Original Article

# Prevalence and Predictors of Food Allergy in Canada: A Focus on Vulnerable Populations

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***What is already known about this topic?*** We previously found that 8% of Canadians self-report food allergy. However, the prevalence of food allergy among those of low education, those with low income, new Canadians, and individuals of Aboriginal identity (vulnerable populations) has not been estimated.

***What does this article add to our knowledge?*** In this first Canadian study to estimate the prevalence of food allergy in vulnerable populations, those of low education and new Canadians reported fewer allergies, but no differences were found according to income or Aboriginal status.

***How does this study impact current management guidelines?*** Vulnerable populations report fewer allergies possibly due to insufficient knowledge or inadequate health care access, which suggests important policy gaps that must be addressed to ensure equal opportunity for all Canadians to seek and receive health care.

**BACKGROUND: Studies suggest that individuals of low education and/or income, new Canadians (immigrated <10 years ago), and individuals of Aboriginal identity may have fewer food allergies than the general population. However, given the difficulty in recruiting such populations (hereafter referred to as vulnerable populations), by using conventional survey methodologies, the prevalence of food allergy among these populations in Canada has not been estimated.**

**OBJECTIVES: To estimate the prevalence of food allergy among vulnerable populations in Canada, to compare with the nonvulnerable populations and to identify demographic characteristics predictive of food allergy.**

**METHODS: By using 2006 Canadian Census data, postal codes with high proportions of vulnerable populations were identified and households were randomly selected to participate in a telephone survey. Information on food allergies and demographics was collected. Prevalence estimates were weighted by using Census data to account for the targeted sampling. Multivariable logistic regression was used to identify predictors of food allergy.**

**RESULTS: Of 12,762 eligible households contacted, 5734 households completed the questionnaire (45% response rate). Food allergy was less common among adults without postsecondary education versus those with postsecondary education (6.4% [95% CI, 5.5%-7.3%] vs 8.9% [95% CI, 7.7%-10%]) and new Canadians versus those born in Canada (3.2% [95% CI, 2.2%-4.3%] vs 8.2% [95% CI, 7.4%-9.1%]). There was no difference in prevalence between those of low and of high income or those with and without Aboriginal identity.**

**CONCLUSION: Analysis of our data suggests that individuals of low education and new Canadians self-report fewer allergies, which may be due to genetics, environment, lack of appropriate health care, or lack of awareness of allergies, which reduces self-report.**  **(J Allergy Clin Immunol Pract 2014;■:■-■)**

***Key words:*** *Food allergy; Self-reported food allergy; Perceived food allergy; Probable food allergy; New Canadians; Low education; Low income; Aboriginal identity; Vulnerable populations*

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*Abbreviations used*
*CT- Census tract*
*FAPQ- Food Allergy Prevalence Questionnaire*
*LICO- Low-income cutoff*
*OR- Odds ratio*
*SCAAALAR- Surveying Canadians to Assess the Prevalence of Food Allergies and Attitudes Towards Food Labelling and Risk*
*SPAACE- Surveying Prevalence of Food Allergy in All Canadian Environments*

Food allergy has become an increasingly important condition in Western society due to its unpredictable nature and the need for extreme dietary vigilance, both of which can substantially compromise the quality of life of affected individuals and their families.[1] Although immune modulatory therapies appear promising, these likely will not induce long-term tolerance,[2] and food allergy will remain largely incurable. Those affected must rely on strict avoidance of the offending food and rescue therapy with epinephrine. In the United States, estimates of the prevalence of self-reported food allergy range between 8.0% and 9.1%.[3,4] However, until recently, the prevalence of food allergy in Canada was unknown.

From 2008 to 2009, our research team estimated that approximately 8% of Canadians self-reported at least 1 food allergy and that the prevalence differs across socioeconomic groups and geographic regions (Surveying Canadians to Assess the Prevalence of Food Allergy and Attitudes Towards Food Labelling and Risk [SCAAALAR] study).[5] However, given that the data were collected by using a large-scale telephone survey, it is not surprising that the resulting sample underrepresented important parts of the Canadian population, specifically those of low education and low income, new Canadians, and individuals of Aboriginal identity. These 4 population groups are hereafter referred to as vulnerable populations. Although other researchers have attempted to estimate the prevalence of food allergy in these vulnerable populations, existing studies are limited in that the majority focus only on children, do not collect data on specific food allergies, and/or do not use an appropriate targeting strategy to ensure an adequate sample of these vulnerable groups, who are particularly difficult to reach, are included.[3,4,6-12] These limitations make it difficult to form any definitive conclusions about how the prevalence of food allergy in these groups compares with that in the nonvulnerable populations.

The current study (Surveying Prevalence of Food Allergy in All Canadian Environments [SPAACE]) attempts to bridge these gaps, by specifically targeting and evaluating the prevalence of specific food allergies in vulnerable populations of children and adults in all Canadian provinces and territories, by comparing vulnerable with nonvulnerable populations, and by examining potential sociodemographic determinants of food allergy.

## METHODS

### Selection of study population

Canadians of low income, new Canadians, and individuals of Aboriginal identity were specifically targeted. Canadians of low education were not targeted because it was anticipated that there would be substantial overlap between low income and low education, and by targeting low income areas, those with low education would also be included.[13] Adults who completed less than a postsecondary degree, trade certificate, or diploma, were defined as being of low education. This group included individuals who were 18 years or older only. Individuals were considered to be low income if their household income was below the low-income cutoff (LICO). The LICO is defined as an income level at which families or unattached individuals spend at least 70% of before tax income on food, shelter, and clothing, and is determined according to family size and geographic location.[14] New Canadians were those who immigrated to Canada within 10 years of completion of the telephone survey. An individual was considered to be of Aboriginal identity if he or she reported "Aboriginal" as his or her cultural background, and identified with First Nations, Métis, or Inuit.

By using the 2006 Canadian census, the 100 census tracts (CT) from within the census metropolitan areas (CMA)[15] that contained either the highest proportion of households living under the LICO (range, 41.5%-91%) or the highest proportion of new Canadians (range, 31.9%-66%) were selected. Individuals of Aboriginal identity were selected in the same way by using a lower threshold, of 15% (range, 15%-94.6%), which resulted in a total of 66 CTs included. These CTs were then converted to postal codes by using the 2006 Statistics Canada postal code conversion file (available via the Computing for Humanities and Social Sciences server at the University of Toronto) and Info-Direct (a company that maintains telephone directory listings or "White Pages" in Canada; Cornerstone Info-Direct, Toronto, Ontario) selected a random sample of household telephone numbers with accompanying mailing addresses from these postal codes.

Due to this targeting strategy, CTs from the province of New Brunswick were not proportionately represented (only 2 CTs were included in the initial selection), and those from Nova Scotia and from Newfoundland and Labrador were excluded from the initial selection because they were not among the top 100 in terms of proportion of low income households or new Canadians, nor in the top 66 in terms of proportion of individuals of Aboriginal identity. Further, Prince Edward Island and the 3 Canadian territories (Northwest, Yukon, and Nunavut) were excluded because they do not contain any Census metropolitan areas, and, hence, there are no CTs.

Although our primary objective was to ensure adequate representation of the vulnerable populations, we also wanted to provide prevalence estimates that involved populations from all Canadian provinces and territories. Hence, for New Brunswick, for Nova Scotia, and for Newfoundland and Labrador, CTs with the highest proportion of households under the LICO (range, 25.8%-38.9% from 8 CTs in Saint John, New Brunswick; range, 24.1%-40.9% from 10 CTs in Halifax, Nova Scotia; range, 27.4%-41.4% from 5 CTs in St John's, Newfoundland) were selected from the main Census metropolitan areas. These areas contained too few new Canadians or individuals of Aboriginal identity to be included in the sampling for these populations. In Prince Edward Island, we targeted the largest Census subdivision in the province, Charlottetown. According to the 2006 Census, 13.2% of households in Charlottetown were below the LICO and 1.4% were new Canadians. In the Northwest and Yukon Territories, a random sample of households was selected from all areas. In Nunavut, all available records were purchased because of the large number of those of Aboriginal identity residing in this territory.

### Participant recruitment

All households, with the exception of those in Nunavut, were mailed a letter that informed them that the research team would contact them to complete a 10- to 15-minute telephone survey about dietary habits and the environment. To help avoid selection bias, the letter did not mention that the study's purpose was to examine food allergy prevalence but did advise (as required by our ethics board) that those with food allergies may have to complete a slightly longer survey. Included in the letter was a $5 coupon for a major restaurant chain or food product. Results of previous research showed that incentives as small as $5 provided before the survey, that is, *a priori* incentives, increase response rates, especially among low-income and minority populations.[16-18] A small pilot study, which provided a $5 *a priori* incentive to some households, chosen at random and no incentive to others, was conducted before the beginning of data collection and confirmed previous findings.[19]

The recruitment strategy in Nunavut was different from the rest of Canada because the White Pages provides only the telephone numbers and does not provide addresses for these households. Hence, we could not send the information letter and incentive to households in Nunavut before the interview. To advertise the study, a public service announcement was broadcast on a major northern Canadian news network during the period when telephone calls were being made to Nunavut residents. A $5 compensation was sent to those households after they completed the telephone survey and provided their address.

### Telephone survey

Approximately 2 weeks after mailing the information letter, households were contacted to complete the telephone survey. The surveys were conducted by a team of similarly trained interviewers based at McGill University in Montreal, Quebec, Canada, by using Computer Assisted Telephone Interview software (WinCati 4.2; Sawtooth Technologies Inc, Northbrook, Ill). Respondents were eligible to participate if they were 18 years or older, were living in the household, appeared to have no cognitive or hearing barriers, could respond in either of Canada's official languages (English or French), and could answer questions about dietary habits and food allergies of all household members. Once eligibility was established, the respondent was invited to participate and was asked whether any household member had an allergy to peanut, tree nut, fish, shellfish, sesame, milk, egg, wheat, and/or soy, or any other foods. If the respondent reported that an individual had an allergy to 1 of the 9 foods specified above, then he or she was queried further by using the Food Allergy Prevalence Questionnaire (FAPQ).

The FAPQ was initially developed by Sicherer et al[20-22] to determine the general population prevalence of peanut, tree nut, fish, and shellfish allergy in the United States, and was modified by our team for the SCAAALAR study to include questions regarding sesame allergy.[23] In the current study, questions regarding a potential allergy to milk, egg, wheat, and soy were added to existing questions about peanut, tree nut, fish, shellfish, and sesame. As described previously by Ben-Shoshan et al,[23] individuals were queried about the history of the most-severe allergic reaction, the interval between exposure and symptom onset, and if the allergy was diagnosed by a physician. Information about the age, sex, country of origin, number of years in Canada (for those not born in Canada), cultural and/or ethnic background (including Aboriginal identity status), education level (for those older than 18 years), and household income was obtained.

To optimize response rates and minimize selection bias, a maximum of 15 attempts were made to contact households on different days and times between 9:00 AM and 9:00 PM (local time) Monday through Friday, and 10:00 AM and 5:00 PM on Saturdays and Sundays. The questionnaires were translated into French and back-translated into English. The study was approved by the institutional review board of the McGill University Health Centre.

### Definitions of food allergy

Two definitions of food allergy were used in this analysis: (1) perceived food allergy, which includes all individuals who reported any food allergy; and (2) probable food allergy, a more conservative definition, which includes all individuals who reported an allergy to peanut, tree nut, fish, shellfish, sesame, milk, egg, wheat, and/or soy, and who reported a convincing history of food allergy and/or who self-reported a physician-diagnosed food allergy. To be considered to have a convincing history,[24-26] an individual had to report experiencing at least 2 mild symptoms (pruritus, urticaria, flushing, or rhinoconjunctivitis), 1 moderate symptom (angioedema, throat tightness, gastrointestinal symptoms, or breathing difficulties [other than wheeze]), or 1 severe symptom (wheeze, cyanosis, or circulatory collapse) after ingestion or contact (or inhalation for fish, shellfish, egg, or soy) within 2 hours after exposure to the food. To ensure that participants who were either lactose intolerant or who had celiac disease were not mistakenly considered to have a milk or wheat allergy, those who reported either of these conditions or had symptoms that were limited to the gastrointestinal tract or those who could tolerate either dairy or wheat products occasionally without experiencing a reaction were excluded from the estimates for probable milk or wheat allergy.

### Statistical analysis

**Estimating prevalence of food allergy among those completing the FAPQ and creating weighted estimates.** Point estimates and 95% CIs for the prevalence of perceived and probable allergy for each of the vulnerable and nonvulnerable groups were calculated by using the Clopper-Pearson exact method.[27] Given the targeted sampling strategy of this study, which purposely oversampled the vulnerable populations, the prevalence estimates were weighted. Even though prevalence estimates were calculated for each vulnerable and nonvulnerable group separately, weighting was still necessary because the other demographic characteristics may be distributed differently across vulnerable and nonvulnerable groups. Hence, our groups of low and high income were neither representative of the general low or high income population unless we accounted for the education, immigration, and Aboriginal population weights.

To create the weighted estimates, nonoverlapping subgroups of interest, each characterized by education, income, Canadian born, and Aboriginal status, were created for both the study population and the 2006 Canadian Census database. The weight for each vulnerable group of interest was calculated by dividing the proportion of individuals in the Census who fell into this subgroup by the proportion of individuals in the SPAACE who fell into this same subgroup. For example, for the subgroup with high education, high income, Canadian-born, and non-Aboriginal, and the proportion of individuals in this subgroup in the Census (456,846/31,241,030) was divided by the proportion in the same subgroup in SPAACE (98/15,022) to yield a weight of $456{,}846 \times 15{,}022/31{,}241{,}030 \times 98 = 2.24$.

The subgroup-specific prevalence in SPAACE was then multiplied by the weight of 2.24 to obtain the weighted prevalence for that subgroup. The overall weighted prevalence is the sum of subgroup-specific prevalence multiplied by group-specific weight for all the subgroups. Because a nontrivial percentage of the sample did not report household income, a sensitivity analysis was performed, in which the prevalence of food allergy for those who did and did not provide their household income was compared.

**Identifying predictors of food allergy.** To identify predictors of food allergy, multivariable logistic regression models were fitted for perceived allergy to any food. Random effects models were used to account for household clustering. The following variables were included as covariates: education (<postsecondary degree vs ≥postsecondary degree; defined for adults only), household income (income, <LICO vs income ≥LICO), a 3-level variable for immigrant status (new Canadian, the reference group, immigrated ≥10 years ago, born in Canada), Aboriginal status (those of Aboriginal identity vs without Aboriginal identity), child (<18 years old), sex, and an interaction term between child and male sex because food allergy prevalence has been shown to be higher in male children, although this trend is reversed in adulthood.[28]

A sensitivity analysis was conducted in which the immigrant variable was either dichotomized as born in Canada versus immigrant or as continuous, which expressed the number of years since immigrating to Canada. In addition, a sensitivity analysis for missing income was performed in which a multivariable model that included individuals who reported their income was compared with a model that included those not reporting their income.

## RESULTS

### Participation rate

Between September 2010 and September 2011, we attempted to reach 17,337 households by telephone, of which, 14,113 households were actually reached. Of the 14,113 households that were reached, 1351 households were ineligible to participate due to a language barrier or unavailability of an adult or individual residing in the household. Of the 12,762 eligible households, 5734 of them, which represented 15,022 individuals, completed the FAPQ (45% response rate). Given the targeting strategy used, the sample consisted of a much higher percentage of vulnerable populations than are present in the general Canadian population. In the sample, 22.8% of participants were below the LICO, 11.8% were new Canadians, and 15.1% were of Aboriginal identity versus 15.7%, 7.2%, and 3.8% of the general Canadian population, respectively.[29]

### Prevalence of food allergy

Adults with low education had a lower prevalence of perceived allergy to any food than those with higher education (6.4% [95% CI, 5.5%-7.3%] vs 8.9% [95% CI, 7.7%-10%]) (Table I). This difference was most notable for tree nut. There was a trend, although nonsignificant, for the perceived prevalence to be greater than the probable prevalence for most of the 9 allergens. It should be noted that the prevalence of probable allergy to any food cannot be calculated because a detailed history regarding allergy was collected for only 9 food allergens and not for any other reported food allergen. To enable children to be included in this analysis, the children were stratified based on highest educational attainment in the household; a trend toward lower prevalence in households with lower educational attainment was observed. The perceived prevalence of tree nut and wheat allergy was lower in individuals who lived in households below the LICO (Table II). In a sensitivity analysis, perceived and probable prevalence estimates were similar in those who reported and did not report household income.

New Canadians had a perceived prevalence of any food allergy of 3.2% (95% CI, 2.2%-4.3%), those who had immigrated at least 10 years earlier had a prevalence of 5.5% (95% CI, 4.5%-6.4%), and those born in Canada had a prevalence of 8.2% (95% CI, 7.4%-9.1%) (Table III). This difference was most notable for peanut and tree nut. The prevalence of food allergy in individuals of Aboriginal identity was similar to the rest of the respondents (Table IV).

### Sociodemographic predictors of perceived allergy

In the multivariable analysis, adults with low education (odds ratio [OR] 0.72 [95% CI, 0.71-0.74]) and men (OR 0.58 [95% CI, 0.57-0.59]) were less likely to report an allergy; those born in Canada (OR 2.95 [95% CI, 2.82-3.09]) or who immigrated to Canada more than 10 years earlier (OR 1.71 [95% CI, 1.63-1.80]) were more likely to report an allergy (Table V). When the immigrant variable was dichotomized, immigrants were less likely than those born in Canada to report an allergy (OR 0.51 [95% CI, 0.50-0.53]); similarly, when the variable was continuous, the prevalence of perceived food allergy increased with increasing number of years since immigrating to Canada (OR 1.03 [95% CI, 1.03-1.03]). The predictors of perceived allergy to any food were the same in the multivariable model, which was restricted to individuals who did not report their income and in the model that was restricted to individuals who did report their income.

## DISCUSSION

SPAACE is the first Canadian study to specifically target and estimate the prevalence of food allergy in those of low education, those of low income, new Canadians, and individuals of Aboriginal identity. The sampling strategy used in this study was successful in targeting the vulnerable groups. In our previous population-based survey, which was based on random sampling, 8.9% of households were below the LICO versus 22% in the current study and only 1.9% of the sample was composed of new Canadians versus 11.8% in the current study.

Food allergy was less commonly reported among adults and children who lived in households with lower educational attainment, which may be both real and a reflection of underdiagnosis. It is possible that the more-educated individuals truly have a higher prevalence of food allergy because they may have been more likely than those with lower education to have followed recommendations that suggested that the restriction of allergenic foods early in life may prevent the development of food allergy.[30] Results of recent studies, however, have indicated that delayed introduction may, in fact, promote food allergy, which potentially results in a higher prevalence in those who were more adherent to these guidelines. Consequently, this advice has since been retracted.[31] It also is possible that the lower prevalence of food allergy in those individuals of lower education results partially from less awareness of food allergy because of lower levels of health literacy. They, therefore, may not recognize

**TABLE I.** Weighted perceived and probable prevalence estimates of food allergy according to education*

| | (A) Low education, % (95% CI) (n = 5332) | (B) High education, % (95% CI) (n = 5363) | Difference between A and B, % (95% CI) |
|---|---|---|---|
| Perceived | | | |
| Peanut | 0.6 (0.3-0.9) | 0.8 (0.4-1.1) | −0.1 (−0.6 to −0.3)† |
| Tree nut | 0.7 (0.4-1.0) | 1.7 (1.2-2.3) | −1.0 (−1.6 to −0.4)† |
| Fish | 0.4 (0.2-0.6) | 0.8 (0.4-1.1) | −0.4 (−0.8 to 0.0) |
| Shellfish | 1.5 (1.1-2.0) | 2.2 (1.6-2.8) | −0.6 (−1.3 to 0.1) |
| Sesame | 0.1 (0.0-0.3) | 0.3 (0.1-0.5) | −0.2 (−0.4 to 0.1) |
| Milk | 0.7 (0.4-1.1) | 0.7 (0.3-1.0) | 0.1 (−0.4 to 0.5) |
| Egg | 0.6 (0.3-0.8) | 0.4 (0.2-0.6) | 0.1 (−0.2 to 0.5) |
| Wheat | 0.4 (0.2-0.7) | 0.4 (0.2-0.7) | 0.0 (−0.3 to 0.4) |
| Soy | 0.1 (0.0-0.2) | 0.2 (0.0-0.4) | −0.1 (−0.3 to 0.1) |
| Any‡ | 6.4 (5.5-7.3) | 8.9 (7.7-10) | −2.4 (−3.8 to −0.9)† |
| Probable | | | |
| Peanut | 0.4 (0.2-0.6) | 0.8 (0.4-1.1) | −0.3 (−0.7 to 0.1) |
| Tree nut | 0.6 (0.3-0.9) | 1.5 (1.0-2.0) | −0.8 (−1.4 to −0.3)† |
| Fish | 0.3 (0.1-0.5) | 0.7 (0.4-1.0) | −0.4 (−0.8 to 0.0) |
| Shellfish | 1.3 (0.9-1.7) | 2.0 (1.4-2.5) | −0.7 (−1.3 to 0.0) |
| Sesame | 0.1 (0.0-0.3) | 0.2 (0.0-0.4) | −0.1 (−0.3 to 0.1) |
| Milk | 0.1 (0.0-0.3) | 0.2 (0.0-0.4) | −0.1 (−0.3 to 0.1) |
| Egg | 0.6 (0.3-0.8) | 0.4 (0.2-0.6) | 0.2 (−0.2 to 0.5) |
| Wheat | 0.3 (0.1-0.5) | 0.2 (0.0-0.4) | 0.0 (−0.3 to 0.3) |
| Soy | 0.1 (0.0-0.2) | 0.2 (0.0-0.4) | −0.1 (−0.3 to 0.1) |

*A total of 15,022: 10,695 adults provided this information, 301 adults did not provide this information, and 4026 children were not asked about education.
†Significant difference.
‡Any perceived allergy refers to self-report of allergy to 1 of the 9 common food allergies and other foods, such as fruit, vegetables, meat, chocolate, seeds, spices, legumes, and grains.

**TABLE II.** Weighted perceived and probable prevalence estimates of food allergy according to income*

| | (A) Low income, % (95% CI) (n = 2424) | (B) High income, % (95% CI) (n = 8205) | Difference between A and B, % (95% CI) |
|---|---|---|---|
| Perceived | | | |
| Peanut | 1.4 (0.8-2.0) | 1.2 (0.8-1.6) | 0.2 (−0.5 to 0.9) |
| Tree nut | 0.6 (0.2-1.1) | 1.6 (1.2-2.0) | −1.0 (−1.6 to −0.4)† |
| Fish | 0.4 (0.1-0.7) | 0.8 (0.4-1.1) | −0.3 (−0.8 to 0.1) |
| Shellfish | 1.6 (0.9-2.3) | 1.9 (1.5-2.4) | −0.3 (−1.1 to 0.5) |
| Sesame | 0.3 (0.0-0.7) | 0.2 (0.1-0.3) | 0.1 (−0.3 to 0.6) |
| Milk | 0.7 (0.3-1.2) | 0.7 (0.4-1.0) | 0.1 (−0.5 to 0.6) |
| Egg | 0.3 (0.1-0.6) | 0.7 (0.4-0.9) | −0.3 (−0.7 to 0.0) |
| Wheat | 0.0 (0.0-0.1) | 0.3 (0.2-0.5) | −0.3 (−0.5 to −0.1)† |
| Soy | 0.1 (0.0-0.3) | 0.1 (0.0-0.2) | −0.1 (−0.2 to 0.2) |
| Any | 7.2 (5.7-8.6) | 7.8 (6.9-8.7) | −0.6 (−2.3 to 1.1) |
| Probable | | | |
| Peanut | 1.2 (0.6-1.8) | 1.1 (0.7-1.4) | 0.1 (−0.6 to 0.8) |
| Tree nut | 0.6 (0.1-1.1) | 1.4 (1.0-1.8) | −0.8 (−1.4 to −0.2)† |
| Fish | 0.4 (0.1-0.7) | 0.7 (0.4-1.0) | −0.3 (−0.8 to 0.1) |
| Shellfish | 1.3 (0.7-1.8) | 1.6 (1.2-2.0) | −0.4 (−1.1 to 0.3) |
| Sesame | 0.2 (0.0-0.5) | 0.2 (0.1-0.3) | 0.0 (−0.3 to 0.3) |
| Milk | 0.2 (0.0-0.4) | 0.2 (0.1-0.3) | 0.0 (−0.3 to 0.3) |
| Egg | 0.3 (0.1-0.6) | 0.7 (0.4-0.9) | −0.3 (−0.7 to 0.0) |
| Wheat | 0.0 (0.0-0.0) | 0.2 (0.1-0.4) | −0.2 |
| Soy | 0.0 (0.0-0.1) | 0.1 (0.0-0.2) | −0.1 (−0.2 to 0.0) |

*Data on household income are missing for 4393 individuals because participants refused to provide this information.
†Statistically significant.

symptoms that may be suggestive of food allergy and are less likely to consult a physician and be diagnosed. Although health care access is theoretically universal in Canada, differential access still exists and may contribute to underdiagnosis in those individuals who are less educated.[32] Access may be limited by geographic remoteness from urban health care facilities and by

**TABLE III.** Weighted perceived and probable prevalence estimates of food allergy according to immigrant status*

| | (A) New Canadian, % (95% CI) (n = 1754) | (B) Immigrant ≥10 years, % (95% CI) (n = 2851) | (C) Born in Canada, % (95% CI) (n = 10,299) | Difference between A and B, % (95% CI) | Difference between B and C, % (95% CI) | Difference between A and C, % (95% CI) |
|---|---|---|---|---|---|---|
| Perceived | | | | | | |
| Peanut | 0.4 (0.1-0.7) | 0.5 (0.2-0.8) | 1.3 (0.9-1.6) | −0.1 (−0.6 to 0.4) | −0.8 (−1.2 to −0.3)† | −0.8 (−1.3 to −0.4)† |
| Tree nut | 0.2 (0.0-0.5) | 0.6 (0.2-0.9) | 1.5 (1.2-1.9) | −0.3 (−0.8 to 0.1) | −1.0 (−1.5 to −0.5)† | −1.3 (−1.7 to −0.9)† |
| Fish | 0.4 (0.1-0.8) | 0.6 (0.2-0.9) | 0.7 (0.4-1.0) | −0.1 (−0.6 to 0.3) | −0.2 (−0.6 to 0.3) | −0.3 (−0.7 to 0.2) |
| Shellfish | 1.3 (0.6-1.9) | 1.5 (1.0-2.0) | 1.8 (1.4-2.2) | −0.2 (−1.0 to 0.6) | −0.3 (−1.0 to 0.3) | −0.6 (−1.3 to 0.2) |
| Sesame | 0.2 (0.0-0.4) | 0.1 (0.0-0.1) | 0.2 (0.1-0.4) | 0.2 (−0.1 to 0.4) | −0.2 (−0.3 to −0.1)† | 0.0 (−0.3 to 0.2) |
| Milk | 0.4 (0.0-0.7) | 0.5 (0.2-0.8) | 0.8 (0.5-1.0) | −0.2 (−0.6 to 0.3) | −0.3 (−0.7 to 0.2) | −0.4 (−0.9 to 0.0) |
| Egg | 0.4 (0.1-0.7) | 0.6 (0.3-1.0) | 0.6 (0.4-0.8) | −0.2 (−0.7 to 0.3) | 0.0 (−0.4 to 0.4) | −0.2 (−0.6 to 0.2) |
| Wheat | 0.0 (0.0-0.0) | 0.5 (0.2-0.8) | 0.4 (0.2-0.6) | −0.5 | 0.1 (−0.3 to 0.5) | −0.4 |
| Soy | 0.1 (0.0-0.3) | 0.1 (0.0-0.2) | 0.1 (0.0-0.2) | 0.0 (−0.2 to 0.2) | 0.0 (−0.2 to 0.1) | 0.0 (−0.2 to 0.2) |
| Any | 3.2 (2.2-4.3) | 5.5 (4.5-6.4) | 8.2 (7.4-9.1) | −2.2 (−3.7 to −0.8)† | −2.8 (−4.1 to −1.5)† | −5.0 (−6.3 to −3.7)† |
| Probable | | | | | | |
| Peanut | 0.4 (0.1-0.7) | 0.4 (0.1-0.7) | 1.1 (0.8-1.4) | −0.1 (−0.5 to 0.4) | −0.7 (−1.2 to −0.3)† | −0.8 (−1.2 to −0.4)† |
| Tree nut | 0.2 (0.0-0.4) | 0.4 (0.1-0.7) | 1.4 (1.1-1.7) | −0.2 (−0.6 to 0.2) | −1.0 (−1.5 to −0.6)† | −1.2 (−1.6 to −0.8)† |
| Fish | 0.4 (0.1-0.8) | 0.5 (0.2-0.9) | 0.6 (0.4-0.9) | −0.1 (−0.6 to 0.4) | −0.1 (−0.5 to 0.3) | −0.2 (−0.6 to 0.2) |
| Shellfish | 1.1 (0.5-1.7) | 1.2 (0.8-1.7) | 1.5 (1.2-1.8) | −0.2 (−0.9 to 0.6) | −0.3 (−0.8 to 0.3) | −0.4 (−1.1 to 0.3) |
| Sesame | 0.2 (0.0-0.4) | 0.0 (0.0-0.1) | 0.2 (0.1-0.3) | 0.1 (−0.1 to 0.3) | −0.2 (−0.3 to 0.0) | 0.0 (−0.3 to 0.2) |
| Milk | 0.2 (0.0-0.4) | 0.2 (0.0-0.4) | 0.2 (0.1-0.3) | −0.1 (−0.3 to 0.2) | 0.1 (−0.2 to 0.3) | 0.0 (−0.2 to 0.2) |
| Egg | 0.4 (0.1-0.7) | 0.6 (0.2-1.0) | 0.6 (0.4-0.8) | −0.2 (−0.7 to 0.3) | 0.0 (−0.4 to 0.4) | −0.2 (−0.6 to 0.2) |
| Wheat | 0.0 (0.0-0.0) | 0.3 (0.1-0.6) | 0.3 (0.1-0.4) | −0.3 | 0.1 (−0.2 to 0.4) | −0.3 |
| Soy | 0.1 (0.0-0.3) | 0.1 (0.0-0.2) | 0.1 (0.0-0.2) | 0.0 (−0.2 to 0.2) | 0.0 (−0.2 to 0.1) | 0.0 (−0.2 to 0.2) |

*Immigrant status was only available for 14,904 participants.
†Statistically significant difference.

**TABLE IV.** Weighted perceived and probable prevalence estimates of food allergy according to Aboriginal identity*

| | (A) Aboriginal, % (95% CI) (n = 2265) | (B) Non-Aboriginal, % (95% CI) (n = 12,732) | Difference between A and B, % (95% CI) |
|---|---|---|---|
| Perceived | | | |
| Peanut | 1.2 (0.0-2.4) | 1.1 (0.8-1.4) | 0.1 (−1.2 to 1.3) |
| Tree nut | 0.7 (0.0-1.7) | 1.3 (1.0-1.6) | −0.6 (−1.6 to 0.4) |
| Fish | 1.4 (0.1-2.6) | 0.7 (0.4-0.9) | 0.7 (−0.6 to 2.0) |
| Shellfish | 2.1 (0.5-3.6) | 1.7 (1.4-2.1) | 0.3 (−1.3 to 2.0) |
| Sesame | 0.4 (0.0-1.1) | 0.2 (0.1-0.3) | 0.2 (−0.5 to 0.9) |
| Milk | 0.6 (0.0-1.2) | 0.7 (0.5-0.9) | −0.1 (−0.8 to 0.5) |
| Egg | 0.7 (0.0-1.5) | 0.6 (0.4-0.8) | 0.1 (−0.8 to 0.9) |
| Wheat | 0.2 (0.0-0.5) | 0.4 (0.2-0.5) | −0.2 (−0.6 to 0.2) |
| Soy | 0.0 (0.0-0.1) | 0.1 (0.1-0.2) | −0.1 (−0.2 to 0.0) |
| Any | 8.5 (5.3-11.6) | 7.4 (6.7-8.1) | 1.1 (−2.2 to 4.3) |
| Probable | | | |
| Peanut | 1.1 (0.0-2.4) | 1.0 (0.7-1.2) | 0.2 (−1.1 to 1.4) |
| Tree nut | 0.7 (0.0-1.6) | 1.2 (0.9-1.5) | −0.5 (−1.4 to 0.5) |
| Fish | 1.0 (0.0-2.2) | 0.6 (0.4-0.8) | 0.4 (−0.7 to 1.6) |
| Shellfish | 2.1 (0.5-3.6) | 1.4 (1.1-1.7) | 0.6 (−1.0 to 2.2) |
| Sesame | 0.4 (0.0-1.1) | 0.2 (0.1-0.3) | 0.2 (−0.5 to 0.9) |
| Milk | 0.0 (0.0-0.1) | 0.2 (0.1-0.3) | −0.2 (−0.3 to 0.0) |
| Egg | 0.7 (0.0-1.5) | 0.6 (0.4-0.8) | 0.1 (−0.7 to 0.9) |
| Wheat | 0.2 (0.0-0.5) | 0.2 (0.1-0.4) | −0.1 (−0.4 to 0.3) |
| Soy | 0.0 (0.0-0.1) | 0.1 (0.1-0.2) | −0.1 (−0.2 to 0.0) |

*Aboriginal identity was available for 14,997 individuals.

social and cultural factors.[33,34] Vierk et al and Pawlinska-Chmara et al also have observed that low socioeconomic status is associated with fewer self-reported food allergies but did not specifically target underrepresented groups[4] or only included children.[6]

Immigrants were less likely to self-report food allergy, and the odds of self-reporting food allergy increased by 2% for each additional year since immigrating to Canada. These findings support the "healthy immigrant effect," that is, new Canadians

**TABLE V.** Sociodemographic predictors of perceived allergy to any food

| Predictors | Model 1, OR (95% CI)*† | Model 2, OR (95% CI)*‡ | Model 3, OR (95% CI)*§ |
|---|---|---|---|
| Low education | 0.72 (0.71-0.74)‖ | 0.73 (0.71-0.74)‖ | 0.71 (0.69-0.72)‖ |
| Low income | 1.00 (0.97-1.03) | 0.97 (0.95-1.00) | 1.03 (1.00-1.06) |
| Immigrated ≥10 y go | 1.71 (1.63-1.80)‖ | | |
| Born in Canada | 2.95 (2.82-3.09)‖ | | |
| Immigrant to Canada | | 0.51 (0.50-0.53)‖ | |
| Years since immigration | | | 1.03 (1.03-1.03)‖ |
| Aboriginal identity | 1.01 (0.96-1.06) | 1.02 (0.97-1.06) | 1.01 (0.96-1.05) |
| Female child | 0.75 (0.72-0.78)‖ | 0.73 (0.71-0.76) | 0.76 (0.73-0.79)‖ |
| Male adult | 0.58 (0.57-0.59)‖ | 0.58 (0.57-0.59)‖ | 0.58 (0.57-0.59)‖ |
| Male child | 1.84 (1.76-1.93)‖ | 1.86 (1.78-1.95)‖ | 1.84 (1.76-1.93)‖ |

*All 3 models contained the following variables: education, household income, Aboriginal status, child, sex, and an interaction term between child and male (reference group, female adult).

†Immigrant status: contained a 3-level variable for immigrant status (new Canadian, the reference group, immigrated ≥10 y ago, born in Canada).

‡Immigrant status: contained a dichotomous variable for immigrant status (born in Canada, the reference group, vs immigrant).

§Immigrant status: contained a continuous variable for immigrant status, expressing the number of years since immigrating to Canada.

‖Statistically significant difference.

tend to have a low prevalence of chronic conditions but their health status worsens with time and eventually converges with that of the Canadian-born population.[35,36] In addition, many immigrants may become more aware of food allergy with increasing time in Canada and potentially be more likely to self-report. Our results are consistent with a recent American study, which reported that foreign-born children had a lower odds of having food allergy, but this study did not assess adult immigrants.[7]

Although the overall prevalence of food allergy may be hypothesized to be lower in individuals of Aboriginal identity because of larger household size, a higher number of early childhood infections, and poorer sanitation, which may protect against allergic diseases,[11,37-39] and because of less access to specialist health care,[9,40-42] we observed that the prevalence was similar between those with and those without Aboriginal identity. This may be because of an inadequate sample size or because our sample consisted of urban and off-reserve Aboriginal populations rather than on-reserve populations, where poor municipal infrastructure is more likely to be problematic. In contrast, a recent publication by our research team, by using the 2006 Aboriginal Children's Survey, demonstrated a lower prevalence among off-reserve Aboriginal children ages 0 to 5 years.[12]

Our study was limited by our inability to perform telephone interviews in languages other than English and French, even though one of the targeted groups was recent immigrants. However, given the extensive ethnic diversity in Canada, it would have been logistically very difficult and expensive to translate the lengthy telephone questionnaire into multiple languages and complete the data collection within a realistic time frame. With the moderate response rates observed in our study, representativeness of survey participants is an important yet often overlooked issue. It is important to consider the potential selection bias that may have arisen if participants and nonparticipants differed in their probability to self-report food allergy. We anticipate that participants may have been more likely to self-report food allergy, potentially inflating prevalence estimates. We are currently preparing a subsequent article about the effects of selection bias on prevalence estimates.

Our estimates of prevalence of allergy to specific foods are based on self-report of a convincing history or self-report of a physician diagnosis. In previous work, we had attempted to confirm self-reporting by requesting permission from participants to contact their physician and request results of diagnostic testing.[23] However, this was unsuccessful because many participants who self-reported food allergy either had not consulted a physician or refused to grant permission; in cases in which the participants consented, few physicians returned results. It is possible that the estimates in our study may have been lower if we required that self-report be confirmed with diagnostic testing. However, estimates for peanut allergy of Montreal school children for whom the diagnosis was based on confirmatory testing[43] were very similar to estimates based on history alone in our previous population-based telephone survey (the SCAAALAR study).[23] Hence, estimates generated in this study by self-report of a convincing history or physician diagnosis likely should not represent a substantial overestimation.

Analysis of this study indicates that Canadians with lower education and new Canadians have fewer food allergies. The difference may be real or apparent, and the reasons are largely unknown. It is possible that the lower prevalence in these vulnerable populations is partially due to underdiagnosis due to their inadequate access to health care services because of geographic, bureaucratic, cultural, and language barriers. These issues highlight important gaps in health care policy, and more research is needed to identify and address these impediments to ensure that all Canadians have an equal opportunity to seek and receive appropriate care. Indeed, our research team is undertaking in-depth studies with low-income families and new Canadians to explore the lived experiences of food allergies in these vulnerable populations.[12,44]

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