METHODS TO ASSESS THE COST AND AFFORDABILITY OF NUTRITIOUS AND HEALTHY DIETS

SUMMARY OF ASSESSMENT METHODS

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Joanne Chui & Alison Donnelly

Save the Children

UCL

WFP World Food Programme

Food Prices for Nutrition

Tufts Friedman School of Nutrition Science and Policy

London School of Hygiene & Tropical Medicine

gain Global Alliance for Improved Nutrition

Executive Summary

Ensuring households have access to nutritious diets is critical in addressing malnutrition and improving public health. However, nutritious foods may not be accessible or affordable, particularly for low-income households. In recent years, there has been a surge in interest towards ensuring the quality, access, and affordability of nutritious and healthy foods to combat malnutrition.

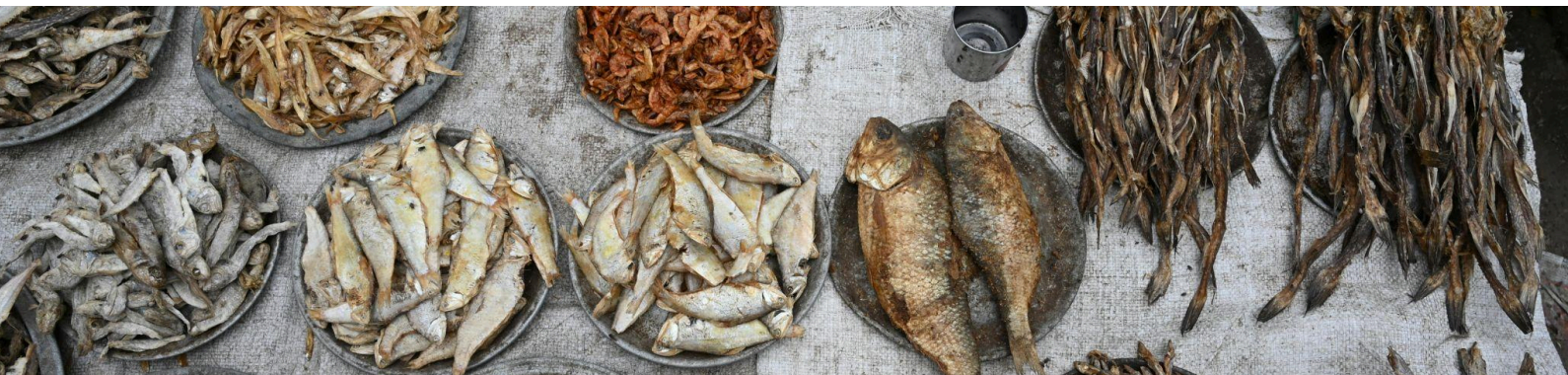
A significant barrier to achieving a nutritious diet is its cost and affordability. Various methods exist to calculate the cost and affordability of nutritious or healthy diets. This paper aims to explain these methods and support practitioners in selecting a method that suits their needs.

Dietary costing assessments are used for a number of purposes, including guiding policy and programme development, shaping social protection programmes, nutrition education campaigns, and tailoring emergency food assistance programmes. These assessments create simulated diets to meet specific dietary needs or national guidelines, providing insight into the feasibility of achieving nutritional objectives with locally available foods and household income levels.

Conducting dietary costing assessments involves collecting, compiling or collating data on local food prices, nutritional composition, and income or expenditure, employing various methodologies and software tools. These tools range from simple applications requiring minimal training to more complex software demanding a higher level of expertise. The choice of tool can be based on the purpose of the analysis, available time and resources, the flexibility needed in data adjustment, and the level of training needed. This paper focused on tools that are used globally.

NutVal and the WHO Diet Impact Assessment (DIA) Model offer rapid calculations for planning purposes with minimal training needed. These tools do not optimise diets based on minimal costs but include cost components. The Cost and Affordability of a Healthy Diet (CoAHD) is used to calculate the lowest cost to meet the recommended intake of different food groups in food-based dietary guidelines. More complex tools such as Cost of the Diet (CotD), Optifood, Enhance, and Cost of a Nutrient Adequate Diet (CoNA) require higher levels of training and support calculations of the cost of meeting energy, macronutrients, and micronutrient requirements. The CoAHD, CotD, Optifood, Enhance and CoNA can be used to model interventions to reduce the affordability gap of a healthy nutritious diet by either increasing the income or modifying the diet.

Understanding and improving the accessibility and affordability of nutritious diets is essential for public health. This paper serves as a guide for practitioners involved in dietary costing assessments, offering insights into selecting appropriate methods and tools to evaluate diet costs and inform policy and programme development towards better nutrition globally.



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Lead authors: Joanne Chui and Alison Donnelly

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1. Introduction

An estimated 42% of the global population (more than 3.1 billion people) could not afford a healthy diet in 2021.[1] Where households cannot provide a nutritious diet, there is a higher risk of malnutrition among children and potentially lifelong consequences in terms of development and health. The cost and affordability of achieving a nutritious diet vary significantly across contexts. Therefore, understanding which foods are available locally and estimating diet costs is essential for designing appropriate interventions to support improved nutrition and health.

There has been an increase in costing diets in recent years and various methods have been developed to support these analyses. These methods typically aim to identify affordability gaps and inform programme design and policies to address these gaps. The purpose of this paper is to offer a summary of these methodologies and to assist practitioners, including programme managers, policymakers, and researchers in choosing the most suitable method for their specific needs.

1.1. What are assessments on the cost and affordability of diets?

Dietary costing assessments calculate the lowest cost of purchasing or obtaining a diet that meets dietary needs and to prevent nutrient deficiency or excess. This may be a diet which meets food-based dietary guidelines, or specific daily nutrient requirements[2] for households or individuals in a specified group of the population (e.g. pregnant women, children 6-23 months old or school-age children). Typically, the results are presented as a combination of the lowest-cost foods from the different food groups. Regardless of the different approaches and specific aims, these methods estimate the lowest cost to meet dietary needs.

The affordability of a nutritious diet is calculated by comparing diets that meet dietary needs to income and/ or expenditure data. The affordability of these diets can be assessed for different population groups.

1.2. What diets are we interested in?

These methods find the cost of diets that meet dietary needs where a combination of foods are selected to simulate a diet or a food basket (Table 1). These diets are modelled to meet the objectives of the exercise, such as adhering to food group requirements, achieving specific nutrient targets, or focusing solely on energy or macronutrient content.

The simulated diets provide a framework for understanding the feasibility of meeting dietary needs. Most of these methods can assess:

- Whether local food availability is sufficient to achieve a nutritious diet
- If not, which food group or nutrient needs cannot be met using locally available foods.
- The approximate cost of a nutritious diet
- The cost of the different food groups within the diet

[1]FAO, IFAD, UNICEF, WFP and WHO. 2023. *The State of Food Security and Nutrition in the World 2023. Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum*. Rome, FAO. https://doi.org/10.4060/cc3017en
[2]Nutrient requirements refer to dietary reference values or typical reference for nutrient intake recommendations.

Additionally, some methods in this field can include additional criteria to reflect dietary preferences and behaviours, making the analysis more relevant to local circumstances.

Table 1 presents the diets generated by these methods. Although a diet which only meets energy and/or macronutrient needs may lead to micronutrient deficiencies, calculating these diets can help identify the lowest-cost energy and protein rich foods or to show the additional cost of meeting additional nutrients (e.g., the relative cost of meeting energy needs only versus meeting energy and nutrient needs).

Table 1. Summary and description of the criteria for each simulated "diet"

CRITERIA	DESCRIPTION
Lowest-cost to meet **energy needs only**	Meets the *energy* needs for either an individual, household, or population. This diet does not aim to meet all their macro and micronutrient needs.
Lowest-cost to meet **energy and macronutrients only**	Meets the *energy and macronutrients (protein, fat, and carbohydrates)* needs of individuals, households or population groups. This diet does not aim to meet all their micronutrient needs.
Lowest-cost to meet **macro and micronutrient needs**	In addition to *energy, protein, fat, and carbohydrates*, meets the (specified) *micronutrient* needs of an individual and/or household. This diet aims to prevent nutrient deficiency or excess.
Lowest-cost to meet **recommended consumption of food groups**	Meets the *recommended amounts of specified food groups*, but not specific macro, and micronutrient requirements. Food groups and quantities can be based on national dietary guidelines or a global standard.
Lowest-cost **nutritious diet with adjustments for behaviour/ habits**	Adjustments can be made to *account for behaviour and preferences* can be added to any of the above diets. This may mean excluding taboo foods, adjusting the frequency of consumption or even portion sizes.

1.3 What are dietary costing assessments typically used for?

Dietary costing assessments have been used globally for a variety of applications. One of the primary uses has been in guiding policy and program development. Governments, non-governmental organisations (NGOs), and international bodies have relied on these tools to understand the economic barriers to a nutritious diet and to design interventions to address the gaps identified.

For instance, in regions with high rates of malnutrition, these assessments have helped to shape social protection programmes, nutrition education campaigns, and agricultural policies to promote the availability and affordability of nutrient-rich foods. Additionally, they've been used to tailor emergency food assistance programs in crisis-hit areas, ensuring that food relief efforts are both cost-effective and nutritionally adequate.

These assessments are also used in academic and clinical research, helping to deepen the understanding of the relationship between diet, health, and economics, and to monitor the impact of policies and market changes over time.

2. Methods and processes to analyse the cost and affordability of diets

2.1. Typical process and data requirements to analyse the cost and affordability of diets

Conducting cost and affordability of diet assessments requires a substantial amount of data. For each study, analysts need the prices of locally available foods, which could be collected specifically for the study or obtained from secondary sources (e.g., national statistical offices or existing market monitoring programmes). Other data such as food composition, edible portions, and nutrient requirements can come from existing databases, which can also be embedded in software tools, or data collection for a specific study. For example, the typical standard for nutritional requirements is based on WHO/FAO for energy, protein, fat, and micronutrients.[3]

The typical process of analysing the cost and affordability of the diet involves various steps and tools to support the process (Box 1). If the aim is to meet multiple objectives, linear programming or another mathematical process is often used to identify the lowest-cost food combinations to meet those objectives. Specialised software or statistical software such as Stata, R, and Excel can be used for this process.

Over the years, different organisations have invested in building and sharing tools to simplify the process and provide guidance on conducting diet cost assessments. Some organisations have developed software or online browser-based applications to facilitate this type of analysis, and others have developed tools and pre-written code for Excel, Stata or R. Many tools come preloaded with some essential data that can be used across various assessments, but diet costing assessments typically require additional data specific to the location studied such as food price data (Figure 1).

Box 1: Typical process and data requirements to analyse the cost and affordability of diets

Regardless of the method used, the process and data requirements to calculate the cost and affordability of nutritious and healthy diets are similar (Figure 1):

Step 1: Define the objectives and scope of the assessment

Step 2: Identify a list of foods relevant to the assessment.

Step 3: Match the list of available foods with existing nutritional composition tables to identify their nutritional content.

Step 4: Collect and enter the prices of the foods using standardised units.

Step 5: Identify the study population, individuals, or households and match the nutritional requirements or number of foods per food group.

Step 6: Identify the diet of study, and calculate the least-expensive way to achieve the diet.

[3]Depending on the method and objectives of the diet, protein, fat, and micronutrients may not be needed.

Step 7: Adjust the diet with additional constraints to limit the taboo foods or set a minimum number of servings of commonly eaten foods to reflect dietary habits and preferences.

Step 8: Assess the affordability of the diets, by comparing the costs with estimated income and/ or expenditure data (Figure 2). The affordability can be assessed in several ways including:

A. Identifying whether the household/individual is or is not able to afford the diet
B. Measure the prevalence of unaffordability
C. Assessing how much additional money would be needed to be able to afford the diet (affordability gap)
D. Assess cost ratios (e.g., diet cost-to-wage ratios)

Step 9: Model interventions to reduce cost or improve affordability. Adjust the diet or income/ food expenditure/ non-food expenditure to create scenarios or interventions and assess how they impact diet cost or affordability. This may include modelling the impact of providing supplementary food, cash, and/or voucher assistance (Figure 2).

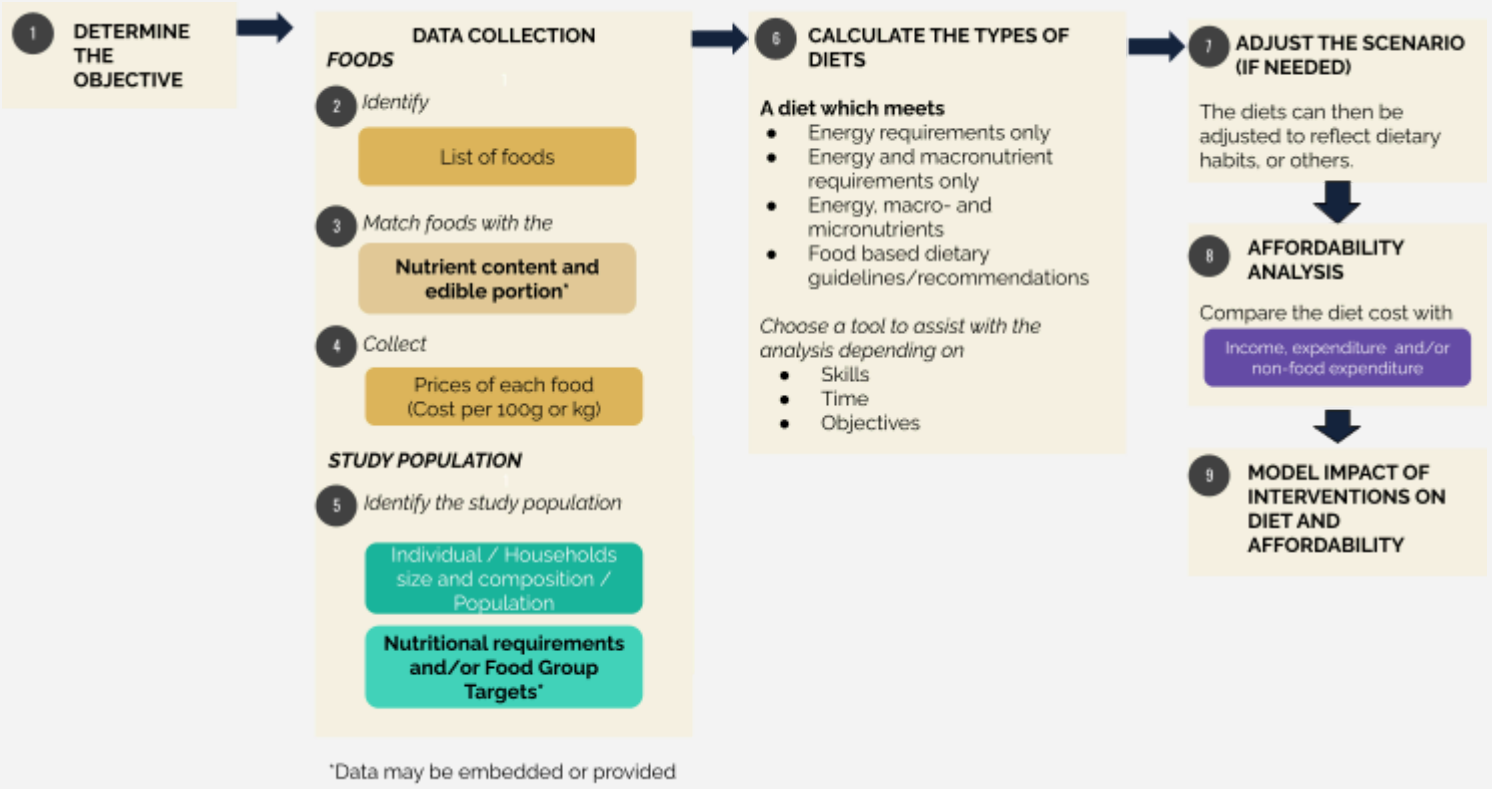

Figure 1. Typical process and data requirements to analyse the cost and affordability of diets

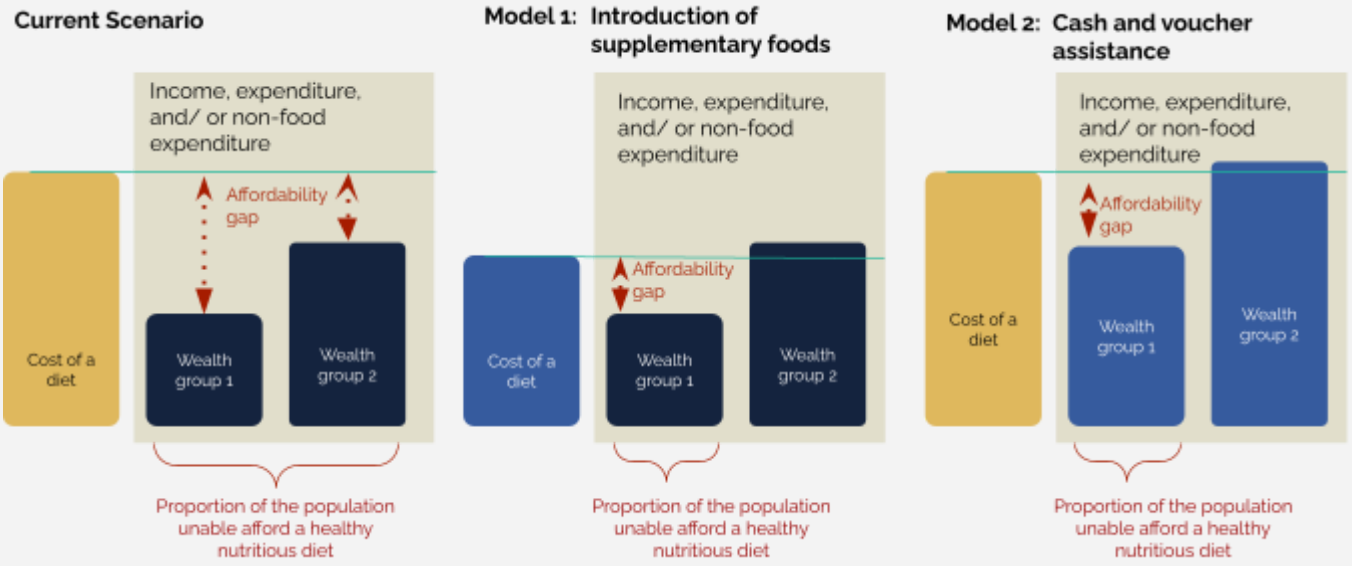

Figure 2. An example of how the affordability of diets and modelling of interventions are assessed. In the current scenario, the cost of the diet is unaffordable to both wealth groups. After introducing supplementary foods at zero cost, the cost of the diet is reduced, making the diet affordable to wealth group 2 but not wealth group 1. Alternatively, interventions can be modelled by increasing income to improve affordability (model 3).

3. Summary of Tools

Organisations have developed a spectrum of tools - some of these using standalone software and others based in Excel, Stata and R - to help calculate the cost and affordability of nutritious or healthy diets. These tools vary in complexity and the level of expertise required for their use (Figure 3). Each method is explained below and organised into 3 categories:

1) Tools for rapid calculations and planning;
2) Tools to calculate the lowest cost to meet recommended food group consumption;
3) Tools to calculate the lowest cost diet which meets specific nutrient requirements,

NutVal and the WHO Diet Impact Assessment (DIA) Model require minimal training and support rapid calculations to be used for planning. These tools include cost components but do not calculate diets based on minimising costs. The Cost and Affordability of the Healthy Diet (CoAHD) is used for calculating the lowest cost to meet the recommended intake of food groups in food-based dietary guidelines. On the other end of the spectrum, more complex tools such as Cost of the Diet (CotD), Optifood, Enhance, and Cost of the Nutrient Adequate Diet (CoNA) require a higher level of training, but support analysis that assesses how to the meet energy, macro, and micronutrient intake recommendations for a healthy life. With CoAHD, CotD, Optifood, Enhance, or CoNA, adjustments can be made to a diet to model how different interventions can improve the affordability of a healthy nutritious diet.

Below is a summary of the contact details, accessibility and required operating systems, level of training and resources needed, preloaded data, ability to adjust data, analytical capabilities, and

typical uses for the latest version of each tool. A series of questions (Box 2) was developed for users to consider when reviewing the methods in more detail to select the most appropriate tool.

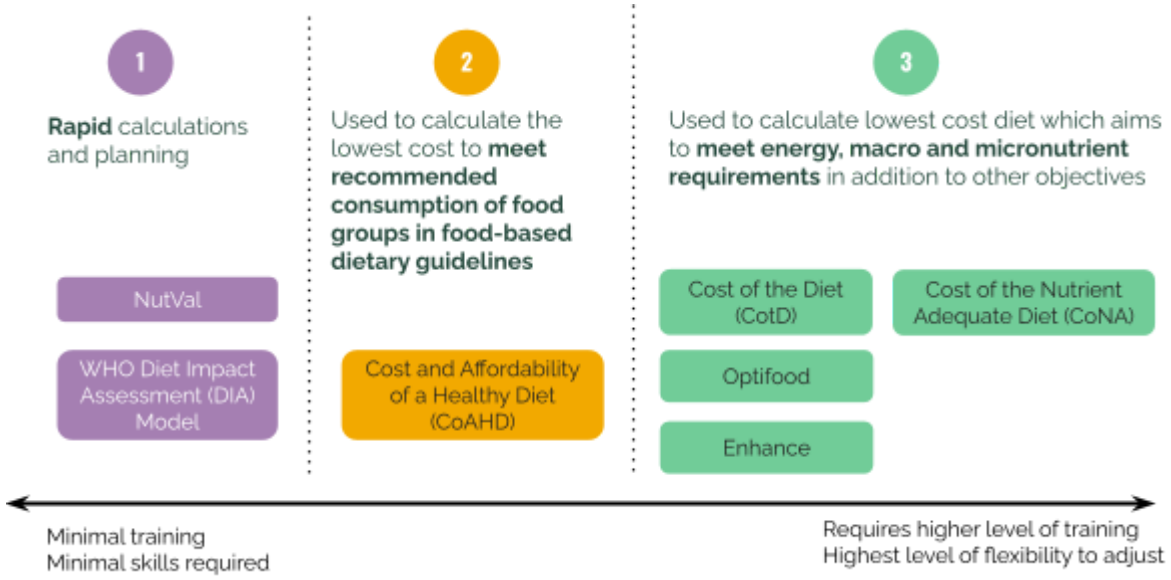

Figure 3. Tools to assess the cost and affordability of nutritious and healthy diets categorised by their complexity and level of expertise required for their use.

Box 2. Questions to help select a tool

Purpose

- What is the purpose of the analysis? What objectives do you want to meet?
- Do you need to input your own cost data?

Time and resources

- How much time and resources do you have to conduct this exercise?
- Will it be for a quick analysis for an emergency or does it require a more detailed cost and affordability analysis for programme planning?

Flexibility to adjust data

- Do you need to use all/most of the data you have gathered?
- How flexible are the data input/format requirements?
- Can you adjust any embedded data?

Level of training required

- How familiar are you with Stata or R?
- What operating system are you using?

Data specificity

- Do you need to consider specific dietary restrictions or cultural dietary patterns?

Stakeholder Engagement:

- Who are the primary stakeholders in this analysis?
- How will the results be used to engage or influence decisions by these stakeholders?

Integration with Other Data

- Will this analysis need to be integrated with other types of data, such as health, demographic, or economic data?
- What formats and standards are required for this integration?

Reporting and Presentation:
- What is the intended format and level of detail for reporting the results?
- Do you require visual representations like graphs or maps?

Repeat Analysis and Updates
- Is this a one-time analysis, or will it be repeated periodically?
- How frequently do you anticipate updating the data or repeating the analysis?

3.1. Rapid calculations and ration planning

NutVal Software

Version 5.1 developed by University College London (UCL) in 2024

SUMMARY

NutVal is a spreadsheet application developed in Excel aimed at supporting the planning, calculation and monitoring of the nutritional value of food assistance. Version 5.1 of NutVal will be launched in 2024. The current version. 4.1 can be accessed on the website.
It aims to help ensure that nutritionally adequate food assistance is provided so as to minimise public health problems, particularly micronutrient deficiencies.

WEBSITE	CONTACT:
www.nutval.net	**a.seal@ucl.ac.uk**

ACCESSIBILITY AND OPERATING SYSTEMS SUPPORTED

This method uses a free, open-access Excel tool. Macros need to be enabled to be functional. The tool is designed for Windows and is not intended for iOS. However, some users have reported that they are able to use this tool on Apple devices.

LEVEL OF TRAINING REQUIRED AND RESOURCES AVAILABLE

NutVal is an Excel application that can run on most computers with minimal setup and does not require significant training or technical expertise.

Minimal time or money is needed. PowerPoint training presentations on using NutVal are available in English and French. They are designed for self-learning or group training sessions.

PRELOADED DATA

Energy, protein, fat, calcium, iron, vitamin A, Thiamine, riboflavin, niacin and Vitamin C. Foods commonly found in food aid baskets are included in the database of over 180 foods.

NutVal does not include vitamin B7 (biotin), iodine, potassium, phosphorus, or sodium in its calculations.

FLEXIBILITY TO ADJUST DATA

It is possible to add relevant data in the Excel file.

ANALYTICAL CAPABILITIES

The main functions include

a) Ration calculator for calculating the cost and nutrient content of a food assistance ration.
b) Compare the nutritional content of individual rations. Provides tables and graphs to compare rations.
c) Food Transfer Programme and Cash and Voucher Programme calculators to assess the total cost of the programme
d) On-site distribution monitoring for food basket monitoring

TYPICAL USES

This tool can be used to design rations and see the contribution of a ration (and food aid commodities) to meeting the major nutrient needs for the whole population or by age (e.g. under five) or physiological status (e.g. pregnant and lactating women).

- Intended to be used by programme managers, nutritionists and health staff.
- To find information on the nutrient content of a food assistance ration for an individual
- To plan a food assistance programme

Nutval is generally used by nutritionists and public health professionals in humanitarian contexts.[4]

WHO Diet Impact Assessment (DIA) Model

Developed by WHO and published in 2023

SUMMARY

The WHO (World Health Organization) Diet Impact Assessment Model is a tool developed to evaluate the impact of dietary changes on health outcomes. This model is primarily used to analyse how modifications in a population's diet can affect the incidence of non-communicable diseases (NCDs) such as heart disease, diabetes, and certain cancers.

WEBSITE	CONTACT
https://gams.ncd.digital/login	N/A

ACCESSIBILITY AND OPERATING SYSTEMS SUPPORTED

Not publicly available but access can be requested. The platform uses a web browser and is available to Mac and Windows users. Visit the website to request access.

LEVEL OF TRAINING REQUIRED AND RESOURCES AVAILABLE

Requires some training. A manual[5] is available for self-instruction.

PRELOADED DATA

Consumption data by region and 28 food groups - Food balance sheets[6] of the Food and Agriculture Organisation of the United Nations FAO adjusting those estimates for the amount of food wasted[7] at the point of consumption.

Predefined dietary scenarios from the Eat Lancet Commission include flexitarian, vegetarian, and vegan dietary patterns.

[4]NutVal was used to assess the nutritional value of recipes in this example: USAID Advancing Nutrition. 2023. *Management of Moderate Wasting using Local Foods: Documentation of Approaches in Nigeria, Senegal, and Uganda.* Arlington, VA: USAID Advancing Nutrition.
[5]https://iris.who.int/bitstream/handle/10665/373835/WHO-EURO-2023-8349-48121-71370-eng.pdf?sequence=1
[6] https://www.fao.org/documents/card/en/c/7d49abaa-eccf-5412-878a-8c190c46748a
[7] Gustavsson J, Cederberg C, Sonesson U, Van Otterdijk R, Meybeck A. Global food losses and food waste: extent, causes and prevention. Rome: Food and Agriculture Organization of the United Nations; 2011(https://www.fao.org/sustainable-food-value-chains/library/details/en/c/266053/, accessed 18 September 2023).

Food prices[8]: used 20,666 estimates of annual average prices in 179 countries covering 463 food items aggregated into a list of 31 food groups.

To calculate the nutrient content, the consumption of each food group is paired with its nutrient density as reported in the Global Expanded Nutrient Supply dataset, which provides estimates of the supply of 23 nutrients in 225 food categories in over 150 countries.

The estimates of recommended energy intake account for the age- and sex-specific energy requirements for a moderately active population of US height as an upper bound, and include the energy costs of pregnancy and lactation. The estimates of calcium intake include accounting for the average calcium content of drinking-water, in line with previous assessment. As WHO has not set guidelines for phosphorus or copper, the recommended intakes of these elements were adopted from those of the US Institute of Medicine.

FLEXIBILITY TO ADJUST DATA

Does not allow users to add data, but allows users to adjust the different simulated diets.

ANALYTICAL CAPABILITIES

Calculates the cost of diets
Estimates environmental footprint, including changes in resource use, and compatibility with global environmental targets (greenhouse gas emissions, land use, water use and fertiliser application).
Provides analysis on health risks and cost burden of each scenario in terms of avoidable deaths

TYPICAL USES

Estimating the health, environmental and affordability implications of diets and dietary change.

Used by WHO and partners with documented uses in predominantly middle to high income countries such as: Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Malta, Monaco, Montenegro, the Netherlands, North Macedonia, Norway, Poland, Portugal, the Republic of Moldova, Romania, the Russian Federation, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Türkiye, Turkmenistan, Ukraine, the United Kingdom, and Uzbekistan.[9]

3.2. Calculate the lowest cost to meet recommended consumption of food groups in food-based dietary guidelines

Cost and Affordability of a Healthy Diet (CoAHD)

Version 6 developed by Food Prices for Nutrition in 2023

[8] https://pubmed.ncbi.nlm.nih.gov/34715058/
[9] https://www.who.int/europe/news-room/events/item/2023/11/06/default-calendar/launch-of-who-europe-diet-impact-assessment-modelling-tool

SUMMARY

CoAHD is used by the UN FAO and national governments to track economic access to healthy diets. The cost of a healthy diet indicator is the cost of purchasing the least expensive locally available foods to meet requirements for energy and food-based dietary guidelines (FBDGs).[10]. The cost of a healthy diet (CoHD) can then be compared to a population's income available for food to measure its affordability.

WEBSITE	**CONTACT**
https://sites.tufts.edu/FoodPricesforNutrition/tools	foodprices@tufts.edu

ACCESSIBILITY AND OPERATING SYSTEMS SUPPORTED

The Excel version is simple to use and comes with preloaded data. The Excel workbook template and Stata code, both with pseudodata, are available for download on the Food Prices for Nutrition website. Stata requires a paid-for licence. Each analyst's adoption and use of the methods depends on the nature and reliability of their own software and hardware.

All calculations can be done within Excel using the workbook in the project's downloadable toolkit, which requires more manual steps to copy and paste price lists for each time and place, compared to using statistical software. However, many users do not have capacity for purchasing or using statistical software and therefore have the option to do the calculations in Excel.

LEVEL OF TRAINING REQUIRED AND RESOURCES AVAILABLE:

An instruction manual and a video tutorial are provided on the Food Prices for Nutrition website. A completed example template is provided for users using pseudodata. By the end of these training materials, the users should be able to run the analysis, given elementary familiarity with Excel or Stata. A self-paced 6-hour e-learning course[11] is publicly available for an overview of CoAHD.

PRELOADED DATA

Food Item Information Database: Includes food composition data needed for CoHD analysis for 400+ foods from 13 national and regional food lists from food price monitoring systems, drawing food composition data primarily from USDA, and also from Pakistan, Ethiopia, Nepal, Kenya, Bangladesh, United Kingdom, and other global databases. Only information on energy density and edible portion of each food is included; micronutrients are not included since it is not required to calculate the CoAHD. Data from any food composition table can be used, in addition to what is provided in the Food Item Information Database.

The toolkit provides quantification of the Healthy Diet Basket, which is the cost standard used in annual monitoring by FAO and the World Bank, based on commonalities in *Food-Based Dietary Guidelines (FBDG)* from around the world.[12] In addition, the toolkit provides quantification of 15 national FBDG and the EAT-Lancet Reference Diet. Other FBDGs can be quantified in terms of calories and number of foods per food group per day by analysts, and used in the tool.

FLEXIBILITY TO ADJUST DATA

Because this method uses Excel and Stata, users can add foods and adjust the energy density (calories / 100g) of each food, and edible portion. The target number of foods and calories needed per food group can also be edited.

[10] https://www.fao.org/faostat/en/#data/CAHD/
[11] https://www.worldbank.org/en/olc/course/62176
[12] Herforth, A., C. Holleman, Y. Bai, & W.A. Masters (2023). The cost and affordability of a healthy diet (CoAHD) indicators: methods and data sources. Metadata for FAOSTAT domain on Cost and Affordability of a Healthy Diet. Rome, FAO.

ANALYTICAL CAPABILITIES

Calculates the cost for the lowest cost items to meet food group requirements specified in national dietary guidelines or the global Healthy Diet Basket targets,

Calculations are based on a diet that includes the recommended number of items and calories from each food group, and does not require nutrient intake recommendations. The criteria used to compute CoAHD are food group quantities derived from FBDGs.

The calculation of CoAHD does not explicitly include criteria on macro- and micronutrients and therefore results are not guaranteed to meet all specific nutrient requirements. In practice, diets that meet FBDGs also generally achieve nutrient adequacy, even while the precise nutrient content of the diet will vary day to day based on food item selection.

TYPICAL USES

Monitoring economic access to healthy diets, defined by food-based dietary guidelines.

Primary users include the FAO, IFAD, UNICEF, WFP, WHO, and the World Bank, for global monitoring in the annual State of Food Security and Nutrition in the World reports[13] and Food Prices for Nutrition Data Hub.[14] National governments, including Nigeria[15] and Ethiopia[16] are also calculating the CoHD; details of where CoAHD has been used can be found on the website.

3.3. In-depth assessments to guide policy and programme development

The Cost of the Diet (CotD) Software

Version 3 developed by Save the Children UK (SCUK) in 2024

SUMMARY

The Cost of the Diet (CotD) was developed by Save the Children and has associated software. This is available for free download on their Resource Centre. A comprehensive practitioner's guide and a database of over 3580 food items with nutritional information are included. Users can adjust data for various needs and preferences, and the software helps identify nutrient gaps, suggesting the lowest cost food to improve diets. CotD is widely used for local and national dietary assessments and planning.

The starting point for the CotD methods is the available foods and their price.

WEBSITE	**CONTACT**
https://resourcecentre.savethechildren.net/article/cost-of-the-diet/	cotd@savethechildren.org.uk

ACCESSIBILITY AND OPERATING SYSTEMS SUPPORTED

The CotD software and practitioners' guide are free and can be downloaded from the Save the Children Resource Centre website.

It is compatible with Windows. It is not compatible with iOS systems.

LEVEL OF TRAINING REQUIRED AND RESOURCES AVAILABLE

[13]https://www.fao.org/publications/home/fao-flagship-publications/the-state-of-food-security-and-nutrition-in-the-world/en

[14] https://databank.worldbank.org/source/food-prices-for-nutrition

[15] National Bureau of Statistics. *Cost of a Healthy Diet. January 2024. https://nigerianstat.gov.ng/elibrary/read/1241467*

[16]Alemayehu, D. et al. *Implementation of the Ethiopian food-based dietary guidelines: analysis of cost and affordability of healthy diets, January 2020 - December 2022,* Food Science and nutrition Research Directorate Scientific Newsletter. Ethiopian Public Health Institute, Addis Ababa.

Use of the CotD software requires one day of training. However, training may also be required on the methods used to gather data e.g. conducting market surveys to collect food price data
The CotD has a publicly available practitioner's guide which provides guidance on how to conduct assessments, use the software and interpret results.

PRELOADED DATA

Food composition The CotD software has a database of the energy, nutrients, in 3,580 food items and supplements based on analysis of the food composition tables of 9 countries. These are organised into 15 food groups. The software also includes calculations for the proportion of the food that is edible and iron bioavailability.

Nutrient requirements The software contains data on nutrient requirements from WHO and FAO and can calculate the energy,[17] protein,[18] fat,[19] and micronutrient[20] requirements (for 13 vitamins and minerals) based on gender and age.

The software also contains data on *portion sizes and representative household compositions of varying sizes.*

FLEXIBILITY TO ADJUST DATA

The user can adjust all data or enter data from another source. Foods not included in the database can also be added. Nutrient requirements cannot be edited, but It is possible to adjust the target levels of the macro and micronutrients to be reached by the model. Additionally, nutrient requirements can be adjusted for activity level (low, medium, high), pregnancy stages (1st, 2nd, 3rd trimester, average) and lactation stages (0-3 months, 4-6 months, 7-12 months, average).

ANALYTICAL CAPABILITIES

CotD identifies nutrient gaps in diets and suggests the most cost-effective way to improve diets using locally available foods. It calculates the minimum cost of food combinations that meet the nutrient requirements (macro and micro) of a given target group based on the availability, price, and nutrient content of local food. Behaviours and food preferences can also be taken into account in developing these food combinations. The affordability of these food combinations is assessed as part of the exercise. CotD can be conducted for a single season of any length (1 to 365 days) or for up to 6 seasons across a 365-day period per file.

TYPICAL USES

Commonly used to determine whether economic barriers limit access to a nutritious diet, model the impact of different interventions (cash transfers, food supplements, agricultural inputs, increased use of specific local cost foods, etc) on the cost and affordability of diets. While it can be used at multiple geographic levels. CotD is typically done at a livelihood zone or district level. CotD has been used extensively by a wide range of NGOs, UN and academic institutions, including Save the Children[21] and WFP for their Fill the Nutrient Gap initiative.[22]

[17] WHO/FAO. Human energy specifications. Geneva: World Health Organization; 2001.
[18] WHO/FAO. Protein and amino acid specifications in human nutrition. Geneva: World Health Organization; 2007.
[19] WHO/FAO. Fats and fatty acids in human nutrition. Geneva: World Health Organization; 2008.
[20] WHO/FAO. Vitamin and mineral requirements in human nutrition. 2nd ed. Geneva: World Health Organization; 2004.
[21]Examples of project level use: Masud, R. *Cost and Affordability of Nutritious Diets in Malawi: December 2023 Update*. 2024; Chui, J. et al. Cost and Affordability of Diet in Myanmar: A Cost of the Diet Study in Northern Shan State and Kachine State, BRICKS Project 2023.
[22]Example of policy-level use: Ethiopian Public Health Institute and World Food Programme. *Fill the Nutrient Gap*, Ethiopia. 2021

Optifood Software

Developed by the London School of Hygiene & Tropical Medicine in collaboration with WHO Food and Nutrition Technical Assistance III Project and others

SUMMARY

Developed by the London School of Hygiene & Tropical Medicine, WHO, and others, Optifood uses software to develop and test food-based recommendations. It identifies ways to improve diets based on local food prices and behaviours. The software includes a database of 1,937 food composition values, as well as data on nutrient requirements. It assesses nutrient gaps and models various food basket recommendations for targeted communities. While it provides a detailed analysis of diet costs, it requires specific training. The software is free but is not currently open access. Optifood is primarily used for behavioural change programming.

WEBSITE	CONTACT
N/A	Elaine.Ferguson@lshtm.ac.uk

ACCESSIBILITY AND OPERATING SYSTEMS SUPPORTED

The Optifood software is free but is not currently open access. The software is compatible with Windows. It is not compatible with iOS systems.

LEVEL OF TRAINING REQUIRED AND RESOURCES AVAILABLE

Training is required to use the Optifood software. To undertake analyses using Optifood, an individual must be trained and understand nutrition concepts, especially those related to assessing nutrient adequacy of populations. Most individuals can learn (beginner level) how to process/import data, run an Optifood analysis and interpret the results with three to four days of training.

PRELOADED DATA

The software has embedded data on food composition, nutrient requirements, and portion sizes, including a core food composition database of 1,937 foods primarily sourced from the USDA National Nutrient Database for Standard Reference Release. It also has a built-in set of nutrient recommendations, which are the FAO/WHO recommended nutrient intake values.

FLEXIBILITY TO ADJUST DATA

Optifood allows for the drafting and evaluation of food-based recommendations and modelling of different diets which are reviewed by local stakeholders and tested for feasibility in the target community. It has the flexibility to upload local food composition data and nutrient requirements.

ANALYTICAL CAPABILITIES

Optifood assesses the extent to which nutrient requirements for specific target groups can be met using local foods within acceptable dietary patterns. It can identify food-based recommendations for behaviour change programming and provide insights into nutrient gaps in local food environments. It also models the lowest cost of coming as close as possible to meeting nutrient needs for diets based on realistic dietary patterns and can model the impact of various interventions on the cost and affordability of diets.

TYPICAL USES

Optifood is used to develop and test food-based recommendations and dietary guidelines, determine the affordability of nutritious diets, and model the impact of interventions to improve dietary adequacy for specific populations. It's typically applied in contexts where local food behaviours and prices are crucial factors in diet planning and assessment. The main users are

LSHTM, UNICEF, WHO, and GAIN and has been used to develop food-based dietary recommendations for children from sub-national[23] to the global policy level[24].

Enhance Software

Developed by World Food Programme in 2024

SUMMARY

Enhance is being developed by WFP in collaboration with Capgemini Netherlands, Johns Hopkins University, and the Zero Hunger Lab of Tilburg University (ZHL) and is expected to be free and open access by 2025. This tool is designed to provide insight to policy and decision-makers by evaluating the impact of poverty, food availability, and food prices on access to nutritious food. Future versions of Enhance will also aim to support the analysis of trade-offs between different programme and policy objectives, including reducing environmental footprint. These analyses can be used to model and design interventions to improve diets whilst considering environmental sustainability.

WEBSITE	**CONTACT**
https://enhancedietsanalytics.wfp.org [25]	nutrition.enhance@wfp.org

ACCESSIBILITY AND OPERATING SYSTEM

The platform is web-based, compatible with all major web browsers, and requires an internet connection. Initially accessible only to WFP internal users, Enhance is planned to be open access by 2025, subject to simple registration.

LEVEL OF TRAINING REQUIRED AND RESOURCES AVAILABLE

Future versions aim for minimal training requirements, especially for those already familiar with cost of diet metrics. Comprehensive support, including a user manual, training materials, and e-learning courses will be made available online. For specific applications, WFP offers targeted training.

PRELOADED DATA

Enhance integrates food composition data, recommended consumption patterns, and the environmental impacts of food production (e.g., greenhouse gas emissions, land and water use). It features nutrient requirement data based on age, sex, and other factors like activity level and pregnancy, drawing from WHO/FAO standards, IOM/EFSA[26], and other nutrient reference values, as well as specific nutrient requirements[27] for children with moderate acute malnutrition.

FLEXIBILITY TO ADJUST DATA

[23]Example: Brouwer, I et al. 2017. *Development of food-based dietary guidelines for children, 6-23 months old, in Karaga District and Gomoa East District, Ghana.*
[24]Example: Arimond et al. *Insights from Optifood Modelling to support revisions of instant and young child feeding recommendations.* June 2022.
[25]This URL will function for external users from 2025.
[26]Drawing from Allen et al. 2020. *Perspective: Proposed Harmonized Nutrient Reference Values for Populations.* Adv Nutr. 2020 May 1;11(3):469-483. doi: 10.1093/advances/nmz096. PMID: 31701998; PMCID: PMC7231601.
[27]Based on nutrient densities described by Golden et al. 2009. *Proposed Recommended Nutrient Densities for Moderately Malnourished Children.*

The platform offers the flexibility to incorporate additional data, such as alternative food composition tables, individual requirements, and environmental impacts. Users need to input country-specific food prices to run an analysis. Environmental impact data can be adjusted..

ANALYTICAL CAPABILITIES

Enhance calculates the least cost of energy-adequate, macronutrient-adequate, nutrition-adequate food baskets, as well as the cost of meeting food-based dietary guidelines, and provides information on their environmental footprint.
Enhance can process data sets covering various regions, individuals, seasons, and diets at once. Users can adjust the diets modelled based on behaviour or consumption patterns, adjust nutrient targets and set priority nutrients, define a maximum cost, and modify recommended diet settings.
Its future iterations will include assessment of the trade offs between achieving different objectives such as cost, affordability, nutritional value, dietary diversity and environmental objectives. An interactive dashboard will visualise results.

TYPICAL USES

Enhance is tailored for analysts and researchers focused on food, diets, and environment from national statistics bureaus, academic institutions, and research organisations. It aims to support evidence-based recommendations to guide policy and decision-making towards achieving healthy, affordable, and sustainable diets. Enhance is designed to understand the cost and affordability of diets in addition to the environmental sustainability within WFP programming areas and has been used for Fill the Nutrient Gap assessments.[28]

Cost of Nutrient Adequacy (CoNA)

Developed by the Food Prices for Nutrition project

SUMMARY

CoNA was developed by the Food Prices for Nutrition project led by Tufts University Friedman School of Nutrition Science and Policy. It calculates the minimum cost of a locally-available diet which meets nutrient requirements. Implemented in Excel or R, users input local food price and nutrient composition data.

WEBSITE	**CONTACT**
https://sites.tufts.edu/FoodPricesforNutrition/tools[29]	William.Masters@tufts.edu

ACCESSIBILITY AND OPERATING SYSTEMS SUPPORTED

This method requires the free and open-access statistical software package R, which can run on Windows and iOS systems. The files containing code to run the analysis are available on the Food Prices for Nutrition website.

LEVEL OF TRAINING REQUIRED AND RESOURCES AVAILABLE

Using the R code requires knowledge of the statistical packages and data management and analysis skills. To calculate a single diet for a single place and time, a useful teaching tool is the

[28]Example: World Food Programme, UNICEF and Council for Agricultural and Rural Development (CARD) *Fill the Nutrient Gap, Cambodia.* Phnom Penh, Cambodia. 2023
[29]Codes and data can be found at the bottom of the page: Code and pseudodata for the calculation of the Cost of Nutrient Adequacy (CoNA), by Yan Bai (2021)

Least-cost Diet Exercise for Nutrient Adequacy[30].
PRELOADED DATA The CoNA R code does not preload data directly into R, but provides example code, data files and guidance to users to input relevant local data into the framework within these software tools to perform the analysis.
DATA ADJUSTMENT/FLEXIBILITY Analysts use local food prices and nutrient composition data for each food to calculate the least-cost diet. It does not model interventions within the analysis, but indicators can be modelled using different interventions to examine the differences in cost and diet compositions. Because the analysis is conducted in R, it has the possibility to change nutrient requirements or conduct complex analyses. It may be best used for research projects allowing users to rerun the same analysis using R code easily.
ANALYTICAL CAPABILITIES Calculates the minimum cost of achieving nutrient adequacy for the chosen target group with no other dietary constraints. Also indicates the most constraining nutrients and the foods contributing most to each nutrient requirement. Provision of code for use in R supports repeat or automated analysis as well as incorporation of dietary costing into wider studies and more complex analysis.
TYPICAL USES Primarily used for research and advocacy to understand economic barriers to nutrient-adequate diets and prioritise interventions. CoNA is mainly used by researchers and studies have used CoNA for global[31], regional[32], and national[33] analysis of diet costs and nutrient availability.

4. Conclusion

Nutritious diets are crucial to combat all forms of malnutrition. To ensure access to such diets, it is important to understand which foods are available, nutritious and affordable, particularly for families with lower income.

Assessments which evaluate the costs associated with healthy diets are vital in guiding the development of policies and programmes in areas suffering from high malnutrition rates. They provide insight into the costs of a healthy diet and can support a wide range of sectors, including health, agriculture, social protection, and education to improve their contribution to improving nutrition for households and vulnerable groups.

[30]https://sites.tufts.edu/foodecon/least-cost-diet-exercise-for-nutrient-adequacy
[31]Example use on differences by age and sex:
Bai, Y., Herforth, A. and Masters, W.A., 2022. Global variation in the cost of a nutrient-adequate diet by population group: an observational study. *The Lancet Planetary Health*, *6*(1), pp.e19-e28.
[32]Example on seasonality of nutrient availability and cost: Bai, Y., Naumova, E.N. and Masters, W.A., 2020. Seasonality of diet costs reveals food system performance in East Africa. *Science Advances*, *6*(49), p.eabc2162.
[33]Example on meal sharing and guidance of intervention: Schneider, K.R, et al, 2023. *Assessing the affordability of nutrient-adequate diets.* American Journal of Agricultural Economics, 105(2), pp.503-524.

Various methods and tools are available for calculating the cost and affordability of a nutritious diet. These methods account for nutritional needs, local food prices and household incomes and may apply local dietary preferences. However, understanding which method to use and for what purpose can be challenging. The paper helps to explain the spectrum of methods available and supports practitioners in selecting the most appropriate method for their purpose. By providing this clarification, it is hoped that dietary costing methods will be increasingly employed to guide policies and interventions designed to improve nutrition and overall public health.