Nutritional Status of Papua New Guinea's Population and Its Determinants

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Abstract

Data from a nationally representative household survey in 1996 are used to describe the nutritional status of the rural and urban populations. The indicators examined are the per capita availabilities of calories and protein, the energy density of the diet, the standardised height of young children and the body-mass index of adults. Multivariate analysis shows that nutrient availability rises by between four and seven percent for every ten percent increase in household economic resources, suggesting that economic growth can have beneficial effects on nutrition. The response of nutrients to increased household resources is highest in the rural sector and is higher for protein than for calories. The hypothesis that rural households oriented towards tree crop production have lower nutrient availability than do households oriented towards food crop production is not strongly supported. In contrast to the direct effects of (especially mother's) education on children's heights, educational effects on nutrient availability work mainly through raising household incomes. A basic constraint on raising household incomes, and on improving health and nutrition status, is lack of access to public services.

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Introduction

Researchers, planners and policy-makers in developing countries have long been concerned with the issues of food security and malnutrition. Papua New Guinea also appears to be moving toward viewing food security, rather than just food self-sufficiency, as the goal of national food policy. This is a step in the right direction because food security – the ability to command sufficient food at all times – is a more sensible goal than self-sufficiency. Command over food can be gained using the most efficient and least risky means, whether that be through directly producing food or else by producing cash crops to exchange for food. But food security, particularly when it is reduced to a quantifiable measure such as whether calories available to a household are sufficient to meet requirements (Garrett and Ruel, 1999), is only a means to an end. The overall goal should be improved nutrition, and calorie availability is one of only several inputs into nutrition. Thus, a preoccupation with food security and calorie availability may lead analysts to ignore other determinants of nutritional status.

This paper uses data from a nationally representative household survey of Papua New Guinea in 1996 to describe differences in nutritional inputs and outcomes between the rural and urban sectors. The nutritional outcomes considered are the height and stunting rates of young children and the body-mass of adults. These outcomes are of considerable welfare significance, with, for example, the consequences of stunting include increased risk of sickness and death (Chen, *et. al.*, 1980) and poor mental development (Grantham-McGregor, *et. al.*, 1996). The inputs to nutrition that are considered are calorie availability, protein availability, energy density of the diet (i.e., calories per gram) and access to health services.

The results show that neither calorie availability, nor food security indicators based on calorie availability, differ between urban and rural sectors. But there are substantial differences in nutritional outcomes between sectors, and also in the non-calorie inputs to nutrition. These significant urban-rural differences highlight the danger of concentrating exclusively on calorie-based measures of food security. The results also show that nutrient availability responds strongly to increased household incomes but a basic constraint on raising household incomes is lack of access to services. Thus, improvements in infrastructure are likely to raise nutrient availability and will also make non-calorie inputs to nutrition (e.g., health services) more readily available, which should further improve nutrition.

The Papua New Guinea Household Survey

Data come from the 1996 Papua New Guinea Household Survey (PNGHS), a nation-wide consumption survey conducted as part of a World Bank poverty assessment. The survey covered a random sample of 1200 households, residing in 73 rural and 47 urban Census Units, selected from the 1990 Census sample frame, stratifying by sector (urban and rural), by environmental conditions (elevation and rainfall), and by the level of agricultural development.[2] Sampling weights were generated from the variation between the Census estimates of the size of each cluster and the actual size found in 1996, and from the deviation of the actual number of households surveyed in each cluster from the target number. All results presented below take account of the clustered, weighted and stratified nature of the sample.

[2] Data from the survey and all survey documentation are freely available on the internet, at: www.worldbank.org/lsms/country/png/pnghome.html.

The survey interviewed households at least twice, with the start of the consumption recall period signalled by the first interview. The average length of time between interviews was almost two weeks and the recall covered all food (36 categories) and other frequent expenses (20 categories). The reported expenditures include the imputed value of own-production, net gifts received, and food stock changes, so they should be a comprehensive monetary measure of consumption. Food quantities were based on conversions from volume measures (households were given empty sacks with marked graduations for recording garden produce), and the Pacific Islands Food Composition Database was used to compute the nutrient quantities from the food quantity data.[3] The remaining components of household consumption were picked up by an annual recall, covering 31 categories of infrequent expenses. An inventory of durable assets was also used to estimate the value of the flow of services from these assets, including rental services from owner-occupied dwellings.

Anthropometric measurements (weight and height) were made on all children in the surveyed households who were age five years and under, and also on the parents of these children. Both children and their parents were weighed and measured twice, once during the first visit to the household and again during the consumption recall interview. This duplication allowed the average of the two measures to be used, which should reduce the effects of measurement error. Documentary evidence on children's age (i.e., date of birth) was requested from the parents (e.g., birth cards, health books) but in some cases the only evidence was parental recall. Visits were also made to health centres and hospitals to check birth records, and to churches to check baptismal records.

Results – The Calorie Puzzle

Average calorie availability appears to be similar in urban and rural sectors of PNG, at around 2660 calories per person per day (Table 1). Moreover, these averages don't appear to disguise a situation where one sector has a higher share of the population at the extremes of the distribution (i.e. poorly-fed or overly-fed) because the degree of inequality in calorie availability in each sector is very similar. In both the urban and rural sectors, approximately 42 percent of the population are not meeting food energy requirements of 2000 calories per person per day.[4] Hence, a calorie-based view of food security, such as that used by Garrett and Ruel (1999), would view urban and rural PNG as equally deserving of attention.

[3] One item where food quantities were not available was cooked meals eaten out of the home; calories from this source were derived as the average "price" each household paid for all other calories plus a 50 percent premium to reflect processing margins. A similar processing margin is assumed by Subramanian and Deaton (1996).

[4] This target is equivalent to the nutritional requirement of 2200 calories per adult equivalent used by the poverty lines in Papua New Guinea (Gibson and Rozelle, 1998) but is lower than some of the recommended daily allowances published by the Department of Health.

Table 1. *Calorie availability in rural and urban sectors of Papua New Guinea, 1996*

	Rural	Urban	Papua New Guinea
per capita daily calorie availability	2665	2645	2662
	(76)	(234)	(74)
Gini coefficient on calories[a]	30.3	31.8	30.5
% of population with <2000 calories per day available	41.9	42.6	42.0
	(2.4)	(5.8)	(2.2)

Note: Results calculated from 1144 households surveyed in 1996 Papua New Guinea Household Survey and weighted to reflect the number of people in the sampling frame. Standard errors in ( ) adjusted for clustering, stratification and sampling weights.

[a] The Gini coefficient is a measure of inequality that ranges from 0 (perfect equality) to 100 (complete inequality where one person controls all the calories and everyone else has none).

Despite the similarity in average calorie availability and in the proportion of the rural and urban population lacking access to sufficient calories, there are big differences in nutritional outcomes for the rural and urban population. Almost one-half of rural children appear to be stunted (low height-for-age) but only one-fifth of urban children are stunted (Table 2)[5]. This estimate of the prevalence of stunting was obtained by comparing the heights of the surveyed children with international growth reference curves.[6] This comparison also showed that the average rural child in PNG is only 92.5 percent of the median height of similarly aged (and gendered) children in the reference population, while urban children average 97.3 percent of the median.

Low height-for-age of children is commonly assumed to reflect malnutrition due to the accumulated effect of extended periods of inadequate food intake and past episodes of infection and sickness. Hence, children's height for age is an indicator which measures certain aspects of food security, but it gives much different results than does the simple calorie availability measure. Unlike the results for calorie availability, the child nutritional outcomes show a clear need to direct resources into the rural sector so as to improve nutritional status. Looking at child height as a nutritional outcome also suggests that there must be significant differences between urban and rural sectors in some of the non-calorie inputs into this production process, in order to account for the different outcomes.

[5] The risk of stunting appears to be the same for boys as for girls (t=0.63) so the results in Table 2 are not broken down by gender.

[6] Previous anthropometric studies in PNG (Heywood, *et al.*, 1988) have suggested that children from the highlands do not fit the international growth curves very well, tending to be shorter (indicating malnourishment) but heavier (indicating good growth). However, even if attention is restricted to children from the lowlands, the stunting rate is 40 percent in the rural sector and 20 percent in the urban sector, so the conclusion that nutritional outcomes are worse in the rural sector holds.

Table 2. *Nutritional outcomes in rural and urban sectors of Papua New Guinea, 1996*

	Rural	Urban	Papua New Guinea
		Children age 0-5 years	
Height as percentage of median for age and sex in reference population	92.5 (0.4)	97.3 (0.6)	93.2 (0.4)
Percent who are stunted[a]	47.0 (3.3)	19.8 (2.3)	42.9 (3.0)
		Adults	
Mother's Body Mass Index (BMI)[b]	21.6 (0.3)	25.3 (1.0)	22.1 (0.3)
Father's Body Mass Index (BMI)[b]	22.1 (0.3)	25.4 (0.6)	22.5 (0.3)
% of mother's with BMI < 18.5	13.5 (2.6)	6.2 (2.6)	12.4 (2.3)
% of father's with BMI < 18.5	4.5 (1.9)	1.4 (0.9)	4.1 (1.6)

Note: Results calculated from 969 children, 544 mothers and 454 fathers who were measured during the 1996 Papua New Guinea Household Survey. Estimates weighted to reflect the number of people in the sampling frame. Standard errors in ( ) adjusted for clustering, stratification and sampling weights.

[a] Height is more than two standard deviations below the median height for that age and gender in the reference population used by the National Center for Health Statistics.

[b] BMI = Weight (kg) / [Height (m)]^2.

The survey also provides some information about the nutritional status of the adult population, although the sample is non-random because the parents of young children are less likely to elderly (the body mass index of elderly women can be low due to maternal depletion syndrome). With this caveat in mind, the bottom part of Table 2 contains estimates of the average body mass index for men and women, and the proportion whose body mass index is below 18.5, which indicates chronic energy deficiency (Shetty and James, 1994). The average body mass index of urban males is approximately 15 percent higher than for rural males (the gap is 17 percent for females). A rural female is twice as likely as an urban female to have a body mass index so low as to indicate chronic energy deficiency (and women are three-times more likely than men to suffer this problem). Hence, the nutritional outcomes for adults also show that problems are considerably worse in the rural sector, despite the similarity of calorie availabilities across rural and urban sectors.

Results – Other Inputs into Nutrition

The quality of the diet, as reflected in protein content and energy density, is considerably higher in the urban sector. Protein availability and energy density for urban residents are approximately 50 percent higher than for rural residents. The average rural diet provides approximately 1.3 calories per gram, due to the dominance of root crops (which have an energy density of approximately one calorie per gram). In contrast, urban diets provide around two calories per

gram due to the much higher content of cereals, fats and oils, and meats. Although an energy-dense diet may cause obesity problems for adults, it can be a considerable advantage for young children who may not be able to ingest all of the calories available from a bulky diet. Thus, the higher energy density and higher protein content of urban diets may partly explain why child stunting is much less prevalent in urban areas, despite the similarity in calorie availability.

In addition to the quantity and quality of the diet, child height also reflects past episodes of infection and sickness. It is highly likely that rural children suffer a greater burden of infection because they have poorer access to primary health care facilities. The average rural person has to travel for over one hour to the nearest primary health care facility, compared with urban residents who typically are only 15 minutes from the nearest health care facilities.[7] This matters to nutritional status because people who are sick may not be able to obtain the full nutritional benefit from their diet, making the comparison of calorie availability a misleading indicator of nutritional status.

Table 3. *Non-calorie nutritional inputs in rural and urban sectors of Papua New Guinea, 1996*

	Rural	Urban	Papua New Guinea
per capita daily protein availability	46.3 (1.9)	67.3 (3.6)	49.5 (1.8)
Gini coefficient on protein[a]	37.6	35.8	38.0
Energy density (calories per gram)	1.27 (0.04)	1.92 (0.06)	1.35 (0.04)
Travelling time to nearest aidpost[b]	70	15	60

Note: Results calculated from 1144 households surveyed in 1996 Papua New Guinea Household Survey and weighted to reflect the number of people in the sampling frame. Standard errors in ( ) adjusted for clustering, stratification and sampling weights.

[a] The Gini coefficient is a measure of inequality that ranges from 0 (perfect equality) to 100 (complete inequality where one person controls all the protein and everyone else has none).

[b] Estimated from community-level data, which refers to the time taken using the means of travel commonly used by people in the community. Where a health centre is closer than an aidpost, the time to the health centre is used.

An additional type of public service that is relevant to nutrition but is not included in Table 3 is education and the provision of literacy services. Previous analyses on the 1996 survey data indicate that there is a strong effect of maternal education in reducing the risk of child stunting (Gibson, 1999) and there is a large gap in education levels between urban and rural sectors (and also between men and women). The effect of maternal education persists even when controlling for household incomes, so it is likely to reflect improvements in the efficiency and productivity with which households use their resources to achieve improvements in nutritional outcomes.

[7] Although it is likely that the urban health care facility will also be better equipped and have a wider range of medicines, the survey cannot inform on this point because no data were gathered on the quality of public services.

The Determinants of Nutrient Availability

What determines nutrient availability at the household level? The results in Table 1 and Table 3 suggest that whatever the determinants, they will differ between urban and rural sectors, given the similarity of calorie availability but the substantial differences in protein availability. Moreover, while calories are slightly less equally distributed in urban areas, protein is less equally available in rural areas and the overall degree of inequality in protein availability is higher. This likely reflects the fact that the major sources of protein are purchased and that access to cash income in the rural sector is less equal than is access to land (which is needed for growing the main calorie sources).

To uncover some of the determinants of nutrient availability, multivariate analysis has been carried out, with the per capita availability of calories and protein regressed on per capita total household expenditure, household size and demographic composition, and controls for the age, education and income sources of the household head. In addition to these variables there are likely to be a number of locational factors, including prices and environmental conditions, that influence nutrient availability. In the absence of detailed information on these factors, one strategy is to use dummy variables for each cluster in the sample (thereby soaking up all inter-community variation) to give a set of within-cluster results.

The results of the regression analysis are reported in Appendix Table 1, and only the main points and implications are highlighted here. The most important finding is that nutrient availability rises by between four and seven percent for every ten percent increase in household economic resources, suggesting that economic growth can have beneficial effects on nutrition. The response of nutrients to increased household resources is highest in the rural sector and is higher for protein than for calories. The estimated nutritional response to extra income is also higher when intercept dummies for each cluster are used (the 'within cluster' results), so excluded price and environmental factors are unlikely to be a cause of the results. Although rural households oriented towards tree crop production appear to have lower nutrient availability than do rural households oriented towards food crop production, this effect disappears once the control variables for each cluster are included. A likely reason is that households where the cash income of the head is derived mainly from sales of food crops are likely to be in more accessible locations and the general rise in living standards associated with accessibility will also tend to raise nutrient availability. Once locational effects are controlled for, the source of income for the household head does not have a significant effect on nutrient availability.

The results from additional experiments with the regressions models are not reported in the Appendix tables and are simply summarised. One key finding is that in contrast to the direct effects of (especially mother's) education on children's heights, educational effects on nutrient availability work mainly through raising household incomes. Once per capita expenditure is controlled for, the effect of either women's education or household head's education is to reduce nutrient availability and the most plausible explanation is that more households with more educated members are more likely to be engaged in sedentary occupations where nutrient requirements are lower.

Conclusions

An over-emphasis on calorie-availability measures of food security is likely to prove misleading in Papua New Guinea. There is no difference between the rural and urban sector in average calorie availability or in the proportion of the population with inadequate levels of calories available (a common statistical indicator of food insecurity). Yet there are large differences in nutritional outcomes between these sectors, with the risk of child stunting and chronic energy deficiency for mothers being twice as high in the rural sector. There are several non-calorie inputs to nutrition which appear to contribute to these poorer nutritional outcomes in the rural sector, including the lower average and more uneven availability of protein in the diet, the lower energy density of the diet and the poorer access to primary health facilities. The importance of these non-calorie inputs into nutrition suggests that it is important to consider food security as a means to the end of improved nutrition rather than an end in itself.

The results also show that nutrient availability responds strongly to increased household incomes but a basic constraint on raising household incomes is lack of access to services. Previous results estimated from the survey suggest that per capita expenditure (as a measure of household economic resources) falls by 10 percent for every one hour increase in travelling time to the nearest road or transport facility (World Bank, 1999). Thus, improvements in infrastructure are likely to raise nutrient availability and will also make non-calorie inputs to nutrition (e.g., health services) more readily available, which should further improve nutrition.

Appendix Table 1. *Nutrient availability regressions, Papua New Guinea, 1996*

	Rural		Urban		Within Cluster Rural		Within Cluster Urban	
	β	|*t*|	β	|*t*|	β	|*t*|	β	|*t*|
				Calories				
ln PCE	0.411	(9.98)	0.322	(4.21)	0.545	(15.1)	0.430	(13.1)
ln household size	-0.261	(5.97)	-0.257	(3.50)	-0.160	(3.53)	-0.308	(3.68)
rf15+	0.032	(0.26)	0.356	(1.89)	0.087	(0.66)	0.309	(2.34)
rf714	0.005	(0.03)	-0.548	(1.35)	0.001	(0.01)	-0.277	(0.82)
rf06	0.008	(0.05)	0.249	(0.73)	-0.127	(0.88)	0.477	(1.69)
rm714	0.071	(0.45)	-0.870	(1.93)	0.127	(1.05)	-0.469	(0.94)
rm06	-0.060	(0.42)	-0.268	(1.19)	-0.105	(0.82)	0.128	(0.54)
Head's school years	-0.014	(2.93)	-0.011	(1.83)	-0.011	(2.73)	-0.011	(1.09)
Age of head	-0.003	(1.79)	-0.003	(0.65)	-0.002	(1.65)	-0.002	(0.34)
Food crop income	0.098	(1.77)	…	…	0.055	(0.85)	…	…
Wage and business	-0.054	(1.02)	-0.242	(4.75)	-0.037	(0.71)	-0.035	(0.43)
Constant	5.807	(17.3)	6.407	(10.4)	5.945	(22.4)	5.601	(11.7)
Zero slopes *F*-test	$F_{(11,56)}$=56.1		$F_{(10,47)}$=62.8		$F_{(10,57)}$=184.2		$F_{(9,48)}$=43.4	
R^2	.425		.497		.631		.635	
				Protein				
ln PCE	0.643	(19.4)	0.373	(3.03)	0.747	(20.7)	0.629	(10.1)
ln household size	-0.179	(4.51)	-0.270	(2.67)	-0.076	(1.92)	-0.276	(2.65)
rf15+	-0.027	(0.21)	-0.158	(0.74)	0.009	(0.08)	-0.224	(1.31)
rf714	0.137	(0.96)	-0.563	(1.89)	0.004	(0.03)	-0.196	(0.81)
rf06	0.424	(2.11)	0.125	(0.32)	0.189	(1.08)	0.649	(1.70)
rm714	0.182	(1.31)	-0.623	(1.76)	0.173	(1.63)	-0.215	(0.61)
rm06	-0.079	(0.53)	-0.326	(0.91)	-0.140	(0.97)	0.475	(1.43)
Head's school years	-0.002	(0.30)	0.002	(0.39)	-0.007	(1.52)	-0.014	(1.89)
Age of head	-0.002	(1.16)	-0.005	(0.88)	-0.003	(1.92)	-0.003	(0.59)
Food crop income	0.188	(3.09)	…	…	0.037	(0.48)		
Wage and business	-0.003	(0.05)	-0.248	(2.00)	-0.122	(1.70)	-0.263	(1.77)
Constant	-0.109	(0.43)	2.484	(2.72)	-0.237	(1.05)	1.074	(2.17)
Zero slopes *F*-test	$F_{(11,56)}$=68.8		$F_{(10,47)}$=28.8		$F_{(10,57)}$=23.6		$F_{(9,48)}$=4.7	
R^2	.533		.508		.689		.695	

Note: The sample is *N*=830 in the rural sector and *N*=314 in the urban sector. The reported absolute *t*-values are corrected for the clustered, stratified, and weighted nature of the sample. Variables beginning with *r* are demographic ratios, so that e.g., rf714 is the ratio of females aged 7-14 to total household members. The omitted group is male adults. In the rural regressions there are three economic activity groups, with households whose head's main income is from tree crops omitted, while in the urban sector the omitted group is households whose head's main income is not from wages or a formal business. The within cluster regression contains 46 dummy variables for the urban sector and 72 for the rural sector.

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