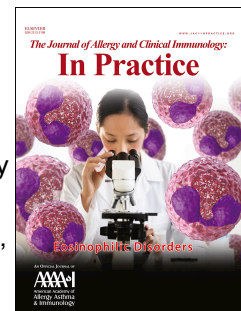


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Race/ethnicity, but not income, are associated with increased odds of shellfish allergy

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EMA is a member of the healthcare advisory board for Food Allergy Canada, does research with DBV Technologies, and is Section Head, Food Allergy and Anaphylaxis, Canadian Society of Allergy and Clinical Immunology

JDG is Executive Director, Food Allergy Canada, and co-leads Canada's National Food Allergy Action Plan.

JG declares no real or perceived conflicts of interest in relation to this study.

CLC declares no real or perceived conflicts of interest in relation to this study.

ES declares no real or perceived conflicts of interest in relation to this study.

JP is a member on the steering committee of Canada's National Food Allergy Action Plan, does research with DBV Technologies, and is Section Head, Allied Health, Canadian Society of Allergy and Clinical Immunology.

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Clinical Implications

In a sample of Canadians, food allergy phenotype differed based on race/ethnicity, with higher rates of shellfish allergy noted among Historically Underrepresented compared with individuals who reported as White. In contrast, no such associations were identified by income.

Food allergy affects approximately 6% of the population with an increase in prevalence over time.¹ While there is extensive research documenting an association between race/ethnicity, income, and other atopic conditions such as asthma,²⁻⁵ little research exists on the relationship between race/ethnicity, income and food allergy. A 2013 systematic review of racial disparities in food allergy in the United States noted 'sparse and methodologically limited data about race/ethnicity disparity in food allergy' but found no definitive disparities among available studies.⁶ In contrast, a 2016 retrospective cohort study of 817 American children noted differing food allergy phenotypes among different racial backgrounds, with higher rates of wheat, soy, corn, fish and shellfish allergy among African-American children vs. non-Hispanic White children, and higher rates of corn, fish and shellfish allergy among Hispanic children vs. non-Hispanic White children.⁷ The implications of the impact of race/ethnicity or income on food allergy phenotypes and prevalence are broad-reaching. As food allergy is a risk factor for severe asthma, understanding food allergy phenotypes in Historically Underrepresented groups may impact on food allergy, and asthma burden.⁷ In addition, as different groups have different dietary habits, the effects of specific food allergy within historically underrepresented groups may differ.⁶ Yet, to our knowledge, no study has examined the relationship between neither race/ethnicity, nor income, among children and adults with physician-diagnosed food allergy in Canada.

Our study population of N=151 was part of a cross-sectional survey on the costs of food allergy, including caregivers of children from a tertiary follow-up food allergy clinic in Winnipeg, Canada (n=56; 37.1%) and a corresponding online, national survey of adults and parents. For this latter group, we made use of data for children with participant/parent-reported physician-diagnosed food allergy (n=95; 62.9%). Demographic and food allergy characteristics, and open-ended answers on participant-reported race/ethnicity and monthly household after-tax income, were recorded. Exclusion criteria were the inability/discomfort responding to questions in English or French, or participant-reported race/ethnicity that was insufficiently descriptive for the categorizations defined herein (White: White, Caucasian; European, including those who named specific country/countries of ethnic origin, and those who reported part White; and Historically Underrepresented: Indigenous, including First Nations, Métis and those who named a specific origin; and, Asian, Black, and East Indian, including those who named specific country/countries of origin). Income was classified as below or above the median household after-tax income of \$70,336 Canadian dollars, based on the 2016 census,⁸ converted to \$5861.22 monthly, as well as income quartiles.

Data were described using n/N, %, and mean±standard deviation. Comparative statistics included chi² or Fisher exact tests, as appropriate for each sample size, between allergies to specific foods, and race/ethnicity. Of these analyses, those in which the p<0.10 were advanced to logistic regression, with corresponding odds ratios (OR) and 95% standard deviation (95%CI) reported, for which the groups "White" and "below median income" were the respective reference categories. Logistic regression analyses were performed first between race/ethnicity or income, and food allergy, then adjusted for income or race, respectively, as well as age, with p<0.05. This study was approved by the University of Manitoba Health Research Ethics Board (HS22066(H2018:319)).

Our study population was predominantly female (114/151; 78.7%) and was, on average, 30.7±20.9 years (**Table 1**). In total, 115/151 (76.2%) reported being White, and 36/151 (23.8%) reported being Historically Underrepresented. The most prevalent food allergy was peanuts/tree nuts (n=62), followed by egg (n=23) and shellfish (n=22). Mean monthly household income for participants who reported a

monthly income $\$7899 \pm \$8152$, after 4 outliers (monthly income $> \$60,000$) were excluded. In total, 56/151 (37.1%) fell below and 95/151 (72.9%) were above the Canadian median income.

Allergies to four foods (fish, peanut/tree nut, shellfish and wheat) were associated with race/ethnicity ($p < 0.10$). Of these foods, individuals who were Historically Underrepresented had an increased odds of allergies to shellfish (OR 3.99; 95%CI 1.35-11.8; $p = 0.012$), and approached, but did not quite reach statistical significance for wheat (OR 5.71; 95%CI 0.95-34.1; $p = 0.056$), compared to individuals who reported as White (**Table 2**). Individual-level analysis of self-reported race/ethnicity amongst those with a significantly increased odds of allergy to shellfish or wheat allergy yielded no further consistent pattern. In contrast, no types of food allergy were associated with income, using a binary cut-off (**Table 2**). Analyses by income quartiles were not possible due cell counts < 5 .

We present the first Canadian study of food allergy phenotype differences based on race/ethnicity, with higher rates of shellfish allergy among Historically Underrepresented compared with individuals who reported as White. This result aligns with an American study in which higher rates of wheat and shellfish allergy among African-American and Hispanic children compared to non-Hispanic White children.⁷ The reason for this discrepancy is unknown but is hypothesized to be multifactorial and may be related to age of introduction of allergens, diet, and for shellfish, possible differential exposure to cockroach and dust mite within the home.⁷ In contrast, no type of food allergy was associated with income.

Further research is required including evaluation of whether, among food allergic Canadians, other atopic conditions vary in prevalence by race/ethnicity, and whether healthcare utilization varies for food allergy (e.g. Emergency Department visits for anaphylaxis). Higher rates of food allergy-associated anaphylaxis and emergency department visits have been identified among African-American and Hispanic children compared with non-Hispanic White children.⁷ Unique strengths of our study include the open-ended way in which participants were able to self-describe their race/ethnicity, and a proportion of Historically Underrepresented individuals consistent with that of the Canadian population (22.3%).⁹ Although sample sizes precluded logistic regression analyses of food allergy prevalence by specific participant-reported race, we used these data *a posteriori* to examine individual-level race of Historically Underrepresented groups, which had an increased odds of shellfish allergy. Yet, little remains known about non-priority allergens, particularly amongst Historically Underrepresented groups. We firmly believe that this little explored area warrants substantial consideration going forward.

In conclusion, food allergy phenotypes differ by race/ethnicity, but not income, in Canada. These results require validation in larger studies, as well as research into how varying food allergies may inform education, guidance and policy.

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Table 1. Demographic Characteristics (N=151)

	n	%
Gender (N=146)		
Male	31	21.3
Female	114	78.7
Ethnicity		
White	115	76.2
Historically Underrepresented	36	23.8
Age groups (years; N=143)		
0-5	26	18.2
6-17	28	19.6
18-50	64	44.8
51+	25	17.5
Type of food allergy*		
Egg	23	15.2
Fish	20	13.2
Milk	17	11.3
Mustard	2	1.3
Peanut, tree nut	62	41.1
Sesame	9	6.0
Shellfish	22	14.6
Soy	10	6.6
Sulphites	6	4.0
Wheat	7	4.6
Has epinephrine autoinjector (N=95)		
No	31	32.6
Yes	64	67.4
Monthly household income Below or above median***		
Below	56	44.1
Above	71	55.9
By income quartile		
800 – 4,000	34	26.8
4,001 – 5,760	22	17.3
5,761 – 8,000	37	29.1
8,001 – 60,000	34	26.8
Mean age $\pm$ SD	30.7 $\pm$ 20.9	
Mean monthly household income $\pm$ SD (N=131)	12391 $\pm$ 28400	
Mean monthly household income $\pm$ SD (N=123)	7899 $\pm$ 8152	

*Not mutually exclusive

**Based on Statistics Canada median household income (2016)

***Excluding N=4 with household incomes >\$60000 Canadian per month

Table 2. Logistic Regression Analyses of Associations between Ethnicity, Income and Food Allergy

		Unadjusted		Adjusted*	
		OR	95%CI	OR	95%CI
Race					
Fish					
	White	1.00		1.00	
	Historically Underrepresented	2.48	0.92; 6.73	2.70	0.94; 7.84
Peanut, tree nut					
	White	1.00		1.00	
	Historically Underrepresented	1.96	0.92; 4.21	2.27	0.78; 6.60
Shellfish					
	White	1.00		1.00	
	Historically Underrepresented	2.80**	1.06; 7.38	3.39**	1.35; 11.8
Wheat					
	White	1.00		1.00	
	Historically Underrepresented	4.52	0.96; 21.4	5.71	0.95; 34.1
Income below or above median Canadian income					
Fish					
	Below	1.00		1.00	
	Above	1.02	0.40; 2.59	1.00	0.37; 2.73
Peanut, tree nut					
	Below	1.00		1.00	
	Above	1.07	0.57; 2.03	1.83	0.73; 4.54
Shellfish					
	Below	1.00		1.00	
	Above	0.98	0.42; 2.30	1.73	0.25; 2.11
Wheat					
	Below	1.00		1.00	
	Above	0.94	0.22; 4.12	0.86	0.18; 4.18

*Adjusted for income or ethnicity, based on exposures of ethnicity or income, respectively, and age

**p<0.05

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