Cost of the Diet (CoD) tool: First results from Indonesia and applications for policy discussion on food and nutrition security

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Abstract

Background. *The Minimum Cost of a Nutritious Diet (MCNut) is the cost of a theoretical diet satisfying all nutrient requirements of a family at the lowest possible cost, based on availability, price, and nutrient content of local foods. A comparison with household expenditure shows the proportion of households that would be able to afford a nutritious diet.*

Objective. *To explore using the Cost of Diet (CoD) tool for policy dialogue on food and nutrition security in Indonesia.*

Methods. *From October 2011 to June 2012, market surveys collected data on food commodity availability and pricing in four provinces. Household composition and expenditure data were obtained from secondary data (SUSENAS 2010). Focus group discussions were conducted to better understand food consumption practices. Different types of fortified foods and distribution mechanisms were also modeled.*

Results. *Stark differences were found among the four areas: in Timor Tengah Selatan, only 25% of households could afford to meet the nutrient requirements, whereas in urban Surabaya, 80% could. The prevalence rates of underweight and stunting among children under 5 years of age in the four areas were inversely correlated with the proportion of households that could afford a nutritious diet. The highest reduction in the cost of the child's diet was achieved by modeling provision of fortified blended food through Social Safety Nets. Rice fortification, subsidized or at commercial price, can greatly improve nutrient affordability for households.*

Conclusions. *The CoD analysis is a useful entry point for discussions on constraints on achieving adequate nutrition in different areas and on possible ways to improve nutrition, including the use of special foods and different distribution strategies.*

Key words: Cost of Diet, food and nutrition security assessment, fortification, linear programming, optimal diet, policy advocacy, 1,000 days intervention

Introduction

Food and nutrition assessments, combined with expenditure surveys, provide information about what people eat, how much money they spend on food, and their nutritional status. Additionally, individuals' nutrient needs are known, and people are advised on how to ensure consumption of a healthy and nutritious diet. However, in contexts where food availability does not appear to be a problem, it remains unknown how much of the nutrient gap is due to economic constraints on acquiring a nutritious diet (unaffordability), a lack of knowledge of healthy eating, and food and nutrition practices. Moreover, current methods to assess food and nutrition security are not able to analyze households' constraints on accessing their nutrient requirements, especially for their most vulnerable members, such as children under 2 years of age. Therefore, a method is needed that can provide information on the estimated cost for a household in a particular area to access foods that meet the nutrient requirements of

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the whole family.

The CoD method uses linear programming to provide this type of information. Linear programming applications have a long history, going back to World War II and even before [1], when minimization of diet cost was one of the problems that pioneers in this area tried to solve. The method has been widely used in many areas within the social sciences and beyond [2]. Nutritionists involved in human nutrition have actually been rather late to start using the method [3], which may be related to the fact that for a long time the focus in human nutrition was more on caring practices and on food patterns and behaviors, and much less on quantitative nutrient needs and intake [4].

The Cost of the Diet (CoD) tool that was developed by Save the Children UK has been introduced and applied in several places in Indonesia since the end of 2011 by the United Nations World Food Programme (WFP), in collaboration with the Ministry of Health, and with input on methodology and analysis by Indonesian research institutions, such as SEAMEO RECFON and the Agricultural Institute Bogor (IPB).

The Minimum Cost of a Nutritious Diet (MCNut) is the cost of a theoretical diet that satisfies all nutrient requirements of a family at the minimum possible cost, based on the availability, price, and nutrient content of local foods. Hence, when compared with household income and expenditure data, this minimum cost can be used to estimate the proportion of households that would be able to afford an adequately nutritious diet.

The objective of this paper is to explore the use of the CoD tool for policy dialogue on food and nutrition security, especially for the most vulnerable groups of the population: pregnant and lactating women and children under 2 years of age [5, 6] in diverse contexts within Indonesia.

Methods

The CoD tool is based on linear optimization using Microsoft Excel software and was developed by Save the Children UK in 2006 [7]. The tool uses Excel's solver function to perform linear optimization. The Save the Children UK tool is derived from an initial idea developed by Briend et al. [8–11] to use Excel's solver function for optimization. In Indonesia, the use of linear programming has been explored to develop context-specific complementary feeding recommendations, aiming at long-term improvement in complementary feeding practices [11–14].

To run the optimization process, the model uses two standard databases. *Food composition tables* are based on international references [15]. The food composition

TABLE 1. Nutrient contents of fortified products included in the CoD intervention modeling

Nutrient	Unit	Fortified rice—per 100 g	Fortified blended food (MP-ASI)—per 100 g	MNP Taburia—per 1 g
Energy	kcal	361	400	—
Protein	g	6.7	15.2	—
Fat	g	0.6	6.1	—
Absorbed calcium[a]	mg	2	120	—
Thiamine (vitamin B_1)	mg	0.56	0.4	0.5
Magnesium	mg	36	84	—
Riboflavin (vitamin B_2)	mg	0.06	0.5	0.5
Zinc	mg	7.1	4.1	5
Niacin equivalent	mg	9.4	4	5
Absorbed iron[b]	mg	0.53	0.37	0.5
Vitamin B_6	mg	0.74	0.7	0.5
Vitamin A	RE	150	350	417
Vitamin B_{12}	µg	1	0.6	1
Vitamin C	mg	0	35	30
Pantothenic acid	mg	1.14	2.1	3
Folic acid	µg	136	100	150

MNP, micronutrient powder; RE, retinol equivalent

a. Assumptions for calcium absorption: 25% in rice, 30% in fortified blended food (MP-ASI).

b. Assumptions for iron absorption: 5% for fortified rice and MNP Taburia, 7% for sodium iron ethylenediaminetetraacetate (NaFeEDTA), and 5% for ferrous fumarate in the fortified blended food (MP-ASI). Iron content in the latter includes 4 mg of ferrous fumarate and 2.5 mg of NaFeEDTA, in addition to native iron.

table available in the CoD tool gives the nutrient contents of foods, except for iron and calcium, for which it gives absorbed values instead of total contents. For specialized fortified products included in the intervention modeling, nutrient contents, including assumed absorbed levels of iron and calcium, were entered manually (**table 1**). Individual energy and nutrient requirements used in the model are based on the Food and Agriculture Organization (FAO/WHO) [16–18]. The model also requires three sets of locally specified data: a comprehensive list of all food items available and their market prices (per 100 g) at a given point in time in the area for which the MCNut is calculated; typical household composition, with information for each member on sex, age, weight, and activity level, which is required to know nutrient needs; and portion sizes for each food item and minimum and maximum allowances for daily consumption of food items and food groups.

In the Indonesia CoD application, the household composition was standardized based on the national household socioeconomic survey (Survei Sosial Ekonomi Nasional—SUSENAS 2010) [19] data on the average household size and age composition in the studied zones. The model household used for the analyses presented in this paper included a breastfed child aged 12 to 23 months, a child aged 7 years, and a breastfeeding woman and a man in their mid-thirties performing vigorous physical activity and of average body weight for their age group within the population.

Portion sizes are available in the CoD tool for a breastfed child 12 to 23 months of age (unpublished data—75th percentile). The portion sizes are adjusted for each household member automatically by the tool, based on energy requirements. In principle, the portion sizes could act as a constraint posed to the linear optimization performed by the tool; however, in practice, the number of times a food item could be selected by the tool (known as minimum and maximum constraints) is a much more limiting factor. The minimum and maximum constraints define how many times a food as well as a food group can be selected. Leaving this option completely open for the tool means that the minimum is set at 0 times per week and the maximum at 21 times per week (3 times per day, 7 days per week).

CoD assessments were conducted in four districts within three provinces of Indonesia: Timor Tengah Selatan in Nusa Tenggara Timur, Sampang and urban Surabaya in East Java, and Brebes in Central Java. Data collection was carried out by WFP in collaboration with the Ministry of Health from October 2011 to June 2012. Data analysis was finalized in August 2012, in collaboration with the Ministry of Health, SEAMEO RECFON, and the Agricultural Institute Bogor (IPB). In each area, several market surveys were conducted to record the availability and pricing of food commodities. Average household expenditure and family composition data were obtained from the national household socioeconomic survey (SUSENAS 2010) [19]. The Minimum Cost of a Nutritious Diet (MCNut) was calculated using the Excel linear optimization solver, which identifies the cheapest combination of food items and quantities to ensure that all energy and nutrient requirements are satisfied. MCNut is a benchmark measure that is based on generalized constraints for food item and food group consumption frequencies.

Focus group discussions were then conducted to better understand local food preferences and consumption behaviors. Based on the results from the focus group discussions, information on food preference patterns was used to inform the adjustment of minimum and maximum constraints on food items and food groups, to calculate a Locally Adapted Cost Optimized Nutritious Diet (LACON). Adjustments were limited to reflect staple preferences of the local population in order to avoid imposing too many constraints on the ability of the tool to optimize.

Affordability was assessed using household food expenditure as well as 70% of total expenditure. Correlation between the percentage of households who could afford LACON and the nutritional status of children under 5 years of age in the four CoD areas, based on secondary data (National Basic Health Survey—RISKESDAS 2007) [20], was also estimated. Different types of fortified foods and distribution mechanisms to households, targeted at the child aged 6 to 24 months or at the entire family, were modeled to assess the reduced weekly cost of a nutritious diet. The nutrient composition of these foods is shown in **table 1**.

Results

Table 2 shows the Minimum Cost of a Nutritious Diet (MCNut) compared with the Locally Adapted Cost Optimized Nutritious Diet (LACON) in four different areas. Both MCNut and LACON were higher in Timor Tengah Selatan than in the other areas. A family in Timor Tengah Selatan needs 212,812 Indonesian rupiah (IDR) (approximately US$22) per week to afford LACON, whereas in Sampang only 136,518 IDR (US$14) is required.

Figure 1 shows the percentage of households that could afford the LACON diet. There are stark differences among the four CoD areas: in Timor Tengah Selatan only 1 of 4 households could afford to meet 100% of their nutrient requirements through locally available foods, whereas in urban Surabaya 8 of 10 could. Affordability for the households was calculated based both on food expenditure and on 70% of total household expenditure. In all areas except Timor Tengah Selatan, more households could afford a nutritious diet if they spent 70% of all their expenditures on food.

The prevalence of underweight and stunting among

TABLE 2. Weekly Minimum Cost of a Nutritious Diet (MCNut) and Locally Adapted Cost Optimized Nutritious Diet (LACON) in Indonesian rupiah (IDR[a]) in four areas of Indonesia according to number of household members consuming the diet

Members consuming diet	Timor Tengah Selatan Jun 2012	Sampang Dec 2011	Surabaya Apr 2012	Brebes May 2012
1 child 12–23 mo				
MCNut	14,983	7,888	10,542	10,268
LACON	16,796	10,446	13,587	11,550
3 other household members				
MCNut	157,883	94,226	116,627	122,334
LACON	196,015	126,071	141,430	131,264
All household members				
MCNut	172,866	102,114	127,169	132,602
LACON	212,812	136,518	155,017	142,814

a. US$1 = 9,500 IDR.

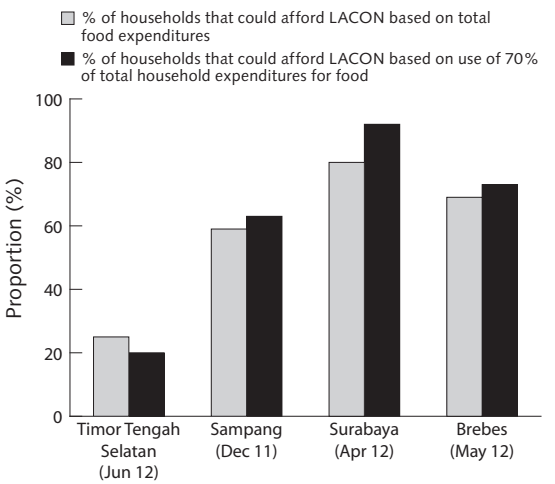

FIG. 1. Proportion of households that could afford the Locally Adapted Cost Optimized Nutritious Diet (LACON) in the four areas

children under 5 years of age in the four areas was inversely correlated with the proportion of households that could afford a nutritious diet (**fig. 2**). In Timor Tengah Selatan, where the proportion of households that could afford a nutritious diet is only 20%, the stunting prevalence is 57%, whereas in urban Surabaya, where the rate of affordability is 80%, stunting prevalence is 25%, which is lower than the national prevalence of 36.8%.

Different types of fortified food transfers to the household, targeted at the child aged 6 to 24 months or at the entire family, were modeled to assess the reduced weekly cost of a nutritious diet for the household and the child. The introduction of the same fortified products through the market, i.e., at a commercial price, is also modeled. Three types of products were modeled: fortified blended food for children aged 6 to 24 months (MP-ASI), micronutrient powder for children aged 6 to 24 months (Taburia) [21, 22], and fortified rice for the household.

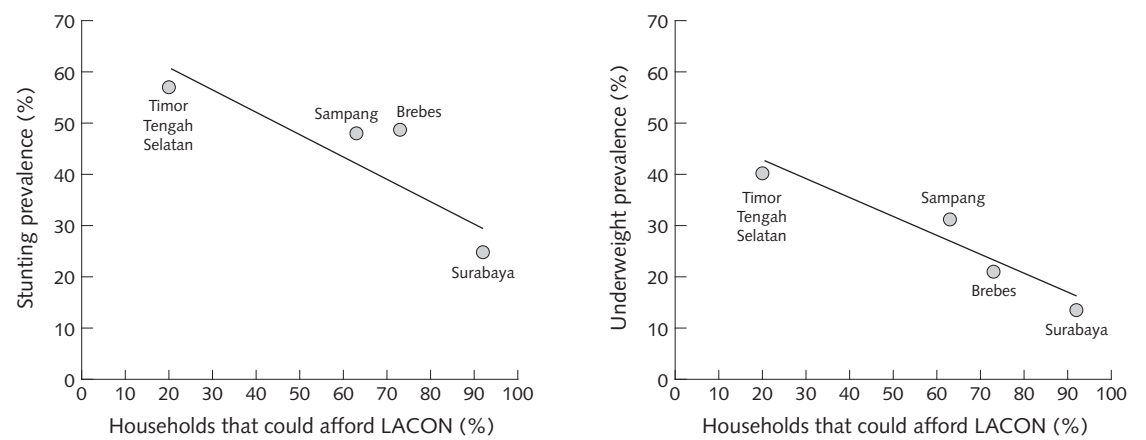

FIG. 2. Correlation between proportion of households that could afford the Locally Adapted Cost Optimized Nutritious Diet (LACON) and the prevalence of undernutrition (stunting and underweight); the regression line is also shown

The first two commodities are already available in Indonesia, either through the commercial market or through government Social Safety Net programs. The composition of the fortified blended food used for the simulation is based on the improved formulation of the MP-ASI SUN produced by Indofood for the WFP pilot project in Nusa Tenggara Timur Province. The composition of the micronutrient powder is based on Taburia's formulation, which contains approximately 1 Recommended Nutrient Intake (RNI) of each of 16 vitamins and minerals. Micronutrient powder is provided by the Indonesian Government through health centers under the Asian Development Bank (ADB)-funded project Nutrition Improvement through Community Empowerment (NICE). Fortified rice is not available in Indonesia yet, but an ADB-funded pilot is planned for 2013, testing the efficacy and effectiveness of incorporating fortified rice into the subsidized rice for the poor (Raskin) program. The composition of the fortified rice used in the CoD simulation is based on the fortification levels proposed for these upcoming efficacy and effectiveness trials. **Table 1** shows the nutrient composition of each of the three foods.

As shown in **table 3**, the highest reduction in the cost of the child's diet is observed with the free provision of MP-ASI through the Social Safety Net. If we analyze the provision of Taburia from a cost-effectiveness perspective, we can see from **table 4** that whether the product is provided for free through the Social Safety Net or at commercial cost through the market, the reduction of expenses for the household to obtain a diet that meets all nutrient requirements outweighs the intervention costs. Furthermore, the return on investment is high both for distribution through the Social Safety Net (32%) and for distribution through the market (15%).

As shown in **table 5**, rice fortification (either through the Social Safety Net or through the market) greatly improves nutrient affordability at the household level. In the example of Timor Tengah Selatan, the percentage of households that can afford the LACON diet increases from 25% to 65% when fortified rice is available through the subsidized rice for the poor (Raskin) program, and to 48% when it is available in the market.

TABLE 3. Effect of dietary interventions on weekly Locally Adapted Cost Optimized Nutritious Diet (LACON) for a child 6 to 24 months of age in Timor Tengah Selatan in June 2012

Intervention	LACON (IDR/wk)	Selected by tool (for commercial options) (g/wk)
None	16,797	—
MP-ASI, 60 g/day, free	7,354	—
MNP Taburia, 3×/wk, free	13,354	—
MP-ASI, commercial[a]	16,611	33
MNP Taburia, commercial[b]	15,582	2

IDR, Indonesian rupiah; MNP, micronutrient powder

a. The estimated commercial price of a 20-g sachet of fortified blended food (MP-ASI) in Timor Tengah Selatan District is 600 IDR. This is higher than the actual commercial price of the same product in Java (500 IDR), due to higher transportation and logistics costs in the eastern part of Indonesia.

b. The price of commercial MNP Taburia is set at 870 IDR (US$1 = 9,500 IDR). This is the government price, including product and programming costs (see **table 4**), but the commercial price for distribution at scale is not expected to be higher than this.

TABLE 4. Cost-effectiveness of MNP (Taburia) in Timor Tengah Selatan, one sachet/day, 3×/week

Variable	IDR/sachet	US$/sachet	Return on investment (%)[a]
Cost reduction LACON (child)[b]	1,148	0.12	—
Production cost	270	0.03	—
Programming cost (government)	600	0.06	—
Total government cost	870	0.09	32
Private sector distribution	1,000[c]	0.11	15

IDR, Indonesian rupiah; LACON, Locally Adapted Cost Optimized Nutritious Diet; MNP, micronutrient powder

a. Return on investment is defined as (amount gained—amount invested)/amount invested.

b. This cost reduction figure is the result of entering one sachet of Taburia for free (3×/week) into the food items list in the CoD tool. So, when one sachet of free Taburia is consumed by the child, the resulting LACON is reduced by 1,148 IDR.

c. 1,000 IDR is based on the price of two sachets of GiziKita (commercially available MNP) per day (1 RNI).

TABLE 5. Effect of fortified rice on household diet cost and affordability, Timor Tengah Selatan, June 2012

Intervention	LACON household (IDR/wk)	Households that could afford diet based on total food expenditure (%)	Selected by tool (g/wk)
None	212,812	25	1,752
Raskin[a]	201,649	29	3,346
Fortified rice, commercial[b]	161,351	48	3,514
Fortified Raskin	132,533	65	5,551

IDR, Indonesian rupiah; LACON, Locally Adapted Cost Optimized Nutritious Diet

a. Price of subsidized rice for the poor (Raskin): 1,600 IDR/kg.

b. Price of commercial rice (non-fortified): 7,960 IDR/kg; for fortified rice a price increase of 3% was assumed (8,207 IDR/kg).

Discussion

The CoD analysis enables useful evaluation to be performed of household affordability and cost-effectiveness, modeling different fortified foods, specialized nutritious products, and various distribution strategies [23]. The tool provides an important benchmark for any nutrition policy discussion, as it illustrates the cost of accessing a nutritious diet, both for children under 2 years of age and for the rest of the household. Although economic access to nutritious food is not the sole determinant of undernutrition, it is an important prerequisite to fulfill and should therefore be carefully considered in policy discussions.

Different areas face different constraints in terms of affordability of a LACON diet, and therefore require a different mix of interventions to address food and nutrition security. For example, an area like Timor Tengah Selatan, with only 20% of households able to afford LACON and extremely high stunting prevalence, will require not only behavior change communication (BCC) types of interventions, but also some kind of specialized food transfer, especially targeted at the most vulnerable groups (e.g., the first 1,000 days, pregnant and lactating women, and children under 2 years of age). Combining this with a cash or voucher transfer to the household could also be a solution. In an area with a much better rate of affordability, such as urban Surabaya (where 80% of households can afford LACON), emphasis on BCC interventions, combined with food or cash transfers and specialized food for pregnant and lactating women and children under 2 years of age targeted to the poorest 20% of households, would be a more suitable solution.

While the affordability analysis is very powerful to illustrate the extent of economic constraints on food access in a particular area, the cost-effectiveness analysis can add to the information available for decision-making at the local level. In particular, an important perspective can be provided for the Social Safety Net and other transfer-based programs, be it food, in-kind, or cash, including vouchers.

The effectiveness of fortified foods to meet nutrient requirements has been shown in several studies [14, 24, 25]. Among the intervention scenarios modeled in the CoD analysis, the use of the fortified blended food provided through the Social Safety Net resulted in a higher reduction in the cost of the diet for a child aged 6 to 24 months than the use of micronutrient powder (Taburia). The main reason is that fortified foods provide both micronutrients and energy, whereas Taburia provides only micronutrients (1 RNI). However, the cost of the child's share of the diet is small compared with the cost of the diet for the rest of the family (approximately 8%), so that the overall cost reduction for the household is limited.

It should be noted that the CoD assumes that households will purchase the combination of foods that ensures meeting the nutrient requirements of the child as well of other family members, which may not reflect actual food-purchasing behavior. Therefore, nutrition education and BCC strategies are very important to promote adequate complementary feeding practices as well as healthy dietary practices for the family as a whole.

Given that the majority of the population in Southeast Asian countries is of lower socioeconomic status, fortification of staple foods or semiprocessed food (e.g., rice and noodles) is another promising alternative [14, 24]. As shown in the Results section, CoD analysis confirms the cost-effectiveness of rice fortification through improved affordability for vulnerable households, both through the Social Safety Net and through commercial delivery mechanisms. Considering that the retail price of fortified rice is approximately 3% to 5% higher than that of normal rice [26], the potential impact of this large-scale fortification intervention is huge and cost-effective. This is also shown in **table 5**, where the quantity of rice at subsidized Raskin price selected by the CoD tool is 65% higher for fortified than for non-fortified rice. If the regular market prices are compared, the CoD tool also selects twice as much fortified rice as non-fortified rice.

Increased availability of fortified food through the commercial market for the wealthier segments of the population is also a viable strategy for all contexts. Individual food choices are based partially on health considerations, but also on convenience (time for preparation), taste preferences, and sociocultural factors and "fashion" trends (fast food, snacks, particular brands). This explains why, even if households were able to afford all required nutrients and knew which foods to choose in order to meet their nutrient requirements in the most cost-effective way, they might not spend their money in the most nutritiously cost-effective way. Therefore, fortified foods, which provide a better mix of nutrients without requiring a change of the diet, can help ensure that at least part of the nutrient needs of the household are met.

Conclusions

The CoD analysis is a useful entry point for discussions of the types of commodities and delivery channels to best achieve nutritional outcomes, both through government Social Safety Nets and through market-based solutions. Moreover, it provides information on the role and potential impact of nutrition-specific interventions targeting the first 1,000 days. It also sheds light on the importance of nutrition-sensitive interventions, such as fortification strategies targeting households. For the most vulnerable households, the initial CoD analysis highlights that both nutrition-specific and

nutrition-sensitive interventions would be required to meet their nutrient gap. Finally, the tool has a great potential to support decentralized policy decision-making, as decisions on the above-described interventions (implementation modalities and budget allocation) are increasingly taken at the district and provincial levels.

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