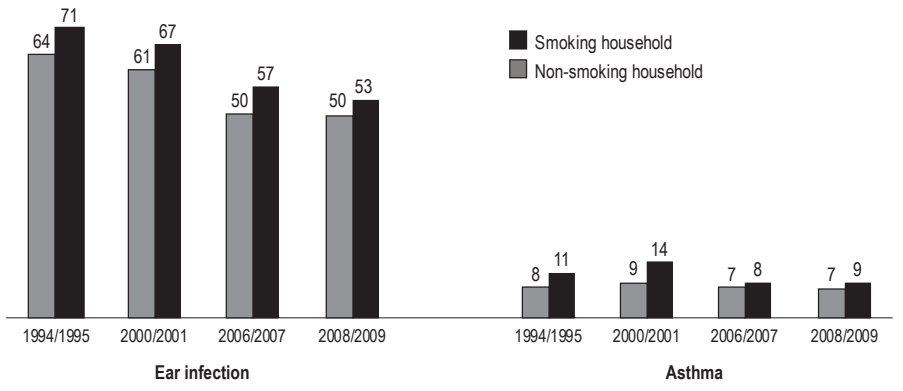
Environmental factors

A number of environmental factors may be related to the recent declines in childhood ear infections and asthma: changes in the population structure; changes in diagnostic practices; decreases in the prevalence of respiratory allergies[12]; improvements in air quality[16,17]; changes in hygiene practices (particularly, in child care settings); and reductions in children's exposure to cigarette smoke at home.[18] An investigation of most of these factors is beyond the scope of this paper, but the possible role of exposure to cigarette smoke can be considered.

The Canadian Tobacco Use Monitoring Survey (CTUMS) reported a steady decline in daily smoking among people aged 15 or older from 19% in 2000 to 13% in 2008,[19] and a simultaneous decrease in the percentage of children aged 0 to 11 who were regularly exposed to tobacco smoke at home from 24% to 6%.[20] NLSCY data also show a decline in the percentage of children aged 2 to 3 living in households where at least one parent smoked daily, from 39% in 1994/1995 to 20% in 2008/2009. These trends suggest that reduced exposure to tobacco smoke may be contributing to the decreased prevalence of ear infections and asthma among young children.

Exposure to cigarette smoke has been causally linked to ear infections.[18,21] According to NLSCY results, children in households where at least one parent was a daily smoker were more likely than children in non-smoking households to have had at least one ear infection since birth (Figure 2). However, since the early 1990s, regardless of whether they lived in a smoking- or non-smoking household, the percentage of children who had had ear infections dropped steadily, and the gap in prevalence between the two groups narrowed. In 1994/1995, 71% of children in households with a parent who smoked had had at least one ear infection, compared with 64% of those in non-smoking households ($p=0.012$); by 2008/2009, the corresponding figures were 53% and 50%, a difference that was not statistically significant. These trends are consistent with the hypothesis that reduced exposure to cigarette smoke contributed to declines in ear infections. But given the drop in the prevalence of ear infections among children in both smoking and non-smoking households, changes in other factors may have also played a role. The current lack of

Figure 2
Prevalence of at least one ear infection and of asthma among children aged 2 to 3, by household smoking, Canada excluding territories and Nunavut, 1994/1995 to 2008/2009



Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

a difference in the prevalence of ear infections between children in smoking and non-smoking households may indicate that adult smoking rates have become low enough that exposure to tobacco smoke is no longer a prominent cause of ear infections among young children.

The medical literature has also causally linked exposure to cigarette smoke with asthma.[18,21] For instance, legislation banning smoking in public places in Scotland was followed by decreases in the incidence of severe episodes of asthma among preschool and school-age children.[22]

In the early years covered by the present study (1994/1995 and 2000/2001), children in households where at least one parent was a daily smoker were more likely than those in non-smoking households to have been diagnosed with asthma (Figure 2). However, in 2006/2007 and in 2008/2009, no statistically significant differences were found in asthma prevalence between children in smoking and non-smoking households. Again, this suggests that reduced exposure to cigarette smoke contributed to declines in asthma over time, and that adult smoking rates have become low enough that parental smoking has ceased to be major cause of asthma in young children.

And even in households where a parent smokes, children's exposure may now be lower because of growing awareness of the dangers of second-hand smoke. According to the CTUMS results, in 2009, 47% of households where smoking was allowed inside the home imposed some restrictions.[19] Parents who smoke may, for example, do so outdoors or in restricted areas.

Smoking and household income

Rates of cigarette smoking tend to be relatively high among low-income groups.[23,24] For example, in 2008/2009, the prevalence of daily smoking by at least one parent in households below the low-income cut-off was 27%; in households at or above the low-income cut-off, the figure was 18%.

To determine if the associations between parental smoking and the prevalence of ear infections and asthma among children was related to factors other than smoking, low-income and higher-income households were examined separately. The patterns of ear infection and asthma prevalence reported above for children in smoking and non-smoking households were found for both the low- and higher-income groups. The decline over time in ear infections and asthma also occurred among children in smoking and non-smoking households in both income groups (data not shown). These findings suggest that the links between parental smoking and ear infections and asthma did not arise from unidentified factors associated with income.

Summary

From 1994/1995 to 2008/2009, the prevalence of upper respiratory infections among children aged 2 to 3 remained constant or declined in most regions of Canada, but rose significantly in Quebec. Ear infections declined in all regions. The prevalence of asthma among children aged 2 to 7 rose steadily until 2000/2001 and then fell. A wide range of environmental factors, including reduced exposure to cigarette smoke, may have contributed to these trends. An examination of possible mechanisms falls outside the scope of this paper, but is a topic for future research. ■

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