

# Causal inference in nutritional epidemiology

## Methodological challenges, opportunities, and future directions

Yohannes Adama Melaku<sup>1</sup>, Zumin Shi<sup>2</sup>, Amy Reynolds<sup>1</sup>, Sarah Appleton<sup>1</sup>, Danny J Eckert<sup>1</sup>, Robert Adams<sup>1</sup>

<sup>1</sup>Flinders Health and Medical Research Institute, Flinders University, Adelaide, Australia; <sup>2</sup>College of Health Sciences, Qatar University, Doha, Qatar

*This work summarises the unique challenges and highlights the critical need to tailor and apply causal inference methods in nutritional epidemiology to enhance the credibility and use of evidence in the field.*

### BACKGROUND

- As a core task in data science, causal inference methods in epidemiology are increasingly employed to estimate the causal effects of exposures on outcomes through observational studies.
- The majority of empirical evidence in nutritional science comes from observational studies.
- Associations between dietary exposures and disease outcomes are frequently observed, yet these associations do not inherently establish causation.
- Therefore, leveraging such findings to design public health and nutritional interventions can be inappropriate.

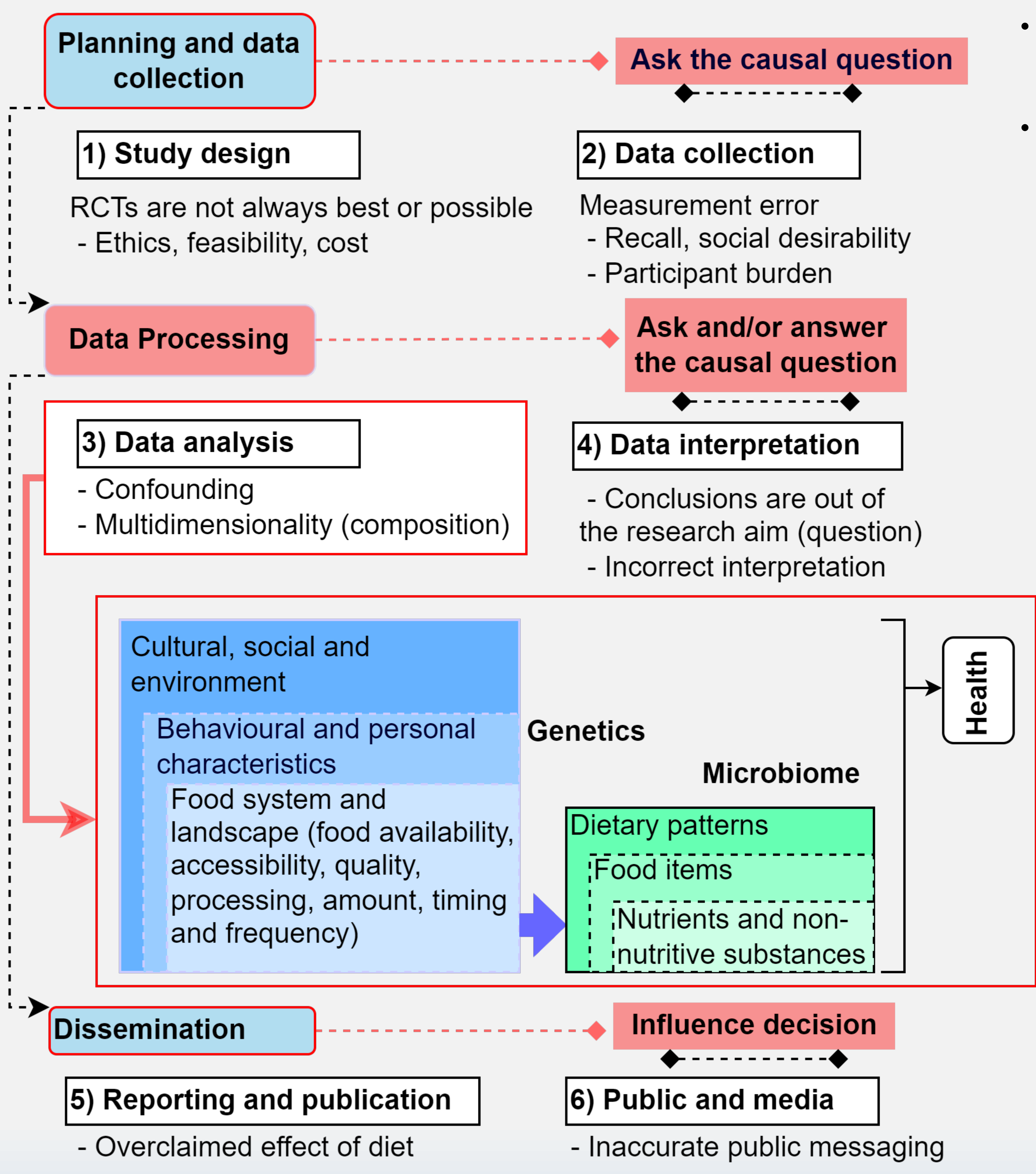
### AIMS

- To combine critical analysis with a selective review of key studies, aiming to offer a nuanced perspective on the application of causal inference concepts and methods in nutritional epidemiology
- To explore potential future pathways for these implementations

### METHODS

- A review of methods was conducted to critically evaluate the unique challenges, opportunities, and future directions in implementing causal inference concepts and methods within nutritional epidemiology.
- This work primarily focuses on analytical challenges.

### HIGHLIGHTS



- Multi-level methodological challenges exist in nutritional epidemiology.
- This underscores the necessity for rigor, transparency, and sophistication in all stages of nutritional epidemiology research.

### CONCLUSIONS

- The complexity of dietary exposures, compared to other types of exposures, presents significant challenges in estimating causal effects.
- While applying causal inference concepts and methods in nutritional epidemiology introduces unique challenges, it remains a crucial process, as evidence from nutritional epidemiological research is often used to inform policy and decision-making.

### FUTURE DIRECTIONS

- The role of emerging artificial intelligence technologies, such as machine learning algorithms, and their integration with causal methods warrants further exploration.

**Contact**  
 Email: [yohannes.melaku@flinders.edu.au](mailto:yohannes.melaku@flinders.edu.au);  
 X: @Yohannes\_A\_M\_6  
**Funding Source**  
 NHMRC Emerging Leadership Fellowship (2009776)

**Figure 1** | Illustrative example challenges at different stages in nutritional epidemiology research ('challenge grid')