Demographic Characteristics associated with Food Allergy in a Nationwide Canadian Study

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To the Editor,

We conducted a nationwide Canadian telephone survey on food allergy (FA) prevalence between 02/2016 and 01/2017 (SPAACE [*S* urveying *P* revalence of Food*A* llergy in *A* ll *C* anadian*E* nvironments] to SPAACE [S2S][1]], targeting vulnerable populations (New, Indigenous, and lower-income Canadians) using 2006 Canadian Census data (Appendix). We compared prevalence between vulnerable and non-vulnerable populations[2] and reported (in univariable analysis) that prevalence was lower in immigrants and less-educated adults. We now examine the independent effect of these and other characteristics (age, sex, race/ethnicity, and household size) on FA.

The adult household respondent completed the Food Allergy Prevalence Questionnaire (FAPQ)[1,3,4] for each household member (Appendix). Food allergy was defined as *perceived* (self-report of any FA) or *probable* (self-report of a convincing history (Appendix) and/or physician diagnosis of a peanut, tree nut, fish, shellfish, sesame, milk, egg, wheat, and/or soy allergy).[1,4] The Research Ethics Boards of the Universities of Calgary and Waterloo approved the study. The association between *perceived* and *probable* FA and demographic characteristics was assessed through weighted univariable and multivariable random effects logistic regressions (Appendix).

Of 11,592 eligible households, 5874 completed the FAPQ (50.7% household response rate), providing data on 14,818 individuals (Table 1).

In multivariable analyses, adults [?]45 years (OR 0.69, 95% confidence interval (CI) 0.56, 0.86), New Canadians (OR 0.51, 95%CI 0.38, 0.69), those immigrating to Canada [?]10 years prior (OR 0.75, 95%CI 0.62, 0.92), and those residing in larger households (OR 0.82, 95%CI 0.75, 0.90) were less likely to report any *perceived* FA (Table 2). Females (OR 1.49, 95%CI 1.27, 1.74) and adults with post-secondary education (OR 1.20, 95%CI 1.02, 1.43) were more likely to report*perceived* FA.

New Canadians (OR 0.46, 95%CI 0.30, 0.68), those immigrating [?]10 years prior (OR 0.64, 95%CI 0.49, 0.82), and those residing in larger households (OR 0.85, 95%CI 0.77, 0.94) were less likely to report*probable* FA, whereas children (OR 1.95, 95%CI 1.38, 2.75), females (OR 1.49, 95%CI 1.22, 1.82), and adults with post-secondary education (OR 1.55, 95%CI 1.23, 1.96) were more likely to report*probable* FA.

In addition to many of the characteristics associated with any FA, race/ethnicity was also associated with some individual FA (Supplemental Table 1A&B).

When the sample was restricted to parents with at least one Canadian-born child, Asian-born parents were less likely to report any*perceived* (OR 0.40, 95%CI 0.24, 0.66) and *probable* FA (OR 0.29, 95%CI 0.14, 0.61) (Supplemental Table 2). However, Canadian-born children of Asian-born parents were more likely to report any*perceived* (OR 1.77, 95% CI 1.13, 2.76) and *probable* FA (OR 2.11, 95% CI 1.29, 3.43).

We have shown that while children, females, and adults with post-secondary education were more likely to report at least one*perceived* or *probable* FA and adults [?] 45 years, immigrants, and those in larger households were less likely to report FA, Asian and Indigenous race/ethnicity were associated with specific foods. It is likely that our observed association between FA and higher education and Canadian birthplace is attributable to increased FA awareness, better healthcare access, and differing genetic and environmental influences. The association between larger household size and decreased FA supports the hygiene hypothesis.[5] Our paradoxical finding of a lower odds of FA in Asian-born parents of Canadian-born children and a higher odds of FA in Canadian-born children of Asian-born parents suggests that early life environmental exposures, such as climate, dietary, and microbial, exert a differential effect depending on genetic background.

Although our nationwide sampling frame precluded food challenges and only included households with landlines and nonresponse bias may have influenced our results, we have demonstrated clear associations between demographic characteristics and FA, potentially important clues to environmental determinants.

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TABLES

Table 1. Demographic Characteristics among Full Sample and those Without and With *Perceived* and *Probable* + Food Allergy

			Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	
			Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	
Variable	**Full Sample (n=14,818)**	**Perceived**	**Perceived**	**Perceived**	**Perceived**	**Probable**	**Probable**	**Probab**
		Without Any *Perceived* FA (n=13,497)	**Without Any *Perceived* FA (n=13,497)**	**With Any *Perceived* FA (n=1321)**	**Difference % (95% CI)**	**Without Any *Probable* FA (n=14,038)**	**With Any of 9 *Probable* FA (n=780)**	**Differe % (95% CI)**
Age group, yrs								
0-17	2970 (20.0)	2750 (20.4)	2750 (20.4)	220 (16.7)	**3.7 (1.6, 5.8)**	2816 (20.1)	154 (19.7)	0.3 (-2.[illegible] 3.2)
18-44	4142 (28.0)	3763 (27.9)	3763 (27.9)	379 (28.7)	-0.8 (-3.4, 1.7)	3932 (28.0)	210 (26.9)	1.1 (-2.[illegible] 4.3)
[?] 45	7706 (52.0)	6984 (51.7)	6984 (51.7)	722 (54.7)	**-2.9 (-5.7, -0.1)**	7290 (51.9)	416 (53.3)	-1.4 (-5.[illegible] 2.2)
Female	7357 (49.6)	6575 (48.7)	6575 (48.7)	782 (59.2)	**-10.5 (-13.3, -7.7)**	6893 (49.1)	464 (59.5)	**-10.4 (-13.9, -6.8)**
Race/Ethnicity[1]								
Asian	2848 (19.2)	2656 (19.7)	2656 (19.7)	192 (14.5)	**5.1 (3.1, 7.2)**	2741 (19.5)	107 (13.7)	**5.8 (3.[illegible] 8.3)**
Black	988 (6.7)	922 (6.8)	922 (6.8)	66 (5.0)	**1.8 (0.6, 3.1)**	941 (6.7)	47 (6.0)	0.7 (-1.[illegible] 2.4)
Indigenous	1788 (12.1)	1643 (12.2)	1643 (12.2)	145 (11.0)	1.2 (-0.6, 3.0)	1709 (12.2)	79 (10.1)	2 (-0.1, [illegible]
White	7647 (51.6)	6849 (50.7)	6849 (50.7)	798 (60.4)	**-9.7 (-12.4, -6.9)**	7174 (51.1)	473 (60.6)	**-9.5 (-13.1, -6.0)**
Other	1547 (10.4)	1427 (10.6)	1427 (10.6)	120 (9.1)	1.5 (-0.1, 3.1)	1473 (10.5)	74 (9.5)	1.0 (-1.[illegible] 3.1)
Immigration status								
New Canadians, immigrated < 10 yrs prior	1554 (10.5)	1481 (11.0)	1481 (11.0)	73 (5.5)	**5.4 (4.1, 6.8)**	1514 (10.8)	40 (5.1)	**5.7 (4.[illegible] 7.3)**
Immigrated [?] 10 yrs prior	3389 (22.9)	3136 (23.2)	3136 (23.2)	253 (19.2)	**4.1 (1.8, 6.3)**	3256 (23.2)	133 (17.1)	**6.1 (3.[illegible] 8.9)**
Canadian-born	9875 (66.6)	8880 (65.8)	8880 (65.8)	995 (75.3)	**-9.5 (-12, -7.1)**	9268 (66.0)	607 (77.8)	**-11.8 (-14.8, -8.8)**

			Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	Frequency*, n (%)	
Adults with post-secondary education[2]	5696 (48.1)	5119 (47.6)	5119 (47.6)	577 (52.4)	**-4.8 (-7.9, -1.7)**	5357 (47.7)	339 (54.2)	**-6.4 (-10.4, -2.4)**
Household income								
Lower-income[3]	3362 (22.7)	3116 (23.1)	3116 (23.1)	246 (18.6)	**4.5 (2.2, 6.7)**	3216 (22.9)	146 (18.7)	**4.2 (1. 7.0)**
Higher-income	9672 (65.3)	8754 (64.9)	8754 (64.9)	918 (69.5)	**-4.6 (-7.2, -2.0)**	9135 (65.1)	537 (68.8)	**-3.8 (- -0.4)**
Missing income	1784 (12.0)	1627 (12.1)	1627 (12.1)	157 (11.9)	0.2 (-1.7, 2.0)	1687 (12.0)	97 (12.4)	-0.4 (-2 2.0)
Household size, # of members (SD)	3.5 (1.8)	3.5 (1.8)	3.5 (1.8)	3.0 (1.6)	**0.5 (0.4. 0.6)**	3.5 (1.8)	3.1 (1.7)	**0.4 (0.3, 0.6)**

[1] Race/ethnicity options include: Asian (Chinese, Japanese, Korean, Filipino, South Asian, and Southeast Asian), Black, Indigenous (self-identified with First Nations, Metis, or Inuit), White, and other (Arab, Latin American, West Asian (Middle East countries), other, multiple, and unknown race/ethnicity).

[2] Children $<$ 18 years were not asked this information.

[3] Lower-income Canadians were those whose self-reported before tax total household income was below the relevant low-income cut-off (LICO), as calculated yearly by Statistics Canada, for each of 7 household sizes and 5 community sizes. The LICO (before tax) is the income level at which families or unattached individuals spend on average 55% of before tax income on food, shelter, and clothing. Given we collected data on household income, household size, and postal code, we were able to ascertain if a household was below the LICO threshold.[6]

+ *Probable* food allergy was defined as any individual who was reported, by the household respondent, to have symptoms/signs compatible with a convincing history and/or a physician diagnosis of a peanut, tree nut, fish, shellfish, sesame, milk, egg, wheat, and/or soy allergy. Refer to Appendix for definition of convincing history.

*Except for household size where the mean (SD) number of household members is reported.

Abbreviations: FA: food allergy

Boldface cell indicate significant results.

Table 2. Univariable and Multivariable Logistic Regression Models: Demographic Characteristics Associated with any *Perceived*or *Probable* + Food Allergy, Odds Ratio (95% CI), n=14,818

	Any *Perceived* Food Allergy	Any *Perceived* Food Allergy	Any of 9 *Probable* Food Allergy	Any of 9 *Probable* Food Allergy
Variable	**Univariable Model**	**Multivariable Model**	**Univariable Model**	**Multivariable Model**
Age group[1]				
0-17 yrs	0.91 (0.73, 1.12)	-	1.17 (0.91, 1.51)	**1.95 (1.38, 2.75)**
[?]45 yrs	0.97 (0.83, 1.14)	**0.69 (0.56, 0.86)**	0.96 (0.78, 1.18)	-
Female	**1.46 (1.25, 1.70)**	**1.49 (1.27, 1.74)**	**1.47 (1.20. 1.80)**	**1.49 (1.22, 1.82)**
Race/ Ethnicity[2]				
Asian	**0.80 (0.64, 0.998)**	-	0.82 (0.62, 1.08)	-
Black	0.84 (0.59, 1.19)	-	1.09 (0.72, 1.65)	-
Indigenous	1.02 (0.71, 1.46)	-	0.72 (0.42, 1.23)	-
Other	0.81 (0.61, 1.07)	-	0.84 (0.60, 1.18)	-
Immigration status[3]				
New Canadians, immigrated < 10 yrs prior	**0.45 (0.34, 0.61)**	**0.51 (0.38, 0.69)**	**0.39 (0.27, 0.57)**	**0.46 (0.30, 0.68)**
Immigrant [?] 10 yrs	**0.71 (0.59, 0.84)**	**0.75 (0.62, 0.92)**	**0.60 (0.47, 0.76)**	**0.64 (0.49, 0.82)**
Post-secondary education[4]	**1.25 (1.06, 1.47)**	**1.20 (1.02, 1.43)**	**1.33 (1.08, 1.64)**	**1.55 (1.23, 1.96)**
Household income				
Income missing	1.02 (0.80, 1.32)	-	1.01 (0.72, 1.40)	-
Low income[5]	0.94 (0.77, 1.14)	-	0.96 (0.75, 1.21)	-
Household size[6]	**0.85 (0.80, 0.92)**	**0.82 (0.75, 0.90)**	**0.88 (0.81, 0.95)**	**0.85 (0.77, 0.94)**

[1] Reference group: $18 - 44$ years

[2] Race/ethnicity options include: Asian (Chinese, Japanese, Korean, Filipino, South Asian, and Southeast Asian), Black, Indigenous (self-identified with First Nations, Metis, or Inuit), White, and other (Arab, Latin American, West Asian (Middle East countries), other, multiple, and unknown race/ethnicity).

Reference group: White

[3] Reference group: Canadian-born

[4] Children < 18 years were not asked this information. Reference group: adults without post-secondary education

[5] Lower-income Canadians were those whose self-reported before tax total household income was below the relevant low-income cut-off (LICO), as calculated yearly by Statistics Canada, for each of 7 household sizes and 5 community sizes. The LICO (before tax) is the income level at which families or unattached individuals spend on average 55% of before tax income on food, shelter, and clothing. Given we collected data on household income, household size, and postal code, we were able to ascertain if a household was below the LICO threshold.[6] Reference group: Households that were not low income

[6] Household size is a continuous variable referring to number of members in the household.

$^{+}$ *Probable* food allergy was defined as any individual who was reported, by the household respondent, to have symptoms/signs compatible with a convincing history and/or a physician diagnosis of a peanut, tree nut, fish, shellfish, sesame, milk, egg, wheat, and/or soy allergy. Refer to Appendix for definition of convincing history.

Empty cells indicate the variable was not included in the selected model.

Boldface cells indicate significant results.

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