HUMAN NUTRITION AND INCOME IN RURAL SEMI-ARID TROPICAL ANDHRA PRADESH, INDIA

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1. Introduction

Nutritional status of people in an economy is an important economic variable since better nutrition means better health and better health means less disease and less waste of work-time. Thus better nutrition leads to more and better work effort. This is not to say, however, that nutrition levels can explain all about health and labour productivity matters.

Widespread undernutrition in developing countries is considered a serious impediment to overall economic development. Some economists believe that the solution to undernutrition lies in improving the income levels in these countries (Pinstrup-Andersen and Caicedo 1978, Knudsen and Scandizzo 1978, Murty 1983, Pitt 1983). To demonstrate the effect of income on nutritional intake, nutrient elasticity with respect to income (total expenditure) is estimated in most studies. The nutrient (mostly calories) elasticity with income is reported to be in the range of 0.6 to 1.00 for low income people. The implication thus is that if income is somehow increased the problem of undernutrition in developing countries will be taken care of.

However, some other economists have argued against the high nutrient elasticities and have reported small nutrient elasticities (Shah 1980, 1983, Chaudhri and Timmer 1986, Behrman and Deolalikar 1987). The argument is that in a market place, food items are judged and bought not only by their nutritive value but also by their price, bulk, appearance, taste, social status, etc. Thus the transition from food expenditure to nutrient expenditure is not direct due to the above mentioned factors. One possible explanation for the high nutrient elasticity reported in some studies lies in equating food expenditure elasticity to the nutrient elasticity. If food expenditure elasticity is equated to nutrient elasticity, the nutrient elasticity would be overstated as the dimensions of food other than nutrition are ignored. This would imply that higher price food may have lower nutritive value relative to lower price food in terms of nutrient per unit of money spent.

This paper attempts to quantify the difference between the cereal expenditure elasticity and calorie elasticity in a village in rural semi-arid tropical Andhra Pradesh in India. T paper is organised as follows. Section 2 presents the conceptual framework relating to the conventional and a modified approach to obtain nutrient elasticities. Section 3 describes the data. Empirical results are reported in Section 4. Finally some policy implications are indicated in Section 5.

2. Conceptual Framework

The conventional approach to obtain nutrient elasticity is as follows:

$$N = f(Xi) \quad (1)$$

$$Xi = f(P1, P2, P3 \ldots Pi, E). \quad (2)$$

Therefore, substituting (2) into (1) gives

$$N = f(P1, P2, P3 \ldots Pi, E) \quad (3)$$

where N = nutrient (e.g., calories),
Xi = i-th food item,
Pi = i-th food price,
E = income (total expenditure).

The indirect relationship (3) is meaningful when the following conditions are fulfilled:

(i) Quantity and nutrient content of food items are proportional in their price and quantity relationship, i.e., higher price food has higher nutritive value.

(ii) Tastes and preferences do not matter in consumption choices

(iii) People are nutrition-conscious and are fully informed about the nutritive value of different foods.

These three conditions may not all be met in reality. Thus the modified framework to obtain a more realistic estimate of nutrient elasticity may be written as follows:

$$N = F(Xi) \qquad (1)$$

$$Xi = f(P1, P2, P3 \ldots Pi, E, \text{taste and preference, nutrition information}) \qquad (2A)$$

$$N = f(P1, P2, P3 \ldots Pi, E, \text{taste and preference, nutrition information}) \qquad (3A)$$

where the notation is the same as before.

The contention in this paper is that if taste and preferences are considered in the analysis, the relevant price and income elasticities of nutrient intake would be smaller than otherwise. Only the case of income (expenditure) elasticity of nutrient intake measured in calories is considered here. However, similar analysis can be done for proteins, vitamins, minerals, etc. The relevant elasticities which take into account taste and preference may be derived as follows. With

$$N = \sum_{i=1}^{n} NiXi \qquad (4)$$

$$PiXi = Ei \qquad (5)$$

$$E = \sum_{i=1}^{n} Ei \qquad (6)$$

where Ni = nutrient (calories) per unit of i-th food item, Ei = expenditure on i-th food item.

and other notation is the same as before, total differentiation of (4) in log form leads to

$$d \ln N/d \ln E = \sum_{i=1}^{n} \theta i \; d \ln Ni/d \ln E + \sum_{i=1}^{n} \theta i \; d \ln Xi/d \ln E. \qquad (7)$$

Total differentiation of (5) in log form leads to

$$d \ln Xi/d \ln E = d \ln Ei/d \ln E - d \ln Pi/d \ln E. \qquad (8)$$

Substituting (8) into (7) yields

$$d \ln N/d \ln E = \sum_{i=1}^{n} \theta i \; d \ln Ei/d \ln E - \sum_{i=1}^{n} \theta i \; d \ln (Pi/Ni)/d \ln E \quad (9)$$

where θi = share of calories from i-th food item,

$$\sum_{i=1}^{n} \theta i = 1$$

(Pi/Ni) = calorie-price derived from i-th food item.

The income (expenditure) elasticity expressions in (9) need some elaboration. The left hand side is the nutrient elasticity. For this paper it is calorie elasticity. The right hand side has two terms - the first is the weighted sum of expenditure elasticities and the second is the weighted sum of a kind of quality (taste) elasticities. The use of the term quality or taste elasticity is only suggestive and is not definitive, however. The quality elasticity is expected to be positive because higher value (price) food is preferred as income increases. The weights are the share of calories from various food items. If the second term on the right hand side in (9) is very small than the relevant income (expenditure) elasticity would be close to nutrient elasticity. But it is possible that the second term is not small and consequently the expenditure elasticity would overstate the nutrient elasticity. The empirical part of the paper estimates the two terms in the right hand side in (9) separately. Regression analysis is employed for the purpose.

3. Data

The data for this paper are drawn from the village Aurepalle, one of the six villages in the Village Level Studies conducted by the Economics Program at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India. The main source of income in the village is agriculture. The agriculture is largely rainfed and the area under irrigation is about 21 per cent. Rainfall is about 611 mm per annum and is erratic. Temperature is, however, not limiting for crop growth. All this implies the pervasiveness of weather-induced production risk in the village. Main crops grown are sorghum, pearl millet, rice, pigeon pea, castor and groundnut. Main cropping is undertaken in the Kharif (rainy) season. The data used here are household-level and relate to the three years 1979-81. The sample includes agricultural labour, small, medium and large farmers. Each category includes 10 households. Most households were the same over the study period. The number of observations is 120. The details of data collection procedures etc. are given in Binswanger and Jodha (1978).

About 89 per cent of total calories in the diet of Aurepalle villagers come from cereals (Bidinger 1983). Analysis considering only cereals (sorghum, wheat, rice and coarse cereals) for calorie intake is therefore justified. Rice is the main cereal consumed in the village. Rice and wheat are higher price cereals relative to sorghum and coarse cereals. The conversion ratios to obtain calories from cereals are taken from Gopalan et al. (1971).

4. Empirical Results

Before reporting the regression results, some descriptive statistics are presented in Table 1.

The expenditure values in Table 1 are on an annual basis per household. As mentioned earlier, rice is predominantly eaten in the village. Wheat consumption is very limited. The relatively high coefficients of variation in expenditures generally reflect large variation in consumption expenditure across households and over time. Calorie-price of different cereals is different. Calories from wheat are most expensive and calories from coarse cereals are cheapest. Cereal expenditure contributes about 44 per cent to total household consumption expenditure. This reflects that these households are very poor relative to world standards.

To obtain the elasticities shown on the right hand side in equation (9), two kinds of regressions are estimated. The usual Engel functions are estimated to arrive at the relevant expenditure elasticities. The

Table 1

Mean and Coefficient of Variation in Variables in Aurepalle
Sample of 120 Households

Variable	Mean	CV(%)
Sorhgum Expenditure (Rs)	187.0	69
Wheat Expenditure (Rs)	9.5	237
Rice Expenditure (Rs)	1256.8	47
Coarse Cereals Expenditure (Rs)	82.8	113
Calorie Price (Rs/K cal)		
Sorghum	0.0029	16
Wheat	0.0043	86
Rice	0.0041	22
Coarse Cereals	0.0026	54
Cereals Expenditure	1536.1	43
Total Expenditure	3507.7	65

second type of regressions involve calorie-price from sorghum, wheat, rice and coarse cereals as dependent variables and are used to obtain the quality or taste elasticities mentioned in Section 2. Dummy variables for 1980 and 1981 are used to capture the effect of time-related factors. A quadratic term for total expenditure is employed to take into account the non-linearity in consumption expenditure. The regression results along with the relevant expenditure elasticity estimates are reported in Tables 2 and 3.

Table 2 reports the results relating to the quadratic Engel functions. The statistical significance of the quadratic term in total expenditure shows non-linearity in sorghum, rice and coarse cereal expenditure. $\bar{R}^2$ ranges from 0.26 to 0.62 across regressions. The dummy variable D2 is significant in the case of sorghum and coarse cereals expenditure indicating a decline in sorghum expenditure and an increase in coarse cereals expenditure in 1981 relative to 1979. The relevant expenditure elasticities relating to sorghum, rice and coarse cereals are less than one reflecting the staple-food nature of these cereals. The expenditure elasticity relating to wheat is, however, greater than one indicating the luxury-good nature of wheat consumption. However, it is important to recall that wheat consumption is very limited in the village.

Table 3 reports the results of regressions involving calorie-price from sorghum, wheat, rice and coarse cereals as dependent variable.

$\bar{R}^2$ has ranges from 0.22 to 0.51 across the regressions in Table 3. The quadratic term in total expenditure is significant in the cases of wheat and coarse cereals showing the non-linearity in consumption expenditure. The year dummies are generally positive and significant (except in the case of wheat in 1980) reflecting an increase in calorie-price over time. The relevant expenditure (taste or quality) elasticities are 0.05, 0.77, 0.24 and 0.33 for sorghum, wheat, rice and coarse cereals respectively. Thus quality elasticity is highest for wheat (0.77) and lowest for sorghum (0.05).

To derive calorie elasticity from the elasticities reported in Tables 2 and 3, the share of calories (θi in Section 2) from various cereals is required. The share of calories from sorghum, wheat, rice and coarse cereals is indicated in Table 4.

Table 2

Regression Coefficients, associated t Ratios, $\bar{R}^2$ and Expenditure Elasticities in Aurepalle (Engel Function-based)

Dependent Variable	Intercept	X1	Independent Variable X2	D1	D2	$\bar{R}^2$	e
Sorghum Expd.	91.47 (2.79)*	0.56E-01 (4.31)*	-0.39E-05 (-3.62)*	19.09 (0.79)	-117.84 (-4.84)*	0.30	0.79
Wheat Expd.	-15.12 (-2.75)*	0.72E-02 (3.28)*	0.22E-06 (-1.21)	4.38 (1.08)	5.37 (1.31)	0.26	2.09
Rice Expd.	64.28 (0.58)	0.45 (10.34)*	-0.24E-04 (-6.57)*	99.02 (1.21)	-30.66 (-0.37)	0.62	0.79
Coarse Cl. Expd.	-22.92 (-0.94)	0.27E-01 (2.82)*	-0.16E-05 (-1.99)*	19.07 (1.06)	95.07 (5.26)*	0.26	0.68

Note: X1 = Total Expenditure,

X2 = Square of Total Expenditure,

D1 = Dummy for 1980, i.e., 1980 = 1, rest = 0,

D2 = Dummy for 1981, i.e., 1981 = 1, rest = 0,

e = Indome (expenditure) Elasticity,

t ratios are in parentheses,

* indicates statistical significance at 5 per cent level.

Table 3

Regression Coefficients, associated t Ratios, $\bar{R}^2$ and Expenditure Elasticities in Aurepalle

Dependent Variable	Intercept	X1	X2	D1	D2	$\bar{R}^2$	e
			Independent Variable				
Calorie Price-							
Sorghum	0.24E-02	0.72E-07	-0.42E-11	0.29E-03	0.76E-03	0.51	0.05
	(25.15)*	(1.88)	(-1.33)	(4.11)*	(10.68)*		
Wheat	0.41E-04	0.15E-05	-0.84E-10	-0.44E-03	0.15E-02	0.22	0.77
	(0.04)	(3.92)*	(-2.55)*	(-0.60)	(2.09)*		
Rice	0.27E-02	0.38E-06	-0.13E-10	0.36E-03	0.64E-03	0.45	0.24
	(13.43)*	(4.71)*	(-1.97)	(2.38)*	(4.29)*		
Coarse Cereals	0.89E-03	0.47E-06	-0.32E-10	0.61E-03	0.12E-02	0.20	0.33
	(2.37)*	(3.17)*	(-2.60)*	(2.20)*	(4.46)*		

Note: X'. X2, D1, D2 and e are the same as in Table 2.

t ratios are in parentheses.

* indicates statistical significance at 5 per cent level.

Table 4

Share of Calories from Sorghum, Wheat, Rice and
Coarse Cereals in Aurepalle

Calorie Source	Share (%)
Sorghum	16.00
Wheat	0.30
Rice	77.60
Coarse Cereals	6.10
Total	100.00

Table 4 shows that about 78 per cent of calories come from rice. Sorghum contributes about 16 per cent whereas coarse cereals share about 6 per cent of calories in the diet of Aurepalle villagers. Calories from wheat are less than one per cent. In a sense, the possibility of substitution across calorie sources is not great in the village if tastes and preferences are assumed given.

Now the right-hand-side terms in equation (9) can be calculated using the relevant values in Tables 2, 3 and 4. The values thus obtained are:

Cereal Expenditure Elasticity = 0.79
Cereal Quality Elasticity = 0.22

The resultant calorie elasticity is therefore 0.79 - 0.22 = 0.57. Thus the calorie elasticity will be overstated by about 28 per cent if equated to cereal expenditure elasticity. It may be of interest to note that the comparable elasticities, when the quadratic term in total expenditure is excluded from the regressions, are 0.46, 0.16 and 0.30 respectively and suggest an overestimation of calorie elasticity by the order of about 35 per cent.

The results in this paper thus support the view that the calorie elasticity, if equated to expenditure elasticity, is overstated. However, some limitations of the empirical work reported here are in order. The specification issues in terms of more flexible functional forms and addition of other relevant variables such as household characteristics etc. need further work.

5. Policy Implications

In this paper it is argued that income-related solution to the problem of undernutrition is not a sure shot. It is conjectured that even at lower levels of income, consumer preferences matter. Thus the income effect on nutrition would be smaller than usually envisaged. This line of thinking implies that income increases may be spent on higher price food and non-food items leading to a small improvement in nutritional status. This paper specifically examined preference-related matters within cereals in a poor village in semi-arid tropical India.

The two economic policy options - lowering food prices and increasing income levels along with nutrition education - may help in improving nutritional levels. However, income distribution and inequality matters are also important. Nonetheless, the role of nutrition education should not be undermined. It is important to reiterate, however, that increasing income levels alone will not solve the problem of undernutrition in the study village and more generally in developing countries.

In conclusion, it may be said that consumption preferences do matter at lower levels of income. Therefore, increasing income levels may not be a sure solution to the problem of undernutrition in Aurepalle. This does not, however, mean that increase in income is not important. The point is that income increase may be a necessary but not a sufficient condition to improve nutrition levels. The same may be said about keeping food prices low in order to improve nutrition levels. The role of nutrition education and information is speculated to be very important in improving nutritional levels in Aurepalle and in developing countries generally.

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