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Age trends in direct medical costs of pediatric asthma: a population study

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To the Editor

Asthma symptoms is prevalent in 11.5% and 14.1% of children at ages 6-7 and 13-14, respectively¹. Although 80% of patients with persistent asthma trace their symptoms to the first 3 years of life, asthma is often overlooked or misdiagnosed during infancy and early childhood². Evidence on the health economic implications of this strong age trend is limited. Further compounding this picture is the potential effect of biologic sex and socioeconomic status (SES) on such trends, which are yet to be studied under Canada's universal health care system. This study estimated the age trends of direct medical costs (DMC) of pediatric asthma, and evaluated the influences of sex and SES on such trends in the secondary analyses.

Data were retrieved between January 1, 1997 and December 31, 2015 from the health administrative databases of the province of British Columbia, Canada (total population 4.77M in 2015 - *Appendix 1*)³⁻⁷. All inferences, opinions and conclusions drawn in this study are those of the authors, and do not reflect the opinions or policies of the Data Steward(s). During every 2-year rolling window, we identified children who had ≥ 2 outpatient physician visits or ≥ 1 hospitalization between 0 to 12 years of age, with asthma being the most responsible diagnosis (International Classification of Diseases [ICD] code, 9th edition [ICD-9]: 493, or tenth revision [ICD-10]: J45) (*Appendix Figure E1*). We followed them from the first diagnosis of asthma or wheezing (ICD-9: 786.0, or ICD-10: R06) until age 18, the administrative end of the study, the last date of presence in the registration database, or date of death.

Direct medical costs (referred to as 'costs' hereafter for brevity) were summed from three components: inpatient episodes, outpatient healthcare visits, and filled prescriptions, including all

costs regardless of the payer. Inpatient costs were calculated using the case mix methodology⁸. Costs of outpatient visits and medication dispensations were directly available in the data. Most emergency department encounters (78%) were already captured by fee-for-service payments to healthcare practitioners within the outpatient encounter database, and the rest were captured within hospitalization costs⁹. All costs were adjusted to 2016 Canadian dollars using the Consumer Price Index¹⁰. The primary outcome was asthma-related costs. For inpatient and outpatient costs these were sum of costs associated with inpatient or outpatient records with asthma or wheezing being the most responsible diagnosis; for medications, we used a specific list of commonly dispensed asthma-related drugs (*Appendix Table E1*). The secondary outcome was costs of other respiratory conditions, including acute respiratory infections, influenza, pneumonia, other chronic respiratory conditions, lung diseases due to external agents, suppurative and necrotic respiratory conditions, other disorders and diseases of the respiratory system (ICD-9, 460-519, ICD-10, J00 – J99 – excluding asthma), other respiratory symptoms (ICD-9, 786, ICD-10, R05, R07, R09 – excluding wheezing), as well as other respiratory-related medications based on the American Hospital Formulary Service major drug category¹¹. We applied generalized linear models to estimate the population-averaged costs per child-year (*Appendix E2*). Generalized Estimating Equations were applied to account for correlated measurements over time within each child. All analyses were performed using SAS 9.3 (SAS Institute Inc, Cary, NC, United States).

The final analysis included 44,552 children with asthma (62.8% boys), 39.9%, 42.9%, and 17.2% of children had the first asthma or wheezing diagnosis at between 0 to 3 years, 4 to 7 years, and 8 to 12 years of age, respectively (*Table 1*). Per child-year and averaged over the follow-up period, costs related to asthma were estimated as \$208.0 (95% CI, 204.7–211.3) and related to other respiratory conditions as \$128.7 (95% CI, 121.8–135.6) (*Table 2*). From age 0 to 3 years, there was a substantial decrease in asthma-related costs (from \$1035.6/child-year to \$381.6/child-year, decreased by 28.9% every year), mainly driven by hospitalization costs (decreased by -30.8% every year) (*Figure 1, left panel*). Between 4 and 18 years of age, per child-year asthma-related costs steadily declined, but at a slower rate of 14.1%, while hospitalization costs declined by 30.0% every year. Overall, children below 3 years of age incurred 3.6 times higher asthma costs and in particular 9.3 times higher asthma-related hospitalization costs compared to those aged 4 and above. Meanwhile, the average costs of

outpatient visits and medications were, respectively, 3.7 times and 1.7 times higher in children aged below 3 compared to those aged 4 and older. For other respiratory conditions, children also incurred the highest costs in their first 3 years of life, which decreased from \$1,144.6/child-year at age 0 to \$215.9/child-year at age 3, corresponding to a decline of 42.3% per year (**Figure 1, right panel**). The age trends persisted after the removal of wheezing-related healthcare encounters from both the definition of index date and asthma-related costs (**Appendix Figure E2**).

Appendix Figure E3 and 4 respectively present the sex- and SES-stratified age trends of costs related to asthma and other respiratory conditions. The overall patterns of both asthma and other respiratory costs over age were similar between boys and girls (interaction term p-values>0.05) except that, costs of asthma medications steadily declined in boys (-7.9%/year), whereas these costs initially declined in girls between age 0 and 14 (-7.9%/year) but increased between age 15 and 17 (18.5%/year) (**Appendix Figure E3**). Such age trends were generally parallel across SES status (**Appendix Figure E4**).

Overall, these results depict a highly dynamic picture of the economic burden of asthma in children. The highest direct medical costs were found in children younger than 3. Age trends were generally consistent between sex and across socioeconomic status. The substantially higher costs in the first 3 years of life reflect the challenge of managing asthma in young children because, despite the early diagnosis, they were frequently hospitalized for asthma and other respiratory conditions. A similarly high burden has also been reported among children from Nordic countries¹². In our study, starting around puberty, costs of asthma-related medications increased again in girls when compared to boys, which is consistent with the evidence that in their adolescence, boys are more likely to experience a remission of asthma symptoms than girls¹³. Interestingly, the SES-related inequalities in pediatric asthma costs were found to be minimal, supporting the recent report of Canadian Institutes for Health Information that, British Columbia appeared to be more effective compared to other provinces with regard to the elimination of income-related inequalities in the hospitalization rate of pediatric asthma¹⁴.

Our study has some limitations. First, we identified children with asthma through health resource use records¹⁵ instead of objective measures of airflow obstruction. Second, several important risk factors related to pediatric asthma outcomes, such as family education status and environmental smoke exposure, were not recorded in our data. Finally, other non-medical direct costs, indirect costs and overall intangible costs were not included in this study.

Both in Canada and worldwide, there is significant enthusiasm towards developing asthma prevention strategies such as antibiotic stewardship and breastfeeding promotion. There is scarcity of evidence on the economic burden of pediatric asthma, which is needed to establish the population-level ‘value for money’ potential of such prevention strategies. Future studies need to evaluate to what extent the future burden of pediatric asthma can be modified through evidence-informed disease management.

Sincerely,

Wenjia Chen, Hamid Tavakoli, J Mark FitzGerald, Padmaja Subbarao, Stuart E. Turvey, Mohsen Sadatsafavi.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest relevant to this article to disclose.

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Dr. Wenjia Chen conceptualized and designed the study, wrote the first draft of manuscript, critically reviewed and revised the manuscript.

Mr. Hamid Tavakoli designed the study, collected data and performed the statistical analysis, critically reviewed the manuscript for important intellectual content.

Drs. J Mark FitzGerald, Padmaja Subbarao and Stuart E. Turvey conceptualized the study, provided critical clinical input, and critically reviewed the manuscript for important intellectual content.

Dr. Mohsen Sadatsafavi conceptualized and designed the study, coordinated and supervised data collection and statistical analysis, critically reviewed and revised the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

All authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics approval was obtained from the University of British Columbia Human Ethics Board (H17-00938).

REFERENCES

1. Lai CKW, Beasley R, Crane J, et al. Global variation in the prevalence and severity of asthma symptoms: Phase Three of the International Study of Asthma and Allergies in Childhood (ISAAC). *Thorax*. 2009;64(6):476-483. doi:10.1136/thx.2008.106609
2. Martinez FD. Development of wheezing disorders and asthma in preschool children. *Pediatrics*. 2002;109(2 Suppl):362-367.

3. British Columbia Ministry of Health [creator]. Consolidation File (MSP Registration & Premium Billing). Population Data BC[publisher]. Data Extract. MOH. 2018. Available at: <http://www.popdata.bc.ca/data>. (Accessed: Jun 30, 2020).
4. BC Vital Statistics Agency [creator]. Vital Statistics Births. Population Data BC [publisher]. Data Extract. BC Vital Statistics Agency. 2018. Available at: <http://www.popdata.bc.ca/data>. (Accessed: Jun 30, 2020).
5. Canadian Institute for Health Information [creator]. Discharge Abstract Database (Hospital Separations). Population Data BC [publisher]. Data Extract. MOH 2017. Available at: <http://www.popdata.bc.ca/data> (Accessed: Jun 30, 2020).
6. British Columbia Ministry of Health [creator]. Medical Services Plan (MSP) Payment Information File. Population Data BC [publisher]. Data Extract. MOH. 2018. Available at: <http://www.popdata.bc.ca/data>. (Accessed: Jun 30, 2020).
7. British Columbia Ministry of Health [creator]. PharmaNet. BC Ministry of Health [publisher]. Data Extract. Data Stewardship Committee. 2018. Available at: <http://www.popdata.bc.ca/data>. (Accessed: Jun 30, 2020).
8. Poole B, Robinson S, MacKinnon M. Resource Intensity Weights and Canadian hospital costs: some preliminary data. *Healthc Manag Forum Can Coll Health Serv Exec Forum Gest Soins Santé Collège Can Dir Serv Santé*. 1998;11(1):22-26.
9. McKendry R, Reid RJ, McGrail KM, et al. Emergency Rooms in British Columbia: A Pilot Project to Validate Current Data and Describe Users. Vancouver (BC): Centre for Health Services and Policy Research; December 2002.
10. Government of Canada SC. Consumer Price Index, by province (monthly) (Canada). Published July 17, 2015. Accessed July 30, 2015. <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/cpis01a-eng.htm>

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11. McEvoy GK. *AHFS Drug Information: Essentials 2006-2007*. Amer Soc of Health System; 2006.
 12. Kocevar VS, Bisgaard H, Jönsson L, et al. Variations in pediatric asthma hospitalization rates and costs between and within Nordic countries. *Chest*. 2004;125(5):1680-1684. doi:10.1378/chest.125.5.1680
 13. Tantisira KG, Colvin R, Tonascia J, Strunk RC, Weiss ST, Fuhlbrigge AL. Airway Responsiveness in Mild to Moderate Childhood Asthma. *Am J Respir Crit Care Med*. 2008;178(4):325-331. doi:10.1164/rccm.200708-1174OC
 14. Asthma Hospitalizations Among Children and Youth in Canada: Trends and Inequalities — Chartbook | CIHI. Published April 26, 2018. Accessed March 14, 2020. <https://www.cihi.ca/en/document/asthma-hospitalizations-among-children-and-youth-in-canada-trends-and-inequalities>
 15. To T, Dell S, Dick PT, et al. Case verification of children with asthma in Ontario. *Pediatr Allergy Immunol*. 2006;17(1):69-76. doi:10.1111/j.1399-3038.2005.00346.x

Table 1. Baseline characteristics of the study sample

	Overall Sample (N=44,552)
Age, n (%)	
0–3 years	17,796 (39.9)
4–7 years	19,093 (42.9)
8–12 years	7,663 (17.2)
Sex, n (%)	
Girls	16,597 (37.3)
Boys	27,955 (62.8)
Neighborhood household income*, n (%)	
Low (1 st and 2 nd quintile)	19,592 (44.0)
Middle (3 rd quintile)	9,068 (26.0)
High (4 th and 5 th quintile)	15,217 (34.7)
Missing	675 (1.5)

N, number

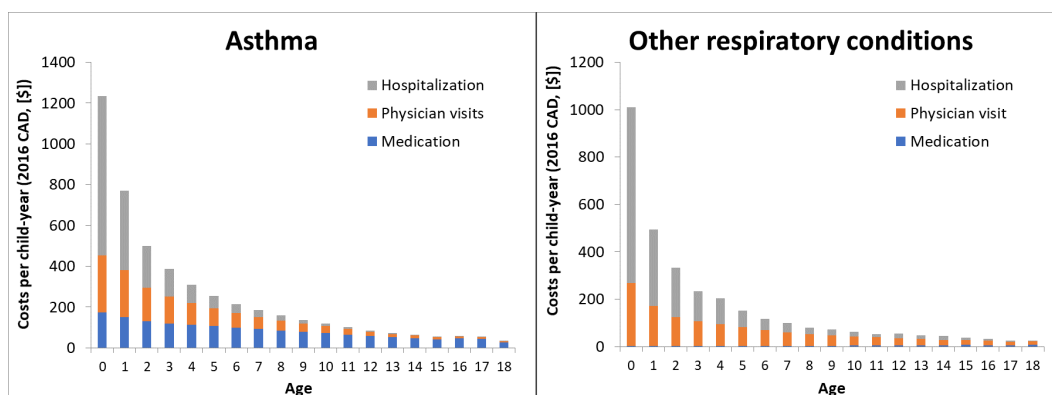
*Measured by the quintiles of median neighbourhood household income of each personal record, categorized into 3 levels: low [the lowest 2 quintiles], middle, high [the highest 2 quintiles]

Table 2. Direct medical costs for pediatric asthma patients

	Costs (\$/child-year) (95% CI)
Asthma-related costs	208.0 (204.7, 211.3)
Hospitalizations	58.1 (55.9, 60.3)
Outpatient visits	64.4 (63.7, 65.1)
Medications	85.5 (84.0, 87.0)
Other respiratory-related costs	128.7 (121.8, 135.6)
Hospitalization	64.0 (57.6, 70.4)
Outpatient visits	60.2 (59.5, 60.8)
Medication	4.5 (3.5, 5.6)

Figure legends

Figure 1. Age trends of pediatric asthma costs. Left panel, direct medical costs related to asthma, total and by components. Right panel, direct medical costs related to other respiratory conditions, total and by components.



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Age trends in direct medical costs of pediatric asthma: a population-based study

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Appendix E1. Description of data source

A provincial health insurance program provides universal health care coverage to all legal residents of British Columbia (BC), Canada, one of the largest provinces, representing 13% of the Canadian population (4.4 million)(1). We retrieved data from the BC provincial health administrative databases for the period of January 1996 to December 2016 (20 years). These databases are linked at individual-level and provide information on health-care encounters of all legal residents of BC. We used registration files (capturing the status of insurance coverage of individuals)(2), vital statistics (capturing births and deaths)(3), the hospital discharge database (capturing inpatient encounters)(4), Medical Services Plan payment information (capturing outpatient encounters with physicians)(5), and PharmaNET (capturing all medication dispensations outside of hospital pharmacies, and regardless of any third-party insurance coverage)(6). Previous analyses have showed a very low prevalence of missing data, under-reporting and misclassification in these databases (7,8).

Appendix E2. Statistical analysis

All analyses were performed using SAS 9.3 (SAS Institute Inc, Cary, NC, United States).

We applied generalized linear models to estimate the longitudinal, population-averaged costs per child-year. The unit of observation was every 12-month period following the index date, with the last period truncated when less than 300 days. The dependent variables were costs of asthma, or other respiratory conditions. The independent variables were age, sex, socioeconomic status (SES, measured by the quintiles of median neighbourhood household income of each personal record, categorized into 3 levels: low [the lowest 2 quintiles], middle, high [the highest 2 quintiles]). The model further controlled for calendar year effect and the high costs incurred at the first year of asthma onset. Normal distribution and identity link were used for the cost estimation. The normality assumption is robust when the sample size is large, and is a recommended approach²⁷. Generalized Estimating Equations was applied to account for correlated cost measurements over time within each child. To test for age trends, we performed the above-mentioned models by adding interaction terms between age and sex, and between age and SES levels.

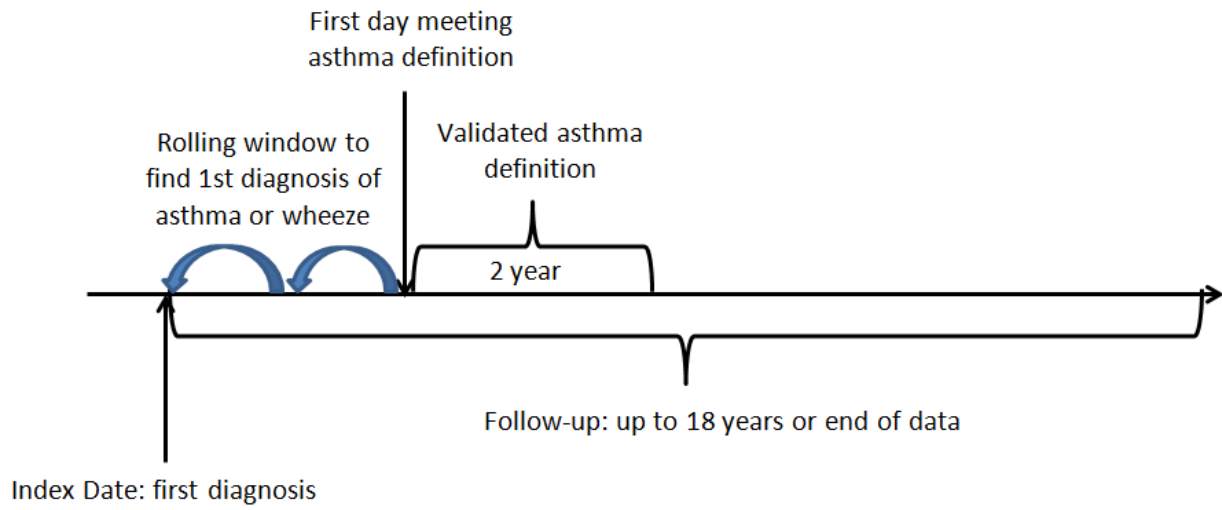
Appendix Table E1. List of asthma-specific medications

Medication categories	Medication type	Active ingredient(s)	ATC	DIN	Used in case definition?
Inhaled corticosteroids (ICS)	Controller	Beclomethasone	R03BA01	2242030, 2242029, 374407, 828521, 828548, 872334, 893633, 897353, 1949993, 1950002, 2079976, 2213710, 2213729, 2215039, 2215047, 2215055, 2216531	Y
		Budesonide	R03BA02	2229099, 1978918, 1978926, 852074, 851752, 851760	Y
		Fluticasone	R03BA05	2237247, 2237246, 2237245, 2237244, 2244293, 2244292, 2244291, 2174731, 2174758, 2174766, 2174774, 2213583, 2213591, 2213605, 2213613	Y
		Ciclesonide	R03BA08	2285614, 2285606, 2303671	Y
Short-acting beta-agonists (SABA)	Reliever	Salbutamol	R03AC02	790419, 812463, 832758, 832766, 851841, 860808, 867179, 897345, 1926934, 1938851, 1938878, 1945203, 1947222, 1986864, 2022125, 2046741, 2048760, 2069571, 2084333, 2148617, 2154412, 2173360, 2208229, 2208237, 2208245, 2212315, 2212323, 2213400, 2213419, 2213427, 2213478, 2213486, 2214997, 2215004, 2215616, 2215624, 2215632, 2216949, 2231430, 2231488, 2231678, 2231783, 2231784, 2232570, 2232987, 2236931, 2236932, 2236933, 2239365, 2239366, 2241497, 2243115, 2243828, 2244914, 2245669, 2259583, 2326450	Y
			R03CC02	620955, 620963, 874086, 894249, 894257, 1932691, 2035421, 2063689, 2091186, 2146843, 2146851, 2164434, 2164442, 2165368, 2165376, 2212390, 2213435, 2213443, 2213451, 2261324	Y
		Terbutaline	R03AC03	786616	Y
		Orciprenaline	R03CB03	249920, 3891, 2236783, 2229862, 2152568, 2192675	Y
Long-acting beta-agonists (LABA)	Controller	Salmeterol	R03AC12	2211742, 2214261, 2231129, 2136139, 2136147	Y
		Formoterol	R03AC13	2230898, 2237224, 2237225	Y
ICS and LABA in combination (ICS+LABA)	Controller	Budesonide, formoterol	R03AK07	2245385, 2245386	Y
		Fluticasone, salmeterol	R03AK06	2240835, 2245126, 2245127, 2240836, 2240837	Y
Leukotriene receptor antagonists (LTRA)	Controller	Montelukast	R03DC03	2247997, 2238217, 2243602, 2238216	Y
		Zafirlukast	R03DC01	2236606	Y
Anti-immunoglobulin E	Controller	Omalizumab	R03DX05	2260565	Y

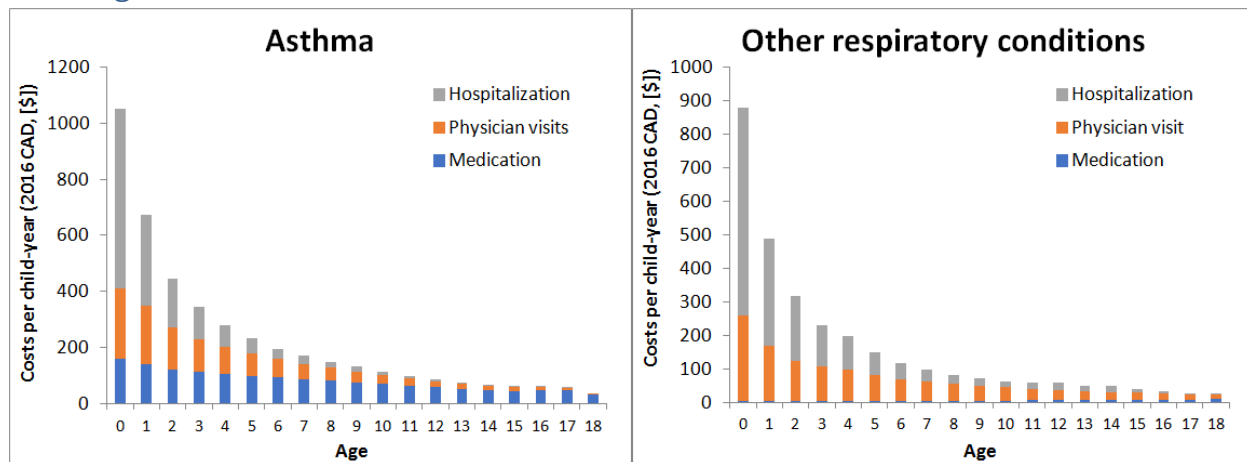
monoclonal antibody					
Inhaled mast cell stabilizers	Controller	Cromoglicic acid (cromolyn)	R03BC01	2231431, 2231671, 2046113, 534609, 555649, 261238, 638641, 2049082, 2219468	Y
Theophylline	Controller	Choline theophyllinate	R03DA02	346071, 405310, 441724, 441732, 451282, 458708, 458716, 476366, 476390, 476412, 503436, 511692, 536709, 565377, 589942, 589950, 792934	Y
		Theophylline	R03DA04	156701, 261203, 460982, 460990, 461008, 466409, 488070, 532223, 556742, 575151, 599905, 627410, 631698, 631701, 692689, 692697, 692700, 722065, 1926586, 1926594, 1926608, 1926616, 1926640, 1966219, 1966227, 1966235, 1966243, 1966251, 1966278, 1966286, 2014165, 2014181, 2230085, 2230086, 2230087	Y
		Aminophylline	R03DA05	14923, 178497, 497193, 497193, 497207, 582654, 582662, 868450, 2014270, 2014289	Y
Inhaled anticholinergics	Reliever	Ipratropium bromide	R01AX03	2246084, 2246083, 2163705, 2163713, 2240508, 2240072	N
			R03BB01	2126222, 2243827, 2231494, 731439, 576158, 2247686, 824216, 2026759, 1950681, 2239131, 2216221, 2210479, 2231785, 2236934, 2236935, 2237134, 2237135, 2239627, 2231135, 2231136, 2231245, 2231244, 2097141, 2097176, 2097168	N
		Ipratropium bromide, fenoterol	R03AK03	02148633	N
		Tiotropium bromide	R03BB04	02246793	N
Other beta-agonists	Reliever	Epinephrine	R03AA01	2017555, 466417, 525103, 1927582	N
		Ephedrine	R03CA02	2237085, 2229698, 2100231, 2100258, 2243148, 2236722, 2229678, 2219743, 2012111, 2229711, 38121, 2242961, 876534, 893323, 893331, 438847, 2242639, 2126419, 2126400	N
		Isoprenaline	R03AB02	2017652	N
		Orciprenaline	R03AB03	1923870, 1928449, 2017660, 254134, 3859	N
Other corticosteroids	Controller	Cortisone	H02AB10	280437, 16241, 16446, 16438	N
		Triamcinolone	H02AB08	2194090, 15016, 15024, 2194082	N
		Prednisone	H02AB07	610623, 598194, 550957, 312770, 252417, 210188, 868426, 868434, 868442, 21695, 232378, 607517, 508586, 156876, 271373, 271381	N
		Prednisolone	H02AB06	21679, 2230619, 2152541, 2245532	N
		Methylprednisolone	H02AB04	1934325, 1934333, 1934341, 30759, 30767, 36129, 30988, 2245406, 2245400, 2245408, 2245407, 2241229, 2231893, 2231894, 2231895, 2232750, 2232748, 2063727, 2063697, 2063719, 2063700, 36137,	N

				2230210, 2230211, 30678, 30651, 30643	
		Betamethasone	H02AB01	2237835, 36366, 2063190, 176834, 28096, 28185	N
		Hydrocortisone	H02AB09	888222, 888230, 888206, 888214, 30910, 30929, 872520, 872539, 878618, 878626, 30635, 30600, 30619, 30627	N
		Dexamathasone	H02AB02	2261081, 2250055, 213624, 16462, 354309, 716715, 874582, 1977547, 664227, 2204274, 2204266, 295094, 285471, 489158, 2239534, 732893, 732885, 2260301, 2237044, 2260298, 2237046, 2237045, 1946897, 1964976, 1964968, 1964070, 2279363, 783900, 751863, 2311267, 2240687, 2240685, 2240684	N
Other xanthines	Controller	Theophylline, combination	R03DA54	545090, 476374, 334510, 356123, 792942, 721301, 317225, 828718, 640093, 828726, 828742, 307548	N
Other anti-allergic agents	Anti-allergic	Levocabastine	R01AC02	2020017	N
		Ketotifen	R06AX17	2221330, 2176084, 2230730, 2218305, 2231680, 2231679, 600784, 577308	N

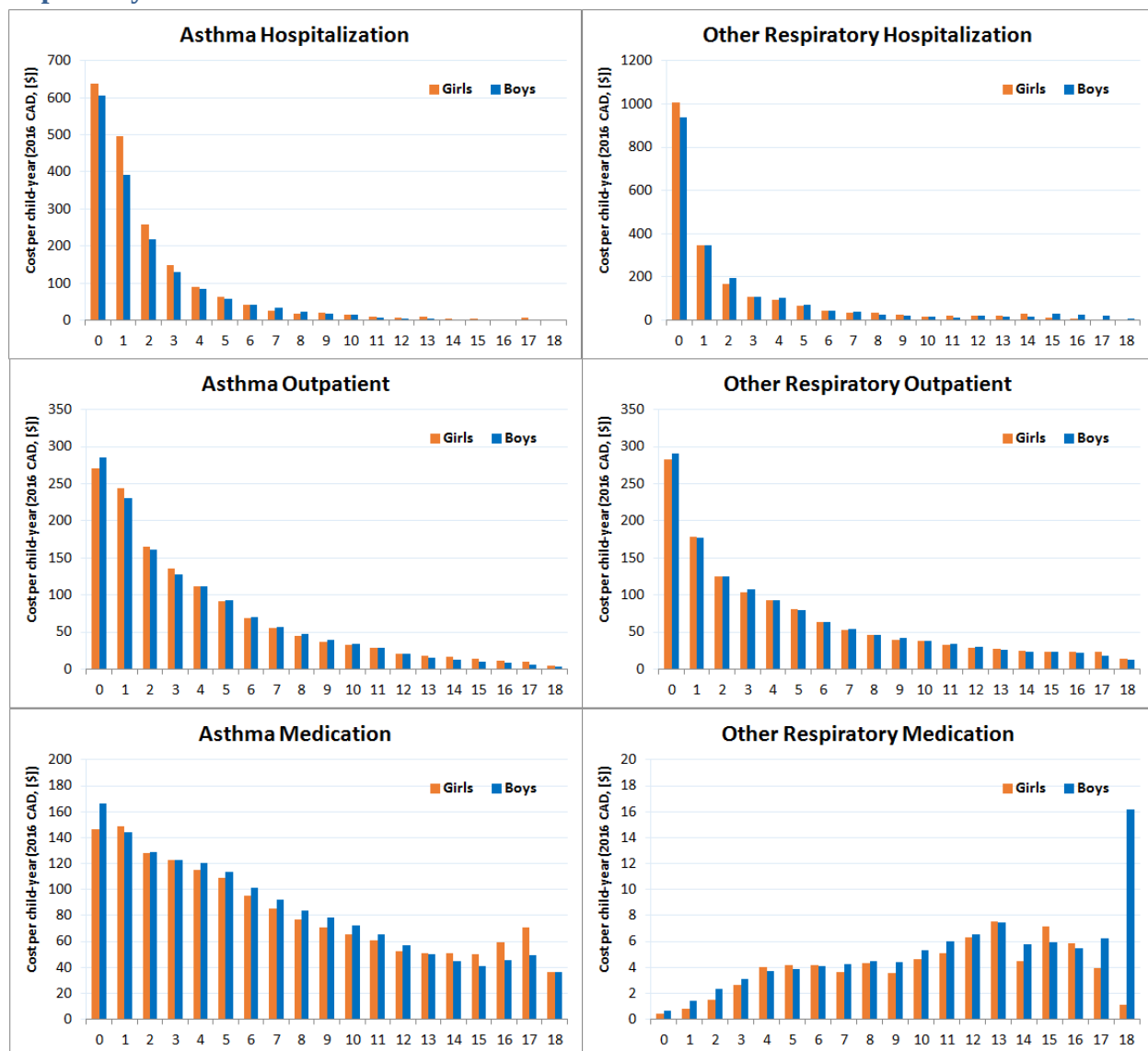
Appendix Figure E1. Schematic presentation of the study design



Appendix Figure E2. Age trends of direct medical costs of pediatric asthma patients, with wheezing-related healthcare encounters removed from asthma costs.

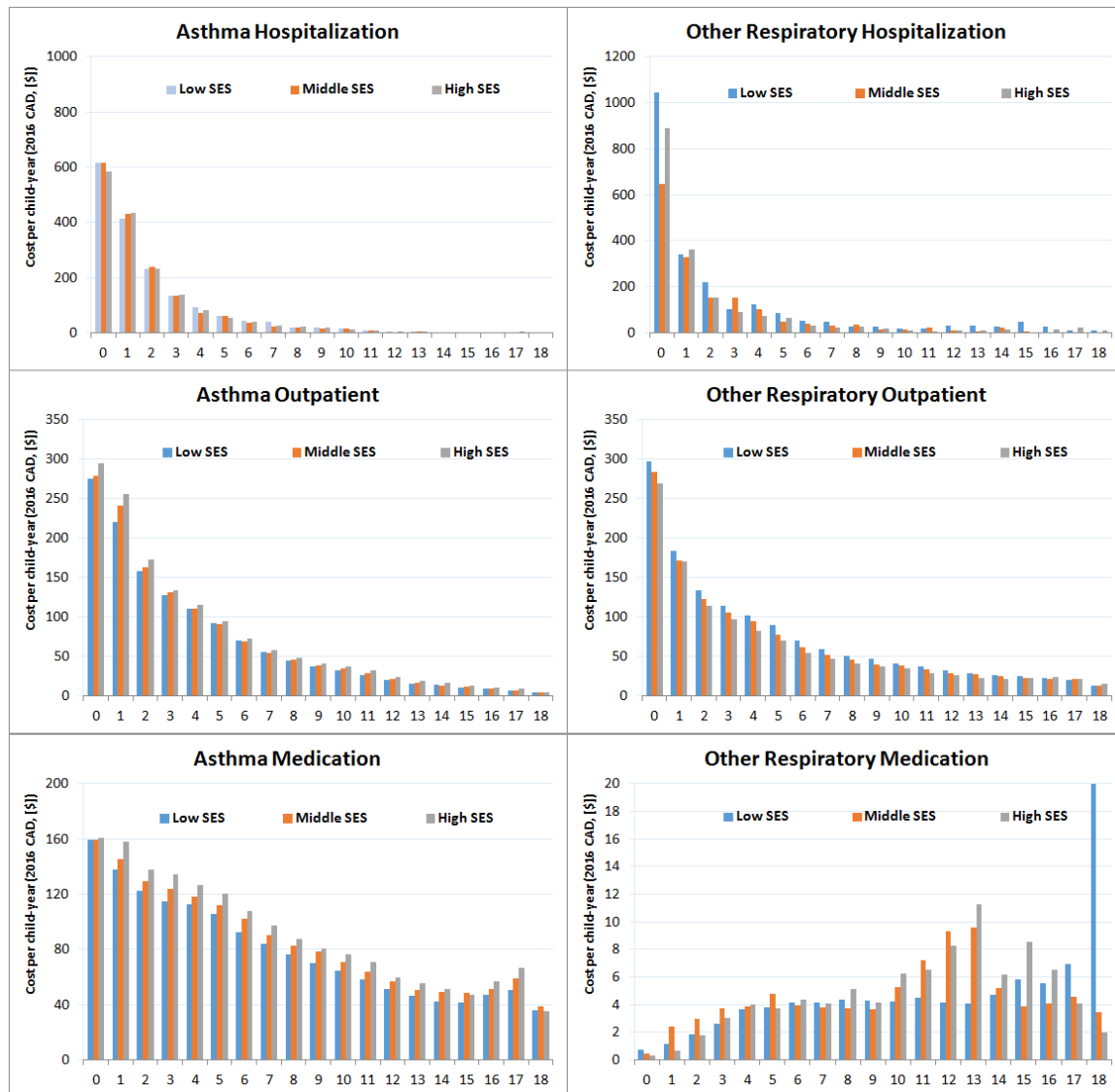


Appendix Figure E3. Age trends of pediatric asthma costs, by sex. Left panel, direct medical costs related to asthma. Right panel, direct medical costs related to other respiratory conditions.



Appendix Figure E4. Age trends of pediatric asthma costs, by socioeconomic status. Left panel, direct medical costs related to asthma. Right panel, direct medical costs related to other respiratory conditions.

Socioeconomic status (SES) was measured by the quintiles of median neighbourhood household income of each personal record, categorized into 3 levels: low [the lowest 2 quintiles], middle, high [the highest 2 quintiles].



References

1. Census: BC and Canada Population, 1871-2016 - BC Stats [Internet]. Available from: <http://www.bcstats.gov.bc.ca/StatisticsBySubject/Census/2016Census/PopulationHousing/BCCanada.aspx>. (Accessed: Jun 30, 2020).
2. British Columbia Ministry of Health [creator]. Consolidation File (MSP Registration & Premium Billing). Population Data BC[publisher]. Data Extract. MOH. 2018. Available at: <http://www.popdata.bc.ca/data>. (Accessed: Jun 30, 2020).
3. BC Vital Statistics Agency [creator]. Vital Statistics Deaths. Population Data BC [publisher]. Data Extract. BC Vital Statistics Agency. 2018. Available at: <http://www.popdata.bc.ca/data>. (Accessed: Jun 30, 2020).
4. Canadian Institute for Health Information [creator] (2011): Discharge Abstract Database (Hospital Separations). V2. Population Data BC [publisher]. Data Extract. MOH (2011). Available at: <http://www.popdata.bc.ca/data> (Accessed: Jun 30, 2020).
5. British Columbia Ministry of Health [creator]. Medical Services Plan (MSP) Payment Information File. Population Data BC [publisher]. Data Extract. MOH. 2018. Available at: <http://www.popdata.bc.ca/data>. (Accessed: Jun 30, 2020).
6. British Columbia Ministry of Health [creator]. PharmaNet. BC Ministry of Health [publisher]. Data Extract. Data Stewardship Committee. 2018. Available at: <http://www.popdata.bc.ca/data>. (Accessed: Jun 30, 2020).
7. (CIHI) CI for HI. CIHI Data Quality Study of the DAD 2009-2010 Discharge Abstract Database [Internet]. 2012. Available from: <https://secure.cihi.ca/estore/productFamily.htm?pf=PFC1762&lang=en&media=0>. (Accessed: Jun 30, 2020).
8. Williams JI, Young W. Inventory of studies on the accuracy of Canadian health administrative databases. Technical report. Institute for Clinical Evaluative Sciences, Ottawa, Canada; 1996.