Master of Sustainability
Capstone Research Project

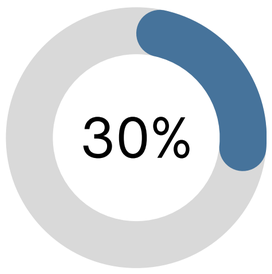
THE UNIVERSITY OF SYDNEY

QUANTIFYING CARBON FOOTPRINT FROM DIETARY SHIFTS:
BARIATRIC SURGERY, INTEGRATED HEALTH AND ENVIRONMENTAL MODELLING

PRESENTED BY Christine Yen

SUPERVISED BY Fabian Sack (Sydney Environment Institute)
Louise Hansell (Sydney Environment Institute)

INTRODUCTION



Food systems contribute

~30% of total global

greenhouse gas (GHG) emissions (FAO, 2024).

Obesity is a **growing global health challenge**, and **bariatric surgery** can reduce energy intake by 30–40 % (~886 kcal/day) (Qanaq et al., 2024).

This research examines **how dietary shifts linked to obesity treatment affect carbon footprints**, offering a new lens on **health–climate co-benefits**.

By connecting **medical interventions with environmental outcomes**, it supports integrated governance that aligns clinical and sustainability goals.

OBJECTIVES

This project aims to:

- Preliminarily quantify GHG emission reductions associated with pre- and post-bariatric dietary patterns.

METHODOLOGY

01 Data Collection

- Australian Health Survey (2011–12) dietary data (9,341 adult 24-h recalls) from Ridoutt et al. (2021)
- Profiles constructed for:
  - **ASD:** Baseline Australian Diet
  - **EDAD:** Energy-Dense Australian Diet (Zoszak et al., 2020)
  - **PBRD:** Post-Bariatric Recovery Diet NEMO Bariatric Surgery Group, 2020)

02 Standardisation Process

- Harmonised into five Australian Food, Supplement and Nutrient Database (AUSNUT) / Eat for Health food groups
- Servings → grams using Australian Dietary Guidelines (2013)
- 2018 FAO farm-gate prices applied for price-per-gram conversions FAOSTAT (2025)

03 EEIO Modelling

- Food-group expenditures mapped to 2018 Australian EEIO results through GHG intensities from Sack et al. (2024)
- Emissions expressed as CO_2-equivalents (kg CO_2-e)

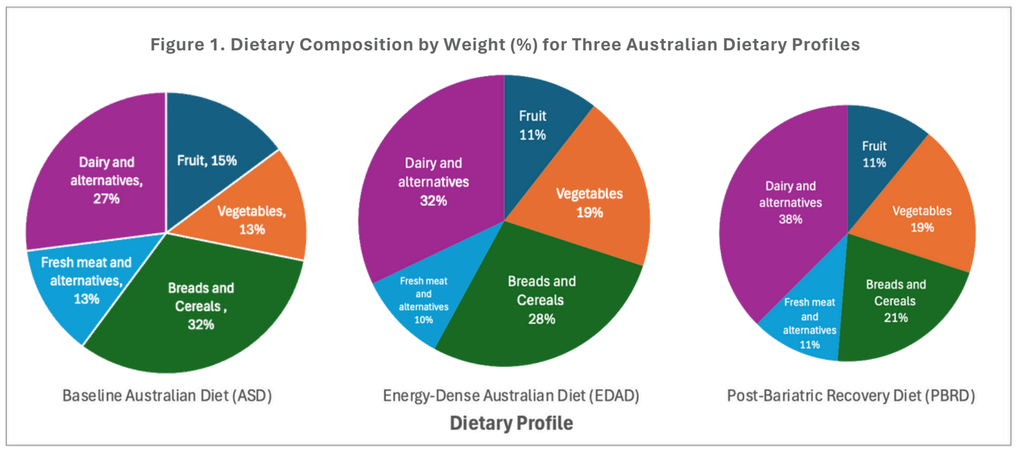
04 Comparative Analysis

- Adopted a descriptive quantitative approach
- Calculated per-capita daily footprints for ASD / EDAD / PBRD
- Compared relative differences in total and food-group-specific GHG contributions
- Used visual and proportional comparison to interpret how dietary shifts influence overall carbon intensity

Limitations

- **Discretionary foods, tofu, and seafood excluded** due to lack of FAO farm-gate data

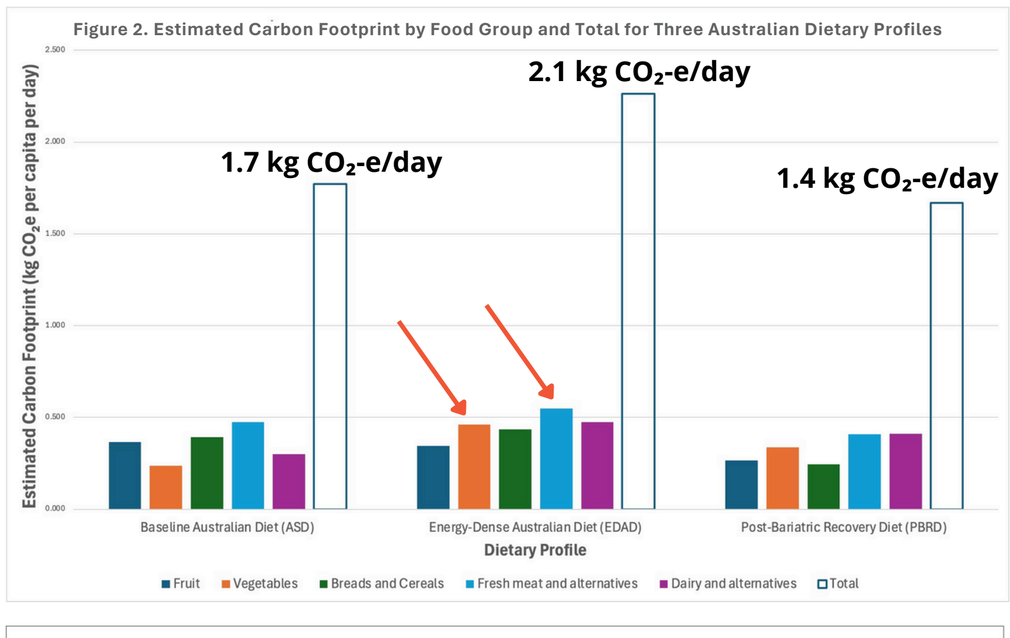
RESULTS



Dietary Composition:

EDAD showed ***higher vegetables (19%)*** and ***lower fruit (11%)*** shares, aligning more closely with the PBRD than the ASD.

PBRD had ***greater dairy (38%)*** and ***reduced total intake***, reflecting clinical moderation.



Footprint:

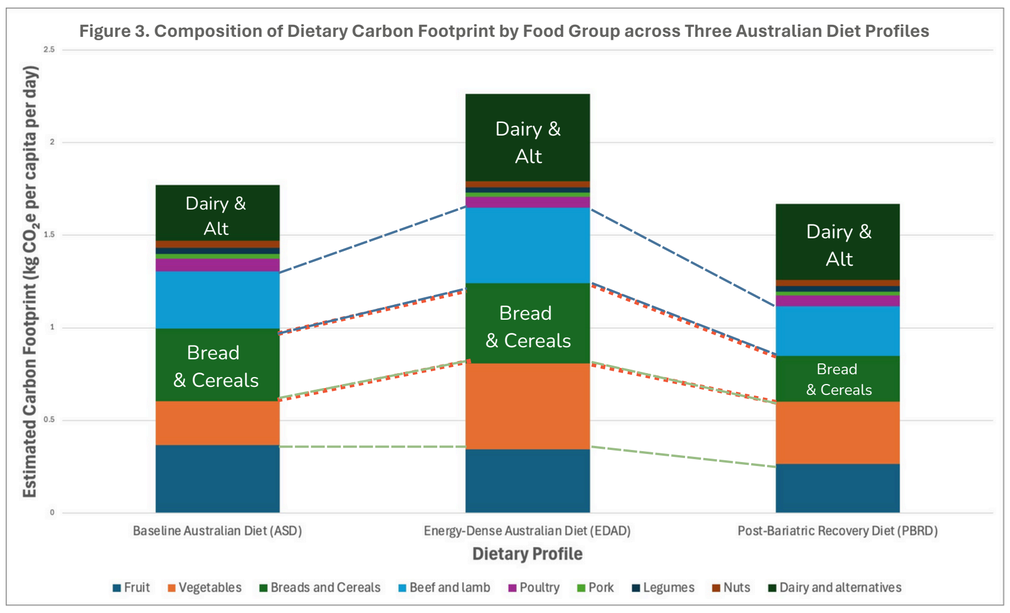
Footprint of EDAD

≈ 30 % ↓ vs PBRD

Footprint of ASD

≈ 18 % ↓ vs PBRD

Driven by ***reduced total intake*** and ***smaller meat portions***.



Drivers:

Biggest drops (EDAD → PBRD):

red meat ↓ ~34 %,
cereals ↓ ~43 %,
vegetables ↓ 27 %

Emission sources: animal-based foods (beef, lamb, dairy) generate ≈ 50 % of total dietary CO_2-equivalent emissions, while **plant foods contribute < 20 %**

Although less than one-third of dietary mass, they drive half the footprint.

ANALYSIS

Quantity, not proportion, drives carbon intensity

- EDAD resembles guideline PBRD ratios but reflects **overconsumption across all food groups**, amplifying both caloric and carbon load.
- PBRD lower emissions through **portion control** that **limits energy-dense carbohydrate**s and **prioritises protein and nutrient-rich foods**, aligning **recovery nutrition with environmental benefit.**

High-impact animal-based foods

- **Animal-based foods (< ⅓ of diet mass)** contribute **≈ ½ of total emissions**, underscoring their high carbon intensity.

Despite lower total emissions, post-bariatric diets maintain high dairy reliance

- This suggests a trade-off between **protein recovery needs** and **GHG efficiency**, highlighting the challenge of designing **clinically effective yet low-carbon** nutrition plans.

CONCLUSION

- Post-bariatric surgery diets **lower per-capita carbon footprints** primarily through **reduced total intake** and **moderation of meat portions**.
- However, the potential rebound from **ultra-processed food reintroduction** underscores the need for **layered, behaviour-aware carbon modelling**.
- This framework advances integrated health–climate governance and supports the development of a **Carbon Calculator for obesity treatment pathways**.

RESEARCH IMPLICATIONS

Health–Climate Co-Benefit

Clinically guided diets can reduce emissions **without compromising recovery needs**

Scalable method

Nutrient-linked EEIO modelling enables **cross-sectoral assessment** of dietary interventions in health and sustainability contexts.

Policy Leverage

Nutrient-linked EEIO modelling enables **cross-sectoral assessment** of dietary interventions in health and sustainability contexts.

Australian Government, National Health and Medical Research Council, Department of Health and Ageing, & Anderson, W. (2013). *Australian Dietary Guidelines*. National Health and Medical Research Council. https://www.nhmrc.gov.au/sites/default/files/documents/australian-dietary-guidelines-2013.pdf
FAO. (2024). Greenhouse gas emissions from agrifood systems. In *FAOSTAT Analytical Brief* [Report]. https://openknowledge.fao.org/server/api/core/bitstreams/111b7ee8-282b-42ff-ad95-cccecd90f8ea/content
FAOSTAT. (2025). *Producer Prices*. https://www.fao.org/faostat/en/#data
NEMO Bariatric Surgery Group. (2020). *Healthy Eating after Bariatric Surgery*. https://www.health.qld.gov.au/__data/assets/pdf_file/0024/1039911/bari-surg-s4-solids.pdf
Qanaq, D., O'Keeffe, M., Cremona, S., Bernardo, W. M., McIntyre, R. D., Papada, E., Benkalkar, S., & Rubino, F. (2024). The role of dietary intake in the weight loss Outcomes of Roux-en-Y Gastric bypass and sleeve Gastrectomy: A Systematic review and Meta-analysis. *Obesity Surgery, 34*(8), 3021–3037. https://doi.org/10.1007/s11695-024-07183-8
Ridoutt, B., Baird, D., & Hendrie, G. A. (2021). Diets within Environmental Limits: The Climate Impact of Current and Recommended Australian Diets. Nutrients, 13(4), 1122. https://doi.org/10.3390/nu13041122
Sack, F., Irwin, A., Van Der Zalm, R., Ho, L., Celermajer, D. J., & Celermajer, D. S. (2024). Healthcare-related carbon footprinting—lower impact of a coronary stenting compared to a coronary surgery pathway. *Frontiers in Public Health, 12*. https://doi.org/10.3389/fpubh.2024.1386826
Zoszak, K., Neale, E., Tapsell, L., & Probst, Y. (2020). Exploring dietary changes in an interdisciplinary intervention trial: Application of a dietary guidelines food composition database. *Journal of Human Nutrition and Dietetics, 34*(2), 265–272. https://doi.org/10.1111/jhn.12790

Related References

SPECIAL THANKS TO
Raymond van der Zalm
Navoda Liyana Pathirana