



Developmental health of Canadian kindergarten children with teacher-reported asthma between 2010 and 2015: A population-level cross-sectional study

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ABSTRACT

Asthma can impact children's quality of life. It is unclear how asthma is associated with the developmental health (i.e. a broad range of skills and abilities associated with growth and development) of young children at school entry. The goals of this cross-sectional, population-level study were to: (1) investigate the association between teacher-reported asthma and children's concurrent indicators of developmental health (developmental vulnerability); and (2) explore whether school absences and functional impairments modified this association.

Participants were a Canadian population-based sample of 564 582 kindergarten children ($M_{age} = 5.71$ years, $SD = 0.32$, 51.3 % male) with data on the *Early Development Instrument* (EDI) collected between 2010 and 2015. Adjusted binary logistic regressions were conducted to address the objectives. From the sample, 958 (0.2 %) children were identified as having a diagnosis of asthma. These children were absent on average 9.4 days and 53.5 % had functional impairments (vs. 6.7 days absent and 15.9 % with functional impairments in children without asthma). After controlling for demographic characteristics, children with asthma had between 1.51 and 2.42 higher odds of being developmentally vulnerable. Only the presence of functional impairments modified this relationship and only for physical health and well-being. In this large, population-based sample of Canadian kindergarten children, few teachers reported knowledge of their students' asthma diagnosis. Among teacher-reported cases, asthma was a risk factor for developmental vulnerability in the domain of physical health and well-being only. Functional impairments may therefore be more detrimental for child development at school entry than asthma alone.

1. Introduction

Asthma is one of the most common chronic illnesses among Canadian children, estimated in 2011–2012, to affect over 3.8 million Canadians, with 6.2 % of children under 5 years of age having a diagnosis of asthma (Public Health Agency of Canada, 2018). The prevalence of asthma has been found to increase with age (Gershon et al., 2010) and is higher among children from lower socioeconomic status (SES) households (Kozyrskyj et al., 2010). Both individual and area-level SES factors are

significant contributors to children's asthma prevalence and severity (Bradley and Corwyn, 2002). The same SES characteristics are also associated with child development and learning (Bradley and Corwyn, 2002; Minh et al., 2017). Thus, SES is a meaningful and shared social determinant of health for both asthma (Cesaroni et al., 2003; Kozyrskyj et al., 2010) and developmental vulnerability (Bradley and Corwyn, 2002). Asthma has also been associated with aspects of children's development. In a study using data collected with the Australian Early Development Census (AEDC),¹ asthma in 5-year-old children was found

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¹ Abbreviations: AEDC: Australian Early Development Census; EDI: Early Development Instrument; CCHICS: Canadian Children's Health in Context Study; Can-NECD: Canadian Neighbourhoods and Early Child Development.

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to be associated with an increased likelihood of being vulnerable in several socioemotional areas, including emotional maturity, hyperactivity and inattentive behaviors, and social competence (Laurens et al., 2019). Common asthma symptoms (e.g., persistent difficulty breathing, wheezing) have also been associated with increased feelings of exclusion at school (Teyhan et al., 2015). In addition, children with asthma have been shown to struggle with more mental health-related issues than those without asthma, including anxiety, depression, and suicidal ideation/attempts (Kewalramani et al., 2008).

Asthma has also been associated with aspects of academic achievement, as children with asthma display lower scores on standardized math and reading tests (Kohen, 2010), and are more likely to be in the lowest quartiles for reading achievement (Liberty et al., 2010) compared to their peers without asthma. Experiencing symptoms of asthma also leads children to feel unwell, which in turn, can make them unable to perform their usual activities at school or within the community (Asher and Pearce, 2014). Asthma is often reported as being one of the leading causes of school absenteeism in Canada (Canadian Institute for Health Information, 2001; Kohen, 2010), with some suggesting that absenteeism at least partially mediates the link between asthma and academic under-performance (Moonie et al., 2008). Yet, others suggest that poorer academic outcomes are not mediated by school absence (Kohen, 2010). This association is complicated by factors such as lower SES, more frequent symptoms, greater impairment in functioning in the classroom (physical and behavioral), as well as more severe forms of asthma requiring the use of prescription medications, have also been linked to increased school absenteeism (Meng et al., 2012).

1.1. Current study

As early childhood lays the foundations for future development (Hertzman and Boyce, 2010), it is important to determine whether having an asthma diagnosis prior to school entry is associated with the developmental health² of young Canadian children starting school. Evidence of an association could be used to alert teachers to potential risks of having asthma and mitigate those risks by improving the availability of programs and services to help children with asthma and set them on a better developmental and learning trajectory. To address this gap in the literature, we used data collected with the Early Development Instrument (EDI) as part of the Canadian Children's Health in Context Study (CCHICS). CCHICS is a large population-level study of the developmental health of Canadian kindergarten children with health disorders (Janus et al., 2018a,b), in which teachers rated child development and reported on a number of existing child diagnoses as informed by parent/caregivers. Accordingly, the aims of the present study were to: (1) investigate the association between teacher-reported asthma and children's concurrent indicators of developmental health (i.e. developmental vulnerability); and (2) explore whether this association is modified by school absences and impairments observed in functioning in the classroom environment. We hypothesized that children with a teacher-reported diagnosis of asthma would have poorer developmental health in kindergarten, compared to their counterparts without asthma. We also anticipated school absences and impairments in functioning to modify this association.

2. Materials and methods

2.1. Study design and population

The CCHICS (Janus et al., 2018a,b) is a cross-sectional, population-

² *Developmental health* is a holistic term defined by Keating and Hertzman (1999) and represents children's development in a global sense. It refers to a range of skills and abilities associated with children's growth and development, from physical and mental health to cognitive and academic skills.

level study of kindergarten children that was conducted in Canada between 2010 and 2015. The study population consisted of 603 904 kindergarten children who attended publicly-funded schools between the 2009/10 and 2014/15 school years from most Canadian provinces and territories. Data were collected through the EDI, a teacher-completed standardized questionnaire of children's ability to meet age-appropriate developmental expectations (Janus and Offord, 2007). The pattern of data collection was dictated by the governments of each province or territory, resulting in different jurisdictions collecting in different years (see (Janus et al., 2018a,b) for details). Only three provinces/territories did not have data in the study time frame (New Brunswick, Prince Edward Island and Nunavut) and they include only 2.4 % of the total population of young children in Canada (Government of Canada, 2022). Children were included in the study if they: (1) were enrolled in senior kindergarten (or the provincial/territorial equivalent); (2) were in the classroom for more than one month; and (3) had no more than 25 % of missing items on the EDI. As a result, 27 640 (4.6 %) records were excluded from analysis. Of the remaining 576 264 records, an additional 11 682 (2.0 %)³ were removed due to missing data on any of the variables of interest, resulting in a final analytic sample of 564 582 children (93.5 % of the original study population). In Canada, senior kindergarten is the grade children start the year they turn 5 years of age, before entry to Grade 1 at six. Over 90 % of Canadian children attend publicly-funded schools (91.8 % in 2018/19) (Government of Canada, 2020). CCHICS has been approved by the Hamilton Integrated Research Ethics Board.

2.2. Measures

The primary exposure variable was a teacher-reported diagnosis of asthma, based on parent/caregiver information. This was determined by teachers' answer to the following statement: "If the child has received a diagnosis or identification by a doctor or psychological professional, please indicate using the codes below"; with asthma included among the codes.

The primary outcome in this study was *developmental vulnerability* (i.e., vulnerability in one or more domains of development). Secondary outcomes included indicators of vulnerability for each of the five developmental domains of the EDI (i.e., physical health/well-being, social competence, emotional maturity, language/cognitive development, communication skills/general knowledge).

2.2.1. Early Development Instrument

Data on children's developmental health in kindergarten were collected with the EDI (Janus and Offord, 2007), a 103-item, teacher-completed checklist. The EDI has been administered at the population level at least once in all but one Canadian province and territory since 2004. The EDI is completed by teachers for children aged 4–6 years in the second half of the kindergarten school year and covers five different domains of development: physical health and well-being, social competence, emotional maturity, language and cognitive development, and communication skills and general knowledge. The domain scores are calculated based on the mean of the items contributing to each domain, measured on a continuous scale, from 0 to 10, where a higher score indicates greater ability (Janus and Offord, 2007). Children whose score in a given domain is equal to or lower than the 10th percentile are deemed to be vulnerable in that area. The cut-off scores for the 10th percentile have been determined using national EDI data (Janus et al., 2018a,b). The teacher-completed EDI has been validated with parent reports and other established instruments (Janus and Offord, 2007). Further psychometric properties and validity of the EDI have been reported in many studies (Janus and Offord, 2007; Janus and Reid-

³ Based on Little's MCAR test, the data were not missing at random. The percentage of missing data per variable was below 0.7%.

Westoby, 2016), as well as associations with other developmental outcomes for both typically-developing children (Forer and Zumbo, 2011) and for children with special needs (Janus et al., 2018a).

The EDI includes demographic questions including: age at the time of EDI completion; sex at birth; first language; whether they have English or French as a second language (E/FSL, an indicator of a child’s level of fluency in the school’s language of instruction); and whether they have been identified as having a special need (school-based designation identifying children who require additional assistance in the classroom). Teachers also report on the child’s classroom attendance. A separate question asks whether or not the child has one or more of the following functional impairments that may impact their ability to participate in classroom activities: physical, vision, hearing, speech, learning disability, emotional problem, behavioral problem, and other (Janus et al., 2018a,b). The functional impairments questions were included on the EDI as children’s special needs are often not diagnosed by the time a child enters school and they carry more relevance to the classroom environment than diagnostic information (Jessop and Stein, 1993). Previous research has indicated that children with specific impairments were more likely to have poorer developmental ratings in the domain associated with their impairment (Janus, 2011).

2.2.2. Neighborhood-level SES

Neighborhood-level SES was derived using variables from the 2010 Taxfiler databases and the 2011 National Household Survey, which are national Canadian surveys collected through Statistics Canada (Guhn et al., 2016). Ten socioeconomic variables⁴ were identified and used to create an SES index for 2058 custom-defined neighborhoods across the country. This neighborhood-level SES index includes variables related to household income, education, mobility, immigration, single parenthood, and first language (Forer et al., 2019). The SES index variables were transformed into z scores (i.e., mean of 0, SD of 1) in order to ensure all variables were on the same metric and weighted equally when combined to create the overall index. The neighborhood SES index was then merged with the EDI dataset using children’s residential postal codes with a 99.3 % match rate. *Analytic plan.*

Descriptive statistics were examined to compare children with and without diagnoses of asthma, including demographic characteristics, the number of school absences, and presence/absence of functional impairments. The chi-square and one-way analysis of variance (ANOVA) statistics, as well as effect sizes (Cramer’s V and Eta) were reported for all descriptive analyses. To examine the association between the presence of an asthma diagnosis and kindergarten children’s developmental health, multiple binary logistic regression analyses were conducted in four steps: (1) unadjusted models examining the association between asthma and developmental vulnerability; (2) the same models, controlling for demographic variables (child’s sex, age, E/FSL, special needs, the SES of the neighbourhood where they live); (3) adding teacher-reported classroom absences (“days absent”) to the model; and (4) adding the presence of any functional impairment to the model. Based on the results of model 4, we examined the role of child’s functional impairment as a potential effect modifier and repeated the 3rd model, stratifying by presence or absence of at least one impairment. The level of statistical significance was adjusted using a Bonferroni correction to

⁴ The variables included in the CanNECD SES index are: percent separated or divorced individuals; percent with incomes twice or higher than the provincial median, families with children under 6; percent low income measure, lone parent families with children under 6; percent of those 25 to 64 with no high school diploma; percent with deducting due, families with children under 6; percent whose home language is a non-official language; percent of families declaring charitable donations, families with children under 6; percent of individuals, non-migrant movers in the past year; percent of families with investment income or capital gains, families with children under 6; GINI coefficient quintiles, lone female parents with children under 6.

account for multiple hypothesis testing and set at $p = 0.001$. The statistical software IBM SPSS Statistics (version 26) (IBM Corp., 2021) was used for all analyses.

3. Results

3.1. Demographics

Of the 564 582 children included in the study, 958 (0.2 %) were identified as having a teacher-reported diagnosis of asthma, 87.3 % of whom had no other reported health diagnoses (from a list of 30). The demographic characteristics of children with and without a teacher-reported diagnosis of asthma are presented in Table 1. Compared to their peers without asthma, children with a teacher-reported diagnosis of asthma were more likely to be male (68.2 % vs 51.2 %), have a special needs designation (19.0 % vs 3.6 %), and have a functional impairment (all differences significant at $p < 0.001$, Cramer’s $V \leq 0.042$, see Table 1). Children with asthma were similar to their peers in age (5.70 vs 5.71 years). There was a minimal (Cramer’s $V = 0.007$), statistically significant difference in neighborhood-level SES, with children with an asthma diagnosis more likely to live in neighborhoods with lower SES. Children with a diagnosis of asthma were absent from school more often than their peers ($p < 0.001$) and were more likely to be vulnerable on any developmental domain than their peers without a diagnosis (see Table 1).

Table 1
Demographic characteristics, developmental vulnerability, and functional impairments of Canadian children with and without a teacher-reported diagnosis of asthma between 2010 and 2015.

Percentage	Asthma diagnosis		χ^2	Cramer’s V	p
	Present (n = 958)	Absent (n = 624)			
Male	68.2	51.2	109.79	0.014	<0.001
Special needs	19.0	3.6	660.57	0.034	<0.001
E/FSL	9.7	13.1	9.54	0.004	0.002
Vulnerability					
1 or more domain	55.9	28.8	342.90	0.025	<0.001
Physical health & well-being	34.1	12.6	404.46	0.027	<0.001
Social competence	25.5	11.3	190.82	0.018	<0.001
Emotional maturity	28.1	13.3	179.88	0.018	<0.001
Language and cognitive development	20.8	8.7	174.05	0.018	<0.001
Communication and general knowledge	32.7	13.4	303.38	0.023	<0.001
Functional impairment	53.5	15.9	1009.03	0.042	<0.001
Speech	29.9	6.9	776.71	0.037	<0.001
Behavior	16.0	5.7	186.97	0.018	<0.001
Learning	13.5	4.0	226.39	0.020	<0.001
Emotional	11.2	3.8	143.19	0.016	<0.001
Physical	9.1	1.2	483.97	0.029	<0.001
Visual	3.8	0.8	107.19	0.014	<0.001
Hearing	3.4	0.7	93.28	0.013	<0.001
Other	14.0	3.2	364.99	0.025	<0.001
Mean (SD)			F	Eta	p
Age in years	5.70 (0.34)	5.71 (0.32)	2.38	0.002	0.123
Neighborhood-level SES, z-score	-0.05 (0.97)	0.12 (1.03)	26.85	0.007	<0.001
Days absent from the classroom	9.44 (10.49)	6.72 (7.83)	115.03	0.014	<0.001

Abbreviations: E/FSL, English/French as a second language; SD, standard deviation; SES, socioeconomic status.

Note. Significance level after Bonferroni correction: $p \leq 0.001$

3.2. Association between an asthma diagnosis and children's developmental health

Results of the primary unadjusted binary logistic regressions can be found in the first column of Table 2. Teacher-reported diagnosis of asthma was associated with higher odds of being vulnerable overall and in each of the domains. Controlling for demographic variables (age, sex at birth, special needs, E/FSL, and neighborhood-level SES, see column 2 of Table 2), results also demonstrated an association between a teacher-reported diagnosis of asthma and children's developmental vulnerability. In this model, children with a diagnosis of asthma had 1.51 to 2.42 times higher odds of being vulnerable on the EDI ($p < 0.001$). The adjusted odds ratios, with the addition of school absence to the model, are listed in column 3 of Table 2, and show the same results: children with asthma had greater odds of being vulnerable overall and in each of the developmental domains than those without asthma, with only slightly diminished odds ratios (1.45 to 2.23 in individual domains).

Finally, the results of the binary logistic regression models, adjusting for the same variables as above and adding the presence of a functional impairment, are shown in column 4 of Table 2 and indicate a shift in the pattern observed thus far. Except for the physical health and well-being domain, a teacher-reported diagnosis of asthma was not associated with being vulnerable overall or in the remaining four developmental domains.

To further understand the nature of the relationship between asthma and functional impairment in our sample, we repeated the model that controlled for sociodemographic variables and days absent, stratifying the sample by presence of functional impairments (see Table 3). Among children without functional impairments, teacher-reported asthma remained significantly associated with overall vulnerability and with vulnerability in physical health and well-being. Among children with functional impairment, asthma was not a significant risk factor for developmental vulnerability.

Table 2

Binary logistic regression models examining the association between a teacher-reported diagnosis of asthma and Canadian kindergarten children's developmental vulnerability from 2010 to 2015 (N = 564 582).

Vulnerability	1 UOR (95 % CI) p	2 AOR (95 % CI) ^a p	3 AOR (95 % CI) ^b p	4 AOR (95 % CI) ^c p
1 or more domain	3.14 (2.76–3.57) < 0.001	2.32 (2.01–2.66) < 0.001	2.15 (1.87–2.48) < 0.001	1.22 (1.04–1.42) 0.016
Physical health & well-being	3.61 (3.16–4.12) < 0.001	2.42 (2.09–2.81) < 0.001	2.23 (1.93–2.59) < 0.001	1.50 (1.29–1.74) < 0.001
Social competence	2.68 (2.32–3.10) < 0.001	1.55 (1.31–1.82) < 0.001	1.46 (1.24–1.72) < 0.001	0.88 (0.75–1.04) 0.143
Emotional maturity	2.54 (2.21–2.92) < 0.001	1.51 (1.29–1.77) < 0.001	1.45 (1.24–1.69) < 0.001	0.86 (0.73–1.01) 0.072
Language and cognitive development	2.74 (2.35–3.21) < 0.001	1.68 (1.42–2.00) < 0.001	1.57 (1.32–1.87) < 0.001	1.02 (0.85–1.21) 0.869
Communication and general knowledge	3.13 (2.73–3.58) < 0.001	2.21 (1.88–2.58) < 0.001	2.06 (1.76–2.41) < 0.001	1.20 (1.02–1.42) 0.026

Abbreviations: UOR, unadjusted odds ratio; AOR, adjusted odds ratio; CI, confidence interval.

Note. Significance level after Bonferroni correction: $p \leq 0.001$.

^a Controlled for children's sex at birth, age, E/FSL, SN status, and neighborhood SES.

^b Controlled for children's sex at birth, age, E/FSL, SN status, neighborhood SES, and days absent.

^c Controlled for children's sex at birth, age, E/FSL, SN status, neighborhood SES, days absent, and any functional impairment.

Table 3

Binary logistic regression models stratified by the presence of a functional impairment examining the association between teacher-reported diagnosis of asthma and Canadian kindergarten children's developmental vulnerability from 2010 to 2015 (n = 564 582).

Vulnerability	Any Functional Impairment		p	p value	p
	Absent ^a (n = 474 374) AOR (95 % CI)	Present ^b (n = 90 208) AOR (95 % CI)			
1 or more domain	1.54 (1.25–1.90)	2.01 (1.56–2.58)	<0.001	0.95 (0.77–1.18)	0.651
Physical health & well-being	2.01 (1.56–2.58)	1.01 (0.71–1.43)	<0.001	1.31 (1.09–1.57)	0.003
Social competence	1.01 (0.71–1.43)	1.19 (0.88–1.61)	0.975	0.87 (0.72–1.04)	0.137
Emotional maturity	1.19 (0.88–1.61)	1.29 (0.90–1.85)	0.248	0.79 (0.66–0.95)	0.011
Language and cognitive development	1.29 (0.90–1.85)	1.03 (0.72–1.46)	0.166	0.98 (0.81–1.19)	0.826
Communication and general knowledge	1.03 (0.72–1.46)	1.26 (1.05–1.52)	0.883	1.26 (1.05–1.52)	0.012

Abbreviations AOR, adjusted odds ratio; CI, confidence interval.

Controlled for children's sex at birth, age, E/FSL, SN status, neighborhood SES, and days absent.

Note. Significance level after Bonferroni correction: $p \leq 0.001$.

^a Number of children with asthma = 446 (0.094 %).

^b Number of children with asthma = 512 (0.567 %).

4. Discussion

The primary aim of this study was to investigate associations between teacher-reported asthma and indices of developmental health in a population-level study of Canadian kindergarten children. A diagnosis of asthma was reported by teachers for 0.2 % of the population of 5- and 6-year-olds, suggesting a possible teacher awareness of only quite severe cases. Similar rates of severe asthma in children have been reported previously (Nordlund et al., 2014). Children with severe asthma tend to show symptoms in the first three years of life, compared to their peers with mild-to-moderate asthma (Guilbert et al., 2014). It has been suggested that severe asthma can be categorized into 2 distinct groups: difficult-to-treat and therapy-resistant (Guilbert et al., 2014). Difficult-to-treat asthma includes poorly controlled cases, which can result from an improper diagnosis, comorbidities, or poor adherence. It is possible that the prevalence of teacher-reported asthma in this study is suggestive of more difficult-to-treat cases (Centers for Disease Control and Prevention, 2022). As a group, children with a teacher-reported diagnosis of asthma were more likely to be male, have special educational needs and functional impairments, and reside in neighborhoods with lower socioeconomic indicators than children without a teacher-reported diagnosis of asthma. All these factors could be associated with severe and/or uncontrolled asthma. Children with a teacher-reported diagnosis of asthma missed 3 more days of school on average than their counterparts without asthma. They were also more likely to be vulnerable in at least one area of their development. This supports previous findings (American Lung Association, 2020; Fuhlbrigge et al., 2002).

When controlling for demographics and school absence, we found that children with teacher-reported asthma had greater odds of being vulnerable in all five areas of development than their peers without asthma. These findings are in line with existing studies, which are quite sparse for the population of children before school entry. Children with asthma had more internalizing behaviors and showed more aggressive behavior when coping with issues with schoolwork than their peers without asthma (Röder et al., 2003; Collins et al., 2008). Physical limitations contributed to lower school readiness scores in children with asthma (Halterman et al., 2001). Previous research has also found that

children with asthma had lower social competence skills than their peers without asthma, but that this difference tended to decrease as children got older (Klennert et al., 2000).

We expected that children with a teacher-reported diagnosis of asthma would miss more days of school than those without, and that the absence would contribute to the association between asthma and children's developmental health. We found only partial support for these assertions. Children with asthma were found to be absent more often than their peers without asthma, which is consistent with previous research (Röder et al., 2003). However, school absence did not significantly modulate the magnitude of the association between asthma and children's developmental vulnerability. An earlier study found that school absenteeism in children with asthma impacted school performance only for those with persistent asthma (Moonie et al., 2008). Given these findings, and generally limited existing evidence on the association between absenteeism and children's developmental outcomes, future research should explore this further, incorporating contextual information on the reason for missing school. The addition of functional impairments to the binary logistic regression model, on the other hand, diminished the strength of the association between asthma and children's vulnerability in all domains, except for physical health and well-being. At first glance, this suggests that how well children function within the classroom, rather than a specific disorder diagnosis, is a stronger contributor to their developmental status. However, when we stratified the analyses by the presence of functional impairments, we found that the teacher-reported diagnosis of asthma was only significantly associated with children's overall and physical well-being vulnerability among children who had no functional impairments. No such association was observed among children with functional impairments suggesting that functional impairments may have such a large impact on developmental vulnerability that a diagnosis of asthma is not related to children's concurrent developmental health.

It is important to interpret this finding in the context of a high level of comorbidity between asthma and functional impairments. A total of 54 % of the children with a teacher-reported diagnosis of asthma were reported to have an impairment by their teacher in comparison to only 16 % of those without asthma. Children with asthma have a greater likelihood of having a comorbidity compared to those without (26 % vs 9 %) (Grupp-Phelan et al., 2001), and higher levels of attention-deficit/hyperactivity disorder, depression, behavioral disorders, and learning disabilities, with more severe cases having higher rates of comorbidities (Blackman and Gurka, 2007; Public Health Agency of Canada; Rusconi et al., 2018). Children with symptomatic asthma have also been found to have increased odds of mental health and neurological problems (Halterman et al., 2001) with one study finding that emotional and behavioral symptoms predicted quality of life in children and adolescents with asthma, rather than disease severity (Goldbeck et al., 2007). In this regard, our findings suggesting that for children with non-asthma related functional impairments, asthma is not a risk factor for developmental vulnerability, can be interpreted as corroborating this existing literature.

4.1. Strengths and limitations

This study was the first investigation at a population (near-national) level of the associations between teacher-reported asthma diagnosis and indices of concurrent kindergarten developmental health status. As such, our results represent a *real world* (vs. clinic-based) perspective of the association between an asthma diagnosis and child development. Although this is a strength, there are some limitations that should be noted. First, it would have been of interest to assess additional relevant contextual information, including environmental factors in children's home or neighborhood (e.g., presence of second-hand smoke in the household, pollutants in the air), whether children were taking medication for their asthma, and family-level socioeconomic data. The lack of these variables in the present study that allowed for broad coverage

represents an unavoidable compromise. Second, based on Little's MCAR test of missing data, the data were not missing at random. Since the percentage of missing values for a given variable was below 0.7 %, the decision was made to use the data as is. We therefore performed the analyses by excluding the missing data and recognize this is a limitation of the study. Lastly, given that teachers were reporting on cases of asthma based on student records, it is possible that, one, associations may be inflated due to teacher reporting on both exposure and outcome, and two, the cases captured by the EDI are the more severe cases as teacher knowledge of the illness would require parents to inform the school of their child's diagnosis. It is also probable that parents of children with milder cases of asthma may not feel the need to inform their child's teacher. Previous research has suggested that the majority of asthma cases in children are mild or moderate (Asher and Pearce, 2014) and that the percentage of children with severe asthma is quite low (Rusconi et al., 2018). The low prevalence of teacher-reported asthma suggests that more research using linked databases is needed to ascertain whether teachers are only aware of severe cases of asthma.

5. Conclusion

In this population-level study of Canadian kindergarten children, we found that children with a teacher-reported diagnosis of asthma were more likely to be vulnerable in their development in the physical health and well-being domain only. Our findings suggest that, when functional impairments are considered, asthma is a risk factor for only one domain of development, that of physical health and well-being. Having asthma, as reported by teachers, did not increase children's odds of being vulnerable in any other area of their development when functional impairments were included in the model. Functional impairments may therefore be more detrimental for child development than asthma alone, at least at school entry.

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CRedit authorship contribution statement

Magdalena Janus: . **Caroline Reid-Westoby:** Investigation, Writing – original draft, Writing – review & editing. **Molly Pottruff:** Formal analysis, Writing – original draft, Writing – review & editing. **Michelle Schneeweiss:** Writing – original draft. **George Hu:** Writing – original draft. **Marni Brownell:** Conceptualization, Funding acquisition, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Magdalena Janus and Marni Brownell report financial support was provided by Canadian Institutes of Health Research. Magdalena Janus and Marni Brownell report a relationship with Canadian Institutes of Health Research that includes: funding grants. There are no other conflicts of interest to report.

Data availability

Data will be made available on request.

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