Meat-Reduced Dietary Practices and Efforts in 5 Countries: Analysis of Cross-Sectional Surveys in 2018 and 2019

Lana Vanderlee,[1] Clara Gómez-Donoso,[2] Rachel B Acton,[3] Samantha Goodman,[3] Sharon I Kirkpatrick,[3] Tarra Penney,[4] Christina A Roberto,[5] Gary Sacks,[6] Martin White,[7] and David Hammond[3]

[1]École de Nutrition, Centre Nutrition, santé et société (Centre NUTRISS), and Institut sur la nutrition et les aliments fonctionnels (INAF), Université Laval, Québec, Canada; [2]Department of Preventive Medicine and Public Health, School of Medicine, University of Navarra, Pamplona, Spain; [3]School of Public Health Sciences, University of Waterloo, Waterloo, Canada; [4]Faculty of Health, York University, Toronto, Canada; [5]Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA; [6]Global Obesity Centre, Institute for Health Transformation, Deakin University, Geelong, Australia; and [7]Centre for Diet and Activity Research, Medical Research Council Epidemiology Unit, University of Cambridge, Cambridge, United Kingdom

ABSTRACT

Background: Diets that reduce reliance on animal-source foods are recommended in some contexts.

Objectives: This study aimed to compare proportions of respondents who reported following meat-reduced dietary practices (i.e., vegetarian, vegan, or pescatarian diets) and/or making efforts to reduce animal-source foods, and to examine sociodemographic correlates across 5 countries.

Methods: Online surveys were conducted in November and December 2018 and 2019 with 41,607 adults from Australia ($n = 7926$), Canada ($n = 8031$), Mexico ($n = 8110$), the United Kingdom ($n = 9129$), and the United States ($n = 8411$) as part of the International Food Policy Study. Respondents were asked whether they would describe themselves as vegetarian, vegan, or pescatarian, and whether they had made efforts to consume less red meat, less of all meats, or less dairy in the past year. Logistic regressions examined differences in the likelihood of each behavior between countries and sociodemographic subgroups.

Results: Approximately 1 in 10 respondents reported following a vegetarian, vegan, or pescatarian diet, ranging from 8.6% (Canada) to 11.7% (UK). In the past 12 months, the proportions of respondents who reported efforts to consume less red meat ranged from 34.5% (Australia) to 44.4% (Mexico), less of all meats ranged from 27.9% (US) to 35.2% (Mexico), and to consume less dairy ranged from 20.6% (UK) to 41.3% (Mexico). Respondents were more likely to report efforts to consume less animal-source products in 2019 compared to 2018 in most countries. Sociodemographic patterns varied by country; in general, women, those with higher education levels, and those in minority ethnic groups were more likely to report following meat-reduced dietary practices or efforts to consume fewer animal-source products.

Conclusions: Nearly half of respondents reported following a meat-reduced diet or efforts to reduce animal-source products, with differences between countries and population subgroups. Population-level approaches and policies that support meat reduction may further reduce consumption of animal-source products. *J Nutr* 2022;152:57S–66S.

Keywords: meat-reduced diets, sustainable diets, dietary patterns, vegetarianism, flexitarianism

Introduction

Increasing attention is being given to meat-reduced, plant-based diets globally (1, 2). Although increases in intakes of animal-source products may be favorable in countries where nutritional inadequacies are prevalent and meat can provide an important source of energy and essential nutrients, many governments and health organizations have recently been placing increased emphasis on plant-based diets and reduced consumption of animal-based products (3–5).

The reasons for promoting meat-reduced diets are multiple, including health, environmental sustainability, ethics and ani-

mal welfare, and personal values. High levels of processed and red meat consumption have been associated with detrimental health impacts, in particular colorectal cancer (6), whereas there is weaker evidence associating meat consumption with diabetes and weight gain (5). Meat and dairy can also be important sources of SFAs, which many national dietary guidelines recommended limiting and replacing with lower-fat or plant-based alternatives (7–9). Shifts towards diets lower in meat or animal-source products also relate to concerns around environmental sustainability. Meat and other animal-source products require greater resources (water, land, fertilizer, fuel)

and have elevated risks related to water contamination, greater greenhouse gas emissions, and biodiversity loss than most plant-based agricultural products ([10], [11]). Concerns over the ethical treatment of animals have also drawn attention to diets that rely less on animal-source products ([12]). In addition, some religious practices incorporate restrictions or avoidance of some types of animal-based products ([13]).

Vegetarianism and veganism are dietary practices that eliminate meat and all animal-source foods, respectively. In addition to traditional meat-avoidance diets, flexitarian or provegetarian diets, which generally aim to reduce meat consumption by incorporating moderate amounts of animal-source foods with generous amounts of plant-based foods, are becoming increasingly common as a way to reduce reliance on animal-source foods ([14–16]).

Although there is evidence demonstrating reduced meat consumption in some countries at a population level, the types of efforts individuals are making to reduce meat consumption are less evident ([17]). Data from the United States in 2010 showed that around 2% of the population self-identified as vegetarian, with 3% of those reporting vegan practices (i.e., total exclusion of animal-source foods) ([18]). Nationally representative Canadian data from 2015 suggest that approximately 5% of the population reported plant-based diets, with the majority (2.8%) excluding red meat, 1.3% vegetarian, and 0.3% vegan ([19]). Estimates of vegetarian and/or vegan practices in the United Kingdom range between 2% and 13%, with a greater percentage of meat reducers ([20], [21]).

Few studies have used consistent methods across countries to compare the prevalences of individuals who make efforts to practice plant-based diets or reduce meat consumption in large, population-based samples ([22]). This is especially true in upper-middle-income and high-income countries, which generally have the greatest consumption of animal-source foods, and where dietary guidance regarding animal-source foods differs between countries ([5], [9]). In addition, there may be important differences in efforts to consume fewer animal-source products among population subgroups, which can help inform targeted policies and interventions that may differ by country.

The first objective of the current research was to compare the proportions of respondents in 5 upper-middle-income and high-income countries who reported following meat-reduced dietary practices (i.e., vegetarian, vegan, or pescatarian diets) and/or making efforts to reduce animal-source foods. The second objective was to examine sociodemographic correlates of these dietary practices.

Methods

Data were drawn from the International Food Policy Study (IFPS). Online surveys were conducted in November and December 2018 and 2019 in Australia, Canada, Mexico, the United Kingdom (UK), and the United States (US). The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE #30829) and Université Laval (#2021-318).

Sample recruitment

The samples were recruited through the Nielsen Consumer Insights Global Panel using a standardized recruitment sampling strategy across countries. Quotas for age and sex were applied to facilitate recruitment of a diverse sample that approximated the known proportions in each country for males and females across age groups ([23–25]).

Eligibility criteria included being ≥18 years of age and residing in a target country. Email invitations with a unique link were sent to a random sample of panelists that met the inclusion criteria. If deemed eligible, potential respondents were provided with information about the study and provided consent prior to participating. Surveys were conducted in the primary language(s) spoken in each country. A data integrity check was included partway through the survey, and data integrity checks were conducted during data cleaning. Respondents received remuneration in accordance with their panel's usual incentive structure. Full methods of the IFPS surveys are reported elsewhere ([23]).

Online surveys were conducted with a total of 22,824 respondents in 2018 (Australia $n = 4103$; Canada $n = 4397$; Mexico $n = 4135$; UK $n = 5549$; US $n = 4640$) and 20,968 respondents in 2019 (Australia $n = 4225$; Canada $n = 4107$; Mexico $n = 4314$; UK $n = 4139$; US $n = 4183$). The response rates of respondents who completed the survey out of all those eligible who accessed the survey link were 69.2% in 2018 and 60.1% in 2019. Of these respondents, 922 (2.1%) were excluded for incomplete information on education, ethnicity, or perceived income adequacy, and a further 1263 (2.9%) were excluded for incomplete information for any of the outcome measures (dietary practices or dietary efforts), for an analytical sample size of 41,607.

Sampling weights

Data were weighted with poststratification sample weights constructed using a raking algorithm with population estimates from the census in each country based on age group, sex, region, ethnicity (except in Canada), and education (except in Mexico). Estimates reported are weighted unless otherwise specified.

Survey measures

To assess whether respondents were following a plant-based or meat-reduced dietary practice, they were asked, "would you describe yourself as:" with response options of vegetarian, vegan, pescatarian, following a religious practice for eating (with an open-ended text box to specify the practice), or none of the above. Those who selected multiple dietary practices were coded as following the most restrictive dietary practice (e.g., if they reported being both vegan and vegetarian, they were coded as vegan). Those who selected a dietary practice and none were coded as not following any specific dietary practice. Open-ended responses for religious practices were examined qualitatively. Given the inconsistencies in reporting (e.g., named religion compared with religious dietary practice), and a lack of clarity over whether these religious practices were related to reducing meat or following plant-based practices, responses to this measure were excluded from the categorization of vegetarian, vegan, or pescatarian practices in subsequent analyses.

Next, respondents were asked, "have you made an effort to consume more or less of the following in the past year" and shown a list of 17 macronutrients, micronutrients, food types, and food categories, with response options of: consume LESS, consume MORE, and no effort made. For this analysis, 3 variables relating to animal-source foods were

considered: dairy, all meats, and red meat (e.g., beef, pork) only. Those who identified as being vegetarian, vegan, or pescatarian in the previous variable were coded as "consume less" for red meats and all meats, as it was assumed they were trying to consume less meat compared to the general population, but may have reported that this was not a unique effort in the past year (e.g., they had been trying to consume less meat for a longer period). Similarly, those who identified as vegan were coded as "consume less" for dairy, as vegan diets normally exclude dairy.

Sociodemographics

Respondents reported their age (years) and sex at birth (male or female). Ethnicity and education were reported using relevant ethnicity measures from national-level surveys unique to each country (26–32) and were recategorized for comparability across countries as either majority or minority ethnicity (in Australia, majority indicates the participant only speaks English at home and minority indicates they speaks a language besides English at home; in Canada, the United Kingdom, and the United States, majority indicates the participant is White and minority indicates they are of another ethnicity; and in Mexico, majority indicates the participant identified as nonindigenous and minority indicates they identified as indigenous) and as low, medium, or high education level according to each nation's educational structure. Perceived income adequacy was assessed using a measure that asked, "thinking about your total monthly income, how difficult or easy is it for you to make ends meet?" The response options were very difficult, difficult, neither easy nor difficult, easy, and very easy, and were further categorized as either an adequate income (very easy, easy, or neither easy nor difficult to make ends meet) or inadequate income (difficult or very difficult to make ends meet). BMI was calculated from self-reported height and weight, using WHO BMI categories (<18.5 kg/m^2, 18.5–24.9 kg/m^2, 25–29.9 kg/m^2, ≥ 30 kg/m^2) (33). Those who were missing height and weight data were maintained in the analysis as a separate category, as those with missing BMI data may systematically differ from those who report height and weight data (34).

Analysis

Descriptive statistics examined the proportions of the sample that reported following any meat-reduced dietary practice (vegetarian, vegan, or pescatarian) and each practice individually (these categories were mutually exclusive). The extent to which individuals restricted meat for religious reasons was explored via coding of open-text responses.

Logistic regression models were conducted to examine differences in the odds of following any meat-reduced dietary practice (vegan, vegetarian, or pescatarian) and each practice of vegetarianism, veganism, and pescatarianism individually, with indicator variables for country and year, adjusting for age, sex, ethnicity, education, BMI, and perceived income adequacy, as these variables have been identified in the literature as potentially important correlates of following meat-reduced eating patterns (35–38) and differed between country samples. Next, a model was fitted to assess sociodemographic factors associated with practicing any of the meat-reduced dietary practices (vegan, vegetarian, or pescatarian), including the above-mentioned covariates, and testing for country by sociodemographic interactions. Sociodemographic interactions were significant at P values < 0.01; therefore, stratified models by country were conducted.

Additional logistic regression models examined country-level differences considering any efforts to consume less meat, red meat, or dairy, as well as each of the practices individually (consume less red meat, consume less all meats, consume less dairy), with the same country and year indicators and adjusting for the same set of variables. Individual models were fitted to again assess the sociodemographic factors associated with each effort individually, including the same covariates and testing for country by sociodemographic interactions. Sociodemographic interactions were again significant, and stratified models by country were conducted.

To account for multiple comparisons, 99% CIs are reported. All analyses were conducted using SAS v.14 (SAS Institute).

Results

Table 1 describes the characteristics of the sample.

Vegetarian, vegan, and pescatarian dietary practices

Figure 1 shows the unadjusted percentages of those following any and each dietary practice by country. The prevalence of practicing any meat-reduced practice (i.e., vegetarian, vegan, or pescatarian) ranged from 8.6% in Canada to 11.7% in the United Kingdom. The prevalence of vegetarianism ranged from 3.7% in Canada to 5.0% in the United Kingdom; the prevalence of veganism ranged from 2.5% in Canada to 5.0% in Mexico; and the prevalence of pescatarianism ranged from 1.9% in Mexico to 3.7% in the United Kingdom.

After coding open-text responses, 227 respondents (0.5%) specifically reported only consuming halal meat or following an Islamic dietary pattern, and 85 (0.2%) reported following a kosher diet or a Jewish dietary pattern (without specifically mentioning a kosher diet). Other common responses included habits frequently undertaken as part of Catholicism, such as abstaining from meat on Fridays or during Lent. In addition, some respondents reported not eating pork, beef, or shellfish without specifying which religion they were practicing. Other faiths included Hinduism, Mormonism, Seventh Day Adventists, Brahma Kumari, Buddhism, Eastern Orthodox or Christian Orthodox, and Bahá'í Faith (all less than 0.01% of the sample).

Differences in meat-reduced dietary practices between countries

Table 2 shows results of the logistic regression model examining between-country differences in the likelihood of reporting any meat-reduced practices (vegetarian, vegan, or pescatarian) and for vegetarianism, veganism, and pescatarianism individually. In adjusted models, Australia, UK, and US respondents were more likely to report any meat-reduced dietary practices than respondents in Mexico, and respondents in Australia and the United Kingdom were more likely to report meat-reduced practices than respondents in Canada. There were no differences in the likelihood of reporting any meat-reduced dietary practices among respondents in Australia, the United Kingdom, and the United States.

In adjusted models, respondents in Mexico were generally less likely to identify as vegetarian or pescatarian and more likely to identify as vegan compared to those in other countries. US respondents were more likely to identify as vegan compared to respondents from other primarily English-speaking countries (e.g., Canada, the United Kingdom, and Australia). Canadian respondents were less likely to identify as pescatarian compared to respondents in Australia and the United Kingdom.

Sociodemographic patterns and changes over time across countries

The results of logistic regressions examining the odds of following any meat-reduced dietary practices (vegetarian, vegan, or pescatarian) among sociodemographic subgroups suggested differences by country. Thus, country-stratified models were conducted (Table 3), and the most notable results are described below. The only country for which differences between study waves were observed was the United Kingdom, with a greater likelihood of following any meat-reduced practice in 2019 compared to 2018.

In Australia and the United Kingdom, females were more likely than males to report following any meat-reduced

TABLE 1 Sociodemographic characteristics of respondents in the analytic sample (weighted; $N = 41,607$)

	Total $N = 41,607$ % (n)	Australia $n = 7926$ % (n)	Canada $n = 8031$ % (n)	Mexico $n = 8110$ % (n)	UK $n = 9129$ % (n)	US $n = 8411$ % (n)
Year						
2018	51.9 (21,592)	49.0 (3884)	51.1 (4018)	48.9 (3965)	56.9 (5191)	52.8 (4444)
2019	48.1 (20,015)	51.0 (4042)	48.9 (3923)	51.1 (4145)	43.1 (3938)	47.2 (3967)
Age, y						
18–29	21.7 (9018)	21.1 (1670)	19.1 (1535)	29.6 (2399)	18.8 (1716)	20.2 (1697)
30–44	26.5 (11,020)	26.3 (2084)	24.9 (2000)	32.2 (2614)	24.1 (2205)	25.2 (2118)
45–59	26.0 (10,838)	24.6 (1950)	25.4 (2037)	28.4 (2302)	26.2 (2390)	25.7 (2158)
≥60	25.8 (10,731)	28.0 (2223)	30.6 (2459)	9.8 (794)	30.9 (2818)	29.0 (2437)
Sex						
Female	51.3 (21,330)	51.0 (4041)	50.4 (4046)	52.2 (4237)	51.3 (4684)	51.4 (4323)
Male	48.7 (20,277)	49.0 (3885)	49.6 (3985)	47.8 (3873)	48.7 (4445)	48.6 (4088)
Ethnicity[1]						
Majority group	80.3 (33,405)	75.8 (6005)	80.4 (6453)	79.0 (6403)	89.3 (8153)	76.0 (6390)
Minority group	19.7 (8202)	24.2 (1921)	19.6 (1578)	21.0 (1707)	10.7 (976)	24.0 (2021)
Education level[2]						
Low	42.5 (17,678)	41.7 (3304)	41.4 (3329)	20.7 (1682)	49.5 (4520)	57.6 (4844)
Medium	22.1 (9192)	32.7 (2591)	33.7 (2707)	13.1 (1058)	22.0 (2007)	9.8 (827)
High	35.4 (14,737)	25.6 (2031)	24.8 (1995)	66.2 (5370)	28.5 (2601)	32.6 (2740)
BMI classification						
<18.5 kg/m^2	2.9 (1222)	3.4 (266)	2.9 (230)	2.2 (175)	2.8 (255)	3.5 (295)
18.5–24.9 kg/m^2	34.3 (14,264)	35.2 (2793)	33.3 (2675)	38.3 (3102)	33.9 (3091)	30.9 (2603)
25.0–29.9 kg/m^2	28.7 (11,942)	27.3 (2161)	29.7 (2382)	31.5 (2558)	27.2 (2481)	28.1 (2361)
≥30.0 kg/m^2	20.7 (8606)	21.1 (1671)	23.5 (1885)	15.0 (1216)	17.4 (1590)	26.7 (2244)
Missing	13.4 (5573)	13.1 (1035)	10.7 (858)	13.1 (1058)	18.8 (1712)	10.8 (909)
Income adequacy[3]						
Adequate	69.3 (28,837)	71.4 (5661)	71.4 (5732)	57.1 (4628)	75.7 (6913)	70.2 (5902)
Inadequate	30.7 (12,770)	28.6 (2265)	28.6 (2299)	42.9 (3482)	24.3 (2216)	29.8 (2509)

[1] Ethnicity categories as per census questions asked in each country: 1) in Australia, majority indicates the participant only speaks English at home and minority indicates they speaks a language besides English at home; 2) in Canada, the United Kingdom, and the United States, majority indicates the participant is White and minority indicates they are of another ethnicity; and 3) in Mexico, majority indicates the participant is nonindigenous and minority indicates they are indigenous.

[2] Respondents were asked, "what is the highest level of formal education that you have completed?" Responses were categorized as low (completed secondary school or less), medium (some postsecondary qualifications), or high (university degree or higher) levels of education according to country-specific criteria.

[3] Respondents were asked, "thinking about your total monthly income, how difficult or easy is it for you to make ends meet?" Response options "very easy," "easy," and "neither easy nor difficult" were categorized as high income adequacy, and response options "difficult" and "very difficult" were categorized as low income adequacy.

practices, whereas in Mexico, females were less likely to report following any meat-reduced practices. In all countries except the United States, respondents in minority ethnic groups were more likely to report following any meat-reduced dietary practices. Those with a high education level were more likely to report following any meat-reduced practices compared to those with low levels of education in all countries except Mexico (where there was no difference). In all countries except Mexico,

respondents aged 18–29 years and those 30–44 years of age were more likely to report following a meat-reduced dietary practice compared to those who were 45–59 years and ≥60 years.

Efforts to consume less animal-source products

Figure 2 shows efforts in the past 12 months to consume less of any of the animal-source products queried, as well as
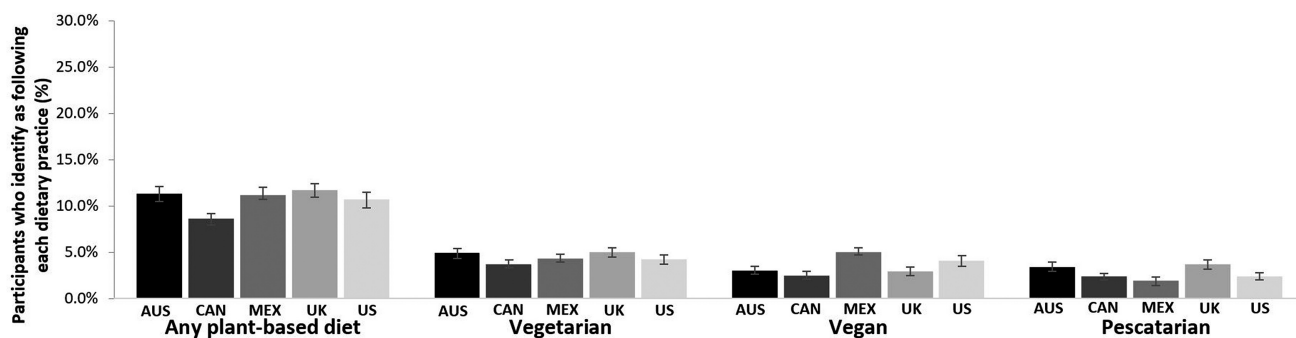

FIGURE 1 Unadjusted percentages of respondents in each country who identified as either vegetarian, vegan, or pescatarian, as well as each dietary practice individually across 5 countries in the International Food Policy Study 2018 and 2019. AUS, Australia; CAN, Canada; MEX, Mexico.

TABLE 2 Results of main effects from logistic regression models examining the likelihood of identifying as following any meat-reduced dietary practice (vegetarian, vegan, or pescatarian) and each practice individually, adjusted for sociodemographic factors[1]

Country comparison	Any meat-reduced dietary pattern AOR (99% CI)	Vegetarian AOR (99% CI)	Vegan AOR (99% CI)	Pescatarian AOR (99% CI)
Australia vs. Canada	1.26 (1.07–1.47)[2]	1.22 (0.97–1.54)	1.12 (0.83–1.50)	1.37 (1.04–1.80)[2]
Australia vs. Mexico	1.20 (1.01–1.41)[2]	1.40 (1.09–1.81)[2]	0.68 (0.52–0.89)[2]	1.95 (1.42–2.69)[2]
Australia vs. UK	0.87 (0.75–1.01)	0.87 (0.70–1.08)	0.96 (0.72–1.27)	0.83 (0.65–1.08)
Australia vs. US	0.97 (0.83–1.13)	1.07 (0.85–1.35)	0.65 (0.50–0.86)[2]	1.33 (0.99–1.79)
Canada vs. Mexico	0.95 (0.80–1.13)	1.15 (0.88–1.49)	0.60 (0.46–0.80)[2]	1.43 (1.03–1.98)[2]
Canada vs. UK	0.69 (0.59–0.81)[2]	0.71 (0.57–0.89)[2]	0.86 (0.64–1.15)	0.61 (0.47–0.79)[2]
Canada vs. US	0.77 (0.66–0.91)[2]	0.87 (0.69–1.11)	0.58 (0.44–0.78)[2]	0.97 (0.72–1.32)
Mexico vs. UK	0.73 (0.62–0.85)[2]	0.62 (0.49–0.79)[2]	1.42 (1.09–1.84)[2]	0.43 (0.31–0.58)[2]
Mexico vs. US	0.81 (0.69–0.96)[2]	0.76 (0.59–0.98)[2]	0.97 (0.75–1.24)	0.68 (0.48–0.96)[2]
UK vs. US	1.11 (0.95–1.30)	1.22 (0.97–1.54)	0.68 (0.52–0.89)[2]	1.60 (1.18–2.15)

[1] Adjusted for year, sex, age, ethnicity, education level, income adequacy, and BMI. The second category is the reference category. AOR, adjusted odds ratio.
[2] Significant at a *P* value < 0.01 in adjusted models.

red meat, all meats, and dairy, individually by country. The results of the logistic regression model examining differences between countries in any effort to consume less animal-source products and each behavior individually can be found in Table 4. Respondents in Mexico were more likely to report trying to consume less of any animal-source products compared to those in all other countries, and those in the United States were more likely to report trying to consume less of any animal-source product compared to those in Australia. A variety of between-country differences were identified for each food category. Respondents in Mexico were more likely to report trying to consume less red meat and less of all meats and less likely to report trying to consume less dairy compared to those in all other countries. Those in Australia were less likely to report trying to consume less red meat compared to those in all other primarily English-speaking countries. Respondents in the United States were more likely to report efforts to eat less of all meats compared to those in all other primarily English-speaking countries, and less likely to report efforts to consume less dairy compared to those in the United Kingdom. Respondents in Australia and the United Kingdom were more likely to report consuming less dairy than participants in Canada.

Sociodemographic patterns and changes in efforts to reduce animal source foods

There were significant interactions between country and education and country and age for reporting efforts to consume less red meat, and so results were stratified by country (Table 5). Notable patterns are described below. In all countries except Mexico, respondents were more likely to report trying to consume less red meat in 2019 than in 2018. In all countries, females and those in minority ethnic groups were more likely to report efforts to consume less red meat than males and those in majority ethnic groups. Those with higher levels of education were more likely to report efforts to consume less red meat compared to those with low or medium levels of education in all countries except Mexico. Respondents in the ≥60-year age category were more likely to report efforts to consume less red meat in all countries, and in Mexico this association was also present for those 45–59 years compared to those in younger age groups. Those with BMIs between 18.5 and 24.9 kg/m² were more likely to report consuming less red meat compared to those with BMIs ≥ 30 kg/m² in all countries except Mexico. Several other variations related to BMI existed within countries.

The models for efforts to consume less of all meats showed significant interactions between country and sex, education, BMI, and age; therefore, models were again stratified by country (Supplemental Table 1). Overall, trends in sociodemographic associations related to reporting efforts to consume less of all meats were similar to those related to reporting efforts to consume less red meat, with a few notable exceptions. There was no association between sex and efforts to consume less of all meats in Mexico, and there were fewer associations with age. Differing from the associations with red meat, those with inadequate incomes were more likely to report efforts to consume less of all meats in Australia, Canada, and the United Kingdom.

Models for less dairy consumption were similarly stratified (Supplemental Table 2), and results differed somewhat from the trends for red meat and all meats. Only respondents in Canada and the United Kingdom were more likely to report efforts to reduce dairy consumption in 2019 compared to 2018. Females were more likely to report efforts to consume less dairy in Australia, Canada, and the United Kingdom only, and those in minority ethnic groups were more likely to report efforts to consume less dairy in the United Kingdom and the United States only. There was an association with income in all countries, such that those with inadequate incomes were more likely to report efforts to consume less dairy, which was not an apparent association for red meat or all meats, and there were fewer associations with education. Age-related trends differed, such that those in the youngest age category were more likely to report efforts to reduce dairy consumption compared to those in the older age categories in all countries except Mexico, where there was a somewhat inverse association.

Discussion

Summary of main findings

Approximately 1 in 10 respondents reported following dietary practices that include little or no meat, and more than 4 in 10 were trying to reduce meat or dairy in their diet, with varying rates between countries.

Comparisons to the literature on plant-based and meat-reduced practices

The various methods used in population surveys to estimate rates of vegetarian, vegan, or pescatarian practices limit

TABLE 3 Results from stratified logistic regressions examining differences in identifying as following any meat-reduced dietary practice (i.e., vegetarian, vegan, or pescatarian) within each country (N = 41,607)[1]

	Australia (n = 7926) AOR (99% CI)	Canada (n = 8031) AOR (99% CI)	Mexico (n = 8110) AOR (99% CI)	United Kingdom (n = 9129) AOR (99% CI)	United States (n = 8411) AOR (99% CI)
Sex					
Female vs. male	1.24 (1.00–1.55)[2]	1.15 (0.90–1.46)	0.67 (0.54–0.85)[2]	1.28 (1.04–1.58)[2]	0.81 (0.64–1.03)
Ethnicity[3]					
Majority vs. minority group	0.63 (0.48–0.83)[2]	0.59 (0.45–0.78)[2]	0.50 (0.39–0.65)[2]	0.59 (0.44–0.80)[2]	0.79 (0.61–1.01)
Year					
2018 vs. 2019	0.90 (0.72–1.12)	0.85 (0.65–1.07)	0.96 (0.77–1.20)	0.81 (0.66–0.99)[2]	0.96 (0.81–1.15)
Perceived income adequacy[4]					
Adequate vs. inadequate	0.74 (0.58–0.94)[2]	0.81 (0.62–1.06)	0.95 (0.75–1.19)	0.80 (0.63–1.02)	0.94 (0.72–1.23)
Education[5]					
High vs. low	1.66 (1.23–2.25)[2]	1.58 (1.15–2.18)[2]	0.98 (0.74–1.29)	1.44 (1.13–1.83)[2]	1.53 (1.19–1.96)[2]
High vs. medium	1.12 (0.87–1.45)	1.11 (0.86–1.43)	0.96 (0.67–1.39)	1.25 (0.99–1.57)	1.61 (1.21–2.15)[2]
Low vs. medium	0.68 (0.51–0.90)[2]	0.70 (0.52–0.95)[2]	0.99 (0.66–1.48)	0.87 (0.66–1.14)	1.05 (0.77–1.45)
Age, years					
18–29 vs. 30–44	1.22 (0.91–1.63)	1.49 (1.10–2.02)[2]	0.99 (0.77–1.27)	1.35 (1.03–1.77)[2]	0.83 (0.61–1.13)
18–29 vs. 45–59	2.00 (1.45–2.76)[2]	2.63 (1.85–3.74)[2]	1.22 (0.90–1.65)	2.00 (1.46–2.74)[2]	1.83 (1.27–2.64)[2]
18–29 vs. ≥60	2.33 (1.67–3.26)[2]	2.45 (1.71–3.51)[2]	0.87 (0.53–1.42)	2.29 (1.67–3.13)[2]	2.49 (1.72–3.62)[2]
30–44 vs. 45–59	1.64 (1.21–2.22)[2]	1.77 (1.27–2.47)[2]	1.24 (0.92–1.66)	1.48 (1.10–1.99)[2]	2.19 (1.57–3.07)[2]
30–44 vs. ≥60	1.92 (1.41–2.62)[2]	1.65 (1.18–2.30)[2]	0.88 (0.53–1.45)	1.69 (1.25–2.27)[2]	2.99 (2.13–4.20)[2]
45–59 vs. ≥60	1.17 (0.84–1.63)	0.93 (0.65–1.34)	0.71 (0.42–1.21)	1.14 (0.82–1.59)	1.36 (0.92–2.01)
BMI					
<18.5 kg/m² vs. 18.5–24.9 kg/m²	1.18 (0.66–2.08)	1.48 (0.88–2.49)	1.43 (0.78–2.60)	1.10 (0.62–1.95)	1.93 (1.12–3.31)[2]
<18.5 kg/m² vs. 25.0–29.9 kg/m²	1.23 (0.67–2.24)	2.25 (1.29–3.92)[2]	1.69 (0.92–3.12)	1.63 (0.90–2.96)	3.23 (1.84–5.69)[2]
<18.5 kg/m² vs. ≥30 kg/m²	1.69 (0.90–3.17)	2.80 (1.57–4.99)[2]	2.20 (1.12–4.32)[2]	2.23 (1.16–4.27)[2]	4.03 (2.20–7.36)[2]
<18.5 kg/m² vs. missing	0.82 (0.44–1.51)	1.46 (0.80–2.65)	0.85 (0.45–1.59)	1.02 (0.56–1.84)	1.30 (0.72–2.33)
18.5–24.9 kg/m² vs. 25.0–29.9 kg/m²	1.05 (0.78–1.40)	1.52 (1.12–2.07)[2]	1.19 (0.90–1.56)	1.49 (1.14–1.94)[2]	1.68 (1.24–2.27)[2]
18.5–24.9 kg/m² vs. ≥30 kg/m²	1.44 (1.02–2.03)[2]	1.90 (1.33–2.70)[2]	1.54 (1.03–2.30)[2]	2.03 (1.39–2.96)[2]	2.09 (1.45–3.00)[2]
18.5–24.9 kg/m² vs. missing	0.70 (0.50–0.97)[2]	0.99 (0.67–1.45)	0.60 (0.43–0.82)[2]	0.93 (0.71–1.21)	0.67 (0.48–0.94)[2]
25.0–29.9 kg/m² vs. ≥30 kg/m²	1.37 (0.96–1.96)	1.25 (0.87–1.79)	1.30 (0.86–1.96)	1.37 (0.91–2.04)	1.25 (0.84–1.84)
25.0–29.9 kg/m² vs. missing	0.67 (0.47–0.95)[2]	0.65 (0.43–0.98)[2]	0.50 (0.36–0.71)[2]	0.62 (0.46–0.85)[2]	0.40 (0.27–0.58)[2]
≥30 kg/m² vs. missing	0.49 (0.33–0.72)[2]	0.52 (0.34–0.81)[2]	0.39 (0.25–0.60)[2]	0.46 (0.31–0.68)[2]	0.32 (0.21–0.49)[2]

[1]The second category is the reference category. AOR, adjusted odds ratio.

[2]Significant at a P value < 0.01 in adjusted models.

[3]Ethnic categories in each country as per census questions asked in each country: 1) in Australia, majority indicates the participant only speaks English at home and minority indicates they speaks a language besides English at home; 2) in Canada, the United Kingdom, and the United States, majority indicates the participant is White and minority indicates they are of another ethnicity; and 3) in Mexico, majority indicates the participant is nonindigenous and minority indicates they are indigenous.

[4]Respondents were asked "thinking about your total monthly income, how difficult or easy is it for you to make ends meet?" Response options "very easy," "easy," and "neither easy nor difficult" were categorized as adequate incomes, and response options "difficult" and "very difficult" were categorized as inadequate incomes.

[5]Education level was categorized as low (i.e., completed secondary school or less), medium (i.e., some postsecondary qualifications), or high (i.e., university degree or higher) according to country-specific criteria related to the highest level of formal education attained.

the comparability between studies (39). For example, the Canadian estimates from the current study are somewhat higher than nationally representative estimates from the 2015 Canadian Community Health Survey (CCHS), which found that 2% reported vegetarian or vegan dietary practices and <1% reported pescatarian practices. However, the data in the aforementioned study were coded using measures that asked about excluding specific food categories, rather than self-identification as following vegetarian or vegan practices (19). Individuals who identify as being vegetarian, vegan, or pescatarian but occasionally consume meat or animal-source products may not have been captured in the CCHS data set but potentially were captured here. The discrepancy could also reflect changes over time in the 4-year interval between the 2015 CCHS survey and the current study. Canadian rates from the current study were more closely aligned with self-reported vegetarian, vegan, and pescatarian practices, which were previously estimated to be around 7% in 2018 (40). Commercial research has suggested that the proportion of the population following plant-based diets in Australia was around 11% in 2016, higher than the estimate of 7.9% in the current study (41). In the United States, a Gallup poll found that 5% of the US population self-reported vegetarianism and 3% reported veganism (42)—similar to the findings of the current study—whereas national estimates from the NHANES 2007–2012 estimated that 2% of the population were meat abstainers (43). More generally, US market research suggests about 39% of Americans were trying to consume more plant-based foods in 2017 (39). In the United Kingdom, the estimated proportion of vegetarians ranges from 2% to 13% (20, 21). German research has compared rates of self-reported vegetarianism when defined as "strictly vegetarian" and "predominantly vegetarian," which were 3%, and 6%, respectively. The measures in our study did not specify whether dietary practices were strictly or predominantly followed, and so this was self-defined by respondents and the current estimates likely more closely resemble predominantly vegan, vegetarian, or pescatarian practices.
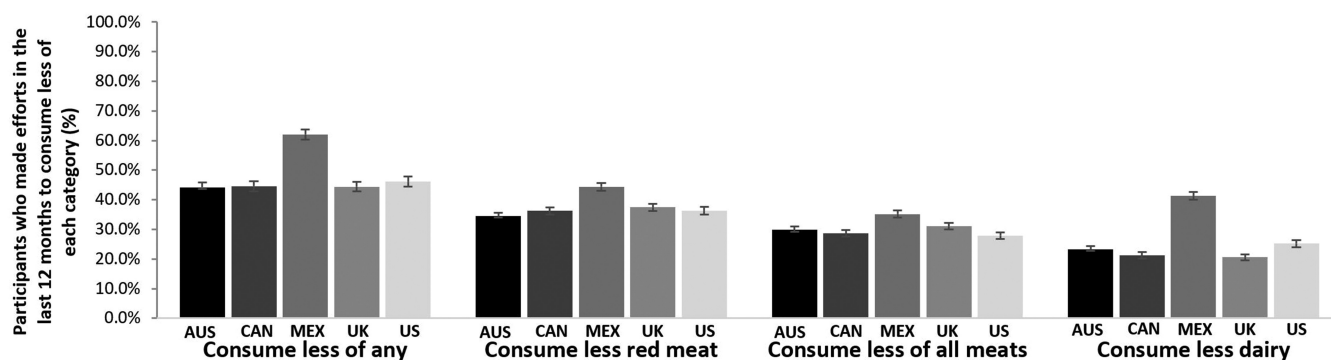
FIGURE 2 Unadjusted percentages of respondents who had made efforts in the last 12 months to consume less of any animal product (red meat, all meats, or dairy), as well as efforts to reduce each category individually across 5 countries in the International Food Policy Study 2018 and 2019. AUS, Australia; CAN, Canada; MEX, Mexico.

There were major differences between Mexico and the primarily English-speaking countries, which may reflect cultural and environmental factors, as well as different stages of the nutrition transition (44). Differences in national dietary guidelines with respect to the recommendations and guidance for environmental sustainability may contribute to additional between-country differences (9). Canadian respondents were less likely to report any of the meat-reduced dietary practices compared to other primarily English-speaking countries; how this will change over time given recent changes to Canadian dietary guidance (7) is of interest. The 2019 version of Canada's Food Guide incorporated recommendations to prioritize consumption of plant proteins, and deemphasized food categories of "milk and milk products" and "meat and alternatives" (7), which may have resulted in some changes to dietary efforts among Canadians between 2018 and 2019. Differences across countries relating to the food industry and the cost, availability, and marketing of meat and animal-source products, as well as sociocultural norms and traditions towards meat, may also contribute to differences between countries.

The current findings were mostly consistent with a large body of research that suggests females, those in younger age groups, and those with higher levels of education are more likely to report practicing plant-based diets (35–38). In some cultures, meat consumption has been linked to ideas of power, masculinity, and wealth (37, 45, 46). In addition, females may

be more prone to reduce meat consumption with health and weight-maintenance behavior goals in mind (47–49).

The current findings showed that those who practiced plant-based diets were more likely to have lower perceived income adequacy in Australia only, which aligns with some, but not all research (36). Previous studies have suggested a plateau or inverted U-shaped relationship between income and meat consumption (23). Differences in meat-reduced dietary practices and efforts to reduce meat consumption by ethnicity could be a result of different cultural attitudes and social norms towards meat consumption. In this study, we found that those in older age categories were more likely to report reducing meat consumption, whereas those in younger age groups were more likely to report following vegetarian, vegan, or pescatarian diets. This study did not assess baseline consumption of animal-source products: those in younger age groups may have already been practicing diets with reduced meat consumption, and thus they may not have reported a special effort to reduce an already low level of meat, red meat, or dairy in the past 12 months. Given this limitation, further research is warranted to assess patterns related to age.

Although overall rates of meat-avoidance dietary practices were approximately 10% in all countries, a greater proportion of respondents reported efforts to consume less dairy or meat. These findings may reflect heightened awareness of recommendations to reduce animal-source products, and

TABLE 4 Results of main effects from logistic regression models examining the likelihood of trying to consume less of any animal-source products (red meat, all meats, or dairy) and each source individually, adjusted for sociodemographic factors[1]

Country comparison	Efforts to consume less of any animal-source product AOR (99% CI)	Efforts to consume less red meat AOR (99% CI)	Efforts to consume less of all meats AOR (99% CI)	Efforts to consume less dairy AOR (99% CI)
Australia vs. Canada	0.96 (0.87–1.06)	0.91 (0.82–1.00)[2]	1.12 (0.83–1.50)	1.37 (1.04–1.80)[2]
Australia vs. Mexico	0.51 (0.46–0.56)[2]	0.68 (0.61–0.75)[2]	0.68 (0.52–0.89)[2]	1.95 (1.42–2.69)[2]
Australia vs. UK	0.92 (0.84–1.01)	0.83 (0.75–0.91)[2]	0.96 (0.72–1.27)	0.83 (0.65–1.08)
Australia vs. US	0.90 (0.82–1.00)[2]	0.90 (0.81–1.00)[2]	0.65 (0.50–0.86)[2]	1.33 (0.99–1.79)
Canada vs. Mexico	0.53 (0.48–0.59)[2]	0.75 (0.67–0.83)[2]	0.60 (0.46–0.80)[2]	1.43 (1.03–1.98)[2]
Canada vs. UK	0.95 (0.87–1.05)	0.91 (0.83–1.01)	0.86 (0.64–1.15)	0.61 (0.47–0.79)[2]
Canada vs. US	0.94 (0.85–1.04)	1.00 (0.90–1.10)	0.58 (0.44–0.78)[2]	0.97 (0.72–1.32)
Mexico vs. UK	1.80 (1.63–1.99)[2]	1.22 (1.10–1.35)[2]	1.42 (1.09–1.84)[2]	0.43 (0.31–0.58)[2]
Mexico vs. US	1.77 (1.60–1.97)[2]	1.33 (1.20–1.47)[2]	0.97 (0.75–1.24)	0.68 (0.48–0.96)[2]
UK vs. US	0.98 (0.89–1.08)	1.09 (0.99–1.20)	0.68 (0.52–0.89)[2]	1.60 (1.18–2.15)[2]

[1] Adjusted for year, sex, age, ethnicity, education level, income adequacy, and BMI. The second category is the reference category. AOR, adjusted odds ratio.
[2] Significant at a *P* value < 0.01 in adjusted models.

TABLE 5 Results from stratified logistic regressions examining differences in efforts to consume less red meat within each country (N = 41,607)[1]

	Australia (n = 7926) AOR (99% CI)	Canada (n = 8031) AOR (99% CI)	Mexico (n = 8110) AOR (99% CI)	United Kingdom (n = 9129) AOR (99% CI)	United States (n = 8411) AOR (99% CI)
Sex					
Female vs. male	1.40 (1.21–1.61)[2]	1.44 (1.25–1.66)[2]	1.27 (1.11–1.47)[2]	1.59 (1.39–1.83)[2]	1.35 (1.17–1.57)[2]
Ethnicity[3]					
Majority vs. minority group	0.69 (0.57–0.84)[2]	0.71 (0.59–0.86)[2]	0.78 (0.64–0.95)[2]	0.56 (0.43–0.71)[2]	0.61 (0.51–0.72)[2]
Year					
2018 vs. 2019	0.78 (0.68–0.90)[2]	0.83 (0.72–0.96)[2]	0.89 (0.77–1.02)	0.72 (0.63–0.82)[2]	0.79 (0.69–0.91)[2]
Perceived income adequacy[4]					
Adequate vs. inadequate	0.86 (0.73–1.00)[2]	0.93 (0.79–1.10)	0.89 (0.77–1.03)	0.87 (0.73–1.03)	0.96 (0.81–1.13)
Education[5]					
High vs. low	1.55 (1.28–1.87)[2]	1.34 (1.12–1.61)[2]	0.87 (0.72–1.04)	1.62 (1.39–1.89)[2]	1.55 (1.33–1.80)[2]
High vs. medium	1.34 (1.12–1.59)[2]	1.22 (1.05–1.42)[2]	0.84 (0.68–1.06)	1.38 (1.19–1.61)[2]	1.36 (1.15–1.60)[2]
Low vs. medium	0.86 (0.73–1.02)	0.91 (0.77–1.08)	0.98 (0.76–1.26)	0.85 (0.72–1.01)	0.88 (0.74–1.05)
Age, years					
18–29 vs. 30–44	0.98 (0.79–1.23)	1.16 (0.93–1.45)	0.88 (0.74–1.03)	1.01 (0.81–1.26)	0.98 (0.78–1.23)
18–29 vs. 45–59	0.86 (0.69–1.07)	0.90 (0.72–1.13)	0.66 (0.54–0.79)[2]	0.83 (0.66–1.04)	0.93 (0.74–1.17)
18–29 vs. ≥60	0.63 (0.51–0.78)[2]	0.61 (0.49–0.77)[2]	0.44 (0.32–0.60)[2]	0.68 (0.55–0.85)[2]	0.71 (0.57–0.88)[2]
30–44 vs. 45–59	0.87 (0.71–1.06)	0.78 (0.64–0.95)[2]	0.75 (0.62–0.90)[2]	0.82 (0.67–1.00)	0.95 (0.77–1.16)
30–44 vs. ≥60	0.64 (0.53–0.78)[2]	0.53 (0.43–0.64)[2]	0.51 (0.37–0.69)[2]	0.68 (0.56–0.81)[2]	0.72 (0.60–0.88)[2]
45–59 vs. ≥60	0.74 (0.61–0.88)[2]	0.68 (0.56–0.82)[2]	0.68 (0.49–0.93)[2]	0.82 (0.69–0.99)[2]	0.76 (0.63–0.92)[2]
BMI					
<18.5 kg/m² vs. 18.5–24.9 kg/m²	1.02 (0.66–1.56)	1.05 (0.68–1.62)	0.82 (0.50–1.33)	0.79 (0.52–1.20)	1.28 (0.82–1.99)
<18.5 kg/m² vs. 25.0–29.9 kg/m²	1.01 (0.65–1.56)	1.23 (0.79–1.90)	0.88 (0.54–1.44)	0.93 (0.61–1.43)	1.45 (0.93–2.27)
<18.5 kg/m² vs. ≥30 kg/m²	1.24 (0.80–1.93)	1.32 (0.85–2.06)	0.96 (0.58–1.61)	1.10 (0.71–1.71)	1.68 (1.07–2.64)[2]
<18.5 kg/m² vs. missing	1.11 (0.70–1.76)	1.16 (0.72–1.87)	0.66 (0.40–1.11)	0.91 (0.59–1.40)	1.24 (0.77–2.01)
18.5–24.9 kg/m² vs. 25.0–29.9 kg/m²	0.99 (0.83–1.18)	1.16 (0.97–1.39)	1.08 (0.91–1.28)	1.18 (1.00–1.40)[2]	1.13 (0.94–1.36)
18.5–24.9 kg/m² vs. ≥30 kg/m²	1.22 (1.00–1.48)[2]	1.25 (1.03–1.53)[2]	1.18 (0.95–1.47)	1.39 (1.13–1.71)[2]	1.31 (1.08–1.59)[2]
18.5–24.9 kg/m² vs. missing	1.09 (0.86–1.39)	1.10 (0.85–1.43)	0.81 (0.65–1.02)	1.15 (0.94–1.41)	0.97 (0.75–1.25)
25.0–29.9 kg/m² vs. ≥30 kg/m²	1.23 (1.01–1.50)	1.08 (0.88–1.32)	1.09 (0.88–1.37)	1.18 (0.95–1.46)	1.16 (0.95–1.41)
25.0–29.9 kg/m² vs. missing	1.11 (0.86–1.42)	0.95 (0.73–1.24)	0.75 (0.60–0.95)[2]	0.97 (0.78–1.21)	0.85 (0.66–1.11)
≥30 kg/m² vs. missing	0.90 (0.69–1.16)	0.88 (0.67–1.16)	0.69 (0.53–0.90)[2]	0.82 (0.65–1.05)	0.74 (0.57–0.97)[2]

[1] The second category is the reference category. AOR, adjusted odds ratio.

[2] Significant at a P value < 0.01 in adjusted models.

[3] Ethnic categories in each country as per census questions asked in each country: 1) in Australia, majority indicates the participant only speaks English at home and minority indicates they speaks a language besides English at home; 2) in Canada, the United Kingdom, and the United States, majority indicates the participant is White and minority indicates they are of another ethnicity; and 3) in Mexico, majority indicates the participant is nonindigenous and minority indicates they are indigenous.

[4] Respondents were asked "thinking about your total monthly income, how difficult or easy is it for you to make ends meet?" Response options "very easy," "easy," and "neither easy nor difficult" were categorized as adequate incomes, and response options "difficult" and "very difficult" were categorized as inadequate incomes.

[5] Education level was categorized as low (i.e., completed secondary school or less), medium (i.e., some post-secondary qualifications), or high (i.e., university degree or higher) according to country-specific criteria related to the highest level of formal education attained.

particularly meat, in the general population. The current results found a smaller absolute proportion of those who reported meat reduction compared to a previous US study (24); however, both studies found that reductions in red meat were the most common efforts made by respondents. Evidence from Australia has suggested that approximately 22% of the population reported a willingness to reduce meat, and an additional 15% were willing to stop consuming meat products (25). Flexitarian or "plant-forward" diets that prioritize plant-based foods and reduce animal-based foods may be advantageous from a behavioral point of view, as they are less restrictive than traditional plant-based patterns that typically include abstinence, while still having associated health and environmental benefits (14, 50). Nevertheless, flexitarian food profiles can vary greatly, resulting in very different health and environmental impacts (14). For instance, if meat products with a high environmental impact are replaced with dairy products, the environmental benefits of reducing meat may be minimized or eliminated (14). Future research to characterize the diversity of plant-forward diets, particularly in relation to animal food substitutes and how this might shift consumption, is warranted.

As a novel measure, this study also examined efforts to reduce dairy consumption. One study in a Swedish population has suggested that a small proportion of respondents reported avoiding dairy in their diet for health-related reasons, and females were more likely to consider dairy as unhealthy (51). Reducing dairy products, the production of which contributes to greenhouse gas emissions, water depletion, and other environmental impacts, may have implications for the healthfulness and sustainability of dietary patterns (52, 53). Literature on the health benefits of dairy consumption is mixed, and recommendations for dairy intake among adults vary between countries (7, 53–56). Examining trends in dairy avoidance or reduction can help to understand how these practices are shifting over time in relation to guidance and other

messaging, including from industry. Changes between 2018 and 2019 may signal a growing interest in reducing animal-based foods.

Strengths and limitations

This study included a large sample size and used the same methods and measures across countries, providing for a rigorous comparison between 5 high-income and upper-middle-income countries. This study employed self-reported measures, and did not provide definitions of vegetarian, vegan, or pescatarian; thus, it may have captured more flexible definitions of these dietary practices than studies based on food exclusions alone. This study did not attempt to classify the diets of those who followed religious dietary practices typically associated with limiting meat consumption. This study did not examine other types of food categories that relate to animal-source products, such as trying to reduce consumption of eggs, trying to increase consumption of plant-based protein foods, or trying to reduce or exclude consumption of ultraprocessed foods (57–59), nor did it assess processed meat independently. Lastly, this study did not examine the motivations for dietary practices or efforts, which are known to differ across populations (39, 60, 61).

This study is subject to limitations common to survey research. Respondents were recruited using nonprobability-based sampling; therefore, the findings do not provide nationally representative estimates. The study used self-reported height and weight to assess BMI, likely resulting in underestimation; in addition, there were notably higher levels of missing data for BMI in the United Kingdom. Lastly, this study examined sex rather than gender, as sex data were more complete in the data set, and differences in dietary practices and patterns may emerge differently when gender is examined.

Policy implications and future directions

This study demonstrates that a considerable proportion of respondents in Australia, Canada, Mexico, the United Kingdom, and the United States are trying to reduce consumption of animal-based products, by following plant-based or meat-reduced practices or making concerted efforts to reduce meat and dairy intake. Overall, meat reduction was more common than meat avoidance across all countries. If consumption of fewer meat or animal-source products is a policy goal, this research suggests that policy levers that promote reduction—rather than complete avoidance—of dairy and meat consumption may be more appealing to the population and more likely to be effective in shifting population dietary practices, while maintaining adequate nutritional intake.

Future work to understand not only the proportions of populations trying to consume less meat and other animal-based products, but also similarities and differences in motivations between countries, will be key in identifying potential policy levers to further reduce meat and animal-product consumption. Targeted policy efforts to shift social norms and purchasing patterns of meat and animal-source products will likely be critical to realizing major shifts in consumption. Better understanding of the role that reducing meat consumption can play in promoting healthy and sustainable diets across the socioeconomic spectrum will support targeted and consistent messaging to the population. The global research agenda must also further elucidate what changes to dietary patterns and shifts between food categories may reduce animal-source products while maintaining healthy, sustainable, and accessible diets.

Data Availability

Data are available to external researchers upon reasonable request.

References

1. Willett W, Rockström J, Loken B, Springmann M, Lang T, Vermeulen S, Garnett T, Tilman D, DeClerck F, Wood A, et al. Food in the anthropocene: The EAT-Lancet Commission on healthy diets from sustainable food systems. Lancet North Am Ed 2019;393(10170):447–92.
2. Kim BF, Santo RE, Scatterday AP, et al. Country-specific dietary shifts to mitigate climate and water crises. Glob Environ Chang 2020;62:101926.
3. Jackson J, Williams R, McEvoy M, MacDonald-Wicks L, Patterson A. Is higher consumption of animal flesh foods associated with better iron status among adults in developed countries? A systematic review. Nutrients 2016;8(2):89.
4. Dror DK, Allen LH. The importance of milk and other animal-source foods for children in low-income countries. Food Nutr Bull 2011;32(3):227–43.
5. Godfray HCJ, Aveyard P, Garnett T, et al. Meat consumption, health, and the environment. Science 2018;361(6399):eaam5324.
6. Bouvard V, Loomis D, Guyton KZ, et al. Carcinogenicity of consumption of red and processed meat. Lancet Oncol 2015;16(16):1599–600.
7. Government of Canada. Canada's food guide [Internet]. 2019. Available from: https://food-guide.canada.ca/en/.
8. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020–2025. 9th Edition. 2020 [Internet]. Available from: https://DietaryGuidelines.gov.
9. Herforth A, Arimond M, Álvarez-Sánchez C, Coates J, Christianson K, Muehlhoff E. A global review of food-based dietary guidelines. Adv Nutr 2019;10(4):590–605.
10. Harguess JM, Crespo NC, Hong MY. Strategies to reduce meat consumption: A systematic literature review of experimental studies. Appetite 2020;144:104478.
11. Mekonnen MM, Hoekstra AY. A global assessment of the water footprint of farm animal products. Ecosystems 2012;15(3):401–15.
12. de Boer J, Aiking H. Considering how farm animal welfare concerns may contribute to more sustainable diets. Appetite 2022;168:105786.
13. Grigg D. The pattern of world protein consumption. Geoforum 1995;26(1):1–17.
14. Springmann M, Wiebe K, Mason-D'Croz D, Sulser TB, Rayner M, Scarborough P. Health and nutritional aspects of sustainable diet strategies and their association with environmental impacts: A global modelling analysis with country-level detail. Lancet Planet Health 2018;2(10):e451–61.
15. Derbyshire EJ. Flexitarian diets and health: A review of the evidence-based literature. Front Nutr 2017;3:55.
16. Gómez-Donoso C, Martínez-González MÁ, Martínez JA, et al. A provegetarian food pattern emphasizing preference for healthy plant-derived foods reduces the risk of overweight/obesity in the SUN cohort. Nutrients 2019;11(7):1553.
17. Bagul K, Koerten J, Rees T. Evolving trends in food and nutrition [Internet]. 2020. Available from: https://go.euromonitor.com/anufood 20.html.

18. Juan W, Yamini S, Britten P. Food intake patterns of self-identified vegetarians among the US population, 2007–2010. Procedia Food Sci 2015;4:86–93.

19. Valdes M, Conklin A, Veenstra G, Black JL. Plant-based dietary practices in Canada: Examining definitions, prevalence and correlates of animal source food exclusions using nationally representative data from the 2015 Canadian Community Health Survey-Nutrition. Public Health Nutr 2021;24(5):777–86.

20. Bryant CJ. We can't keep meating like this: Attitudes towards vegetarian and vegan diets in the United Kingdom. Sustainability 2019;11(23):6844.

21. Grassian DT. The dietary behaviors of participants in UK-based meat reduction and vegan campaigns–A longitudinal, mixed-methods study. Appetite 2020;154:104788.

22. Frank SM, Jaacks LM, Batis C, Vanderlee L, Taillie LS. Patterns of red and processed meat consumption across North America: A nationally representative cross-sectional comparison of dietary recalls from Canada, Mexico, and the United States. Int J Environ Res Public Health 2021;18(1):357.

23. Vranken L, Avermaete T, Petalios D, Mathijs E. Curbing global meat consumption: Emerging evidence of a second nutrition transition. Environ Sci Policy 2014;39:95–106.

24. Neff RA, Edwards D, Palmer A, Ramsing R, Righter A, Wolfson J. Reducing meat consumption in the USA: A nationally representative survey of attitudes and behaviours. Public Health Nutr 2018;21(10):1835–44.

25. Malek L, Umberger WJ, Goddard E. Committed vs. uncommitted meat eaters: Understanding willingness to change protein consumption. Appetite 2019;138:115–26.

26. Australia Bureau of Statistics. 2016 Census of population and housing: Language spoken at home [Internet]. 2016. Available from: https://profile.id.com.au/australia/language.

27. Government of Ontario. Data standards for the identification and monitoring of systemic racism [Internet]. 2021. Available from: https://www.ontario.ca/document/data-standards-identification-and-monitoring-systemic-racism.

28. International Tobacco Control Policy Evaluation Project. 4-Country smoking and vaping w1 [Internet]. 2009. Available from: https://itcproject.s3.amazonaws.com/uploads/documents/ITC_4CV1_web_Eng_09May.pdf.

29. Statistics Canada. Canadian Community Health Survey - Annual component (CCHS) [Internet]. 2013. Available from: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&lang=en&db=imdb&adm=8&dis=2.

30. Office for National Statistics. Ethnic group, national identity and religion [Internet]. 2016. Available from: https://www.ons.gov.uk/methodology/classificationsandstandards/measuringequality/ethnicgroupnationalidentityandreligion.

31. Instituto Nacional de Salud Pública. Encuesta nacional de salud y nutrición medio camino [Internet]. 2016. Available from: https://ensanut.insp.mx/encuestas/ensanut2016/descargas/hogar/hogar_socioeconomico/hogar_socioeconomico.pdf.

32. Instituto Nacional de Estadística y Geografía (INEGI). Encuesta Intercensal 2015 [Internet]. n.d. Available from: https://www.inegi.org.mx/programas/intercensal/2015/.

33. WHO Regional Office for Europe. Body mass index – BMI [Internet]. n.d. Available from: https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi.

34. Read SH, Lewis SC, Halbesma N, Wild SH. Measuring the association between body mass index and all-cause mortality in the presence of missing data: Analyses from the Scottish National Diabetes Register. Am J Epidemiol 2017;185(8):641–9.

35. Cramer H, Kessler CS, Sundberg T, et al. Characteristics of Americans choosing vegetarian and vegan diets for health reasons. J Nutr Educ Behav 2017;49(7):561–567.e1.

36. Pfeiler TM, Egloff B. Examining the "veggie" personality: Results from a representative German sample. Appetite. 2018;120:246–55.

37. Rothgerber H. Real men don't eat (vegetable) quiche: Masculinity and the justification of meat consumption. Psychol Men Masc 2013;14(4):363.

38. Allès B, Baudry J, Méjean C, et al. Comparison of sociodemographic and nutritional characteristics between self-reported vegetarians, vegans, and meat-eaters from the Nutrinet-Santé study. Nutrients 2017;9(9):1023.

39. Miki AJ, Livingston KA, Karlsen MC, Folta SC, McKeown NM. Using evidence mapping to examine motivations for following plant-based diets. Curr Dev Nutr 2020;4(3):nzaa013.

40. Charlebois S, Simogyi S, Music J. Plant-based dieting and meat attachment: Protein wars and the changing Canadian consumer (preliminary results). Truro, Canada: Dalhousie University; 2018.

41. Roy Morgan R. The slow but steady rise of vegetarianism in Australia [Internet]. 2016. Available from: http://www.roymorgan.com/findings/vegetarianisms-slow-but-steady-rise-in-australia-201608151105.

42. Reinhart R. Gallup. Snapshot: Few Americans vegetarian or vegan [Internet]. Gallup. 2018. Available from: https://news.gallup.com/poll/238328/snapshot-few-americans-vegetarian-vegan.aspx.

43. Conrad Z, Karlsen M, Chui K, Jahns L. Diet quality on meatless days: National Health and Nutrition Examination Survey (NHANES), 2007–2012. Public Health Nutr 2017;20(9):1564–73.

44. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev 2012;70(1):3–21.

45. Schösler H, de Boer J, Boersema JJ, Aiking H. Meat and masculinity among young Chinese, Turkish and Dutch adults in the Netherlands. Appetite 2015;89:152–9.

46. De Backer C, Erreygers S, De Cort C, et al. Meat and masculinities. Can differences in masculinity predict meat consumption, intentions to reduce meat and attitudes towards vegetarians? Appetite 2020;147:104559.

47. Wardle J, Haase AM, Steptoe A, Nillapun M, Jonwutiwes K, Bellisie F. Gender differences in food choice: The contribution of health beliefs and dieting. Ann Behav Med 2004;27(2):107–16.

48. Rosenfeld DL. Gender differences in vegetarian identity: How men and women construe meatless dieting. Food Qual Prefer 2020;81:103859.

49. Rosenfeld DL, Tomiyama AJ. Gender differences in meat consumption and openness to vegetarianism. Appetite 2021:166:105475.

50. Springmann M, Clark M, Mason-D'Croz D, et al. Options for keeping the food system within environmental limits. Nature 2018;562(7728):519–25.

51. Bärebring L, Palmqvist M, Winkvist A, Augustin H. Gender differences in perceived food healthiness and food avoidance in a Swedish population-based survey: A cross sectional study. Nutr J 2020;19(1):140.

52. Clune S, Crossin E, Verghese K. Systematic review of greenhouse gas emissions for different fresh food categories. J Clean Prod 2017;140:766–83.

53. Wang Y, Li S. Worldwide trends in dairy production and consumption and calcium intake: Is promoting consumption of dairy products a sustainable solution for inadequate calcium intake? Food Nutr Bull 2008;29(3):172–85.

54. Ding M, Li J, Qi L, et al. Associations of dairy intake with risk of mortality in women and men: Three prospective cohort studies. BMJ 2019;367:l6204.

55. Morency M-E, Birken CS, Lebovic G, et al. Association between noncow milk beverage consumption and childhood height. Am J Clin Nutr 2017;106(2):597–602.

56. Chartres N, Fabbri A, McDonald S, Diong J, McKenzie JE, Bero L. Association of food industry ties with findings of studies examining the effect of dairy food intake on cardiovascular disease and mortality: Systematic review and meta-analysis. BMJ Open 2020;10(12):e039036.

57. Seferidi P, Scrinis G, Huybrechts I, Woods J, Vineis P, Millett C. The neglected environmental impacts of ultra-processed foods. Lancet Planet Health 2020;4(10):e437–8.

58. Fardet A, Rock E. Ultra-processed foods and food system sustainability: What are the links? Sustainability 2020;12(15):6280.

59. Clark MA, Springmann M, Hill J, Tilman D. Multiple health and environmental impacts of foods. Proc Natl Acad Sci 2019;116(46):23357–62.

60. Ruby MB. Vegetarianism. A blossoming field of study. Appetite 2012;58(1):141–50.

61. Hartmann C, Siegrist M. Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. Trends Food Sci Technol 2017;61:11–25.