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Abstract

Background
The impact of asthma on school performance, particularly compared with that of other chronic conditions, is relatively unexplored, and the results of analyses that have been conducted are inconclusive. This article examines associations between asthma and school functioning.

Data and methods
The data are from the 1998/1999 National Longitudinal Survey of Children and Youth. The study pertains to a sample of 8,914 children aged 7 to 15. Descriptive and regression analyses were used to examine associations between asthma severity and scores on standardized math and reading tests, and maternal ratings of school performance. School absence and the use of educational services were considered as potential mediators. Comparisons were made with children who had other chronic conditions or no chronic conditions.

Results
Compared with children who did not have a chronic condition, children with asthma scored lower on standardized math and reading tests and had less favourable mother-reported school performance. Those with the most severe asthma had the poorest outcomes. These associations persisted when adjusting for child and family factors. The poorer scholastic outcomes were not mediated by school absence. However, the use of educational services appeared to mediate low math scores for children with severe asthma.

Interpretation
The relationship between asthma and children's school functioning may be of interest to physicians and educators. Educational support and remedial services may be beneficial.

Keywords
achievement, asthma severity, chronic illness, math performance, reading performance

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The prevalence of asthma has been increasing among Canadian children and youth.[1] Compared with other children, those with asthma are in poorer health, are limited in daily activities, and experience more visits to health care professionals and hospitalizations.[2,3] They also miss more school than children who do not have the condition.[3-10] In fact, asthma has been reported to be the leading cause of school absence.[11,12]

The increased absenteeism of children with asthma has been well documented,[5-10] but associations between asthma severity and absence are less clear. Some studies have found asthma severity to be related to school absences,[5,13] while others have not.[14-16]

Although frequent absences may mean that children with asthma do less well academically than those who do not have the condition,[9,10] the impact of asthma on school performance is relatively unexplored, and the results of the studies that have been conducted are inconclusive.[10] In a population-based sample of American children in Grades 1 to 12, Fowler et al.[17] noted a greater likelihood of grade failure among children with asthma compared with healthy children. Other research suggests associations between asthma and reading problems,[18] grade repetition,[19] learning disabilities,[17] and behaviour problems.[20-22]

On the other hand, a population-based cohort study by Silverstein et al.[8] reported no difference in school functioning between children who did and did not have asthma. Several other studies[4,14,23] have had similar findings.

These discrepant results may be attributable to differences in the definitions of asthma and of school performance; whether the analysis accounted for asthma severity; the inclusion of a control group; and the use of standardized versus caregiver-reported measures of school performance.

The current study is based on a cross-sectional sample of school-aged children from the third cycle (1998/1999) of Statistics Canada's National Longitudinal Survey of Children and Youth (NLSCY). Associations between asthma severity and standardized and parent-reported measures of school functioning are examined.

Methods

Data source and sample

Since 1994/1995, the NLSCY has collected information about Canadian children's development and factors related to their well-being.[24] This study presents cross-sectional estimates from the third NLSCY cycle, which obtained data for a sample of 38,035 children aged 0 to 15 years in the fall of 1998 and the spring of 1999. Cycle 3 was selected because it contains standardized and parent-reported school performance outcomes that were dropped in later cycles of the NLSCY.

The sample for this study consisted of 8,914 children aged 7 to 15 (Grade 2 and higher) who had complete data on the measures of interest. All analyses were weighted using a normalized population weight. To adjust the standard error estimates for the complex design of the survey, bootstrap techniques were used in the regression analyses.[25]

Measures

Although clinical information was not available, and questions about asthma severity were not specifically asked, the NLSCY collected data that can serve as proxies for severity:[26] past-year wheezing or whistling in the chest and regular use of inhalers. Three levels of severity were identified: low, moderate and severe (Appendix Table A).

Questions about socio-demographic characteristics, child health, school absences, and use of educational services were answered by the person most knowledgeable about the child (the biological mother in 92% of cases) in computer-assisted personal interviews.

Math and reading scores were based on standardized tests administered in the classroom with parental consent; these scores were available for only a subset of children.[24]

Analyses

Descriptive analyses were conducted by asthma severity for three measures of school performance: scores on standardized math tests and reading tests and maternal raatings of the child's scholastic functioning. Comparisons were made with children with no chronic conditions and children who had chronic conditions other than asthma.

Logistic regression was used to "validate" the survey-based categorization of asthma severity. Associations between asthma severity and maternal reports of child health (excellent/very good versus good/fair/poor) and activity limitations (yes/no) were compared with results for children without chronic conditions. These analyses revealed associations between asthma severity and other ratings of child health, thereby providing some validation for the categorization of asthma severity. Associations between asthma severity and school absence and the use of educational services were also examined.

Logistic regressions were then used to assess associations between asthma severity and scores on standardized math and reading tests and maternal ratings of school performance, controlling for child age and sex, maternal age, female family headship, maternal education, and household income.[2,27,28] In final regression models, school absences and the use of educational services were examined as mediating factors in the relationship between asthma severity and scholastic outcomes.

The sample sizes for the logistic regression models examining associations between asthma severity and *math scores* were: 4,742 (socio-demographic variables only); 4,616 (school absence included); and 4,739 (use of educational services included). The corresponding sample sizes for the *reading scores* model were 4,744, 4,418 and 4,615, and for the *mother-rated school performance* model, 8,723, 8,380 and 8,377.

Results

The sample

The characteristics of children varied depending on whether they had been diagnosed with asthma or other chronic conditions. Significantly high percentages of children with asthma or other chronic conditions were male, lived in mother-headed households, had poor health, had missed at least 7 days of school, and had received educational services (Table 1). Children who did not have a chronic condition were slightly younger than those with a condition other than asthma, but not significantly different in age from children with asthma. Children with severe asthma tended to have younger mothers than did other children.

Health status and activity limitations

As might be expected, the odds of less favourable health ratings were significantly high among children with asthma, even when other factors that could potentially be associated with health status were taken into account (Table 2). As well, a gradient was evident, with the odds of poor health increasing with asthma severity. For instance, children with the least severe asthma had twice the odds of poor health, compared with children without chronic conditions; for children with the most severe asthma, the odds of poor health were almost ten times higher. Children with a chronic condition other than asthma also had significantly high odds of poor health.

Similarly, children with asthma were more likely to have activity limitations, and the odds of activity limitations rose with asthma severity. Children with the least severe asthma had about three and a half times the odds of activity limitations, compared with those who had no chronic conditions; for children with the most severe asthma, the odds were more than twenty-two times higher. Children with a chronic condition other than asthma were also more likely to have activity limitations.

These associations between asthma severity and poor health and activity limitations are not surprising, but the gradients do support the categorization of asthma severity in this analysis.

Table 1
Characteristics of sample, household population aged 7 to 15 with complete data on measures of school functioning, 1998/1999 National Longitudinal Survey of Children and Youth

Characteristic	Total	No chronic condition	Asthma			No asthma, but other chronic condition	Statistical comparison
			Low	Moderate	Severe		
Total number	**8,914**	**5,626**	**513**	**438**	**482**	**1,855**	
Child							
Mean age† (standard deviation)	10.8 (2.6)	10.7 (2.7)‡	11.0 (2.6)	10.8 (2.6)	10.8 (2.5)	11.1 (2.6)§	F = 7.80*
Female (%)	49.6	52.4	43.1	41.8	42.3	47.1	χ^2= 176.18*
Family							
Mean maternal age† (standard deviation)	38.5 (5.53)	38.5 (5.5)‡	38.3 (5.3)‡	38.6 (5.3)	38.0 (5.4)§	38.9 (5.7)‡	F = 5.74*
Female-headed (%)	15.3	14.6	16.8	17.0	17.4	16.2	χ^2= 38.84*
Maternal education							
Less than secondary graduation (%)	13.1	13.4	13.1	11.4	11.8	13.0	χ^2=100.68*
Secondary graduation (%)	19.9	21.1	17.4	17.1	17.4	18.3	
Some postsecondary (%)	28.4	27.7	29.8	29.5	32.0	28.8	
Postsecondary graduation (%)	38.6	37.8	39.8	42.0	32.8	39.9	
Mother not currently employed (%)	6.6	6.6	7.5	8.1	4.6	6.4	χ^2=5.25
Mother not employed prior year (%)	18.7	18.8	20.1	17.9	19.9	18.0	χ^2=7.57
Income adequacy	3.66 (0.96)	3.66 (0.96)	3.65 (0.96)	3.68 (0.94)	3.59 (0.98)	3.67 (0.94)	F=0.58
Child health							
Health status							
Excellent (%)	53.4	62.5	44.3	32.0	13.7	43.8	χ^2=1543.27*
Very good (%)	33.0	29.8	41.9	46.0	42.1	35.0	
Good/Fair/Poor (%)	13.6	7.8	13.8	22.2	44.2	21.1	
Chronic condition (%)	29.7	0.0	39.6	58.2	69.7	100.0	
School functioning							
Days absent (%)							
0	39.0	41.8	37.6	30.6	28.0	35.4	χ^2=268.94*
1 to 3	46.0	44.9	47.6	53.9	50.6	45.7	
4 to 6	9.6	9.0	9.2	10.3	12.2	10.8	
7 or more	5.5	4.3	5.7	5.3	9.1	8.1	
Use of educational services (%)	6.6	2.6	6.3	9.1	11.2	17.0	χ^2=1164.24*

* $p < 0.05$; significantly different categories for continuous variables have different superscripted symbols
† continuous variable
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

Math and reading scores/ Maternal ratings

Scores on standardized math and reading tests and maternal ratings of children's school performance were related to family structure, maternal education and employment, and household income (Tables 3 to 5, column 1). But even when the influence of these factors was taken into account, differences in standardized scores and maternal ratings emerged by asthma severity.

The odds of low math scores were significantly high for children with moderate or severe asthma, compared with children who had no chronic conditions. The odds of low reading scores were significantly high only for children with moderate asthma. And the odds that mothers would rate their child's school performance as poor were high for children whose asthma symptoms were low or severe, but did not reach statistical significance for the moderate group.

Children with other chronic conditions were also more likely to have low math and reading scores and poor maternal ratings of their school performance, compared with children who did not have chronic conditions.

School absence and use of educational services

Children with asthma were significantly more likely than those with no chronic conditions to have been absent from school and to have used educational services (Table 2). This was also the case for children with chronic conditions other than asthma.

Additional models examined the effects of these potential mediators—school absence and use of educational services—on the associations between the three measures of school functioning and asthma and other chronic conditions.

Being away from school was linearly associated with low scores on standardized *math* tests. That is, the children who missed the most days (a week or more) had about two and a half times the odds of low scores, compared with children who missed no days (Table 3, column 2). However, controlling for school absence did not appreciably diminish the odds of low math scores

Table 2
Odds ratios relating selected characteristics to poor health status, activity limitations, school absence and educational services , household population aged 7 to 15, Canada, 1998/1999

	Poor health status (n=8,723)			Activity limitations (n=8,722)			School absence more than one week§ (n=8,380)			Use of educational services (n=8,377)		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Characteristic	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Child												
Age (continuous)	1.02	1.00	1.04	1.05*	1.02	1.08	1.15*	1.12	1.19	1.00	1.00	1.02
Female†	1.32*	1.20	1.45	1.32*	1.15	1.52	1.26*	1.09	1.46	0.72*	0.63	0.82
Family												
Older maternal age†	1.03*	1.02	1.03	1.00	0.99	1.01	0.99	0.98	1.01	0.98*	0.97	1.00
Female-headed†	0.88	0.77	1.00	0.95	0.78	1.16	1.40*	1.15	1.71	1.77*	1.50	2.09
Higher maternal education†	0.84*	0.80	0.88	0.87*	0.81	0.97	0.81*	0.76	0.88	0.85*	0.79	0.90
Mother not currently employed†	1.08	0.88	1.34	1.11	0.82	1.52	1.06	0.76	1.49	0.96	0.72	1.29
Mother not employed prior year†	1.22*	1.08	1.37	1.02	0.84	1.23	1.31*	1.08	1.59	1.28*	1.08	1.51
Higher income adequacy†	0.73*	0.69	0.78	0.95	0.87	1.03	0.88*	0.80	0.96	0.92	0.85	1.00
Chronic condition												
None‡	1.00	…	…	1.00	…	…	1.00	…	…	1.00	…	…
Asthma												
Low	1.98*	1.64	2.39	3.49*	2.56	4.75	2.03*	1.55	2.67	2.64*	2.00	3.49
Moderate	3.42*	2.85	4.11	6.61*	4.97	8.78	1.59*	1.14	2.21	4.08*	3.13	5.32
Severe	9.46*	8.06	11.10	21.55*	17.22	26.97	3.53*	2.74	4.55	5.38*	4.21	6.88
Other	2.92*	2.61	3.26	8.81*	7.32	10.60	2.05*	1.72	2.43	8.85*	7.58	10.34

* significantly different from estimate for reference category ($p < 0.05$)
† reference category is absence of characteristic
‡ reference category
§ interview date included as a control
... not applicable
Notes: All models control for province of residence. Because of rounding, an odds ratio with 1.00 as upper confidence limit is significant.
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

among children with asthma or with other chronic conditions.

Children who used educational services were much more likely than those who had not to obtain low math scores (Table 3, column 3). Controlling for the use of educational services reduced the strength of the association between moderate asthma and low math scores, and for children with severe asthma, the association was no longer significant.

Unlike the results for math, school absence was not related to low scores on the standardized *reading* tests (Table 4, column 2). Moreover, including school absence in the model actually strengthened the association between moderate and severe asthma and low reading scores, suggesting the presence of a suppressor effect or a correlation between school absence and a variable that was not examined in this analysis.

The use of educational services, however, was associated with low reading scores (Table 4, column 3). Controlling for the use of educational services reduced the odds that children with moderate asthma would have low reading scores, and for those with severe asthma, the association was no longer significant.

School absence was related to poor *maternal ratings* of academic performance only for children who missed the fewest days (no more than 3) (Table 5, column 2). As well, controlling for days absent had almost no effect on the relationship between asthma and poor mother-reported school performance.

On the other hand, the use of educational services was associated with poor maternal ratings (Table 5, column 3). And when the use of educational services was taken into account, the strength of the association between asthma and poor maternal ratings was reduced.

Discussion

The estimates of asthma and asthma severity in this study differ from those derived from other contemporary sources. According to the 1998/1999 NLSCY, 16% of school-aged children had been diagnosed with asthma, well above the estimated 12%, based on the 1996/1997 National Population Health Survey (NPHS).[29] However, the NPHS figure includes children younger than age 4, and the low prevalence of asthma (8%) at these ages would reduce the overall prevalence rate.

In this study, about one-third of the children who had asthma were classified in the most severe category, whereas in Bussing et al.,[20] the figure was just over 18%. But Bussing et al. looked at

Table 3
Adjusted odds ratios relating selected characteristics to low scores on standardized math tests, household population aged 7 to 15, Canada, 1998/1999

	Adjusted for socio-demographics and chronic conditions (n=4,742)			Adjusted for socio-demographics, school absences and chronic conditions (n=4,616)			Adjusted for socio-demographics, use of educational services and chronic conditions (n=4,739)		
		95% confidence interval			95% confidence interval			95% confidence interval	
Characteristic	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Child									
Age (continuous)	1.01	0.98	1.05	1.01	0.97	1.05	1.01	0.99	1.02
Female†	1.06	0.90	1.26	1.02	0.86	1.21	1.02	0.99	1.06
Family									
Older maternal age†	0.98*	0.97	1.00	0.98*	0.96	1.00	0.98	0.97	1.00
Female-headed†	1.91*	1.53	2.37	1.91*	1.52	2.40	1.84*	1.46	2.32
Higher maternal education†	0.81*	0.75	0.88	0.81*	0.79	0.98	0.82*	0.75	0.90
Mother not currently employed†	0.74	0.49	1.12	0.72	0.47	1.11	0.71	0.46	1.09
Mother not employed prior year†	1.53*	1.24	1.88	1.59*	1.28	1.97	1.63*	1.31	2.04
Higher Income adequacy†	0.86*	0.80	0.96	0.88*	0.79	0.98	0.92	0.82	1.02
Days absent									
0‡	...	...	...	1.00	...	...	...	...	...
1 to 3	...	...	...	1.57*	1.28	1.93	...	...	...
4 to 6	...	...	...	2.05*	1.52	2.75	...	...	...
7 or more	...	...	...	2.41*	1.71	3.41	...	...	...
Use of educational services†	...	...	...	...	...	...	4.79*	3.72	6.17
Chronic condition									
None‡	1.00	...	...	1.00	...	...	1.00	...	...
Asthma									
Low	1.39	1.00	1.92	1.36	0.98	1.90	1.24	0.89	1.74
Moderate	1.90*	1.34	2.68	1.84*	1.30	2.62	1.61*	1.13	2.30
Severe	1.62*	1.17	2.25	1.59*	1.14	2.22	1.41	1.00	1.98
Other	1.75*	1.43	2.14	1.72*	1.40	2.11	1.37*	1.10	1.70

* significantly different from estimate for reference category ($p < 0.05$)
† reference category is absence of characteristic
‡ reference category
§ interview date included as a control
... not applicable
Notes: All models control for province of residence. Because of rounding, some odds ratios with 1.00 as upper confidence limit are significant.
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

severity among children who had only asthma, whereas children with asthma in the present study may also have had other chronic conditions.

The association between asthma severity and school absence observed in this study has been found in other research, based on school administrative records[5-10] and on maternal reports.[3,4] However, in the literature, the relationship between school absence and school performance is less clear. The NLSCY results suggest that the associations between asthma and poor school performance are not due to absences.

On the other hand, the use of educational services seemed to mediate some of these associations, particularly for children with severe asthma. Unfortunately, with NLSCY data, it was not possible to determine what kind or how many services were used or where they were offered.

The variations in research findings may be related to the specific outcomes examined and to whether asthma severity was taken into account. Fowler et al.[17] found that children with asthma had more mother-reported learning difficulties than did healthy children, but according to school records, no more grade failure or suspension/expulsion. Similarly, other studies have not reported differences between children with asthma and their healthy peers on standardized tests of math, reading and overall performance,[6] though based on maternal reports, outcomes for children with asthma have been less favourable.

Thus, the NLSCY results are consistent with the literature for poor mother-reported school performance, but not for scores on standardized math and reading tests. However, the present study, unlike many others,[8,23,30] includes

Table 4
Adjusted odds ratios relating selected characteristics to low scores on standardized reading tests, household population aged 7 to 15, Canada, 1998/1999

	Adjusted for socio-demographics and chronic conditions (n=4,744)			Adjusted for socio-demographics, school absences and chronic conditions (n=4,618)			Adjusted for socio-demographics, use of educational services and chronic conditions (n=4,615)		
		95% confidence interval			95% confidence interval			95% confidence interval	
Characteristic	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Child									
Age (continuous)	1.07*	1.04	1.11	1.07*	1.04	1.11	1.08*	1.04	1.11
Female†	0.90	0.78	1.04	0.91	0.78	1.06	0.95	0.81	1.10
Family									
Older maternal age†	0.99	0.97	1.00	0.99	0.97	1.00	0.99	0.97	1.00
Female-headed†	1.27*	1.05	1.55	1.34*	1.09	1.64	1.26*	1.03	1.55
Higher maternal education†	0.78*	0.72	0.84	0.76*	0.71	0.82	0.77*	0.71	0.83
Mother not currently employed†	0.76	0.54	1.08	0.78	0.55	1.10	0.75	0.53	1.06
Mother not employed prior year†	1.04	0.86	1.26	1.09	0.89	1.32	1.05	0.86	1.27
Higher Income adequacy†	0.71*	0.65	0.77	0.71*	0.64	0.77	0.71*	0.65	0.78
Days absent									
0‡	...	...	...	...	...	...	...	...	...
1 to 3	...	...	...	0.97	0.82	1.14	...	...	...
4 to 6	...	...	...	1.14	0.88	1.49	...	...	...
7 or more	...	...	...	0.90	0.63	1.28	...	...	...
Use of educational services†	...	...	...	...	...	...	2.76*	2.16	3.52
Chronic condition									
None‡	1.00	…	…	1.00	…	…	1.00	…	…
Asthma									
Low	0.82	0.59	1.15	0.86	0.62	1.20	0.78	0.56	1.09
Moderate	1.73*	1.28	2.32	1.83*	1.36	2.46	1.59*	1.17	2.15
Severe	1.23	0.91	1.67	1.36*	1.00	1.86	1.17	0.85	1.60
Other	1.52*	1.27	1.81	1.57*	1.31	1.88	1.35*	1.12	1.62

* significantly different from estimate for reference category ($p < 0.05$)
† reference category is absence of characteristic
‡ reference category
§ interview date included as a control
... not applicable
Note: All models control for province of residence.
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

a control group of children with and without chronic conditions and uses a large population-based sample.

According to the NLSCY, most children, even those with severe asthma, had not been absent from school for many days: 96% of healthy children and 91% of children with severe asthma were reported to have missed fewer than 7 days. By contrast, Fowler et al,[17] found that just 58% of children with asthma missed no more than 5 days of school, substantially below the figure even for children with severe asthma in the present study. Although the models for the NLSCY analysis controlled for the number of days since school started, many interviews were completed early in the school year, which could be one reason why reported school absence was so low.

Consistent with other findings,[23] school absence was independently associated with low scores on standardized math tests. However, school absence did not mediate the association between asthma severity and math and reading scores and mother-rated performance. Even though children with asthma were more likely to miss school, it is possible that they and/or their parents compensated for the absences, perhaps through additional services within and outside the school. Future studies could examine these possibilities, as well as factors such as parenting practices and the provision of learning experiences in the home.

The worsening of health outcomes with asthma severity suggests that the conceptualization of asthma severity in this study captured a construct related to the child's health. Associations between asthma severity and school performance were less straightforward. Potential confounders such as maternal education, family structure and household income were taken into account, but other factors related to school performance could not

Table 5
Adjusted odds ratios relating selected characteristics to poor mother-rated school performance, household population aged 7 to 15, Canada, 1998/1999

	Adjusted for socio-demographics and chronic conditions (n=4,742)			Adjusted for socio-demographics, school absences and chronic conditions (n=4,616)			Adjusted for socio-demographics, use of educational services and chronic conditions (n=4,739)		
		95% confidence interval			95% confidence interval			95% confidence interval	
Characteristics	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Child									
Age (continuous)	0.60*	0.59	0.62	0.60*	0.59	0.61	0.60*	0.58	0.61
Female†	0.71*	0.66	0.77	0.71*	0.65	0.77	0.73*	0.67	0.80
Family									
Older maternal age†	0.99	0.99	1.00	0.99*	0.98	1.00	0.99*	0.98	1.00
Female-headed†	1.28*	1.13	1.44	1.31*	1.16	1.48	1.24*	1.09	1.40
Higher maternal education†	0.82*	0.78	0.85	0.82*	0.78	0.85	0.82*	0.79	0.86
Mother not currently employed†	0.98	0.82	1.62	0.99	0.83	1.18	0.98	0.82	1.18
Mother not employed prior year†	1.01	0.91	1.13	1.05	0.94	1.18	1.03	0.92	1.15
Higher Income adequacy†	0.92*	0.88	0.97*	0.93*	0.88	0.98	0.94*	0.89	0.99
Days absent									
0‡	...	...	...	...	...	...	...	...	...
1 to 3	...	...	...	1.15*	1.05	1.26	...	...	...
4 to 6	...	...	...	1.11	0.95	1.29	...	...	...
7 or more	...	...	...	1.12	0.90	1.38	...	...	...
Use of educational services†	...	...	...	...	...	...	3.12*	2.72	3.70
Chronic condition									
None‡	1.00	...	...	1.00	...	...	1.00	...	...
Asthma									
Low	1.60*	1.35	1.88	1.63*	1.38	1.93	1.59*	1.34	1.88
Moderate	1.16	0.96	1.40	1.15	0.95	1.39	1.09	0.90	1.32
Severe	1.57*	1.32	1.88	1.55*	1.29	1.89	1.41*	1.17	1.69
Other	1.55*	1.40	1.72	1.56*	1.40	1.73	1.27*	1.13	1.41

* significantly different from estimate for reference category ($p < 0.05$)
† reference category is absence of characteristic
‡ reference category
§ interview date included as a control
... not applicable
Notes: All models control for province of residence. Because of rounding, some odds ratios with 1.00 as upper confidence limit are significant.
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

be considered: the child's prior levels of performance, motivation, intelligence, and behavioural problems; parenting practices; resources and learning environments; and parental participation in school activities.[31-34]

Strengths and limitations

Although the analysis pertains to 1998/1999, the data source is undoubtedly a strength of the current study. Cycle 3 of the NLSCY collected data for a large, representative sample of children with various health conditions, thereby making it possible to compare those with asthma with healthy children and with children who had other chronic conditions. Standardized test results and mother-reported measures of school performance were available.

Even so, the NLSCY is limited in a number of ways. It was not designed to specifically address chronic illnesses and their association with children's school performance. The identification of children with asthma was based on maternal reports, not medical records. Although parental reports of children's chronic conditions have been demonstrated to be valid,[35] the reported prevalence of asthma may be underestimated as a result of undiagnosed cases.

The ability to generate classes of individuals with similar conditions (asthma of varying levels of severity with and without other chronic conditions) is limited. Guidelines for more rigorous methods of severity classification exist,[36] but they were not part of the NLSCY.

The three levels of asthma severity specified in this study are not homogeneous, and likely represent differences in asthma other than just severity. For example, to be in the

What is already known on this subject?

- The prevalence of asthma among Canadian children and youth has been increasing.
- Children with asthma miss more school than do children without the condition.
- Frequent school absences can interfere with learning, but the impact of asthma on school performance is relatively unexplored, and the results of the analyses that have been conducted are inconclusive.

What does this study add?

- Children with asthma scored lower on standardized math and reading tests and had less favourable mother-reported school performance than did children who did not have chronic conditions.
- Children with the most severe asthma had the poorest outcomes.
- These associations persisted even when adjusting for child and family factors.
- The poorer scholastic outcomes were not mediated by school absences, but the use of educational services appeared to mediate low math scores for children with severe asthma.

"severe" category, children had to be taking asthma medication, but still coughing or wheezing. This may not indicate the most severe asthma, but rather, that the children are not responding to the medication, are not receiving the appropriate dosage, or are not complying with the administration of the medication. Nevertheless, the consistency of the associations with ratings of health and with activity limitations suggests that the conceptualization of asthma severity in this study represents an aspect of poor health.

A high percentage of children with asthma, especially severe asthma (70%), had another chronic condition. The NLSCY sample for this group was not large enough to permit an in-depth investigation of the other conditions affecting the children with asthma nor of asthmatic children by severity.

Another factor to be considered is the reported use of asthma medication. The NLSCY question asks about inhalers. However, asthma treatment includes relievers (inhalers and puffers) and controllers (oral medication when a child becomes symptomatic).[3] Detailed information about the use of these medications was not available in the NLSCY.

A further complication is the uncertain effect of the medications on school performance. Taking medication may reduce and control symptoms and improve school performance. On the other hand, side-effects such as drowsiness and decreased attention, could interfere with academic attainment.[9,37] Further research is required to disentangle these associations.

A final limitation is the high non-response to the standardized math and reading tests.[24] Complete data on these measures were more likely to be available for children with asthma than for those who did not have the condition. Attrition analyses were performed to compare the group that had math and reading scores with the group that did not (Appendix Table B).

Conclusion

With data from Statistics Canada's National Longitudinal Survey of Children and Youth, this study examined associations between asthma severity and three measures of school performance. Compared with children who did not have chronic conditions, those with asthma tended to perform less well, and those with the most severe asthma had the poorest outcomes. Children with the most severe asthma had the greatest odds of missing more than a week of school, but their low scores on standardized math and reading tests and poor mother-rated academic performance were not mediated by school absences. The use of educational services, however, appeared to mediate the associations.

The increased risk of poor scholastic outcomes for children with asthma (and other chronic conditions) has implications for clinicians, teachers, and parents. The results suggest the importance of additional assistance such as educational services to improve the school performance of children with asthma. ■

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Appendix

Table A
Measures used in analyses

Variable	Description
Province of residence	Ontario as comparison group
Child characteristics	
Age	Years
Gender	Female
Maternal characteristics	
Age	Years
Education	Highest level: less than secondary graduation; secondary graduation; some postsecondary; postsecondary graduation
Currently employed	Yes/No
Employed prior year	Yes/No
Income adequacy	Based on household income and household size; range 1 to 5
Child health	
Asthma	Maternal report of ever having been diagnosed with asthma†
Asthma severity	Based on two items: child had wheezing or whistling in chest any time in previous 12 months; prescribed and regular use of Ventolin, inhalants or puffers for asthma
Low	Diagnosed asthma, but no wheezing or whistling and no use of medication
Moderate	Diagnosed asthma with reported wheezing or whistling OR use of medication
Severe	Diagnosed asthma with reported wheezing or whistling AND use of medication
Chronic condition	Presence of any of following: allergies, bronchitis, heart condition, epilepsy, cerebral palsy, kidney, mental handicap, learning disability, emotional problems
No chronic condition	No diagnosis of asthma or other chronic condition
Health status	Maternal rating of child's health as excellent/very good or good/fair/poor
Activity limitations	Long-term conditions or health problems that prevent or limit participation in school, play or sports (yes/no)
School functioning	
School absence	Maternal report of number of school days absent for any reason: 0, 1 to 3, 4 to 6, 7 or more‡
Use of educational services	Maternal report of receipt of special help because of physical, emotional, behavioural or other problem limiting kind or amount of school work child can do (yes/no)
Standardized math and reading tests	Shortened version of Mathematics Computation Test and Reading Comprehension Test of Canadian Achievement Tests (CAT/2): good/low§
Maternal rating of school performance	Maternal rating of child's performance in math, reading, writing and overall; range 4 to 20; dichotomized into good/poor

† phrasing of this item, consistent with other large studies, limits variability because of seasonality of child age
‡ number of days missed since start of school; analyses controlled for month and day of survey administration
§ because of ceiling effects on these tests, scores were dichotomized; scores above mean categorized as good, and scores below mean categorized as low

Table B
Odd ratios comparing characteristics of respondents with math and reading scores with characteristics of those who did not, household population aged 7 to 15, Canada, 1998/1999

Characteristic	Odds ratio	95% confidence interval from	to
Province			
Ontario†	1.00	…	…
Newfoundland	0.68*	0.53	0.88
Prince Edward Island	0.47*	0.28	0.78
Nova Scotia	0.42*	0.34	0.53
New Brunswick	0.48*	0.38	0.61
Quebec	1.17*	1.07	1.29
Manitoba	0.75*	0.63	0.91
Saskatchewan	0.77*	0.64	0.92
Alberta	0.79*	0.70	0.90
British Columbia	0.82*	0.73	0.92
Child			
Age (continuous)	1.03*	1.01	1.05
Female‡	0.85*	0.79	0.91
Family			
Older maternal age‡	1.00	0.99	1.00
Female-headed‡	1.18*	1.06	1.13
Higher maternal education‡	0.98	0.94	1.01
Mother not currently employed‡	0.82*	0.70	0.96
Mother not employed prior year‡	0.95	0.86	1.04
Higher Income adequacy‡	0.95	0.90	0.99
Chronic condition			
None†	1.00	…	…
Asthma			
Low	0.80*	0.71	0.91
Moderate	0.82*	0.71	0.95
Severe	0.72*	0.62	0.83

* significantly different from estimate for reference category ($p < 0.05$)
† reference category
‡ reference category is absence of characteristic
§ interview date included as a control
... not applicable
Source: 1998/1999 National Longitudinal Survey of Children and Youth.