American Society for Nutrition
Excellence in Nutrition Research and Practice
www.nutrition.org

NUTRITION 2023

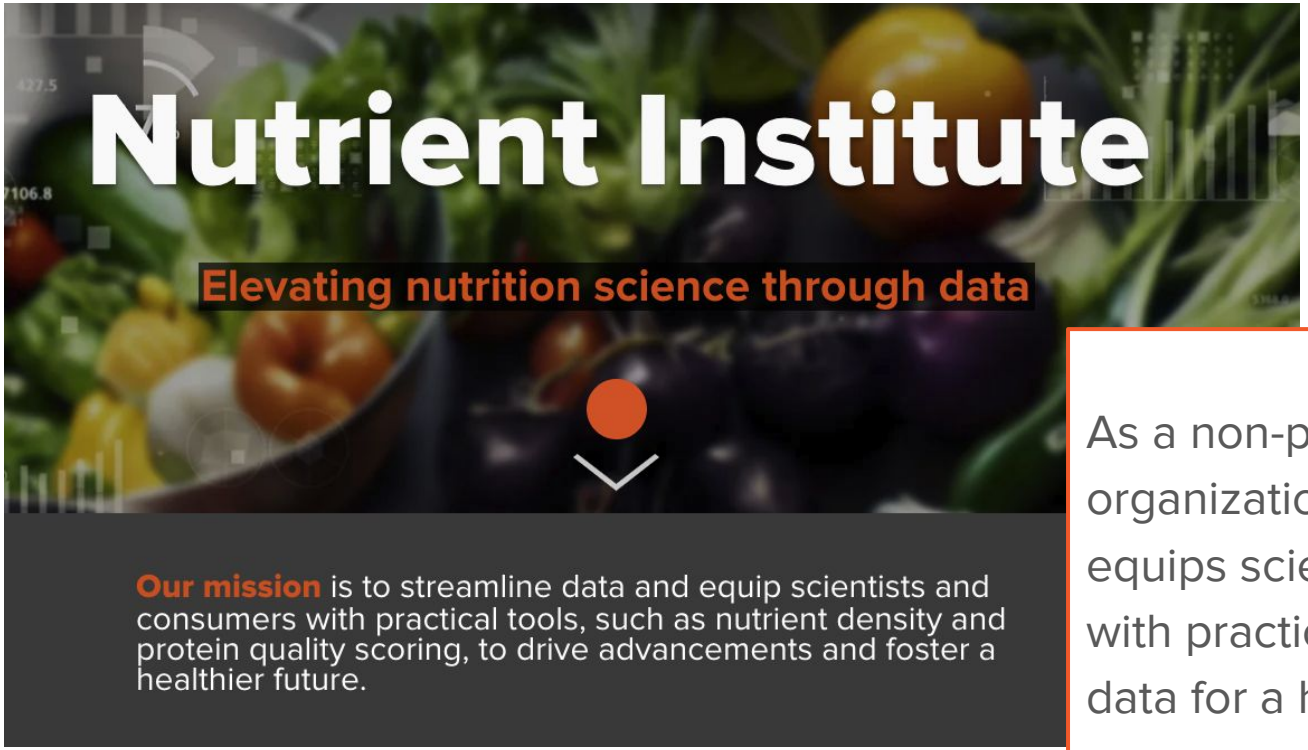
Sponsored Satellite Program

Advancing Real World Data and Tools to Better Understand Diet Quality

Shavawn F. Forester Ph.D., RDN.

Executive Director
Nutrient Institute (501(c)(3))

Welcome!



As a non-profit 501(c)(3) organization, the Nutrient Institute equips scientists and consumers with practical tools, streamlining data for a healthier future.

Disclosures

AFFILIATION/FINANCIAL INTERESTS **(prior 12 months)**	**ENTITIES**
Grants/Research Support	
Scientific Advisory Board/Consultant/ Board of Directors	WISEcode
Owner	
Speakers Bureau	
Stock Shareholder	
Employee	
Other	

Outline

Food Landscape

- What foods are out there?
- What do we eat by $ spent?
- What do we say we eat?

Data Landscape

- Sources of food composition data and who they serve
- Forward looking food data org's and companies

Opportunities

- Defining food data quality
- Applying FAIR principles
- Adopting a standard for food data citation
- Use of visualization to see opportunities

Food Landscape

Eating at home: Abundance of foods on the store shelves offer a wide range of options

Walmart and Amazon - Largest grocers in the US

- Walmart Grocery has around **13 million** food and beverage products
- Amazon's Prime Now around **305k** food and beverage products

Source: FoodIndustry.Com top 10 grocery chains in the US by revenue – 2021
Source: ScrapeHero: Number of Products sold at Walmart vs Amazon

150 million online shoppers, which accounts for nearly half of the country's population.
Source: Statista Research Department, 2022

31,530

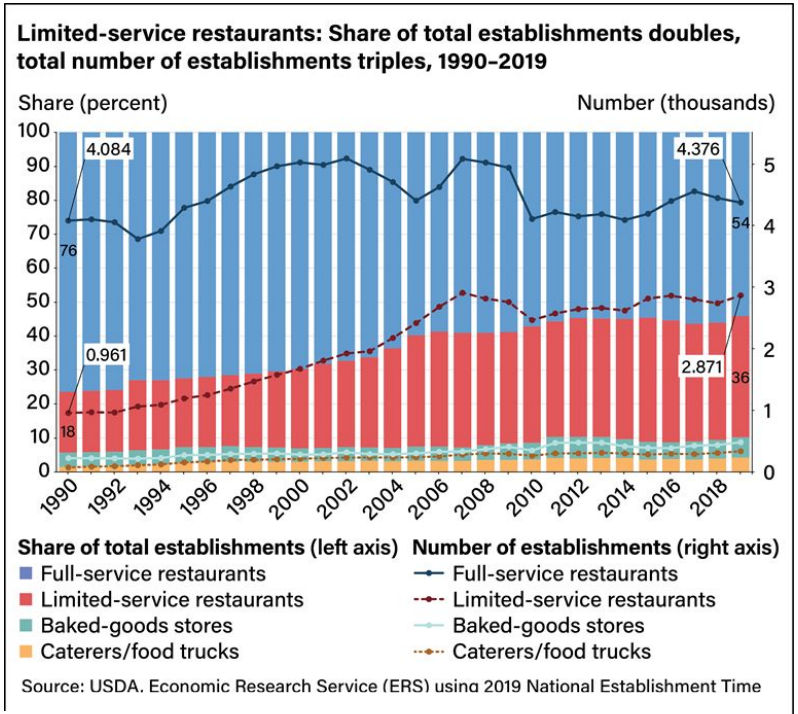
Average number items carried in a supermarket (2022)

Source: FMI

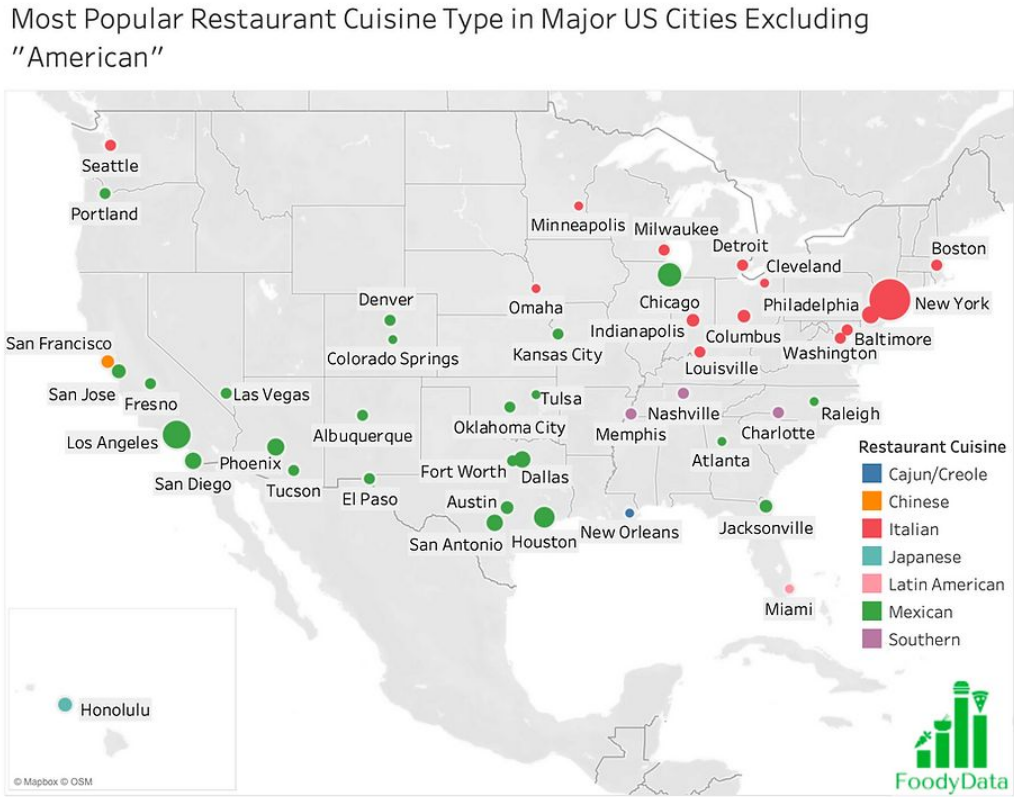
Source: FMI Consumer Data Reports 2023

Food Landscape

Eating out: full-service and counter service establishments are the prevailing options



Source: [USDA 2023 - using 2019 NETS geographic, industry, ownership and management, sales, and employment data]

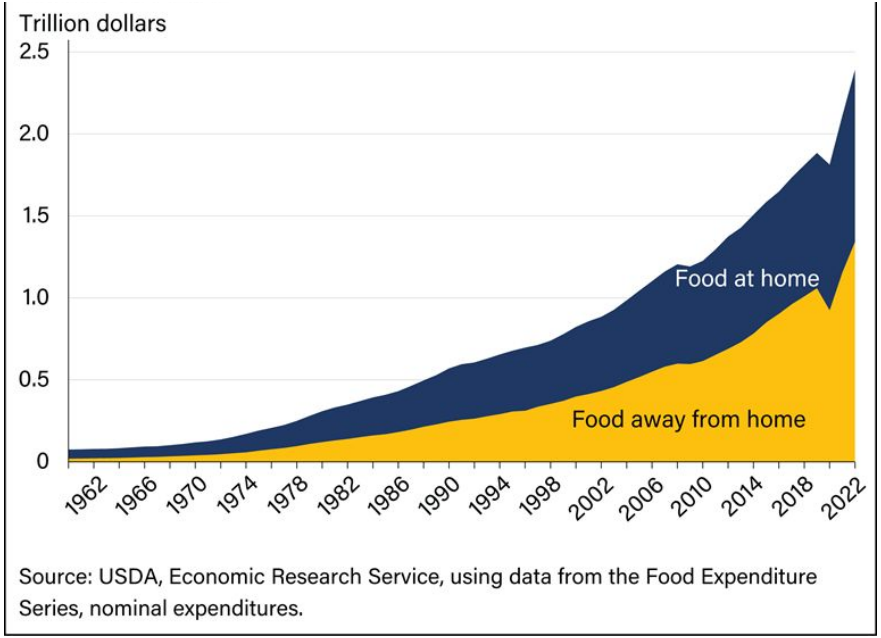


Source: [FoodyData 2021]

Food Landscape

Food expenditure: Evaluating sales in the grocery and restaurant sectors

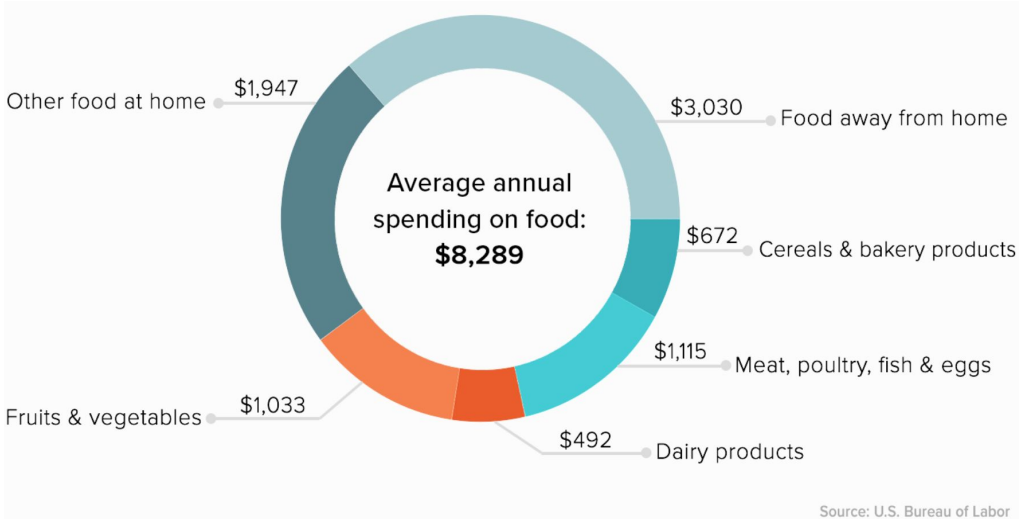
Expenditures for food at home and away in U.S. 1960-2022



Source: USDA, Economic Research Service, using data from the Food Expenditure Series, nominal expenditures.

Source: USDA 2023 Expenditure data based on U.S. Census Bureau's annual, quarterly, monthly, and quinquennial sales data

How Much Each American Spends on Food Annually

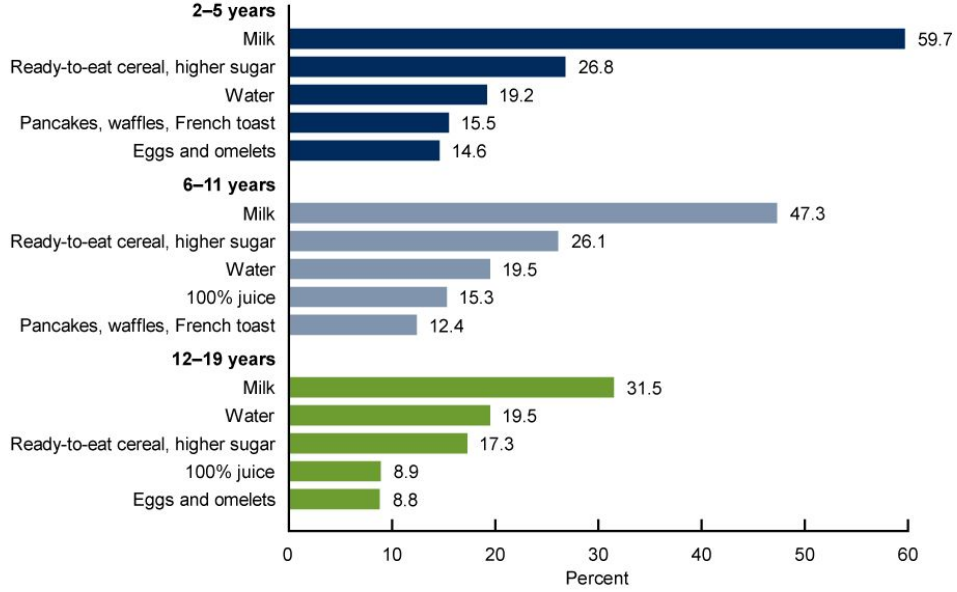


Source: BLS Consumer Expenditures in 2021 (published 2023)

Food Landscape

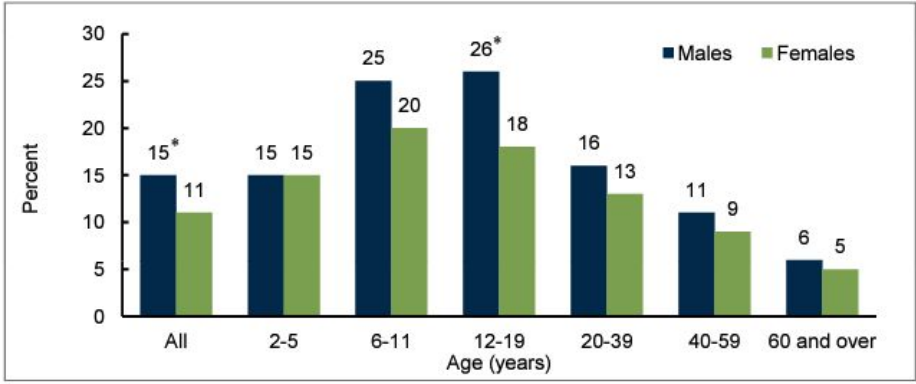
What do we say we eat: Examining dietary recall data

Most consumed breakfast foods by age



Source: NHANES 2015-2018

Percentage of U.S. population who consumed pizza on any given day

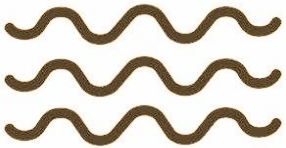


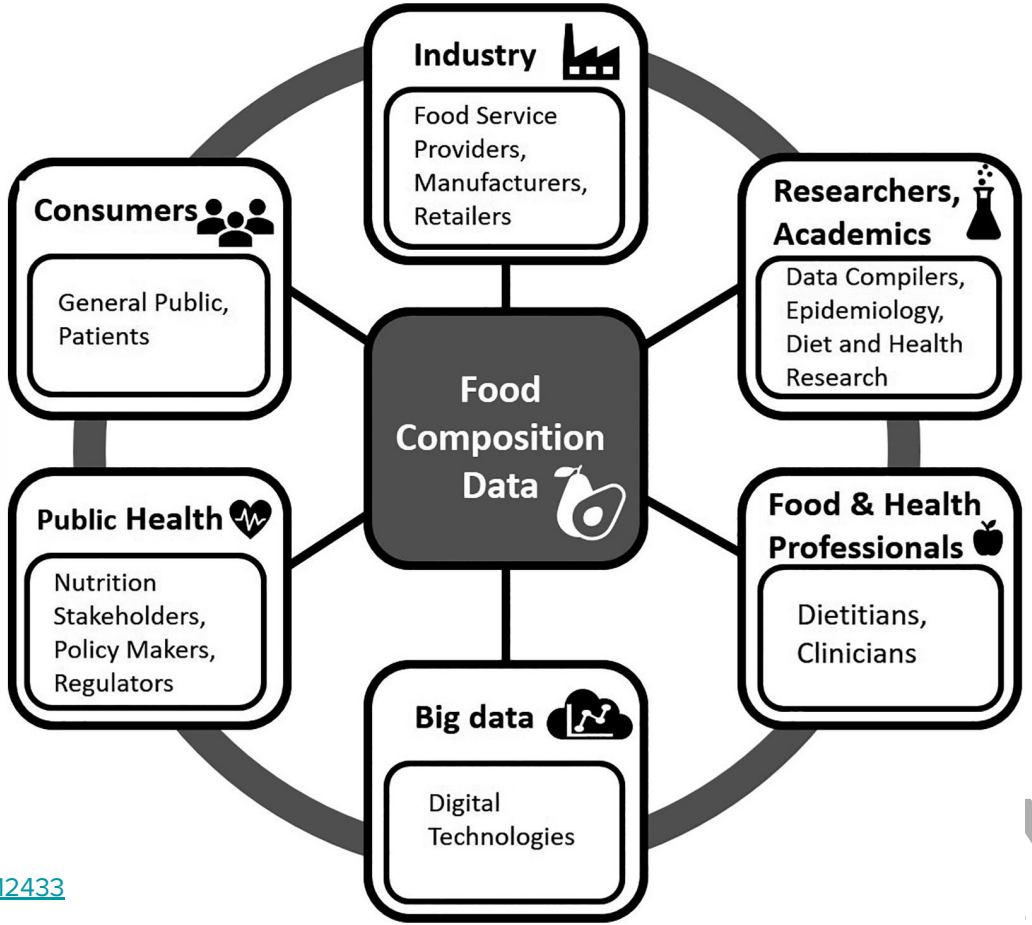
*Significantly different from females (p<0.01)
SOURCE: What We Eat in America, NHANES 2007-2010, day 1, individuals 2+ years

Source: NHANES 2007-2010 - Food Surveys Research Group, Dietary Data Brief No. 11, 2014

Food composition data serves multiple entities and applications

What's topping your slice?



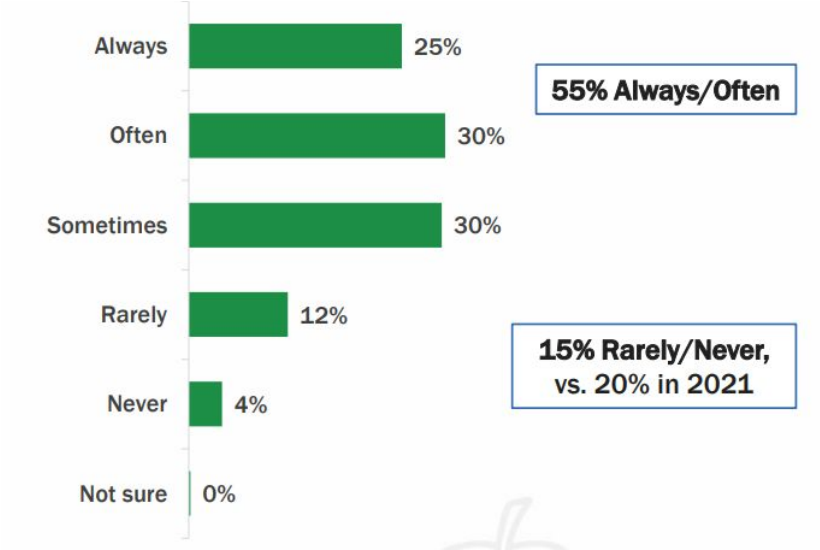


Traka et al. Nutr Bull, 45: 230-240. (2020) https://doi.org/10.1111/nbu.12433

Food Composition Data Landscape

Nutrition data for consumers: NFP and health claims are the predominate source

How often do you pay attention to the labels on food and beverage packaging when shopping?



Consumer Snapshot

39% regularly buy foods and beverages labeled as "natural"

The top two reasons for buying "natural" products are believing that natural foods are generally healthier and wanting to avoid artificial ingredients

International Food Information Council. 2022 Food and Health Survey. 18 May 2022. https://foodinsight.org/2022-food-and-health-survey/
Survey of 1,022 Americans ages 18 to 80

Food Composition Data Landscape

Food and nutrient data for Research, Policy & Industry: USDA is foundational

USDA Nutrient and Ingredient Data Resources

FoodData Central

SR Legacy

FNDDS

Experimental

Foundation

Dietary Supplement Data

Dietary Supplements Ingredient Database (DSID)

Dietary Supplements Label Database (DSLD)

Specific Component Data

Flavonoids
Isoflavones
Proanthocyanidins
Choline
Purines
Fluoride
Iodine

Food Composition Data Landscape

Food and nutrient data for Research, Policy & Industry: Hundreds of sources

International

Rely heavily on USDA food composition data.Are expanded to include country specific foods

Open source

Open data sharing repositories such as data.world

Private

Companies provide pay per service. Such as ESHA Research.

Applications

Consumer Nutrition applications like MyFitnessPal and Lose it!

Food Composition Data Landscape

The future, food systems databases: Insight-driven with precision in mind

Companies are actively involved in improving the **accessibility** and **quality** of food data

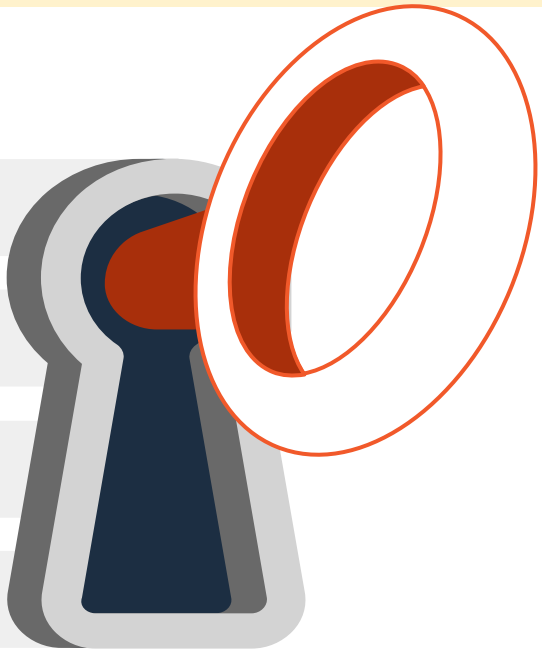
- PTFI
- WISEcode
- FOODB
- Open Food Facts
- Bionutrient Institute

Nutritional dark matter = Huge potential

Opportunities to Advance Real World Data

Presenting Four opportunities

- Defining Food Data Quality
- Applying FAIR Principles
- Comprehensive FoodData Citation (CFDC)
- Visualization to see opportunity



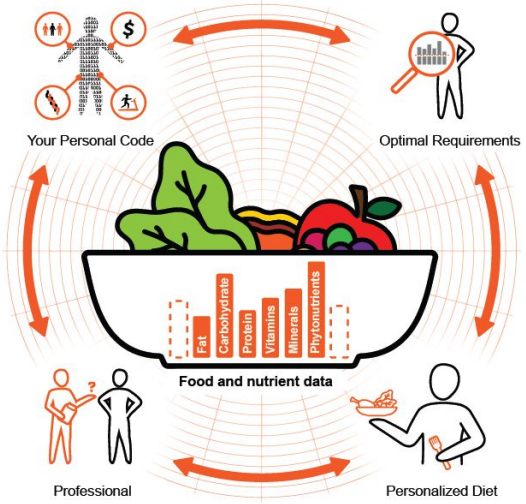
DIET QUALITY TOOLS

Opportunities to Advance Real World Data

Defining Food Data Quality: Identifying needs for improvement

A Comprehensive Evaluation of Data Quality in Nutrient Databases

Zhaoping Li, Shavawn Forester, Emily Jennings-Dobbs, David Heber



Food composition data inform all aspects of precision nutrition.

To identify the most critical components needed for improvement of nutrient databases, food composition data were analyzed for quality, with completeness and for FAIRness as the two guiding factors.

Li et al. doi: 10.1016/j.advnut.2023.02.005

Opportunities to Advance Real World Data

Food Data quality: FAIR a framework for effective data management and sharing

In 2016, the '**FAIR Guiding Principles for scientific data management and stewardship'** were published in *Scientific Data*. The authors intended to provide guidelines to improve the **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets.

The principles emphasise machine-actionability (i.e., the capacity of computational systems to find, access, interoperate, and reuse data with none or minimal human intervention) because humans increasingly rely on computational support to deal with data as a result of the increase in volume, complexity, and creation speed of data.

A practical "how to" guidance to go FAIR can be found in the **Three-point FAIRification Framework**.

Opportunities to Advance Real World Data

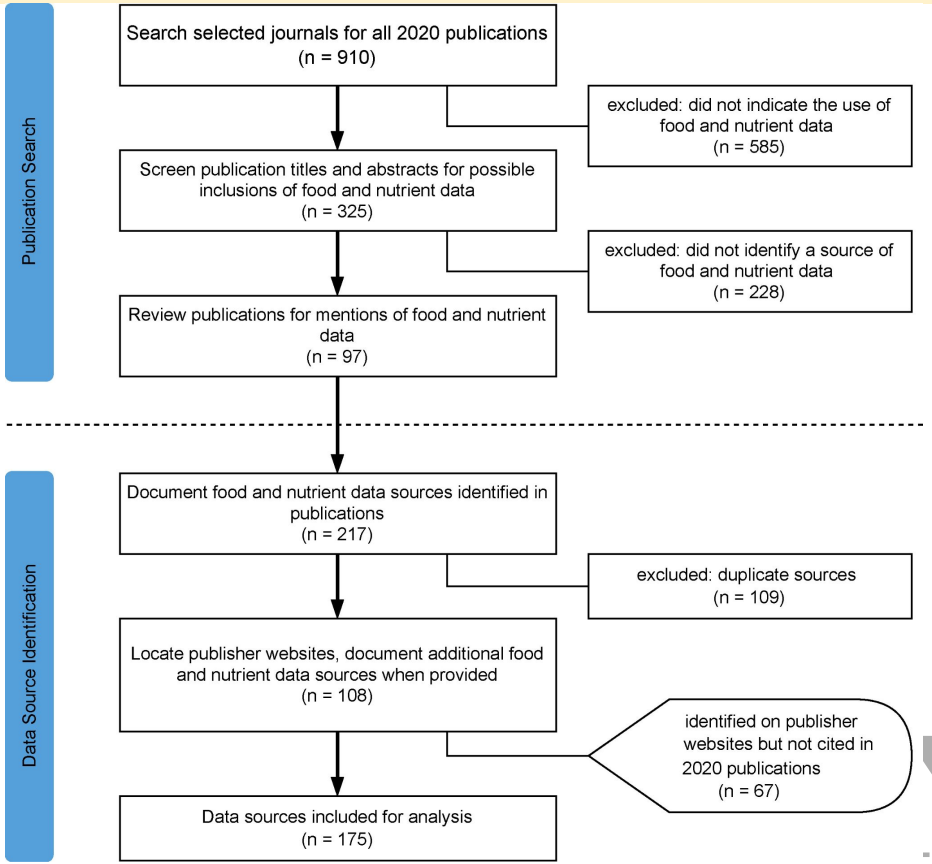
Defining Food Data Quality: proposing inclusion of completeness and FAIR principles

Definition of completeness:

1. All 15 nutrition fact panel (NFP) nutrient measures
2. All 40 National Academies of Sciences, Engineering, and Medicine (NASEM) essential nutrient measures

Methods:

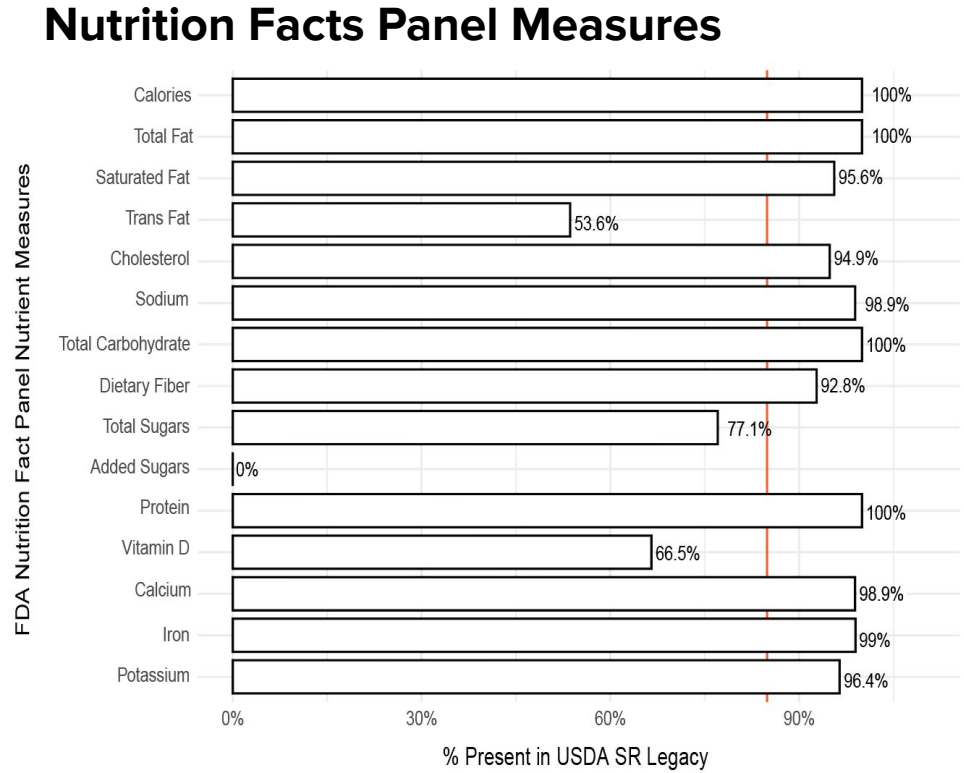
- USDA SR Legacy used to assess NFP and NASM completeness criteria
- **175 food data sources identified** and included in **FAIR** analysis



Li et al. doi: 10.1016/j.advnut.2023.02.005

Opportunities to Advance Real World Data

Assessment of completeness: NFP measures available for each food in SR Legacy



100% of foods have calorie, total carbohydrate, total fat, and protein data.

Only **67%** have **vitamin D** data;
54% have **trans fat** data;
and **0%** have **added sugars** data.

Li et al. doi: 10.1016/j.advnut.2023.02.005

Opportunities to Advance Real World Data

Assessment of completeness: NASEM measures available for each food in SR Legacy

Some nutrients are well-represented:

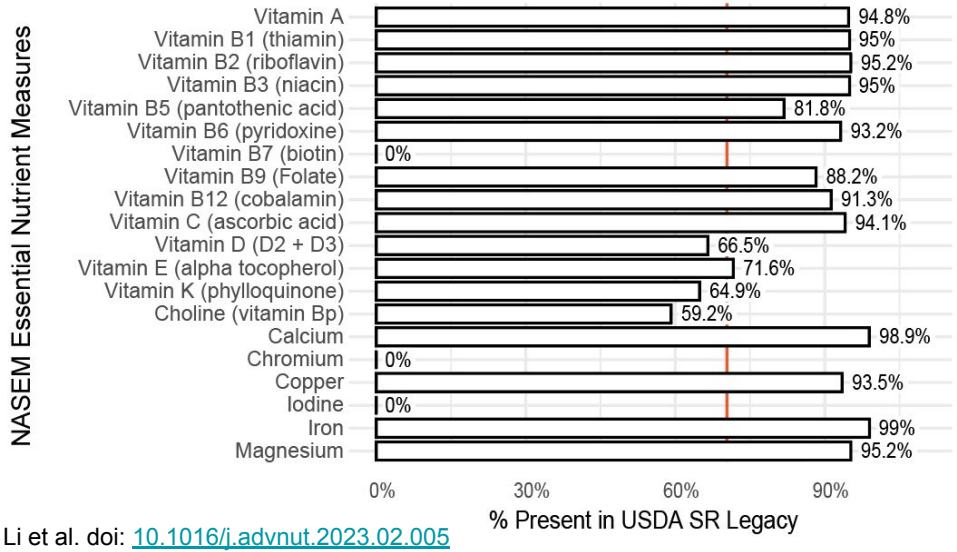
99% of iron, calcium & sodium

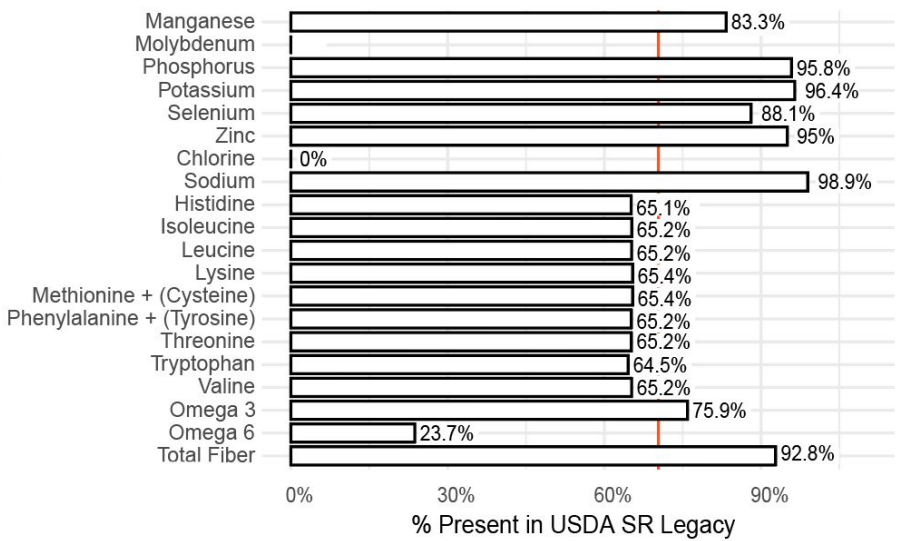
Some nutrients are absent from all foods:

Vitamin B7 (biotin), iodine, chlorine & chromium

Not one food:

Has **100% complete data** for NASEM essential nutrients.





Li et al. doi: 10.1016/j.advnut.2023.02.005

Opportunities to Advance Real World Data

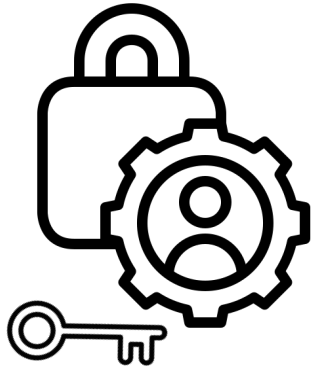
Assessing FAIRness of food data sources: Findable & Accessible

Findable

How easily can a data source be found?

- Of 175 total data sources reviewed, 12% (n=21) were not findable
- 32% of URL links failed at the time of collection

Accessible



How easily can data be obtained from a source?

Of 154 findable data sources:

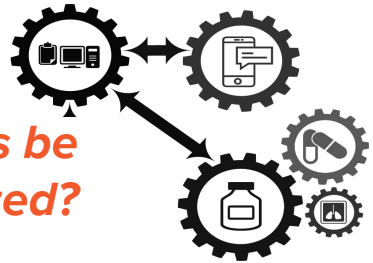
- 44% were exportable in an Excel and/or CSV format
- 21% required **fees** or **credentials**
- 47% were exportable as PDFs
- 10% were **view-only**

Li et al. doi: 10.1016/j.advnut.2023.02.005

Opportunities to Advance Real World Data

Assessing FAIRness of food data sources: Interoperable & Reusable

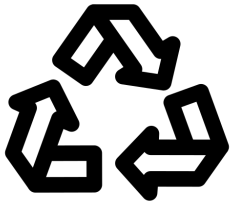
Interoperable



How easily can sources be connected or harmonized?

- Not able to quantify due to lack of common ontological framework and limited database documentation.
- USDA databases are the largest currently available globally connected network of food and nutrient data.

Reusable



How easy is it to repeatedly use and access data?

- Of 137 citations, 51% did not provide the version or the retrieval date.

Li et al. doi: 10.1016/j.advnut.2023.02.005

Opportunities to Advance Real World Data

Proposed Opportunities: Advancing FAIRness in food composition data sources

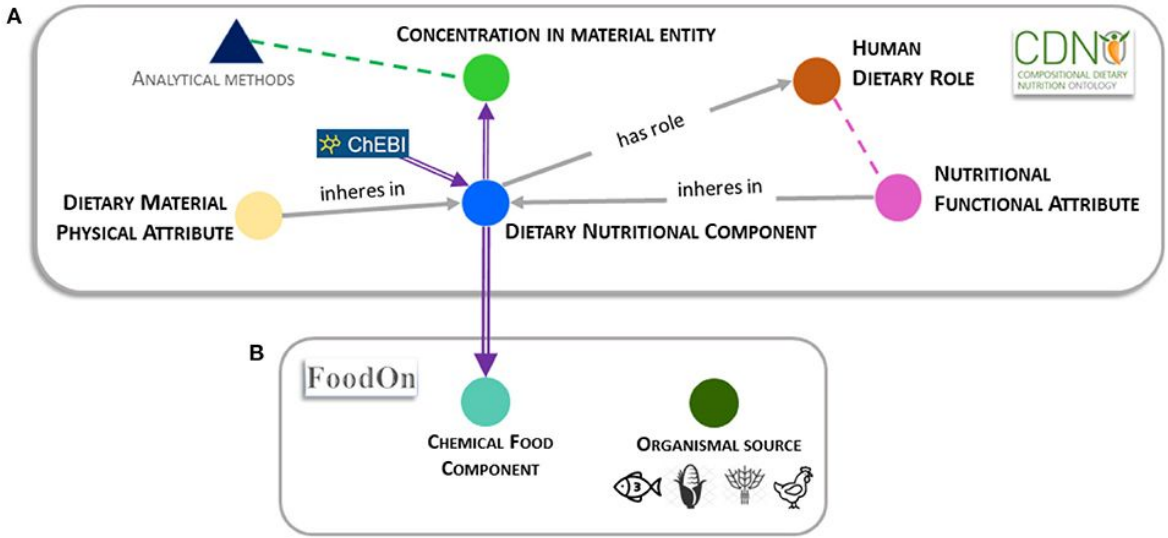
	Quality	Findability	Accessibility	Interoperability	Reusability
Opportunity	**9** Phytonutrient compounds in SR Legacy **38** Siloed in USDA Special Interest DBs	**32%** Of citation URLs failed	**47%** Of data source files available as PDFs **10%** Of data sources were view only	**none** No sources provided complete instructions	**51%** Of citations are missing version or retrieval date
Solution & Action	Integrate SR with USDA Special Interest db on Flavonoids	Create a persistent URL for each data source	Prioritize usable formats: such as CSV, TSV, ASCII, and Excel	Implement global unique identifiers - FoodOn	Adopt a citation standard

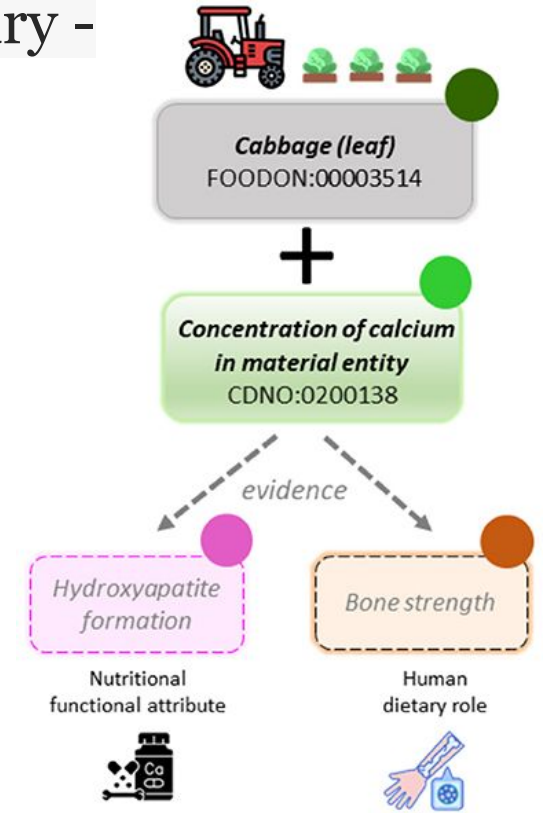
Li et al. doi: 10.1016/j.advnut.2023.02.005

Addressing Interoperability: Compositional Dietary Nutrition Ontology (CDNO)

Establishing a Common Nutritional Vocabulary - From Food Production to Diet

Liliana Andrés-Hernández, et. al.



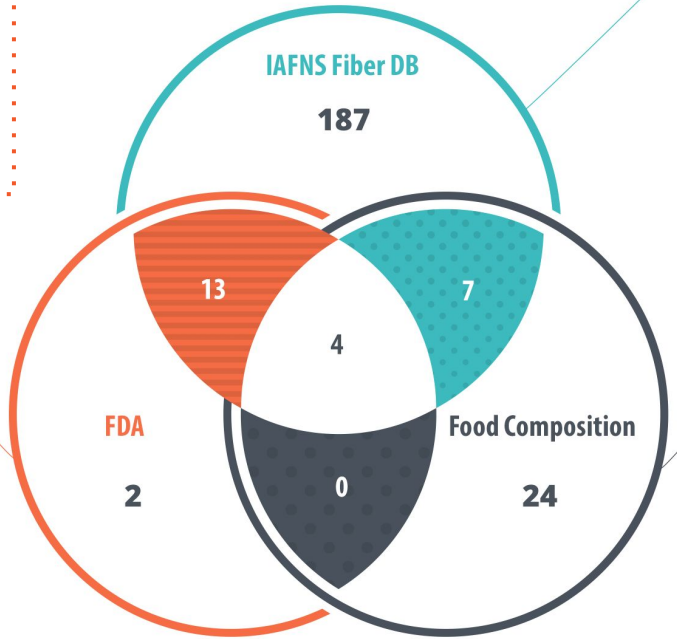


Front. Nutr. 9:928837.(2022) doi: 10.3389/fnut.2022.928837 -
Correspondence: King

Addressing Interoperability: Harmonization through a common fiber ontology

INTERSECTIONS AND GAPS IN FIBER TERMINOLOGY

Fiber measures found in food and nutrient DB do not align with research terminology nor federal determination of Fiber per FDA ruling.



Diet-Related Fibers & Human Health Outcomes DB

- 211 fiber measures total; 187 unique fiber measures

FDA Labeling Regulations

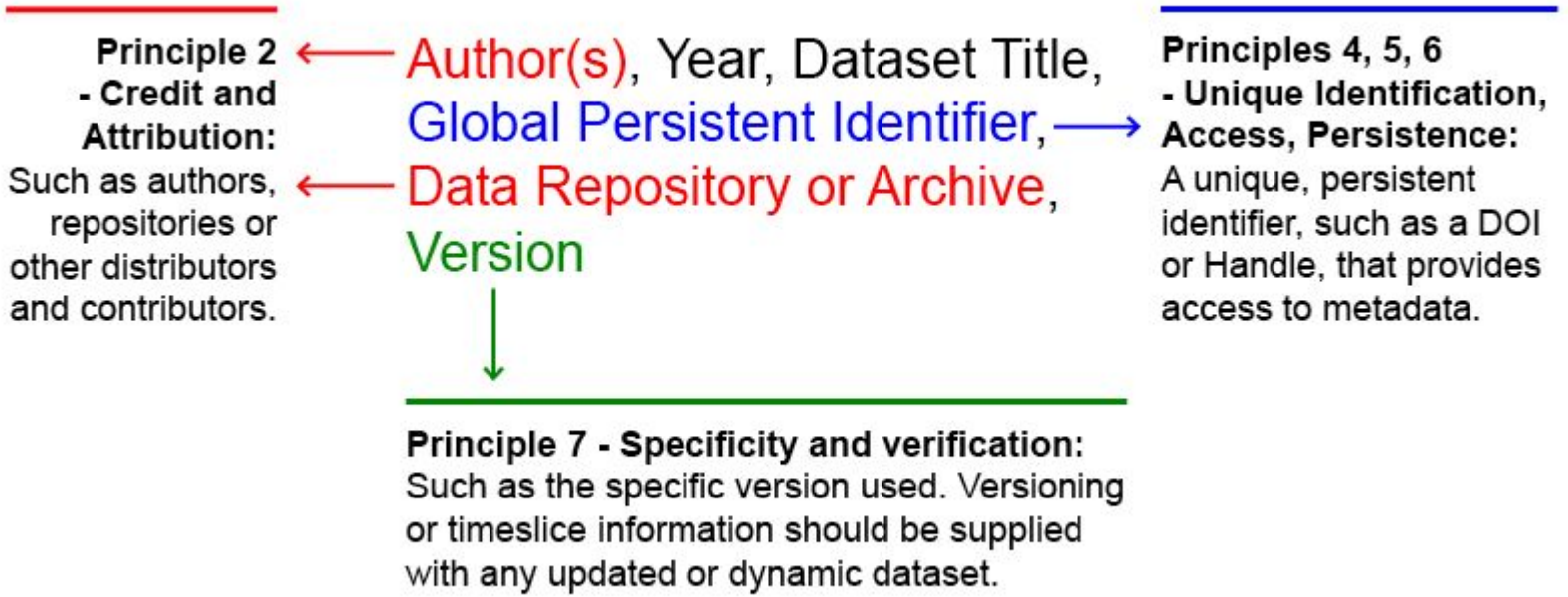
- 15 fiber measures total; 2 unique fiber measures

Food Composition Databases

- 35 fiber measures total; 24 unique fiber measures

Opportunities to Advance Real World Data

Addressing Reusability: Citing Food Composition Data to allow for reproducibility



Example of a data citation based on the Joint Declaration of Data Citation Principles (2014).

Opportunities to Advance Real World Data

Assessing food composition data citation: Preliminary findings (submitted, and in review)

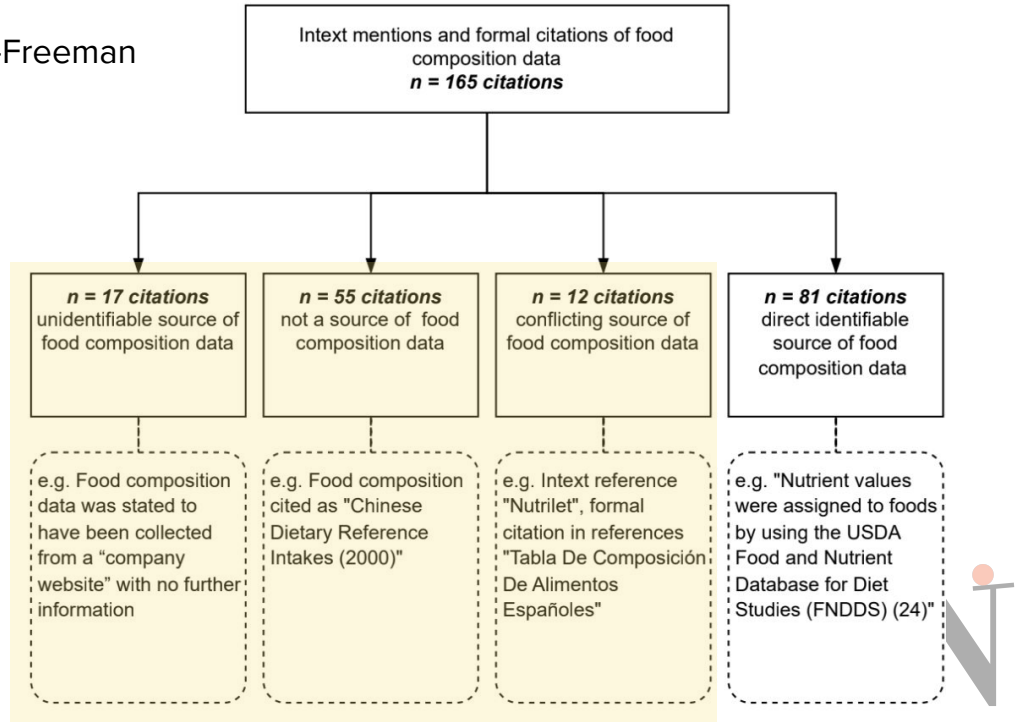
Development of a comprehensive food data citation standard: A surprising gap in the nutrition research literature

Shavawn Forester, Emily Jennings-Dobbs, Britt Burton-Freeman

89 publications included for citation analysis

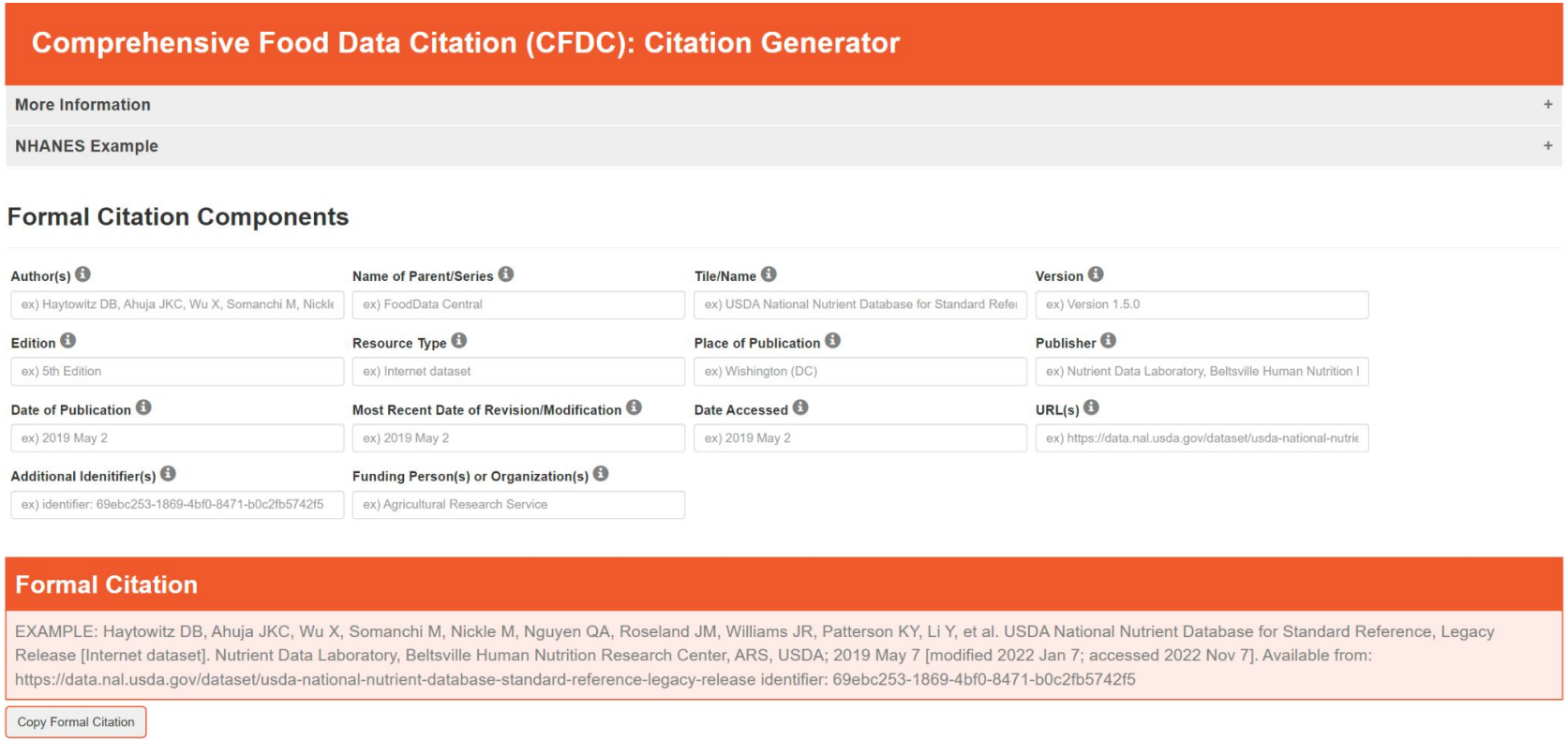
165 data citations were identified

84 of the 165 **(50.9%)** citations for food and nutrient data could not be used to identify the food composition data source used.



Opportunities to Advance Real World Data

Proposed opportunity to improve food data citation: Interactive citation tool CFDC

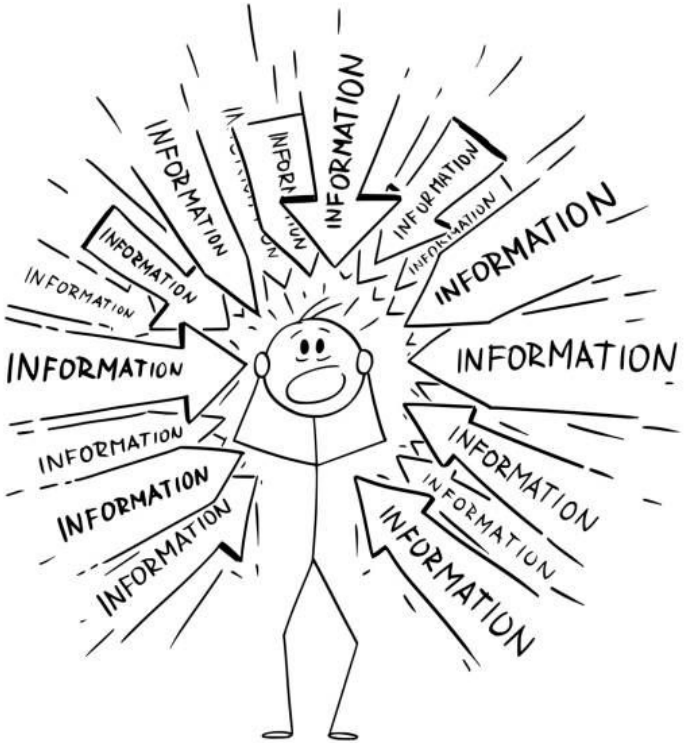


www.nutrientinstitute.org/cfdc

Elevating data through visualization: Driving insights and progress

DATA VISUALIZATION SOCIETY

Visualization proves to be a powerful tool for enabling the human eye to perceive trends and recognize opportunities more effectively.

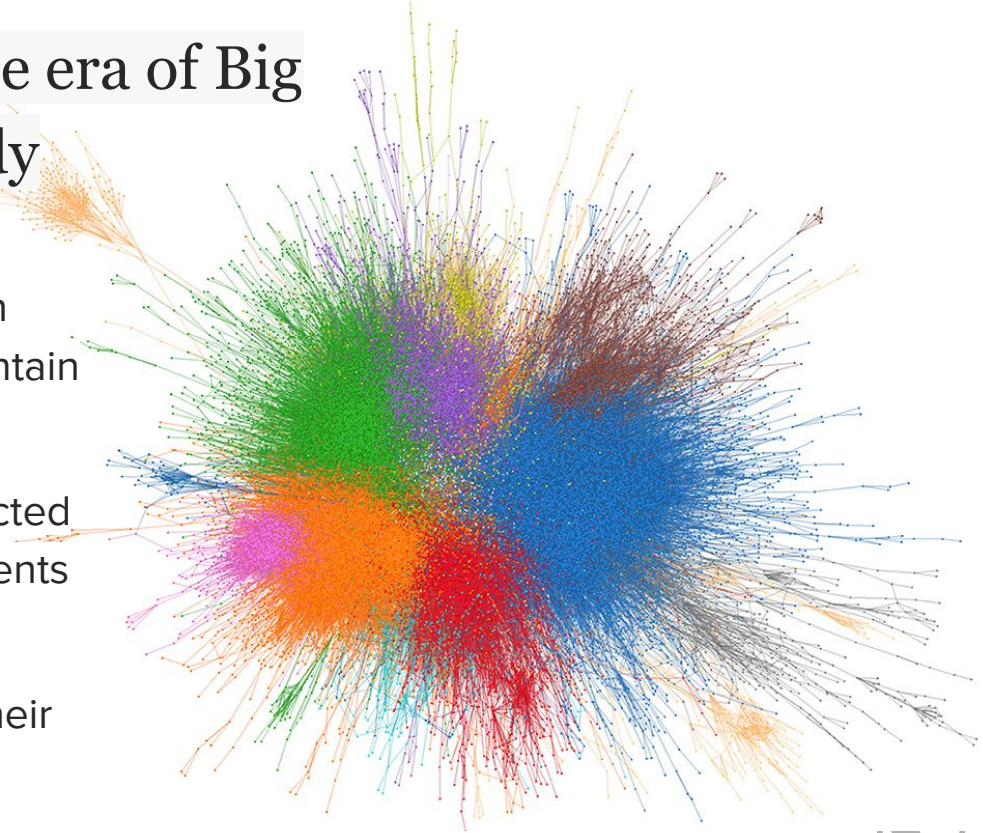


Visualization of the palm oil citation network: An example

Food composition databases in the era of Big Data: Vegetable oils as a case study

Henrique Ferraz de Arruda et. al.

- Scientific records that cite each other can form communities, signaling that they contain similar information.
- Each color represents a community detected in the network, labels represent the contents present in the community.
- Communities are ordered according to their size, with A (dark blue) being the largest.



Ferraz de Arruda et al. Front. Nutr. 9:1052934. (2023) doi: 10.3389/fnut.2022.1052934

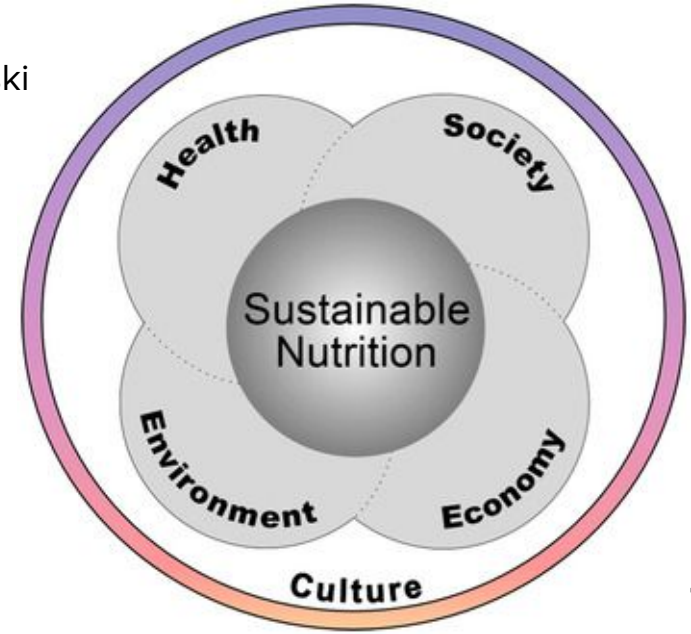
Opportunities to Advance Real World Data

Visualization to see opportunity: Proof of concept (submitted, in review)

Visualizing data interoperability for food systems sustainability research—from spider webs to neural networks

Emily M Jennings-Dobbs, Shavawn M Forester, Adam Drewnowski

Lack of interoperability across databases poses a challenge to advancing research on sustainable food systems.



von Koerber et al. *Proceedings of the Nutrition Society, 76*(1), 34-41. doi:10.1017/S0029665116000616

Opportunities to Advance Real World Data

Visualizing Food Sustainability Data: Study overview

What is interoperability?

The ability of different data sources to connect and be used together

To address this problem we:

1. Identified 200 data sources within the sustainability domains
2. Identified existing crosswalks
3. Proposed visualizations that aid in Identifying databases in need of expansion, integration, and harmonization

Opportunities to Advance Real World Data

Visualizing Food Sustainability Data: Chord diagram

Best used for identifying:

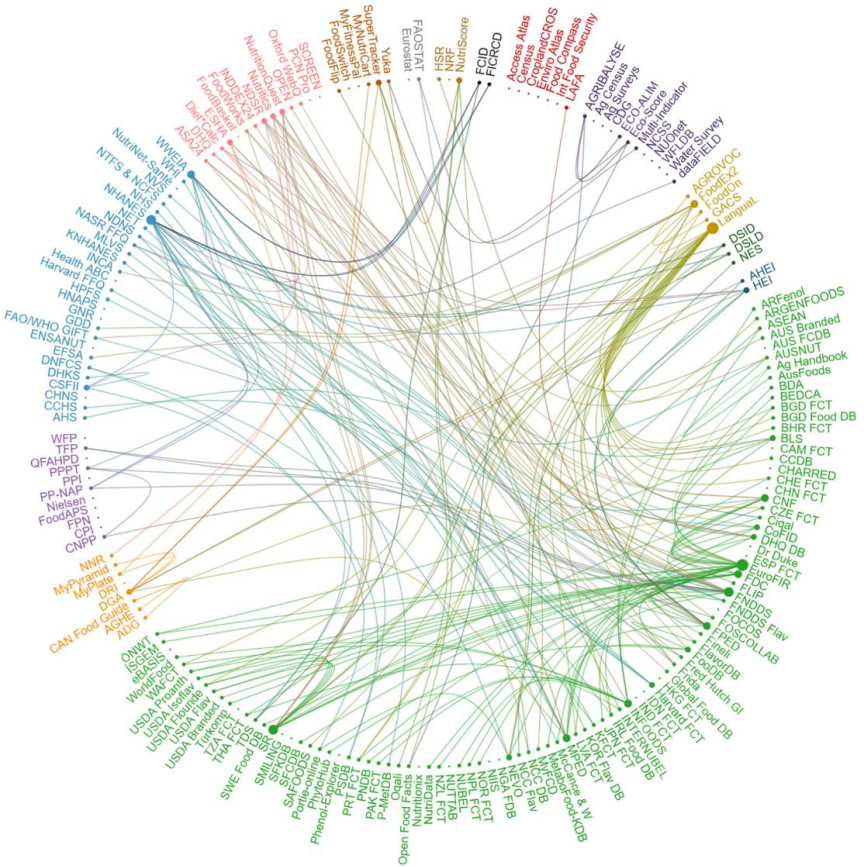
One-to-one connections

Density of connections between categories

Limitations:

Usefulness diminishes with increasing data sources

Secondary (indirect) connections not shown



Data Source Categories

- Food Composition
- Dietary Supplements
- Commodities
- Dietary Intakes
- Prices & Expenditures
- Environmental
- Geospatial
- Food Balance Data
- Research Applications
- Consumer Applications
- Dietary Guidelines
- Diet Quality Metrics
- Nutrient Profiling
- Food Ontologies

Opportunities to Advance Real World Data

Visualizing Food Sustainability Data: Neural network diagram

Best used for identifying:

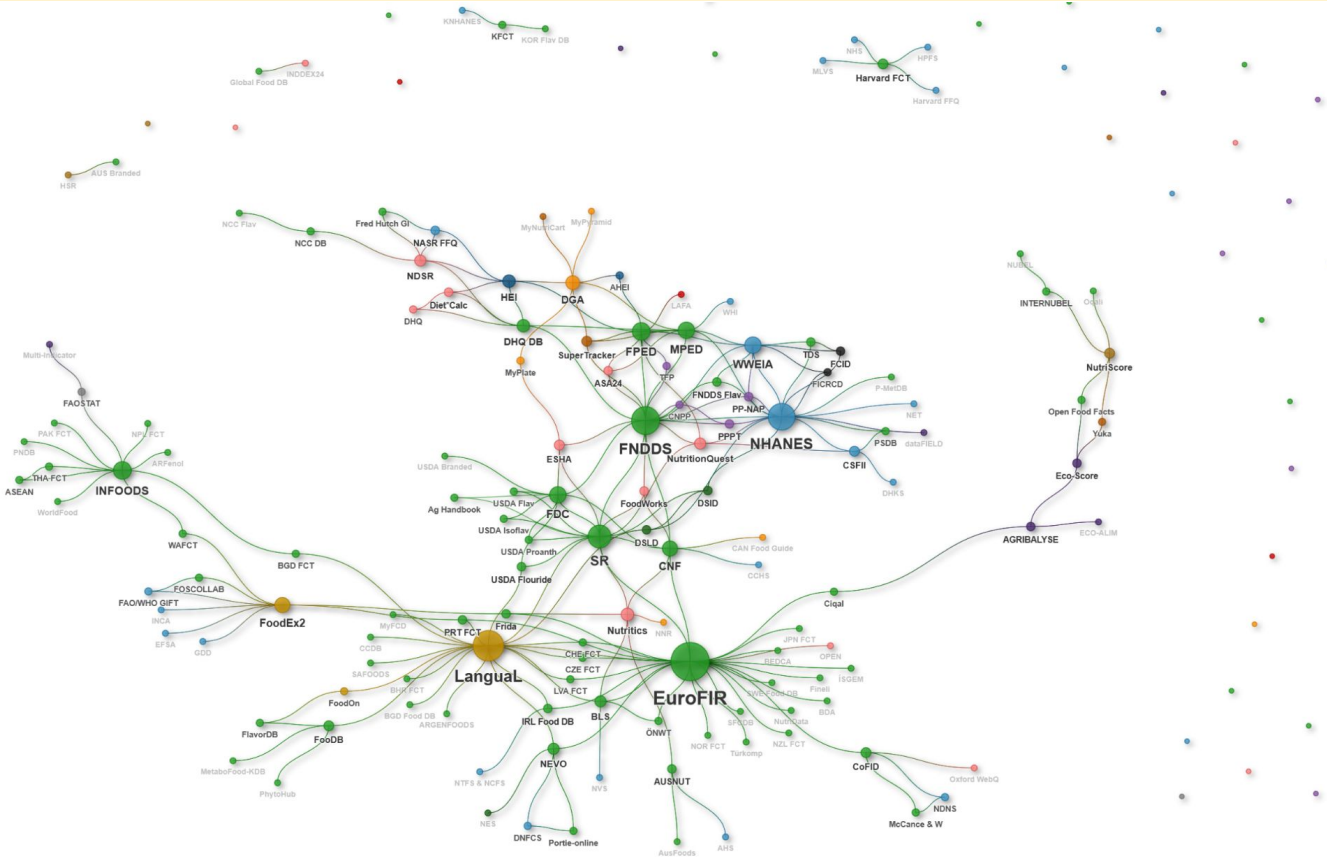
One to one connections

Secondary (indirect) connections

Clusters of connections

Limitations:

Require more technical skill and explanation



Opportunities to Advance Real World Data

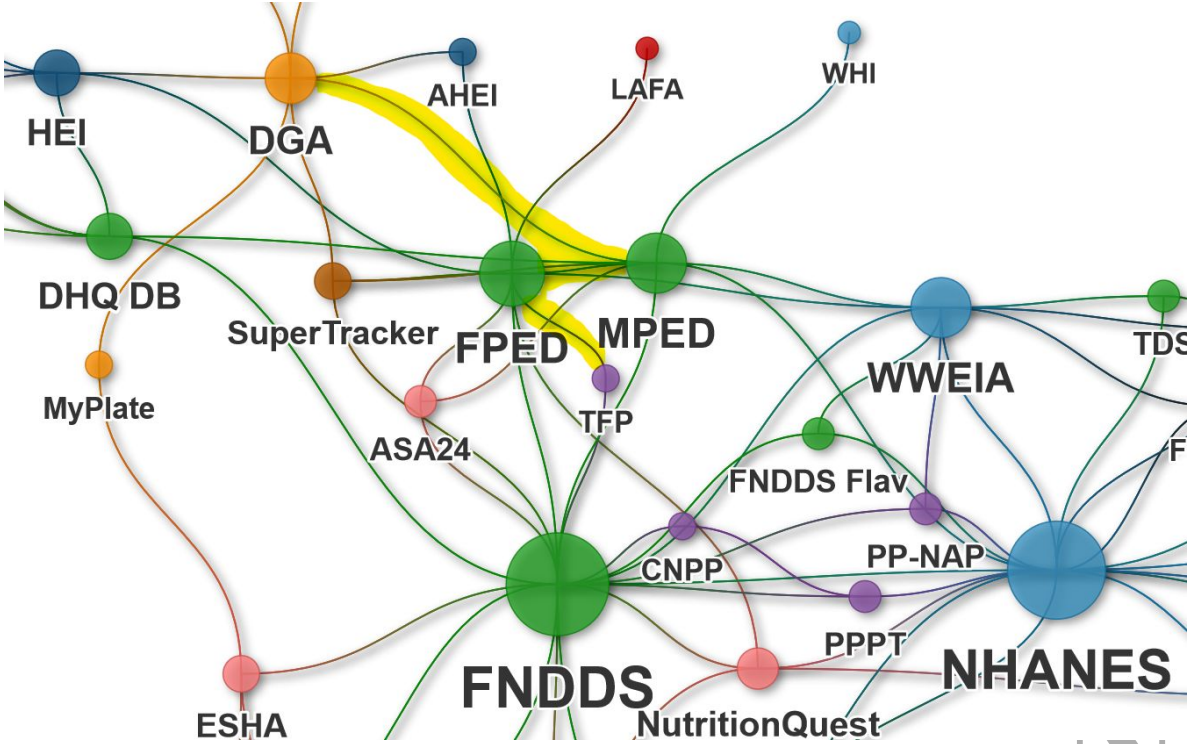
Application of Neural network diagram: Connecting food price data to DGA

To connect DGA with food prices we need to use the neural network diagram.

The **closest** food price database (light purple) is Thrifty Food Plan (TFP)

There is no direct connection from DGA to TFP.

Instead, DGA can connected to MPED/FPED which then can connect to TFP.



Bridging the gap between scientific advancements and practical application

- Defining Food Data Quality
- Applying FAIR Principles
- Comprehensive FoodData Citation (CFDC)
- Visualization to see opportunity

DIET QUALITY TOOLS

Diet quality assessment tools play a pivotal role in **bridging the gap** between scientific advancements and practical application, enabling the **translation of scientific knowledge** into actionable tools and insights.

Opportunities to Advance Real World Data

Diet Quality Tools: Government sponsored Nutrient Profiling Models a global imperative.

Created in one of three major ways:

1. Focus on nutrients to limit
2. Emphasize nutrients known to be beneficial to health
3. Some combination of both.

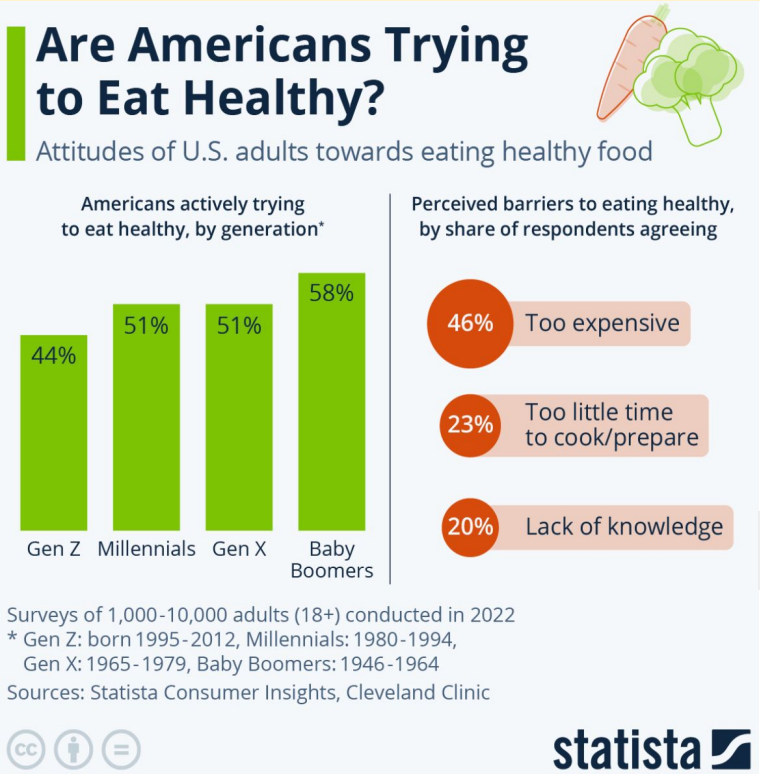
Federally funded models are designed to help **implement dietary guideline** advice and address public health concerns.

Healthy Eating Index

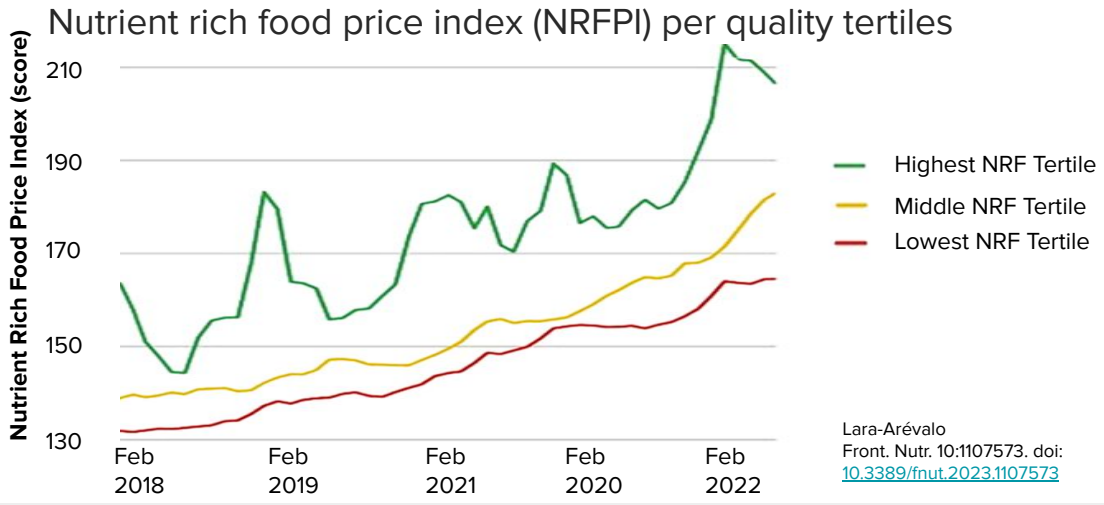
GUIDING STARS®
NUTRITIOUS CHOICES MADE SIMPLE

Opportunities to Advance Real World Data

Diet Quality Tools: Nutrient Density and Cost



Source: Statista Consumer Insights, 2023



Lara-Arévalo
Front. Nutr. 10:1107573. doi: 10.3389/fnut.2023.1107573

Toward Affordable Nutrient Density in Processed Foods

Selected aspects of product reformulation for health

	Remove or reduce	Add
Energy and nutrients	Energy, fat, trans fat, sugar, sodium	Protein, fiber
Micronutrients	Antinutrients, phenols	Calcium, iron, zinc, iodine, folate, vitamins A, D, B-12
Ingredients		Whole grains, fruit, nuts, seeds
Functional ingredients		Plant protein isolates, sweeteners, salt alternatives

Drewnowski et al. Curr Dev Nutr. 2022 Jun; 6(6): doi: 10.1093/cdn/nzac089.

Opportunities to Advance Real World Data

Diet Quality Tools: Innovations in assessing diet quality

Carbohydrate Food Quality Score (CFQS)

Table 1. Carbohydrate Food Quality Score (CFQS) Components.

Components	Component Scores	Score Range
Fiber	1 point if fiber ≥ 10 g/100 g carb portion; else 0 points	0 to 1
Free Sugar	1 point if free sugar < 10 g/100 g carb portion; else 0 points	0 to 1
Sodium	1 point if Na < 600 mg/100 g dry weight; else 0 points	0 to 1
Potassium	1 point if K > 300 mg/100 g dry weight; else 0 points	0 to 1
Whole Grains	1 point if whole grains ≥ 25 g/100 g dry weight; else 0 points	0 to 1

Drewnowski et al. Nutrients 2022 Apr 2; 14(7):1485. doi: 10.3390/nu14071485

ELSEVIER

The Journal of Nutrition
Available online 8 June 2023
In Press, Corrected Proof What's this?

Perspectives

Perspective: Developing a Nutrient-Based Framework for Protein Quality

Shavawn M. Forester [1], Emily M. Jennings-Dobbs [1], Shazia A. Sathar [2], Donald K. Layman [3]

Show more

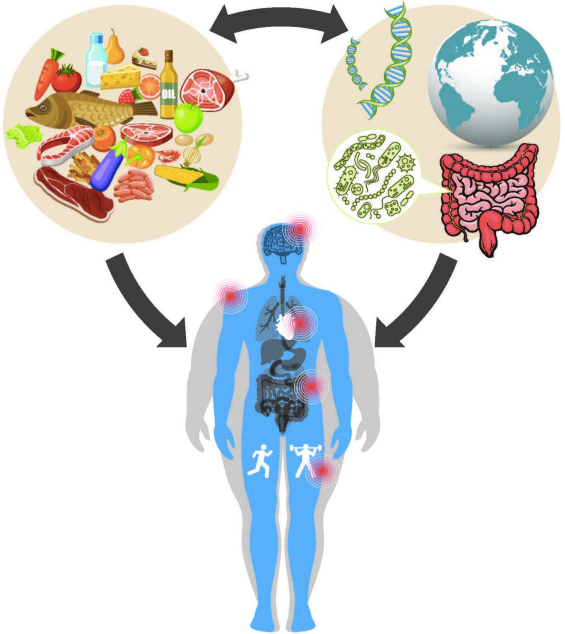
+ Add to Mendeley Share Cite

https://doi.org/10.1016/j.tjnut.2023.06.004 Get rights and content
Under a Creative Commons license open access

Forester et al. J Nutr. 2023;S0022-3166(23)72409-7. doi: 10.1016/j.tjnut.2023.06.004

Opportunities to Advance Real World Data

Diet Quality Tools: Population & Precision Nutrition in harmony



Diet quality tools applied to individuals

- Nutrient Density
- Carbohydrate quality
- Protein quality

Precision science informs nutrition recommendations, promoting optimal well-being for everyone

In Summary

Thank You