Approaches to Dietary Pattern Analyses: Potential to Inform Guidance

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Outline

- What do we mean by dietary patterns, and why are we interested?
- What are the primary methods for studying dietary patterns, and what questions do they address?
- How do methodological considerations affect results?
- What questions, if answered, could inform guidance?
- Challenges ahead
Introduction, definitions
Definition of dietary patterns

- The quantities, proportions, variety or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed*

* Nutrition Evidence Library, Technical Expert Collaborative on Study of Dietary Patterns
Definition of dietary patterns

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Why study dietary patterns?

- Complexity of diet
- Correlation among dietary constituents
- Evidence for positive health outcomes with changes in “total diet”
- Relevance for policy and guidance
Dietary Patterns

Surveillance

Policy-related Analyses

Epidemiology

Interventions
Methods for studying dietary patterns
Dietary Patterns

Methods

Investigator-Defined

Data-Driven, Outcome-Independent

Data-Driven, Outcome-Dependent
Dietary Patterns Methods

- Investigator-Defined
- Data-Driven, Outcome-Independent
- Data-Driven, Outcome-Dependent

Selective Diets
Indexes/Scores
Selective Diets (e.g., Vegetarian)
Selective Diets (e.g., Vegetarian)

Are you a vegetarian?
Selective Diets (e.g., Vegetarian)

Are you a vegetarian?

Yes!
Are you a vegetarian?

Yes!

Exclude
- Meat
- Fish
- Poultry
- (Eggs)
- (Milk)

Include
- Fruits?
- Vegetables?
- Whole grains?
- Refined grains?
- Added sugars?
- Solid fats?
Indexes/Scores
Indexes/Scores

How close is the population to meeting a set of dietary recommendations?
Indexes/Scores

How close is the population to meeting a set of dietary recommendations?

Overall Diet Quality: Total score = 58/100
Overall Diet Quality:
Total score = 58/100

How close is the population to meeting a set of dietary recommendations?
Indexes/Scores

- Characterize the total diet
- Intuitively appealing and relatively simple to compute
- Results are interpretable
- Reproducible across studies
- Scoring algorithms affect results
Dietary Patterns Methods

- Investigator-Defined
  - Special Diet
  - Indexes/Scores
- Data-Driven, Outcome-Independent
  - Cluster Analysis
  - Factor Analysis
Cluster Analysis
Cluster Analysis

Are there groups of people with distinct eating patterns?
Cluster Analysis

Are there groups of people with distinct eating patterns?

Groups **people** according to their dietary patterns
Factor Analysis
Factor Analysis

What elements of the diet track together in explaining variation in diets?
What elements of the diet track together in explaining variation in diets?

Identifies elements of the diet that track together
Cluster Analysis

- Characterize the total diet
- Results are interpretable
- Limited reproducibility across studies

Factor Analysis
Hypothesis Testing

Selective Diets
- People who meet/don’t meet criteria

Indexes/Scores
- Individuals’ scores on quality and its components

Cluster Analysis
- Groups of individuals and their diet patterns

Factor Analysis
- Factors explaining variation in individuals’ scores

How do dietary patterns relate to health outcome?
Dietary Patterns Methods

Investigator-Defined

Data-Driven, Outcome-Independent

Data-Driven, Outcome-Dependent

Special Diet

Indexes/Scores

Cluster Analysis

Factor Analysis

Reduced Rank Regression

CART
Reduced Rank Regression
Reduced Rank Regression

What combination of foods explains the most variation in a set of intermediate health markers?
Reduced Rank Regression

What combination of foods explains the most variation in a set of intermediate health markers?

Reduced Rank Reduction

Food group 1
Food group 2
Food group 3
Food group 4
...
Food group x

Score 1
  - fg1
  - fg2
  - fg3

Score 2
  - fg4
  - fg5
  - fg6

Response 1
Response 2
Response 3
Response 4

Disease

Prior Knowledge
CART
What dietary components explain the most variation in a health outcome?
What dietary components explain the most variation in a health outcome?

Hypothetical example of CART results
Dietary Patterns

Methods

Investigator-Defined

Selective Diet

Indexes/Scores

Data-Driven, Outcome-Independent

Cluster Analysis

Factor Analysis

Data-Driven, Outcome-Dependent

Reduced Rank Regression

CART
Methodological considerations
Data collection method

- Food frequency questionnaires
  - Represent long-range intake
  - Cognitively difficult, so accuracy is diminished
  - Traditionally, only affordable method for large-scale studies

- 24-hour recalls
  - Represent short-term intake
  - Requires modeling to estimate usual intake
  - Captures details
  - New tools make them affordable
Time frame of reference

Meal
Day
Month
Year
Diet over the life course

- In Utero
- Childhood
- Adolescence
- Adulthood (including pregnancy and lactation)
- Older Adulthood
Diet as dynamic exposure

- In utero
- Childhood
- Adolescence
- Adulthood
- Older Adulthood

Meal
Day
Month
Year
New technologies

Offer capability to capture streams of data
## Food categories or food groups?

<table>
<thead>
<tr>
<th>Food categories</th>
<th>Food groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pasta dishes</td>
<td>• Whole fruit</td>
</tr>
<tr>
<td>• Macaroni and cheese</td>
<td>• Fruit juice</td>
</tr>
<tr>
<td>• Burritos, tacos</td>
<td>• Whole grain</td>
</tr>
<tr>
<td>• Stir-fry mixtures</td>
<td>• Refined grain</td>
</tr>
<tr>
<td>• Pizza</td>
<td>• Hi-omega 3 fish</td>
</tr>
<tr>
<td>• Cereal, high sugar</td>
<td>• Low-omega 3 fish</td>
</tr>
<tr>
<td>• Cereal, low sugar</td>
<td>• Added sugars</td>
</tr>
<tr>
<td>• Lettuce salads</td>
<td>• Solid fats</td>
</tr>
<tr>
<td>• Etc.</td>
<td>• Etc.</td>
</tr>
</tbody>
</table>
Subjectivity

- Choice of variables
- Treatment of input variables
- Labeling of patterns
- Scoring algorithms
  - Determination of min/max
  - Truncation
  - Weighting to derive total score
Population being examined

- Data-driven methods may not derive comparable patterns in different populations.
- Investigator-driven methods will always identify patterns in the same way, although prevalences will vary among populations.
- Many cohort studies, each with different populations, have used different indices/scores.
Analyses examining diet quality indices and their associations with mortality
Questions to inform guidance
Questions posed by major methods

- Who are the vegetarians, …
- How close is the population to meeting recommendation on key aspects of diet, …
- What dietary patterns are shown by the population, …
  - … and how do those patterns relate to health outcome?
- Which dietary patterns are most predictive of health outcome?
Additional questions worth examining

- Who is and is not following recommendations, and what are the patterns of deviation?
- Among vegetarians (or pregnant women or any other group), what are patterns of eating relative to recommendations, and what foods as-eaten characterize those patterns?
- What combinations of food groups, and in what quantities, would be needed to achieve nutritional adequacy while avoiding excessive intakes of deleterious dietary components, within the context of typical dietary choices?
Future research questions

- What combinations of food intake explain the most variation in a specific health outcome?
- What are the patterns upstream?
- How else can we characterize patterns (beyond what is eaten)?
- How can we examine diet as a dynamic exposure?
What are the patterns upstream?

Food supply  Market/Community  Individual
Characterizing dietary patterns at multiple levels

Food Supply

Market

Individual
Posing questions at different levels

How close is the population to meeting dietary recommendations?

Individual
Posing questions at different levels

How do menus at top fast food restaurants compare with recommendations?

How close is the population to meeting dietary recommendations?

Market

Individual
Posing questions at different levels

Does the food supply align with current dietary recommendations?

How do menus at top fast food restaurants compare with recommendations?

How close is the population to meeting dietary recommendations?

Food Supply

Market

Individual
Characterizing dietary patterns at multiple levels

Food Supply → Market → Individual
Expanding the definition

- The **qualities**, quantities, proportions, variety or combination of different foods, drinks, and nutrients in diets, and the **timing, location** and frequency with which they are habitually consumed
Moving beyond what is eaten: adding layers

- Food supply
- Market/Community
- Individual

- What
- When
- Where
- Why
- How
Temporal eating patterns

Final thoughts
Future challenges

- Methods of data capture and analysis to handle streams of data
- Continued refinement of indices
- Standardization of input variables and algorithms, harmonization of methods
- Learning from other disciplines to address additional questions
Bottom line

- Match methods and measures to questions of interest

What are your questions?