

A simple and quick method to evaluate the influence of food price policy on population-based nutrition status and related nutrition intervention

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Food price policies have a major influence on population food choice and nutritional status, especially for low-income families. Therefore, simple and quick methods to evaluate their influence is desirable. Consistent with nutritional rationality and economical feasibility, a mathematical model was developed by Linear Programming to appraise the influence and rationality of the subsidization of egg and pork in Tianjin, using the data about food varieties and their prices in Tianjin in 1990. It was found that food subsidism to influence choice was not rational for improvement in nutritional status of low-income families. The concept, of "food choice space" was developed and its implications for nutrition intervention explored. The model developed can be used to judge the nutritional effect of food price policies and provide baseline data for nutrition intervention.

Key words: Food price policy, nutrition status, linear programming

Introduction

Population nutritional status is related to food selection^{1,2}. Factors which influence food choice include: 1) socioculture, life style; 2) organoleptic (taste and smell); 3) demographic factors (age, sex, income and education); 4) food availability, cost, quality; 5) psychological factors (cognitive); 6) health status; and 7) nutrition status³. All the factors mentioned can be classified into two categories: "personal factors" and the "nutrition environment". The nutrition environment embodies the variety, price and quality of foods which a market provides. Food price policies influence population food choice by way of affecting the nutrition environment. Then they affect a population's nutrition status. Therefore, monitoring and evaluating change in the nutrition environment can be used to predict change in population nutrition status. In other words, nutritional outcomes of food price policies can be assessed by analysing the constituents of the nutrition environment and how it operates.

Methodology

Conceptualisation. Even if food price policy influence on population nutrition status can be analysed through the link with the nutrition environment, the environment itself cannot simply convey influence on people's food selection and nutrition status, for it consists at least of assorted food varieties and prices. A mathematical model is required to untangle the environment and give it meaning and shape. Linear programming serves the purpose⁴. Linear programming is based on the mathematical technique which assists in finding an optimum solution to a problem when there is a constraint, alternatives, and an objective (eg RDA) that needs to be minimised or maximised.

Mathematical model. The matrices C and X represent the prices and the amounts of foods in a market, respectively, with CX representing total food expenditure. The matrices B1 and B2 stand for RDA⁵ (Recommended Dietary Allowance) levels and the upper limits for safe intake of nutrients (this is for future use) respectively. Matrix A is food composition and Matrix Bj signifies the largest valorised amount of food kinds with subsidies in form of coupons.

Then the mathematical model is:

Minimise: CX

Subject to: $B_1 \leq AX \leq B_2$

$X_j \leq B_j$

$X \geq 0$

With linear programming, the optimal value in the mathematical model is minimum food expenditure. Meanwhile, it should satisfy nutritional requirements and give full consideration to food subsidies. Another group of indices are shadow prices. B1's shadow prices mean the least increase in expenditure in order to acquire some nutrients beyond the RDA. In fact, what they reflect is the skewed place of nutrients in the market, the so called "nutrient's fringe cost". They should be conversely proportionate to possible intake of the nutrients.

Data sources. Data about 60 kinds of basic foods and their prices were collected in Tianjin in 1990. Additionally, a food composition database was set up using the Chinese Food Composition Tables^{6,7} and DBase III⁸. The database was converted into a text file (.txt) for use in the main program, written in FORTRAN 77⁹. Energy, protein, fat, vitamin A, thiamin, riboflavin, niacin, vitamin C, calcium and iron were chosen as nutrients, but only calcium and riboflavin are presented in this paper. The Chinese RDA's⁵ were used, but that for the lightest male labourer was used for B1.

Table 1. The fringe costs of calcium and riboflavin in Tianjin in 1990 (RMB: Fen/0.1 RDA)

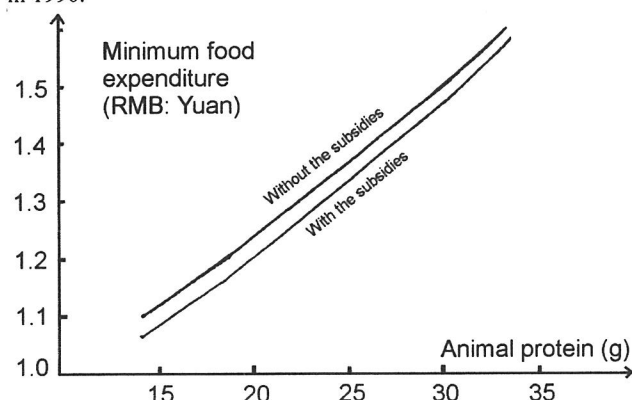
	Subsidization		Unsubsidization		Difference	
	Animal protein	Calcium	Riboflavin	Calcium	Riboflavin	Calcium
14g	4.224	0.044	4.210	0.040	0.014	0.004
18g	4.224	0.044	4.210	0.040	0.014	0.004
22g	4.064	0.038	4.010	0.040	0.054	-0.002
26g	4.064	0.038	4.010	0.040	0.054	-0.002
30g	4.064	0.038	4.010	0.047	0.054	-0.009
34g	4.064	0.038	4.010	0.047	0.054	-0.009

The fringe costs of iron, vitamin A, thiamin, niacin and vitamin C were zero and are not listed in the table.

Result and Discussion

The figure of minimal food expenditure for animal protein was computed for two conditions, supposing that the subsidization of egg and pork in Tianjin existed and did not exist, and by gradually increasing the animal source protein RDA. At the same time, a table was obtained of a nutrient's fringe cost to animal protein for the conditions with or without the two subsidies. (Table 1)

Figure 1. Minimum food expenditure to animal protein in Tianjin in 1990.



Every food subsidy which a government introduces should have a specific target population. An ideal target population for food subsidization ought to be low-income families. In the same way, benefit size should decrease as a family's income increases. Although the distance between the valorised curve (the bottom one) and the unvalorised one progressively draws close, it is not obvious. From the viewpoint of the target population, even if the

low-income families did benefit from the subsidies, the valorising policy would not be rational, for it is unable to focus on the target population. Next, due to subsidization, a nutrient's, say calcium's, fringe cost becomes larger for all animal protein levels, and riboflavin's fringe cost increases for even low animal protein levels. Low-income families in the range of low animal protein levels have the most potential benefit. But the increase in fringe cost makes it more difficult to have a nutrient-balanced diet. The subsidy of egg and pork makes the population more likely to experience deficiencies of calcium and riboflavin except for those with middle and high animal protein intakes for riboflavin intake. In a word, the valorising policy does not focus on low-income families and makes the nutrition environment non-beneficial for a nutritious diet. The policy is not rational in respect to nutrition. From the principle of linear programming, the model's optimal values are critical points which comprise a curve. Below the curve, it is impossible for people to reach nutritional needs. As a matter of fact, any population's food expenditure far surpasses this value. The size of the difference of actual food expenditure and this value indicates the scope of a population's free choice of foods. It can be called *Food Choice Space*. The larger the space, the easier the population tends to eat in a way detrimental to the principle of adequate nutrition. In this event, the population needs more nutrition education and nutrition intervention.

Conclusion

The present study suggests that the evaluation of food policy influence on the nutrition environment and on a population's possible nutrition outcome is possible and desirable. The method also provides a capability to provide baseline data for nutrition intervention.

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用一個簡便快速的方法來評價食物價格政策對以人群為基礎的營養和相關的營養干預的影響

食物價格政策對人群的食物選擇和人群營養狀態的影響很大，特別是對於低收入的家庭。這樣就很需要一種簡便快速的方法，用來評價這種影響。為了使營養的合理性與經濟條件的可行性達到一致，天津的LINEAR項目採用1990年天津各種食物的價格資料，提出了一個評價天津雞蛋和豬肉價格對營養合理性的影響的數學模型。研究發現補貼對於促進低收入家庭的營養狀態並不合理。該研究還提出了食物選擇空間的概念，並就它們與營養干預的關係進行了討論。結論是：這種方法可以用來評價食物價格政策對營養的影響，並能為營養干預提供基綫資料。

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