

Original Article

Prevalence of Physician-Reported Food Allergy in Canadian Children

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What is already known about the topic? Self-reported prevalence of food allergy in Canada is approximately 8%, but physician-reported prevalence rates have never been documented.

What does this article add to our knowledge? Physician-reported prevalence of pediatric food allergy in Canada is 2.53%. Children with food allergy were more likely to be atopic, less likely to be obese, and more likely to have a psychiatric comorbidity.

How does this study impact current management guidelines? Physician-reported prevalence rates are lower than self-report rates. Further studies into the association of food allergy and psychiatric comorbidities are necessary.

BACKGROUND: Food allergy prevalence data have largely been derived from self-report, and estimates vary.

OBJECTIVE: Determine the prevalence of physician-reported food allergy in children using electronic medical record data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN).

METHODS: This was a retrospective cohort study using the CPCSSN repository, Canada's only primary care practice-based surveillance system. Machine learning algorithms were applied to assess for food allergy documentation. Demographic information, chronic diseases of interest, prescribed medications, and health behaviors from the CPCSSN repository were identified.

RESULTS: The prevalence of physician-reported food allergy in Canadian children was 2.53% (95% CI, 2.48%-2.59%). The most common food allergies documented were peanut (0.8% of children), tree nut (0.6%), cow's milk (0.4%), egg (0.3%), fruit (0.2%), finned fish (0.2%), and shellfish (0.2%). Among children with food allergy, only 33.7% had an epinephrine autoinjector prescription. In logistic regression analysis, children with food allergy were more likely to have an atopic comorbidity (odds ratio [OR], 2.20; 95% CI, 2.06-2.35) and less likely to be obese than children without food allergies (OR, 0.84; 95% CI, 0.78-0.90). In the age- and sex-adjusted models, patients with food allergy were significantly more likely to have a psychiatric morbidity, specifically: attention deficit/hyperactivity disorder (OR, 1.81; 95% CI, 1.66-1.96), autism (OR, 1.89; 95% CI, 1.63-2.19), and depression (OR, 1.17; 95% CI, 1.02-1.35).

CONCLUSIONS: Our study is the first to estimate national physician-reported prevalence of food allergy, and demonstrates a lower rate than that based on self-report. Further studies into the association of food allergy and psychiatric comorbidities (attention deficit/hyperactivity disorder, autism, depression) and the association of food allergy and obesity are needed. © 2020 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2020;■:■-■)

Key words: Food allergy; Prevalence; Obesity; Atopy; Autism; Depression

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INTRODUCTION

Although food allergy is known to be common,¹ and potentially increasing over time,² prevalence varies significantly between studies.¹ Much of the prevalence estimates thus far are derived exclusively from self-report, such as in Canada, where the self-reported prevalence of food allergy in children has been estimated to be 9.3% (up from 7.1% in 2010).^{3,4} Among different food allergens, there is significant variability in

Abbreviations used

ADHD- Attention deficit/hyperactivity disorder

BMI- Body mass index

EMR- Electronic medical record

ICD-9-CM- International Classification of Diseases, Ninth
Revision, Clinical Modification

OR- odds ratio

prevalence estimates although in general, cow's milk, egg, and nuts (peanut and tree nuts) account for most food allergies in children.⁵

Some studies have suggested that the prevalence of food allergy based on self-report is higher than the true prevalence of food allergy based on physician diagnosis. For example, a population-based cohort study of 3623 children reported that up to 35% of parents perceived food allergies in their children.⁶ In Canada, although most patients with a self-reported food allergy noted they had testing performed, most of their physicians did not provide test results.⁷ As a result, there remains a gap in the prevalence literature from the perspective of physician reporting. Our study is the first in North America aiming to determine the prevalence of physician-reported food allergy in children using electronic medical record (EMR) data from providers participating in the Canadian Primary Care Sentinel Surveillance Network (CPCSSN).

METHODS

We conducted a retrospective cohort study using primary care EMR data from the CPCSSN repository, Canada's only primary care practice-based multidisease sentinel surveillance system. CPCSSN extracts, deidentifies, and processes EMR-derived information from 1183 primary care providers in 8 provinces and 1 territory in Canada. This study included demographic information of the patient and the provider (sex, age, postal code), patient biometric data (body mass index [BMI]-to-age percentile), chronic diseases of interest (pediatric asthma, eczema, rhinitis, autism, attention deficit/hyperactivity disorder [ADHD], depression), specific prescribed medications, and health behaviors (visit frequency) from the CPCSSN repository. This study obtained approval from the Health Research Ethics Board at the University of Manitoba (HS21787(H2018:189)).

Study population

We identified pediatric patients (age ≤ 19 years) from the CPCSSN repository with 1 or more appointment with a provider participating in CPCSSN. Patients were considered only if they had at least 1 encounter with a CPCSSN provider between January 1, 2015, and December 31, 2018. The CPCSSN repository contains multiple tables of deidentified information extracted from the EMR. Unlike billing and health condition (problem list) tables, the allergy tables derived from EMR data do not contain diagnostic codes (ie, SNOMED, *International Classification of Diseases, Ninth Revision*/ *International Classification of Diseases, Tenth Revision*, or ICD-10). Therefore, we developed and applied machine learning algorithms to assess semi-structured text in the allergy table of the CPCSSN data repository for documentation of a food allergy. A subsample of the semi-structured text in the allergy table was reviewed and categorized by 2 researchers (N.N. and R.P.), and any disagreement in coding was adjudicated by the supervising clinician scientist (A.S.). An

algorithm was developed to expand this categorization to the entire CPCSSN network. A manual validation was performed to compare the categorization from the developed algorithm to the chart review. We used the chart review to further categorize any records that were not categorized because of spelling errors, abbreviations, or similar but different terminology. This process was continued until all food allergy records were categorized. Among patients with a food allergy, an algorithm was applied to categorize potential food allergens into 11 types: peanut, tree nut, cow's milk, egg, fruit, finned fish, shellfish, soy, gluten/wheat, sesame, other. [Appendix A](#) (available in this article's Online Repository at www.jaci-inpractice.org) outlines terms that were categorized into each type of food allergy. Patients may have had more than 1 type of food allergy recorded.

Covariates

Patient age was calculated at the index date of December 31, 2018. The US Centers for Disease Control and Prevention's Growth Charts were used to calculate the BMI-to-age percentile for each patient at the date of the examination record and define normal (BMI %tile, $\leq 85\%$), at risk for being overweight (BMI %tile, $>85\%$ – $\leq 97\%$), and overweight (BMI %tile, $>97\%$) BMI percentiles.⁸ The BMI percentile closest to the allergy date was used in the analyses. Previously validated case definitions were applied to assess the prevalence of pediatric asthma and depression.⁹ Pediatric asthma was indicated by the presence of an *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) code starting with 493 or semi-structured text indicating asthma in the billing, encounter diagnosis or health condition tables in the EMR, or at least 2 prescriptions for asthma-specific medications identified using Anatomical Therapeutic Chemical classification system codes.¹⁰ The health condition table in CPCSSN captures diagnoses entered by the primary care provider to track a patient's health and is sometimes referred to as a "problem list" or cumulative patient profile, whereas the billing or encounter tables capture diagnoses typically entered for the purpose of remuneration at the time of a visit. Several conditions of interest were also included although formal validation studies have not been conducted to assess the sensitivity and specificity of these definitions. Conditions of interest included eczema (ICD-9-CM starting with 691, 692), rhinitis (ICD-9-CM starting with 477, 472), autism (ICD-9-CM starting with 299), ADHD (ICD-9-CM starting with 314), and anxiety (ICD-9-CM starting with 300). To indicate the presence of a diagnosed condition of interest, we required 2 *International Classification of Diseases, Ninth Revision* codes from the encounter diagnosis or billing table or 1 ICD-9-CM code from the health conditions table. Anatomical Therapeutic Chemical classification system codes from the medication table were used to indicate a prescription for an eczema treatment (D02A, D07, D11AH), steroid—all routes with the exception of ophthalmic (S02B, S03B, H02, A07EA, C05AA, H02AB, R01AD, R03BA, S01BA, S01BB, S01BC, S01CA, S01CB), or an epinephrine autoinjector (C01CA24). Urban residency was defined as a patient with a residential postal code from a Canadian Metropolitan Area (population $\geq 100,000$ people).

Statistical analysis

We characterized patients with, and without, documentation of food allergy in the EMR using descriptive statistics including mean, SD, and frequency (percent [%]). We assessed the prevalence of each type of food allergy within the cohort of patients with a food allergy, and the pediatric population in the CPCSSN repository. Bivariate

comparisons assessed similarities and differences between patients who had, or did not have, documentation of food allergy in the EMR using *t* tests and χ^2 tests, as appropriate. For each cohort, we determined the prevalence of atopic comorbidities, specifically pediatric asthma, eczema, and rhinitis, as well as other conditions of interest (listed above) using our case definitions. We also calculated the average number of the previously mentioned prescriptions of interest.

The multivariable logistic regression model examined the association between documentation of food allergy (yes vs no) and clinical factors (ie, sex [male vs female], age [15–19 vs ≤5; 10–14 vs ≤5; 6–9 vs ≤5], atopic comorbidities [yes/no], ADHD [yes/no], autism [yes/no], anxiety [yes/no], depression [yes/no], prescriptions of interest [yes/no], visit frequency [≥3 visits vs <3 visits, annually], and BMI [>85 BMI %tile vs ≤85 BMI %tile]) and clinic location (urban vs rural). Visit frequency was considered a categorical variable represented by greater or equal to, or less than, the mean of 3 visits annually. Patient age was categorized into age quartiles for analysis (ie, 15–19, 10–14, 6–9, ≤5). Our second model examined the association between documented food allergy (yes vs no) and patient psychiatric comorbidity (ie, ADHD, autism, anxiety, and depression) using an age- and sex-adjusted logistic regression. We report associations using odds ratios (ORs) with 95% CIs. Statistical analyses were conducted using SAS V9.4 (SAS Institute, Inc, Cary, NC).

RESULTS

The prevalence of physician-reported food allergy in Canadian children from our cohort was 2.53% (7,312 of 288,490; 95% CI, 2.48%-2.59%). Of those with reported food allergy, 54.6% were males (vs 51.0% without food allergy) with a median age of 11 years (vs 9.7 years) (Table I). The vast majority (78.2% vs 75.8%) were not overweight or obese. Among children with a food allergy, there were somewhat high rates of documented atopic comorbidities including asthma (34.8% vs 13.3%), eczema (16.7% vs 7.6%), and rhinitis (11.4% vs 3.7%).

Rates of psychiatric comorbidities among children with food allergy were as follows: autism (2.7% vs 1.3%), ADHD (9.2% vs 4.8%), anxiety (2.3% vs 1.8%), and depression (3.3% vs 2.1%). Among children with documented food allergy in their medical records, only 33.7% had a prescription for an epinephrine autoinjector from their primary care provider. The vast majority (91.4%) were followed in urban clinics. The most common food allergies documented in the EMR were peanut (0.8% of children), tree nut (0.6%), cow's milk (0.4%), egg (0.3%), fruit (0.2%), finned fish (0.2%), and shellfish (0.2%) (Table II).

In the logistic regression analysis, male children (OR, 1.15; 95% CI, 1.08-1.22) and older children (OR, 1.77; 95% CI, 1.61-1.95) had higher odds of documented food allergy compared with female children and younger children (Table III). Children with 3 or more annual visits to their primary care provider had 1.2 times higher odds of documented food allergy when compared with children with fewer than 3 visits (95% CI, 1.13-1.30). Children with an atopic comorbidity had 2.2 times higher odds of food allergy documentation (95% CI, 2.06-2.35). Obese children had lower odds of food allergy documentation than nonobese children (OR, 0.84; 95% CI, 0.78-0.90). Children seen at an urban clinic had 1.38 times higher odds of having documented food allergy when compared with children followed at a rural clinic (OR, 1.38; 95% CI, 1.23-1.55).

In the age- and sex-adjusted model (Table IV), patients with a psychiatric morbidity, specifically ADHD (OR, 1.81; 95% CI, 1.66-1.96), autism (OR, 1.89; 95% CI, 1.63-2.19), and depression (OR, 1.17; 95% CI, 1.02-1.35), had higher odds of documented food allergy. Although there was a significant difference between children with and without food allergies and the presence of diagnosed anxiety ($P = .001$), in logistic regression children with anxiety did not have higher odds of documented food allergy (OR, 0.92; 95% CI, 0.78-1.08).

DISCUSSION

Our study is the first to estimate the overall prevalence of food allergy in a nationally representative cohort that uses physician report instead of self-report. It demonstrates a much lower rate of food allergy in Canadian children than that based on self-report. This is consistent with studies suggesting that only 30% cases of all self-reported food allergy in children are ultimately confirmed allergic after allergist evaluation.¹¹ Previous Canadian self-reported prevalence data note much higher rates of probable peanut (1.68%), tree nut (1.59%), and shellfish (0.50%) allergy in children than our estimates. However, when this self-reported study relied on confirmatory allergy testing, the prevalence data are not that discrepant, with their reported prevalence of 1.03% for peanut allergy, 0.69% for tree nut allergy, 0.06% for shellfish allergy, and 0.03% for sesame allergy.⁷ This highlights the need for physician evaluation, and confirmatory testing, of all children with suspected food allergy.

Australian prevalence data are higher than what we are reporting in Canada. The HealthNuts study from Melbourne, Australia, noted very high food allergy prevalence estimates of 3.8% at age 4 years, which were based on the rigorous methodology of oral food challenge—proven food allergy.¹² Ironically, this is among the highest prevalence ever described in the world. However, it is known that Australia has some of the highest rates of food allergy in the world, even among high-income countries.¹² This study looked at an overall younger population than our study, which also may partially explain the higher rates. In contrast, a European study of 12,000 infants (9 countries) noted more similar prevalence rates to ours (cow's milk allergy prevalence of 0.54%) and also noted high variability in prevalence rates between European countries.¹³ However, these differences, in particular Australia's much higher prevalence rates, add further mystery into the relative contribution of "methodology" versus "regional environmental factors" in determining true prevalence.

Previous studies have noted that of those with food allergy, 35% to 71% have eczema, 33% to 40% have rhinitis, and 34% to 49% have asthma.¹⁴ Although our study found that children with food allergies had significantly higher rates of atopic comorbidities compared with children without food allergies, the prevalence of eczema and rhinitis in our study was lower. It is possible that the older age of children in our study (mean age 11 years for children with food allergies) reduced eczema rates, because eczema is more common in younger children and perhaps no longer listed in the EMR as the children got older. There are fewer hypothesized explanations for the low rates of rhinitis captured as a comorbidity. Because our study relied exclusively on EMR data, it is possible that the algorithm undercaptured the prevalence of atopic comorbidities. It is also possible that atopic comorbidities, in particular rhinitis, are not being screened for as frequently by primary care providers, compared with allergists. This suggests there may be an

TABLE I. Characteristics of pediatric patients (aged <19 y) who visited a primary care provider participating in CPCSSN with or without an indication of a food allergy in their EMR (N = 288,490)

Variable name	Patients with no indication of a food allergy in the EMR (n = 280,897)	Patients with a record for a food allergy in the EMR (n = 7,312)	P value
Patient characteristics			
Sex: male, n (%)	143,241 (51.0)	3,989 (54.6)	<.0001
Patient age (y), median (IQR)	10 (9)	11 (8)	<.0001
Patient age (≤ 5), n (%)	73,136 (26.0)	1,249 (17.1)	<.0001
Patient age (6– ≤ 9), n (%)	65,499 (23.3)	1,579 (21.6)	
Patient age (10– ≤ 14), n (%)	77,120 (27.4)	2,346 (32.1)	
Patient age (15– ≤ 19), n (%)	65,419 (23.3)	2,142 (29.3)	
BMI-for-age percentile, mean $\pm$ SD	53.9 $\pm$ 32.4	50.5 $\pm$ 32.7	.3271
BMI %tile ≤ 85 % (not obese), n (%)	101,777 (73.1)	3,873 (78.2)	.0001
BMI %tile >85– ≤ 97 (overweight), n (%)	21,327 (15.3)	737 (14.9)	
BMI %tile >97 (obese), n (%)	11,254 (8.4)	346 (7.0)	
≥ 1 or more atopic comorbidities, n (%)	56,638 (20.1)	3,511 (48.0)	<.0001
Pediatric asthma*	37,426 (13.3)	2,549 (34.8)	<.0001
Eczema*	21,329 (7.6)	1,219 (16.7)	<.0001
Rhinitis*	10,407 (3.7)	837 (11.4)	<.0001
Autism	3,540 (1.2)	195 (2.7)	<.0001
ADHD	13,454 (4.8)	676 (9.2)	<.0001
Depression	5,841 (2.1)	243 (3.3)	<.0001
Anxiety	5,107 (1.8)	171 (2.3)	.001
Visit frequency, mean $\pm$ SD	2.7 $\pm$ 1.9	2.8 $\pm$ 1.8	<.0001
Average number of prescriptions, mean $\pm$ SD	0.5 $\pm$ 1.1	1.2 $\pm$ 1.7	<.0001
Eczema medication, n (%)	29,905 (10.6)	1,647 (22.5)	<.0001
Steroid medication, n (%)	34,283 (12.2)	2,174 (29.7)	<.0001
Epinephrine autoinjector, n (%)	3,222 (1.2)	2,462 (33.7)	<.0001
Provider characteristics			
Urban clinic, n (%)	248,553 (88.4)	6,688 (91.4)	<.0001
Provider age, mean $\pm$ SD	49.8 $\pm$ 10.4	47.8 $\pm$ 10.1	.008
Female provider, n (%)	164,500 (59.5)	4,869 (66.9)	<.0001

Epipen: C01CA24.

Eczema medication: D02A-, D07-, D11AH-.

Steroid medication: S02B-, S03B-, H02- A07EA-, C05AA-, H02AB-, R01AD-, R03BA-, S01BA-, S01BB-, S01BC-, S01CA-, S01CB-.

*Atopic comorbidities include 1 or more diagnosis in the EMR for pediatric asthma, eczema, and rhinitis.

TABLE II. Type of food allergy recorded in the EMR among patients with a food allergy record

Food category	Frequency	Pediatric patients with a food allergy (n = 7,316)	CPCSSN pediatric patients (N = 288,490)
Peanut	2,268	31.0%	0.8%
Tree nut	1,827	25.0%	0.6%
Dairy	1,258	17.2%	0.4%
Egg	942	12.9%	0.3%
Fruit	674	9.2%	0.2%
Fish	637	8.7%	0.2%
Shellfish	523	7.2%	0.2%
Soy	385	5.3%	0.1%
Gluten/wheat	168	2.3%	0.1%
Sesame	143	2.0%	0.05%
Other	535	7.3%	0.2%

opportunity for quality improvement strategies focused on primary care providers.

The types of food allergies recorded in our cohort are largely consistent with the most common food allergies in children—peanut, tree nuts, cow's milk, and egg.⁵

A concerning finding within our study was that of those children with documented food allergy, only 33.7% had a prescription for an epinephrine autoinjector from their primary care provider. There are several explanations for this finding. It is possible that some of the food allergies entered were in fact

TABLE III. Logistic regression of factors associated with a record of food allergy in the EMRs of patients who visited a primary care provider participating in CPCSSN (N = 288,490)

Variable name	P value	OR	95% CIs
Male patient (vs female patient)	<.0001	1.15	1.08-1.22
Patient age group (15-≤19 y vs ≤5 y)	<.0001	1.77	1.61-1.95
Patient age group (10-≤14 y vs ≤5 y)	<.0001	1.57	1.44-1.73
Patient age group (6-≤9 y vs ≤5 y)	.0004	1.18	1.08-1.29
Visit frequency (≥3 annual appointments to the primary care provider vs <3 annual appointments)	<.0001	1.22	1.13-1.30
Atopic comorbidity* (vs no atopic comorbidity)	<.0001	2.20	2.06-2.35
Urban clinic (vs rural clinic)	<.0001	1.38	1.23-1.55
Prescription of interest vs no prescription of interest	<.0001	2.64	2.47-2.83
>85 BMI %tile vs ≤85 BMI %tile	<.0001	0.84	0.78-0.90

*Atopic comorbidities include 1 or more diagnosis in the EMR for pediatric asthma, eczema, and rhinitis.

TABLE IV. Age- and sex-adjusted logistic regression of psychiatric comorbidities associated with a record of food allergy in the EMRs of patients who visited a primary care provider participating in CPCSSN (N = 288,490)

Variable name	P value	OR	95% CIs
Diagnosed ADHD (vs no diagnosis)	<.0001	1.81	1.66-1.96
Diagnosed autism (vs no diagnosis)	<.0001	1.89	1.63-2.19
Diagnosed anxiety (vs no diagnosis)	.2899	0.92	0.78-1.08
Diagnosed depression (vs no diagnosis)	.0229	1.17	1.02-1.35

intolerances, or food avoidances, and hence an epinephrine autoinjector was appropriately not prescribed. It is possible that the epinephrine autoinjector was prescribed by an allergist and not the primary care provider and hence may not have been captured in the primary care EMR. It is also possible that epinephrine autoinjectors were not being prescribed in children with histories consistent with IgE-mediated food allergy, either due to time constraints or lack of education around the importance of this medication. Multiple international guidelines recommend an epinephrine autoinjector be available at all times in a child with a food allergy because epinephrine is the only life-saving intervention available for anaphylaxis.¹⁴⁻¹⁶ Delay or lack of use of epinephrine has been consistently associated with anaphylaxis morbidity and mortality.^{17,18} In addition, a previous Canadian study noted low adherence to filling epinephrine autoinjector prescriptions, even when appropriately prescribed.¹⁹ Educational efforts to ensure epinephrine autoinjectors are prescribed in the context of a possible, or confirmed, food allergy should be undertaken within primary care communities in Canada.

A novel finding was that obese children had lower odds of documented food allergy. Data from the National Health and Nutrition Examination Survey noted an increased OR for atopy in obese children compared with those of normal weight, with this association largely driven by food sensitization.²⁰ However, there is a growing body of literature pointing to aversive food behaviors and feeding disorders in children and adults with food allergy, including associations with not only feeding dysfunction²¹ but also avoidant/restrictive food intake disorder.²² Replication of this finding is required in other studies, but may point to a need for ongoing monitoring of adequate weight gain among children with food allergy.

Male children had higher odds of having documented food allergy, in keeping with male sex being a known risk factor associated with food allergy in childhood.¹ Children with food allergy in our study were more likely to live in urban (vs rural) locations. Urban location is a known risk factor for food allergy. For example, a national US survey of 38,645 children noted increasing population density to be associated with increasing food allergy prevalence.²³ Hypothesized explanations include the hygiene hypothesis (rural exposure to microbes may be protective) as well as possible air pollutants encountered in urban, versus rural, areas.²³

When adjusted for age and sex, we found that children with ADHD were more likely to have a food allergy documented in the EMR. A recent systematic review and meta-analysis also noted the association between children with ADHD and other atopic conditions, although not specifically food allergy.²⁴ In some studies, the risk of ADHD increases by as much as 30% to 50% with atopic comorbidities (although once again not food allergy specifically).²⁵ The etiology of such an association is unclear, but may be related to shared risk factors for atopic disease and ADHD and/or similar neuroinflammatory cascades.²⁵ However, because food elimination diets are common in children with ADHD, it is also possible that some of the food allergies reported in the charts were related to restriction/elimination diets instead of IgE-mediated food allergy.²⁶

Children with autism in our study were more likely to have a food allergy compared with children without autism documentation in the EMR. This adds to the growing, and controversial, association noted in the literature between allergies in general (and food allergy in particular) and autism spectrum disorder.²⁷ A cross-sectional study of 199,520 children (aged 3-17 years) noted a higher weighted prevalence of food allergy, asthma, and eczema among children with autism spectrum disorder.²⁷ Again, the etiology of this association is unclear but has been postulated to be related to shared immune dysregulation early in life and/or maternal inflammatory markers.²⁷

Also significant in the logistic regression model was the association of food allergy and depression. The association between food allergy and depression remains controversial. For example, a study of 4972 adolescents in Australia found condition-specific associations between asthma and depression but not food allergy and depression.²⁸ In another study of 1303 adolescents, food allergy was associated with maternal depression and anxiety, but the association with depression was age-specific and present from adolescence to adulthood.²⁹

Although anxiety had a slightly higher prevalence among children with food allergy, this association was not significant in our multivariable model. Anxiety has been strongly associated with food allergy in other studies.^{28,29} Our reliance on physician-diagnosed anxiety instead of self-reported anxiety may have contributed to its lack of significance.

A key limitation of our estimates is that we relied on physician documentation in their EMR allergy table, which could both overestimate or underestimate the true prevalence. The date the allergy or psychiatric comorbidity was recorded in the EMR may not be synonymous with the date the problem started for the patient. We therefore could not ascertain a causal link between our associations. CPCSSN data hold primary care EMR data and do not represent specialist visits and diagnoses. Despite the processing of the allergy terms being validated, it is possible that the algorithm may have failed to capture all cases of documented food allergy. A limitation of our study is that oral food challenges were not done to confirm food allergy. An underestimate may have been attributable to the lack of diagnostic codes for food allergy. Moreover, the biggest source of underestimation could be that families of children with true food allergy may not always mention or have the time to mention food allergy or symptoms with food ingestion at a routine primary care visit (eg, appointment for a sore throat or abdominal pain), unless an appointment is booked specifically for the purpose of food allergy. Conversely, it is also possible the prevalence was overestimated because this algorithm was not designed to detect the results of confirmatory testing or consultation reports. It is possible that some food allergies were entered in the EMR by primary care providers when they were, in fact, intolerances or pending evaluation.

According to the Canadian 2019 census data, there were 7,220,000 children aged 0 to 17 years in Canada.³⁰ Our study captured 288,490, or roughly 4.0% of the pediatric population in Canada. As a result, we cannot say for certain that this sample is representative of all primary care practices. However, Queenan et al³¹ demonstrated that when compared with other national data sources the patient population within CPCSSN practices is representative of the general populations in Canada.

CONCLUSIONS

Our study notes a much lower physician-reported prevalence of food allergy in children in Canada than previous studies relying on self-report. The relative contribution of methodological differences versus regional environmental factors in determining estimates of prevalence requires further elucidation. Further studies into the association of food allergy and psychiatric comorbidities (ADHD, autism, depression) and the association of food allergy and obesity are needed. The development of *International Classification of Diseases* diagnostic codes specific for food allergy would help with standardization of food allergy diagnosis in primary care. Additional studies using representative cohorts of allergist-diagnosed cases including allergy testing and oral food challenge information are necessary to refine the certainty and accuracy of prevalence estimates.

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Appendix A: Food Categories

Category	Allergy Name
Peanut	ARACHIDE
	ARACHIDES
	PEANUT
	PEANUT BUTTER
	PEANUT OIL
	PEANUTBUTTER
	PEANUTS
Tree nut	ALL KINDS OF NUTS
	ALL NUTS
	ALL TREE NUTS
	ALL TYPES OF NUTS
	ALMOND
	ALMONDS
	AMANDES
	AUX NOIX
	BRAZIL NUT
	BUTTERNUTS
	CACHOU
	CAJOU
	CASHEW
	CASHEW NUTS
	CHESTNUTS
	HAZEL NUTS
	HAZELNUT
	KASHEW
	MACADAMIA NUTS
	MIXED NUTS
	MULTIPLE NUT
	NOIX
	NUT
	NUTS
	PECAN
	PECANS
	PINE NUT
	PINE NUTS
	PINENUTS
	PISTACHE
	PISTACHIO
	PISTACHIOS
	TREE NUTS
	TREENUTS
	VARIOUS TREE NUTS
	WALNUT

	WALNUTS
Dairy	ALL DAIRY
	BUTTER
	CASEIN
	CASÉINE
	CHEESE
	COW MILK
	COW MILK PROTEIN
	COW'S MILK
	COW'S MILK PROTEIN
	COWS MILK
	COWSMILK
	CREAM
	DAIRY
	DAIRY (ALL)
	DAIRY PRODUCTS
	DAIRY PROTEIN
	HOMO MILK
	ICE CREAM
	ICECREAM
	LACTOSE
	LAIT
	MILK
	MILK CONTAINING PRODUCTS
	MILK PROTEIN
	PRODUIT LAITIER
	WHIPPED CREAM
	YOGHURT
	YOGURT
Egg	ALL EGGS
	EGG
	EGG PRODUCTS
	EGG WHITE
	EGG WHITE (RAW)
	EGG WHITE AND YOLK
	EGG WHITES
	EGG YOLK
	EGGS
	EGGS-RAW
	EGGWHITE
	FRESH EGGS
	OEUF
	OEUFS
	RAW EGG
	UNBAKED EGG
	UNCOOKED EGG

	WHOLE EGG
Fruit	ALL RAW FRUITS
	ANANAS
	APPLE
	APPLE JUICE
	APPLE PROTEIN
	APPLE SAUCE
	APPLE SKIN
	APPLES
	APRICOT
	APRICOTS
	AVOCADO
	BANANA
	BERRIES
	BLACKBERRIES
	BLEUETS
	BLUEBARRIES
	BLUEBERRY
	C FRUITS
	CANTALOE
	CANTALOUPE
	CANTELOPE
	CANTELOUPE
	CHERRIES
	CHERRY
	CITRUS
	CITRUS FRUITS
	CLEMENTINE
	CONCOMBRE
	CRANBERRY JUICE
	CUCMBERS
	CUCUMBER
	FRAMBOISE
	FRESH APPLE
	FRESH FRUITS
	FRESH PEACHES
	FRESH PINEAPPLE
	FRESH TOMATOES
	FRUIT
	FRUIT
	FRUITS
	FRUITS DE MER
	GRAPE
	GRAPEFRUIT
	GRAPES
	GUÊPE

	GUÊPES
	HONEYDEW
	KIWI
	KIWIFRUIT
	KIWIS
	MANGO
	MANGOES
	MANGOS
	MELON
	MELONS
	MOST TROPICAL FRUIT
	NECTARINE
	NECTARINES
	ORANGE
	ORANGE PEEL
	ORANGES
	PAPAYA
	PEACH
	PEACHES
	PEAR
	PEARS
	PÊCHE
	PINEAPPLE
	PINEAPPLES
	PLUMS
	POMME
	POMMES
	PUMPKIN
	RASBERRIES
	RASBERRY
	RAW APPLE
	RAW BANANA
	RAW CHERRY
	RAW CUCUMBER
	RAW FRUIT
	RAW PUMPKIN
	SOME FRUIT
	SOME FRUITS
	SQUASH
	STRAWBERRIES
	STRAWBERRY
	TANGERINE
	TANGERINES
	TOMATOE
	TOMATOE CANNED
	TOMATOE SAUCE

	TOMATOE SOUP
	TOMATOES
	TOMATOES (COOKED)
	WATERMELON
	ZUCCHINI
Fish	ANY TYPE OF FISH
	BASSA FISH
	COD
	FISH
	FISH - FRESHWATER
	FISH OIL
	FISH SAUCE
	FRESH WATER FISH
	HERRING
	MACKEREL
	SALMON
	TILAPIA
	TROUT
	TUNA
	WHITE FISH
Shellfish	CALAMARI
	CLAMS
	CRAB
	CRABS
	CREVETTES
	CRUSTACEAN
	CRUSTACEANS
	CRUSTACÉS
	IMITATION CRAB MEAT
	KING CRAB
	LOBSTER
	MOLLUSK
	MUSSELS
	OCTOPUS
	OYSTER
	OYSTERS
	PRAWNS
	RAW OYSTER
	SCALLOP
	SCALLOPS
	SEAFOOD
	SHELLFISH
	SHRIMP
	SQUID
Soy	SOY
	SOY MILK

	SOY PROTEIN
	SOYA
	SOYBEAN
	SOYBEAN OIL
Gluten / Wheat	BARLEY
	FLOUR
	GLUTEIN
	GLUTEN
	GRAINS
	WHEAT
	WHEAT FLOUR
Sesame	SESAME
	SÉSAME
	SESAME SEED
	SESAME SEEDS
Other	ACHOVIES
	ACIDIC FOODS
	BACON
	BEANS
	BEEF
	BROCOLI
	BROCOLLI
	CAJOU
	CANDY
	CANNED FOODS
	CANOLA
	CARMEL
	CARROT
	CARROTS
	CAULIFLOWER
	CELERY
	CHIA SEEDS
	CHICK PEA
	CHICK PEAS
	CHICKEN
	CHICKPEAS
	CHOCOLATE
	CINAMMON
	COCONUT
	CORN
	CORN POPS
	CORN SYRUP
	CORNED MEAT
	CORNMEAL
	CRACKERS
	CURRY

	DIET
	DIETARY FRUCTOSE
	DILL
	FAVA BEANS
	FLAXSEED
	FOOD
	FOOD COLORING
	FOOD COLOURING
	FOOD COLOURINGS
	FOOD PRESERVATIVES
	FOODS
	GARBANZO BEANS
	GARLIC
	GREEN PEAS
	GINGERALE
	GOOD START
	GRAHAM CRACKERS
	GREEN FOOD COLOURING
	GREEN PEPPER
	HONEY
	HOT DOGS
	HUMMUS
	HUMUS
	INDIAN SPICED FOODS
	JALAPENO
	KETCHUP
	KIDNEY BEANS
	LAMB
	LEGUME
	LEGUMES
	LENTILES
	LIVER
	LIVER SPREAD
	MAPLE
	MINT
	MSG
	MULTIPLE FOOD
	MULTIPLE FOODS
	MUSHROOM
	MUSHROOMS
	MUSTARD
	NESTLE BABY CEREAL
	OAT CEREL
	OATMEAL
	OATS
	OLIVES

	ONION
	PEA
	PEAS
	PEPPER
	PEPPERONI
	PICKLE JUICE
	POIS VERTS
	POPCORN
	POPPY SEEDS
	PORK
	PORK GELATIN
	PROCESSED CHICKEN
	PROCESSED FOODS
	PROCESSED MEAT
	PROTEINES BOVINE
	PROTEINES BOVINES
	PRUNES
	QUINOA
	RADISH
	RANCH DIP
	RANCH SALAD DRESSING
	RASINE
	RAW HONEY
	RED PEPPER
	RED WINE
	RICE
	RICE CEREAL
	RUBARB
	SAGE
	SALAD DRESSING
	SEEDS
	SEEDS (SUNFLOWER)
	SEVERAL FOOD
	SEVERAL FOODS
	SNAP PEAS
	SPINACH
	SUGAR
	SULPHITES
	SUNFLOWER
	SUNFLOWER INGESTION
	SUNFLOWER OIL
	SUNFLOWER SEED
	SUNFLOWER SEED PRODUCTS
	SUNFLOWER SEEDS
	SUSHI
	SWEET POTATOE

	SWEET POTATOES
	TARTRAZINE
	TOFU
	TURKEY
	UNKNOWN FOODS
	WHEY PROTEIN
	YEAST
	ACHOVIES