Carbon footprint of Canadian self-selected diets: comparing intake of food groups, nutrients, and diet quality among low- and high-GHGE diets

Olivia Auclair

PhD student, McGill University

Supervisor – Dr. Sergio Burgos

Colloque Excellence en Relève

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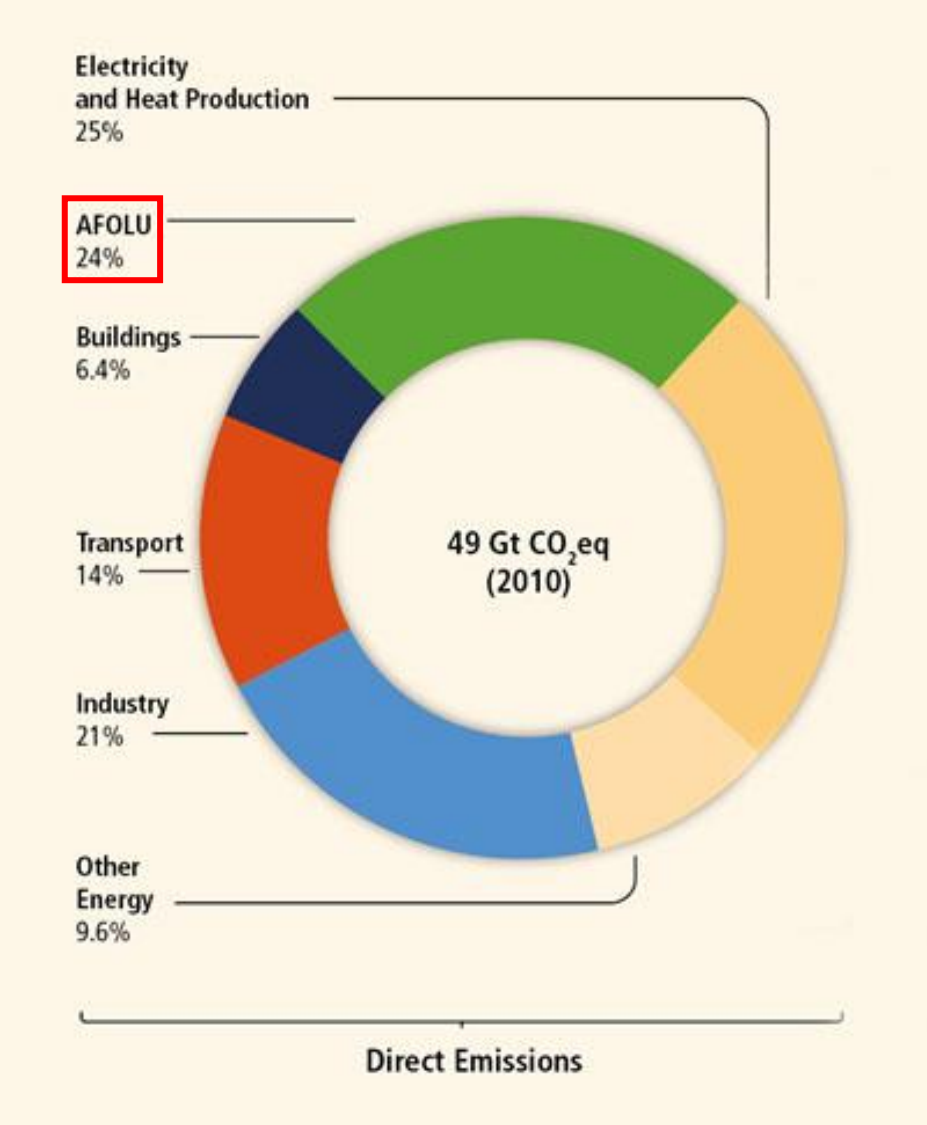
Background

Contribution of the global food system to climate change

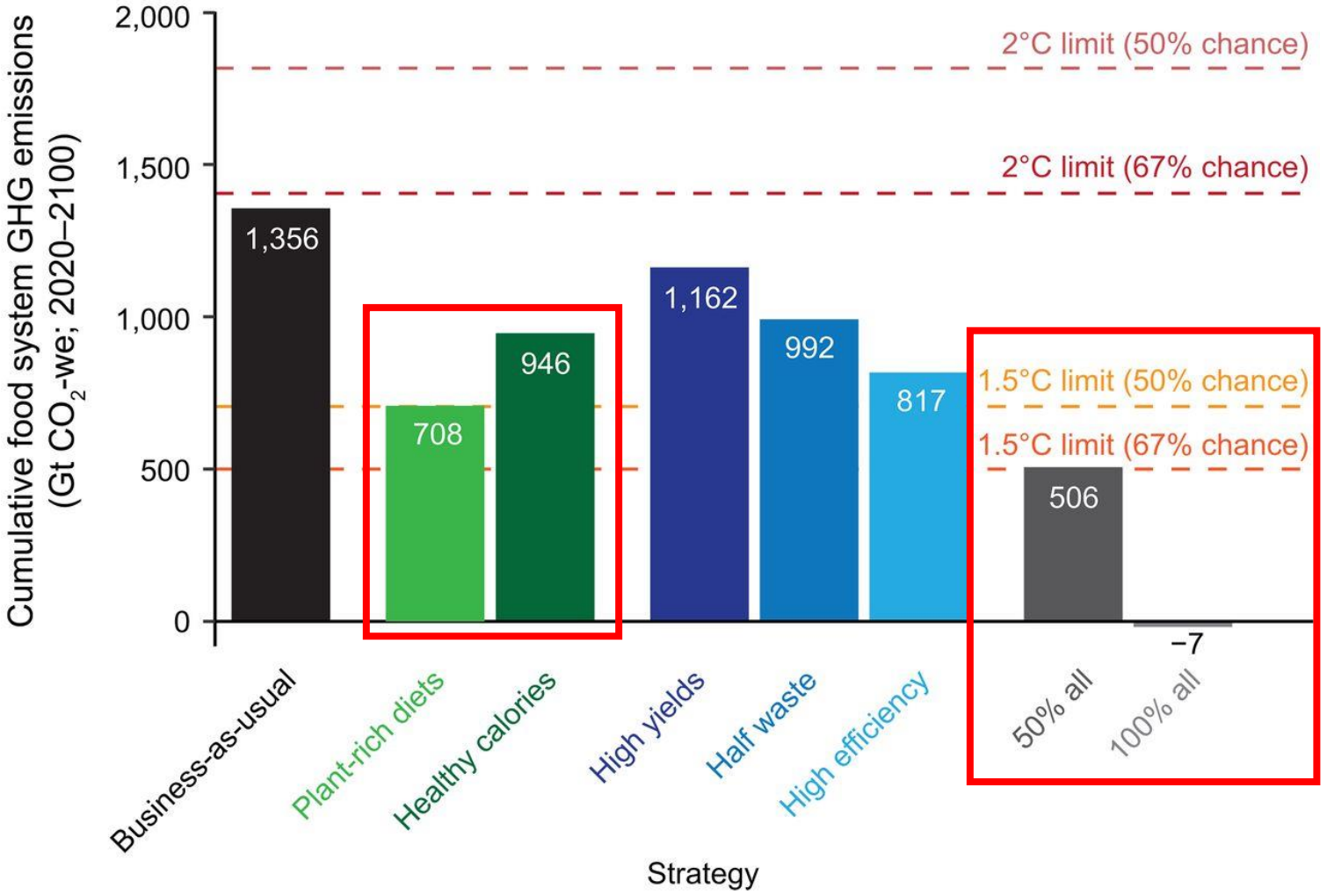
- The global food system accounts for ¼ of greenhouse gas emissions (GHGE).
- The Paris Agreement aims to limit global temperature rise to 1.5°C.
- GHGE must be ↓ 45% from 2010 levels by 2030.



IPCC. (2015). AR5 Climate Change: 2014. Mitigation of Climate Change.

Projected cumulative 2020-2100 GHGE from the global food system

- Business-as-usual
- Dietary patterns
- Food supply chains
- Combined changes



M. A. Clark et al. (2020). *Science, 370:* 705-708.

Food supply chain

- Major sources of GHGE are:
  - Land clearing
  - Fertilizers
  - Enteric fermentation
  - Rice paddies
  - Livestock manure
  - Fossil fuels

- Other impacts:
  - Land use
  - Water use
  - Acidification
  - Eutrophication
  - Loss of biodiversity

61% of GHGE

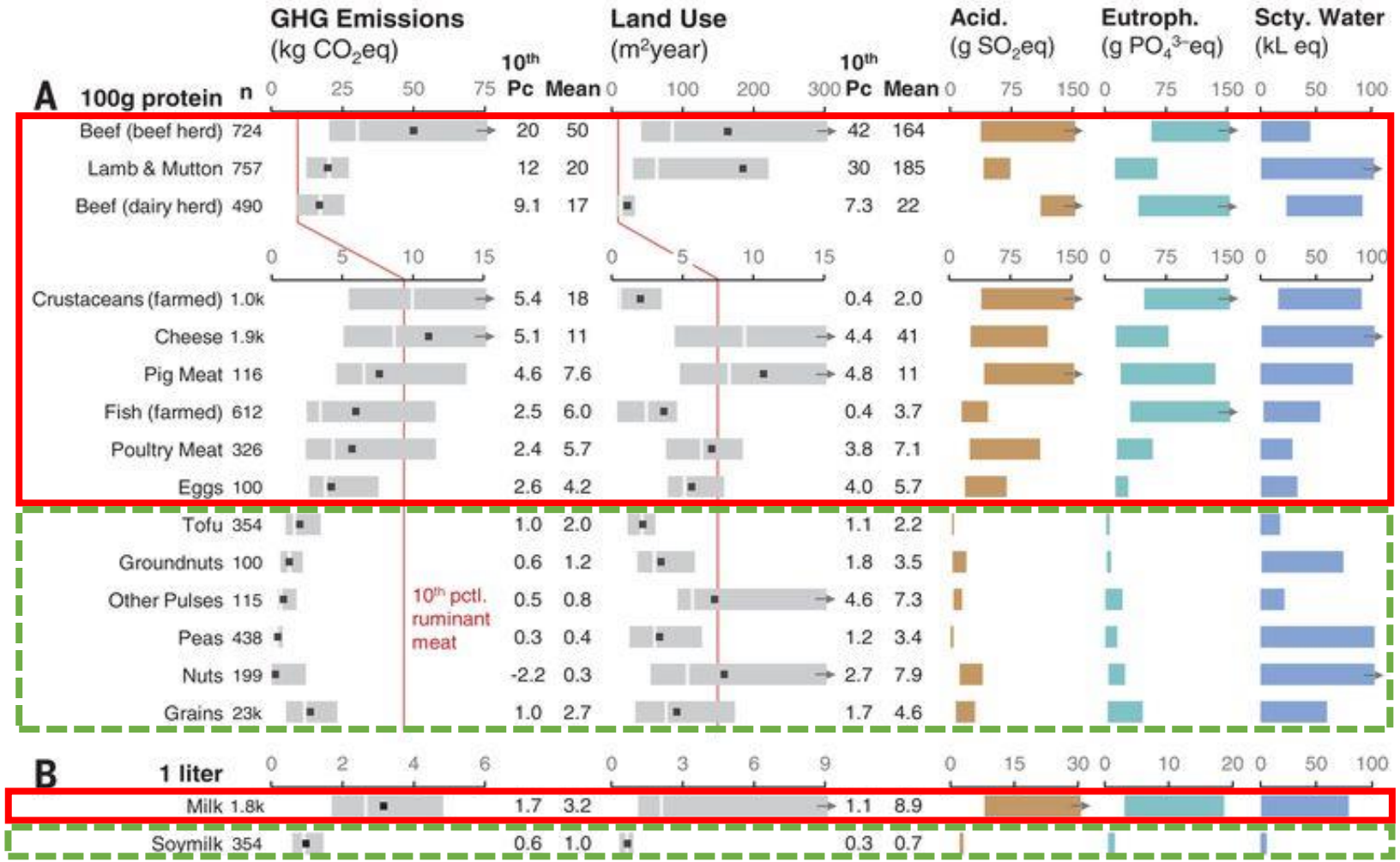
J. Poore and T. Nemecek. (2018). *Science, 360* (6392): 987-992.

Animal- and plant-based foods

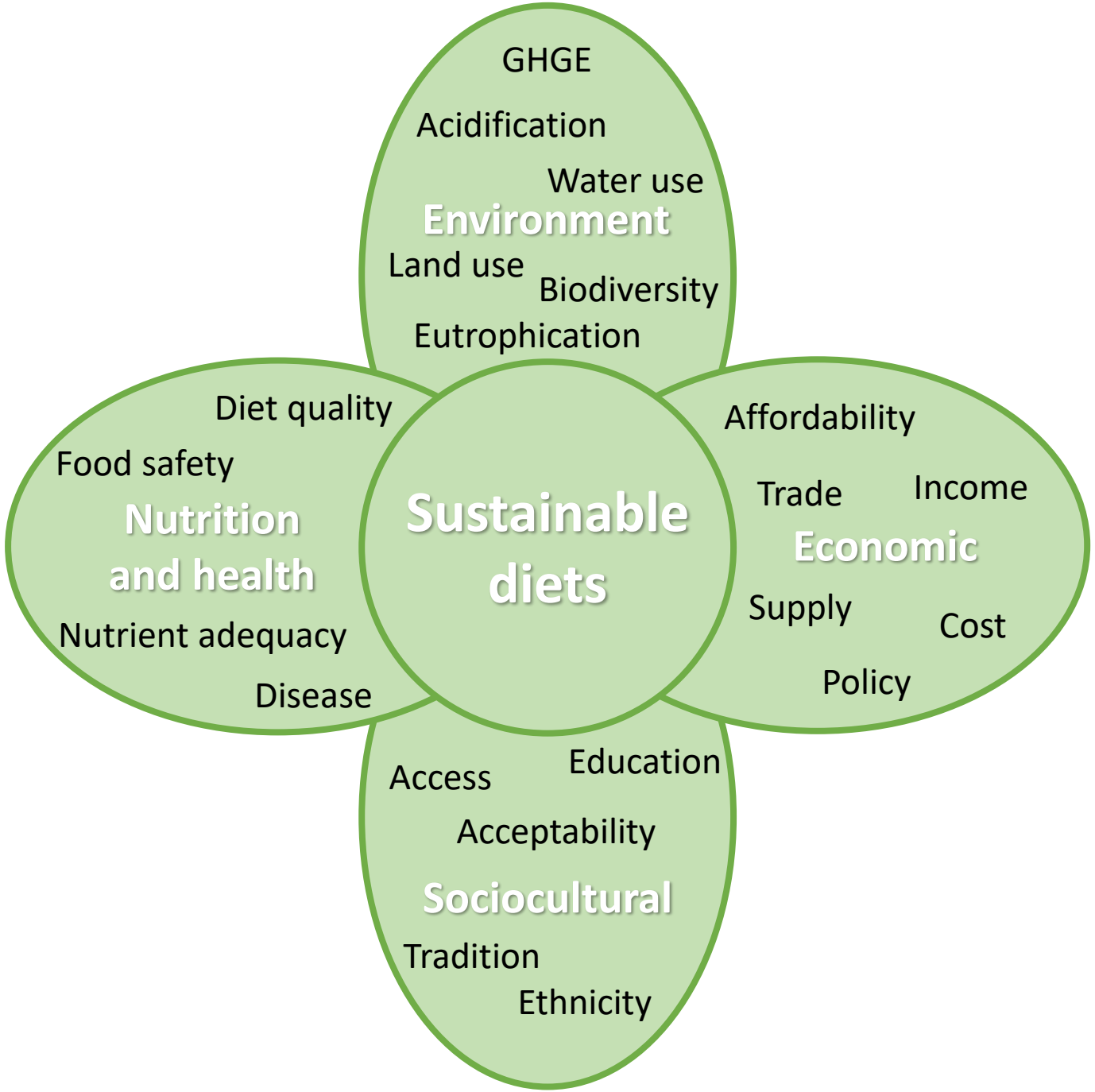
(A) Protein-rich foods.
(B) Milk and soy beverage.

Animal-based foods

Plant-based foods



J. Poore and T. Nemecek. (2018). *Science, 360* (6392): 987-992.


GHGE
Acidification
Water use
Environment
Land use
Biodiversity
Eutrophication
Diet quality
Food safety
Nutrition and health
Nutrient adequacy
Disease
Sustainable diets
Affordability
Trade
Income
Economic
Supply
Cost
Policy
Education
Access
Acceptability
Sociocultural
Tradition
Ethnicity

What do sustainable diets look like?

- GHGE estimates of single foods are linked to dietary intake from **national nutrition surveys**.

- Environmental, nutritional, economic, and sociocultural characteristics of **population-wide habitual diets**.

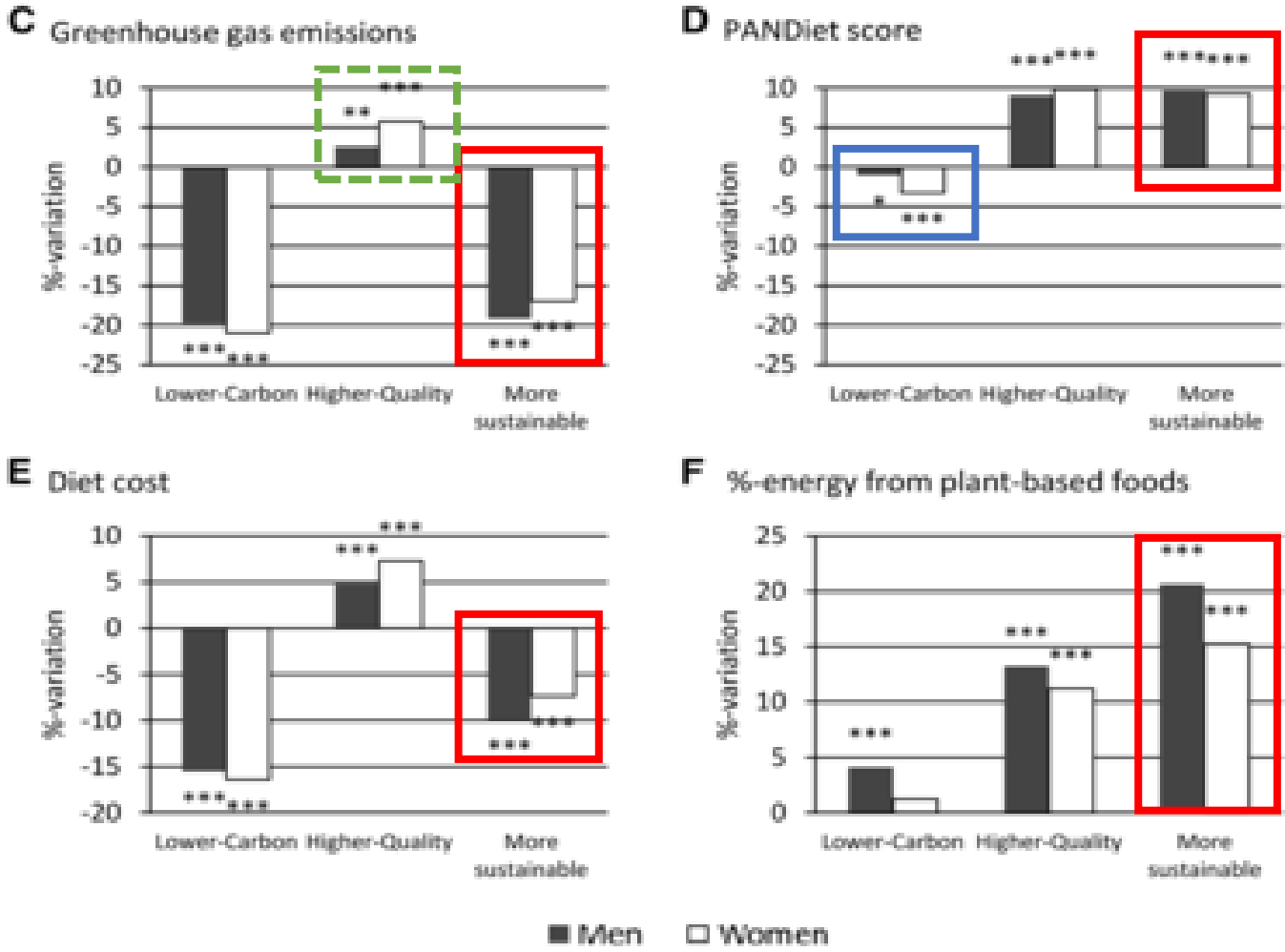
Population-wide habitual diets

More sustainable

Higher-quality

Lower-carbon

- In **France**, 20% of adults consumed ‘more sustainable’ diets.
- Trade-offs among environmental sustainability and nutritional adequacy.

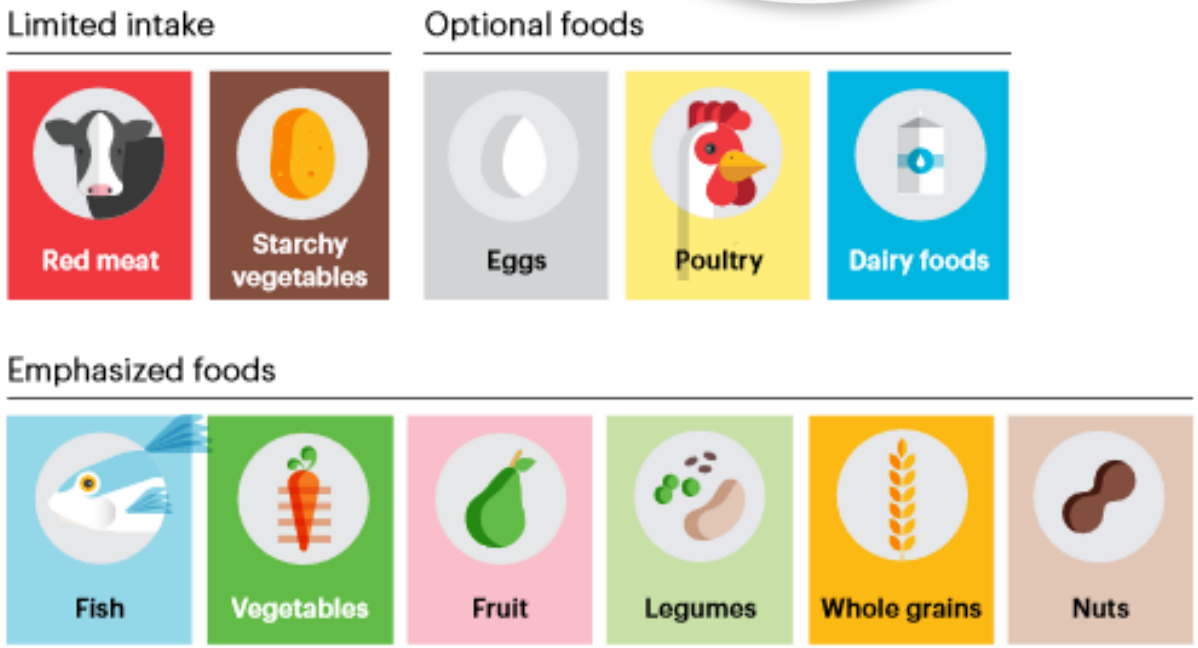


%-variation between means of ‘average diets’.

Masset et al. (2014). *American Journal of Clinical Nutrition, 99* (6): 1460-1469.

Planetary Health Diet

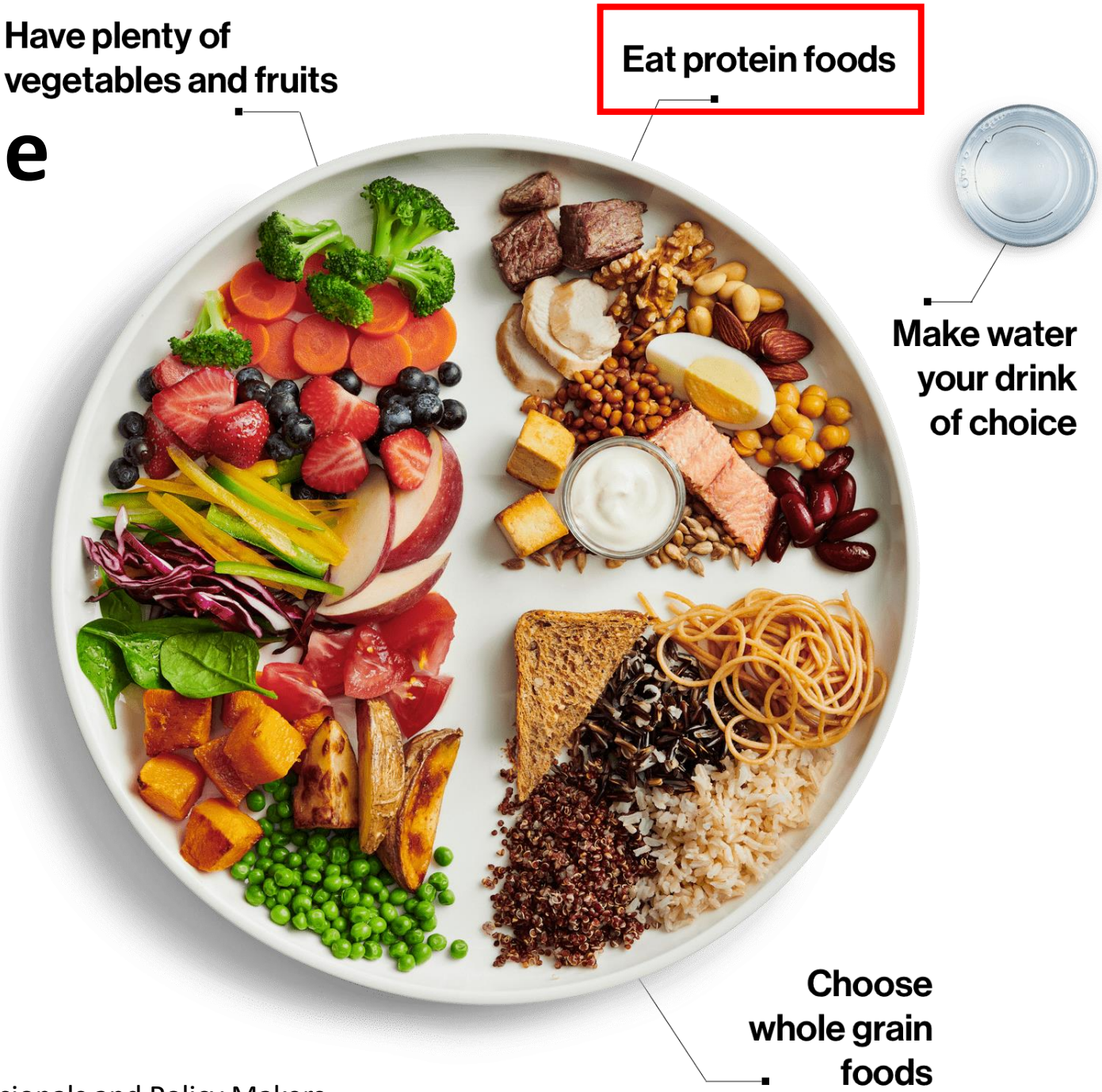
- EAT-*Lancet* report.
- Global scientific targets for healthy diets and sustainable food production.
- Would require substantial shifts in dietary patterns.



Willett, W., et al. (2019). *Lancet, 393*(10170): 447-492.

Canada's Food Guide

- Promotes largely **plant-based** diets.
- *'Protein from plants should be consumed more often'.*
- Not informed by environmental sustainability.



Health Canada. (2019). Canada's Dietary Guidelines: For Health Professionals and Policy Makers.

Objectives

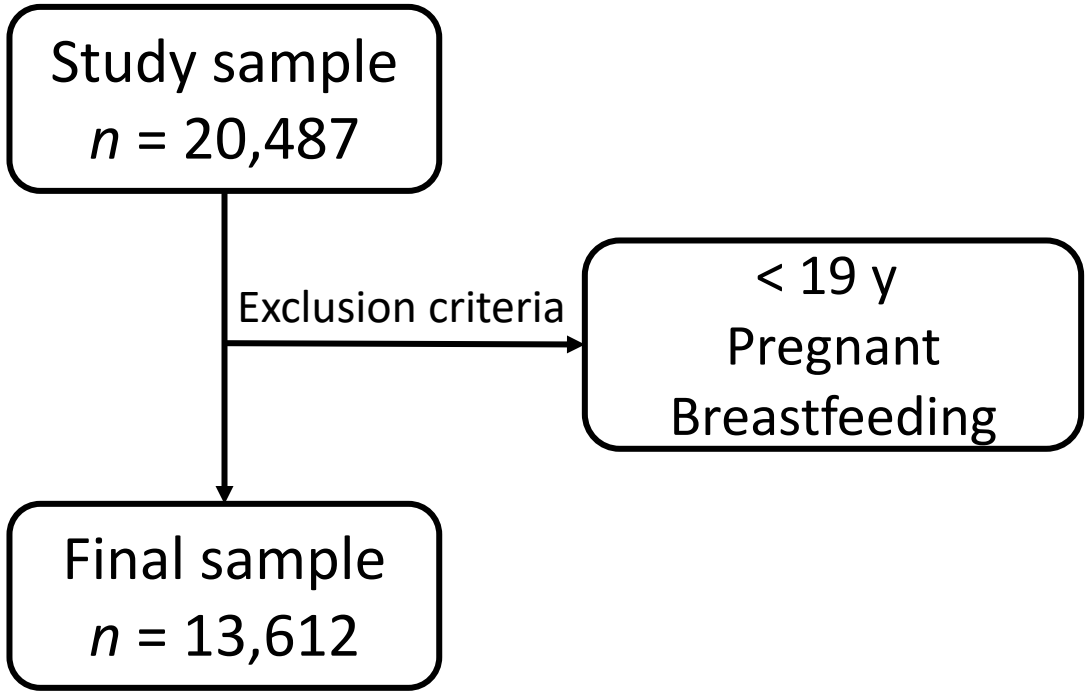
1) To estimate the **carbon footprint** of **Canadian diets.**

2) To compare intake of **food groups**, **nutrients,** and **diet quality** between low- and high-GHGE diets.

Methods

2015 Canadian Community Health Survey – Nutrition

- 2015 Canadian Community Health Survey (CCHS) – Nutrition.
- 24-h recalls were used to collect dietary intake.
- Nutrient intakes from the Canadian Nutrient File.

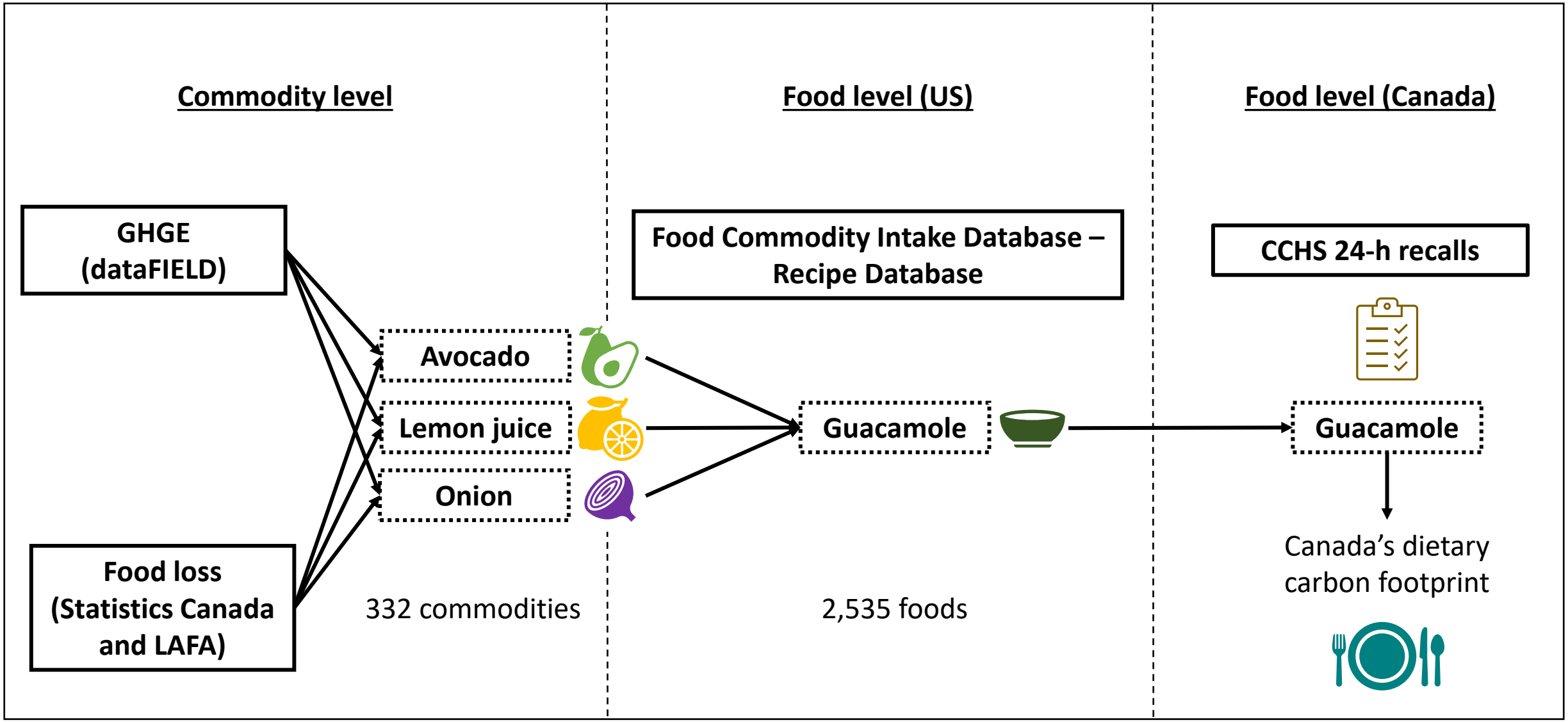


GHGE estimates for foods

- GHGE estimates of 332 commodity foods taken from dataFIELD[1].
- Life cycle assessment boundaries were mostly farm-to-gate.
- Food loss included in calculation of GHGE.
- Canadian GHGE used for dairy products[2].

[1]Heller et al. (2018). *Environmental Research Letters, 13*(4): 044004. Available online: http://css.umich.edu/page/datafield.
[2]Vergé et al. (2013). *Journal of Dairy Science, 96*(9): 6091-6104.

Linking GHGE of commodities to foods reported in the CCHS



Nutrient outcomes

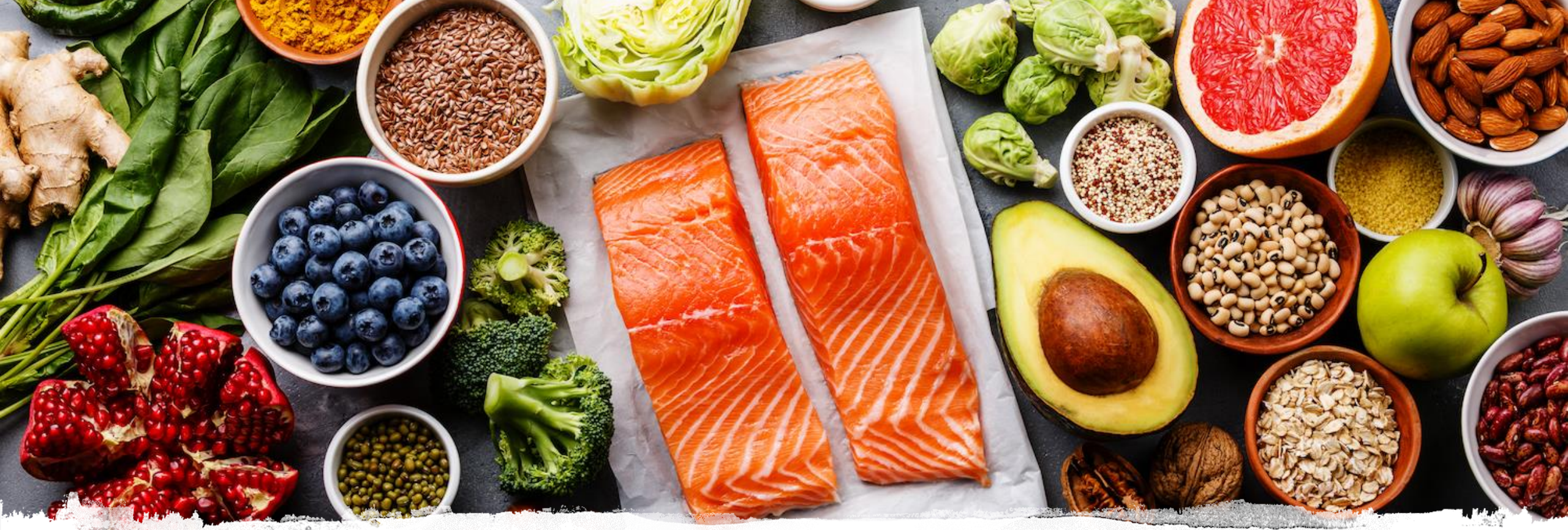
- Nutrient intakes[1]:
  - Nutrients of public health concern are calcium, vitamin D, iron, potassium.
  - Nutrients to limit are saturated fat, total sugars, sodium.

- Diet quality[2]:
  - Alternative Healthy Eating Index (AHEI)-2010.
  - Based on foods and nutrients associated with markers of disease risk.
  - Higher score indicative of higher diet quality.

[1]Health Canada. (2014). Health Canada's Proposed Changes to the Core Nutrients Declared in the Canadian Nutrition Facts Table.
[2]Chiuve et al. (2012). *Journal of Nutrition, 142*(6): 1009-18.

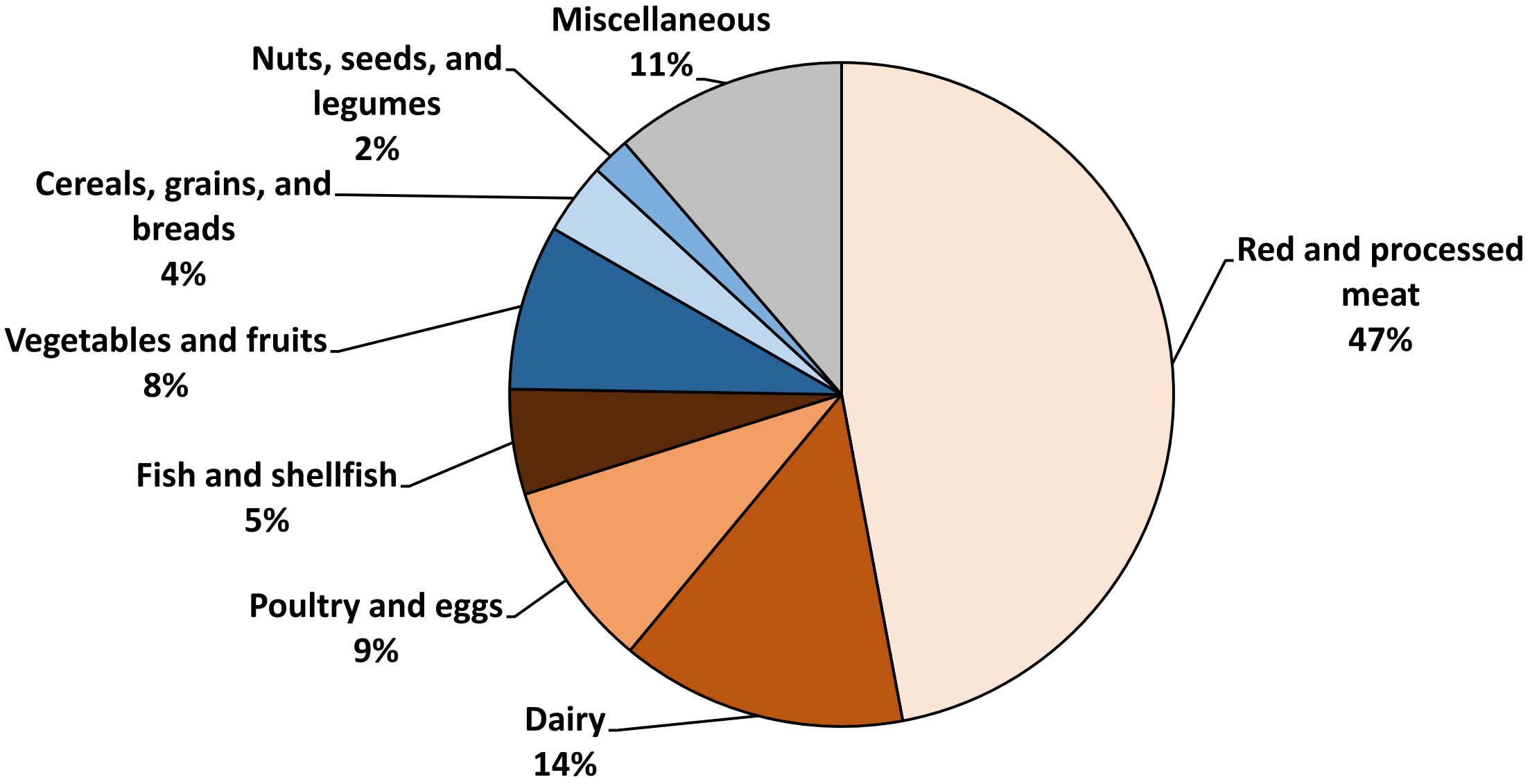
Statistical Methods

- Sample divided into quintiles based on their dietary GHGE (kg CO_2-equivalents/1,000 kcal).
  - 1st quintile = low-GHGE diets.
  - 5th quintile = high-GHGE diets.
- Age- and sex-standardized means based on 1-d intake. *t*-tests were used to detect differences among GHGE diet groups.
- Survey and bootstrap weights were used to obtain nationally representative estimates.
- All analyses were conducted in SAS and SUDAAN software at the McGill-Concordia Research Data Centre.

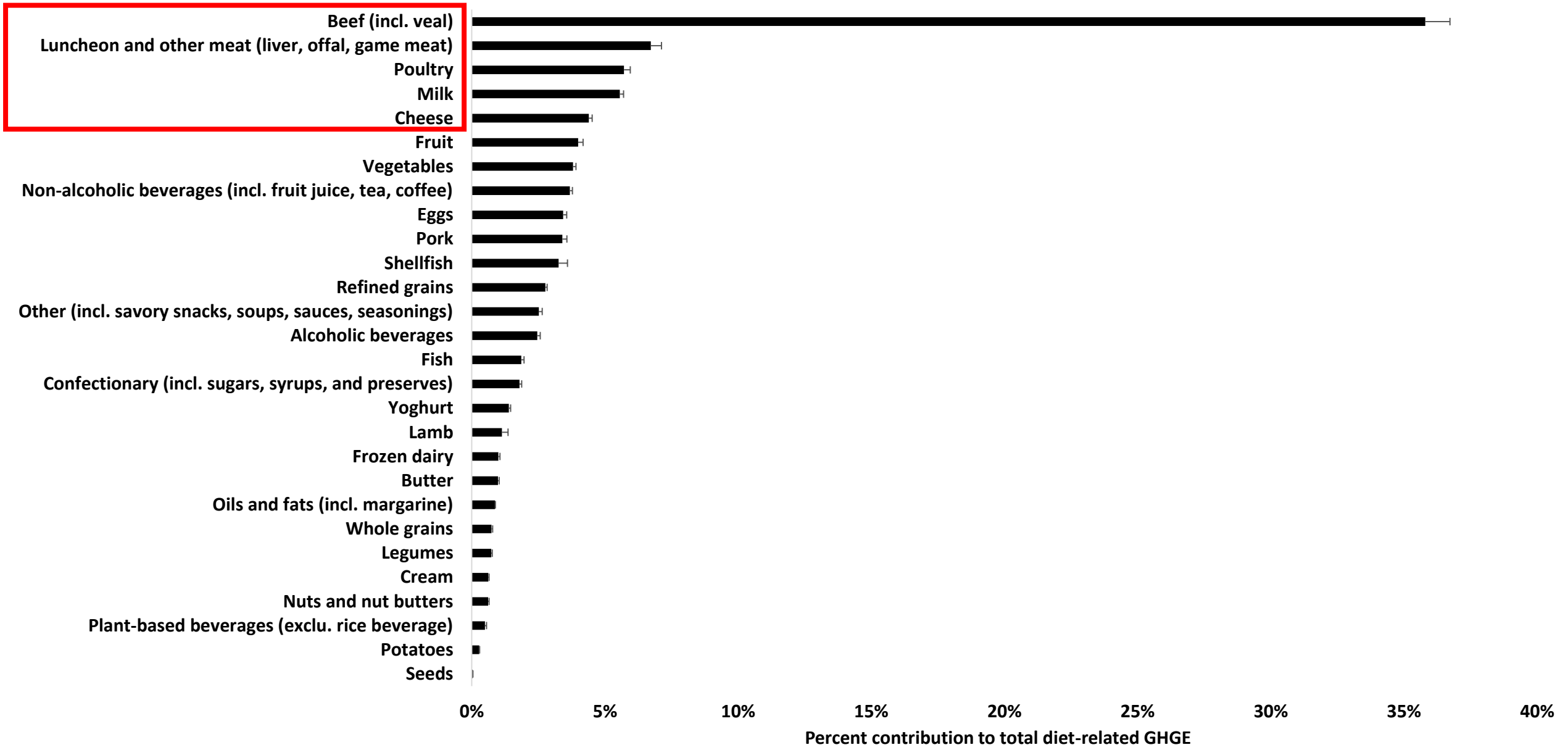


Results

Contribution of animal- and plant-based foods to GHGE as consumed by Canadian adults



Top sources of diet-related GHGE



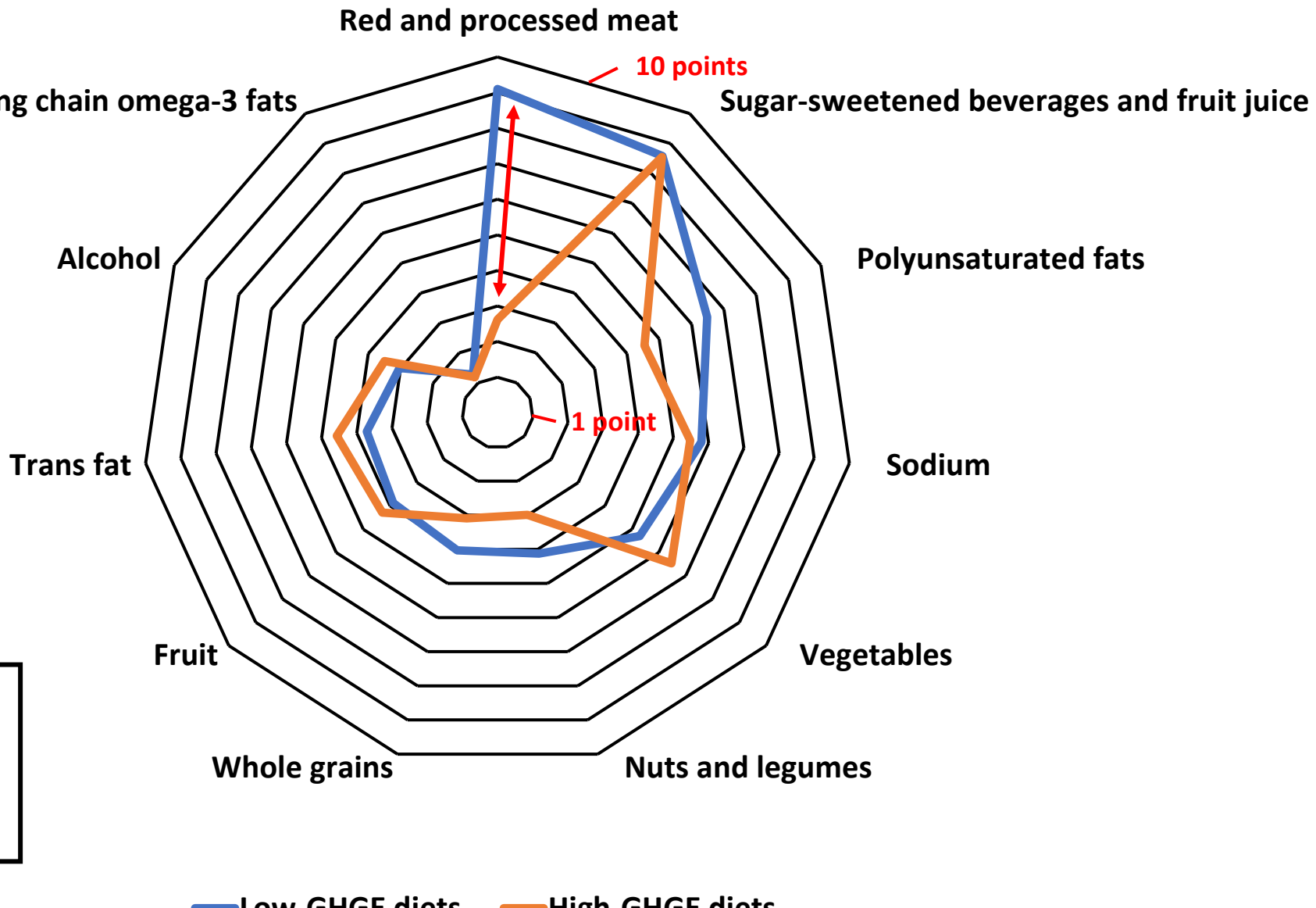
Intake of animal- and plant-based foods between low- and high-GHGE diets

*Significant difference from low-GHGE diets based on the *t*-test ($P < 0.05$).

Intake of nutrients of concern and to limit between low- and high-GHGE diets

	Low-GHGE diets	High-GHGE diets	P
Nutrients of concern			
Iron, mg/1,000 kcal	6.7 ± 0.1	7.7 ± 0.1	<0.00001
Potassium, mg/1,000 kcal	1,278.4 ± 16.8	1,647.9 ± 25.4	<0.00001
Vitamin D, µg/1,000 kcal	2.0 ± 0.1	2.4 ± 0.1	0.0023
Calcium, mg/1,000 kcal	377.9 ± 5.9	419.2 ± 8.6	0.0001
Nutrients to limit			
Saturated fat, g/1,000 kcal	11.0 ± 0.2	12.3 ± 0.2	<0.00001
Total sugars, g/1,000 kcal	47.3 ± 0.7	44.1 ± 0.9	0.0064
Sodium, g/1,000 kcal	1,394.2 ± 17.0	1,582.2 ± 25.3	<0.00001

Diet quality between low- and high-GHGE diets



Total AHEI-2010 score
Low-GHGE diets: 55.3 ± 0.5
High-GHGE diets: 47.3 ±0.5
P < 0.0001

Summary of findings

- Animal-based foods contributed most to diet-related GHGE.
- Intake of nutrients of concern, but also nutrients to limit, was greater for high-GHGE diet respondents, yet diet quality was lesser.
- Potential for shifting to lower carbon diets, but the compatibility of diet-related GHGE with nutrient outcomes called into question.

Significance

Significance and implications

- Extend knowledge of sustainable diets to the **Canadian context**.
- Inform **food policy** and **dietary guidance**.
- Increase **public awareness** as to the link between **human and planetary health**.

Acknowledgements

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- Lab members

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Questions?

Scoring scheme for the AHEI-2010

	Criteria for min score (0)	Criteria for max score (10)
Vegetables, servings/d	0	≥5
Fruit, servings/d	0	≥4
Whole grains, g/d	0	75 (women) or 90 (men)
Sugar-sweetened beverages and fruit juice, servings/d	≥1	0
Nuts and legumes, servings/d	0	≥1
Red and/or processed meats, servings/d	≥1.5	0
Trans fats, % of energy	≥4	≤0.5
Long-chain omega-3 fats, mg/d	0	250
Polyunsaturated fats, % of energy	≤2	≥10
Sodium, mg/d	Highest decile	Lowest decile
Alcohol, drinks/d	≥2.5 (women) or ≥3.5 (men)	0.5-1.5 (women) or 0.5-2.0 (men)
Total score	0	110

Chiuve et al. (2012). *Journal of Nutrition, 142*(6): 1009-18.