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PATTERNS OF MACRONUTRIENT AND MICRONUTRIENT CONSUMPTION AND IMPLICATIONS FOR MONITORING AND EVALUATION

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INTRODUCTION

Much of the early work on consumption effects of a range of agricultural policies and programs concentrated on an analysis of the effects of income on caloric intake and to a lesser extent on protein intake (Kramer and Rubey 1989; Dawson and Kennedy 1987). The assumption in much of this consumption analysis was that calories were the most limiting factor for households and individuals within households and that as energy intake increased, there would be a concurrent increase in the intake of other nutrients.

The emphasis on calories as the primary measure of dietary adequacy was influenced, in part, by the energy versus protein debate which had raged in the 1970s. Research conducted in the mid to late 1970s had concluded that in most developing countries, calories tended to be more limiting than protein. Households and individuals who were found to have inadequate protein intakes were almost always consuming diets too low in energy (Kennedy 1979).

No one argued that micronutrients were not essential but rather that as caloric consumption increased so did other micronutrient consumption. Thus, until recently, most of the monitoring systems that contained any information on nutrient consumption used energy consumption as a proxy for overall diet quality. Indeed the companion piece to the present report (Haddad, Sullivan, and Kennedy 1991) identifies household caloric adequacy as the traditional indicator for household food security in most monitoring and evaluation systems. This issue is now being revisited as a result of newer information.

An upcoming international conference scheduled for October 1991 entitled "Ending Hidden Hunger" will focus worldwide attention on the problems caused by dietary deficiencies of micronutrients in particular vitamin A, iron, and iodine. These three micronutrients are singled out because they tend to be the ones which are most deficient in large segments of the developing world.

The purpose of the present report is to examine the relationship between household income, caloric consumption, and other nutrient consumption in households and individual household members. Data sets from four countries—Kenya, Mexico, Pakistan, and the Philippines—are used. The implications of these analyses for systems which monitor food security and nutrition are discussed in the final section of the report.

Data sources

There was a purposeful selection of data sets to:

(1) reflect geographical diversity;

(2) provide a comparison of caloric intake with micronutrient intake at the household and preschooler level;

(3) examine the relationship between household and preschooler variables and the growth, morbidity, and mortality of preschool-aged children.

In order to conduct this work quickly, the decision was made to use extant data. Data sets from Kenya, Mexico, Pakistan, and the Philippines were selected because they met two on more of the above criterion.

The Kenya research was conducted to assess the effects of commercialization of agriculture on household food security and preschooler nutritional status. The study was conducted in South Nyanza, Kenya from 1984 to 1987 (Kennedy 1989). The sample contained in this data set is a representation sample of agricultural and non-agricultural households in the community served by the South Nyanza Sugar Company. The Mexico data set came from an evaluation of the Conasupo Milk Subsidy Program in Mexico City in the late 1970s (Overholt et al. 1981). The sample is a random sample of participants and non-participants in the milk subsidy program. The sample is an entirely urban sample. The Pakistan data set comes from a food security project conducted by IFPRI throughout the country (Alderman and Garcia, 1991). The sample provides a representative sample of households in Pakistan. Finally, the Philippines data set was derived from a pilot food subsidy experiment conducted in six villages in the Philippines. The areas of this project were selected based on high rates of preschooler malnutrition (Garcia and Pinstrup-Andersen 1987).

The variables contained in each of these data sets vary somewhat reflecting the different purposes for which the case study specific information was collected. Despite some diversity in the type of information, each data set has variables which allow comparisons between household caloric intake and micronutrient consumption and/or preschooler caloric intake and preschool micronutrient consumption and/or preschooler nutritional status.

Each of the data sets had been analyzed previously to examine the

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relationship between household income and household caloric consumption. This is the first time, however, that the relationship between income and micronutrient consumption had been analyzed in these data sets.[1]

RESULTS

General

Before presenting the results for specific nutrients some general observations are warranted. As shown in Table 1, for each of the four countries, household calories increase as income increases. This association has been reported in most consumption studies (see Alderman, 1986) and although the strength of the income/calorie association varies across the four studies the finding is consistent with the relationship reported in the recent indicators research (Haddad, Sullivan and Kennedy, 1991).

In three of the four countries—all except Mexico—household protein consumption is significantly correlated with household caloric consumption. In addition, the mean adequacy levels for protein at each income quintile are higher than are the caloric adequacy levels; thus, on average, calories are more limiting at the household level than is protein. As already mentioned, the calorie versus protein issue was a contentious issue in the 1970s and based heavily on the amino acid

[1] For more detail on the research design and data collection strategies, the reader is referred to: Kennedy and Cogill 1987 and Kennedy 1989 for Kenya; Overholt, Kennedy, et al. 1981 for Mexico; Alderman and Garcia 1991 for Pakistan; and Garcia and Pinstrup-Andersen 1987 for the Philippines.

Table 1--Household micronutrient adequacy* by income/cap quintile

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fortification trials in Guatemala, Thailand, and Tunisia, it was concluded that under normal circumstances when the caloric needs of an individual are met, there is not protein deficiency (see Kennedy, 1978 for a review of the issues).

For the four cases, the adequacy levels for most nutrients are higher than the household caloric adequacy levels within each of the income categories. There are some exceptions. In Kenya, at each income level, calcium adequacy is less than caloric adequacy. This is due primarily to the low consumption of milk at the household level; milk, if consumed at all, tends to be taken in tea and even this is only in small amounts. Although some calcium is obtained from dark, green leafy vegetables, this type of calcium is less bio-available than the calcium in milk. Since calcium intake is low it is not surprising in Kenya that the riboflavin intake is also low; milk is a major source of riboflavin. It is worth noting in a review of nutrition studies done in Kenya from the mid-1970s to 1987, riboflavin deficiency based on clinical signs was not noted as a problem in Kenya (Jansen, Horelli, and Quinn 1987).

For Pakistan, the adequacy levels for calories are substantially higher than are the adequacy levels for vitamin A in each of the income quintiles.[2] This pattern reflects the low consumption of beta carotene rich vegetables and fruits across income levels.

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[2] For Pakistan data were already summarized as calories/AEU in the data set. If one uses a calorie standard of 2600 calories/AEU—one reasonable for Pakistan—calorie adequacy is high at all income levels.

Mexico, the only urban case study included in this analysis, has caloric adequacy levels above 100 percent in each income group. Despite this, the nutrient density of the diet is not as good as some other countries with lower levels of caloric consumption. The data set did not contain the specific food items in the diet. One can only speculate, therefore, about dietary patterns. In general, urban diets because they rely heavily on purchased foods are composed more of foods high in fat, refined sugar and salt in comparison to rural diets in the same country. In the Mexico City case it is probable that in having a purchased foods diet, some of the nutrients that traditionally have come from home production such as fruits and vegetables have declined.

Table 2 provides the same types of comparisons as in Table 1 but for preschooler's consumption. There were no individual dietary data for Pakistan, so Table 2 contains only three of the four case studies.

Similar to the household data, there is an association between the child's caloric consumption and household income, although this association is weaker than at the household level. This is shown descriptively in Table 2 and corroborated by the data in Table 3. The income elasticities for child's calories range from -.088 to .052 whereas the household income elasticities range from .012 to .14. The negative elasticity for child's calories in Mexico is due to the fact that most children are above 100 percent caloric adequacy and thus increments in income are not used to provide more calories. These Table 3 data for Mexico are also consistent with the anthropometric data for preschoolers which indicate that overweightness tends to be more of a

Table 2--Preschooler micronutrient adequacy* by income/cap quintile

Table 3--Income elasticities of micronutrients

	Kenya			Philippines			Mexico		Pakistan	
	HH[a]	Child[b]	All	HH[a]	Child[b]	All	HH[c]	Child[c]	HH[d]	Child
Vitamin A	0.084	0.005	0.228	0.100	0.095	-0.18	0.036	0.070	0.204	
Iron	0.056	0.031	0.226	0.068	0.076	0.077	0.002	-0.58	0.165	
Protein	0.070	0.004	0.177	0.141	0.115	0.148	0.009	0.029		
Calcium	-0.014	-0.031	0.233			0.106	0.030	-0.008		
Fat										
Niacin	0.047	-0.004	0.136			0.089	0.038	-0.027		
Thiamine	0.042	0.029	0.122			0.176	0.002	-0.14		
Riboflavin	0.032	0.172	0.157			0.338	0.034	-0.007		
Vitamin C	0.073	0.006	0.258			0.035	0.087	0.11		
Calories	0.071	0.052	0.185	0.082	0.042	0.422	0.012[e]	-0.88[b]	0.14	

[a] Variables used in computing elasticities are INTAKE PER AEU and INCOME/CAP.
[b] Variables used in computing elasticities are ACTUAL INTAKE and INCOME/CAP.
[c] Variables used in computing elasticities are PERCENT ADEQUACY and INCOME/CAP, except if noted otherwise.
[d] Variables used in computing elasticities are INTAKE PER AEU and INCOME/CAP where ____ is computed from calorie requirements.
[e] Variables used in computing elasticities are INTAKE PER AEU and INCOME/CAP.

problem than underweightness in children in the Mexico City sample (Overholt et al. 1981).

Table 2 data for preschoolers also indicate that for most nutrients, the adequacy levels are higher than the adequacy levels for calories. Here again, this is similar to the household data shown in Table 1.

As a general rule, most nutrients both at the household and preschooler level tend to move with income and calories. The next sections provide more detailed data on two nutrients known to lacking in many developing country populations—vitamin A and iron.[3]

Vitamin A

Asia has historically been perceived of as an area of the world where inadequate vitamin A consumption is more of a problem than either Latin America or Asia (IVACG 1981). The descriptive dietary data contained for the household (Table 1) and the preschooler (Table 2) would indicate, on average, this is true.

Vitamin A assessment based on dietary data only is plagued by the fact that as a fat-soluble vitamin it is stored in the body. Vitamin A consumption tends to show a very bimodal pattern of consumption—many days of low intake are balanced by a smaller number of days where vitamin A rich foods are consumed. For this reason, it is not valuable to use dietary vitamin A data derived from only one measurement point to

[3] With the extant data, it was not possible to evaluate iodine.

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provide an indication of the degree of deficiency within a population or for individuals. Therefore, we place more confidence in the data from Kenya, and the Philippines in interpreting the vitamin A data since both of these studies were based on from four to eight observations per household and per individual.

Data in Tables 1 and 2 have already shown that in Kenya, for both households and preschoolers, average vitamin A consumption levels are well above requirements at each income levels. The Philippines, on the other hand, had low vitamin A consumption levels for households at each income levels and for preschoolers in the two lowest income quintiles. The data for the Philippines (Table 3) also indicate that the income elasticity for vitamin A for households and children is higher than the caloric income elasticity; increasing household income will increase vitamin A consumption faster than energy consumption.

Not surprisingly, vegetables are the chief source of vitamin A (in the form of Beta carotene) in both Kenya and the Philippines for preschoolers (Table 4); the same is true for households in these two countries (Appendix 1 and 2).

If one used these descriptive data only (Tables 1 to 4), one might conclude that there is a substantial vitamin A problem in the Philippines but not in Kenya. In order to examine some of the issues further, data for the households and preschoolers were disaggregated by quintiles of vitamin A adequacy (Table 5A and 5B). In Kenya, the lowest quintile of household vitamin A adequacy has an intake which in only 43.7 percent of requirements; this lowest quintile represents 20 percent

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Table 4--Primary sources of preschooler vitamin A, by income quintile and food group (in retinol equivalents)

Table 5a--Selected household- and child-level indicators of preschoolers, by HH vitamin A adequacy quintile

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Table 5b--Selected household- and child level indicators of preschoolers, by child vitamin A adequacy quintile

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of the sample households. The quintiles of vitamin A adequacy do not parallel the household energy consumption levels. For example, the household caloric adequacy (90.6 percent) of the lowest vitamin A quintile (43.7 percent) is similar to the energy consumption (92.8 percent) of the households in the fourth vitamin A quintile (316 percent).

However, in the Philippines there is a relationship between household vitamin A and household caloric adequacy. The households in the lowest quintile of vitamin A adequacy in the Philippines are also the households with the lowest caloric consumption and the households in the highest category of vitamin A also have the highest level of caloric adequacy.

The preschooler's dietary data were also stratified into vitamin A adequacy quintiles (Table 5b). One striking finding is that in the lowest quintile in Kenya, children have extremely low dietary vitamin A adequacy levels. The low vitamin A intake in children does not correspond to the child's caloric adequacy quintile. Similar to the Kenya household level data, preschoolers with very low vitamin A consumption levels (based on multi-measures) do not have energy adequacy levels that are lower than children consuming higher amounts of vitamin A. Forty percent of children in the sample are consuming diets inadequate in vitamin A. This finding is particularly disturbing given that the data are based on multi-measures of the child's diet and equally important used the 1985/1987 period which was a good agricultural production year in the survey area. It is plausible that

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in a drought period the incidence of low vitamin A intakes would be worse.

In the Philippines a greater proportion of the preschoolers have diets low in vitamin A. Increases in the child's caloric intake are paralleled by increases in the vitamin A adequacy of the diet.

The Kenya and Philippines case studies provide an interesting contrast. In Kenya, low vitamin A intakes of the child exist side by side with high (i.e. greater than 100 percent of requirements) vitamin A intakes in the household. In the Philippines, it is more typical to find that low vitamin A consumption by the preschooler occurs simultaneously with low vitamin A consumption in the household. As already shown from the data in Table 3, in the Philippines the child's vitamin A consumption increases faster than calories with increasing income; the same is not true for children in Kenya.

The issue of chronic dietary vitamin A deficiency is examined another way in Table 6. The analyses took advantage of the longitudinal nature of the Kenya and Philippines data. Children who at each measurement point were either less than 30 percent or less than 100 percent of dietary vitamin A adequacy were compared to children who on all rounds had vitamin A adequacy levels that were greater than 100 percent of requirements. In Kenya, 22 percent of children have vitamin A intakes which are chronically less than 30 percent of requirements and 27 percent of the sample children have intakes less than 100 percent of requirements. This has important implications for monitoring and evaluation systems. The mean vitamin A consumption levels presented in

Table 6--Selected household and child-level indicators by vitamin A adequacy group

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Table 2 would not suggest this magnitude of deficiency.

Here again, for Kenya, children with chronically low intakes of vitamin A do not necessarily come from households where vitamin A intake is also low. And again, the child's caloric adequacy is not a good predictor of the child's vitamin A adequacy. This issue will be taken up again in the discussion of Table 7.

In the Philippines, approximately 7 percent of the preschoolers have vitamin A intakes less than 30 percent and approximately 25 percent have intakes less than 100 percent of requirements. The greatest proportion of children in the Philippines sample have adequacy levels which vary across rounds. These data suggest more seasonality in the child's vitamin A consumption that what was seen in Kenya. In the Kenya case intakes of vitamin A were apt to be either high or low. Only 30 percent of the children showed dietary patterns where the vitamin A adequacy levels varied. In the Philippines only 17 percent of the children have vitamin A intakes which are consistently above 100 percent of requirements.

The noticeable differences in the patterns between Kenya and the Philippines continues to be seen in the data in Table 7. The significant determinants of the child's vitamin A consumption differs in the two countries. In Kenya, the child's caloric adequacy has a significant, negative association with the child's vitamin A adequacy. As the child's calories increase, vitamin A consumption declines. This is because as the household incomes increase the consumption of vitamin A rich foods declines (Table 4). In this particular study area

Table 7--Determinants of preschooler vitamin A adequacy[a]

Independent Variable	Kenya		Philippines	
	β	t-statistic	β	t-statistic
Gender (1 = boy)	-26.9	-1.36	1.22	0.20
Child caloric adequacy (percent)	-1.13	-3.20	0.61	4.87
Age (months)	9.40	3.1	1.37	0.85
Age squared	-.09	-2.82	-0.02	-1.30
Household vitamin A adequacy (percent)	.52	10.97	1.18	29.70
R^2 = .14			R^2 = .61	
F = 23.34			F = 188.55	
Significance of F = .0000			Significance of F = .0000	

[a] For Kenya, children with complete dietary data only, for the Philippines, children 24 months and older.

Note: Results from a separate regression showed household income per adult equivalent was not a significant determinant of the preschooler's vitamin A dietary adequacy.

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of Kenya, vegetables are seen as low prestige foods.

In Kenya, it is the household's vitamin A adequacy that is the single biggest determinants of the child's vitamin A consumption.

In contrast to Kenya, in the Philippines, as the preschooler's caloric adequacy increases, there is an increase in the vitamin A adequacy of the child's diet. This is consistent with the data presented in Table 2 and Table 6. In the Philippines, similar to Kenya, the child's dietary vitamin A adequacy is associated positively with the household consumption of vitamin A.

The research was also interested in the relationship between the child's vitamin A consumption and health. An equally important concern in this work was also to identify indicators that could be used as proxies for identifying children who are "at risk" of vitamin A deficiency. The common clinical measures that are used to diagnose vitamin A deficiency are often n-stage indicators. There is an urgent need to identify techniques that can be routinely used as part of monitoring and evaluation systems to assess micro- as well as macronutrient consumption.

As will be discussed in the companion report on the inventory of food and nutrition monitoring systems (Kennedy and Payongayong, 1991) where any measures on preschoolers are included in monitoring and evaluation systems, they tend almost universally to be a measure of child anthropometry and this is usually weight for age. Table 8 provides a categorization of preschooler morbidity and nutritional status (based on anthropometry) variables broken down by quintiles of

Table 8--Selected preschoolers indicators by child vitamin A adequacy quintile

child's vitamin A adequacy. In Kenya and Mexico, there is no relationship between the various anthropometric measures and the level of the preschooler's caloric adequacy. This is similar to some of the early work in Indonesia (Tarwotjo et al. 1983). The Indonesia research found that areas with high levels of preschooler malnutrition (based on anthropometry) did not correspond to areas with a high prevalence of vitamin A deficiency. These descriptive data would suggest that the process leading to poor growth is different than the process producing a low vitamin A consumption. However one should note that in the Philippines, the Z score for weight for age does improve as one moves from the lowest to the highest vitamin A adequacy.

The correlations of the preschooler's dietary vitamin A and morbidity and anthropometry are shown in Table 9. These correlation coefficients parallel what was seen in the descriptives. In Kenya, there is no significant correlation between the preschoolers Vitamin A adequacy and the child's weight for age whereas in the Philippines and Mexico, there is. In Kenya, however, preschooler's dietary vitamin A adequacy is correlated with a significant decrease in the total time ill and also the total time ill with lower respiratory infection, measles and diarrhea (weakly). In the Philippines, however, there is no significant correlation between the child's vitamin A intake and the incidence of diarrhea or fever.

Table 10 presents models for the incidence and prevalence of preschooler morbidity with an emphasis on the role of vitamin A. Given that the current research is based solely on extant data, the analyses

Table 9--Correlation coefficients of preschooler vitamin A adequacy with anthropometric and morbidity measures

Table 10--Association between vitamin A dietary adequacy and incidence and prevalence of total illness, diarrhea, and lower respiratory infection[a]

Selected Variables[c]	Total Illness	Diarrhea	Lower Respiratory Infection
Prevalence			
Preschooler dietary vitamin A Adequacy (percent)	-.006 (-2.31)[b]	-.001 (-1.3)	-.003 (-2.07)
Weight-age Z-score	-4.09 (-4.65)	-.74 (-2.3)	.14 (.30)
Household income	-5.2 - 04 (-1.1)	-2.7 - 05 (-1.57)	3.4 - 05 (.13)
Age (in months)	-.18 (-.71)	-.36 (-3.9)	.12 (.84)
Incidence			
Preschooler dietary vitamin A (percent)	-1.0 - 04 (-2.85)	-4.4 - 05 (-2.14)	-3.9 - 05 (-1.84)
Weight-age Z-score	-.04 (-3.26)	-.01 (-2.05)	.003 (.39)
Household income	-4.14 - 06 (-.63)	-7.0 - 06 (-1.8)	5.7 - 06 (1.4)
Age (in months)	-.004 (-1.2)	-.009 (-4.5)	.003 (1.4)

a Vitamin A dietary status was not significantly associated with incidence or prevalence of upper respiratory infection or fever.

b t-statistic in parenthesis.

c Full regression model included percent of preschoolers in the household, gender (1=boy), age squared.

were limited to the Kenya data set only since this was the only study that provided information on vitamin A consumption for the individual preschooler, morbidity and growth.

The weight-for-age Z-score measured during round one of the study (baseline measure) is used to explain illness patterns in the later rounds of the study.

Household income per AEU does not have a significant association with either the incidence or prevalence of illness.

The prior weight-for-age Z-score of the preschooler is a significant determinant of the incidence and prevalence of total illness and diarrhea. As the weight-for-age of the preschooler increases, the total time ill and the time ill with diarrhea decreases.

The illness models in Table 10 indicate that the level of vitamin A adequacy of the preschooler's diet has a beneficial effect on morbidity that is distinct from the influence of household income and the influence of the weight-for-age of the child. As the level of dietary vitamin A adequacy increases, the incidence of total illness, diarrhea, and lower respiratory infection declines. The level of dietary vitamin A adequacy is also associated with a decrease in the prevalence of total illness and lower respiratory infection in preschoolers.

The relationship between morbidity patterns and mortality in preschoolers was examined. Results in Table 11 indicate that a higher prevalence of lower respiratory infection increases the risk of mortality of preschoolers. Vitamin A intake by decreasing the incidence

Table 11--Probit model for mortality in preschoolers[a]

Selected Variable[b]	Coefficient	t-statistic
Household income/AEU	.18-03	.91
Weight-age Z-score (average for Study 2)	-.40	-3.2
Time ill with lower respiratory infection	.15-01	2.47
Birth order	.43 - 02	.08

a Preschooler died (1 = yes)

b Full probit model included age of child, age of child squared, gender of child, percent time ill with diarrhea, birth order. These variables were not significant in the probit model.

and prevalence of lower respiratory infection, decreases the probability of mortality in preschoolers.

While the significant links between vitamin A consumption and lower respiratory infection and, in turn, LRI and mortality are exciting, one needs to be cautious. The relationship in the studies reported in the literature between vitamin A and a decrease in morbidity are ambiguous. The large community based field trials on either low dose or mass dose of vitamin A do not show a beneficial effect of vitamin A on lowering symptoms of morbidity (see, for example, Rahmathullah et al. (1990), Vijayaraghauan et al. (1990), Sommer et al. (1986)). These studies analyze primarily the effect of vitamin A supplementation, not dietary vitamin A, on morbidity. It is not clear why vitamin A supplements compared to dietary vitamin A would have differential effects on morbidity. However these associations between dietary vitamin A and morbidity should be explored in studies which include clinical and biochemical measures of vitamin A status as one means of validating some of the findings reported in this report.

Iron

For decades, iron deficiency anemia has been identified as a major public health problem in developing countries. The problem is related to diets low in iron, particularly heme iron, and exacerbated by heavy parasitic loads.

As was shown from the data in Tables 1 and 2, in general, dietary iron consumption tends to parallel increases in both household and

caloric intake and in most cases, the mean adequacy level for iron consumption is higher than the mean adequacy level for calories at both the household and individual level. In addition, Table 3 data had indicated that iron consumption for households and preschoolers is significantly correlated with household income per capita. The one exception to this is household iron consumption in Mexico City.

Tables 12 and 13 present the iron consumption data stratified by quintiles of adequacy for the household and preschooler respectively.

In general household iron adequacy levels are at, or in most cases above, the caloric adequacy levels for the households in each quintile. None of the households in Kenya have iron intakes less than 100 percent of requirements; this is despite the fact the average caloric intakes in the first three quintiles are below 100 percent. Similarly in Mexico, household iron adequacy is above household caloric adequacy in each of the income quintiles. In the Philippines, iron adequacy levels are low but still not lower than the household caloric adequacy levels in each income quintile.

Similar to the household, the preschooler's iron consumption increases as the child's calories increase in Kenya and the Philippines (Table 13). It is interesting that in Mexico City which has, on average, the highest levels of caloric intake for children, the mean adequacy level for iron consumption are lower than for calories. This implies that the iron density of the diet decreases with increasing child calories. This finding is also consistent with what was discussed previously; it may be that as urban populations rely more on purchased

Table 12--Selected household- and child-level indicators of preschoolers, by HH iron adequacy quintile

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Table 13--Selected household- and child-level indicators of preschoolers, by child iron adequacy quintile

foods, while calories increase (primarily from increased fat intake) many other nutrients decline. This pattern is seen in the United States: inadequate intake of dietary iron is common (USDA, 1987). Recent data from consumption surveys of 1,320 women find that 57 percent of low income women (under 76 percent of U.S. poverty line) have inadequate iron intakes but even in other income groups (76 percent to 130 percent of U.S. poverty line) the prevalence of inadequate intakes is 56 percent. Given the increased urbanization that is occurring throughout the developing world (von Braun and Pandya-Lorch 1991), this negative nutrition effect is of concern.

The analyses of preschoolers dietary patterns based on chronic patterns of adequacy/inadequacy (Table 14) are similar to the average consumption patterns shown in Table 13. Approximately 23 percent of children in Kenya and 41 percent of preschoolers in the Philippines have intakes which are less than 80 percent of requirements. In Kenya, 36 percent of children have chronic dietary intakes of iron less than 100 percent and the figure is 58 percent for the Philippines.

Table 15 provides a model to explain the determinants of the preschoolers iron adequacy, based on data from Kenya and the Philippines. The model suggests that for both Kenya and the Philippines, as child calories increase so does the iron adequacy of the child's diet and similarly , for both data sets, as the household's dietary iron adequacy increases, the iron intake of the child improves.

The research was also interested in the relationship between iron consumption and morbidity. Table 16 presents the correlations between

Table 14--Selected household- and child-level indicators of preschoolers, by child iron adequacy groups

Table 15--Determinants of preschooler iron adequacy[a]

Independent Variable	Kenya		Philippines	
	β	t-statistic	β	t-statistic
Gender (1 = boy)	5.16	1.16	4.48	1.44
Child caloric adequacy (percent)	1.76	21.74	0.86	13.05
Age (months)	0.74	1.09	0.43	0.51
Age squared	0.008	1.04	-0.008	-0.95
Household iron adequacy	0.046	2.90	1.03	27.562
R^2 = 0.45			R^2 = 0.67	
F = 134.72			F = 235.11	
Significance of F = .0000			Significance of F = .0000	

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Table 16--Correlation coefficients of preschooler iron adequacy with anthropometric and morbidity measures

the child's dietary iron adequacy and morbidity for the three countries.

A model for child morbidity using the percent of preschooler's iron consumption as a explanatory variable is shown in Table 17. There is no significant association between the child's dietary iron adequacy and the incidence of illness in Kenya or the Philippines. There is also no association between total length of illness in Kenya and the child's iron adequacy.

Approximately 40 percent of the preschoolers in Kenya and 60 percent of the preschoolers in Philippines consume a diet with less than the recommended requirements for iron. This figure does not take into account the further negative impact of parasitic infections on iron nutriture nor the effect of the bio-availability of iron.

IMPLICATIONS FOR MONITORING AND EVALUATION

This report started out with a key question "Is Caloric adequacy at the household and preschooler level a good proxy for other nutrients?". The answer unfortunately is, "it depends". In general, for most of the household data presented in this report, the mean adequacy levels for most nutrients are higher than the mean caloric adequacy level. The exceptions are noted in the report. While the strength of the calorie/nutrient relationship is somewhat weaker at the preschooler level it still exists for many nutrients. However there are some situations which need to be discussed.

Vitamin A is a problematic nutrient to assess as part of surveillance systems. Because of the ability to store the nutrient, low

Table 17--Association between iron adequacy and incidence and prevalence of total illness, diarrhea, and lower respiratory infection[a]

Selected Variables[b]	Kenya			Philippines[c]	
	Total Illness	Diarrhea	Lower Respiratory Infection	Fever	Diarrhea
A. Prevalence					
Preschooler iron adequacy	0.004 (0.46)[d]	-0.002 (-0.56)	7.95 - 0.4 (0.18)		
Weight-age Z-score	-4.08 (-4.62)	-0.73 (-2.31)	0.15 (0.32)		
Household income	-4.67 - 04 (0.99)	-2.51 - 04 (-1.48)	5.99 (0.23)		
Age (in months)	-0.23 (-0.88)	0.37 (-3.94)	0.10 (0.71)		
B. Incidence					
Preschooler iron adequacy	-1.62 - 05 (-0.14)	-2.22 - 05 (-0.33)	4.45 - 05 (0.62)	1.51 - 04 (0.52)	-2.42 - 04 (-1.41)
Weight-age Z-score	-0.04 (-3.22)	-0.01 (-2.02)	0.003 (0.404)	-0.02 (-0.99)	-0.01 (-0.89)
Household income	-3.13 - 06 (-0.47)	-6.57 - 06 (-1.71)	5.96 - 06 (1.47)	4.24 - 06 (0.36)	-4.23 - 06 (-0.60)
Age (in months)	-0.005 (-1.35)	-0.01 (-4.57)	0.003 (1.22)	-.004 (-3.01)	-.001 (-1.58)

a Iron dietary status was not significantly associated with incidence or prevalence of upper respiratory infection or fever.

b Full regression model included percent of preschoolers in the household, gender (1 = boy), age squared.

c Preschoolers greater than 24 months of age.

d t-statistic in parentheses.

intakes on a number of occasions do not necessarily indicate a deficiency. Some measure of consumption patterns over a longer period of time are needed. However, the collection of information on consumption patterns of individual children is rarely done and as evidenced from a recent inventory of food and nutrition monitoring systems (Kennedy and Payongayong, 1991) none of the countries indicated that dietary data is kept for children on repeated measures. The information in Table 3 indicted that there is no positive correlation between child caloric consumption and the preschoolers vitamin A dietary adequacy. In fact, in Kenya as child's caloric adequacy increases, there is a decrease in the child's dietary vitamin A adequacy.

Unfortunately, the data also suggest that the child's anthropometric status—measured by either height, weight or weight for height—is not sensitive in identifying low vitamin A consumption.

The problem of vitamin A assessment is compounded by the fact that even in countries—like Kenya—where the average consumption of vitamin A by households and individuals is in excess of requirements, there can still be subsets of the populations with low intakes. In Kenya, 20 percent of preschoolers have diets which consistently supply less than 30 percent of vitamin A requirements. However, the average consumption levels of vitamin A in the preschooler population would not detect this problem.

The Kenya/Philippines comparisons on children also presented an interesting dilemma (Table 7); even where intakes of vitamin A are similarly low, the reasons for this and hence the type of intervention

strategy used to combat this problem would differ. In Philippines, increasing the child's calories concurrently increases a child's vitamin A intake. However, in Kenya the opposite occurs because as the child's caloric adequacy increases, the consumption of Beta-carotene rich foods decrease and hence, the child's vitamin A consumption decreases. This is clearly a problem for the 30 percent of children consuming a diet chronically low in vitamin A containing foods.

The data for Kenya would suggest that a nutrition education intervention for preschoolers emphasizing consumption of locally available vegetables and B-carotene rich fruits is warranted whereas in the Philippines, anyone of a number of interventions geared to household income/food security would begin to address the underlying causes of the problem.

In each of the four data sets used in this research vitamin A deficiency could be measured using only dietary measures. Although the Philippines and Kenya data sets provide longitudinal information for households and preschoolers which improves the utility of this data for identifying deficient groups. It still would have been useful to have clinical and biochemical data to corroborate the dietary findings. The ocular changes which are known to occur with dietary vitamin A deficiency are n-stage indicators. The use of dietary measures provides the opportunity of using an early warning system for identifying those at risk of xerophthalmia and if left untreated, eventual blindness.

Dietary assessment alone is rarely used to assess vitamin A deficiency and only sporadically used to identify "at risk" households

and individual family members. The new Food and Nutrition Monitoring Project should try to advance our state of knowledge in both of these areas.

One opportunity presents itself to test out the utility of dietary screening to identify "at risk" individuals in the agriculture/nutrition linkages work that will be conducted in South Nyanza Kenya. This research builds on the earlier 1984 to 1987 survey work and will revisit the same households that were part of the earlier research. This provides the opportunity to reidentify children who, four years earlier, had chronically low intakes of vitamin A and determine whether this apparent dietary vitamin A deficiency is associated with adverse ocular changes and/or other negative effects.

An equally important issue to resolve in the context of monitoring systems is what proxy measures are useful to identify the risk of vitamin A deficiency at community and possibly individual levels. One assumption is that quantitative dietary information is not generally available for households or individuals and this is born out by the recent inventory work (Kennedy and Payongayong, 1991). In this context and similar to techniques that have been used in the food security and nutrition indicators work (Haddad, Sullivan and Kennedy, 1991), analyses were done for Kenya and the Philippines to ascertain other variables which might be helpful in identifying vitamin A deficiency.

As shown in Table 18, there are some "user friendly" variables which correlate with some of the micronutrient data. For Kenya, children are more likely to achieve dietary vitamin A adequacy as the

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Table 18--Correlation of vitamin A and iron adequacy with selected indicators of child's diet

	Number of Meals	Mother's Schooling	Father's Schooling	Household Size	Dependency Ratio	% Purchased Food	Number of Food Items
Kenya N = 1187							
Vitamin A adequacy	.046[b]	.089[c]	.14[c]	.168[c]	-.003	-.037[a]	-.047[b]
Iron Adequacy	.06[c]						
Philippines N = 595							
Vitamin A adequacy	N/A	.03	.05		-.11[c]		.23[c]
Iron adequacy	N/A	.03	.06[a]		.04		.22[c]
Mexico N = 318							
Vitamin A adequacy	N/A	.02	.01	N/A	-.10[b]	N/A	N/A
Iron adequacy	N/A	.002	.009	N/A	.03	N/A	N/A

[a] Significant at 10 percent level.
[b] Significant at 5 percent level.
[c] Significant at 1 percent level.

number of meals a child consumes increases. This indicator was one identified as also potentially useful (see Kennedy, Peters, and Bouis (1991)) in identifying the nutrition insecure population. It may be useful as a proxy measure for vitamin A inadequacy. Equally important in Kenya, the number of meals eaten is significantly correlated with the iron adequacy of the child's diet giving further credence to this as an alternative indicator of micronutrient consumption. Unfortunately number of meals eaten was available for only one data set. The utility of this variable needs to be tested in a larger number of settings.

In contrast to the number of meals eaten, Table 18 results show that in Kenya the number of food items eaten has a significant, negative correlation with the child's vitamin A adequacy. As the child diet diversifies, there is a decrease in the consumption of vegetables.

There is also a negative correlation between the percent of food purchased and the child's vitamin A adequacy in Kenya. This is consistent with the interpretation of the earlier descriptive data in Table 4 which indicated that as incomes increase there is a decrease in the consumption of B-carotene rich foods. Earlier work on Kenya and other countries has indicated that as incomes increase in rural areas, the percent purchased foods also increases (von Braun and Kennedy, 1991).

There is the opposite effect of the number of food items and the percent of purchased food on dietary iron adequacy. Both of these variables shown a positive correlation with iron. In the case of iron adequacy as the child's diet diversifies through consumption of more

food items and through increased reliance on purchased food, iron nutriture improves.

In the Philippines, dietary iron adequacy also improves as the number of food items in the child's diet increases. However, in the Philippines, unlike Kenya, the child's vitamin A consumption also increases as the number of food items in the diet increases.

Table 18 data for Kenya also suggest some demographic variables such as household size, mother's and father's education may be useful in identifying children likely to have micronutrient deficits or in the case of Kenya, low vitamin A consumption levels. More work should be done to identify possible cut-off points for educational levels. For example, if a mother has less than three years of formal education can this be used as a risk factors for micronutrients across countries?

The Mexico data provide less insights into types of variables for identifying micronutrient deficiencies. None of the correlations were significant for iron. And only the dependency ratio had a significant correlation with the vitamin A adequacy of the child's diet. Mexico has consistently come out of these analyses as a case study that often differs from the other country studies. One wonders whether indicators need to be modified based on whether they are to be used in an urban versus a rural setting.

SUMMARY AND CONCLUSIONS

The "conventional wisdom" that either household or individual caloric consumption is a good proxy for micronutrient adequacy does not hold in all cases. The most problematic nutrient from these analyses is Vitamin A. Mean levels of vitamin A consumption within income groups can mask large deficits of vitamin A in certain subgroups of the population as in the case of Kenya.

Vitamin A consumption is not correlated with caloric consumption in all settings. Here again, in Kenya, as the child's caloric consumption rose the vitamin A adequacy of the child's diet declines. This appears to be due to changing food patterns that accompany income changes .

In the Philippines, income, caloric consumption and micronutrient intakes tended to move together. The difference between some of the Kenya and Philippines findings point to the need for context specificity in designing approaches for monitoring and evaluation systems particularly in monitoring micronutrient consumption.

APPENDIX

Appendix Table 1--Primary sources of household vitamin A, by income quintile and food group, by round (in retinol equivalents/AEU), Philippines

Appendix Table 1--Primary sources of household vitamin A, by income quintile and food group, by round (in retinol equivalents/AEU), Philippines (continue)

Appendix Table 2--Primary sources of household vitamin A, by income quintile and food group, (in retinol equivalents), Kenya

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REFERENCES

Alderman, Harold. 1986. *The effects of food price and income changes on the acquisition of food by low-income households.* Washington, D.C., U.S.A.: International Food Policy Research Institute.

Alderman, Harold, and Marito Garcia. 1991. Community factors in childhood nutrition: Explaining the slow rate of improvement in Pakistan. International Food Policy Research Institute, Washington D.C., U.S.A. Mimeo.

von Braun, Joachim, and Eileen Kennedy (eds.). 1991. *Commercialization of agriculture: Poverty and nutritional effects.* Washington, D.C., U.S.A.: International Food Policy Research Institute.

von Braun, Joachim, and Rajul Pandya-Lorch (eds.). 1991. *Income sources of malnourished people in rural areas: Microlevel information and policy implications.* Working Papers on Commercialization of Agriculture and Nutrition No. 5. Washington, D.C., U.S.A.: International Food Policy Research Institute.

Dawson, Anthony, and Eileen Kennedy. 1987. *An evaluation of the tripartite nutrition in agriculture project.* Report to Science and Technology Bureau/Office of Nutrition/U. S. Agency for International Development, Education Development Center, Inc. (edc).

Garcia, Marito, and Per Pinstrup-Andersen. 1987. *The pilot food price subsidy scheme in the Philippines: Its impact on income, food consumption, and nutritional status.* Research Report 61. Washington, D.C., U.S.A.: International Food Policy Research Institute.

Haddad, Lawrence, Joan Sullivan, and Eileen Kennedy. 1991. Identification and evaluation of alternative indicators of food and nutrition security: Some conceptual issues and an analysis of extant data. International Food Policy Research Institute, Washington, D.C., U.S.A. Mimeo.

IVACG (International Vitamin A Consultative Group). 1981. *Proceedings of the IVACG Annual Meeting*, Nairobi, Kenya.

Jansen, A. A. J., H. T. Horelli, and V. J. Quinn. 1987. *Food and nutrition in Kenya: A historical review.* Kenya: University of Kenya and UNICEF.

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Kennedy, Eileen. 1989. *The effects of sugarcane production on food security, health, and nutrition: A longitudinal analysis.* Research Report 78. Washington, D.C., U.S.A.: International Food Policy Research Institute.

_____. 1990. Health and nutrition effects of the commercialization of agriculture: A comparative analysis. In *Commercialization of agriculture: Poverty and nutritional effects*, ed. J. von Braun and E. Kennedy. Washington, D.C., U.S.A.: International Food Policy Research Institute.

Kennedy, Eileen, and Harold Alderman. 1987. *Comparative analyses of nutritional effectiveness of food subsidies and other food-related interventions.* Joint WHO-UNICEF Nutrition Support Programme. Washington, D.C., U.S.A.: International Food Policy Research Institute.

Kennedy, Eileen, and Bruce Cogill. *Income and nutritional effects of the commercialization of agriculture in southwestern Kenya.* Research Report No. 63. Washington, D.C., U.S.A.: International Food Policy Research Institute.

Kennedy, Eileen, and Ellen Payongayong. 1991. Inventory of food and nutrition monitoring systems. International Food Policy Research Institute, Washington, D.C., U.S.A. Mimeo.

Kennedy, Eileen, and Pauline Peters. 1990. Household food security and child nutrition: The interaction of income and gender of household head. International Food Policy Research Institute, Washington, D.C., U.S.A. Mimeo.

Kennedy, Eileen, Mohamed el Lozy, and Stanley Gershoff. 1979. Cereal fortification: Nutritional need. In *Global malnutrition and cereal fortification*, ed. James E. Austin, 15-34. Cambridge, MA, U.S.A.: Ballinger Publishing.

Kennedy, Eileen, Pauline Peters, and Howdy Bouis. 1991. Characteristics of the food insecure/nutrition insecure: Implications for a food and nutrition monitoring system. International Food Policy Research Institute, Washington, D.C., U.S.A. Mimeo.

Kramer, Carol S., and Lawrence M. Rubey. 1989. *AID food policy programming: Lessons learned—An assessment of the consumption effects of agricultural policies project, 1978-88.* Report prepared for the Nutrition, Economics Group, OICD, USDA, and Office of Nutrition, Bureau of Science and Technology, USAID.

Overholt, Catherine, Eileen Kennedy, Federico Sanchez, Adolfo Chavez, and James E. Austin. 1981. Case study—Subsidized milk distribution in Mexico. In *Nutrition intervention in developing countries, Study V: Consumer food price subsidies*, pp. 79-114. Cambridge, MA, U.S.A.: Oelgeschlager, Gunn, and Hain.

Rahmathullah, Laxmi, Barbara A. Underwood, Ravilla D. Thulasiraj, Roy C. Milton, Kala Ramaswamy, Rabeem Rahmathullah, and Ganeesh Babu. 1990. Reduced mortality among children in southern India receiving a small weekly dose of vitamin A. *The New England Journal of Medicine* 3232 N 14 (October 4): 929-935.

Sommer, A., I. Tarwotjo, E. Djunaedi, K. P. West, A. A. Loeden, R. Tilden, L. Mele, and the Aceh Study Group. 1986. Impact of vitamin A supplementation on childhood mortality: A randomized controlled community trial. *Lancet* 1: 1169-1173.

Tarwotjo, Ignatius, Robert Tilden, Susan Prentiss, Alfred Sommer, Slamet Soedibjo, Gusti Hussaini, Julianti Sulistijo, and Henry Nendrawati. 1983. Interactions of community, nutritional status, and xerophthalmia in Indonesia. The *American Journal of Clinical Nutrition* 37: 645-651.

USDA (U.S. Department of Agriculture). 1987. *NFCS, CSFII (Continuing Survey of Food Intakes by Individuals) Report No. 86-2: Low income women 19-50 years and their children 1-5 years, 1 Day, 1986.* Washington, D.C., U.S.A.

Vijayaraghauan, K., G. Radhaiah, B. S. Prakasam, K. V. R. Sarma, and V. Reddy. 1990. Effect of massive dose vitamin A on morbidity and mortality in Indian children. *Lancet* 2: 1342-1345.