Original Article

Designing appropriate complementary feeding recommendations: tools for programmatic action

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Abstract

Suboptimal complementary feeding practices contribute to a rapid increase in the prevalence of stunting in young children from age 6 months. The design of effective programmes to improve infant and young child feeding requires a sound understanding of the local situation and a systematic process for prioritizing interventions, integrating them into existing delivery platforms and monitoring their implementation and impact. The identification of adequate food-based feeding recommendations that respect locally available foods and address gaps in nutrient availability is particularly challenging. We describe two tools that are now available to strengthen infant and young child-feeding programming at national and subnational levels. *Pro*PAN is a set of research tools that guide users through a step-by-step process for identifying problems related to young child nutrition; defining the context in which these problems occur; formulating, testing, and selecting behaviour-change recommendations and nutritional recipes; developing the interventions to promote them; and designing a monitoring and evaluation system to measure progress towards intervention goals. Optifood is a computer-based platform based on linear programming analysis to develop nutrient-adequate feeding recommendations at lowest cost, based on locally available foods with the addition of fortified products or supplements when needed, or best recommendations when the latter are not available. The tools complement each other and a case study from Peru illustrates how they have been used. The readiness of both instruments will enable partners to invest in capacity development for their use in countries and strengthen programmes to address infant and young child feeding and prevent malnutrition.

Keywords: infant and young child feeding, complementary feeding, *Pro*PAN, Optifood, infant and young child nutrition.

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Introduction

Programmes to promote breastfeeding and complementary feeding are among the most effective interventions to promote healthy growth and development in infants and young children (Jones *et al.* 2003). The World Health Organization (WHO)/United Nations Children's Fund (UNICEF) Global Strategy for Infant and Young Child Feeding (WHO/UNICEF 2003) provides the overall framework for actions needed to protect, promote and support appropriate feeding practices in early childhood. It

recommends early initiation of breastfeeding, exclusive breastfeeding for 6 months, and the introduction of adequate complementary foods at 6 months with continued breastfeeding for 2 years or beyond.

The time of complementary feeding, typically between 6 and 23 months of age, is nutritionally the most vulnerable and in developing countries coincides with a rapid acceleration in the incidence of stunting, especially among children 6–12 months (Victora *et al*. 2010). Complementary foods may be dilute, lacking diversity, not given frequently enough, given in too little amounts, or prepared and given with insufficient attention to hygiene and food safety. The Pan American Health Organization/WHO Guiding Principles for Complementary Feeding of the Breastfed Child propose 10 guiding principles for complementary feeding (PAHO/WHO 2003). Similar guiding principles are available for feeding of non-breastfed children (WHO 2005). Recognizing the challenge to provide a nutritionally adequate diet for young children in resource-poor settings (Dewey & Brown 2003), national strategies should maximize the utilization of locally produced foods in any given setting, and consider the promotion of additional products only if they can fill a critical gap in nutrients in an acceptable, feasible, affordable, sustainable and safe way (WHO 2008a). Where locally available foods alone will not satisfy nutritional requirements, various types of products offer promise; they may include centrally produced fortified foods, micronutrient powders or lipid-based nutrient supplements (WHO 2008a).

An excellent qualitative tool, Designing by Dialogue, is available to support the design, implementation and evaluation of infant and young child-feeding programmes (Dickin *et al*. 1997). However, tools that include a systematic, quantitative assessment of diet including one based on linear programming to identify nutrient gaps and food-based feeding recommendations, and relying primarily on locally available foods to remedy these gaps, have not been available. The need for a more detailed framework and user-friendly tools to guide assessment, prioritization, planning and evaluation of interventions for children 6–23 months has been apparent for some time (WHO 2008a). In this paper, we describe two tools to guide the development of appropriate infant and young child-feeding recommendations and programmes. Process for the Promotion of Child Feeding (*Pro*PAN by its Spanish acronym) provides qualitative and quantitative methods to assess the local situation with respect to breastfeeding and complementary feeding practices and develop locally appropriate and acceptable feeding recommendations (Pan American Health Organization & UNICEF 2013). Optifood provides an electronic interface which uses linear programming analyses to identify 'problem nutrients' (i.e. nutrients whose requirements cannot be met using foods as eaten), and guides the selection of food-based recommendations, for any age group, based on locally available foods, with the addition of fortified products or supplements when needed (World Health Organization, London School of Hygiene and Tropical Medicine, USAID 2013). Linear programming analysis is a mathematical optimization process, which in Optifood is used to model realistic diets for the target population. The food patterns and nutrient adequacy of these modelled diets inform decisions.

Key messages

- Design of adequate food-based feeding recommendations that maximize the use of locally available foods and fill nutrient gaps can be a challenge, especially in resource-limited settings.
- *Pro*PAN and Optifood tools are now available to enhance the assessment, planning, monitoring and evaluation of infant and young child-feeding programmes.
- When used alone or in synergy, these tools provide guidance for development of feeding recommendations, prioritization of interventions, design of key messages and communication strategy, policy and advocacy, monitoring and evaluation.

The objectives of this paper are to describe the basic principles and methods of each tool and provide an example of how the tools can be used jointly to design interventions.

*Pro*PAN

*Pro*PAN, which was first published in 2004 and recently updated, is a tool designed for ministries of health, non-governmental organizations, and bilateral and international organizations working to improve the diets and feeding practices of children under 24 months of age to prevent early childhood malnutrition (Pan American Health Organization & UNICEF 2013). It guides users through a step-by-step process for identifying problems related to young child nutrition, breastfeeding and complementary feeding, within a specific target population; defining the context in which these problems occur, including barriers to and facilitators of improved or 'ideal' practices (Table 1); formulating, testing, and selecting behaviour-change recommendations and nutritional recipes; developing the interventions to promote them; and designing a monitoring and evaluation system to measure progress towards intervention goals. *Pro*PAN materials include a multi-module field

Table 1. *Pro*PAN ideal practices

1. All infants breastfed for first time within 1 h of birth
2. All infants not fed anything other than breast milk during first 3 days of life
3. All infants fed colostrum
4. All infants and young children breastfed on demand, day and night
5. All infants less than 6.0 months exclusively breastfed
6. All children breastfed through the age of 2 years old or older
7. All infants fed semi-solid complementary foods at the age of 6 months (180 days)
8. All infants and young children aged 6.0–23.9 months meet recommended daily energy and nutrient requirements
9. All infants and young children aged 6.0–23.9 months fed nutrient- and energy-dense foods
10. All infants and young children 6.0–23.9 months fed recommended number of meals daily
11. All infants and young children 6.0–23.9 months fed by caregiver responsive to child
12. All infants and young children 6.0–23.9 months fed as recommended during and after illness

manual with detailed instructions on how to collect, analyse, and integrate the quantitative and qualitative data required to design and evaluate interventions, an Epi Info™-based software program developed specifically for quantitative analysis of household demographic and socio-economic characteristics and infant and young child diets and as an analytical tool for identifying locally available foods that provide the greatest amount of energy and nutrients at the lowest cost, and a software user's guide.
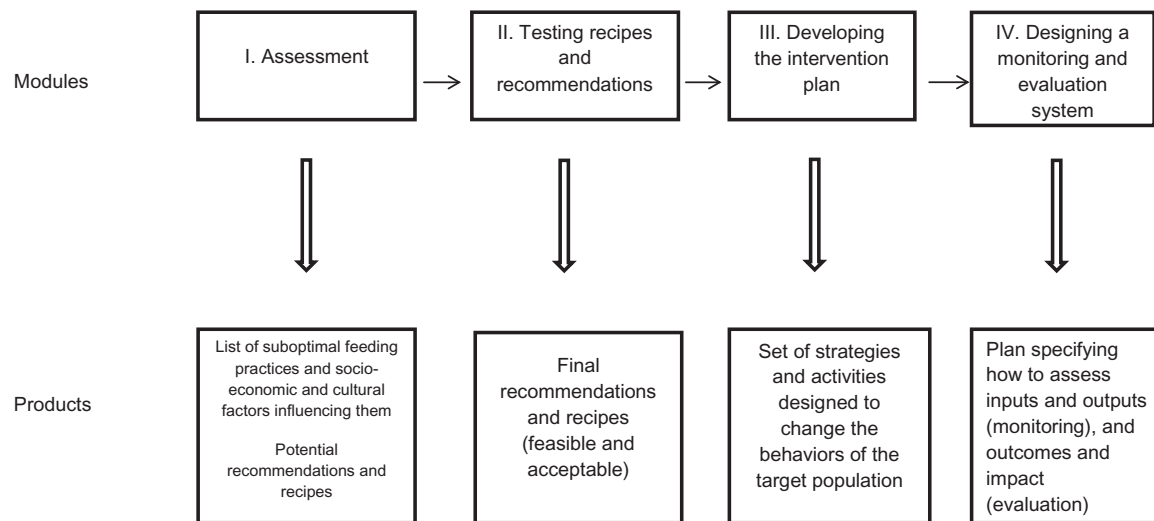
*Pro*PAN field manual

The *Pro*PAN field manual comprises four modules: Assessment (Module I); Testing recommendations and recipes (Module II); Developing the intervention plan (Module III); and Designing a monitoring and evaluation system (Module IV). Each module has two components: (1) an overview of the module's purpose, products, and steps, and the concepts and techniques that will be applied in the research, and (2) an annex containing custom-designed data-gathering tools and instructions on how to apply them. *Pro*PAN methodologies can be used to develop interventions to improve both breastfeeding and complementary feeding but places a relative emphasis on complementary feeding because less is known about how to most effectively improve these practices.

The development of *Pro*PAN benefited from earlier manuals on aspects of infant and young child feeding. In particular, 'Designing by Dialogue' (Dickin *et al.* 1997) and 'Tools to Measure Performance of Nutrition Programs' (Levinson *et al.* 2000) contributed towards many of the concepts used in Modules II and IV, respectively. In addition, many ideas, such as the Food Attributes Exercise and the methodologies used in the semi-structured interviews and focus groups, were borrowed from 'Culture, Environment, and Food to Prevent Vitamin A Deficiency' (Kuhnlein & Pelto 1997).

As shown in Fig. 1, the main methods and products (outcomes) of *Pro*PAN, by module, are as follows: Module I guides users in applying quantitative and qualitative research methods to identify diet and feeding problems based on a set of 'ideal' practices (Table 1), the practices that lead to them and the

Modules

| I. Assessment | → | II. Testing recipes and recommendations | → | III. Developing the intervention plan | → | IV. Designing a monitoring and evaluation system |

⇓ ⇓ ⇓ ⇓

Products

| List of suboptimal feeding practices and socio-economic and cultural factors influencing them

Potential recommendations and recipes | Final recommendations and recipes (feasible and acceptable) | Set of strategies and activities designed to change the behaviors of the target population | Plan specifying how to assess inputs and outputs (monitoring), and outcomes and impact (evaluation) |

Fig. 1. Structure and products of the *Pro*PAN modules.

context in which they occur. This module provides an assessment algorithm for evaluating responsive feeding, based on research conducted in Peru (Creed-Kanashiro *et al*. 2010) as well as questions on infant feeding within the context of human immunodeficiency virus infection/acquired immunodeficiency syndrome. The main product is the identification of problematic diet and feeding practices and the generation of a list of recommendations that could be promoted to improve them. Module II helps users test the acceptability and feasibility of the potential recommendations identified in Module I, using behaviour and recipe testing based on trials of improved practices methodology developed by the Manoff Group (Dickin *et al*. 1997). The main products of Module II are final recommendations based on practicality, feasibility and acceptability by the community – that is, practices that caregivers, family members, health workers or other gatekeepers can and are willing to adopt, and foods and recipes that family members are willing to prepare and feed to young children. Module III helps users devise an intervention plan based on the final recommendations selected and tested in Module II. The main product of this module is the selection of optimal strategies, activities, materials and messages for promoting the desired changes in diet and feeding practices. Lastly, Module IV helps users (1) design

appropriate indicators to monitor the intervention-implementation process and impact, and (2) select an appropriate evaluation design. The main product of this module is the design of a system for monitoring and evaluating the intervention.

In addition to the content described above, *Pro*PAN includes a logistics section explaining the resources required to carry out the various components and the estimated budget, staffing and time frame required.

*Pro*PAN software

Epi Info™ is a public domain software package designed and developed for public health practitioners and researchers worldwide by the US Centers for Disease Control and Prevention (2008). The *Pro*PAN software program is compatible with Epi Info™ version 3.5.4 and has been updated for use in Windows. It allows for creation and modification of survey questionnaires and database construction, data entry, data analysis and standardized outputs. The data analysis tools can help identify key nutrient gaps, and determine the relative nutritional importance and cost of local foods available to fill them. They can also be used to analyse the anthropometric data collected in Module I (described below), and the energy and nutrient profile of recipes created in

Module II (described below), and to determine the frequency of consumption of foods, average food serving sizes and the number of servings of foods provided from selected food groups and food sub-groups – outputs that are required inputs for Optifood (World Health Organization, London School of Hygiene and Tropical Medicine, USAID 2013). A *Pro*PAN Software User's Guide is available to facilitate use of the software (Pan American Health Organization & UNICEF 2013).

*Pro*PAN criteria for the quantitative analysis of diet and feeding practices are based on international guidelines and indicators (Dewey & Brown 2003; PAHO/WHO 2003; WHO 2005, 2008b). Assessment of weight-for-age, length-for-age and weight-for-length Z-scores is based on the WHO Child Growth Standards (WHO 2006) and mid-upper arm circumference is based on the WHO/UNICEF recommendation (WHO/UNICEF 2009).

*Pro*PAN uses

*Pro*PAN is designed for use as one comprehensive unit – from the assessment of the general nutrition situation through monitoring and evaluation of the intervention. However, it can also be applied 'cafeteria style'. That is, where users select and apply only the modules or parts of modules needed to complement existing information on infant and young child feeding and to meet programming needs as was done in Bolivia and Ecuador (Pachón & Reynoso 2002; Lutter *et al.* 2008), among other countries. For those wishing to design a new programme on infant and young child feeding, use of all of the modules is recommended. *Pro*PAN can be used to build on existing programmes [e.g. to conduct formative research for programme planning (Haider *et al.* 2010), develop key programme messages (Arabi *et al.* 2009), identify optimal recipes for community demonstrations, assess the quality of the diet (Arabi *et al.* 2005), or determine facilitators of and/or barriers to the adoption of improved practices (Rasheed *et al.* 2011)]. Users seeking to adapt, expand or improve an existing programme may only want to apply selected modules or components relevant to a specific purpose (e.g. Module II, for testing the feasibility and acceptability

of new recommended practices or recipes, or Module IV, for designing a monitoring and evaluation system). Although *Pro*PAN is primarily designed for developing interventions directed at caregivers, it can also be used for alternate applications, such as incorporating infant feeding counselling into health providers' routine care or training nutrition researchers in quantitative and qualitative methods.

While *Pro*PAN materials focus mainly on undernutrition, they can also be applied to address problems of overweight. For example, the 24-hour Dietary Recall and Anthropometry questionnaire can be used to identify populations where energy intake is above recommendations and the percentage is high of the population with weight-for-height Z-score above two standard deviations of the WHO Child Growth Standard. Other tools in *Pro*PAN can be used to explore the reasons for these problems and to identify and test potential recommendations to correct them.

*Pro*PAN is comprehensive and adaptable and thus can be used in a variety of settings. To date, *Pro*PAN has been used in over 15 countries in Africa, Asia and Latin America. Lessons learned from these experiences have been incorporated into the current, updated version of *Pro*PAN, including a global food composition table found in the *Pro*PAN software package, which can be updated with new foods as needed (described below).

Optifood

Optifood is a tool designed for use by nutritionists working in academic institutions, government or non-government organizations to inform nutrition programme planning and government policy decisions regarding nutrition interventions for any age group. It is a computerized tool based on linear programming analysis, a mathematical optimization process that selects the best diet from among all possible alternative diets given model parameters (Briend *et al.* 2003). Its strength lies in mathematical optimization, which simultaneously takes into account the target population's dietary patterns and their estimated requirements for energy and 13 nutrients – a process which is too complex to do by hand (Ferguson *et al.* 2006). It is also very fast, which allows rapid comparisons across

Table 2. Optifood modules, purpose, outputs and questions answered

Module	Purpose	Outputs	Questions answered
I – Check Diets	To check model parameters (i.e. dietary data constraints entered prior to starting analyses) to ensure Optifood is generating realistic diets	21 diets, including two diets to define the possible energy range to help user check model parameters	1. Is the model generating realistic diets? 2. Do changes need to be made to model parameters to make diets realistic?
II – Identify Draft Recommendations	To identify the two best diets for the target population given the dietary constraints– one diet follows average food patterns and the other deviates from them. Both diets come as close as possible to meeting recommended nutrient intakes	- Create food-based recommendations - Problem nutrients i.e. nutrients whose requirements are difficult to achieve using local foods	1. Can a nutritionally adequate diet be promoted given local foods & food patterns? 2. What are the best food sources of nutrients for this target population? 3. What are the nutritional and cost implications of selecting recommendations that deviate from the population's average food patterns? 4. What alternative food-based recommendations should be tested in Module III?
III– Test Food Based Recommendations	Test and compare alternative sets of food-based recommendations	Comparison of the lowest nutrient content and cost of diets that adhere to tested food-based recommendations	1. Which set of recommendations is best for the target population, taking nutrients and cost (if modelled) into consideration? 2. Are food-based recommendations likely to ensure that nutrient needs are met?
IV – Cost Analysis (*optional module*)	To generate the lowest cost nutritionally adequate diet	- Lowest cost diet - Percentage of diet cost contributed by each food in the lowest cost diet	1. What is the lowest cost nutritionally 'best' diet for this target population? 2. What foods are most expensive in the lowest cost nutritionally 'best' diet for this target population? 3. What nutrient requirements are the most expensive to achieve?

many alternative sets of food-based recommendations, providing evidence to transparently justify the selection of a set of food-based recommendations from among alternatives (Santika *et al*. 2009).

Optifood's models were previously created in MS Excel using the solver function (Ferguson *et al*. 2006). This process was complex and error prone, which made it extremely difficult to master. With the creation of the Optifood interface, which guides the user through the modelling process, this problem has been overcome. Optifood users do not require any expertise in linear programming analysis. Through its interface they can set up and run robust linear programming models without having to make decisions about model structures. The only expertise required to use Optifood is knowledge of the target population's typical dietary practices, some background in

nutrition and experience with menu-driven computer applications. Most users can master the tool within a week.

Optifood has two sets of internal reference data: a food composition table (FCT) and a set of recommended nutrient intakes (RNIs). It has two data entry areas. In one optional data entry area (Reference data area), food composition data and RNI values are entered to supplement or use in place of the existing reference data in Optifood. In the other mandatory data entry area (Target group area), target group-specific data are entered to set up the model parameters for linear programming analyses.

The linear programming analyses are done in four analytical modules, each of which generates a series of optimized diets that answer the questions outlined in Table 2. These modelled diets show the number of

servings per week from individual foods over a 7-day period, i.e. weekly diets. The specific foods in these modelled diets, however, are not prescriptive; instead their food patterns inform decisions.

Optifood reference data

The validity of an Optifood analysis depends on the FCT and RNI reference data. The FCT is used to estimate the nutrient content of each modelled diet. The RNIs are used to evaluate and compare alternative sets of food-based recommendations and, with data on food prices, identify the lowest cost nutritionally best diet. Although Optifood has an inbuilt FCT and set of RNIs, it provides flexibility for users to import and use analysis-specific reference data. In cases where user-defined reference data are employed, they must include a complete set of data for energy and all nutrients modelled; namely protein, fat; carbohydrate and water (FCT only); calcium, iron, zinc; vitamins A (expressed as retinol equivalents and retinol activity equivalents), C, B_6, B_{12}, folate, thiamine, riboflavin and niacin.

The inbuilt core reference data for RNIs are drawn from the WHO/FAO (Food and Agriculture Organization of the United Nations) vitamin and mineral requirements (WHO/FAO 2004), with the exception of iron for pregnant women (IOM 2001), the WHO/FAO/United Nations University (UNU) protein requirements (WHO/FAO/UNU 2007) and the FAO/WHO/UNU energy requirements (FAO/WHO/UNU 2004). The RNIs cover 13 nutrients and 27 demographic groups ranging from infants to the elderly. For fat, the desired level is expressed as a percentage of the energy intake, which is set as 30% for all target groups (FAO/WHO 2008). The algorithms for calculating protein and energy requirements require data on the target population's average body weight; and the estimated average physical activity levels for adult energy requirements. For flexibility, the user can also overwrite the calculated energy requirements with a number the user can enter.

Optifood and *Pro*PAN use the same FCT. It was developed based on the version included in the first release of *Pro*PAN (PAHO *et al.* 2004). The inbuilt core food composition database in Optifood has
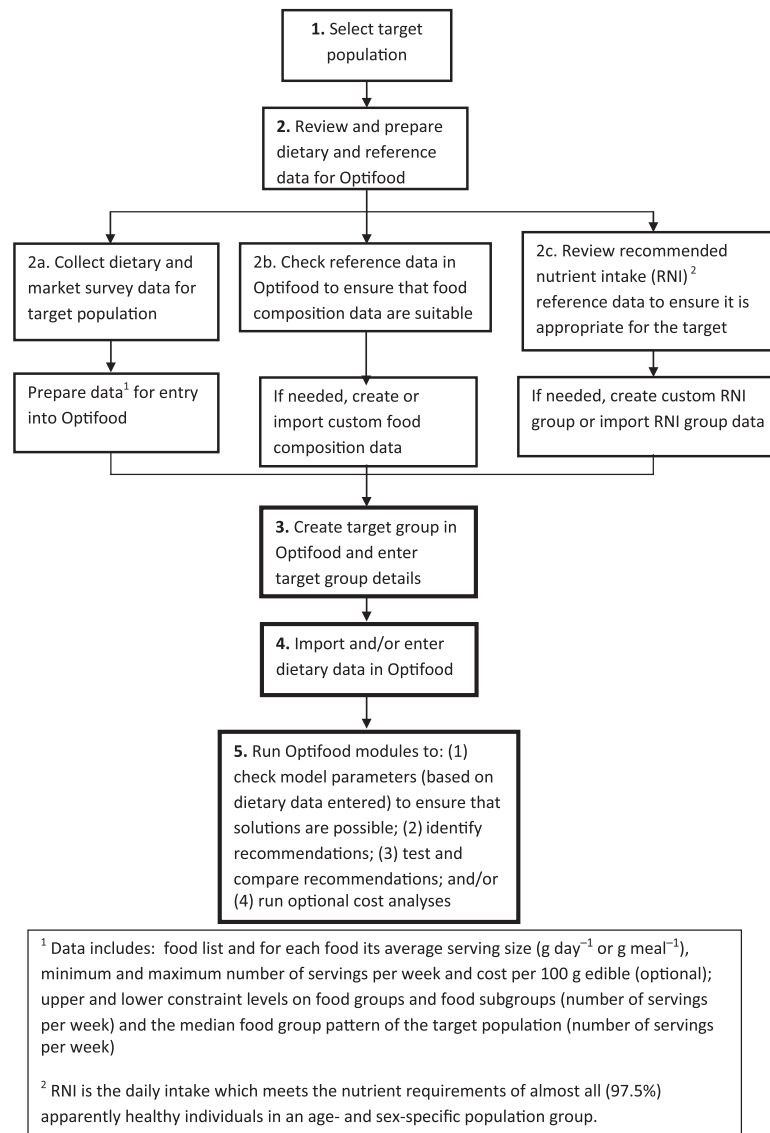
nearly 2000 foods. The primary source of these data is the United States Department of Agriculture National Nutrient Database for Standard Reference, Release 23 (USDA 2010). Secondary sources are from Tanzania (Lukhmanji *et al.* 2008), Zambia (National Food and Nutrition Commission 2007), Mali (Barikmo *et al.* 2009), West Africa (Stadlmayr *et al.* 2010), Southeast Asia (Puwastien *et al.* 2000), the English-speaking Caribbean (Caribbean Food and Nutrition Institute 2000) and Central America (Menchú & Méndez 2007), as well as McCance and Widdowson's Composition of Foods (Food Standards Agency 2002).

Data entry and analysis in Optifood

Data are entered into the reference data or target group data entry areas either by hand or by importing csv files to save time and avoid data entry errors (Fig. 2). In the target group data entry area, five data entry sheets guide users through the process of setting up the models, using dietary data, the target populations mean body weight, and market survey data (see footnote in Fig. 2). The market survey data are optional, depending on whether or not the user will model diet cost. Error trapping messages alert users to data entry errors, with guidance provided for their resolution.

Once the data are entered into Optifood, the analyses are done in four analytical modules. The purpose and outputs from each analytical module are outlined in Table 2. The first and only mandatory analytical module (Module I) is used to first verify that entered target group data create realistic modelled weekly diets before running the main analyses in Modules II, III and IV. It is an iterative process where target group data are modified until the user is satisfied the models are robust. At this point, the model parameters are locked and the user elects whether to run analytical modules II and III to formulate and test food-based recommendations or analytical module IV to undertake a detailed cost analysis.

Module II generates the two nutritionally best diets for the target population; one conforms to the target population's average food patterns, whereas the other can deviate from the average food patterns while

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┌─────────────────┐
│ 1. Select target │
│   population     │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│ 2. Review and prepare │
│ dietary and reference │
│  data for Optifood    │
└─────────────────┘
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1. Select target population

2. Review and prepare dietary and reference data for Optifood

2a. Collect dietary and market survey data for target population

2b. Check reference data in Optifood to ensure that food composition data are suitable

2c. Review recommended nutrient intake (RNI)[2] reference data to ensure it is appropriate for the target

Prepare data[1] for entry into Optifood

If needed, create or import custom food composition data

If needed, create custom RNI group or import RNI group data

3. Create target group in Optifood and enter target group details

4. Import and/or enter dietary data in Optifood

5. Run Optifood modules to: (1) check model parameters (based on dietary data entered) to ensure that solutions are possible; (2) identify recommendations; (3) test and compare recommendations; and/or (4) run optional cost analyses

[1] Data includes: food list and for each food its average serving size (g day^{-1} or g meal^{-1}), minimum and maximum number of servings per week and cost per 100 g edible (optional); upper and lower constraint levels on food groups and food subgroups (number of servings per week) and the median food group pattern of the target population (number of servings per week)

[2] RNI is the daily intake which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age- and sex-specific population group.

Fig. 2. Overview of the Optifood process.

remaining within the observed food pattern ranges. These diets indicate whether realistic combinations of local foods can achieve desired nutrient intake levels (WHO/FAO 2004). Where gaps remain, the 'problem nutrients' are identified, thus providing evidence to advocate for solutions that go beyond the use of locally available food sources. Further, because they represent the nutritionally best diets, their food patterns are used to help formulate alternative sets of food-based recommendations for evaluation in Module III. Any number of individual food-based

recommendations, which are expressed as the number of servings per week from individual food groups, food subgroups or foods, can be selected. They are first screened in Module III to select three to six individual recommendations that are then combined into alternative sets of multiple food-based recommendations for further testing.

In Model III, alternative sets of food-based recommendations are compared on the basis of cost (optional) and their ability to ensure a nutritionally adequate diet. These recommendations can be either

those formulated from Module II or external food-based recommendations already in use in the country. From these comparative results, the best set of food-based recommendations from among alternatives is selected. An interface between *Pro*PAN and Optifood corresponds to the testing of the food-based recommendations in community-based trials to assess their feasibility and acceptability for long-term use by the target population prior to dissemination. This methodology is described in *Pro*PAN's Module II.

The final type of analysis in Optifood is done in Module IV to select the lowest cost nutritionally best diet, showing the percentage cost contribution of each food in the diet. Outputs from this module inform decisions regarding the minimum price of a nutritional diet. It is independent of Modules II and III.

Older versions based on linear programming analyses

Two other diet modelling tools are available using linear programming analyses, namely Nutrisurvey and the Cost of Diet tool (Frega *et al.* 2012). They differ from Optifood in their scope (i.e. in the number and types of linear programming models run) and in the nature of the modelled diets. Optifood is based on 188 different linear programming models, including two goal programming models, whereas the other two tools are based on one or two different linear programming models. Further, Optifood unlike the other two tools aims to select a realistic modelled diets (i.e. diets that are consumed by the target population) when a nutritionally adequate diet is unfeasible. These intertool differences mean the data requirements and modelling processes are slightly more complex in Optifood than in the other two tools. However, its interface is designed to mask its complexity. All three tools can be used to identify the lowest cost diet and 'problem nutrients', and to compare the costs of alternative dietary interventions. Only the Cost of Diet tool is designed to analyse diets at both the individual and household level. Only the Optifood tool is designed to test alternative sets of food-based recommendations, select the nutritionally best diets when a nutritionally adequate diet is not

feasible or identify the level at which individual nutrients have an impact on diet cost.

Uses of Optifood

Optifood has been tested or is currently being used in 10 countries in Asia, Africa and Latin America to generate food-based recommendations for young children and women of reproductive age, to inform agriculture-nutrition programmes and food value-chain interventions and to help formulate a regional strategy to address maternal and child micronutrient malnutrition in south-east Asia.

Optifood models are best set-up using high-quality dietary data, for example, using dietary data collected in *Pro*PAN Module I, which has been designed to interface with Optifood dietary data input requirements – a distinct advantage in terms of dietary data preparation time. Optifood's use is not restricted to the availability of high quality dietary data. Expert opinion or published data can also be used to set up target group model parameters. However, it will influence the quality of Optifood outputs and confidence in the results.

Discussion

Role and place of *Pro*PAN and Optifood in the programme cycle

The programming and implementation cycle for improved infant and young child feeding includes (1) baseline situation assessment, (2) development of a national infant and young child feeding policy with clear recommendations for adequate infant and young child-feeding practices, (3) development of a comprehensive infant and young child-feeding strategy with prioritized interventions, (4) integration of the interventions in commonly used delivery platforms such as maternal and child health services, (5) development of subnational action plans and implementation, and (6) monitoring and evaluation (UNICEF, Cornell University 2011). *Pro*PAN and Optifood tools support several steps of this cycle and Panel 1 provides a concrete example of how both tools have been used in Peru.

*Pro*PAN guides the baseline assessment, development of feeding recommendations, identification of interventions to promote these recommendations, and their integration in other programmes. It focuses on infant and young child-feeding practices. It provides input data on existing feeding practices, available foods, feeding frequency and servings and prices that are necessary to run the Optifood tool. *Pro*PAN can be used alone but it gains strength when combined with Optifood for the identification of the lowest-cost food-based feeding recommendations and the need to include a non-food-based strategy (e.g. micronutrient powders) to ensure dietary adequacy, as illustrated in the example from Peru. *Pro*PAN is particularly helpful for making evidence-based decisions on how to promote the identified feeding recommendations. It guides the design of key messages and the development of a communication strategy. It provides information that can be used to support policy changes that may be necessary for implementing the recommended feeding practices. Finally, *Pro*PAN is designed to help guide the user towards the design of a monitoring and evaluation plan.

Optifood is complementary to *Pro*PAN, and can be used for older age groups as well. It can be used to help identify the best set of food-based recommendations to promote in a given nutrition programme. Its results provide evidence about whether a behaviour-change strategy alone could be used to improve micronutrient status or whether micronutrient malnutrition relates to a lack of accessible or affordable micronutrient-rich foods, as is shown in the Peruvian example (Panel 1). The latter justifies public–private sector partnerships to increase the availability and affordability of micronutrient-rich foods through the Ministry of Health, food industry and/or agricultural-based food value chains. Further, Optifood can be used to predict the impact of a food-based intervention on dietary micronutrient adequacy or to investigate the nutritional basis for an observed lack of programme impact on micronutrient status. Finally, results from Optifood can support nutrition advocacy by providing mathematical evidence that local food supplies will or will not ensure all individuals in a target populations achieve their nutrient needs.

There are obviously also some limitations with regards to the use of both tools. *Pro*PAN is resource-intensive when used in its totality, and requires a multidisciplinary team which may be hard to assemble in a low-resource country. The food composition has few foods from Asia, and hence there is a need to manually update the FCT in those settings which is prone to error. *Pro*PAN software modifications require a skilled Epi Info™ user. Similar to all mathematical modelling techniques, the validity of conclusions drawn from an Optifood analysis will depend on the accuracy of model parameters (i.e. dietary and food composition data) and the assumptions made about nutrient requirements. The process of quickly testing hundreds of alternative sets of food-based recommendations requires careful planning to avoid exceeding the computer's memory capacity with unnecessary tests. The use of both tools therefore requires that there is expertise in nutrition and dietary data analyses. Further, the results alone are insufficient to lead the larger system changes that are often necessary to facilitate desired behaviour changes. Nevertheless, experiences of using *Pro*PAN and/or Optifood in countries in Africa, America and Asia have shown that tools fill a critical gap and that relevant local expertise can be mobilized to facilitate their use. Moreover, both tools are 'living' documents and they will be revised and updated as information and feedback from their application in the field is obtained.

Looking towards the future

There is a clear global demand, expressed by many countries, for guidance on infant and young child-feeding programming, especially for improved strategic planning on complementary feeding. In 2012–2013, UNICEF supported several intercountry workshops to strengthen national strategic planning for stunting reduction involving a broad range of partners. Hosted by the governments of Malawi (for Malawi, Lesotho, and Zambia), Namibia (for Botswana, Namibia, South Africa, Tanzania), Ghana (for Ghana, Liberia, Sierra Leone) and Pakistan, these workshops generated significant interest in *Pro*PAN

and participants pointed out its importance for improvement of national planning and programming process. Optifood was still under development at the time and not specifically discussed. Tanzania has since then implemented *Pro*PAN and results are being analysed. The workshops emphasized the importance of a good orientation about the tools in order for national policymakers and programme managers to appreciate its role. This will generate demand but is also a first building block towards national capacity for effective use of the tools. Experience with field application of Optifood in 10 countries confirms these findings. It is worth noting that in Guatemala, Optifood was also used to develop food-based recommendations for pregnant and lactating women. There is a clear interest to use Optifood for maternal nutrition.

In order to respond to the need and demand generated to date, WHO and UNICEF, together with a host of other partners, will build capacity by (1) using different nutrition fora for providing relevant briefing and orientation on *Pro*PAN and Optifood tools, (2) developing capacity of a core team of facilitators in each region to support countries to use the available tools, and (3) supporting the implementation of the tools in countries with a high burden of malnutrition. By doing so, we hope to make a significant contribution towards evidence-based planning for infant and child nutrition programmes and ensuring that all children enjoy healthy growth.

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Conflicts of interest

Helena Pachón works at the Flour Fortification Initiative (FFI) which receives in-kind contributions from vitamin and mineral pre-mix companies to host meals and breaks at FFI co-sponsored workshops held worldwide. All other authors declare that they have no conflict of interest.

Contributions

AB and EF conceptualized the Optifood tool. AB and BD provided oversight to the development of the Optifood tool and CKL, HP, EC, NM and RM provided oversight to the development of the *Pro*PAN tool. EF wrote the linear programming models and technically guided the design of the electronic platform and its field testing. MW led the development of and updates to the Optifood reference data files and gave technical advice throughout the process. HP co-ordinated the harmonization of *Pro*PAN and Optifood, HCK participated in the development of *Pro*PAN. HCK, RP and NS field tested Optifood. BD, CKL, HP, EF, NS, HCK, RP and NM drafted sections

of the manuscript. All authors read, edited and approved the final manuscript.

Disclaimer

BD is a staff member of the Pan American Health Organization and CKL is a staff member of the World Health Organization. The authors alone are responsible for the views expressed in this publication and they do not necessarily represent the decisions, policy or views of the Pan American Health Organization or of the World Health Organization.

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Panel 1 The Peru experiences

*Pro*PAN

*Pro*PAN has been applied in Peru to assist in the development of infant and young child-feeding interventions in different populations. In a peri-urban population of Lima, all the steps of *Pro*PAN were applied with local adaptation, resulting in the

selection, recipe development, household testing and promotion of locally appropriate complementary feeding recommendations. The application of *Pro*PAN facilitated the selection of key recommendations: (1) giving food of an appropriate consistency at each meal instead of the commonly given dilute soups, (2) adding available, accessible and acceptable animal source foods (chicken liver, egg, or fish) and suggested preparations using these foods to improve the quality of the diet and increase the intakes of the deficient nutrients, and (3) a responsive feeding message to address concerns of the mother. These recommendations have subsequently been promoted widely by the Ministry of Health and other institutions.

The following components of the *Pro*PAN guide were found particularly useful in the Peru setting and have subsequently been applied for interventions in other parts of the country to complement information already known or to focus on specific aspects. (1) The calculation of the Best Buy, the cost-nutrient benefit of locally available foods in the market which facilitated the selection of low-cost nutrient-rich foods accessible to the target population. (2) The exploration of perceptions towards specific foods in the food attributes exercise as a first step towards learning of their acceptability. (3) The household trials and the behaviour analysis which were extremely valuable in selecting the behaviours with most potential for nutritional benefit and most acceptable and feasible to put into practice by the target population. (4) The analysis and integration of the quantitative and qualitative data using the user-friendly matrixes to determine the barriers and opportunities for behaviour change of the different practices, thus facilitating the selection of the foods and practices. (5) Alternatives for intervention channels at both the health service and community levels. (6) The responsive feeding component. These parts have been used, according to need (separately or in sequence), and adapted to the local context in the development of several infant-feeding interventions in different populations and geographical areas in Peru. In particular, the application of the household trials and behaviour analysis to test responsive feeding recommendations in a rain forest area of Peru (Ucayali) facilitated the selection

of four responsive feeding messages, subsequently promoted by local organizations (Creed-Kanashiro *et al.* 2010).

Optifood

The Optifood tool was used in an impoverished peri-urban population in Lima, Peru to identify food-based recommendations for infants 9 to 11 months of age. Analysis of the food patterns reported for this group found deficiencies in several nutrients, especially iron, zinc and calcium. The Optifood programme was used to calculate how nutrient intakes could be increased with local food, with the finding that it was impossible to meet the recommended intakes of the deficient nutrients using only available food in acceptable quantities and frequency. Therefore, the following three food-based recommendations were developed and subsequently tested in household trials with 32 mothers using pictorial education materials as promotional aids: (1) the addition of chicken liver to the infant's diet three times a week, (2) adding milk (3 tablespoonfuls) daily to the child's pudding, stew or purée, and (3) mixing multiple micronutrient powder into the child's food every other day (home fortification consistent with Ministry of Health recommendations).

The household trials were conducted for a period of 2 weeks during which mothers were visited at home on four occasions to explore acceptability and encourage adoption of the recommended practices. A 24-hour recall of the infant's intake was conducted before and after the intervention to explore changes in food and nutrient intakes.

All the recommendations tested were well received by mothers, with almost 90% of them putting the recommendations into practice from the beginning. According to the pre-intervention 24-h recall, children consumed less than 60% of the recommended nutrient intakes (RNIs) of zinc and iron, and mean calcium intake was near to the RNIs; at the end of the intervention, mean intakes of iron and calcium surpassed, and zinc approached 100% of RNI, showing that the recommendations tested had a positive impact on the infant's nutrient intake as well as being well accepted by the mothers.

Complementarity of *Pro*PAN and Optifood

In the Peru experience, several aspects of *Pro*PAN facilitated the application of Optifood and vice versa. Optifood was used to determine the nutrient deficiencies from dietary intake data collected using a recall methodology similar to *Pro*PAN. Based on this data, the exploration for potential food-based strategies, alternatives, amounts and frequency of consumption to arrive at specific recommendations to improve nutrient intakes was easily done using Optifood.

The cost section of Optifood provided important information for determining the food-based recommendations (FBRs); the information on the local foods available and their prices required for this was obtained using the market survey of *Pro*PAN.

The household trials to test the FBRs arrived at using Optifood were conducted using the Test of Recommendation module of *Pro*PAN. Specifically, the 24-hour dietary recall conducted before and after the introduction of the FBRs to caregivers was based on the *Pro*PAN format and the calculation of adequacy of nutrient intakes using Optifood. The guides for the exploration of the acceptability and feasibility of mothers in implementing the FBRs were taken from the *Pro*PAN module.

The analysis of the results of these trials was done using *Pro*PAN's matrixes which facilitated defining the barriers and opportunities from the mothers' experiences of implementing the recommendations. The two tools were complementary in providing the information required to develop adequate and acceptable FBRs to improve the infants' nutrition.