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Dietary Diversity, Dietary Quality, and Child Nutritional Status: Evidence from Eleven Demographic and Health Surveys

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ACRONYMS

DHS	Demographic and Health Surveys
HAZ	Height-for-age Z-score
KPC	Knowledge, Practices, and Coverage
PAHO	Pan American Health Organization
PVO	Private Voluntary Organization
USAID	United States Agency for International Development
WAZ	Weight-for-age Z-score
WHZ	Weight-for-height Z-score
WHO	World Health Organization

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EXECUTIVE SUMMARY

Nutritionists have long recognized the value of dietary diversity, and the concept of diversity is reflected in various national dietary guidelines. When people eat a variety of foods, they are more likely to meet their needs for a wide range of essential nutrients. Yet for many poor people across the globe dietary diversity is very low, and the daily diet is dominated by one main staple food.

Young children in particular need energy- and nutrient-dense foods to meet their dietary needs. In this report we focus on the issue of dietary diversity for young children, across the vulnerable age-range when most children transition from breastfeeding to the family diet (6-23 months). For many poor children, this is also the age when growth falters, usually due to a combination of frequent illness and inadequate diet.

While there is consensus that dietary diversity is good, there are a number of unanswered questions about the definition and measurement of diversity, and about the relationship between diversity, nutrient adequacy, and outcomes such as child nutritional status. Relatively few studies have focused on dietary diversity among young children in developing countries. Studies to date have used a wide range of operational definitions of dietary diversity. Nevertheless, there has been some consistency in results, with dietary diversity shown to be associated with both nutrient adequacy and child nutritional status in most of the few studies where these relationships have been examined.

Many programs in developing countries seek to improve the quality of children's diets. Managers of these programs need simple indicators to monitor and evaluate progress towards improvement. Dietary diversity is considerably simpler to measure than nutrient adequacy; thus, dietary diversity may be one such simple indicator. But additional work is needed to refine indicators, to determine if standardized indicators are appropriate, and finally to confirm and extend knowledge about associations among dietary diversity, nutrient adequacy, and nutritional status, across various populations.

We review current knowledge about these relationships and use data from eleven recent Demographic and Health Surveys (DHS) to accomplish four tasks:

1. To describe how a simple dietary diversity score relates to diet patterns among young children;

2. To explore the feasibility of deriving global or regional cut-off points for low and high diversity;

3. To determine whether simple dietary diversity indicators are meaningfully associated with height-for-age among young children across a range of countries;

4. To test the nature and strength of the associations between food group and dietary diversity indicators derived from a 24-hour food group recall and those derived from a 7-day food group recall across a range of countries with varying levels of dietary diversity.

Dietary diversity and child height-for-age

Our results show that there is a strong bivariate association between dietary diversity tercile and height-for-age Z-score (HAZ), which is statistically significant in nine of the eleven countries studied. The size of the differences between the low and high diversity groups is large and of practical significance in most countries, ranging from 0.25 to 0.51 Z-score units in the nine countries where the association was observed. In models controlling for a variety of biological and household socioeconomic factors, the association between dietary diversity and HAZ remains significant in six countries. In addition, dietary diversity interacts significantly with other factors, such as child age, urban/rural location of household, or whether the child was still breastfed in four of the remaining five countries, indicating that diversity is more strongly associated with HAZ for some sub-groups.

An interaction between breastfeeding status and dietary diversity, observed in four countries, is particularly interesting, showing very large Z-score differences between low and high diversity groups for non-breastfed children. Dietary diversity may be particularly important to ensure nutrient adequacy for non-breastfed children. Dietary diversity may thus be a particularly relevant proxy for diet quality in the case of non-breastfed children in the age-range studied.

Our analysis of dietary diversity and HAZ is limited by the fact that measurement of household welfare and socioeconomic status is limited in the DHS data sets. Therefore even in the countries where associations remained significant, we cannot conclusively state that the associations are not due to socioeconomic characteristics such as wealth or income.

Cut-offs for dietary diversity

In the absence of international recommendations for adequate or optimal food group or dietary diversity we have used cut-offs for diversity based on terciles, which were derived individually for each study sample. The cut-offs varied greatly among countries, even within narrow age ranges. In addition, in some countries the use of cut-offs based on sample terciles resulted in ranking children as "high" for diversity when, in fact, diversity was clearly too low. We conclude that cut-offs must be based on further research, in a variety of countries, relating specific diversity indicators and cut-offs to nutrient adequacy.

Usefulness of the 7-day food group recall

Food group recalls can be used to gather information on population-level diet patterns. We assessed the "added value" of the 7-day recall in simple surveys that also include a 24-hour food group recall. At the population level, agreement was very good between the proportion of children eating each food group yesterday, and the proportion eating each group 3 or more days in the last seven days. Food group diversity indicators for yesterday were also very similar to indicators for diversity in food groups eaten 3 or more days. We conclude that when the objective is to identify which food groups are eaten regularly, the 7-day recall does not provide much information beyond what is available from the 24-hour recall. We do not assess the 7-day recall relative to other objectives.

Conclusion

Our work suggests that simple indicators of dietary diversity reflect important differences in diet patterns, and are associated with height-for-age. Further work, with richer data sets, could better define the relationship between specific dietary diversity indicators and nutrient adequacy. In such work, particular attention should be paid to non-breastfed children in the vulnerable 6-23 month age group. Further work could also better define apparent relationships among dietary diversity, household socioeconomic status, and outcomes such as child nutritional status.

1. Review of Dietary Diversity: Measurement, Meaning, and Associations with Nutrient Adequacy and Child Nutritional Status

All people need a variety of foods to meet requirements for essential nutrients, and the value of a diverse diet has long been recognized. In the context of many developing countries, monotonous diets based on a very small number of foods contribute to micronutrient malnutrition, particularly in rural areas. In these contexts, a large proportion of calories may come from starchy staples, with relatively low energy density and very few micronutrients. For vulnerable young children the problem is particularly critical, because young children need energy- and nutrient-dense foods to grow and develop. Beyond meeting needs for essential nutrients, diverse diets are increasingly recognized as playing a role in the prevention of some chronic diseases.

For all these reasons, dietary diversity is recommended as an objective to be included in each country's food-based dietary guidelines (WHO/FAO, 1998). Dietary diversity is also advocated in the recently updated guidance for complementary feeding of infants and young children (PAHO/WHO, 2003). However, while there is consensus among nutritionists that dietary diversity is good, there are a large number of unanswered questions about the definition and measurement of diversity, and about the relationships among diversity, nutrient adequacy, and outcomes such as child nutritional status. Existing knowledge on these issues is reviewed in this chapter.

In addition to reflecting the quality of the diet, dietary diversity has also been linked with food security, and particularly with household-level access to calories. In an analysis of data from ten poor and middle-income countries, increases in dietary diversity were associated with increased availability of calories both from staples and from non-staple foods, at the household level (Hoddinott and Yohannes, 2002).

Many programs in developing countries seek to improve household access to food, food consumption, diet quality, child nutritional status, or all of these. Managers need simple, relevant indicators of progress and impact in order to monitor and evaluate these programs. Managers also need simple, meaningful indicators when they advocate for their programs to donors and policy-makers. Dietary diversity is an attractive indicator because it is relatively simple to measure, and because it may reflect well improvements in household food access, food consumption, and improvements in diet quality. For these reasons, an indicator of dietary diversity is found on the Title II Generic Indicator list for use in the Title II development program that is administered by the United States Agency for International Development.

While dietary diversity is a promising indicator, it has not been widely used in development programs. As noted, a number of questions remain. After reviewing existing knowledge, the objective of this paper is to shed light on several questions about dietary diversity, using data from eleven recent Demographic and Health Surveys (DHS)[1] to accomplish four main tasks, listed below.

[1] The countries included in our analysis are: Benin, Cambodia, Colombia, Ethiopia, Haiti, Malawi, Mali, Nepal, Peru, Rwanda, and Zimbabwe. Criteria for selecting these data sets are described in Chapter 3.

Our focus is on dietary diversity and very young children, from the age of six months up to two years. During this age span – from 6-23[2] months – children are very vulnerable. In developing countries, this is the age span when growth falters, usually due to a combination of frequent illness and inadequate diet that are often present as children transition from breastfeeding to the family diet.

The DHS use both a 24-hour and a 7-day food group recall to collect data to characterize diet patterns among young children. Because a standard questionnaire is used, the DHS data sets provide an opportunity to explore associations between dietary diversity and child nutritional status using a standardized definition of dietary diversity across countries. We use these data sets to accomplish four tasks:

1. To describe how a simple dietary diversity score relates to diet patterns among young children

2. To explore the feasibility of deriving global or regional cut-off points for low and high diversity

3. To determine whether simple dietary diversity indicators are meaningfully associated with height-for-age among young children across a range of countries

4. To test the nature and strength of the associations between food group and dietary diversity indicators derived from a 24-hour food group recall and those derived from a 7-day food group recall across a range of countries with varying levels of dietary diversity.

Each of these tasks is described further following a review of current knowledge. The review is in two parts, focusing first on definitions and measurement issues, and secondly on developing country studies documenting relationships between dietary diversity, nutrient adequacy, and child nutritional status.

1.1. Dietary Diversity and Related Terms: Definitions and Measurement

1.1.1. Definitions

Throughout this paper we use the term *dietary diversity*. This is a widely used term, and has been defined as either the number of foods or the number of food groups consumed over a given reference period (generally from one day to two weeks). Other authors have used the terms *dietary variety* or *food variety* to indicate the same thing.

Two other related terms are *nutrient adequacy* and *dietary quality*. *Nutrient adequacy* refers to the extent to which the diet provides sufficient energy, protein, and essential micronutrients. We review below evidence for a relationship between dietary diversity and nutrient adequacy in the context of developing countries.

[2] Where age ranges are mentioned, the following convention is used: 6-23 months means 6-23.9 months, 0-5 months means 0-5.9 months, 6-9 months means 6-9.9 months, etc.

Dietary quality is a broader concept than either dietary diversity or nutrient adequacy. Historically, when the main nutrition concerns were related to nutrient adequacy, nutrient adequacy and dietary quality were often equated. Currently, in developed countries concepts of diet quality are multi-dimensional and include the avoidance of excess (for example, of simple carbohydrates, saturated fat and sodium) as well as achievement of nutrient adequacy. In middle- and low-income countries, concerns about avoidance of excess and imbalanced diets are increasingly relevant, as diet-related risk factors for chronic disease are rapidly becoming prevalent in many populations (WHO/FAO, 2003). However, in the poorest developing countries and the poorest areas of many other countries, nutrient adequacy remains the predominant diet quality concern, particularly when considering the needs of young children.

1.1.2. Measurement of dietary diversity

Dietary diversity is usually measured by summing the number of foods or food groups consumed over a reference period (Krebs-Smith et al., 1987; Löwik, Hulshof, and Brussaard, 1999). The reference period usually ranges from one to three days, but seven days is also often used and periods of up fifteen days have been reported (Drewnowski et al., 1997). A variety of dietary assessment methods have been used, including in-home observation, food frequency questionnaires and simple food group recalls.

While most dietary diversity measures consist of a simple count of foods or food groups, some scales in developed countries have weighted elements and/or taken into consideration the number of servings of different food groups in conformity with dietary guidelines. Examples of this latter approach include the "dietary score" developed by Guthrie and Scheer (1981), which allocates equal weights to each of four food groups consumed in the previous 24 hours: milk products and meat/meat alternatives receive 2 points for each of 2 recommended servings, and fruits/vegetables and bread/cereals receive 1 point for each of 4 recommended servings.

A modification of this approach developed by Kant et al. (1991; 1993) evaluates the presence of a desired number of servings from 5 food groups (2 servings each from the dairy, meat, fruit and vegetables groups and four servings from the grain group) over a period of 24 hours. This score, called the "Serving Score", allocates a maximum of four points to each food group, for a total score of 20.

Finally, Krebs-Smith and colleagues (1987) used and compared four different types of dietary diversity measures (which they refer to as dietary variety): 1) an overall variety score (simple count of food items), 2) a variety score among major food groups (6 food groups), 3a) a variety score within major food groups, counting separate foods, and 3b) a variety score within major food groups, counting minor food groups. All dietary measures are based on a 3-day recall.

In developing countries, single food or food group counts have been the most popular measurement approaches for dietary diversity, probably because of their simplicity. The number of servings based on dietary guidelines was not considered in any of the developing country studies reviewed. In China (Taren and Chen, 1993), Ethiopia (Arimond and Ruel, 2002) and Niger (Tarini, Bakari, and Delisle, 1999) researchers used food group counts, while in Kenya (Onyango, Koski, and Tucker, 1998), and Ghana and Malawi (Ferguson et al., 1993) they used the number of individual foods consumed. Studies in Mali (Hatloy, Torheim, and Oshaug, 1998) and Vietnam (Ogle, Hung, and Tuyet, 2001) used both single food counts (called the Food Variety Score (FVS)) and a food group count (called the Dietary Diversity Score (DDS)).

This brief overview highlights the fact that researchers have used a variety of dietary diversity measures based on different food and food group classification systems, different numbers of foods and food groups and varying reference period lengths. This has made comparisons among studies difficult.

1.1.3. Measurement of nutrient adequacy

In assessing the nutrient adequacy of diets, several types of measures have been used. These include simple measures of energy and nutrient intake, measures of nutrient density (as a percent of energy) for selected nutrients, and other nutritional indices scored using a fixed cut-off value of the U.S. Recommended Dietary Allowances (RDA) for each nutrient (for example, two-thirds or three-fourths of the RDA).

One widely used approach involves calculation of the “nutrient adequacy ratio” (NAR) and the “mean nutrient adequacy ratio” (MAR). These two measures were first developed by Madden and Yoder (1972) and have since then been used both in developed and developing countries (Guthrie and Scheer 1981; Krebs-Smith et al. 1987; Hatloy, Torheim, and Oshaug 1998). The NAR is defined as the ratio of intake of a particular nutrient to its recommended dietary allowance (RDA). The MAR is the average of the NARs, computed by summing the NARs and dividing by the number of nutrients. Each NAR is usually truncated at 100 percent of the RDAs to avoid high consumption levels of some nutrients compensating for low levels of others in the resulting MAR.[3]

1.1.4. Measurement of dietary quality

Measures of dietary quality range from simple indicators such as the percentage of energy from animal sources (Allen et al. 1991) to complex indices that combine both nutrient and food components (Patterson, Haines, and Popkin 1994; Kennedy et al. 1995; Haines, Siega-Riz, and Popkin 1999). Recognition of the need to include both concepts of nutrient deficiency and over-nutrition in the definition of dietary quality has led to the development of a variety of new measurement tools; most of these have been developed for use in the U.S. and Europe. Several reviews are available which provide descriptions of these tools (Kant, 1996; Ruel, forthcoming).

In developing countries, dietary quality has been equated with nutrient adequacy. Consequently, researchers have often used some combination of the measures described above (nutrient intake, nutrient density, and/or the NAR and MAR) to measure dietary quality. However, as the nutrition transition accelerates in a variety of developing countries, new, multi-dimensional measures will be needed. A 1996 WHO/FAO report recommended that developing countries

[3] Note that this approach, although useful, does not completely eliminate interpretation problems arising from situations where very low intake of some nutrients exists in combination with high (albeit lower than 100 percent) intake of others.

also develop and use measures of dietary quality that capture both problems of nutrient deficiency and dietary excess and over-nutrition (WHO/FAO 1996).

1.2. Relationships among Dietary Diversity, Nutrient Adequacy, and Child Nutritional Status

Validation studies[4] of dietary diversity and dietary quality indicators abound in developed countries and Kant (1996) provides an exhaustive list these validation studies covering the years prior to 1996. This work is not reviewed here. Rather, we focus on validation studies of indicators of dietary diversity carried out in developing country contexts. We review studies that specifically validate or assess associations of dietary diversity against nutrient intake or nutrient adequacy (Table 1.a).

We also review studies that looked at associations between indicators of dietary diversity and child nutritional status (Table 1.b). These studies do not validate dietary diversity indicators, but are useful because they examine the degree of association between changes in the dietary diversity indicator and the ultimate outcome of interest: child nutritional status.

Tables 1a and 1b present a summary of the studies reviewed by outcome examined. Studies that have analyzed more than one outcome are listed under the different outcomes. Note that most studies were carried out on preschool children; the only exception was in Viet Nam, where the study subjects were adult women (Ogle, Hung, and Tuyet 2001).

1.2.1. Association between dietary diversity and nutrient intake or adequacy

A study in Mali specifically validated dietary diversity against nutrient adequacy (Hatloy, Torheim, and Oshaug 1998). The study used two types of diversity scores: one based on a simple count of the number of foods (the food variety score (FVS)) and one based on eight food groups (the dietary diversity score (DDS)). Both measures were computed from a quantitative dietary assessment using direct weighing for three days.[5] Nutrient adequacy was measured using the NAR/MAR method described previously (Guthrie and Scheer 1981; Krebs-Smith et al. 1987; Schuette, Song, and Hoerr 1996). This carefully conducted study documents a significant association between nutrient adequacy (NAR/MAR) and both measures of dietary diversity (FVS and DDS): the correlation coefficients between nutrient adequacy and FVS and DDS were 0.33 and 0.39, respectively.

4 By "validation studies", we mean studies comparing one measurment method (test method) with another, which is considered more accurate (reference method) (Willett and Lenart, 1998).
5 For 9 out of the 76 children, data were available for only two days.

Table 1a. Characteristics of the studies that looked at the association between dietary diversity and nutrient intake or adequacy in developing countries[1]

Author	Country	Age group	Dietary Diversity (DD) approach (indicator)	Method and reference period	Descriptive DD findings	Type of Validation/ association	Against which measure?	Main findings
VALIDATION/ASSOCIATION WITH NUTRIENT INTAKE OR ADEQUACY								
1. Hatløy, Torheim and Oshaug, 1998	Mali	< 60 mo	1) Food Variety Score (FVS): single foods (n=75) 2) Dietary Diversity Score (DDS): 8 food groups: staples, vegetables, fruits, meat, milk, fish, egg, green leaves	Direct weighing for 2-3 d Total consumed over 2-3 d	Mean FVS: 20.5 DDS: 5.8	Validation against NAR and MAR Calculated Sensitivity (Se) and specificity (Spe) of different cut-off points for FVS and DDS	NAR for energy, fat, protein, iron, vitamin A, thiamin; riboflavin, niacin, calcium folic acid. MAR (using 75% RDA)	1) Correlation FVS and DDS with NAR: significant for % fat, vitamin C, and vitamin A 2) Correlation MAR with FVS = 0.33; with DDS = 0.39 3) DDS = stronger determinant of MAR than FVS (regression) 4) Cut-off points: DDS = 6: Se=77%, Spe=33% FVS=23: Se=87%, Spe=29%
2. Ogle, Hung and Tuyet, 2001	Vietnam	Adult women	1) FVS: all foods in 7-d (n>120) 2) DDS: 12 food groups cereals, starch, green leafy vegetables, other vegetables, fish/seafood, meat, eggs, nuts/legumes, fruits/juice, oil/fats, sauces, beverages/biscuits /sweets	7-d food frequency	FVS: Range: 6-39; mean=18 and 20 (2 regions); DDS: Range: 5-11; mean=8 and 9	Validation against: 1) intake of 13 nutrients 2) nutrient density Created terciles of FVS: low ≤15; high: ≥21	Measured: 1) nutrient intake 2) nutrient intake as % of energy	1) FVS>21: significantly greater intake of most nutrients than FVS≤15 2) FVS ≥21 also consumed higher variety of foods from most food groups 3) DDS ≥ 8: significantly higher MAR of energy, protein, niacin, vitamin C, zinc 4) High FVS group had higher micronutrient density, especially for vitamin A, C, riboflavin and calcium, but only in 1 of 2 regions studied

Author	Country	Age group	Dietary Diversity (DD) approach (indicator)	Method and reference period	Descriptive DD findings	Type of Validation/ association	Against which measure?	Main findings
VALIDATION/ASSOCIATION WITH NUTRIENT INTAKE OR ADEQUACY								
3. Brown et al. 2002	Guatemala	9-11 mo	No. of single foods	12-h weighed intake + 12-h recall	Mean no. of foods = 10	Bivariate association between diversity terciles and energy and nutrient intake and nutrient density (% energy)	Intake of energy, fat, protein, vitamin A, niacin, riboflavin, calcium, iron, zinc; % energy from these nutrients and from animal source foods	1) Dietary diversity terciles associated with: energy density, non-breast milk energy, total energy, protein, fat, vitamin A, niacin, riboflavin, calcium, iron, zinc 2) Dietary diversity NOT associated with higher density of any of these nutrients
4. Onyango, Koski and Tucker, 1998	Kenya	12-36 mo	No. of single foods	Average daily intake from 3 24-h recalls	Mean no. foods: 5 for BF children; 6 for non BF children	Association between low ≤ 5 and high >5 diversity and % RDA	RDA for energy, protein, vitamin A, C, thiamin, riboflavin, niacin, iron, calcium	Diversity >5 associated with greater intake of all nutrients
5. Tarini, Bakari and Delisle, 1999	Niger	24-48 mo	Diversity score (DS): 11 food groups over 3 d: cereals, green leafy vegetables, other vegetables, pulses/nuts, roots/tubers, fat, fruits, legumes, milk/eggs, meat, sugar	3-d modified weighed intake. All ingredients weighed; if shared bowl used child's mouthfuls were counted and a sample of mouthfuls weighed	DS: mean = 4.8, 5.3, 5.3 (3 seasons)	Association between DS and nutritional quality score (NQS)	NQS: 4 points, with 1 point each for adequacy of energy, protein, vitamin A, and zinc	Diversity ≤ 5 significantly lower NQS in all 3 seasons compared to DS ≥ 6

Author	Country	Age group	Dietary Diversity (DD) approach (indicator)	Method and reference period	Descriptive DD findings	Type of Validation/ association	Against which measure?	Main findings
VALIDATION/ASSOCIATION WITH NUTRIENT INTAKE OR ADEQUACY								
6. Ferguson et al. 1993	Ghana and Malawi	36-72 mo.	1) No. of single foods 2) 13 food groups: citrus, non-citrus fruits, kenkey, bread, banku (corn or cassava), fufu (cassava or plantain), fish, meat, bush meat, cassava, sweet potatoes, corn, groundnuts	Average over 3-d from direct weighing	Mean daily number of foods ranged from 6.4 to 7.1 in Malawi; 7.1 to 8 in Ghana. Seasonal variations found	Correlation between DD and nutrient densities (results only briefly reported)	Nutrient densities (% energy) for protein, fat, calcium, zinc, iron	1) No correlation with protein, fat, calcium density in either country 2) Ghana: no correlation with zinc or iron density 3) Malawi: negative correlation with iron and zinc density during food shortage season 4) Malawi: correlation with energy intakes
7. Rose et al. 2002	Mozambique	Adults	Mozambique Diet Assessment Tool Household level: Each food scored 1-4 based on nutrient density, availability, size of portion. E.g.: vegetables, fruits, oils, sugars=1; Cereals, bread, tubers=2 Beans, nuts=3 Meat, fish, milk, egg=4	Recall of all foods consumed by all individuals at all meals in 1 d	Very low scores: (0-12: 11% of sample); average (12-19: 35%); adequate (≥ 20: 54%)	Association with Dietary Quantitative Index (DQI) based on quantitative dietary assessment (24-h recall at HH level)	DQI: 10 points, based on nutrient adequacy for: energy (2 points), vitamin A (2 points), iron (2 points), protein (2 points), 7 other nutrients (2 points total).	1) Mozambique Diet Assessment Tool (MDAT) associated with Diet Quality Index (DQI) for all nutrients except vitamin A 2) Changing cut-off points that define low, average and adequate scores improved performance of MDAT

Table 1b. Characteristics of the studies that looked at the association between dietary diversity and child nutritional status in developing countries[a]

Author	Country	Age group	Dietary Diversity (DD) approach: (indicator)	Method and reference period	Descriptive DD finding	Type of Association	Against which outcome?	Main findings
ASSOCIATION WITH CHILD NUTRITIONAL STATUS								
1. Arimond and Ruel, 2002	Ethiopia DHS data	12-36 mo	1) 24-h food group diversity (8 groups): grains, roots/tubers, milk, vitamin A- fruits/ vegetables, other fruits/vegetables, meat/poultry/fish/ cheese/eggs/yogurt, legumes, fats/oils 2) 7-d food group diversity: (same as above except grains combined with roots/tubers) (n=7 groups)	24-h food group recall; 7-d food group recall	Mean 24-h diversity: 2.25 Mean 7-d diversity: 2.86	Association with height-for-age Z-scores (HAZ) (controlling for SES) Created terciles of 24-h. diversity and 7-d. diversity	HAZ	1) Both 24-h and 7-d food group diversity strongly associated with HAZ, controlling for child, maternal and household socioeconomic factors 2) Differences in adjusted mean HAZ between lowest and highest tercile of 24-h diversity: 0.65 Z-scores 7-d diversity: 0.67 Z-scores
2. Brown et al. 2002	Guatemala	9-11 mo	No. of single foods	12-h weighed intake + 12-h recall	Mean no. of foods = 10	Bivariate association between diversity terciles and nutritional status	Child HAZ and WHZ	No significant association between dietary diversity terciles and HAZ and WHZ
3. Hatløy et al. 2000	Mali	6-59 mo	Household level: 1) FVS 2) DDS (defined as above; see Table 1a)	HH-level 24-h. food frequency (104 food items)	FVS: mean =19.6 (urban), =14.3 (rural) DDS: mean	Association with child nutritional status (controlling	Stunting, underweig htwasting	1) In urban areas: lower FVS or DDS has twice risk of stunted or underweight 2) In rural areas: no association

Author	Country	Age group	Dietary Diversity (DD) approach: (indicator)	Method and reference period	Descriptive DD finding	Type of Association	Against which outcome?	Main findings
ASSOCIATION WITH CHILD NUTRITIONAL STATUS								
					=6.7 (urban) =6.1 (rural)	for SES)		(controlling for SES)
4. Tarini, Bakari and Delisle, 1999	Niger	24-48 mo.	Diversity score (DS): 11 food groups over 3 d (defined as above; see Table 1a)	3-d modified weighed intake	DS: mean = 4.8, 5.3, 5.3 (3 seasons)	Association between DS and child nutritional status	Child HAZ, WAZ, WHZ	Association DS and nutritional status not significant (low correlations, significant only for WHZ in one round).
5. Onyango, Koski and Tucker, 1998	Kenya	12-36 mo	No. of single foods	Average daily intake from 3, 24-h recalls	Mean no. foods: 5 (BF children); 6 (non BF children)	Association with child nutritional status (multivariate analysis, but no control for SES);	Child HAZ, WAZ, WHZ, triceps skinfold (TS), mid-upper arm circumference (MUAC)	1) Diversity associated with HAZ, WAZ, WHZ, TS and MUAC 2) Diversity>5 more important for HAZ among non-BF children (difference between diversity groups: 0.9 HAZ among non-BF, vs. 0.2 among BF)
6. Marquis et al. 1997	Peru	12-15 mo	1) 27 foods and beverages consumed more than twice/wk 2) 5 animal food groups: cow milk, meat, organ meats, eggs, fish	Average of 3, 1-mo food-frequency questionnaire	Mean no. foods: 14.8 Mean no. animal foods: 3.6	Association with length at 15 mo. (multivariate analysis, but no control for SES)	Length at 15 mo	1) Association between no. of animal foods and length not significant as main effect 2) Interactions: a) animal foods associated with length in children with low overall diversity; b) BF associated with length in children with low intakes of animal foods
7. Taren and Chen	China	12-47 mo	Food group scale (0-7): rice, egg,	Recall of usual intake at 12	Mean no. of food groups:	Bivariate association	Child HAZ,	Significant difference of 0.20 HAZ between children who consumed < 3

Author	Country	Age group	Dietary Diversity (DD) approach: (indicator)	Method and reference period	Descriptive DD finding	Type of Association	Against which outcome?	Main findings
ASSOCIATION WITH CHILD NUTRITIONAL STATUS								
1993			vegetables, fruits, soybeans, meat, other	mo.	4.8	with nutritional status	WAZ, WHZ	groups and rest of sample
8. Allen et al. 1991	Mexico	18-30 mo	8 food groups: 5 plant groups : tortillas, legumes, vegetables, fruits, other 3 animal groups: dairy, eggs, meat	Mean daily intake from 2-d quantitative recall data each mo for at least 8 mo	88% of energy intake from plant foods; 12% from animal foods	Correlation between % energy from different food groups and nutritional status	Child HAZ, WAZ, WHZ at 30 mo	1) Positive correlation between % energy from animal foods and HAZ 2) Positive correlation between % energy from dairy foods and HAZ 3) Negative correlation between % energy from plant foods (tortillas in particular) and HAZ

[a] Abbreviations: BF: Breastfeeding; DDS: Dietary diversity score; DS: Dietary Score; FVS: Food variety score; HAZ: Height-for-age Z-scores; HH: Household; MAR: mean adequacy ratio; MUAC: Mid-Upper Arm Circumference; NAR: Nutrient adequacy ratio; NQS: Nutritional quality score; RDA: Recommended dietary allowances; Se: Sensitivity; SES: socioeconomic status; Spe: Specificity;TS: Triceps skinfolds; WAZ: Weight-for-age Z-scores; WHZ: Weight-for-Height Z-scores.

This study also includes a comparison of the two diversity measures. A regression analysis showed that DDS (based on food groups) was a stronger determinant of nutrient adequacy than FVS (based on individual foods). Thus in this context, increasing the number of food groups has a greater impact on nutrient adequacy than increasing the number of individual foods in the diet.

An additional methodological contribution of the study is the sensitivity-specificity analysis carried out to identify best cut-off points to predict nutrient adequacy for both diversity indicators. In this sample, the cut-off points of six for food-group diversity and 23 for food variety provided the best sensitivity and specificity combinations to predict nutrient adequacy. Although these findings are highly context-specific, they provide useful methodological guidance for similar studies to be conducted in other populations.

The study in Viet Nam, which included adult women, used a similar methodology to validate the same diversity measures (FVS and DDS) against nutrient intake and nutrient density (Ogle, Hung, and Tuyet 2001). FVS and DDS were derived from a seven-day food frequency questionnaire and included more than 120 foods and 12 food groups, respectively. The findings confirm a positive association between the two measures of diversity and intake of a variety of nutrients. Women in the highest tercile of FVS—those who had consumed 21 or more different foods in 7 days—had a significantly higher intake of most nutrients studied than those from the lowest tercile—who had consumed 15 or fewer foods. Similarly, women with a food group diversity greater or equal to eight (out of a maximum of 12 groups) had significantly higher nutrient adequacy ratios for energy, protein, niacin, vitamin C, and zinc than women with lower food group diversity.[6]

Two other studies that have looked at the association between diversity measures and nutrient intakes confirm the positive association between dietary diversity and intake of a variety of nutrients (Onyango, Koski, and Tucker 1998; Tarini, Bakari, and Delisle 1999). In contrast, a study conducted in Ghana and Malawi documents only weak, and in some cases negative, associations between diversity and density of certain nutrients (Ferguson et al. 1993). In this study, which aimed to describe and compare major nutrient sources in two countries, analysis of the association between diversity and nutrient intakes was not a primary objective, and the findings are reported only briefly.

Finally, a study in Mozambique evaluated a rapid assessment tool called the Mozambican Diet Assessment Tool (MDAT); the MDAT can be considered as a context-specific, weighted diversity score. (Rose et al., 2002). The tool was applied at the household level and gathered information on all individual foods consumed by all household members in one day. Each food received a score of 1–4, based on its nutrient density, the bioavailability of the nutrients it contains, and typical portion sizes (foods received a lower score if consumed in small amounts compared to foods of similar nutrient value consumed in larger amounts).[7] Total scores below 12 points were considered to indicate very low dietary quality, 12–19, average, and 20 or higher, adequate.

[6] The authors also measured a variety of nutritional status indicators (anthropometry, hemoglobin, serum ferritin, retinol, retinol binding protein and C-reactive proteins) and report only weak associations between women's nutritional status and the dietary diversity measures.

[7] Examples of foods receiving different scores are as follows: 1: vegetables, fruits, oils, sugars, some popular condiments; 2: cereals, tubers, bread, spaghetti, cookies, cakes; 3: beans, nuts, coconuts; 4: meat, fish, shellfish, eggs, milk products.

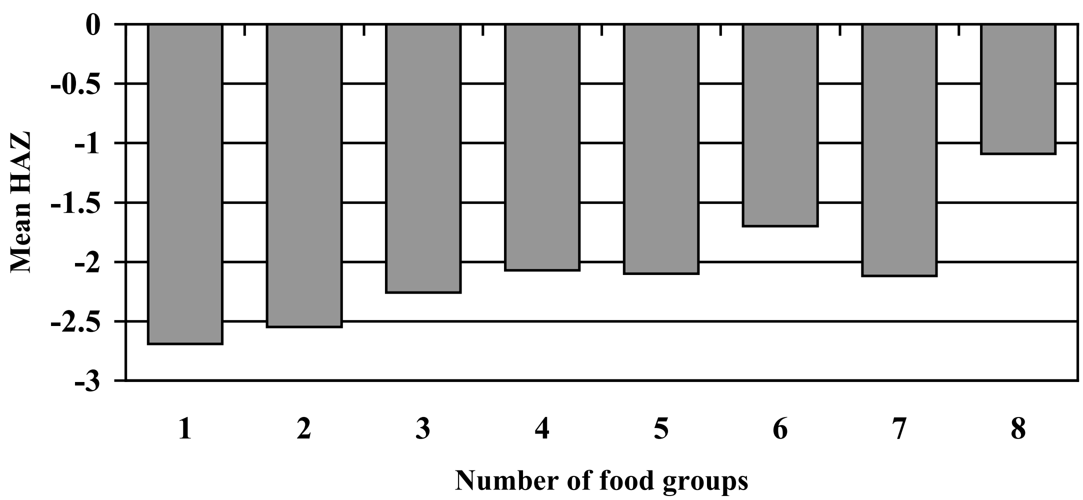
The association between this rapid assessment tool and a Diet Quality Index (DQI) score[8] computed from data from a quantitative household-level 24-hour recall was tested. Findings show that households classified by the rapid assessment tool as having acceptable diets had higher mean intakes of energy, protein, and iron than those classified as having poor or very poor diets. Findings for vitamin A intakes, however, were in the opposite direction.

This review of developing country research confirms the consistent pattern of a positive association between diversity measures and nutrient adequacy previously documented in developed countries. The results are surprisingly consistent, considering the wide differences among studies in definitions of foods, food groups, reference period, dietary assessment method, scoring systems, cut-off points used, as well as age of study subjects and general environmental and socioeconomic characteristics.

1.2.2. Association between dietary diversity and child nutritional status

A number of studies have looked at the association between some measure of dietary diversity and child nutritional status, as seen in Table 1. Our recent analysis of data from the Ethiopia 2000 DHS showed a strong and statistically significant association between food-group diversity measures based either on a 24-hour or seven-day recall and children's height-for-age Z-scores (HAZ) (Arimond and Ruel 2002). Figure 1 shows the adjusted mean HAZ of 12–36 month old children by the seven-day food group dietary diversity score.

Figure 1. Mean adjusted[a] height-for-age Z-scores, by dietary diversity score in previous 7-days (children 12-36 months of age: Ethiopia DHS 2000)



[a]Means were adjusted for child age and gender, maternal age, height, body mass index, education, parity, attendance at prenatal visits (as a proxy for access to health care), partner's education, household socioeconomic factors (assets, quality of housing, availability of services), number of preschool children, and area of residence.

[8] A composite measure was created based on household nutrient intakes of energy, protein, vitamin A, iron, and seven other nutrients. Each of these five components received two points, for a maximum score of 10 points.

A positive and generally linear trend in mean HAZ is observed as food group diversity increases. The difference between the extremes – one food group as compared to eight – is 1.6 Z-scores. Differences in HAZ scores of this size have been associated with both short-term and long-term functional outcomes, especially cognitive development, fulfillment of intellectual potential, work capacity and reproductive performance, and are therefore considered biologically meaningful, or of functional significance (Martorell and Scrimshaw, 1995). Note that the mean HAZ values presented here are adjusted by multivariate analysis for a variety of child, maternal, and household socioeconomic factors, thereby reducing the possibility that this association is due to other potentially confounding influences. When terciles of dietary diversity are used, the difference in adjusted mean HAZ between children from the lowest diversity tercile compared to the highest tercile is 0.65 Z-scores. Similar findings are obtained when food group diversity in the previous 24 hours is used.

A study in Mali also documents a strong association between dietary diversity and nutritional status, for children aged 6-59 months (Hatloy et al. 2000). In urban areas of Mali, lower food variety scores (FVS) or dietary diversity scores (DDS) were associated with twice the risk of being stunted or underweight, controlling for socioeconomic factors.[9] No association between diversity and nutritional status was found in rural areas, however.

In Kenya, diversity was measured as the number of individual foods consumed in 24 hours, using an average of three 24-hour recalls. This was significantly associated with five nutritional status indicators (HAZ, WAZ, WHZ, triceps skinfolds, and mid-upper arm circumference) among 12–36 month old children (Onyango, Koski, and Tucker 1998). In this age group, diverse diets appeared to be more strongly related to nutritional status among children who were no longer breastfed. Among the non-breastfed group, the height-for-age of children with dietary diversity greater than five was 0.9 Z-scores higher than the HAZ of children with lower dietary diversity scores. The size of the difference between diversity groups among children who were still breastfed was only 0.2 Z-scores. This finding highlights the importance of diversity in complementary foods, especially among children who are no longer breastfed and therefore are entirely dependent on complementary foods for their nutrient intakes.

The importance of animal-source foods as one component of dietary diversity is highlighted in studies in Peru and Mexico (Marquis et al. 1997; Allen et al. 1991). In Peru, animal source foods were not significantly associated with length at 15 months as a main effect, but significantly interacted with overall diversity and breastfeeding in multivariate models.[10] Animal foods were significantly associated with length at 15 months only among children who had low overall dietary diversity (measured as total number of foods consumed more than twice a week). The interaction with breastfeeding, on the other hand, showed that breastfeeding was positively

[9] Although the authors did control for socioeconomic factors in their analysis, we have concerns about the validity of the indicator used to reflect household socioeconomic status. Our main concern is that the indicator was based on a series of household assets, many of which were agricultural tools that may have been irrelevant to socioeconomic status in urban areas. It is well recognized that socioeconomic status indicators for urban and rural areas should be created separately (and probably based on a different set of variables) because the characteristics that define wealth in urban and rural areas are expected to be different (Ruel and Menon 2002).

[10] Note that the multivariate models used did not include any indicators of socioeconomic status or maternal education. They controlled for child-level characteristics such as weight-for-height and diarrhea, and for breastfeeding and complementary feeding practices.

associated with length only among children who had low intakes of animal products. This finding is similar to the one documented previously in Kenya (Onyango, Koski, and Tucker 1998) and highlights the importance of dietary diversity (and possibly animal-source foods in particular) among children who are not breastfed – or, conversely, the importance of continued breastfeeding for children who do not receive high quality diets during their second year of life.

Again, in spite of the variety in measurement approaches and environmental conditions, the results are consistent in showing a positive association between dietary diversity and child nutritional status. One weakness of most studies, however, is the lack of appropriate control for socioeconomic factors. It may be that the association between diversity and nutritional status is in fact due to socioeconomic factors, because dietary diversity is also associated with household socioeconomic characteristics. That is, it may be that dietary diversity is merely a good proxy for socioeconomic status. In this case better nutritional status may be due to a combination of favorable conditions, including higher maternal education, higher household income, greater availability of health and sanitation services, etc. On the other hand, improved dietary diversity and nutrient adequacy may in fact be one of the mechanisms through which socioeconomic factors produce a positive effect on child nutritional status.

2. DIETARY DIVERSITY IN THE DEMOGRAPHIC AND HEALTH SURVEYS

The Demographic and Health Surveys (DHS) are a series of standardized, nationally-representative surveys that have been implemented in 67 countries since 1984.[11] Multiple survey rounds have been completed in many countries. The earliest DHS surveys are referred to as the DHS-I round; subsequently, the questionnaire has been revised for DHS-II, DHS-III and, most recently, the MEASURE *DHS*+ round.

The current model questionnaire includes two questions on foods and liquids (see Boxes 1 and 2). These questions provide much more detail about a range of liquids and foods than did questions in the earlier DHS rounds. Mothers are asked to provide information for their youngest child under three years of age; if there are no children under three no data are collected. Mothers are asked first about a number of liquids and groups of liquids, and then secondly about a number of food groups. For each liquid or food group, the mother is first asked how many *days* in the last week the child drank or ate any item in the group. If the response for the last week is greater than zero, the mother is then asked how many *times* the child had an item in the group yesterday (during the day or at night). Liquids and foods were generally grouped based on nutrient content (ORC Macro, 2001).

Box 1. Liquid group recall question from the *DHS*+ model questionnaire

		LAST 7 DAYS NUMBER OF DAYS	YESTERDAY/ LAST NIGHT NUMBER OF TIMES
	Now I would like to ask you about liquids (NAME) drank over the last seven days, including yesterday. How many days during the last seven days did (NAME) drink each of the following? FOR EACH ITEM GIVEN AT LEAST ONCE IN LAST SEVEN DAYS, BEFORE PROCEEDING TO THE NEXT ITEM, ASK: In total, how many times yesterday during the day or at night did (NAME) drink (ITEM)?		
a	Plain water	a ☐	a ☐
b	Commercially produced infant formula?	b ☐	b ☐
c	Any other milk such as tinned, powdered, or fresh animal milk?	c ☐	c ☐
d	Fruit juice?	d ☐	d ☐
e	Any other liquids such as sugar water, tea, coffee, carbonated drinks, or soup broth?	e ☐	e ☐
	IF 7 OR MORE TIMES, RECORD '7'. IF DON'T KNOW, RECORD '8'.		

[11] The DHS program is funded by the U.S. Agency for International Development (USAID) and administered by ORC Macro. Summary statistics, country reports, and datasets are available at www.measuredhs.com.

Box 2. Food group recall question from the *DHS*+ model questionnaire

	Now I would like to ask you about the types of foods[1] (NAME) ate over the last seven days, including yesterday.		
	How many days during the last seven days did (NAME) eat each of the following foods either separately or combined with other food?		
	FOR EACH ITEM GIVEN AT LEAST ONCE IN LAST SEVEN DAYS, BEFORE PROCEEDING TO THE NEXT ITEM, ASK:		
	In total, how many times yesterday during the day or at night did (NAME) eat (ITEM)?		
a	Any food made from grains [e.g., millet, sorghum, maize, rice, wheat, porridge, or other local grains]?	a ☐	a ☐
b	Pumpkin, red or yellow yams or squash, carrots, or red sweet potatoes?[2]	b ☐	b ☐
c	Any other food made from roots or tubers [e.g., white potatoes, white yams, manioc, cassava, or other local roots/tubers]?	c ☐	c ☐
d	Any green leafy vegetables?	d ☐	d ☐
e	Mango, papaya [or other local vitamin A rich fruits]?	e ☐	e ☐
	Any other fruits and vegetables [e.g., bananas, apples/sauce, green beans, avocados, tomatoes]?	f ☐	f ☐
	Meat, poultry, fish, shellfish, or eggs?	g ☐	g ☐
	Any food made from legumes [e.g., lentils, beans, soybeans, pulses, or peanuts]?	h ☐	h ☐
	Cheese or yoghurt?	i ☐	i ☐
	Any food made with oil, fat, or butter?	j ☐	j ☐
	IF 7 OR MORE TIMES, RECORD ‘7’. IF DON’T KNOW, RECORD ‘8’.		

[1]The following separate food categories must be added in countries where these foods are fed to children: commercially prepared baby food; chicken/beef liver, tripe, other organ meats; grubs, snails, insects, other small protein food.

[2]Items in this category should be modified to include only vitamin A rich tubers, starches, or red or yellow vegetables that are consumed in the country.

These liquid and food group recall questions are sufficient to provide a good picture of diet patterns of young children, at the population level. The data can also be used to construct dietary diversity indicators, using different groupings of the listed food groups, and to describe the diet patterns associated with varying levels of these diversity indicators (for example, among children with low diversity, what proportion ate animal-source foods?). They do not provide any quantitative information about intake of foods or nutrients.

We use DHS data from eleven recent surveys to construct a dietary diversity indicator based on liquid and food groups. Using this indicator, we aim to fill several gaps in knowledge about diversity indictors.

First, we present a descriptive analysis showing how, in each country, varying levels of dietary diversity relate to the consumption of specific liquid or food groups. This is useful because there is very little information available about the relationship of diversity indicators to diet patterns for young children in developing countries. This descriptive work contributes to answering the question: "What does dietary diversity mean in the diets of young children in developing countries?"

Secondly, we consider the issue of cut-offs for the dietary diversity variable. Some of the studies described in the previous chapter tried to identify cut-offs based on the relationship of the cut-off to nutrient adequacy, as part of a validation exercise. This is not possible with the DHS data. Our exploration of cut-offs is motivated differently, and relates to the need for simple indicators. For many purposes, program managers may prefer an indicator such as "Percent of children having low diversity diets" or "Percent of children having high diversity diets" rather than a mean diversity score, which has little intuitive meaning for most people.

However, there is no international recommendation concerning an adequate or optimal level of food group diversity for young children. In our previous work with DHS data from Ethiopia, we created terciles for dietary diversity based on the distribution in the data set (Arimond and Ruel, 2002). This approach has two drawbacks: it does not allow for comparisons between countries, and, in countries such as Ethiopia where dietary diversity is extremely low, even the "high" diversity group may include children whose diets are far from adequate. On the other hand, from a project evaluation perspective this approach has the advantage of identifying a cut-off for "high" diversity that is achievable for a substantial proportion of the population. In low diversity countries and areas this may be useful for setting realistic program objectives with respect to dietary diversity.

In this paper, we compare sample specific dietary diversity tercile cut-offs for ten countries[12], in an effort to determine if global or regional cut-offs may be feasible based on similar distributions of diversity in many countries. This addresses the desire for cross-country comparisons, but does not address the second issue noted above, whereby relatively "high" diversity may not correspond to an adequate diet. We also describe an approach to defining diversity categories based on the proportion of children who ate specific nutrient–dense food groups the previous day.

[12] Zimbabwe is excluded from this analysis because the questionnaire used in Zimbabwe did not include one food group from the model questionnaire, and the diversity score therefore cannot be compared with other countries.

Thirdly, we relate dietary diversity to height-for-age Z-scores (HAZ) for children 6-23 months. As noted in the review, a number of studies have shown some relationship between dietary diversity and anthropometric indicators. Clearly a child's current height, which is the product of processes beginning in utero, is not determined by what was eaten yesterday or last week. Recent dietary diversity will be meaningful as a contributor to growth to the extent that it reflects dietary patterns and nutrient adequacy over longer, biologically meaningful time periods. For example, if children with more diverse diets yesterday and/or in the past week have generally received more diverse, higher quality diets over the last year, then measures of recent dietary diversity may be meaningfully related to outcomes.

We first present information on bivariate relationships between dietary diversity and HAZ, then assess the relationship while controlling for a number of maternal and household-level factors.

Fourthly and finally, we address the issue of the "added value" of the 7-day food group recall, above and beyond the 24-hour food group recall. This issue has been under discussion for several years, both in relation to the DHS questionnaire, and in relation to the widely used Knowledge, Practices, and Coverage (KPC) 2000+ questionnaire. The objective of this latter questionnaire is to provide a simple, standardized and quantitative survey tool, useful both for baseline assessments and for assessments of outputs and outcomes of Child Survival and Health projects funded by USAID. Like the DHS, the KPC has included a 24-hour food-group recall. Based on feedback from private voluntary organizations (PVOs) that pilot-tested a version similar to the DHS, the 7-day food group recall was not included in the KPC.

We assess the added value of the 7-day recall by comparing results for the 24-hour recall to results for the 7-day recall, both for individual food and liquid groups, and for the diversity indicators.

The next chapter (Chapter 3) describes the selection of data sets and statistical methods. Chapter 4 presents selected descriptive statistics for households, women and their partners, and the children in order to provide a context for the analysis of the food group recall data. Chapter 5 presents results for the first task above, describing differences in food group patterns by diversity score within each country. Chapter 6 addresses the issue of the feasibility and usefulness of cut-offs for low and high diversity. Chapter 7 reports results describing the association between dietary diversity and height-for-age in these DHS data sets. Chapter 8 addresses the question of the added value of the 7-day food group recall, above and beyond the 24-hour food group recall, when the objective is to assess population-level diet patterns of young children. Chapter 9 summarizes our analyses and highlights remaining questions.

3. METHODS

3.1. Selection of Data Sets

We used the following three criteria for selecting data sets:

1. Surveys from the *DHS+* round (the most recent round, which provides information on more liquids and food groups)
2. Countries in Africa, South or Southeast Asia, or the Latin America/Caribbean region
3. The food-group recall on the questionnaire must have included at least seven of the following eight food groups:
   - Food made from grains
   - Food made from roots and tubers
   - Food made from legumes
   - Dairy
   - Meat, poultry, fish or eggs
   - Vitamin A-rich fruits and vegetables
   - (one or more of the three sub-groups on the model questionnaire)
   - Other fruits and vegetables
   - Foods made with oil, fat or butter

Eleven data sets met these criteria. For some countries, preliminary data were available at the time the data were acquired and analysis begun. A "P" in the list below indicates preliminary data. Countries and survey years included in the analysis were:

- Africa:
  - Benin 2001
  - Ethiopia 2000 P
  - Malawi 2000
  - Mali 2001 P
  - Rwanda 2000 P
  - Zimbabwe 1999
- Asia:
  - Cambodia 2000
  - Nepal 2001 P
- Latin America/Caribbean:
  - Colombia 2000
  - Haiti 2000 P
  - Peru 2000 P

Within these countries, all living children aged 0-23 months were selected, then, one child per household was randomly selected. Table 2 shows the number of children aged 6-23 months remaining in each data set after selecting one child per household, as our analyses focus on children in this age group.

Table 2. Sample size by country

Country	Number of children 6-23 months of age
Africa	
Benin	1312
Ethiopia	2697
Malawi	3228
Mali	1136
Rwanda	2110
Zimbabwe	958
Asia	
Cambodia	2049
Nepal	1809
Latin America/Caribbean	
Colombia	1346
Haiti	1758
Peru	3662

3.2. Variations in Questionnaires

Ten of the eleven countries included all eight food groups. In Zimbabwe the food group list did not include foods made with fats and oils, so Zimbabwe is excluded from analyses comparing levels of dietary diversity across countries. The Haiti survey included the 24-hour food-group recall, but not the 7-day food group recall, so Haiti is excluded from analyses comparing the 24-hour to the 7-day food group recall.

The DHS questionnaires are meant to be adapted, at country level, to include foods in each group that are locally available. However, sometimes this adaptation process results in some significant deviations from the Model questionnaire. Most of the substantive differences occurred in relation to infant formula and "other milks", and in relation to the vitamin A-rich fruits and vegetables (for example, with the inclusion of items not rich in vitamin A, such as celery, leeks, etc.). Differences from the Model questionnaire are documented in Annex 1.

3.3. Data Cleaning

DHS data sets undergo extensive cleaning before they are released. In the case of most variables, we performed no additional cleaning. However, in the case of the children's height-for-age, we excluded additional extreme values, based on the "flexible criteria" recommended by WHO (WHO, 1995). Z-scores that were more than 4 Z-score units from the sample-specific mean value were excluded. The exception to this (per same recommendations) was that an upper limit of +3.0 is used for HAZ. For mothers, we examined outliers for height, and based on observed distributions and BMIs for outliers, excluded heights less than 135 cm or greater than 183 cm. Because the BMI calculation includes height, BMI was also coded missing for these women.

3.4. Variable Construction

3.4.1. Dietary diversity

Until validation studies provide information on the relationship between various formulations of diversity indicators and nutrient adequacy, decisions about grouping foods will remain somewhat arbitrary.

When working with data sets with existing food groupings, as with the DHS data sets, certain decisions have already been made and grouped foods cannot be "ungrouped". For example, we cannot separate "eggs yesterday" from "meat, poultry, fish, and shellfish yesterday" even though there are some nutritional differences (eggs are not a good source of iron, and meat, poultry, etc. are a good source). The only remaining decisions involve selecting which groups to include, and combining existing groups on the questionnaire.

In selecting groups to include in the diversity variable, we organized our thinking around the idea of measuring diversity in complementary feeding. Because our focus was on complementary feeding, neither breastmilk nor infant formula was included in our diversity indicator; infant formula is considered as a replacement for, and not a complement to breastmilk. However, other milks, yogurt, and cheese were combined into a dairy variable and provide one point in the diversity score.

Secondly, and in order to balance the number of plant food vs. animal-source food groups, we combined all three vitamin A-rich fruit and vegetable groups into one variable for the purposes of the diversity score. That is, any child who had any of the three vitamin A-rich plant food groups in the last 24-hours (or last 7 days) is given a point towards his/her diversity score.

Thirdly, we combined grain-based foods with roots and tubers. Although these are somewhat different from each other nutritionally, other nutritionally different foods are already grouped together on the questionnaire (for example, eggs and meat). We did not feel that a child who had, for example, maize and cassava yesterday should score two points, while a child who had meat and eggs yesterday should score one point.

Finally, we combined "other fruits and vegetables" (other than vitamin A-rich fruits and vegetables) with fruit juice. Fruit juice may provide some of the same vitamins found in this general fruits and vegetables group (notably, vitamin C from citrus juice, pineapple juice and some others). Excess consumption of sweet drinks – including juice – by small children may displace food or may be associated with excess calorie intake, and is a concern in developed countries. It may also be a concern in some middle- and low-income countries, particularly in urban areas. However, in the poorest countries and poorest areas, consumption of fruit juice may make a positive contribution to nutrient intake.

The final 7-point diversity score included the groups shown in Box 3.

Box 3. Food groups in dietary diversity score

1. Starchy staples – two questionnaire items combined:
   - Foods made from grain
   - Foods made from roots or tubers
2. Food made from legumes
3. Dairy – two items combined:
   - Milk other than breastmilk
   - Cheese or yogurt
4. Meat, poultry, fish or eggs
5. Vitamin A-rich fruits and vegetables – three items combined:
   - Pumpkin, red or yellow yams or squash, carrots, or red sweet potatoes
   - Green leafy vegetables
   - Mango, papaya, or other local vitamin A rich fruits
6. Other fruits and vegetables, or fruit juice – two items combined
7. Foods made with oil, fat or butter

The intention was to develop a score that included a point for each of the major nutritionally important types of food the child may have eaten, while providing some balance between plant foods and animal-source foods. Other liquids, such as thin soups, teas, and infusions are not included in the diversity score; generally these liquids are neither energy- nor nutrient-dense because water is a primary ingredient.

Diversity scores for the 24-hour and the 7-day food group recall were constructed by summing these seven food groups. In order to construct diversity variables scoring the number of food groups eaten 3 or more days out of the last 7 days, and 4 or more days out of the last 7 days, we needed to make some assumptions about the 7-day recall data, when items were combined.

Mothers were asked how many days out of the last seven days their child had eaten each item. For items that are not combined in the list above – such as legumes – variables were easily constructed indicating whether the child had the food three or more days (or four or more days). For combined items, it was not possible to know if the days the mother reported for one item overlapped, or were entirely different from the days she reported for the other item(s). For example, if the child had mango 3 days and leafy greens 3 days, the number of days the child actually had vitamin A-rich fruits and vegetables could have been as few as 3 (if she had both mango and leafy greens on the same 3 days, and neither the other days) or as many as 6 (if she never had mango and greens on the same day). In these cases, we took the mean number of days out of this possible range (in this example, 4.5) and assigned that as the number of days the child had the food group.

We then constructed dichotomous variables for each food group (for example, did the child have the food group 3 or more days, or not?) and summed these variables to construct scores for diversity indicating the number of food groups each child ate at least 3 days out of the last seven.

Finally, the diversity scores were used to create a series of categorical variables, indicating low, middle and high diversity. Several types of categorical variables were constructed. First, using the data for all children aged 6-23 months, terciles were constructed for dietary diversity. Secondly, age-specific terciles were constructed, within narrow age ranges (6-8 months, 9-11 months, 12-17 months, and 18-23 months). Children were ranked as having had low, middle, or high diversity compared to children in their same narrow age group, then these ranking variables were combined into a single age-specific ranking variable for all the children. Finally, categorical variables were constructed using fixed cut-offs of 0-2, 3-4, and 5-7 food groups.

3.4.2. Proxy index for household wealth

Following the method developed by Filmer and Prichett (1998), we used principal components analysis as a data reduction tool to combine a large number of variables into a household-level index. For simplicity, and following Filmer and Prichett, we refer to this as an "asset index". Note that there are several categories of variables included in the principal components analysis, not all of which are assets. The categories of variables are:

- Household items: radios, telephones, television, refrigerator
- Whether or not the household has electricity
- Ownership of bicycle, motorcycle or car/truck
- Agricultural implements and related assets (hoes, plows, etc.)
- Main source of drinking water
- Type of toilet or latrine (or none)
- Main material of the floor
- Main material of the roof
- Main type of fuel used for cooking
- Number of household members per sleeping room

Some categories of variables were not available in all countries (for example, only Benin, Cambodia, Ethiopia, and Peru had information on the main material of the roof, and only Colombia, Ethiopia, and Peru had the number of household members per sleeping room). Many countries had no information on agricultural implements/assets. In some cases, variables were included in the data set but in our sub-sample there was no variability, and these were dropped.

In addition to the list above, country-specific variables were included where these were available. For example, in Benin there was a variable for ownership of a boat; in Cambodia there were variables for ownership of a sewing machine or loom, a boat with motor, and a boat without a motor. Several countries had one or more variables for ownership of livestock. Annex 2 presents a complete list of the variables included in the principal components analysis for each country.

Gwatkin and colleagues (2000) provide a model for using the Filmer/Pritchett approach with DHS data. We have followed their methods, except that we performed the analysis separately for urban and rural areas, because the assets and household characteristics that differentiate better off from worse off households can be expected to vary between urban and rural areas. Once the index was constructed, we used the index score to create terciles, again separately for urban and rural areas. These ranking variables (terciles) were then combined into a single variable, with each child/household was scored as low, middle, or high for the index. Dummy variables for the index terciles were in turn used in the regression analyses. More details of the construction of the index, for each country, are included in Annex 2.

3.5. Analytical Methodology

Sample weights (available in each DHS data file) were used for all analyses. Initial variable construction was performed in SPSS for Windows, version 11.0. Statistical tests were performed using Stata (version 7). Stata allows specification of sample design, and can provide appropriate statistical tests given the stratified cluster sample design of the surveys.

For the first and third tasks listed in the introduction – description of diet patterns by diversity score, and addressing the issue of cut-offs – simple descriptive statistics are presented. Methods for the second and fourth tasks are detailed next.

Analyses for task 3: To determine whether simple dietary diversity indicators are meaningfully associated with height-for-age among young children.

We first performed bivariate analyses comparing mean HAZ for children in low, middle, and high diversity groups. The statistical significance of differences between means was tested using an adjusted Wald test for joint hypothesis testing (StataCorp, 2001, p. 210).

In the multivariate analyses, the dependent variable was HAZ. The independent variables included dietary diversity (age-specific terciles for number of food groups eaten 3 or more days in the last seven), and a series of child, maternal, and household characteristics that are known to be associated with child nutritional status, namely:

- Biological variables:
  - Child age (and age squared)
  - Sex of child
  - Maternal height
- Variables reflecting household welfare/socioeconomic status:
  - Maternal BMI
  - Maternal education
  - Education of mother's partner
  - Number of antenatal care visits (related to welfare/socioeconomic status, but also serves as a proxy for access to health care)
  - Whether the household is in an urban or rural area
  - Asset index tercile
- Other variables:
  - Whether the child was still breastfed (related to socioeconomic status, but also influences nutrient requirements from complementary food; included in order to assess interactions with dietary diversity)
  - Number of children in household under five years (related both to mother's parity and to socioeconomic status)

The multivariate analysis also tested two-way interactions between dietary diversity and several other variables. The purpose was to determine whether the magnitude of association between dietary diversity and HAZ differed according to the level of these characteristics. For example, was dietary diversity more strongly associated with HAZ among older children? Among non-breastfed children? We did not test all interactions, but rather a set of conceptually plausible interactions of dietary diversity with:

- Child age
- Whether the child was still breastfed
- Mother's education
- Urban/rural location of household
- Asset index tercile

Factors were considered significant as main effects with p-values of < 0.05. Interactions were considered significant with p-values of < 0.20.

Adjusted mean HAZ scores were computed to obtain mean HAZ by dietary diversity tercile, after adjusting by multivariate analysis for all continuous variables in the model.

Analyses for task 4: To test the nature and strength of the associations between food group and dietary diversity indicators derived from a 24-hour food group recall and those derived from a 7-day food group recall across a range of countries with varying levels of dietary diversity.

Food group recall data from DHS surveys may be used for a variety of purposes. One important use of the data is to assess the proportion of children eating each food group sufficiently frequently to be of nutritional significance. For the purposes of this work, we take this as the objective. We arbitrarily define "sufficiently frequently" to be at least three days out of the last seven days, for each food group. We then compare how closely the food groups eaten yesterday reflect the food groups eaten at least three days out of the last seven.

We assess the comparability of 24-hour and 3-day indicators at both the population level and at the level of the individual child. At population-level, judgments can be made without statistical testing since what is at issue is the practical significance of differences of the magnitude observed. In samples as large as the DHS samples, even very small differences in proportions may be statistically significant, but are not always of practical importance.

At the individual level, we use the kappa statistic for each food group, to assess the strength of agreement between the two measures. We use rho_c, a concordance coefficient (Lin, 1989), to test the agreement between 24-hour diversity and diversity for 3 or more days.

Kappa is widely used to assess agreement between measures, particularly for dichotomous variables (Fleiss, 1981). A kappa value of "1" indicates perfect agreement, and a value of "0" indicates that agreement is no better than would be expected based on chance. Fleiss provides the following rule of thumb for assessing the level of agreement:

Kappa below 0.40	Poor agreement
0.40-0.74	Fair to good agreement
0.75 or higher	Excellent agreement

The concordance coefficient, rho_c, is an appropriate statistic for assessing agreement between two continuous measures (or ordered categorical variables with many categories, such as our diversity score). The concordance coefficient combines measures of both accuracy and precision to determine if the data deviate significantly from the line of perfect concordance (i.e., the line at 45 degrees). The strength of association represented by a particular concordance coefficient can be evaluated similarly to a simple correlation coefficient.

4. Description of Households, Mothers, and Children

In order to provide some context for the analysis of dietary diversity, this chapter presents a series of tables and figures with key descriptive statistics, by country. We include the following:

- Selected household characteristics
- Characteristics of the mother and her partner
- Selected proxies for access to health care
- Anthropometric indicators for children aged 6-23 months
- Morbidity and feeding during diarrhea for children aged 6-23 months
- Feeding practices for children aged 6-23 months

4.1. Selected Household Characteristics

Table 3 presents descriptive statistics for key household characteristics, and provides a snapshot of some of the major differences between countries. In most countries, more than two-thirds of the households are in rural areas; in Colombia and Peru the proportion is much lower (32% and 44%, respectively). The proportion of female-headed households ranges from 11-22% in most countries, but is markedly higher in Zimbabwe (32%) and Haiti (37%).

The proportion of households with piped water is lowest in Cambodia (4%) and Ethiopia (13%) and is well under 50% in all the other African and Asian countries. In Latin America, the proportion with piped water ranges from 50% in Haiti to 83% in Colombia.

Access to latrines/toilets differs from some of the other characteristics in that countries where households have poor access to piped water and electricity may have a high proportion of households using latrines (for example, Malawi, Mali, and Rwanda).

In general, Colombia and Peru have more favorable household characteristics, while Ethiopia consistently ranks low.

4.2. Characteristics of the Mother

Table 4 presents selected descriptive statistics for the mother and her partner. Average maternal height was lowest in Nepal, Cambodia and Peru (150-153 cm) and highest (>158 cm) in Haiti, Benin, Mali and Zimbabwe. The proportion of women with low BMI (< 18.5) ranged from 1%-11% in most countries, but was markedly higher in Ethiopia (26%) and both Asian countries (Cambodia with 20% and Nepal with 24%). At the other end of the spectrum, the highest rates of overweight and obesity (BMI ≥ 25) were in Colombia (38%) and Peru (42%).

Maternal education and literacy varied particularly widely between countries. In four countries, over 70% of women reported that they had not attended school at all (Benin, Ethiopia, Mali and Nepal). In another set of countries, approximately 1/3 of the women reported no education (Malawi, Rwanda, Cambodia, and Haiti). In the remaining countries (Zimbabwe, Colombia, and Peru) the proportion with no education was less than 10%, and in these same countries over 50% of the women surveyed had at least some secondary education.

Table 3. Selected household characteristics, by country (all households with children 0-23 months)

	Africa						Asia		Latin America/Caribbean		
	Benin	**Ethiopia**	**Malawi**	**Mali**	**Rwanda**	**Zimbabwe**	**Cambodia**	**Nepal**	**Colombia**	**Haiti**	**Peru**
% rural	66	90	87	73	85	67	87	94	32	68	44
% female-headed	13	12	19	22	17	32	18	11	21	37	13
% with piped water	40	13	22	28	35	43	4	33	83	50	66
% with *no* toilet or latrine, use field/ bush/river	70	85	19	20	3	29	85	79	12	46	29
% with electricity	19	7	4	11	6	34	12	17	94	30	60
% with radio	77	20	58	73	40	51	36	41	84	46	82
% with bicycle	55	0	49	51	10	21	49	29	NA	14	22

Table 4. Characteristics of mother and her partner, by country (all households with children 0-23 months)

	Benin	**Ethiopia**	**Malawi**	**Mali**	**Rwanda**	**Zimbabwe**	**Cambodia**	**Nepal**	**Colombia**	**Haiti**	**Peru**
Maternal height (Mean ht in cm)	158.1	157.2	155.7	161.6	158.0	159.4	152.5	150.3	154.5	158.1	150.2
Maternal BMI											
Mean	21.9	20.0	21.9	21.8	22.4	22.9	20.4	20.1	24.4	22.3	24.8
% < 18.5	11	26	6	9	6	5	20	24	3	10	1
% ≥ 25.0	13	3	10	13	15	20	4	3	38	19	42
Maternal education											
% with none	71	81	31	82	32	6	32	73	3	38	7
Some/all primary	20	14	61	11	57	43	53	14	39	47	38
At least some 2°	9	5	8	6	11	51	15	13	58	15	55
% of mothers who cannot read at all	81	80	48	87	35	NA	37	67	NA	53	14
Paternal education											
% with none	52	62	17	78	32	4	17	36	4	29	2
Some/all primary	27	27	65	10	56	35	50	25	40	42	31
At least some 2°	22	12	18	12	13	61	33	39	57	30	67

Table 5. Selected proxies for access to health care, by country (all households with children 0-23 months)

	Benin	Ethiopia	Malawi	Mali	Rwanda	Zimbabwe	Cambodia	Nepal	Colombia	Haiti	Peru
% of women with no antenatal visits for last pregnancy	9	74	5	46	6	6	54	50	9	20	13
% of women with four or more antenatal visits for last pregnancy		10	56	33	10	77	10	14	88	43	71
% of women delivering at home (own /other home)	20	95	46	59	74	22	90	87	13	74	42
% who were given or bought iron tablets / syrup during last pregnancy	85	NA	66	36	20	61	23	24	73	57	58
% who received a Vit. A dose w/in 2 mos after last delivery	20	12	39	18	15	NA	9	11	NA	25	15
% of children who received a Vit A dose in last 6 mos	19	50	62	37	65	NA	24	NA	NA	32	NA

4.3. Proxies for Access to Health Care

Table 5 presents some proxies for access to health care services (including antenatal care and micronutrient supplementation). The proportion of women who reported attending no antenatal visits is highest in Ethiopia (74%), and is also quite high in Mali, Cambodia, and Nepal (46%-54%).

Information on iron and vitamin A supplements is not available for all countries; among countries with data, the proportion of women receiving iron supplements during pregnancy (yes/no) ranges from a low of 20% in Rwanda to a high of 85% in Benin. The coverage of post-partum vitamin A supplementation and vitamin A supplementation for children also varies widely. Note that access to supplementation for children – which occurs through different channels – is not related to access to antenatal care. For example, very few women in Ethiopia received antenatal care, but 50% of the children were reported to have received vitamin A supplements in the last six months.

4.4. Anthropometric Indicators for Children Aged 6-23 Months

Figure 2 illustrates the prevalence of low height-for-age (HAZ < -2). Prevalence of low HAZ is highest in Ethiopia and Malawi, and is notably lower in all three countries in the Latin America/Caribbean region.

Figure 2. Low HAZ (< -2) among children 6-23 months, by country

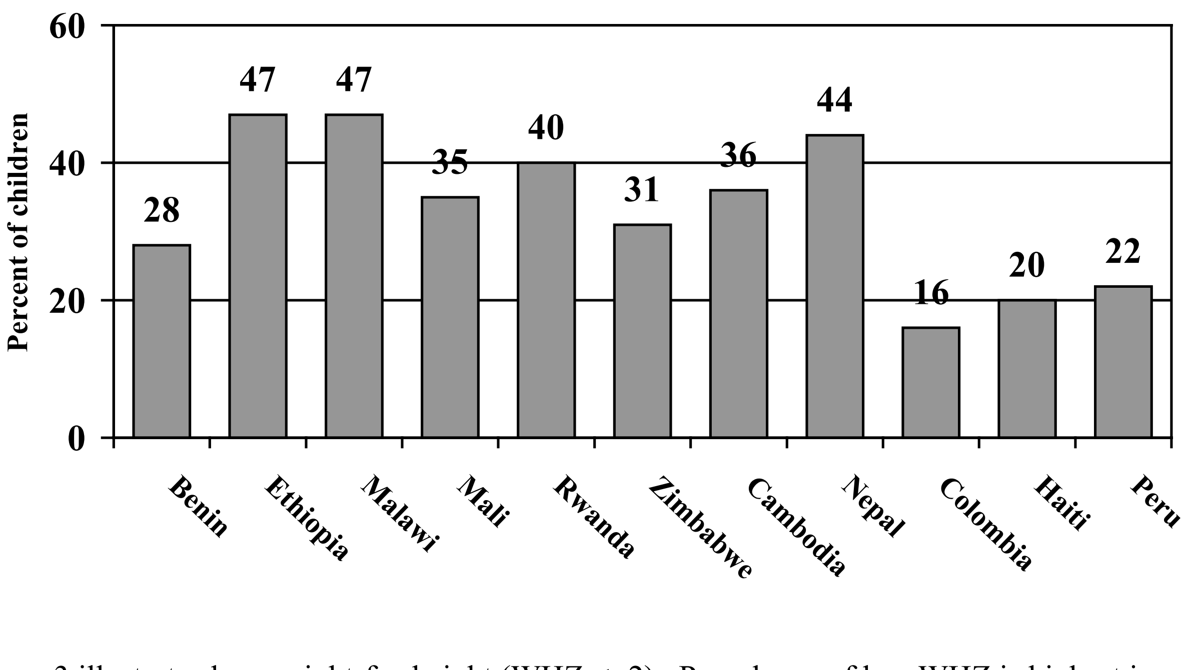
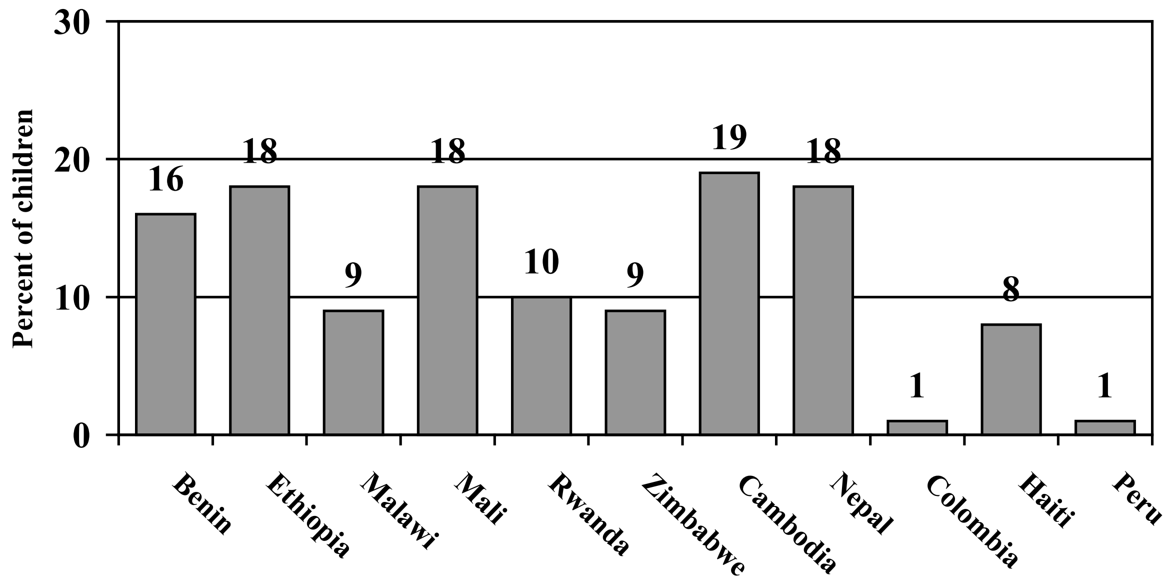


Figure 3 illustrates low weight-for-height (WHZ < -2). Prevalence of low WHZ is highest in Ethiopia, the West Africa countries (Benin and Mali) and in both Asian countries (Cambodia and Nepal), at 16-19%, and very low (1%) in Colombia and Peru.

Figure 3. Low WHZ (< -2) among children 6-23 months, by country



4.5. Morbidity and Feeding during Diarrhea for Children Aged 6-23 Months

Table 6 shows the proportion of children aged 6-23 months who were reported to have had fever, cough or diarrhea in the last two weeks. While there is some variation among countries in prevalence of each illness, the overall picture is one of highly prevalent illness among children in this age range, in all countries. For example, even in Colombia and Peru, roughly 1/3 of the children had fevers in the last two weeks, 1/2 had coughs, and 1/4 had diarrhea. Countries with the highest prevalence of fever (> 50%) were Benin, Malawi, and Haiti; the highest prevalence of diarrhea occurred in Ethiopia (38%) and Haiti (43%). The burden of illness seems particularly high in Haiti, where 73% of the children were also reported to have had coughs in the last two weeks.

Table 6 also shows the proportion of mothers who report following recommended practices for feeding during diarrhea (increased liquids and at least the same amount of food). With few exceptions, less than half of the children who had diarrhea were fed according to recommendations.

4.6. Feeding Practices for Children Aged 6-23 Months

Finally, Table 7 presents information on feeding practices for children in the 6-23 month age group. For children this age, continued breastfeeding, avoidance of baby bottles, and adequately frequent feeding are each important. All children in this age group should be receiving solid and/or semi-solid food regularly. Recommendations for adequate frequency of feeding vary by age; breastfed children aged 6-8 months should be fed complementary foods at least twice a day, with additional snacks as desired, while breastfed children 9-23 months should be fed at least three times a day, with additional snacks (PAHO/WHO, 2003).

Table 6. Percent of children 6-23 months with fever, cough, or diarrhea in last two weeks, and feeding during diarrhea, by country

	Benin	Ethiopia	Malawi	Mali	Rwanda	Zimbabwe	Cambodia	Nepal	Colombia	Haiti	Peru
% with fever	53	37	55	36	40	38	46	43	31	52	32
% with cough	30	41	51	32	46	47	40	52	52	73	49
% with diarrhea	20	38	33	27	29	26	29	32	22	43	24
IF child had diarrhea:											
% offered more liquids	37	30	36	56	19	53	54	28	33	38	52
% offered the same amount or more food	43	12	59	37	50	37	38	35	49	34	35

Table 7. Feeding practices for children 6-23 months, by country: Breastfeeding, bottle use, and frequency of feeding

	Benin	Ethiopia	Malawi	Mali	Rwanda	Zimbabwe	Cambodia	Nepal	Colombia	Haiti	Peru
% still breastfed	88	92	93	90	91	78	81	96	47	69	75
% given anything by bottle yesterday	4	9	4	5	10	7	19	3	27	21	42
% breastfed children fed at least the minimum recommended number of times	39	43	50	25	15	42	59	68	66	22	68
Mean number of times child ate yesterday	2.0	2.1	2.3	1.6	1.3	2.2	2.8	2.7	2.7	1.8	2.9
% with NO solid food groups in last 7 days											
6-8 mos	28	59	5	57	19	5	22	35	8	NA	21
9-11 mos	16	23	2	43	3	0	12	11	1		2
12-23 mos	5	5	1	16	0	1	3	1	0		0

Table 7 shows that breastfeeding is maintained through the second year of life for most children in these countries. Over 85% of the children were still breastfed in five of the six African countries, and in Nepal. Rates were lowest in Colombia (47%) and Haiti (69%).

Bottle use is rare (10% or less) in all six African countries and in Nepal, and is somewhat higher in Cambodia (19%), Haiti (21%), and Colombia (27%). Bottle use is particularly prevalent in Peru (42%). Note that even in countries with low overall prevalence, bottle use may be much higher in urban areas. For example in Ethiopia, where the overall rate of bottle use was 9%, in urban areas 28% of the children aged 6-23 months were fed by bottle the day before the survey.

Low frequency of feeding appears to be a problem in most countries, and particularly in Mali, Rwanda, and Haiti. In these three countries, on average children were fed less than twice the day before the survey.

As noted, all children 6-23 months of age should be receiving solids or semi-solids foods regularly. Late introduction of complementary foods can be assessed indirectly by looking at the proportion of children who received none of the food groups on the questionnaire in the last seven days. Based on this indirect assessment, late introduction of solids/semi-solids is a problem in a number of countries, and is particularly extreme in Ethiopia and Mali, where more than half of the 6-8 month old children received none in the last week. In the case of Mali, nearly one-half of the 9-11 month old children also received none. In Mali, even among 12-23 month old children, 16% had none of the solid/semi-solid food groups in the last week.

This brief description provides a context for the food group recall results, reported in Chapter 5.

5. DIETARY DIVERSITY AND FOOD GROUP PATTERNS

Because dietary diversity indicators have rarely been used in development projects, it is useful to provide a picture of how diet patterns change as diversity increases. In this chapter, we present a series of tables based on the 24-hour food group recall. The results are similar when the 7-day food group recall is used (results not shown). The tables illustrate which food groups children are likely to have eaten yesterday at each level of dietary diversity. For example, if a child has had only one food group, for what proportion of children was this a grain-based staple food? For what proportion was it dairy? At what diversity score did half the children receive meat, poultry, fish or eggs?

Taken together, the results show that particular diversity scores and increases in diversity mean different things in different countries. For example, at a diversity score of “3”, in Benin half the children ate meat, poultry, fish or eggs, yesterday, and most (82%) had food made with oil or fat. However at this same diversity score of “3”, in Ethiopia only 13% had meat, poultry, fish or eggs; in Malawi among those scoring “3” almost no children (4%) had food cooked in fat or oil.

The results also show that in each country, diets do appear to be more adequate as diversity increases. For example, the new Guiding Principles for complementary feeding of breastfed children recommend that children have meat, poultry fish or eggs, and also vitamin A-rich plant foods daily or as often as possible. In each country, children with high dietary diversity scores are much more likely to have had these foods. While this is natural, as the diversity score sums these (and other) groups, it is useful to illustrate this in order to give more meaning to diversity scores.

Before presenting results for individual countries, we provide a comparison of diversity across countries. Table 8 shows the average 24-hour food group diversity score for each country, the percent of children scoring zero, and the percent scoring 0-2 out of a possible range of 0-7.

Table 8. Average 24-hour food group diversity for children aged 6-23 months, by country

	Mean diversity score (range 0-7)	% scoring zero	% scoring 0-2
Africa	(2.6)		
Benin	2.9	15	43
Ethiopia	2.2	13	61
Malawi	2.7	3	45
Mali	1.5	34	77
Rwanda	2.9	6	41
Zimbabwe[a]	3.1	2	38
Asia	(3.0)		
Cambodia	3.3	9	33
Nepal	2.8	8	41
Latin America/Caribbean	(4.3)		
Colombia	4.7	1	10
Haiti	3.8	4	19
Peru	4.5	3	12

[a]The mean diversity score for Zimbabwe is on a scale of 0-6 because one food group was missing from the questionnaire.

Dietary diversity is lowest in Mali and Ethiopia and highest in Peru and Colombia. The regional averages shown in Table 8 are not weighted by sample size but are simple averages of the country-level mean scores. Clearly too few countries are included for these figures to represent entire regions, but the overall picture of low dietary diversity in Africa, intermediate diversity in Cambodia and Nepal, and higher average diversity in the three Latin American/Caribbean countries is not unexpected.

Tables 9-19 show the proportion of children eating each food group yesterday, by diversity score. Those food groups that are elements in the diversity score will naturally be 100% present among children scoring 7. Sub-groups will not necessarily increase to 100%. For example, 100% of the children in Benin who scored “7” had vitamin A-rich plant foods yesterday, exactly because 1 of the 7 points in the score is given for the presence of this group. However, only 50% of the children scoring “7” had yellow/orange vitamin A-rich vegetables, while 67% had leafy greens, and 33% had vitamin A-rich fruits. The final column in Tables 9-19 shows the proportion of all children aged 6-23 months who ate each food group yesterday.

In Tables 9-19, diversity groups are shaded when at least half of the children at a given score had eaten meat, poultry, fish or egg, or vitamin A-rich plant foods. Diversity groups are also shaded when more than half the children had eaten vitamin A-rich fruits or yellow/orange vegetables (i.e., the vitamin A-rich plant food group with leafy greens excluded). These are separated from leafy greens to highlight the fact that these are considered to be a better source of bioavailable carotenoids. In Malawi, Zimbabwe, and Nepal, even at the highest level of diversity the proportion of children who had eaten these more bioavailable sources was less than 50%.

Dairy foods are also very nutrient-dense and are particularly important for non-breastfed children. The relationship between diversity scores and the likelihood of having had dairy yesterday is explored separately below, but only in those countries where a substantial number of children were no longer breastfed. In countries where nearly all the children were still breastfed, the number of non-breastfed children with any particular diversity score is too small for meaningful analysis.

Table 9. Benin: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							**% of all 6-23 mos**
	1	**2**	**3**	**4**	**5**	**6**	**7**	
Percent of sample	**(18%)**	**(10%)**	**(14%)**	**(19%)**	**(16%)**	**(7%)**	**(1%)**	**(85%)**
1. Starchy staples	71	66	85	93	95	98	100	72
Foods made from grain	70	66	83	92	94	98	89	71
Foods made from roots/tubers	1	6	10	14	19	28	39	10
2. Food made from legumes	1	5	15	17	36	81	100	19
3. Dairy	6	13	9	14	37	48	100	17
4. Meat/poultry/fish/eggs	6	34	51	79	91	98	100	49
5. Vit A-rich fruits & vegetables	3	26	35	52	75	92	100	38
Yellow/orange vegetables	1	10	12	20	23	42	50	14
Green leafy vegetables	2	17	29	40	57	64	67	28
Vitamin A-rich fruits	0	2	2	5	12	15	33	5

Yellow/orange fruits/vegs[a]	1	12	14	24	34	53	78	18
6. Other fruits/vegetables/juice	8	19	23	55	69	85	100	35
Other fruits/vegetables	3	9	15	44	54	69	61	26
Fruit juice	6	13	10	20	33	48	56	17
7. Food made with fat or oil	7	37	82	91	97	99	100	57

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

In Benin, as in many countries, most children who only ate one food ate a grain-based staple food. Foods made from roots or tubers, legumes, and dairy, were eaten by a fairly low proportion of children except in the highest diversity groups. By contrast, at a diversity score of "3" more than half the children ate some form of meat, poultry, fish or egg, a third ate vitamin A-rich fruits and vegetables, and more than three-quarters had food cooked in fat or oil.

Also as in many countries, a large proportion of children ate very few food groups yesterday. Including the 15% of children who scored "zero" for diversity (Table 8), nearly half (43%) of the children had fewer than three food groups yesterday.

In Ethiopia, diversity is even lower, with 61% of children scoring 0-2 for diversity yesterday (Table 8). Table 10 (next page) shows results by diversity score. The most common food group eaten by those scoring "1" was once again grain-based foods, but in contrast to many other countries, approximately one-third of children with low diversity scores had milk (other than, and usually in addition to breastmilk) the previous day. Legumes are more common at low diversity scores (e.g. 44% of those scoring "2"), while both meat/poultry/fish/eggs and all fruits and vegetables were less frequently reported for children with low diversity scores.

Table 10. Ethiopia: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							**% of all 6-23 mos**
	1	**2**	**3**	**4**	**5**	**6**	**7**	
Percent of sample	**(22%)**	**(26%)**	**(22%)**	**(11%)**	**(5%)**	**(1%)**	**(0.3%)**	**(87.3)**
1. Starchy staples	63	95	97	99	100	100	100	77
Foods made from grain	58	87	92	92	97	95	100	71
Foods made from roots/tubers	10	16	18	27	36	40	11	16
2. Food made from legumes	0	44	65	76	82	90	100	40
3. Milk other than breastmilk	33	31	32	59	74	76	100	33
4. Meat/poultry/fish/eggs/cheese /yogurt	1	5	13	33	50	85	100	12
5. Vit A-rich fruits & vegetables[a]	2	6	12	22	34	71	100	10
Yellow/orange vegetables	---	---	---	---	---	---	---	---
Green leafy vegetables	---	---	---	---	---	---	---	---
Vitamin A-rich fruits	---	---	---	---	---	---	---	---
Yellow/orange fruits/vegs	---	---	---	---	---	---	---	---
6. Other fruits/vegetables/juice	1	6	10	29	64	79	100	12
Other fruits/vegetables	1	6	9	27	54	68	70	11
Fruit juice	0	0	1	3	11	18	60	2
7. Food made with fat or oil	0	13	72	82	98	100	100	35

[a]On the Ethiopia questionnaire, there was only one food group combining all vitamin A-rich fruits and vegetables.

Table 11. Malawi: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Percent of sample	**(18%)**	**(25%)**	**(28%)**	**(17%)**	**(8%)**	**(2%)**	**(1%)**	**(99)**
1. Starchy staples	97	99	99	99	99	100	100	96
Foods made from grain	97	97	98	99	98	100	100	95
Foods made from roots/tubers	11	25	36	44	44	44	26	30
2. Food made from legumes	0	13	33	54	62	77	100	28
3. Dairy	0	2	3	12	29	66	100	8
4.Meat/poultry/fish/eggs/termites	0	16	45	68	86	97	100	37
5. Vit A-rich fruits & vegetables	1	58	84	91	93	100	100	63
Yellow/orange vegetables	0	7	15	19	26	12	39	12
Green leafy vegetables	1	50	71	76	76	87	84	53
Vitamin A-rich fruits	0	9	19	23	25	36	37	14
Yellow/orange fruits/vegs[a]	1	16	31	38	46	41	42	23
6. Other fruits/vegetables/juice	1	10	33	66	84	93	100	32
Other fruits/vegetables	0	8	27	59	74	89	100	27
Fruit juice	0	3	8	14	21	30	53	8
7. Food made with fat or oil	0	2	4	9	46	66	100	8

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

In Malawi, the proportion scoring 0-2 for diversity is similar to the proportion in Benin, at 45% (Table 8).[13] Nearly all children with low diversity scores ate grain-based foods, with the next food to enter the pattern likely to be leafy greens. Very few children had dairy or any food made with fat or oil, except among those with the highest diversity scores. Other than the leafy greens, vitamin A-rich plant foods are also unlikely to be eaten except by those children with the highest scores.

Mali had the highest proportion of children scoring "zero" for diversity the day before the survey. Fully 1/3 of the children had none of the food groups yesterday. Three-quarters of the children had very low scores (0-2). The overall low diversity is the most compelling piece of information about the diet pattern of these children. As diversity increased, children were more likely to have meat, poultry, fish, or eggs, vitamin A-rich fruits or vegetables, or foods cooked with fat, than they were to have legumes or dairy. At scores of "3", roughly half of the children had meat, poultry, fish or eggs, roughly half had one or more vitamin A-rich plant foods, and roughly half had foods cooked with fat or oil.

[13] Note that the percents reported in Table 8 for 0-2 food groups (e.g., for Malawi, 45%), may differ slightly from the sum of the percents shown in tables 9-19, because of rounding (e.g., Table 8 shows 3% eating none, and Table 18% and 25% eating 1 and 2 groups, respectively. 3+18+25 sums to 46%, but when a categorical variable for 0-2 food groups is used, the rounded percent of children eating 0-2 is 45%).

Table 12. Mali: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	1	2	3	4	5	6	7	% of all 6-23 mos
Percent of sample	**(28%)**	**(15%)**	**(8%)**	**(8%)**	**(4%)**	**(3%)**	**(1%)**	**(67)**
1. Starchy staples	77	83	90	86	100	96	100	55
Foods made from grain	76	80	88	82	93	83	100	53
Foods made from roots/tubers	3	5	11	20	39	71	100	8
2. Food made from legumes	0	8	12	26	43	50	100	8
3. Dairy	6	21	29	51	58	72	100	16
4. Meat/poultry/fish/eggs	5	36	48	73	93	96	100	23
5. Vit A-rich fruits & vegetables	1	27	49	74	76	86	100	20
Yellow/orange vegetables	0	8	15	19	32	45	90	7
Green leafy vegetables	0	6	10	41	28	32	80	8
Vitamin A-rich fruits	1	16	38	41	49	71	90	14
Yellow/orange fruits/vegs[a]	1	23	45	54	68	75	100	17
6. Other fruits/vegetables/juice	7	9	26	28	68	100	100	14
Other fruits/vegetables	2	4	15	12	61	64	90	8
Fruit juice	6	7	14	20	35	54	40	8
7. Food made with fat or oil	3	15	47	62	65	100	100	18

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

In Rwanda, the proportion of children scoring zero was low (6%), but the proportion scoring 0-2 was once again comparable to Benin and Malawi, at 41%. Roots and tubers were more frequently eaten in Rwanda as compared to the other African countries. Among children with low diversity scores, legumes were also more commonly eaten than in many other countries (see Table 13, next page). Children with low to moderate scores were also fairly likely to have eaten vitamin A-rich vegetables. Only children with the highest diversity scores were likely to have had any animal source foods (the dairy group, or meat, poultry, fish or eggs).

Table 13. Rwanda: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Percent of sample	**(13%)**	**(21%)**	**(26%)**	**(19%)**	**(10%)**	**(4%)**	**(1%)**	**(94)**
1. Starchy staples	72	83	91	96	99	99	100	83
Foods made from grain	57	59	71	79	83	83	100	65
Foods made from roots/tubers	30	62	66	73	79	75	86	59
2. Food made from legumes	3	51	75	80	86	87	100	58
3. Dairy	7	4	7	16	29	60	100	13
4. Meat/poultry/fish/eggs	1	4	8	16	30	72	100	13
5. Vit A-rich fruits & vegetables	13	37	69	79	89	92	100	55
Yellow/orange vegetables	9	20	39	41	45	50	46	30
Green leafy vegetables	5	20	39	50	59	67	86	34
Vitamin A-rich fruits	1	6	9	23	26	45	71	13
Yellow/orange fruits/vegs[a]	10	26	45	56	59	74	82	39
6. Other fruits/vegetables/juice	3	12	23	49	81	98	100	31
Other fruits/vegetables	3	10	21	45	71	87	79	27
Fruit juice	1	3	4	8	19	31	54	7
7. Food made with fat or oil	1	10	28	64	87	93	100	35

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

Table 14. Zimbabwe: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Percent of sample	**(11%)**	**(25%)**	**(25%)**	**(19%)**	**(13%)**	**(5%)**	---	**(98)**
1. Starchy staples	91	96	97	100	100	100	---	96
Foods made from grain	91	96	97	100	99	100	---	95
Foods made from roots/tubers	1	7	10	26	33	40	---	16
2. Food made from legumes	0	16	40	64	83	100	---	43
3. Dairy	1	7	12	24	47	100	---	21
4. Meat/poultry/fish/eggs	1	11	36	66	91	100	---	43
5. Vit A-rich fruits & vegetables	2	54	71	75	88	100	---	63
Yellow/orange vegetables	0	4	3	7	19	28	---	7
Green leafy vegetables	1	52	70	71	81	98	---	60
Vitamin A-rich fruits	0	3	5	9	10	9	---	6
Yellow/orange fruits/vegs[a]	0	7	7	16	29	36	---	13
6. Other fruits/vegetables/juice	5	15	44	72	90	100	---	47
Other fruits/vegetables	3	14	38	64	82	84	---	42
Fruit juice	2	7	17	31	51	74	---	23
7. Food made with fat or oil	---	---	---	---	---	---	---	---

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits. Because the Zimbabwe questionnaire did not include a food group for foods cooked with fats or oil the diversity score ranges from 0-6 instead of 0-7; this makes direct comparisons with other countries more difficult. However the general pattern seen for Zimbabwe is similar to Malawi, with the vast majority of children having had a grain-based staple yesterday, and with the next most commonly eaten food among children with low scores being leafy greens. Few children ate yellow/orange vegetables or vitamin A-rich fruits. It is also worth noting that despite the smaller range of possible scores, the average diversity score in Zimbabwe (3.1) was higher than in any of the other African countries analyzed, and was twice as high as the average score in Mali (1.5). (See Table 8).

Moving on to the two Asian countries, the average diversity score in Cambodia was similar to Zimbabwe, at 3.25. The proportion scoring 0-2 was lower than in any of the African countries, at 33%. Table 15 shows results by diversity score for Cambodia.

Table 15. Cambodia: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Percent of sample	**(10%)**	**(14%)**	**(19%)**	**(23%)**	**(15%)**	**(10%)**	**(1%)**	**(92)**
1. Starchy staples	92	96	97	100	100	100	100	89
Foods made from grain	92	96	97	100	99	100	100	89
Foods made from roots/tubers	1	7	11	19	25	58	87	18
2. Food made from legumes	0	2	5	7	27	93	100	17
3. Tinned/ powdered/ condensed milk	3	4	2	2	3	12	100	4
4. Meat/poultry/fish/eggs/organ meats, other small protein food	1	57	83	93	95	100	100	70
5. Vit A-rich fruits & vegetables	0	10	49	84	97	100	100	55
Yellow/orange vegetables	0	6	15	36	50	74	87	27
Green leafy vegetables	0	5	27	52	68	84	87	37
Vitamin A-rich fruits	0	5	21	40	42	55	100	27
Yellow/orange fruits/vegs[a]	0	9	33	62	69	89	100	41
6. Other fruits/vegetables/juice	4	25	44	80	93	100	100	55
Other fruits/vegetables	3	21	36	66	79	94	87	47
Fruit juice	2	8	12	33	47	53	73	24
7. Food made with fat or oil	0	7	22	35	81	96	100	35

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

In interpreting Table 15, note the extremely low proportion of children who were reported to have had dairy yesterday. Unlike the Model questionnaire, on the Cambodia questionnaire included in the country report (National Institute of Statistics, Directorate General for Health [Cambodia], and ORC Macro, 2001) the group for milk other than breastmilk was worded as “Any other milk such as tinned, powdered, or sweetened condensed milk?” If fresh milk was not included in the questionnaire in the field, this could explain the extremely low proportion of children reported to have had milk yesterday (except at a diversity score of 7, which by definition includes a point for dairy and must = 100%). Overall, only 4% of the children were reported to have had milk yesterday. This would also affect all other proportions in Table 15. Leaving this aside, it appears that even at low diversity scores children are quite likely to have had non-dairy animal foods, and next most likely to have had fruits and vegetables.[14]

In Nepal, the average diversity score (2.8) was lower than in Cambodia, and was very similar to Benin and Rwanda. Table 16 shows results by diversity score for Nepal.

[14] Note that the proportion having vitamin A-rich fruits may be overestimated; see Annex 1 for details.

Table 16. Nepal: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Percent of sample	**(11%)**	**(22%)**	**(26%)**	**(19%)**	**(10%)**	**(3%)**	**(1%)**	**(92)**
1. Starchy staples	78	99	100	100	100	100	100	89
Foods made from grain	77	99	100	100	100	98	100	89
Foods made from roots/tubers	34	53	58	70	72	80	87	54
2. Food made from legumes	1	23	49	65	77	93	100	42
3. Dairy	19	29	39	58	73	88	100	40
4. Meat/poultry/fish/eggs	0	6	12	24	42	58	100	16
5. Vit A-rich fruits & vegetables	1	15	29	48	69	88	100	30
Yellow/orange vegetables	---	---	---	---	---	---	---	---
Green leafy vegetables	1	13	26	41	53	62	93	25
Vitamin A-rich fruits	---	---	---	---	---	---	---	---
Yellow/orange fruits/vegs[a]	0	3	4	11	18	34	25	7
6. Other fruits/vegetables/juice	---	---	---	---	---	---	---	---
Other fruits/vegetables	1	4	12	29	56	82	100	19
Fruit juice	---	---	---	---	---	---	---	---
7. Food made with fat or oil	0	26	59	77	83	90	100	47

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

Unlike in any of the countries described to this point, in Nepal many people are vegetarian and this obviously affects diet patterns for children. Overall 16% of the children aged 6-23 months had eaten meat, poultry, fish or eggs the previous day. Among children with lower diversity scores, the most common foods were foods made from grain (presumably rice), roots or tubers (likely potatoes), legumes, dairy, and foods cooked with fat or oil. Fruits and vegetables were less commonly reported, and yellow/orange fruits and vegetables were particularly rare.

As noted previously, average dietary diversity in Colombia – at 4.7 food groups yesterday – was higher than in any other country included in our analysis. In Colombia, only 10% of the children in the survey had scores of 0-2 for food group diversity yesterday. Table 17 shows results by diversity score for Colombia.

Other than the overall high diversity, other diet patterns to note in Colombia include the high proportion of children who scored "1" who had dairy the day before. This is related to the fact that a higher proportion of children are no longer breastfed in Colombia than in any of the other countries (only 47% of the children aged 6-23 months were still breastfed).[15] Meat, poultry, fish and eggs, and also fruit juice, were commonly reported even among children with low diversity scores. Among children scoring "3" 59% had meat, poultry, fish or eggs, and among children scoring as low as "2", 31% had fruit juice the previous day.

[15] Also see Annex 1 for an explanation of some issues with this food group on the Colombia questionnaire. The vitamin A-rich fruit group also included a number of foods which are not extremely rich sources of carotenoids; this is also detailed in Annex 1.

Table 17. Colombia: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Percent of sample	**(3%)**	**(6%)**	**(10%)**	**(17%)**	**(29%)**	**(26%)**	**(9%)**	**(100)**
1. Starchy staples	33	74	86	91	98	100	100	92
Foods made from grain	29	61	72	79	89	94	99	83
Foods made from roots/tubers	26	44	66	72	83	83	85	75
2. Food made from legumes	0	6	12	18	25	49	100	33
3. Dairy	46	45	63	70	91	96	100	82
4. Meat/poultry/fish/eggs	8	24	59	79	90	96	100	80
5. Vit A-rich fruits & vegetables	0	6	26	50	79	89	100	66
Yellow/orange vegetables	0	6	15	38	62	68	82	51
Green leafy vegetables	---	---	---	---	---	---	---	---
Vitamin A-rich fruits	0	0	14	28	45	58	60	39
Yellow/orange fruits/vegs[a]	0	6	26	50	79	89	100	66
6. Other fruits/vegetables/juice	13	42	42	59	82	95	100	74
Other fruits/vegetables	3	15	21	30	53	69	78	48
Fruit juice	8	31	31	44	67	73	83	58
7. Food made with fat or oil	0	6	14	32	35	76	100	46

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

The average diversity score in Haiti was lower than in Colombia, at 3.8, but higher than in any of the countries in Africa or Asia. Nineteen percent of the children in Haiti had scores of 0-2. Table 18 shows results by diversity score for Haiti.

Table 18. Haiti: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Percent of sample	**(4%)**	**(11%)**	**(22%)**	**(26%)**	**(20%)**	**(11%)**	**(3%)**	**(97)**
1. Starchy staples	15	71	92	96	94	99	100	85
Foods made from grain	9	61	88	92	84	97	98	80
Foods made from roots/tubers	6	20	21	33	36	32	51	28
2. Food made from legumes	0	2	7	25	32	80	100	26
3. Dairy	4	19	8	17	41	57	100	26
4. Meat/poultry/fish/eggs	3	3	11	28	67	83	100	35
5. Vit A-rich fruits & vegetables	4	13	31	52	80	84	100	50
Yellow/orange vegetables	3	4	11	15	34	42	70	20
Green leafy vegetables	0	7	9	20	43	45	82	24
Vitamin A-rich fruits	3	4	17	35	40	43	66	28
Yellow/orange fruits/vegs[a]	4	7	25	46	62	67	86	41
6. Other fruits/vegetables/juice	57	31	59	84	87	98	100	71
Other fruits/vegetables	17	8	27	38	53	65	53	36
Fruit juice	47	27	47	64	68	71	98	56
7. Food made with fat or oil	16	62	94	98	99	99	100	86

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

Among children in Haiti with low diversity scores, starchy staples and foods cooked with fat or oil were most commonly eaten. Even at low diversity scores, many children had juice. Children with low diversity scores were unlikely to have eaten legumes, meat, poultry, fish or eggs, or yellow/orange vegetables.

Finally, Table 19 shows results for Peru. The average diversity score for Peru, at 4.49, was almost as high as in Colombia. In interpreting differences between Colombia and Peru (for example, the proportion of children having had dairy) note that in Peru three-quarters of the children were still breastfed (as compared to roughly half in Colombia).

Table 19. Peru: Percentage of 6-23 month old children who consumed different food groups, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Percent of sample	**(3%)**	**(6%)**	**(13%)**	**(19%)**	**(26%)**	**(23%)**	**(8%)**	**(98)**
1. Starchy staples	59	89	96	99	100	100	100	94
Foods made from grain	48	77	86	92	94	97	99	89
Foods made from roots/tubers	39	72	80	88	89	92	93	84
2. Food made from legumes	2	11	19	25	31	44	100	34
3. Dairy	21	13	21	43	66	89	100	57
4. Meat/poultry/fish/eggs	7	23	41	61	85	96	100	70
5. Vit A-rich fruits & vegetables	5	25	58	76	92	98	100	77
Yellow/orange vegetables	4	14	41	59	73	81	81	61
Green leafy vegetables	1	10	22	38	58	67	79	47
Vitamin A-rich fruits	1	10	23	29	46	54	61	38
Yellow/orange fruits/vegs[a]	5	23	53	71	87	94	95	73
6. Other fruits/vegetables/juice	1	9	17	32	52	86	100	50
Other fruits/vegetables	0	7	12	27	43	71	84	41
Fruit juice	1	3	6	13	22	36	54	21
7. Food made with fat or oil	5	30	49	66	75	86	100	67

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

In Peru as in Colombia the overall picture is one of very high diversity. Only 12% of the children scored from 0-2. Children with low diversity scores were likely to have eaten grain-based foods and potatoes, and food made with fat or oil. At scores as low as "3" children were likely to have had at least one vitamin A-rich fruit or vegetable.

Note, however, that on the Peru questionnaire a number of atypical items were listed among the vitamin A-rich fruits and vegetables. Tomatoes were included with pumpkin, carrots, etc. While tomatoes provide some carotenoids, they are generally not considered rich enough sources to be included on lists of vitamin A-rich plant foods. Celery and leeks were included in the "greens" group, and plantains were included with the vitamin A-rich fruits. Plantains are not generally very rich in carotenoids, but it is possible that some local varieties are. In sum, the proportion of children eating vitamin A-rich fruits and vegetables may be overestimated.

Breastfeeding, dairy, and diversity

Milk and other dairy foods are particularly important for children who are no longer breastfed. For these children, dairy foods can be a very important source of calcium and other nutrients. Table 20 shows the proportion of children who had dairy yesterday at each level of the diversity score. Breastfed children are compared to children who are no longer breastfed.

Countries were excluded (Benin, Mali, and Nepal) if there were fewer than 150 non-breastfed children, because the number of non-breastfed children at any one level of the diversity score becomes very small. Cambodia also was excluded because of uncertainties about the wording of the milk question, and the unusually small number of children reported to have had milk.

Diversity scores are shaded where at least 50% of the non-breastfed children had dairy.

Table 20. Percentage of 6-23 month old children who consumed dairy, by category of 24-hour food group diversity

	Food group diversity: # of food groups consumed yesterday							% of all 6-23 mos
	1	2	3	4	5	6	7	
Africa								
Ethiopia								
Not breastfed	8	40	56	77	96	100	100	56
Breastfed	34	30	29	56	67	69	100	31
Malawi								
Not breastfed	0	6	4	17	48	44	100	16
Breastfed	0	2	3	12	27	70	100	7
Rwanda								
Not breastfed	0	0	16	25	44	75	100	29
Breastfed	7	4	6	15	25	56	100	11
Zimbabwe								
Not breastfed	0	7	14	27	62	100	---	36
Breastfed	1	7	11	22	40	100	---	17
Latin America/Caribbean								
Colombia								
Not breastfed	47	52	70	74	96	98	100	89
Breastfed	46	43	59	66	84	93	100	74
Haiti								
Not breastfed	0	7	6	19	45	59	100	35
Breastfed	5	22	8	16	38	56	100	22
Peru								
Not breastfed	0	13	27	54	85	96	100	78
Breastfed	22	13	20	40	58	86	100	51

Table 20 shows that in most countries, children with low diversity scores are unlikely to have had milk or dairy. In Ethiopia and Colombia, children are more likely to have had dairy. Because of differing diet patterns (reflecting access to milk and dairy) there is no consistency across countries in the score at which at least half of the children had milk.

Tables 9-20 provide a picture of the relationship between each diversity score and the likelihood that children will have eaten particular food groups, including those rich in micronutrients. These tables also illustrate the difficulties with summarizing information on food group diversity when each diversity score is looked at separately. In the next chapter, we explore the possibility of creating categories for diversity.

6. CATEGORIES FOR DIETARY DIVERSITY

When assessing the diets of young children in developing countries, there is consensus that more diverse diets are generally better. However, there is no international recommendation concerning an adequate or optimal level of food group diversity for young children, and thus there are no agreed upon cut-offs for low or high diversity.

The most meaningful categories for dietary diversity would reflect defined relationships to nutrient adequacy. Several studies described in Chapter 1 look at diversity categories in this way. Future validation work may show whether it is possible to consistently relate diversity indicators and cut-offs to nutrient adequacy across contexts, or whether cut-offs must always be context-specific and based on detailed local work.

Meanwhile, if diversity indicators are to be useful to project managers some other approach to thinking about diversity categories may be needed. For many purposes, managers may prefer indicators with cut-offs, which can be expressed as percents, to indicators such as "the average diversity score". In this chapter we describe two approaches. First, as we have done previously (Arimond and Ruel, 2002), we create sample-specific terciles for dietary diversity, and then compare these among countries. Secondly, we describe an approach for defining diversity groups based on recommendations in the recently published Guiding Principles for complementary feeding (PAHO/WHO, 2003).

6.1. Sample-specific Diversity Terciles

The 7-point diversity score described previously was used to create terciles. Two different types of categorical variables (both terciles) were created. First, as in our previous analysis, we looked at the distribution of diversity scores within small age groups (6-8, 9-11, 12-17, and 18-23 months) and created terciles within each age group. That is, each child was ranked as having low, middle or high diversity, but the diversity cut-off for these groups vary by age, reflecting the distribution of diversity within age groups in the samples. These ranking variables were then combined into one and used in further analysis in the next chapter focusing on the relationship between dietary diversity and height-for-age.

A second categorical variable for diversity was constructed more simply, using the distribution of diversity across the entire age range (6-23 months). In the context of programs and projects, sample sizes within small age groups preclude construction of the more complex variable described above, with age-specific terciles. For monitoring and evaluation purposes, it does not matter that younger children are likely to have lower diversity scores, so long as any monitoring or evaluation involves groups with similar age distribution (e.g., at baseline and end of project).[16]

[16] For analytic purposes, it does matter that younger children score lower and therefore the more complicated, age-specific terciles are needed in the bivariate and multivariate analyses reported in Chapter 7.

Table 21 shows the resulting categories for low, middle, and high diversity for this second, simpler indicator, by country.[17] This gives a visual overview of the variation in cut-offs by country. Tables 22-25 follow, with the age-specific cut-offs.

Table 21. Dietary diversity terciles for ten countries, children aged 6-23 months

	Food group diversity: # of food groups consumed yesterday							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Africa								
Benin	▒	▒	▒	▒	▒	█	█	█
Ethiopia	▒	▒	▒	█	█	█	█	█
Malawi	▒	▒	▒	▒	█	█	█	█
Mali	▒	▒	█	█	█	█	█	█
Rwanda	▒	▒	▒	▒	█	█	█	█
Asia								
Cambodia	▒	▒	▒	▒	▒	█	█	█
Nepal	▒	▒	▒	▒	█	█	█	█
Latin America/Caribbean								
Colombia	▒	▒	▒	▒	▒	▒	█	█
Haiti	▒	▒	▒	▒	▒	█	█	█
Peru	▒	▒	▒	▒	▒	▒	█	█

▒ = Low diversity

▒ = Middle diversity

█ = High diversity

Table 21 illustrates large differences in cut-offs, reflecting large differences between countries in the distribution of diversity scores. In the country with the lowest diversity, Mali, the lowest tercile includes only those children who had none of the food groups, the middle tercile includes only those who had just one food group, and the "high" diversity group ranges from 2-7 food groups yesterday. In Ethiopia, the groups are 0-1 (low), 2 (middle), and 3-7 ("high" diversity). At the other extreme, in Colombia the low diversity tercile includes children who had from 0-4 food groups yesterday, the middle group had 5, and the high diversity tercile includes only children with 6 or 7 food groups yesterday. Even within the Africa region, there are a variety of cut-offs, with the high diversity group in Benin including children who had 5-7 groups yesterday.

Tables 22-25 document the cut-offs for the diversity when terciles are determined within each small age group. Since diversity changes with age, we examined these cut-offs to see if cut-points defining low, middle and high groups might be more consistent across countries but within small age groups, as compared to the cut-offs defined across the 6-23 month age group and illustrated in Table 21. Tables 22-25 show that the lack of consistency in tercile cut-offs remains, even within narrow age groups. For example, even among the youngest children aged 6-8 months – who would be expected to have the least diverse diets – the cut-off for low

[17] Zimbabwe is excluded from this analysis because one food group was not on the questionnaire, and the range for the diversity score in Zimbabwe is therefore smaller.

diversity ranges from < 1 in Benin, Ethiopia, and Mali, to < 3 in Colombia and Peru. Among the older children the range is wider.

Table 22. Dietary diversity terciles for ten countries, children aged 6-8 months

	Food group diversity: # of food groups consumed yesterday							
	0	1	2	3	4	5	6	7
Africa								
Benin								
Ethiopia								
Malawi								
Mali								
Rwanda								
Asia								
Cambodia								
Nepal								
Latin America/Caribbean								
Colombia								
Haiti								
Peru								

= Low diversity

= Middle diversity

= High diversity

Table 23. Dietary diversity terciles for ten countries, children aged 9-11 months

	Food group diversity: # of food groups consumed yesterday							
	0	1	2	3	4	5	6	7
Africa								
Benin								
Ethiopia								
Malawi								
Mali								
Rwanda								
Asia								
Cambodia								
Nepal								
Latin America/Caribbean								
Colombia								
Haiti								
Peru								

= Low diversity

= Middle diversity

= High diversity

Table 24. Dietary diversity terciles for ten countries, children aged 11-17 months

	Food group diversity: # of food groups consumed yesterday							
	0	1	2	3	4	5	6	7
Africa								
Benin								
Ethiopia								
Malawi								
Mali								
Rwanda								
Asia								
Cambodia								
Nepal								
Latin America/Caribbean								
Colombia								
Haiti								
Peru								

= Low diversity

= Middle diversity

= High diversity

Table 25. Dietary diversity terciles for ten countries, children aged 18-23 months

	Food group diversity: # of food groups consumed yesterday							
	0	1	2	3	4	5	6	7
Africa								
Benin								
Ethiopia								
Malawi								
Mali								
Rwanda								
Asia								
Cambodia								
Nepal								
Latin America/Caribbean								
Colombia								
Haiti								
Peru								

= Low diversity

= Middle diversity

= High diversity

From a project evaluation perspective, sample-specific terciles (of either type shown above) have the advantage of identifying a cut-off for "high" diversity that is achievable for a substantial proportion of the population. In low diversity countries and areas this may be useful for setting realistic program objectives with respect to dietary diversity. However, sample-specific terciles require some extra steps in analysis of baseline (or other) data and may be more complicated than some managers prefer. Secondly, as shown in the tables above, in low diversity areas such as Ethiopia and Mali even the "high" diversity group may include many children whose diets are far from adequate.

6.2. Diversity Categories Based on Recommended Food Groups

While there are no existing international recommendations regarding the number of food groups young children should eat, the recently published Guiding Principles for complementary feeding (PAHO/WHO, 2003) offer the following guidance on the nutrient content of complementary food:

> *Feed a variety of foods to ensure that nutrient needs are met. Meat, poultry, fish, or eggs should be eaten daily, or as often as possible. Vegetarian diets cannot meet nutrient needs at this age unless nutrient supplements or fortified products are used. Vitamin A-rich fruits and vegetables should be eaten daily. Provide diets with adequate fat content. Avoid giving drinks with low nutrient value, such as tea, coffee and sugary drinks such as soda. Limit the amount of juice offered so as to avoid displacing more nutrient-rich foods.*

We recently considered the issue of cut-offs in work meant to meet PVO needs for simple indicators (Arimond and Ruel, 2003), and we drew on the above PAHO/WHO guidance. We scored diversity as low, middle or high based on the following rationale: When children receive only one food, in most countries it is extremely likely to be a starchy staple food (grain-based or root/tuber-based) (see Tables 9-19). A diversity score of two allows only one additional food group, and therefore the child's diet cannot meet the guidelines, which recommend both animal source foods and vitamin A-rich plant foods daily. Therefore children eating 0-2 food groups are considered to have "low" diversity.

In order to define "high" diversity we looked at the 10 DHS surveys (all except Zimbabwe). Using a low diversity group scoring 0-2, the middle group must, at minimum, consist of a score of 3. We constructed categorical variables using cut-offs of 4, 5, and 6 for the high diversity group. We looked for a cut-off point that would mean, in each country, that at least 50% of the children ate meat, poultry, fish or eggs the day before, at least 50% had vitamin A-rich fruits or vegetables, and at least 50% of non-breastfed children had dairy products yesterday. Using a cut-off score of 5 (that is, the high diversity group comprises those scoring 5-7), these criteria were met in almost all cases. There were three exceptions: in Ethiopia, only 45% in the "high" diversity group had vitamin A-rich fruits and vegetables; in Rwanda 48% in the high diversity group had meat, poultry, fish or eggs, and in Nepal 49% in the high diversity group had meat, poultry, fish or eggs.

The use of a 50% criterion is arbitrary, and represents a compromise. If the criterion was that all children must have both meat, poultry, fish, or eggs and also vitamin A-rich fruits and vegetables, the cut-off for high diversity would have to be set at "7"; this seems unrealistically high. Looking at Table 21, groups of 0-2 (low), 3-4 (middle), and 5-7 (high diversity) do represent a compromise between the extremes. Arguments could be made for setting the cut-off for "high" at 4, particularly in Africa, or alternatively for setting the bar higher, and seeking cut-offs where a higher proportion of children (two-thirds or three-fourths) had the high-quality nutrient dense food groups recommended in the Guiding Principles.

Ultimately, a satisfactory answer to the question of cut-offs will require more work validating various types of diversity indicators, with a variety of cut-offs, against nutrient adequacy. In the meantime, Table 26 shows the proportion of children in each country who would be classified into the three diversity groups described above, and Tables 27 and 28 provide examples of how the diversity groups can be used to summarize the types of information found in tables 9-20.

Table 26. Percent of children 6-23 months in 10 countries with low, middle, and high scores for dietary diversity, using fixed cut-offs

	Low diversity (0-2 food groups)	Middle (3-4 food groups)	High diversity (5-7 food groups)
Africa			
Benin	43	33	24
Ethiopia	61	33	7
Malawi	45	45	10
Mali	77	16	7
Rwanda	41	44	15
Asia			
Cambodia	33	42	26
Nepal	41	45	14
Latin America/Caribbean			
Colombia	10	27	63
Haiti	19	47	34
Peru	12	31	57

Table 26 again reflects differences between countries in dietary diversity; diversity is lowest in Mali and Ethiopia, with only 7% of children classified as having had high diversity yesterday, and well over half the children in the lowest diversity group. Diversity is highest in Colombia and Peru, where only 10-12% of children were classified as having had low diversity, and over half were classified as having had high dietary diversity.

Tables 27 and 28 show results for Benin and Ethiopia using the three fixed categories for low, middle, and high diversity. Contrasts between the diet patterns at different levels of diversity are easier to see and interpret than in the earlier presentation (Tables 9 and 10).[18]

[18] In addition, when surveys are done in the context of projects, sample sizes are much smaller than DHS sample sizes. With small sample sizes, the number of children represented by each cell in Tables 9-20 becomes very small,

Table 27. Benin: Percentage of 6-23 month old children who consumed different food groups by dietary diversity category (fixed cut-offs for low, middle, and high diversity)

	Dietary diversity: # of food groups consumed yesterday			% of all 6-23 mos
	Low 0-2	Middle 3-4	High 5-7	
Percent of sample	**(43%)**	**(33%)**	**(24%)**	**(100)**
Starchy staples	45	90	96	94
Food made from legumes	2	16	53	34
Dairy	5	12	44	57
Meat/poultry/fish/eggs	11	67	94	70
Vit A-rich fruits & vegetables	7	45	81	77
Green leafy vegetables	5	35	60	47
Yellow/orange fruits/vegs[a]	3	20	42	73
Other fruits/vegetables/juice	8	41	75	50
Other fruits/vegetables	4	31	60	41
Fruit juice	5	16	39	21
Food made with fat or oil	12	87	97	67

[a]This category combines the yellow/orange vegetables (pumpkin, carrots, etc.) with the vitamin A-rich fruits.

Table 28. Ethiopia: Percentage of 6-23 month old children who consumed different food groups by dietary diversity category (fixed cut-offs for low, middle, and high diversity)

	Dietary diversity: # of food groups consumed yesterday			% of all 6-23 mos
	Low 0-2	Middle 3-4	High 5-7	
Percent of sample	**(61%)**	**(33%)**	**(7%)**	**(100)**
Starchy staples	63	98	100	77
Food made from legumes	19	69	84	40
Milk other than breastmilk	25	41	74	33
Meat/poultry/fish/eggs	2	19	59	12
Vit A-rich fruits & vegetables	3	15	45	10
Other fruits/vegetables/juice	3	16	68	12
Other fruits/vegetables	3	15	58	11
Fruit juice	0	2	15	2
Food made with fat or oil	6	75	99	35

In the next chapter, we explore the relationship between dietary diversity and height-for-age Z-scores.

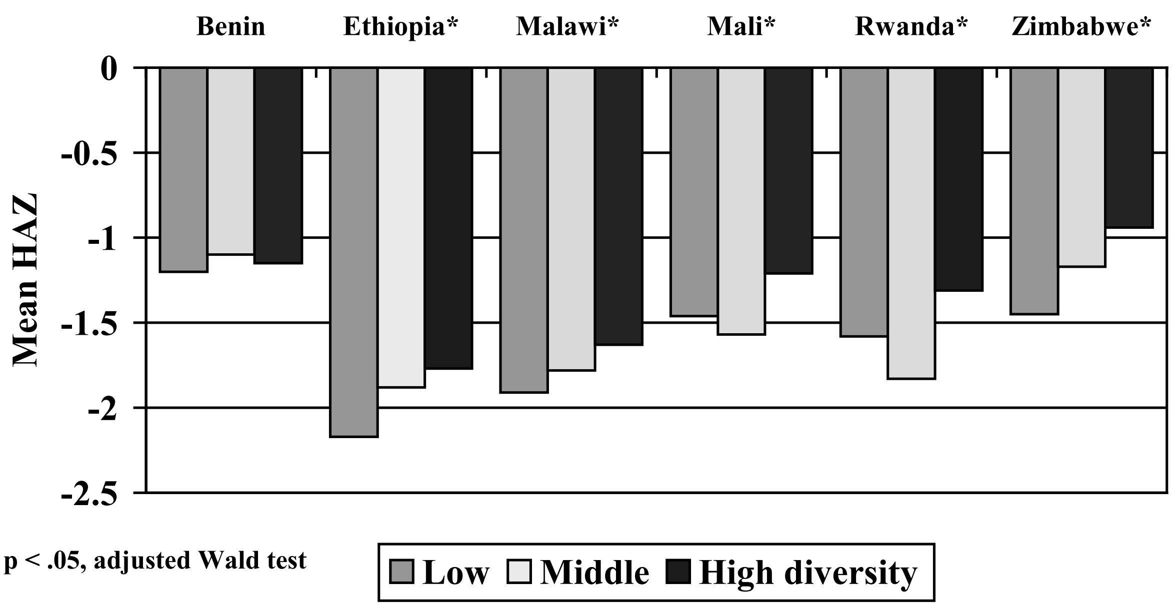
and can be hard to interpret.

7. ASSOCIATION BETWEEN DIETARY DIVERSITY AND HEIGHT-FOR-AGE Z-SCORES

In previous work, we assessed the association between dietary diversity and HAZ in the Ethiopia *DHS+* sample. We found a strong linear association between diversity and HAZ, which remained after statistical control for a number of potential confounders (Arimond and Ruel, 2002). We repeated this analysis using data from eleven recent *DHS+* surveys. In this report, we have focused on children aged 6-23 months and therefore also present results for Ethiopia once more, since the age group used in the previous analysis was different (12-35 months).

Bivariate results (simple comparisons of HAZ by diversity tercile[19]) are presented in Figures 4 and 5. These Figures show overall results, across age groups, and indicate whether each association between HAZ and dietary diversity tercile is statistically significant across the age range of 6-23 months.

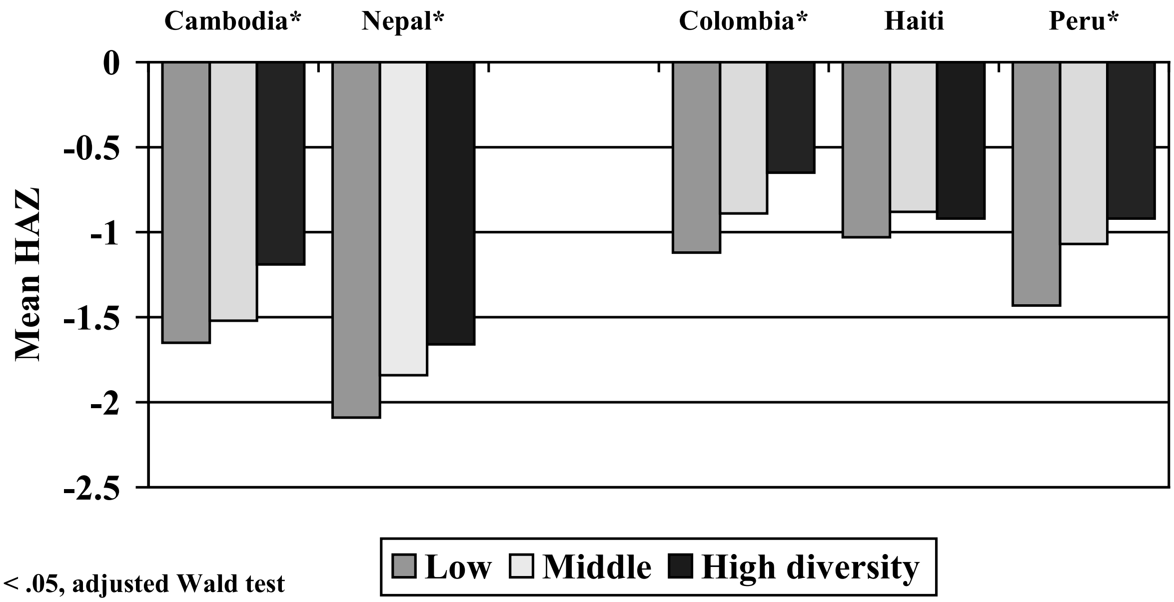
Figure 4. Mean HAZ by dietary diversity tercile in six African countries



*** p < .05, adjusted Wald test**

[19] For all analyses in this chapter, we used dietary age-specific diversity terciles reflecting the number of food groups eaten three or more days out of the last seven. The exception to this is Haiti, where 24-hour diversity terciles were used as there was no 7-day recall. Chapter 8 compares the 3-day diversity indicator to the indicator derived from the 24-hour recall, and shows the two to be similar.

Figure 5. Mean HAZ by dietary diversity tercile (6-23 months): Five countries in Asia and the LAC region



* p < .05, adjusted Wald test

In nine of eleven countries, Figures 4 and 5 show significant bivariate associations between HAZ and dietary diversity terciles. Differences between extreme terciles in these nine countries range from 0.25 in Mali to 0.51 in Zimbabwe. The differences are generally in the expected direction, but in some cases are not consistent in direction. In Mali and Rwanda children in the middle diversity tercile have the lowest mean HAZ. Figures 6-16 show associations within six-month age groups. When results are shown within age groups, children in Mali and Rwanda no longer look "worse off" in the middle diversity tercile.

In Figures 6-16, results are presented within age group. Figure 6 shows HAZ by diversity tercile for Benin, for ages 6-11 months, 12-17 months, and 18-23 months. Figures 7-16 follow, and show HAZ by diversity tercile within these age groups for the remaining ten countries. Figures 6-16 show generally consistent patterns in the association between dietary diversity and mean HAZ. In five of the nine countries with significant associations – Ethiopia, Mali, Cambodia, Nepal, and Colombia – the difference between the lowest and the highest tercile of dietary diversity is largest among the oldest children (18-23 months). Differences in this age group range from 0.52 Z-score units in Colombia to 0.91 Z-score units in Cambodia.[20] In three other countries, all in Eastern or Southern Africa, the difference is largest for the youngest children (Malawi, Rwanda, and Zimbabwe). In Rwanda and Zimbabwe, the difference among the oldest age group is also large (0.53 and 0.49 Z-score units, respectively). In Peru differences are large for both the middle and the oldest age group (0.77 and 0.59 Z-scores units for the two age groups).

[20]Differences in HAZ scores of this size have been associated with both short-term and long-term functional outcomes, especially cognitive development, fulfillment of intellectual potential, work capacity and reproductive performance, and are therefore considered biologically meaningful, or of functional significance (Martorell and Scrimshaw, 1995).

Figure 6. Benin: HAZ by dietary diversity tercile, within age groups

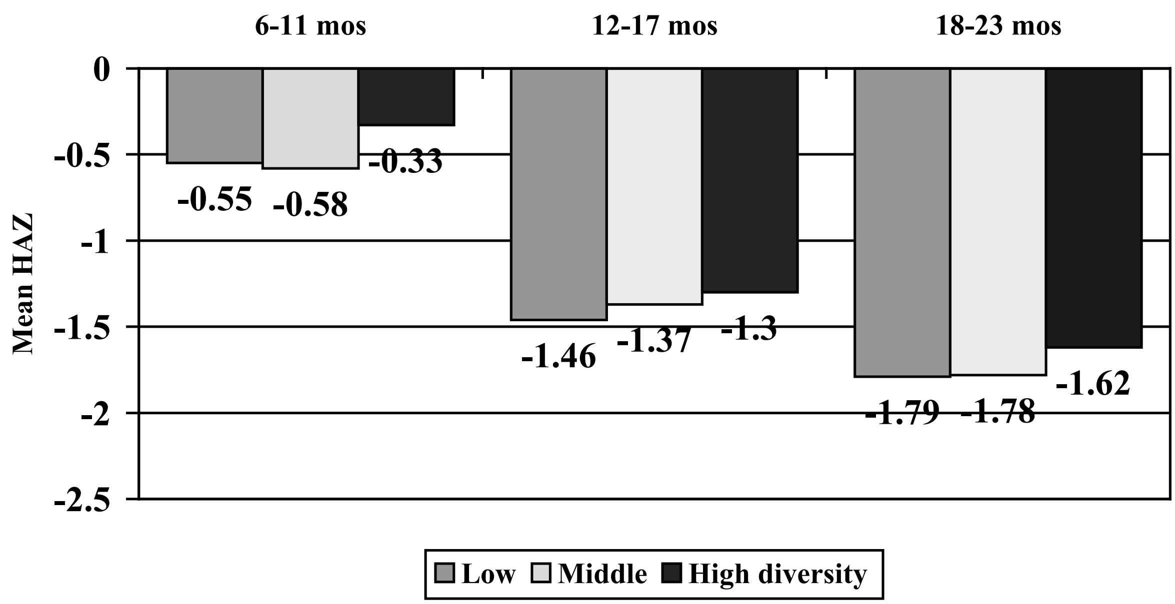


Figure 7. Ethiopia: HAZ by diet diversity tercile, within age groups

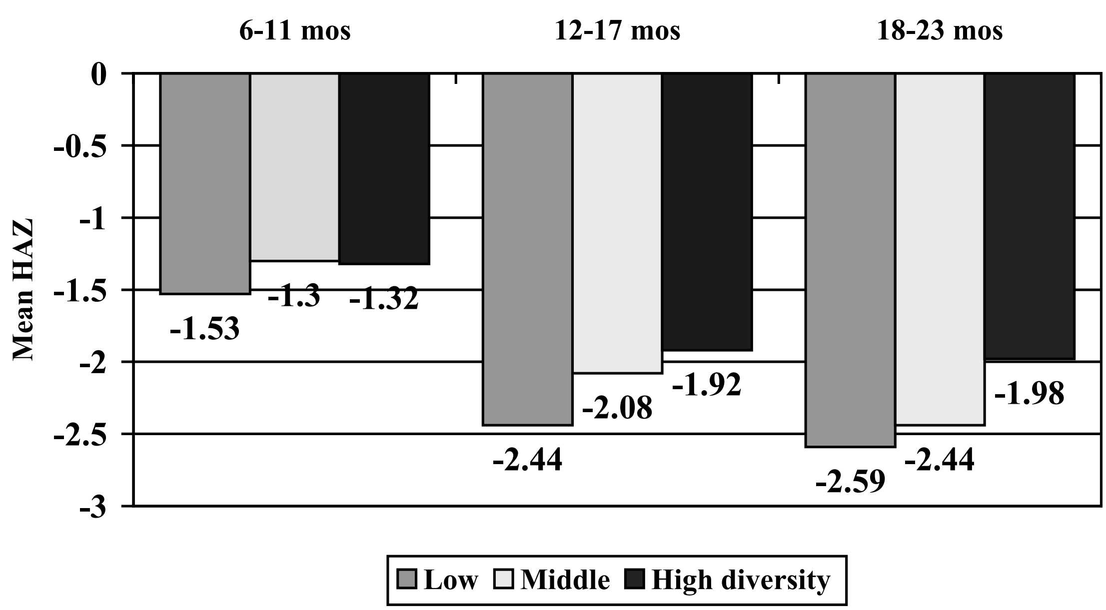


Figure 8. Malawi: HAZ by dietary diversity tercile, within age groups

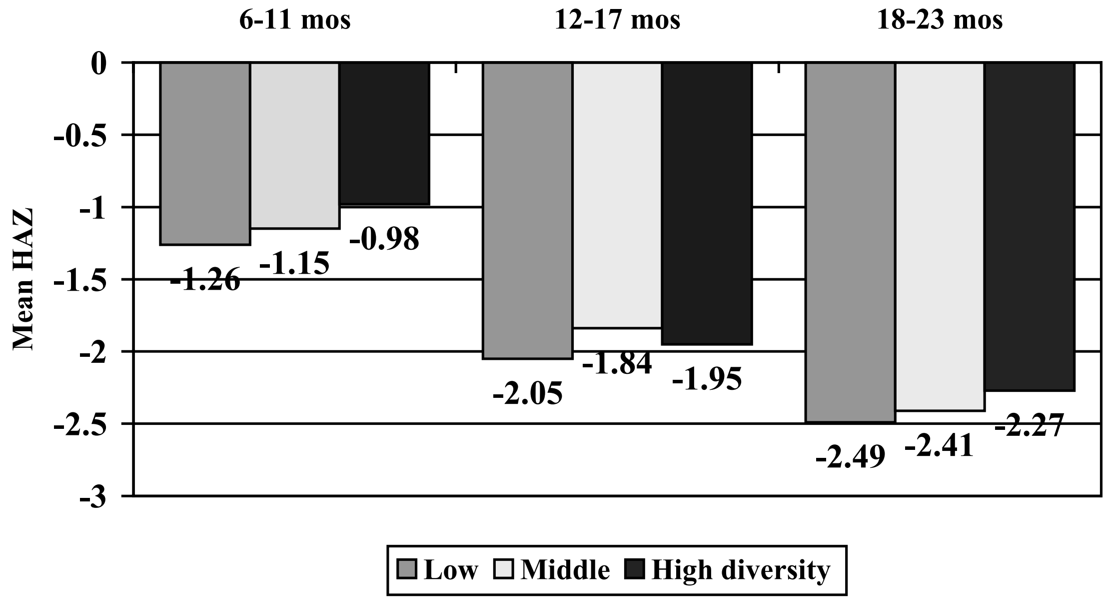


Figure 9. Mali: HAZ by diet diversity tercile, within age groups

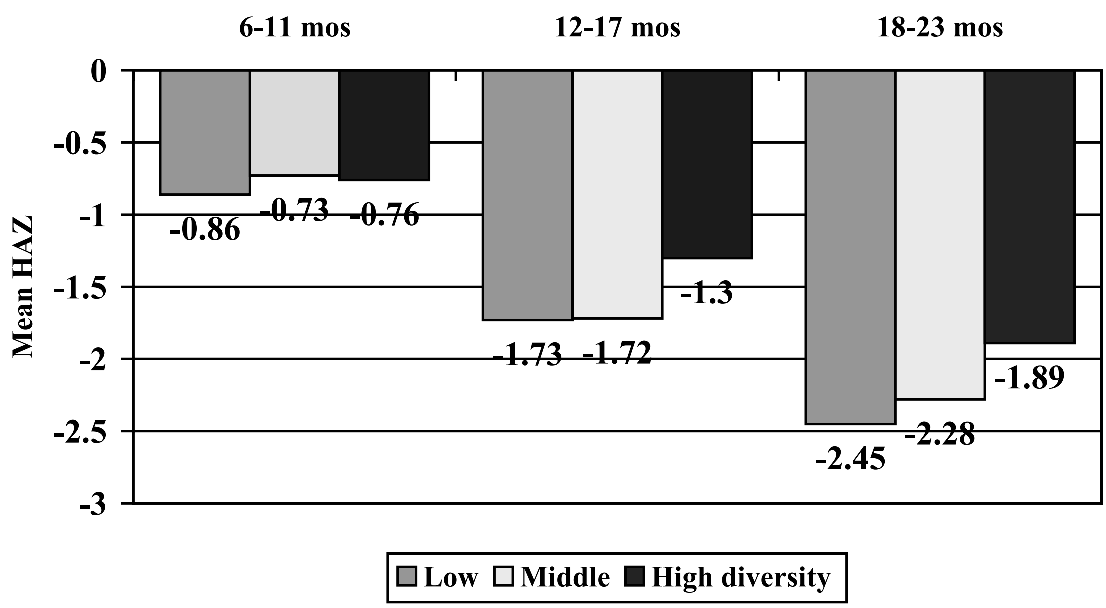


Figure 10. Rwanda: HAZ by dietary diversity tercile, within age groups

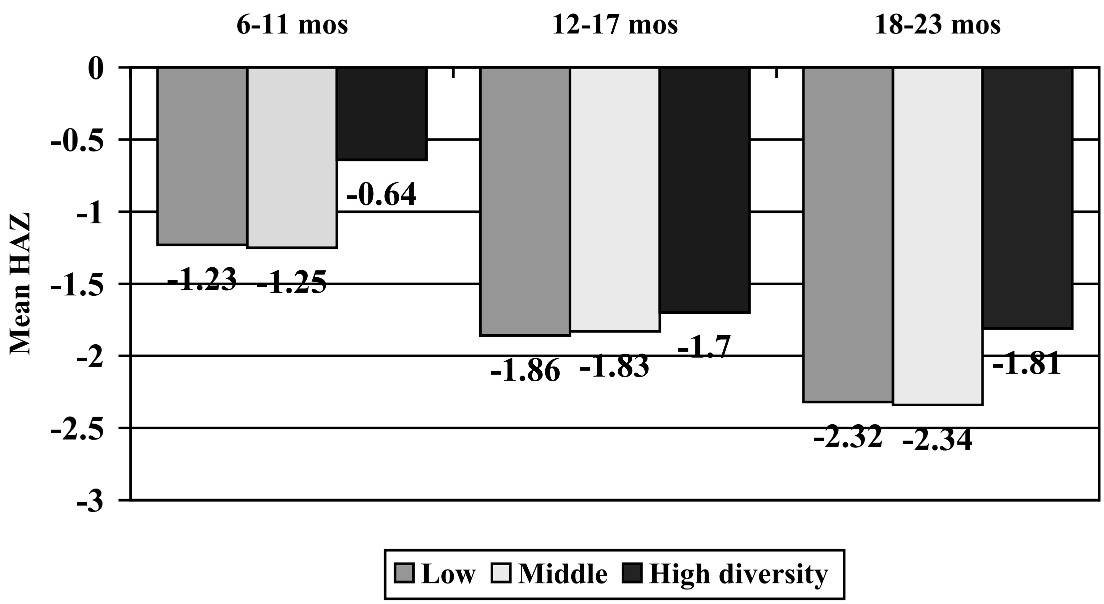


Figure 11. Zimbabwe: HAZ by diet diversity tercile, within age groups

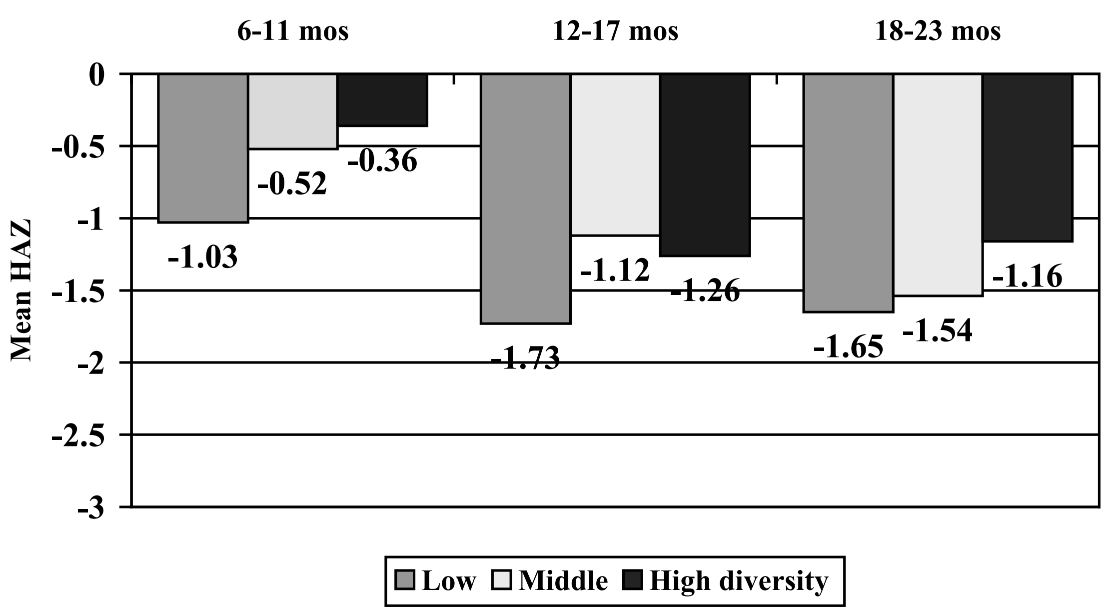


Figure 12. Cambodia: HAZ by dietary diversity tercile, within age groups

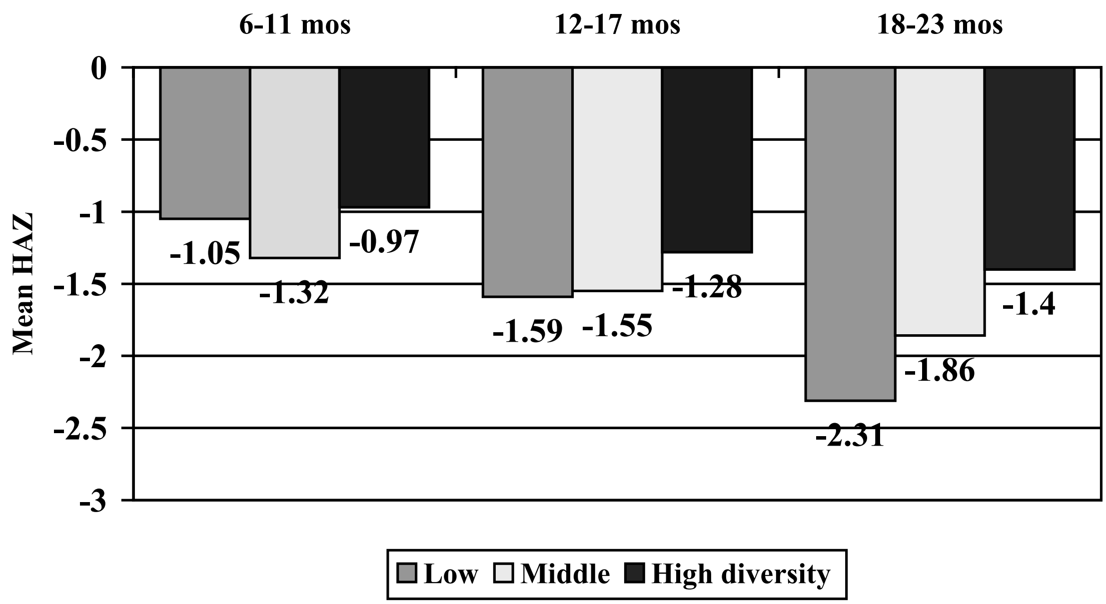


Figure 13. Nepal: HAZ by diet diversity tercile, within age groups

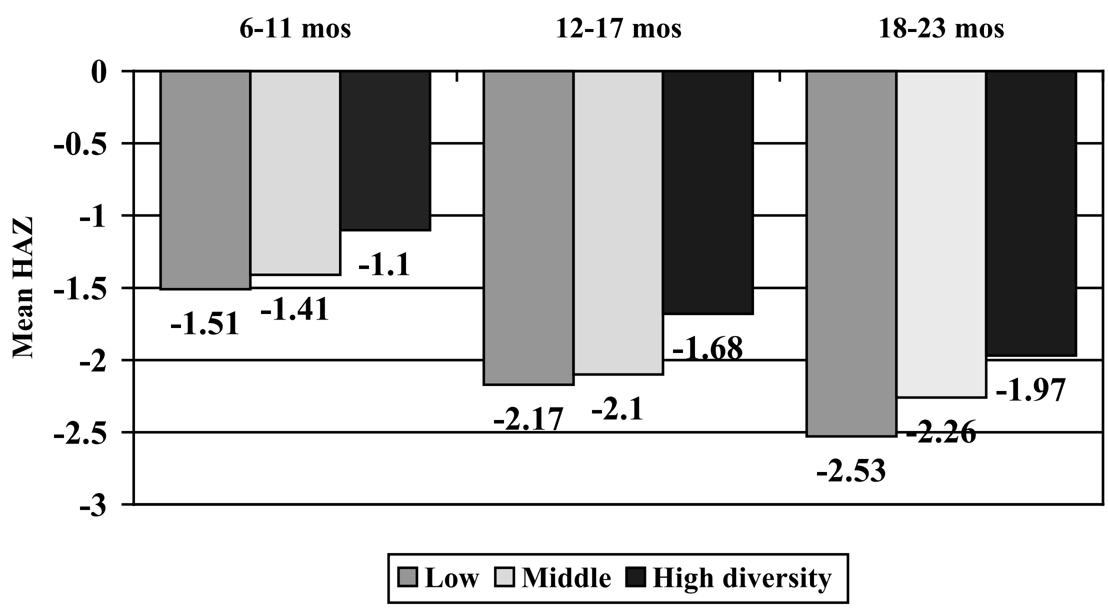


Figure 14. Colombia: HAZ by dietary diversity tercile, within age groups

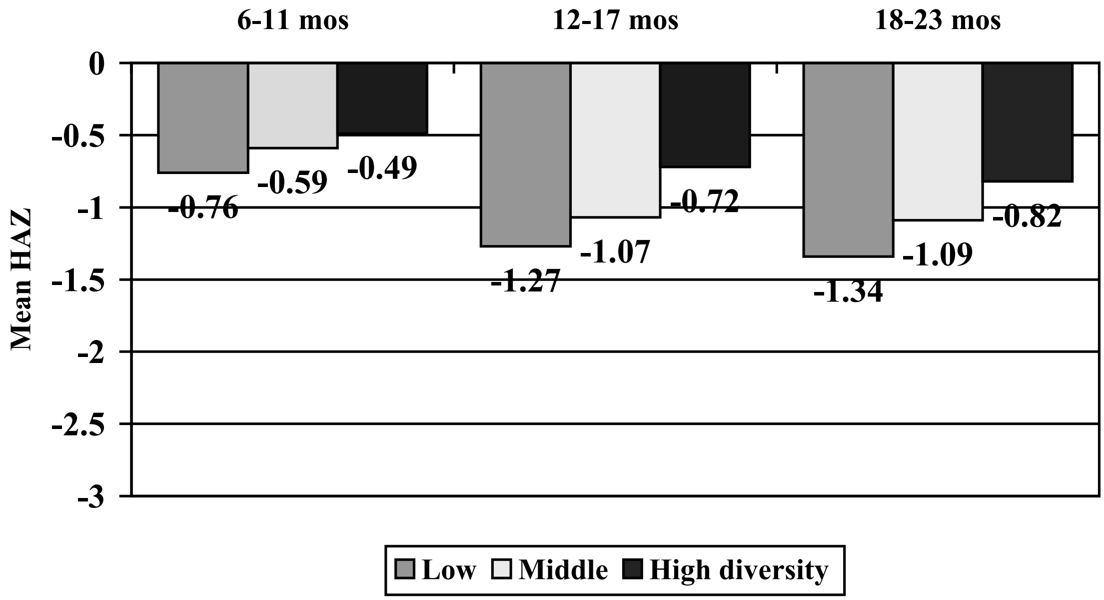


Figure 15. Haiti: HAZ by diet diversity tercile, within age groups

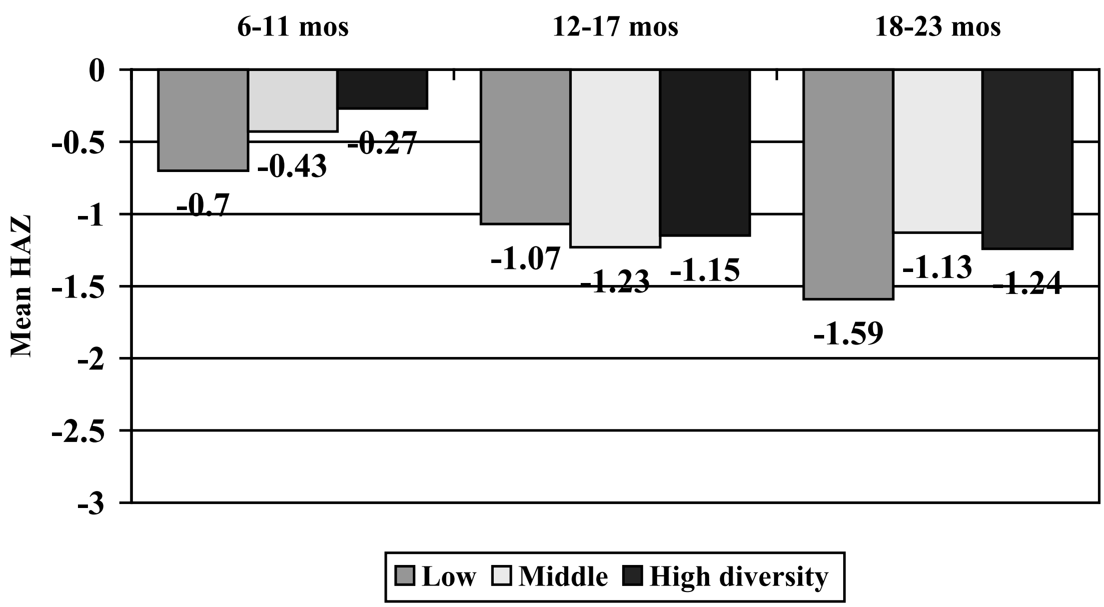
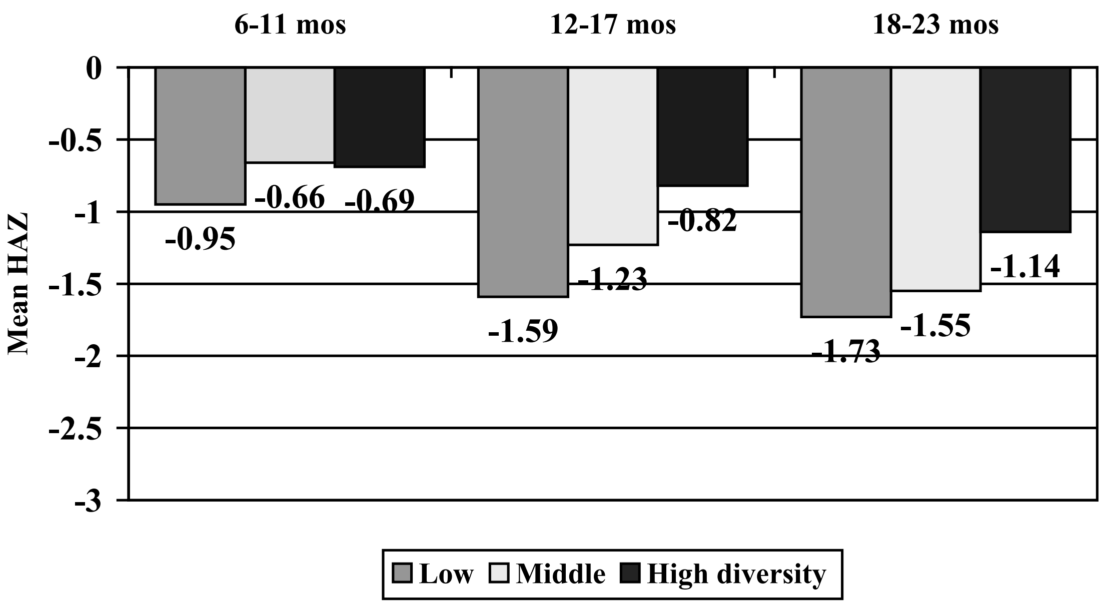


Figure 16. Peru: HAZ by dietary diversity tercile, within age groups



In order to assess whether the observed bivariate relationships could be explained by some other factor known to effect HAZ, we entered the following variables into regression models:

- Biological variables:
  - Child age (and age squared)
  - Sex of child
  - Maternal height
- Variables reflecting household welfare/socioeconomic status:
  - Maternal BMI
  - Maternal education
  - Education of mother's partner[21]
  - Number of antenatal care visits (related to welfare/socioeconomic status, but also serves as a proxy for access to health care)
  - Whether the household is in an urban or rural area
  - Asset index tercile
- Other variables:
  - Whether the child was still breastfed (related to socioeconomic status, but also influences nutrient requirements from complementary food; included in order to assess interactions with dietary diversity)
  - Number of children in household under five years (related both to mother's parity and to socioeconomic status)
  - Dietary diversity tercile (3 or more days[22])

[21] The data sets have information on the mother's partner, not on the child's father.

In addition to assessing the significance of each of these factors in the model, we explored five interactions with dietary diversity. That is, we explored whether the association between dietary diversity and HAZ varied depending on some other factor. For example, was the association stronger (or weaker) for women with no education as compared to women with primary or secondary education? Was the association stronger (or weaker) for non-breastfed children? The following variables were assessed for interactions with dietary diversity:

- Child age
- Whether the child was still breastfed
- Mother's education
- Urban/rural location of household
- Asset index tercile

Table 29 summarizes which factors were significant (at the $p<0.05$ level) in the regression models, and Table 30 shows which interactions were significant (at the $p<0.20$ level). Annex 3 gives more details of these analyses, with tables showing coefficients for each factor and R^2 values for the models. R^2 values ranged from at low of 0.14 in Zimbabwe to a high of 0.30 in Peru.

[22] Except in Haiti, where 24-hour diversity terciles were used.

Table 29. Summary of regression results: Dependent variable = HAZ. Significant coefficients by country[a]

	Benin	Ethiopia	Malawi	Mali	Rwanda	Zimbabwe	Cambodia	Nepal	Colombia	Haiti	Peru
Child age	-	-	-	-	-	-		-	-		-
Child age squared	+	+	+		+			+	+		+
Sex of child[b]		-	-						-	-	
Maternal height	+	+	+	+	+	+	+	+	+	+	+
Maternal BMI				+		+		+	+	+	
Maternal education			+				+				+
Education of mother's partner						+		+			
Number of antenatal care visits					+/-[c]					+	
Urban or rural[d]			-	-	-		+	-			-
Asset index tercile		+	+		+			+	-	+	+
Still breastfed[e]	-	-	-								
Number of children under 5 years	-	-					-		-	-	-
Dietary diversity tercile (3 or more days)		+	+		+	+	+	+			

[a] A "+" indicates a positive association, and a "-" indicates a negative association.
[b] A negative coefficient indicates a negative association for boys, as compared to girls.
[c] The coefficient for 1-3 visits was negative (as compared to 0 visits) while the coefficient for 4 or more visits was positive. Four or more visits are recommended by WHO for normal pregnancies (WHO, 1994).
[d] A negative coefficient indicates a negative association for rural areas, as compared to urban areas.
[e] A negative coefficient indicates a negative association with continued breastfeeding.

In general, significant coefficients are associated with child HAZ in the expected direction. Maternal height is significantly associated with greater HAZ, whereas child age is associated with decreasing HAZ Maternal BMI is positive and significant in five countries. There is a negative association for boys, indicating poorer HAZ among boys compared to girls, in four countries; this has been observed elsewhere (see e.g. Jacobs, Joubert, and Hoffman, 1988; Jooste et al., 1998; Ngare and Muttunga, 1999).

Coefficients for the asset index terciles are significant (and positive) in six of the eleven countries. In Colombia, there was a negative coefficient when the highest asset tercile was compared to the lowest; we do not have an explanation for this. Children in urban areas also have significantly higher HAZ than children in rural areas in five countries. Surprisingly, rural children have higher HAZ than urban children in Cambodia in our sub-sample.[23] The number of children under five years of age in the household has a negative and significant coefficient in six countries.

Most surprisingly, neither the mother's nor her partner's education level are significant in these models in a majority of countries. Partner's education was significant (and positive) in two countries: Zimbabwe and Nepal. Mother's education was significant in Malawi, Cambodia, and Peru, but only when women with some secondary education are compared with women with none. In some countries, a lack of association may be due to the fact that very few women have more than a few years of education, and most have none (for example, in Benin, Ethiopia, Mali, and Nepal). However, in other countries there is good variability in the level of mother's education, and the coefficient for education is also not significant in these countries.

Dietary diversity tercile remained significant in these models in six of the nine countries where significant bivariate associations were observed: Ethiopia, Malawi, Rwanda, Zimbabwe, Cambodia, and Nepal.[24] In all remaining countries except Colombia, dietary diversity significantly interacted with one or more of the factors tested (see Table 30). Thus, an association between dietary diversity and child HAZ was confirmed in 10 of the 11 countries studied, either as a main effect or in interaction.

A significant interaction between dietary diversity and child age group was found in four countries (Malawi, Rwanda, Haiti, and Peru). The nature of the interaction varied by country and no consistent pattern was observed. In some countries dietary diversity was more strongly associated with HAZ among younger children (Malawi and Rwanda), whereas in other countries Z-score differences between diversity terciles were larger among the middle or oldest age group.

A statistically significant association was found between the level of maternal education and dietary diversity only in Malawi, with a stronger association between diversity and HAZ both for women with no education and for women with secondary education, as compared to women with some primary education.

[23] In the DHS Country Report for Cambodia, the urban/rural comparison is available for all children under 5 years of age, and shows a slightly lower mean Z-score in rural areas (-1.8) as compared to urban areas (-1.6) (National Institute of Statistics, Directorate General for Health [Cambodia], and ORC Macro, 2001, p.174).

[24] In Malawi, only the contrast between middle and low diversity terciles was significant; the joint test that assessed the overall significance of both contrasts (middle vs. low and high vs. low) was not significant (p = .07).

Urban/rural differences in the association between dietary diversity and HAZ were also observed in five countries (Benin, Mali, Zimbabwe, Nepal, and Haiti). Dietary diversity was more strongly associated with HAZ in urban areas in Benin, Haiti and Nepal, but it was more strongly associated among rural children in Mali and Zimbabwe. Interactions were also observed with the asset index terciles in Benin, Cambodia and Peru. Again, the nature of the interaction varied by country and no consistent pattern was observed.

Table 30. Summary of regression results: Significant interactions with dietary diversity, by country [a]

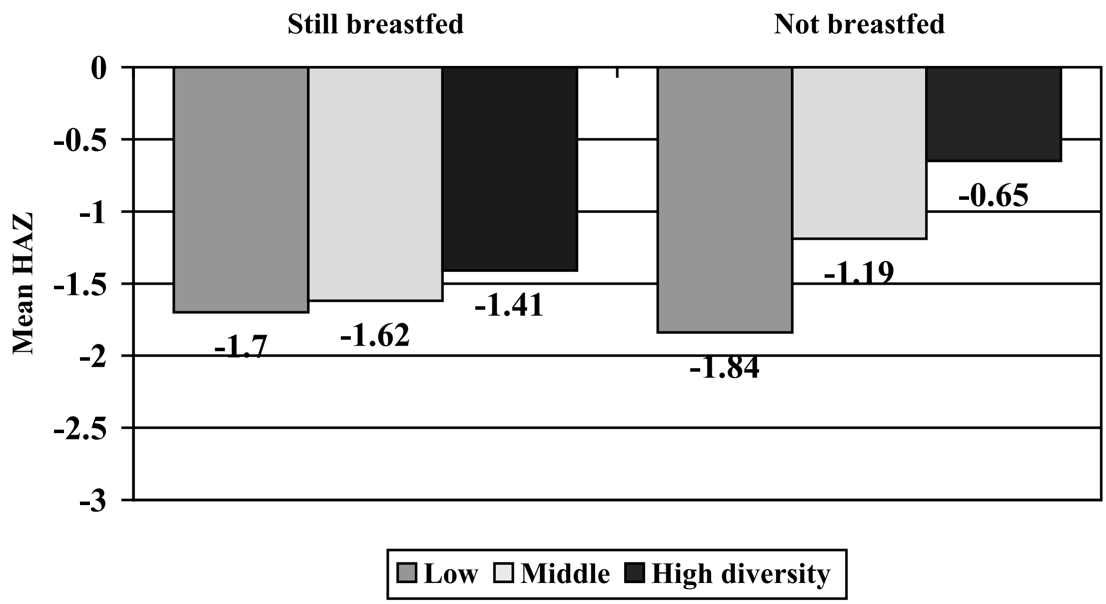
	Benin	Malawi	Mali	Rwanda	Zimbabwe	Cambodia	Nepal	Haiti	Peru
Child Age		X		X				X	X
Still breastfed	X	X	X		X	X	X		
Mother's education		X							
Urban/rural location	X		X		X		X	X	
Asset index tercile	X					X			X

[a] No significant interactions were observed in Ethiopia or Colombia.

The last interaction we assessed was between breastfeeding status and dietary diversity. As noted in Chapter 1, results of several studies suggest that dietary diversity is more important for non-breastfed children. In these DHS data sets, the association between diversity and HAZ differed depending on breastfeeding status in six countries (Benin, Malawi, Mali, Zimbabwe, Cambodia, and Nepal). In four of these countries – Benin, Mali, Cambodia, and Nepal – the difference in HAZ between low and high diversity groups was much larger in the non-breastfed group. In one country – Zimbabwe – the association was stronger for breastfed children.[25] In five of the six countries, there were very few (< 50) non-breastfed children in the lowest diversity group, so the results should be interpreted with caution. Figure 17 shows results for Cambodia, where the number of children was sufficiently large in each sub-group.

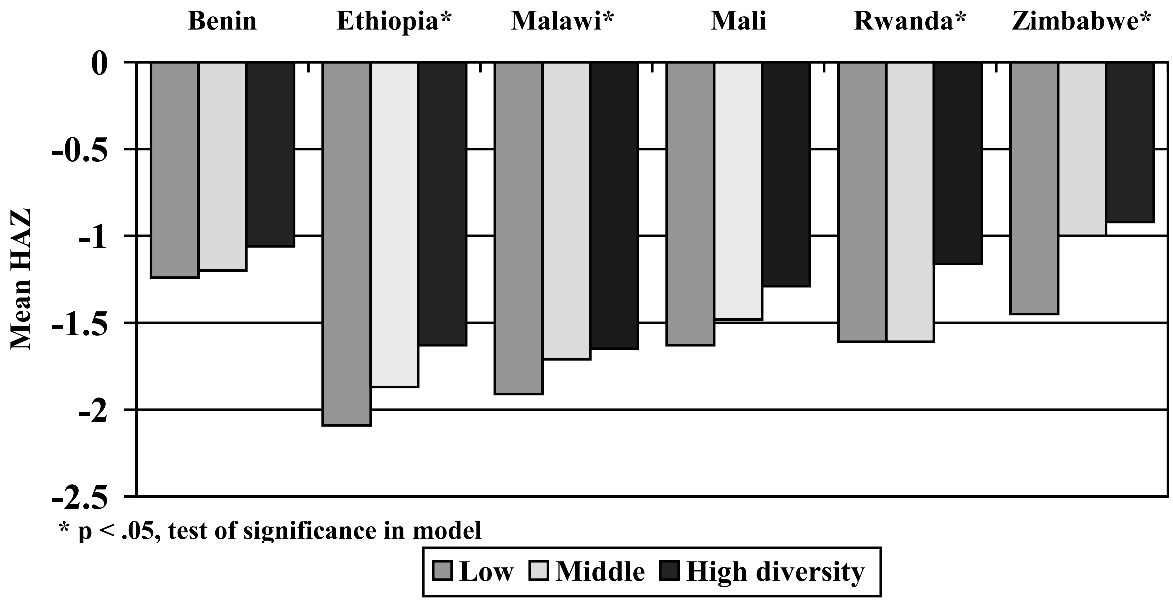
[25] In Malawi the interaction is difficult to interpret, as the relationship between diversity and HAZ is U-shaped among non-breastfed children, with the highest HAZ in the middle diversity group.

Figure 17. Cambodia: Interaction between breastfeeding status and dietary diversity



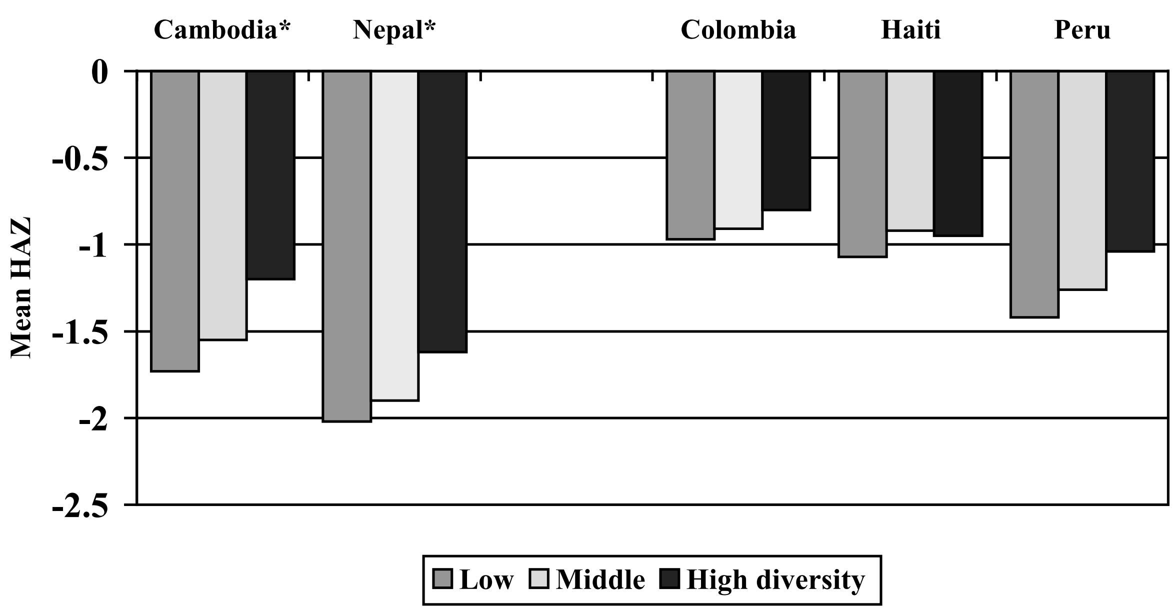
In summary, dietary diversity is strongly associated with HAZ in bivariate associations. In regression models controlling for a number of potential confounders – both biological and socio-economic – dietary diversity remains significantly associated with HAZ in 10 of the 11 countries, either as a main effect or in interaction with one or more factors. The only country where dietary diversity is not associated with child HAZ is Colombia, the country with the highest overall diversity score in our sample, and the lowest prevalence of malnutrition. Figures 18 and 19 (next page) show mean Z-scores by diversity tercile, after adjusting for all continuous variables in the model. For those countries with significant coefficients for diversity, the size of the adjusted Z-score difference between low and high diversity groups ranges from 0.40 in Nepal, to 0.53 in both Zimbabwe and Cambodia. These differences are very similar to the non-adjusted means presented above in Figures 4 and 5.

Figure 18. Adjusted[a] mean HAZ by dietary diversity tercile in six African countries



[a] Means were adjusted for all continous variables in the model: child age (and age squared), maternal height and BMI, her partner's years of education, and the number of children under five years of age in the household.

Figure 19. Adjusted[a] mean HAZ by dietary diversity tercile: Five countries in Asia and the LAC region



[a] Means were adjusted for all continuous variables in the model: child age (and age squared), maternal height and BMI, her partner's years of education, and the number of children under five years of age in the household.

In Chapter 9 of this report we comment further on these results and outline unanswered questions. In the next chapter, we address our final objective, by comparing the 24-hour recall with the 7-day recall.

8. COMPARING THE 24-HOUR AND 7-DAY FOOD GROUP RECALLS

The current DHS surveys include both a 24-hour food group recall and a 7-day food group recall (see the DHS questions in Boxes 1 and 2, Chapter 2). In the DHS and other surveys that include simple food group recalls, shortening and simplifying questionnaires is always an objective. Each question (or set of questions) that remains on the questionnaire should provide unique and important information. In this chapter, we assess the "added value" of the 7-day recall by comparing results from the 24-hour and the 7-day recall, both for individual food and liquid groups, and for the dietary diversity indicators.

The DHS and similar surveys can provide a good picture of population-level diet patterns. Simple food group recalls are not meant to provide quantitative information about nutrient intake or adequacy. Therefore in assessing the "added value" of the 7-day recall, we assess it relative to the task of providing a population-level picture of diet patterns for young children.

More specifically, we consider the objective to be to provide a description of which food groups children eat with some regularity. If a child has eaten a food only one day out of the last seven, we do not consider this to be sufficiently regular to have great nutritional significance. While it is easy to say "once a week is not enough" it is more difficult to say – for all food groups and in all places – how often a food group must be eaten to be nutritionally significant. A thorough answer to this question would once again involve validation work with a number of data sets. In the meantime, we consider a child who has eaten a food group three or more times in the last week to have eaten that food group "regularly" for the purposes of this analysis.

Simple food group recalls may be used for purposes other than providing a picture of diet patterns. For example, Helen Keller International (HKI) used a simple food group recall in their survey tool for assessing population-level risk of vitamin A deficiency (Rosen, Haselow, and Sloan, 1993). Program managers may also use data from simple food group recalls to obtain indirect evidence of access, at the level of the child, to various foods. Access at the level of the child reflects both household-level access to food, and cultural practices including intra-household distribution. When food group recalls are used to answer this type of question, the proportion of children who ate a particular food group at all in the last week may be of interest.[26]

For example, in Nepal only 16% of the children ate meat, poultry, fish or eggs yesterday, and only 9% had any of these foods three or more days in the last seven. However, 38% had meat, poultry, fish or eggs at least once in the last week. This means that when these foods are available in the household they are given to children, at least some of the time. In most cases, even differences between yesterday and the last seven days were not this extreme, but certainly figures for the last seven days are very different from figures for yesterday.

We do not assess the usefulness of the 24-hour as compared to the 7-day recall for these latter purposes. For those interested in assessing differences between responses for yesterday as compared to the last seven days, Annex 4 provides a set of tables. These tables compare results for each food group for yesterday, the last seven days, three or more days in the last seven, and

[26] Note that other, non-survey methods, including qualitative methods, may be more appropriate for exploring cultural practices and intra-household distribution of foods.

four or more days in the last seven. If, for any reason, estimates are needed of the proportion of children receiving a particular food group at least once in the last week, the 24-hour recall is not sufficient.

We also note that the DHS are extremely large surveys, both in sample size and in length of the questionnaire. The food group recall is only one very small element in these surveys. It is possible that if simple food group recalls are implemented differently than they are in the context of the DHS – if, for example, there were longer training and more probing on the nutrition questions – 24-hour and 7-day indicators might not relate in the same way as they do in these data sets.

Turning back to the issue of assessing foods groups eaten regularly, Figures 20-29 compare the proportion of children eating each food group yesterday to the proportion who ate each food group three or more days in the last seven days.[27] The following food groups are shown in the figures:

1. Starchy staples (food made from grain, roots or tubers)
2. Food made from legumes
3. Dairy
4. Meat, poultry, fish, or eggs
5. Vitamin A-rich fruits and vegetables (all three sub-groups together)
6. Orange/red vitamin A-rich fruits and vegetables
7. Other fruits, vegetables, and juice
8. Foods cooked with fat or oil

For simplicity, grain-based staples and roots and tubers are not shown separately, and juice is not shown separately from other fruits and vegetables. However, the vitamin A-rich orange/red vegetables and fruits are shown separately in recognition of their higher carotenoid bioavailability.

Table 31 follows the figures, and summarizes all differences in proportions shown in the figures that are larger than five percentage points.

[27] Haiti is excluded from this analysis because there was no 7-day recall on the Haiti questionnaire.

Figure 20. Benin: Comparing food groups eaten yesterday to 3 or more days last week

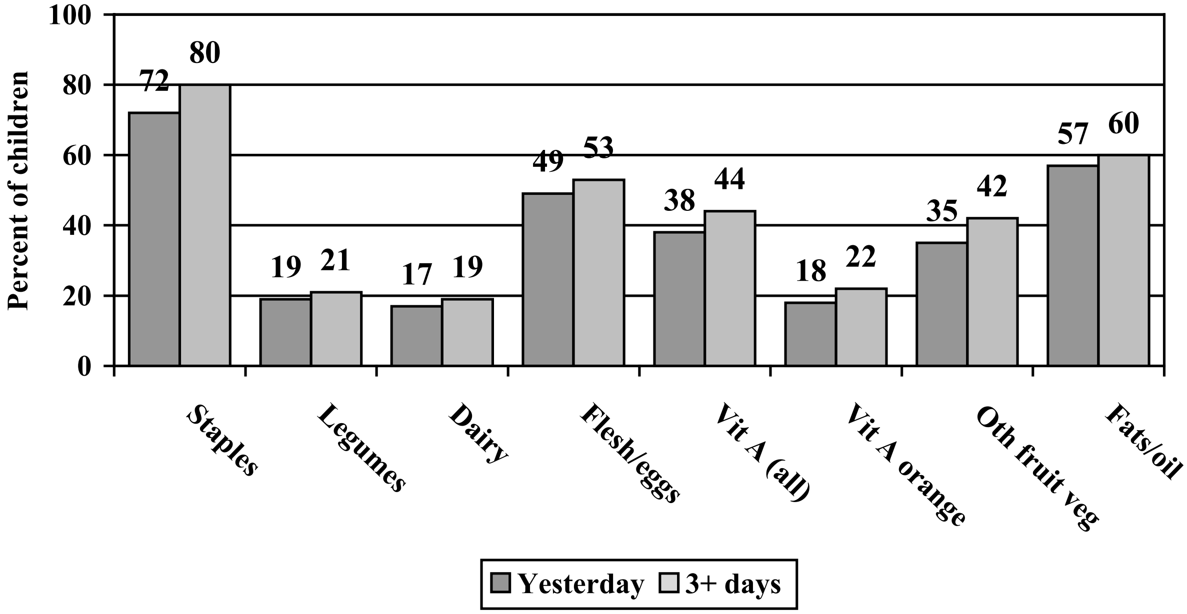


Figure 21. Ethiopia: Comparing food groups eaten yesterday to 3 or more days last week

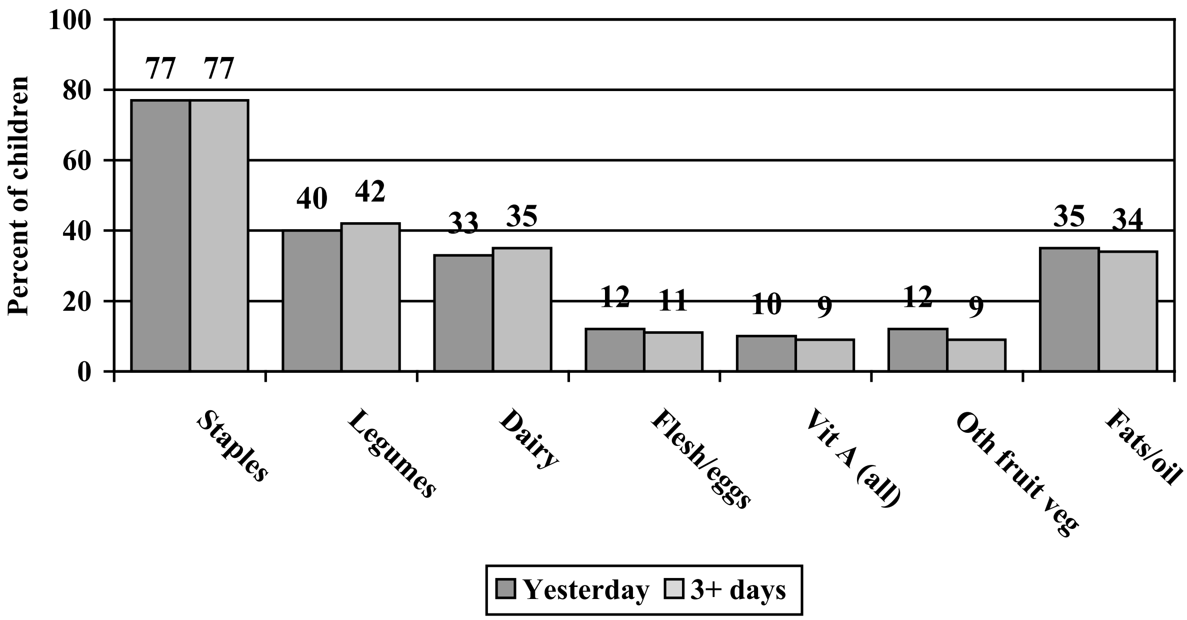


Figure 22. Malawi: Comparing food groups eaten yesterday to 3 or more days last week

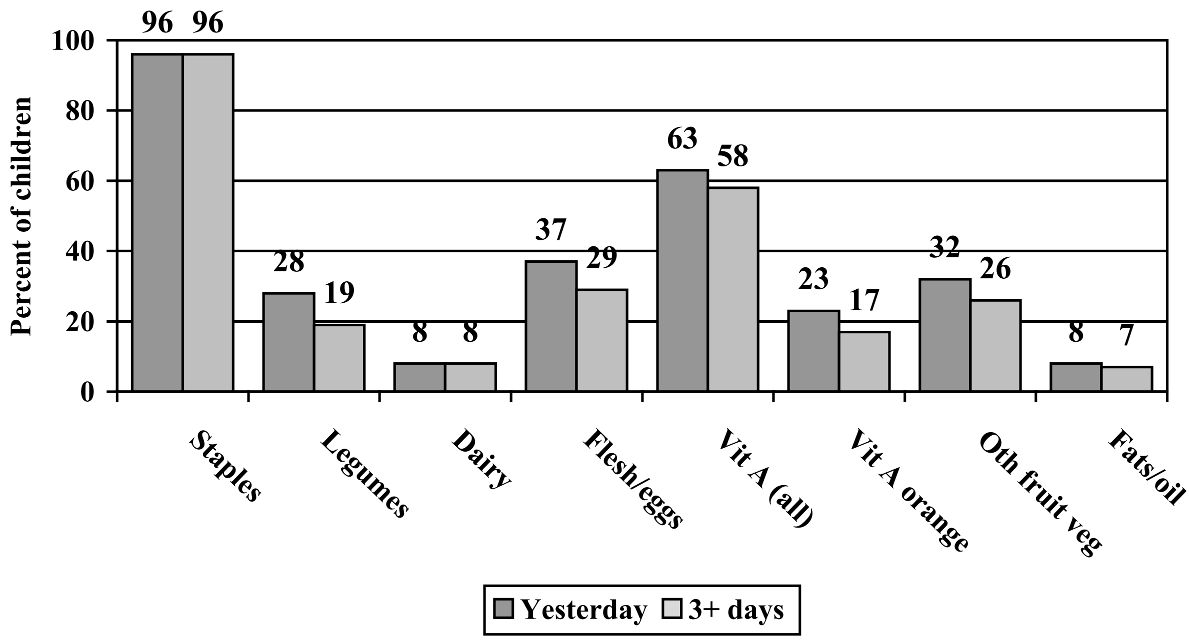


Figure 23. Mali: Comparing food groups eaten yesterday to 3 or more days last week

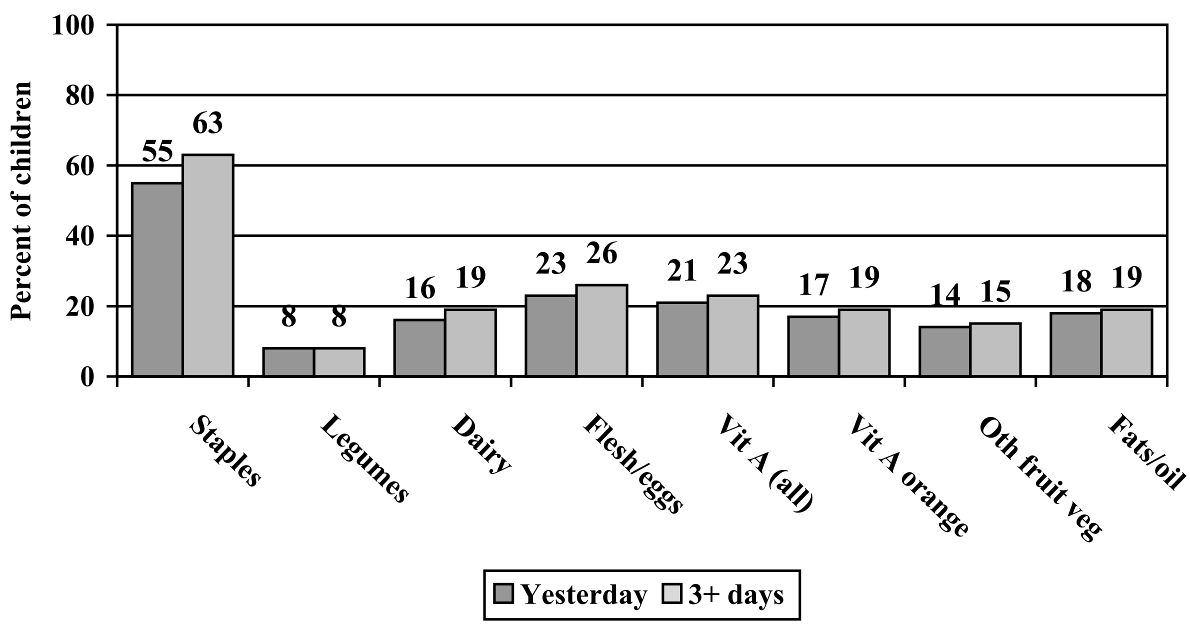


Figure 24. Rwanda: Comparing food groups eaten yesterday to 3 or more days last week

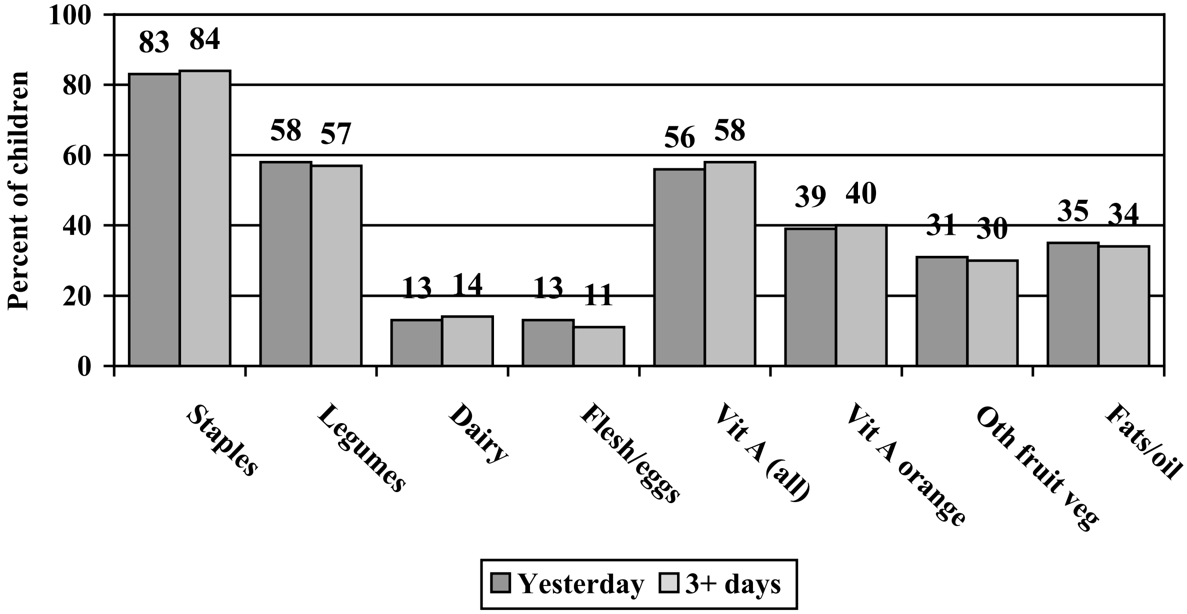


Figure 25. Zimbabwe: Comparing food groups eaten yesterday to 3 or more days last week

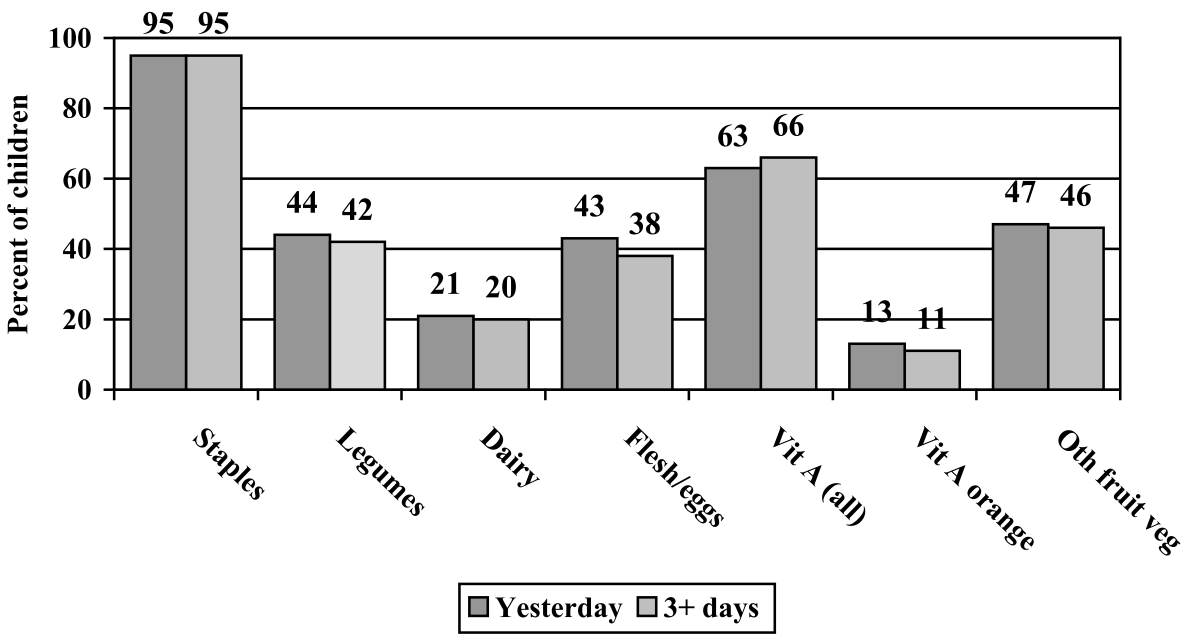


Figure 26. Cambodia: Comparing food groups eaten yesterday to 3 or more days last week

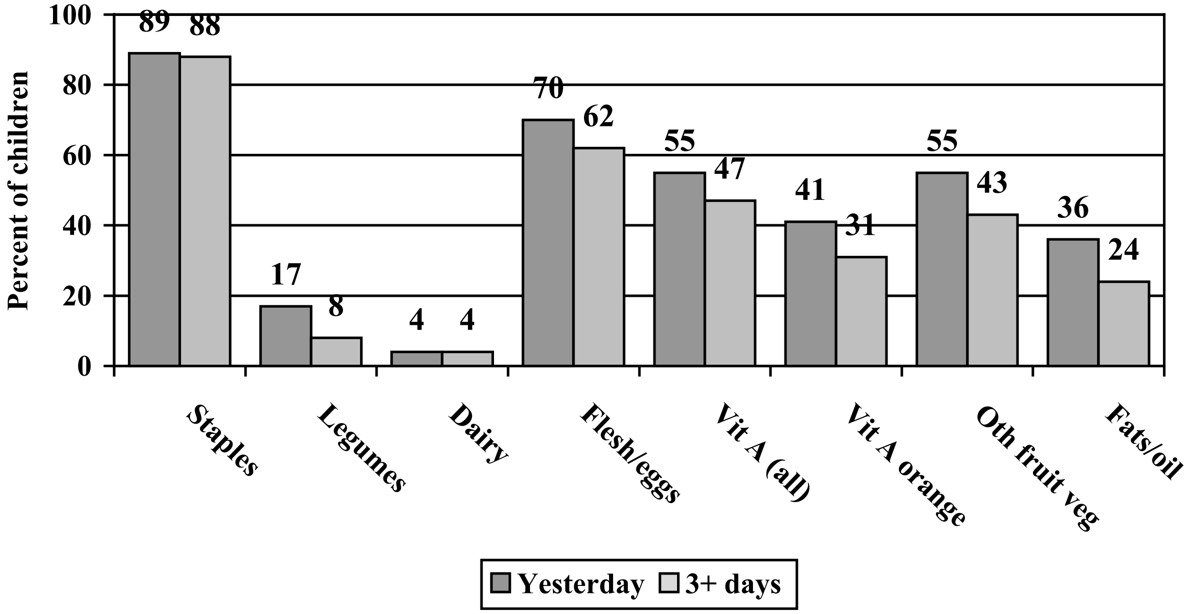


Figure 27. Nepal: Comparing food groups eaten yesterday to 3 or more days last week

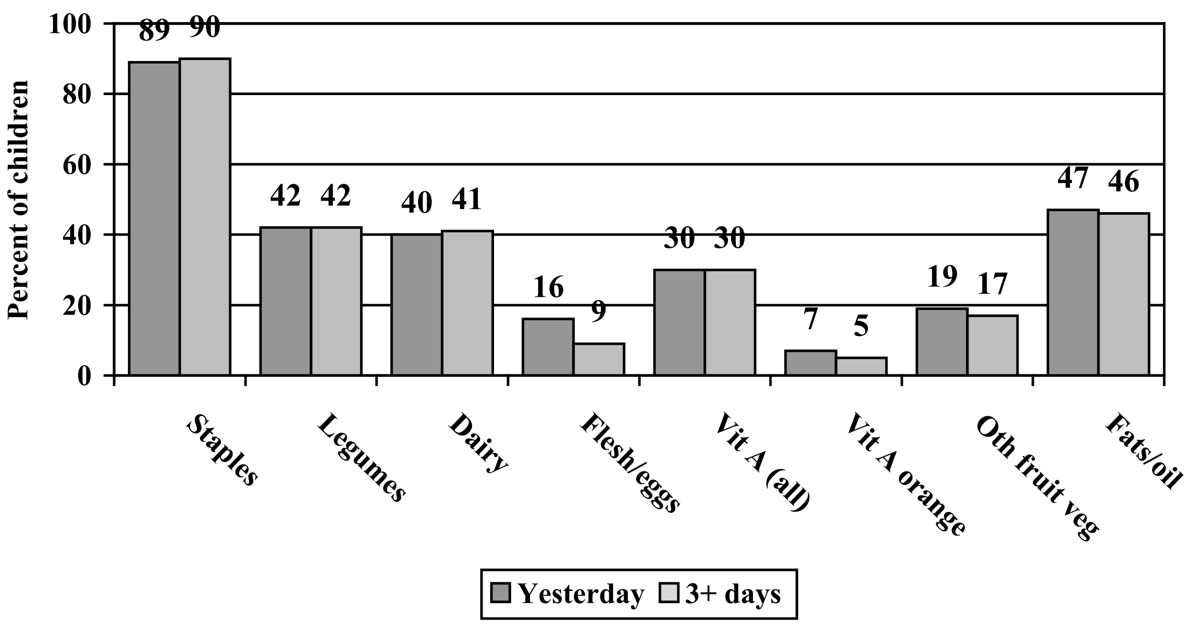


Figure 28. Colombia: Comparing food groups eaten yesterday to 3 or more days last week

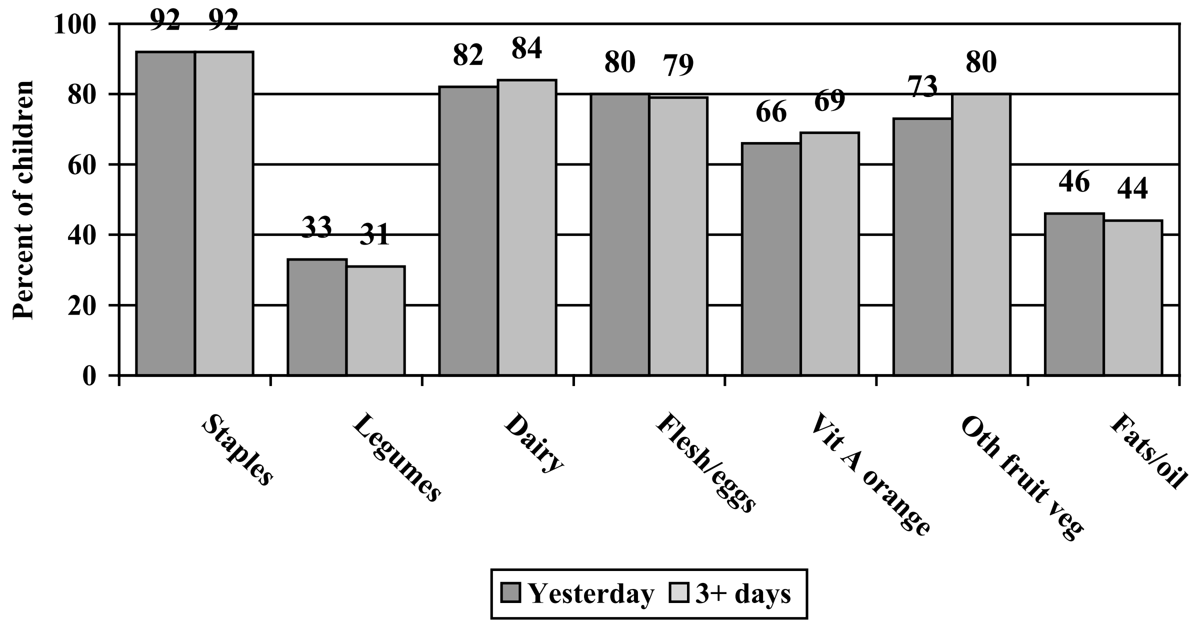
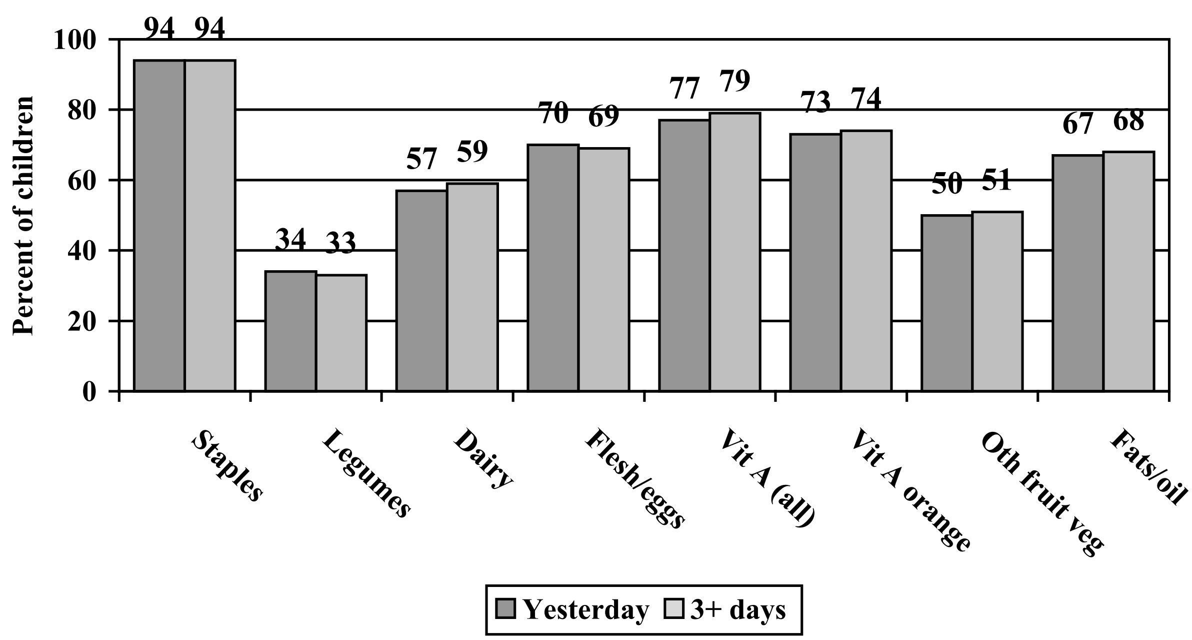


Figure 29. Peru: Comparing food groups eaten yesterday to 3 or more days last week



The overall picture provided by Figures 20-29 is of quite good agreement between the proportion having the food group yesterday as compared to three or more days in the last seven. Table 31 shows that the agreement was worst in Benin, Malawi, and Cambodia, but even in these countries the differences were generally less than 10 percentage points. Agreement was best in Ethiopia, Rwanda, Zimbabwe, and Peru, where none of the percentage point differences exceeded 5%. In the remaining countries (Mali, Nepal, and Colombia), only one food group differed by more than 5 percentage points.

Table 31. Differences (> 5 percentage points) between food groups eaten yesterday and those eaten three or more days in the last seven, for children aged 6-23 months, by country

	Food groups	Percentage point difference		Range of differences (percentage pts)
		Higher yesterday[a]	Higher 3+ days[b]	
Benin	Starchy staples Vit A-rich (all) Other fruits/vegs/juice	---	8 6 7	2-8
Ethiopia	None	---	---	0-3
Malawi	Legumes Meat/poultry, etc. Vit A-rich (orange) Other fruits/vegs/juice	9 8 6 6	---	0-9
Mali	Starchy staples	---	8	0-8
Rwanda	None	---	---	1-2
Zimbabwe	None	---	---	0-5
Cambodia	Legumes Meat/poultry, etc. Vit A-rich (all) Vit A-rich (orange) Other fruits/vegs/juice Fats and oil	9 8 8 10 12 12	---	0-12
Nepal	Meat/poultry, etc.	7	---	0-7
Colombia	Other fruits/vegs/juice	---	7	0-7
Peru	None	---	---	0-2

[a] "Higher" means the percent eating yesterday was more than 5 percentage points higher than the percent eating the food group 3 or more days out of the last seven. A "---" means that the difference was 0 to 5 percentage points.
[b] "Higher" in this column means that the percent eating the food group 3 or more days out of the last 7 was more than 5 percentage points higher than the percent eating the food group yesterday.

Differences in both directions were observed, and no single food group dominates the list of differences. The number and size of the differences was not associated with overall dietary diversity, as both the lowest diversity countries (Mali and Ethiopia) and the highest diversity countries (Colombia and Peru) showed few differences.

Whether or not differences of the sizes seen in the figures and in Table 31 are important will depend on the objectives of the survey.[28] When the purpose of the survey is to provide a general picture of diet patterns, differences of this size might not be important.

In addition to assessing the size of the differences in proportions, we statistically assessed the agreement of the two measures. If the objective of both the 24-hour recall and the 7-day recall is to assess whether food groups are eaten regularly, then the two recalls can be considered as two methods of measuring the same underlying reality. The Kappa statistic is frequently used to assess agreement between two methods of measurement. This statistic assesses agreement at the level of the individual, and therefore is a more stringent test than may be needed. For project purposes, the information in Figures 20-29 may be all that is needed to assess if the two measures are close enough. Nevertheless, the Kappa statistic gives another useful assessment of agreement between the measures.

The Kappa statistic ranges from 0 to 1, with 1 indicating perfect agreement and 0 indicating that the agreement is no better than would be expected due to chance. A Kappa ≥ 0.75 is taken to indicate excellent agreement between measures, and a Kappa of 0.40 – 0.74 indicates fair to good agreement (Fleiss, 1981).

Table 32 (next page) shows both the Kappa and the percent agreement for each comparison. The percent agreement is the percent of children for whom the answer for yesterday (yes/no for the food group) is the same as the answer for 3 or more days. In total, Table 32 shows results for 77 comparisons.

Overall, the percent agreement ranges from 68%-98%. Only three comparisons show agreement in fewer than 80% of the children, 33 show agreement for 80-89% of the children, and 41 show agreement in at least 90% of the children. Each Kappa is significant at the $p < .001$ level. Among the 77 comparisons, one-third (27/77) have Kappas in the excellent range, and all but one of the others are in the fair to good range (Kappa for legumes in Colombia is 0.39). Only 3 Kappas are less than 0.50. Agreement is best for starchy staples, dairy, and foods cooked with fats or oil and is worst for fruits and vegetables (both vitamin A-rich and other). However, even in these groups Kappas were solidly in the fair to good range (range for these groups was 0.54-0.79).

In summary, at either the population level or the individual level, there is good though not perfect agreement between individual food groups eaten yesterday and those eaten three or more days in the last seven. Whether the level of agreement is good enough will depend on survey objectives.

[28] When surveys are undertaken for project management purposes, managers must assess both the objectives for asking the food group recall questions and sample size issues. In many KPC surveys, for example, sample sizes will yield estimates with confidence intervals of +/- 10%, or +/-5% at best. In these cases the differences seen above are of the same magnitude as differences due to chance.

Table 32. Comparing 24-hour food group recall (Y/N) to three or more days last week, by country and food group: Kappa[a] and percent agreement for each comparison

	Foods made from grain, or roots and tubers		Food made from legumes		Dairy		Meat, poultry, fish, shellfish, or eggs		Vitamin A-rich fruits & vegetables (all 3 groups)[b]		Orange vitamin A-rich fruits & vegetables (leafy greens excluded)		Other fruits & vegetables or juice		Foods made with fat or oil	
Benin	0.75	91%	0.61	88%	0.82	95%	0.78	89%	0.67	83%	0.63	68%	0.76	89%	0.87	94%
Ethiopia	0.89	96%	0.83	92%	0.91	96%	0.67	93%	0.69	94%	---	---	0.68	93%	0.86	94%
Malawi	0.65	97%	0.48	81%	0.78	96%	0.53	78%	0.65	83%	0.59	87%	0.60	84%	0.75	96%
Mali	0.77	89%	0.54	94%	0.78	93%	0.66	87%	0.73	91%	0.73	92%	0.69	92%	0.74	92%
Rwanda	0.63	90%	0.75	88%	0.86	96%	0.65	91%	0.71	86%	0.72	86%	0.60	82%	0.74	88%
Zimbabwe	0.73	98%	0.78	90%	0.79	93%	0.58	80%	0.79	91%	0.61	92%	0.71	86%	---	---
Cambodia	0.86	97%	0.54	90%	0.68	97%	0.77	90%	0.71	86%	0.67	85%	0.63	81%	0.60	83%
Nepal	0.91	98%	0.70	85%	0.90	95%	0.46	88%	0.63	84%	0.54	94%	0.66[c]	90%	0.89	94%
Colombia	0.68	95%	0.39	73%	0.75	93%	0.60	87%	---	---	0.63	84%	0.57	84%	0.70	85%
Peru	0.84	98%	0.56	80%	0.80	90%	0.64	84%	0.71	89%	0.68	87%	0.65	83%	0.85	93%

[a] $P < .001$ for all Kappa

[b] The three groups are: 1. Yellow/orange vitamin A-rich vegetables such as pumpkin, carrot, and orange sweet potatoes; 2. Green leafy vegetables; and 3. Mango or other vitamin A-rich fruits.

[c] In Nepal, juice was not included on the questionnaire; statistics are shown for "other fruits and vegetables."

In addition to assessing agreement for individual food groups, we assessed agreement between measures of dietary diversity based on the 24-hour food group recall and the 7-day food group recall. We compared the number of food groups eaten yesterday to the number eaten three or more days, four or more days, or at all in the last seven days. Table 33 presents the average food group diversity by country for yesterday and last week, and also gives the concordance coefficient (Rho_c) for each comparison. Rho_c was significant at the $p < .001$ level for all comparisons; in assessing the strength of the relationship, Rho_c can be interpreted in the same way as a simple correlation coefficient.

Table 33. Concordance coefficients[a] for 24-hr diversity as compared to three or more days, four or more days, and at least once in the last seven days, by country

	Average food group diversity				Rho_c for 24-hr vs. 3 or more days	Rho_c for 24-hr vs. 4 or more days	Rho_c for 24-hr vs. at least once in 7 days
	24hr	3+d	4+d	1+d[b]			
Benin	2.9	3.2	2.8	3.9	0.85	0.84	0.76
Ethiopia	2.2	2.2	1.9	2.8	0.88	0.81	0.81
Malawi	2.7	2.4	1.9	3.6	0.70	0.53	0.67
Mali	1.5	1.7	1.5	2.4	0.81	0.78	0.72
Rwanda	2.9	2.9	2.4	3.8	0.82	0.74	0.72
Zimbabwe[c]	3.1	3.1	2.7	3.9	0.81	0.74	0.73
Cambodia	3.3	2.8	2.2	3.7	0.77	0.60	0.84
Nepal	2.8	2.8	2.4	3.7	0.82	0.76	0.74
Colombia	4.7	4.8	4.2	5.9	0.75	0.69	0.56
Haiti	3.8	(no 7-day data)			---	---	---
Peru	4.5	4.5	3.9	5.5	0.82	0.74	0.72

[a]$P < .001$ for all rho_c

[b]This is the same as 7-day dietary diversity; each food group is coded yes if the child ate it ever in the last week, and no if not. The food groups are summed to give a 7-day dietary diversity score, indicating whether or not the child had the food at least one day in the last seven ("1+ days").

[c]Zimbabwe questionnaire did not include "foods made with fat or oil" so the highest possible diversity score for Zimbabwe is 6. The highest possible score for all other countries is 7.

As Figures 20-29 did for individual food groups, the first column in Table 33 gives a population-level view of food group diversity yesterday as compared to in the last week. In most countries, children had approximately one more food group over the last seven days than they had the previous day. In comparing the number of food groups eaten yesterday to the number of food groups children had three or more days in the last seven, once again agreement is very good. Diversity was the same based on these two measures in five countries (Ethiopia, Rwanda, Zimbabwe, Nepal, and Peru), while the largest difference in average diversity was 0.5, in Cambodia.

The concordance coefficient assesses agreement at the individual level. As with the individual food group results, the coefficients show reasonably strong, but not perfect agreement, at the individual level.

Another way of comparing at the individual level is to look at the categorical variables for diversity[29], and compare rankings for yesterday to rankings for three or more days or seven or more days. Table 34 shows these comparisons for Benin, and comparisons for all other countries are in Annex 4.

Table 34. Benin: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
Number of food groups yesterday		**Low**	**Middle**	**High**		**Low**	**Middle**	**High**
		Percent of children (% of total)				Percent of children (% of total)		
	Low	25	6	3		24	6	3
	Middle	5	21	9		6	20	9
	High	0	4	28		0	7	25

Table 34 shows that in Benin, nearly three-quarters of the children are classified into the same diversity tercile (low, middle or high) regardless of which measure is used (number of food groups yesterday, number eaten three or more days, or number of food groups in the last week). Very few children (3%) are classified into extreme terciles (low on one measure and high on the other). Looked at another way, among the children who were in the lowest tercile for yesterday, 74% were also in the lowest tercile for number of food groups eaten at least three days. Among children who were in the highest tercile for yesterday, 88% were also in the highest tercile for number of food groups eaten at least three days. This gives some sense of how well diversity yesterday "predicts" diversity over the last week.

Results for other countries are provided in Annex 4. When diversity tercile for yesterday is compared to the tercile for foods eaten 3 or more days, 60%-76% of children are classified identically, depending on the country. Only 2%-6% are classified into opposite terciles. Among children who were classified as having low diversity yesterday, 68%-90% also had low diversity for foods eaten 3 days or more. Among those classified high yesterday, the proportion classified as high for 3 days ranged from 55% in Colombia to the 88% already shown for Benin.

Annex 4 also provides results of similar comparisons using fixed cut-offs for diversity instead of the sample-specific diversity terciles. When fixed cut-offs are used, the proportion classified identically ranges from 71% to 85%, and the proportion classified in extreme terciles is 3% or less for each country.

In summary, population-level agreement between food groups eaten yesterday and food groups eaten regularly (three or more days in the last week) is quite good in DHS data sets. This is true for single foods groups and for measures of dietary diversity. At the level of the individual child the agreement is still reasonably good, but whether it is good enough will depend on the objectives of the survey. For many project management purposes, a population-level assessment is all that is required.

[29] For these analyses, we used the age-specific dietary diversity terciles described previously.

9. SUMMARY

Analysis of the *DHS+* data sets has contributed to our understanding of the four tasks outlined in Chapter 1:

1. To describe how a simple dietary diversity score relates to diet patterns among young children

2. To explore the feasibility of deriving global or regional cut-off points for low and high diversity

3. To determine whether simple dietary diversity indicators are meaningfully associated with height-for-age among young children across a range of countries

4. To test the nature and strength of the associations between food group and dietary diversity indicators derived from a 24-hour food group recall and those derived from a 7-day food group recall across a range of countries with varying levels of dietary diversity.

9.1. Dietary Diversity and Food Group Patterns

Analysis of the *DHS+* data sets has contributed to our understanding of the relationship between dietary diversity indicators and diet patterns among young children in these countries. The results detailed in Chapter 5 show that in each country, children with high diversity scores are much more likely to have eaten both animal-source foods and vitamin A-rich fruits and vegetables, as recommended. They are also more likely to have eaten other high quality foods (dairy, legumes, other fruits and vegetables, etc). While this is inevitably so, because the score sums food groups, it is useful to illustrate because dietary diversity indicators derived from DHS surveys have not been analyzed up to this point. Chapter 5 shows that differences in diversity scores reflect important differences in dietary patterns.

9.2. Dietary Diversity Indicators and Height-for-Age Z-score (HAZ)

In several studies reviewed in Chapter 1, we observed a strong bivariate association between diet diversity and HAZ, which is statistically significant in nine of the eleven countries studied. The size of Z-score differences between the low and high diversity groups is large and of functional significance. In models controlling for a variety of biological and household socioeconomic factors, the association between dietary diversity and HAZ remains significant in six countries, and dietary diversity interacts significantly with other factors in four of the remaining 5 countries.

Colombia was the only country for which there was no association between dietary diversity and Z-scores and no interactions between diversity and other factors. Colombia – the wealthiest country included in the analysis – also has the lowest rates of malnutrition among the eleven countries (16% stunting and 1% wasting among children 6-23 months) and the highest mean dietary diversity (4.7 on a scale of 7 points). When the fixed cut-off for low diversity is used (0-2 food groups yesterday) only 10% of the Colombian children aged 6-23 months, and only 4% of those aged 12-23 months score “low”. It is likely that low dietary diversity is not a main constraint for child nutritional status in this country.

The interaction between breastfeeding status and dietary diversity, observed in four countries, is particularly interesting. The observed interaction is consistent with several studies reviewed in Chapter 1, makes sense conceptually, and shows very large Z-score differences between low and high diversity groups for non-breastfed children. Dietary diversity may be particularly important to ensure nutrient adequacy for non-breastfed children. Dietary diversity may thus be a particularly relevant proxy for diet quality in the case of non-breastfed children in the age-range studied.

Our analysis of dietary diversity and HAZ is limited by the fact that measurement of household welfare and socioeconomic status is limited in the DHS data sets. Further, the summary asset/welfare measure (the “asset index”) used in our analysis did not capture a large proportion of the variability in asset and housing variables (the proportion of shared variation captured by the index ranged from 8% in rural Ethiopia to 25% in urban Benin). Therefore even in the countries where associations remained significant, we cannot conclusively state that the associations are not due to socioeconomic characteristics such as wealth or income.

9.3. The Question of Cut-offs for a Dietary Diversity Score

In the absence of international recommendations for food group diversity, we have used cut-offs for dietary diversity based on terciles, which were derived individually for each study sample. The cut-offs derived using this approach varied greatly among countries. As expected, there was a tendency for countries with overall higher mean dietary diversity scores (Table 8) to have higher cut-off points to define high dietary diversity and vice versa.

Looking across regions, cut-offs were lowest in Sub-Saharan Africa and highest in the Latin American/Caribbean countries. Looking within regions, there was great variability in cut-offs within the Sub-Saharan Africa region. Too few *DHS+* data sets were available in Asia and the Latin America/Caribbean region to make judgments about variability within these regions.

Within Sub-Saharan Africa, cut-offs defining low diversity varied from ‘<1’ for Mali, to ‘<2’ for Benin and Ethiopia, to ‘< 3’ for the remaining 2 countries. An even greater variability was found for the cut-offs that defined high diversity (‘>1’ for Mali, ‘>2’ for Ethiopia ‘>3 for Malawi and Rwanda and ‘>4’ for Benin). Clearly, using the sample-based approach to define cut-offs can result in a “high” diversity group corresponding to very low diversity in the diet (for example, in Mali a child who consumed two food groups would be classified in the high diversity group).

We illustrate the usefulness of cut-offs both for descriptive analysis of diet patterns, and for research purposes, but we do not make any recommendations about cut-offs. Several studies in Chapter 1 addressed the issue of cut-offs in relating dietary diversity to nutrient adequacy. Similar studies are needed in a variety of contexts, using a variety of operationalized dietary diversity indicators. Such studies could provide the information needed to define nutritionally meaningful dietary diversity cut-offs.

9.4. Comparing 24-hour and 7-day Food Group Recalls

When fielding household surveys, the added value of each set of questions should always be assessed, as it is a challenge to keep fieldwork, data entry, and data processing timely and manageable. This is particularly true for surveys undertaken in the context of projects or programs, as compared to research settings. Our analysis contributes to an on-going discussion of the usefulness of the 7-day recall, in addition to the 24-hour recall, in the context of simple surveys.

We assessed the comparability of the 24-hour food group recall and indicators derived from the 7-day food group recall, when the purpose is to capture population-level diet patterns. More specifically, we assessed this relative to the goal of identifying which food groups are eaten sufficiently regularly to be of nutritional significance. We defined "sufficiently regularly" as three or more days in the last seven days.[30]

The proportion of children eating a food group yesterday and the proportion eating that food group three or more days out of the last seven are remarkably consistent for almost all food groups in all countries. At the population level, the diversity indicator constructed from the 24-hour food group recall was also very similar to the indicator reflecting the number of food groups eaten three or more days in the last seven. There was reasonably strong agreement even at the individual level; whether the individual-level agreement is sufficient would depend on the question at hand. In most project contexts, population-level analysis is all that is practical and frequently is all that is needed.

We conclude that in the context of the DHS, there is little added value to the 7-day recall, if the objective is to characterize population-level diet patterns reflecting frequently eaten foods. Another, compromise approach which has been used in some surveys is to ask about all foods or food groups eaten in the last 24 hours, and in addition to ask about specific foods or food groups of interest eaten in the last week (for example, vitamin A-rich foods, animal-source foods, etc.).

9.5. Conclusion

Our work suggests that simple indicators of dietary diversity reflect important differences in diet patterns, and are associated with height-for-age Z-scores. Further work, with richer data sets, could better define the relationship between specific dietary diversity indicators and nutrient adequacy. In such work, particular attention should be paid to non-breastfed children in the vulnerable 6-23 month age group. Further work could also better define apparent relationships between dietary diversity, household socioeconomic status, and outcomes such as child nutritional status.

[30] As with a number of other issues raised in this report, the relationship between the number of days a food group is eaten and nutrient intake could be clarified by research validating simple indicators.

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ANNEX 1. FOOD GROUPS ON COUNTRY QUESTIONNAIRES

The MEASURE *DHS+* model questionnaire is presented in Chapter 2. This Annex provides information on any food groups that differ from those on the model questionnaire. Some differences represent appropriate adaptations of the questionnaire, while others are less consistent with the model.

The model questionnaire is compared to questionnaires as presented in each country report. Country reports (and questionnaires) are either in English (Ethiopia, Malawi, Zimbabwe, Cambodia, Nepal), French (Benin, Mali, Rwanda, Haiti) or Spanish (Colombia, Peru). In the four French questionnaires the food groups appear to be direct translations of the model questionnaire food groups, with no adaptation. For these countries – Benin, Mali, Rwanda, and Haiti – no further information is provided below.

For the remaining seven countries, differences are summarized below, by liquid or food group.[31] Food group descriptions from the Model Questionnaire are in bold letters.

- **Commercially produced infant formula?**

  Ethiopia: No group for infant formula
  Nepal: No group for infant formula, but included with other milks, below.
  Colombia: Leche en polvo para bebe? (powdered milk for babies?)

  Comments: In both Ethiopia and Nepal, formula use is very rare so lack of a separate food group for formula is not very problematic. In Colombia, because the wording did not clearly indicate infant formula, we examined the data to see what this group represents. The data suggest that this group was capturing other powdered milk in addition to formula. The proportion of children receiving this did not decline among the older children; 30% of the children 18-23 months of age had "leche en polvo" the day before the survey. This variable was combined with other dairy, in Colombia only.

- **Any other milk such as tinned, powdered, or fresh animal milk?**

  Ethiopia: Milk other than breastmilk?
  Zimbabwe: Split milks into two groups:
  Fresh cow or goat milk?
  Any other milk such as tinned or powdered milk?
  Cambodia: Any other milk such as tinned, powdered, or sweetened condensed milk?
  Nepal: Any milk, other than breastmilk, such as cow milk, mohi, tinned or powdered milk, or infant formula?

[31] Differences are not listed if the only change was to shorten the list of examples (e.g., in Malawi, the list of examples for roots and tubers was shortened to included only those commonly eaten in that country: white potatoes, cassava, or other. This is not listed as a difference).

Comments: In Cambodia, a very low proportion of children were reported to have had milk in the previous day or even in the previous week. It is possible that the wording of the question, which does not mention fresh milk, contributes to this.

- **Fruit juice?**

Cambodia: Fruit juice such as coconut juice?
Nepal: Did not include this group.

- **Any other liquids such as sugar water, tea, coffee, carbonated drinks, or soup broth?**

Malawi: Any other liquids such as tea, coffee, carbonated drinks, "freezes", or soup broth?
Zimbabwe: Any other liquids such as glucose water, tea, herbal teas/roots, or mahewu?
Nepal: Any other liquids such as ghee, honey, tea, soup, rice water?

Comments: In Nepal, note that ghee is listed twice, with other liquids and with fats. We assume it is sometimes given diluted or as an ingredient in a drink.

- **Other country-specific liquid groups added:**

Malawi: Thobwa

- **Any food made from grains [e.g., millet, sorghum, maize, rice, wheat, porridge, or other local grains]?**

Ethiopia: Any food made from grains e.g. millet, sorghum, maize, rice, wheat, barely [sic], teff, oats?
Malawi: Split grain-based foods into three groups:
Any food made from grains [e.g. millet, etc., as above, except porridge]
Plain porridge?
Porridge enriched with foods such as legumes, vegetables, fruits, ground nut flour, fish or meat?
Zimbabwe: Any other foods made from grains such as sadza, bread, porridge or thin gruel?
Cambodia: Rice, rice flour, maize, bread, wheat, cakes, porridge, or noodles?
Nepal: Any food made from grains, like rice, millet, sorghum, maize, wheat, or porridge?
Peru: Any food made with grain (rice, maize, oats, quinoa, wheat (flour, bread, noodles, biscuits/cookies), kiwicha)?

Comments: In Malawi, because porridge enriched with other foods is included as a separate food group, it is likely that those other ingredients (e.g., ground nuts) did not also get recorded in their own group. This could have resulted in lower estimates for the proportion of children receiving some food groups, and lower diversity scores for some *children. Approximately 15% of the children had enriched porridge the day before the survey. In Zimbabwe, it would have been better if the thin gruels were included as liquids, rather than with the solid food groups, as the main ingredient is probably water.*

- **Pumpkin, red or yellow yams or squash, carrots, or red sweet potatoes?**

Ethiopia: Combines three groups:
Any food made from pumpkins, carrots, red sweet potatoes, green leafy vegetables, mango, papaya?
Malawi: Pumpkin, yellow squash, carrots, or yellow sweet potatoes?
Zimbabwe: Pumpkin, squash, sweet potatoes, or carrots?
Nepal: Combines two groups:
Pumpkin, carrots, papaya, or mango?
Colombia: Pumpkin, carrots, kidney beans (habichuela) and tomato
Peru: Squash, pumpkin, carrots, tomatoes?

Comments: In Zimbabwe: White sweet potatoes are eaten in southern Africa, and are low in carotenoids. By not specifying color, this questionnaire may have led to an overestimate of the proportion of children eating vitamin A-rich vegetables. In Colombia, two foods are listed that are not generally considered to be high in vitamin A (kidney beans and tomato). Similarly, tomato is included in Peru. There are several ways to assess which foods to include in lists of vitamin A-rich fruits and vegetables. They can be assessed based on carotenoid content (per gram), in which case tomato would not be included. Or they can be assessed based on the role they play in the diet; in some contexts, tomatoes may provide more carotenoids than other foods, because they are much more frequently eaten or eaten in larger quantities (WHO, 1998, p.107).

- **Any other food made from roots or tubers [e.g., white potatoes, white yams, manioc, cassava, or other local roots/tubers]?**

Ethiopia: Any food made from roots or tubers [e.g. white potatoes, cassava, enset or other local roots/tubers]?
Zimbabwe: Potatoes or other food made from tubers?
Cambodia: Any other food made from roots or tubers such as white potatoes, taro, white or purple yams, cassava, or daikon?
Nepal: Food made from roots or tubers like potatoes, yams, tapioca?
Peru: Food made from tubers or roots (potatoes, manioc, sweet potatoes, olluca, mashua)

Comments: Peru: Note that sweet potatoes are included in this group. Presumably no carotenoid rich orange/yellow varieties are eaten.

- **Any green leafy vegetables?**

Ethiopia: Combined with orange vegetables, above.
Cambodia: Any green leafy vegetables such as morning glory, basil, amaranth, mustard greens?

Colombia: Did not include this group.
Peru: Any greens (celery, leek, spinach, chard, etc.)?

Comments: In Peru, several foods are included that are not generally considered high in carotenoids (celery and leek). Possibly these words have local definitions and indicate other foods ("apio" and "poro").

- **Mango, papaya [or other local vitamin A rich fruits]?**

Ethiopia: Combined with orange vegetables, above.
Cambodia: Ripe mango, ripe papaya, jackfruit, or durian?
Nepal: Combined with orange vegetables, above.
Colombia: Mango, papaya, pineapple, plums, grapes, berries?
Peru: Mango, papaya, plantain "de la isla", maduro, aguaje[32]?

Comments: In Cambodia, jackfruit and durian are included. Jackfruit are reasonably, though not extremely high in carotenoids; in the WorldFood[33] database, using the old 6:1 conversion factor, jackfruit is listed at 91 RE/100 grams. Durian, however, are not high in carotenoids, according to this source (4 RE/100 grams). The proportion of children eating vitamin A-rich fruits may thus be overestimated in Cambodia. In Colombia a number of fruits, not generally considered high in carotenoids are also included. In Peru, several words could not be translated.

- **Any other fruits and vegetables [e.g., bananas, apples/sauce, green beans, avocados, tomatoes]?**

Malawi: Any other fruits and vegetables [e.g. oranges, bananas, guava, green beans, avocados, tomatoes]?
Zimbabwe: Any other fruits and vegetables such as oranges, bananas, or tomatoes?
Cambodia: Any other fruits and vegetables such as bananas, green beans, tomatoes, watermelon, pineapple?
Nepal: Any other fruits and vegetables, like bananas, apples, guava, green beans, amala, orange, tomatoes?
Colombia: Other fruits (bananas, apples, guava)?
Nepal: Other fruits (plantain "de la seda" apple, avocado)?

- **Meat, poultry, fish, shellfish, or eggs?**

Ethiopia: Meat, poultry, fish, egg, cheese, or yogurt?
Malawi: Meat, poultry, fish, termites, or eggs?
Cambodia: Split into two groups:
Red meats, poultry, fish, shellfish, snake, snails, frog, rat, or insects?
Liver, tripe, kidneys, and other organ meats, or eggs?

[32] Maduro means ripe, but can also mean plantain; could not find a food-related translation for aguaje.
[33] The WorldFood Dietary Assessment System is a public domain program available at: www.fao.org/infoods/software/worldfood.html.

Nepal: Meat, poultry, fish, liver, or eggs?

- **Any food made from legumes [e.g., lentils, beans, soybeans, pulses, or peanuts]?**

Malawi: Any food made from legumes [e.g., peas, beans, cowpeas, pulses, or groundnuts]?
Zimbabwe: Beans, groundnuts or peanut butter?
Cambodia: Any food made from legumes such as beans, mung beans, soybeans, tofu, or nuts?
Nepal: Any food made from legumes, like daal, peanuts, beans?

- **Cheese or yogurt?**

Ethiopia: Combined with meat, poultry, etc., above.
Cambodia: Did not include this group.

- **Any food made with oil, fat, or butter?**

Malawi: Any food made with oil, fat, margarine, or butter?
Zimbabwe: Did not include this group.
Cambodia: Any food made with oil, fat, or coconut milk?
Nepal: Any food made with ghee, oil, fat, or butter?

- **Other country-specific food groups added:**

Colombia: Grain-based enriched weaning foods distributed by a variety of government and non-governmental organizations.

Comments: These foods were combined with other grain-based foods for the purposes of constructing diversity scores.

ANNEX 2. CONSTRUCTION OF ASSET INDEX FOR EACH COUNTRY

Details of the method used by Gwatkin et al. (2000) were provided to us, including a sample Stata command file (personal communication with Rohini Pande, one of the co-authors). We followed their method, with the following exceptions: we did the analysis separately for rural and urban areas, and we created terciles rather than quintiles because our sub-sample sizes are smaller. Finally, we used larger groupings for some variables. For example, for water source we used the following variables, each dichotomously coded yes or no:

Piped water
Covered wells/springs
Open wells/springs
Surface water
Rainwater
Tanker or bottled water
Other water sources

Gwatkin and colleagues included more categories in some countries (for example, using separate variables for water piped into the dwelling, piped into the compound, or a public standpipe).

The following Stata commands and options used were:

Factor *varlist* [aweight=*weightvariable*] if v025==1, pc means mineigen (2)
Score u1
Xtile utertile=u1, nq(3)

Factor *varlist* [aweight=*weightvariable*] if v025==2, pc means mineigen (2)
Score r1
Xtile rtertile=r1, nq(3)

Generate tertile=utertile if v025==1
Replace tertile=rtertile if v025==2

V025 is coded "1" for urban households and "2" for rural households.

Note that "Factor" is not a SVY (survey) command in Stata, so design elements such as stratification and clustering cannot be specified. However, sample weights can be applied (see below).

OPTIONS USED:

WEIGHTS: Aweights and fweights are allowed for this Stata, not pweights. Our weight variable (in data set from ORC Macro) is a pweight. This can be a problem when standard errors are calculated, because aweights are actually meant for situations where data are already means, and therefore represent >1 observation; this is not the case with pweights. However, when only point estimates (e.g., in this case, of factor scores) the results will be very close.

PC specifies that the method of extraction is principal components. Stata distinguishes between the option “pc” -- where principal components is used to analyze the correlation (or, optionally, covariance) matrix – and “pcf”, where factor analysis is performed using the principal-components factor method. The default correlation matrix is used.

Stata manual also clarifies that when the “pc” method is used, rotation is not an option as rotation can result in correlated components, and this violates the definition of principal components analysis.

MEANS presents the means for each variable in the output

MINEIGEN specifics the minimum eigenvalue for inclusion. The default value is 1 so Gwatkin et al. used a more stringent condition, which we also followed.

SCORE creates a new variable (or set of variables) that are estimates of the factor. In this case we created only one variable, estimating the first principal component.

The proportion of the shared variation in the included variables that is captured by the first principal component (the asset score) is shown in Table A1, for urban and rural areas.

Table A1. Variation captured by first principal component (asset score)

	Urban	Rural
Benin	.25	.15
Ethiopia	.14	.08
Malawi	.23	.13
Mali	.18	.11
Rwanda	.17	.11
Zimbabwe	.21	.15
Cambodia	.23	.11
Nepal	.21	.17
Colombia	.16	.17
Haiti	.12	.13
Peru	.16	.11

Table A2 on the next several pages shows which variables were used in the principal components analysis in each country. A “---” indicates that either the variable was not included on the questionnaire, or there was no variability in our subset. When there was no variability in either urban or the rural areas, the variable was included only in one area. For example in Ethiopia, there was a question for “television” on the questionnaire, but no one in rural areas (at least in our sub-sample) had a television. This is indicated by “urban” in the table. If a variable is incorporated in both the urban and rural analysis, this is indicated on the table by “both”.

Table A2. Variables included in principal components analysis, by country

		Benin	Ethiopia	Malawi	Mali	Rwanda	Zimbabwe
Variables used in most countries:							
Has electricity	V119	Both	Both	Both	Both	Both	Both
Has radio	V120	Both	Both	Both	Both	Both	Both
Has television	V121	Both	Urban	Both	Both	Both	Both
Has refrigerator	V122	Both	---	---	Both	Both	Both
Has bicycle	V123	Both	Both	Both	Both	Both	Both
Has motorcycle/scooter	V124	Both	Urban	Both	Both	Both	Both
Has car/truck	V125	Both	Urban	Both	Both	Both	Both
Has telephone	V153	Both	Urban	---	Both	Both	Both
Piped water	PIPED	Both	Both	Both	Both	Both	Both
Protected well/spring	COVWELL	Both	Both	Both	Both	Both	Both
Open well/spring	OPENWELL	Both	Both	Both	Both	Both	Rural
Surface water	SURFACE	Both	Both	Both	Both	Both	Rural
Rain water	RAINWAT	Both	Rural	Rural	---	Rural	Rural
Tanker truck/bottled water	TANK_BOT	Rural	---	Rural	---	Both	---
Other water	OTHERWAT				Urban	Urban	Rural
No toilet - use field/bush	NOTOILET	Both	Both	Both	Both	Both	Rural
Flush toilet	FLUSHTOI	Both	Urban	Both	Both	Both	Both
Pit latrine	PITTOILE	Both	Both	Both	Both	Both	Both
Other toilet	OTHERT	Both	---	---	---	---	Rural
Natural floor material - Earth, dung, sand, etc.	NATURF	Both	Both	Both	Both	Both	Both
Rudimentary floor material – Wood planks, palm, bamboo, etc.	RUDIMF	Rural	Both	Both	Rural	Both	Urban
Finished floor – vinyl, asphalt, Cement, carpet, tile, polished wood	FINISHF	Both	Both	Both	Both	Both	Both
Other floor	OTHERFL	Rural	Both	---	---	Both	Rural
Use charcoal for cooking	CHARCOAL	Both	Both	Both	Both	Both	Rural
Use firewood for cooking	FIREWOOD	Both	Both	Both	Both	Both	Both
Use natural gas for cooking	LPG	Urban	---	---	Urban	---	Urban
Use gasoline for cooking	GASOLINE	Both	---	---	---	---	---
Use electricity for cooking	ELECTRIC	---	Urban	Both	Rural	Urban	Both
Use biogas for cooking	BIOGAS	---	Urban	---	---	---	---
Use dung for cooking	DUNG	---	Both	---	Both	Rural	Rural
Use kerosene for cooking	KEROSENE	---	Both	Both	---	Urban	Both
Use coal for cooking	COAL	---	---	---	Urban	Urban	---
Use other fuel for cooking	OTHERF	Both	---	---	Rural	Both	Rural

		Benin	Ethiopia	Malawi	Mali	Rwanda	Zimbabwe
Country-specific variables:							
No. of HH members per sleeping room	NUMPERRM		Both				
Owns a boat	S028D	Both					
Electricity is source for light	ELECLITE	Both					
Petrol is source for light	PETRLITE	Both					
Gas is source for light	GASLITE	Both					
Earth, leaves for roof	NATURRF	Both					
Wood planks, palm branches	RUDIMRF	Both					
Finished roof – tile or cement	FINISHRF	Both					
Other roof	OTHERRF	Urban					
Wood and mud roof	WOODRF		Both				
Thatch roof	THATCHRF		Both				
Reed/bamboo roof	REEDRF		Both				
Plastic sheet roof	PLASTRF		Both				
Mobile roofs of nomads	MOBILRF		Both				
Finished roof: corrugated iron, cement, concrete	FINISHRF		Both				
Other roof	OTHERRF		Rural				
Has electric mitad	SH25E		Both				
Has kerosene lamp	SH25F		Both				
Has a bed/table	SH25G		Both				
Owns house	SH25AA		Both				
Owns crop land	SH24AB		Both				
Owns cattle/camels	SH25AC		Both				
Owns horse/donkey/mule	SH25AD		Both				
Has a paraffin lamp	SH025B			Both			
Has horse-drawn cart	SH28D				Both		
Has plow	SH28E				Both		
Has horse	SH28F				Both		
Has wheel barrow	SH28G				Both		
Has donkey	SH28H				Both		
Has modern oxcart	SH22A						Both

		Cambodia	Nepal		Colombia	Haiti	Peru
Variables used in most countries:							
Has electricity	V119	Both	Both		Both	Both	Both
Has radio	V120	Both	Both		Both	Both	Both
Has television	V121	Both	Both		Both	Both	Both
Has refrigerator	V122	Both	---		Both	Both	Both
Has bicycle	V123	Both	Both		---	Both	Both
Has motorcycle/scooter	V124	Both	---		---	Both	Both
Has car/truck	V125	Both	---		---	Both	Both
Has telephone	V153	Both	Both		---	Both	Both
Piped water	PIPED	Both	Both		Both	Both	Both
Protected well/spring	COVWELL	Both	Both		---	Both	---
Open well/spring	OPENWELL	Both	Both		Both	Both	Both
Surface water	SURFACE	Both	Both		Rural	Both	Both
Rain water	RAINWAT	Both	---		Both	Both	Both
Tanker truck/bottled water	TANK_BOT	Both	---		Both	Both	Both
Other water OTHERWAT		Both	---		Both	---	Both
No toilet - use field/bush	NOTOILET	Both	Both		Both	Both	Both
Flush toilet	FLUSHTOI	Both	Both		See below	Both	Both
Pit latrine	PITTOILE	Both	Both		Both	Both	Both
Other toilet	OTHERT	Both	---		---	---	Both
Natural floor material - Earth, dung, sand, etc.	NATURF	Both	Both		Both	Both	Both
Rudimentary floor material – Wood planks, palm, bamboo, etc.	RUDIMF	Both	Both		Both	Both	Both
Finished floor – vinyl, asphalt, Cement, carpet, tile, polished wood	FINISHF	Both	Both		Both	Both	Both
Other floor	OTHERFL	Rural	Both		Rural	---	Both
Use charcoal for cooking	CHARCOAL	Both	---		Both	Both	Both
Use firewood for cooking	FIREWOOD	Both	---		Both	Both	Both
Use natural gas for cooking	LPG	Both	Both		Both	Both	Both
Use gasoline for cooking	GASOLINE	---	---		Both	---	---
Use electricity for cooking	ELECTRIC	Both	---		Both	---	Urban
Use biogas for cooking	BIOGAS	---	Both		---	Urban	---
Use dung for cooking	DUNG	---	---		---	---	Both
Use kerosene for cooking	KEROSENE	Both	Both		Both	Both	Both
Use coal for cooking	COAL	---	---		---	---	---
Use chulo for cooking	CHULO	---	Both		---	---	---
Use wood/charcoal/dung TRADFWCD		---	Both		---	---	---
Use other fuel for cooking	OTHERF	---	Both		---	Rural	Rural

	Cambodia	Nepal		Colombia	Haiti	Peru
Country-specific variables:						
No. of HH members per sleeping room NUMPERRM				Both		Both
Thatch/palm/bamboo/bark roof THATCH	Both					
Plastic sheet/tent roof PLASTIC	Both					
Galvanized iron/aluminum roof GALVIRON	Both					
Tiles/cement/concrete roof CEMENTRF	Both					
Other roof OTHERRF	Rural					
Has wardrobe S25B	Both					
Has sewing machine/loom S25C	Both					
Has boat with motor S28D	Both					
Has boat without motor S28E	Both					
Has oxcart/horsecart S28F	Both					
Owns land OWNSLAND		Both				
Owns livestock OWNSLVST		Both				
Toilet to sewer FLUSHSEW				Both		
Toilet to pit FLUSHPIT				Both		
Toilet to creek/open space FLUSHCRK				Both		
Electricity from EDH SH24B					Both	
Other source of electricity SH24C					Both	
Has furnace SH25A					Both	
Has bed SH25B					Both	
Has horse, mule SH28D					Both	
Owns home OWNHOME					Both	
Rents home RENTHOME					Both	
Stays for free FREEHOME					Both	
Wood roof WOODRF						Both
Corrugated iron/cement fiber CALAMRF						Both
Bamboo/matting w/mud BAMBOORF						Both
Palm leaf/thatch PALMRF						Both
Concrete roof CEMENTRF						Both
Tile roof TILESRF						Both
Other roof OTHERRF						Both
Has computer SH25F						Both
Has other transport SH28D						Both

ANNEX 3. REGRESSION RESULTS

This annex presents more complete regression results for the analyses summarized in Chapter 9. Tables A3-A13 show the coefficients, T-statistics, and p-values for each variable in the regressions (main effects model). P-values for joint tests of the significance of categorical variables, and also p-values for significant interactions are shown below each table. Our criteria in evaluating significance are p-values of < 0.05 for main effects, and p-values of < 0.20 for interactions.

Table A3. Regression results for Benin, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.22	-4.77	0.00
Child age^2	0.00	2.28	0.02
Child sex	-0.14	-1.76	0.08
Maternal height	0.05	7.07	0.00
Maternal BMI	0.01	0.88	0.38
Mother's education – primary vs. none	-0.04	-0.37	0.71
Mother's education – secondary vs. none	-0.14	-0.78	0.44
Father's education in years	0.01	0.38	0.70
Antenatal care – 1-3 visits vs. none	-0.10	-0.58	0.57
Antenatal care – 4+ visits vs. none	0.05	0.36	0.72
Continued breastfeeding (Yes)	-0.35	-2.44	0.02
Dietary diversity tercile – middle vs. low	0.02	0.24	0.81
Dietary diversity tercile – high vs. low	0.12	1.34	0.18
Urban or rural location (Rural)	-0.11	-1.37	0.17
Asset index tercile – middle vs. low	0.01	0.07	0.95
Asset index tercile – high vs. low	0.02	0.17	0.87
Number of children < 5 years old in household	-0.10	-3.08	0.00
Constant	-5.86	-5.16	0.00

Sample size	**931**
F	**20.07**
R^2	**0.23**

Joint tests for categorical variables	**p-value**
Mother's education level	0.74
Number of antenatal visits	0.25
Asset index terciles	0.99
Dietary diversity terciles	0.39

Tests for interactions of dietary diversity with:	**p-value**
Urban-rural location	0.13
Asset index terciles	0.12
Continued breastfeeding	0.19

Table A4. Regression results for Ethiopia, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.24	-5.34	0.00
Child age^2	0.01	3.40	0.00
Child sex	-0.25	-3.76	0.00
Maternal height	0.04	6.73	0.00
Maternal BMI	0.02	0.85	0.40
Mother's education – primary vs. none	0.15	1.48	0.14
Mother's education – secondary vs. none	0.35	1.40	0.16
Father's education in years	0.00	0.31	0.76
Antenatal care – 1-3 visits vs. none	-0.06	-0.64	0.53
Antenatal care – 4+ visits vs. none	0.08	0.64	0.52
Continued breastfeeding (Yes)	-0.56	-2.54	0.01
Dietary diversity tercile – middle vs. low	0.19	2.33	0.02
Dietary diversity tercile – high vs. low	0.31	3.78	0.00
Urban or rural location (Rural)	-0.15	-0.88	0.38
Asset index tercile – middle vs. low	0.20	2.58	0.01
Asset index tercile – high vs. low	0.17	1.72	0.09
Number of children < 5 years old in household	-0.12	-2.31	0.02
Constant	-5.00	-4.36	0.00

Sample size	**2379**
F	**19.81**
R^2	**0.19**

Joint tests for categorical variables	**p-value**
Mother's education level	0.17
Number of antenatal visits	0.57
Asset index terciles	0.03
Dietary diversity terciles	0.00

No significant interactions with dietary diversity

Table A5. Regression results for Malawi, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.23	-5.49	0.00
Child age^2	0.00	2.80	0.01
Child sex	-0.19	-3.18	0.00
Maternal height	0.04	6.00	0.00
Maternal BMI	0.02	1.69	0.09
Mother's education – primary vs. none	0.01	0.18	0.86
Mother's education – secondary vs. none	0.36	2.06	0.04
Father's education in years	0.01	1.21	0.23
Antenatal care – 1-3 visits vs. none	0.11	0.62	0.54
Antenatal care – 4+ visits vs. none	0.19	1.09	0.28
Continued breastfeeding (Yes)	-0.32	-2.27	0.02
Dietary diversity tercile – middle vs. low	0.16	2.14	0.03
Dietary diversity tercile – high vs. low	0.12	1.43	0.15
Urban or rural location (Rural)	-0.31	-2.18	0.03
Asset index tercile – middle vs. low	0.10	1.14	0.25
Asset index tercile – high vs. low	0.29	3.17	0.00
Number of children < 5 years old in household	0.01	0.25	0.80
Constant	-5.32	-4.99	0.00

Sample size	**2584**
F	**29.41**
R^2	**0.20**

Joint tests for categorical variables	**p-value**
Mother's education level	0.08
Number of antenatal visits	0.37
Asset index terciles	0.01
Dietary diversity terciles	0.07

Tests for interactions of dietary diversity with:	**p-value**
Child's age category	0.02
Mother's education level	0.17
Continued breastfeeding	0.01

Table A6. Regression results for Mali, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.19	-2.90	0.00
Child age^2	0.00	0.96	0.34
Child sex	-0.08	-0.78	0.44
Maternal height	0.03	3.48	0.00
Maternal BMI	0.05	2.34	0.02
Mother's education – primary vs. none	0.11	0.78	0.43
Mother's education – secondary vs. none	0.22	1.00	0.32
Father's education in years	0.00	0.27	0.79
Antenatal care – 1-3 visits vs. none	0.17	1.17	0.24
Antenatal care – 4+ visits vs. none	0.03	0.20	0.84
Continued breastfeeding (Yes)	0.03	0.15	0.88
Dietary diversity tercile – middle vs. low	0.11	1.07	0.29
Dietary diversity tercile – high vs. low	0.15	1.09	0.28
Urban or rural location (Rural)	-0.37	-2.72	0.01
Asset index tercile – middle vs. low	0.02	0.21	0.84
Asset index tercile – high vs. low	0.17	1.21	0.23
Number of children < 5 years old in household	-0.07	-1.20	0.23
Constant	-4.62	-3.26	0.00

Sample size	**829**
F	**14.19**
R^2	**0.26**

Joint tests for categorical variables	**p-value**
Mother's education level	0.49
Number of antenatal visits	0.49
Asset index terciles	0.44
Dietary diversity terciles	0.42

Tests for interactions of dietary diversity with	**p-value**
Urban-rural location	0.19
Continued breastfeeding	0.19

Table A7. Regression results for Rwanda, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.30	-6.14	0.00
Child age^2	0.01	3.77	0.00
Child sex	-0.09	-1.13	0.26
Maternal height	0.04	4.46	0.00
Maternal BMI	0.03	1.73	0.09
Mother's education – primary vs. none	-0.02	-0.20	0.84
Mother's education – secondary vs. none	0.10	0.60	0.55
Father's education in years	0.00	0.22	0.83
Antenatal care – 1-3 visits vs. none	-0.12	-0.79	0.43
Antenatal care – 4+ visits vs. none	0.21	1.14	0.26
Continued breastfeeding (Yes)	-0.06	-0.31	0.76
Dietary diversity tercile – middle vs. low	-0.05	-0.51	0.61
Dietary diversity tercile – high vs. low	0.21	1.82	0.07
Urban or rural location (Rural)	-0.38	-2.73	0.01
Asset index tercile – middle vs. low	0.01	0.06	0.95
Asset index tercile – high vs. low	0.25	2.16	0.03
Number of children < 5 years old in household	-0.04	-0.73	0.47
Constant	-4.42	-2.94	0.00

Sample size	**1217**
F	**22.47**
R^2	**0.21**

Joint tests for categorical variables	**p-value**
Mother's education level	0.71
Number of antenatal visits	0.02
Asset index terciles	0.04
Dietary diversity terciles	0.05 (0.0489)

Tests for interactions of dietary diversity with	**p-value**
Child's age category	0.02

Table A8. Regression results for Zimbabwe, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.18	-2.58	0.01
Child age^2	0.00	1.43	0.16
Child sex	-0.10	-0.65	0.52
Maternal height	0.03	2.80	0.01
Maternal BMI	0.04	2.15	0.03
Mother's education – primary vs. none	-0.08	-0.26	0.80
Mother's education – secondary vs. none	-0.41	-1.27	0.21
Father's education in years	0.05	2.34	0.02
Antenatal care – 1-3 visits vs. none	0.36	1.06	0.29
Antenatal care – 4+ visits vs. none	0.44	1.47	0.14
Continued breastfeeding (Yes)	0.03	0.10	0.92
Dietary diversity tercile – middle vs. low	0.51	3.15	0.00
Dietary diversity tercile – high vs. low	0.70	4.17	0.00
Urban or rural location (Rural)	0.18	0.84	0.40
Asset index tercile – middle vs. low	0.01	0.07	0.94
Asset index tercile – high vs. low	-0.03	-0.16	0.87
Number of children < 5 years old in household	-0.10	-1.14	0.25
Constant	-6.18	-3.13	0.00

Sample size	**560**
F	**5.98**
R^2	**0.14**

Joint tests for categorical variables	**p-value**
Mother's education level	0.17
Number of antenatal visits	0.31
Asset index terciles	0.97
Dietary diversity terciles	0.00

Tests for interactions of dietary diversity with	**p-value**
Urban-rural location	0.05
Continued breastfeeding	0.18

Table A9. Regression results for Cambodia, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.08	-1.32	0.19
Child age^2	0.00	-0.05	0.96
Child sex	-0.09	-0.88	0.38
Maternal height	0.05	4.02	0.00
Maternal BMI	0.02	0.73	0.47
Mother's education – primary vs. none	0.16	1.33	0.18
Mother's education – secondary vs. none	0.42	2.10	0.04
Father's education in years	-0.01	-0.62	0.53
Antenatal care – 1-3 visits vs. none	-0.10	-0.84	0.40
Antenatal care – 4+ visits vs. none	0.18	0.91	0.37
Continued breastfeeding (Yes)	-0.29	-1.55	0.12
Dietary diversity tercile – middle vs. low	0.16	1.34	0.18
Dietary diversity tercile – high vs. low	0.46	3.08	0.00
Urban or rural location (Rural)	0.36	2.03	0.04
Asset index tercile – middle vs. low	0.23	1.80	0.07
Asset index tercile – high vs. low	0.06	0.49	0.63
Number of children < 5 years old in household	-0.22	-2.81	0.01
Constant	-8.33	-4.08	0.00

Sample size	**812**
F	**6.30**
R^2	**0.16**

Joint tests for categorical variables	**p-value**
Mother's education level	0.10
Number of antenatal visits	0.30
Asset index terciles	0.19
Dietary diversity terciles	0.01

Tests for interactions of dietary diversity with	**p-value**
Asset index terciles	0.11
Continued breastfeeding	0.03

Table A10. Regression results for Nepal, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.21	-6.05	0.00
Child age^2	0.00	3.85	0.00
Child sex	-0.01	-0.18	0.86
Maternal height	0.05	8.22	0.00
Maternal BMI	0.04	3.02	0.00
Mother's education – primary vs. none	0.12	1.54	0.13
Mother's education – secondary vs. none	0.17	1.72	0.09
Father's education in years	0.03	3.45	0.00
Antenatal care – 1-3 visits vs. none	0.06	0.90	0.37
Antenatal care – 4+ visits vs. none	0.14	1.65	0.10
Continued breastfeeding (Yes)	0.06	0.32	0.75
Dietary diversity tercile – middle vs. low	0.09	1.22	0.22
Dietary diversity tercile – high vs. low	0.25	2.90	0.00
Urban or rural location (Rural)	-0.29	-3.11	0.00
Asset index tercile – middle vs. low	0.18	2.54	0.01
Asset index tercile – high vs. low	0.25	3.25	0.00
Number of children < 5 years old in household	-0.05	-1.36	0.17
Constant	-7.46	-8.02	0.00

Sample size	**1607**
F	**23.88**
R^2	**0.24**

Joint tests for categorical variables	**p-value**
Mother's education level	0.11
Number of antenatal visits	0.26
Asset index terciles	0.00
Dietary diversity terciles	0.01

Tests for interactions of dietary diversity with	**p-value**
Urban-rural location	0.17
Continued breastfeeding	0.01

Table A11. Regression results for Colombia, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.12	-3.50	0.00
Child age^2	0.00	2.02	0.04
Child sex	-0.19	-3.26	0.00
Maternal height	0.06	11.29	0.00
Maternal BMI	0.02	3.60	0.00
Mother's education – primary vs. none	-0.08	-0.49	0.63
Mother's education – secondary vs. none	-0.03	-0.18	0.86
Father's education in years	0.01	0.83	0.41
Antenatal care – 1-3 visits vs. none	-0.01	-0.06	0.95
Antenatal care – 4+ visits vs. none	0.21	1.89	0.06
Continued breastfeeding (Yes)	-0.11	-1.63	0.10
Dietary diversity tercile – middle vs. low	0.00	-0.05	0.96
Dietary diversity tercile – high vs. low	0.12	1.51	0.13
Urban or rural location (Rural)	-0.05	-0.76	0.45
Asset index tercile – middle vs. low	-0.10	-1.35	0.18
Asset index tercile – high vs. low	-0.16	-2.28	0.02
Number of children < 5 years old in household	-0.17	-3.99	0.00
Constant	-8.83	-10.19	0.00

Sample size	**1050**
F	**21.66**
R^2	**0.26**

Joint tests for categorical variables	**p-value**
Mother's education level	0.72
Number of antenatal visits	0.06
Asset index terciles	0.07
Dietary diversity terciles	0.19

No significant interactions with dietary diversity

Table A12. Regression results for Haiti, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.09	-1.89	0.06
Child age^2	0.00	0.53	0.59
Child sex	-0.20	-2.51	0.01
Maternal height	0.04	6.51	0.00
Maternal BMI	0.05	3.91	0.00
Mother's education – primary vs. none	-0.04	-0.34	0.73
Mother's education – secondary vs. none	0.00	0.06	0.95
Father's education in years	0.02	1.48	0.14
Antenatal care – 1-3 visits vs. none	0.25	1.95	0.05
Antenatal care – 4+ visits vs. none	0.22	2.30	0.02
Continued breastfeeding (Yes)	-0.00	-0.00	1.00
Dietary diversity tercile – middle vs. low	0.11	0.72	0.47
Dietary diversity tercile – high vs. low	0.07	0.68	0.50
Urban or rural location (Rural)	-0.08	-0.87	0.39
Asset index tercile – middle vs. low	0.20	1.97	0.05
Asset index tercile – high vs. low	0.23	2.18	0.03
Number of children < 5 years old in household	-0.16	-3.13	0.00
Constant	-7.76	-6.70	0.00

Sample size	**1390**
F	**25.81**
R^2	**0.22**

Joint tests for categorical variables	**p-value**
Mother's education level	0.93
Number of antenatal visits	0.04
Asset index terciles	0.06
Dietary diversity terciles	0.74

Tests for interactions of dietary diversity with	**p-value**
Child's age category	0.02
Urban-rural location	0.10

Table A13. Regression results for Peru, dependent variable HAZ

Independent variables	Coefficient	t	p-value
Child age	-0.17	-5.50	0.00
Child age^2	0.00	3.56	0.00
Child sex	-0.03	-0.68	0.50
Maternal height	0.05	10.97	0.00
Maternal BMI	0.01	1.39	0.17
Mother's education – primary vs. none	0.12	1.40	0.16
Mother's education – secondary vs. none	0.22	1.99	0.05
Father's education in years	0.01	1.20	0.23
Antenatal care – 1-3 visits vs. none	0.06	0.71	0.48
Antenatal care – 4+ visits vs. none	0.03	0.46	0.64
Continued breastfeeding (Yes)	-0.02	-0.34	0.74
Dietary diversity tercile – middle vs. low	-0.04	-0.55	0.58
Dietary diversity tercile – high vs. low	0.05	0.76	0.45
Urban or rural location (Rural)	-0.55	-9.01	0.00
Asset index tercile – middle vs. low	0.13	1.94	0.05
Asset index tercile – high vs. low	0.31	4.33	0.00
Number of children < 5 years old in household	-0.16	-4.74	0.00
Constant	-7.30	-9.38	0.00

Sample size	**2836**
F	**36.76**
R^2	**0.30**

Joint tests for categorical variables	**p-value**
Mother's education level	0.13
Number of antenatal visits	0.78
Asset index terciles	0.00
Dietary diversity terciles	0.38

Tests for interactions of dietary diversity with	**p-value**
Child's age category	0.00
Asset index terciles	0.11

ANNEX 4. TABLES COMPARING THE 24-HOUR AND 7-DAY FOOD GROUP RECALLS

This annex presents more complete tables for the results presented in Chapter 8. Tables A14-A23 show a four-way comparison for each food group within each country.

Table A14. Benin: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	72	82	80	77
Food made from legumes	19	38	21	15
Dairy	17	26	19	17
Meat, poultry, fish, shellfish, eggs	49	63	53	47
Vitamin A rich fruits & vegs	38	60	44	34
Orange/red vitamin A-rich fruits & vegs	18	38	22	16
Other fruits, vegetables or juice	35	52	42	34
Foods made with fats or oil	57	64	60	56

Table A15. Ethiopia: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	77	80	77	73
Food made from legumes	40	51	42	35
Dairy	33	40	35	32
Meat, poultry, fish, shellfish, eggs	12	24	11	7
Vitamin A rich fruits & vegs	10	17	9	6
Orange/red vitamin A-rich fruits & vegs				
Other fruits, vegetables or juice	12	24	9	5
Foods made with fats or oil	35	43	34	28

Table A16. Malawi: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	96	98	96	95
Food made from legumes	28	48	19	9
Dairy	8	12	8	6
Meat, poultry, fish, shellfish, eggs	37	62	29	15
Vitamin A rich fruits & vegs	63	77	58	48
Orange/red vitamin A-rich fruits & vegs	23	38	17	11
Other fruits, vegetables or juice	32	51	26	17
Foods made with fats or oil	8	12	7	5

Table A17. Mali: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	55	67	63	61
Food made from legumes	8	16	8	5
Dairy	16	27	19	16
Meat, poultry, fish, shellfish, eggs	23	38	26	20
Vitamin A rich fruits & vegs	21	33	23	19
Orange/red vitamin A-rich fruits & vegs	17	30	19	15
Other fruits, vegetables or juice	14	26	15	11
Foods made with fats or oil	18	29	19	14

Table A18. Rwanda: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	83	92	84	78
Food made from legumes	58	69	57	49
Dairy	17	14	12	13
Meat, poultry, fish, shellfish, eggs	13	25	11	7
Vitamin A rich fruits & vegs	56	73	58	47
Orange/red vitamin A-rich fruits & vegs	39	55	40	29
Other fruits, vegetables or juice	31	53	30	18
Foods made with fats or oil	35	48	34	25

Table A19. Zimbabwe: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	95	97	95	94
Food made from legumes	44	57	42	34
Dairy	21	32	20	16
Meat, poultry, fish, shellfish, eggs	43	65	38	28
Vitamin A rich fruits & vegs	63	73	66	60
Orange/red vitamin A-rich fruits & vegs	13	27	11	8
Other fruits, vegetables or juice	47	63	46	41
Foods made with fats or oil				

Table A20. Cambodia: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	89	91	88	86
Food made from legumes	17	25	8	3
Dairy	4	5	4	3
Meat, poultry, fish, shellfish, eggs	70	74	62	53
Vitamin A rich fruits & vegs	55	66	47	35
Orange/red vitamin A-rich fruits & vegs	41	53	31	20
Other fruits, vegetables or juice	55	67	43	28
Foods made with fats or oil	36	46	24	13

Table A21. Nepal: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	89	91	90	90
Food made from legumes	42	59	42	32
Dairy	40	46	41	38
Meat, poultry, fish, shellfish, eggs	16	38	9	5
Vitamin A rich fruits & vegs	30	50	30	20
Orange/red vitamin A-rich fruits & vegs	7	13	5	2
Other fruits, vegetables or juice	19	30	17	10
Foods made with fats or oil	7	53	46	43

Table A22. Colombia: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	92	96	92	89
Food made from legumes	33	77	31	15
Dairy	82	90	84	79
Meat, poultry, fish, shellfish, eggs	80	91	79	68
Vitamin A rich fruits & vegs	66	84	69	61
Orange/red vitamin A-rich fruits & vegs	66	84	69	61
Other fruits, vegetables or juice	73	91	80	72
Foods made with fats or oil	46	62	44	33

Table A23. Peru: Comparing 24-hour and 7-day recalls

Percent of children aged 6-23 months who ate:	Last 24 hrs	Last 7 days	3 or more days in the last 7	4 or more days in the last 7
Food made from grain, roots or tubers	94	96	94	93
Food made from legumes	34	65	33	18
Dairy	57	70	59	53
Meat, poultry, fish, shellfish, eggs	70	85	69	55
Vitamin A rich fruits & vegs	77	86	79	72
Orange/red vitamin A-rich fruits & vegs	73	84	74	66
Other fruits, vegetables or juice	50	71	51	38
Foods made with fats or oil	67	75	68	62

Tables A24-A43, below, compare rankings based on food group diversity yesterday as compared to food group diversity in the last seven days. There are two sets of tables; the first set uses the country-specific diversity terciles, and compares rankings for yesterday to rankings for last week. The second set uses the fixed cut-offs for diversity described in Chapter 6 (0-2, 3-4, and 5-6 food groups).

Sample-specific terciles

Diversity in the last week is described both by the number of food groups eaten at least three days in the last seven and by the number of food groups eaten in the last week. We know that in each country more food groups were eaten over seven days than yesterday, but in these rankings the terciles are defined separately for each variable, and cut-offs for low, middle and high groups are not necessarily the same for yesterday as for last week. These tables therefore address the question: "If a child scored high for diversity yesterday, relative to other children, did they also score high for the last week relative to other children in the sample?" The age-specific diversity terciles are used in this analysis.

The first Table (Table A34), for Benin, was also presented in Chapter 8; it is included here for completeness. Beneath each table, the proportion of children classified identically (sum of diagonal) is shown, as well as the proportion classified into opposite extremes (for example, those classified as having low diversity yesterday and high diversity over the last week). We also assess how well yesterday can "predict" the last week by giving the row percent for low and high diversity. For example in Benin, among the children who were classified as having low diversity yesterday, 89% also had low diversity for foods eaten three or more days in the last seven days.

Table A24. Benin: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
		Low	Middle	High		Low	Middle	High
Number of food groups yesterday		Percent of children (% of total)				Percent of children (% of total)		
	Low	25	6	3		24	6	3
	Middle	5	21	9		6	20	9
	High	0	4	28		0	7	25

Total percent classified identically:	74%	69%
Total percent in opposite extremes:	3%	3%
Percent of low yesterday low last week:	74%	71%
Percent of high yesterday high last week:	88%	79%

Table A25. Ethiopia: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
		Low	Middle	High		Low	Middle	High
Number of food groups yesterday		Percent of children (% of total)				Percent of children (% of total)		
	Low	26	3	1		23	4	2
	Middle	12	31	5		11	27	10
	High	1	4	19		0	4	20

Total percent classified identically:	76%	70%
Total percent in opposite extremes:	2%	2%
Percent of low yesterday low last week:	90%	80%
Percent of high yesterday high last week:	81%	84%

Table A26. Malawi: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
		Low	Middle	High		Low	Middle	High
Number of food groups yesterday		Percent of children (% of total)				Percent of children (% of total)		
	Low	25	10	2		26	8	3
	Middle	9	16	9		9	15	11
	High	3	7	19		0	7	22

Total percent classified identically:	60%	63%
Total percent in opposite extremes:	5%	3%
Percent of low yesterday low last week:	68%	72%
Percent of high yesterday high last week:	64%	76%

Table A27. Mali: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
Number of food groups yesterday		Low	Middle	High		Low	Middle	High
		Percent of children (% of total)				Percent of children (% of total)		
	Low	34	5	3		31	8	3
	Middle	11	11	5		7	14	5
	High	1	5	25		0	8	24

Total percent classified identically:	70%	69%
Total percent in opposite extremes:	4%	3%
Percent of low yesterday low last week:	82%	75%
Percent of high yesterday high last week:	79%	75%

Table A28. Rwanda: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
Number of food groups yesterday		Low	Middle	High		Low	Middle	High
		Percent of children (% of total)				Percent of children (% of total)		
	Low	23	6	1		22	5	2
	Middle	7	25	7		13	17	10
	High	2	7	23		0	8	24

Total percent classified identically:	71%	63%
Total percent in opposite extremes:	3%	2%
Percent of low yesterday low last week:	76%	75%
Percent of high yesterday high last week:	73%	76%

Table A29. Zimbabwe: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
Number of food groups yesterday		Low	Middle	High		Low	Middle	High
		Percent of children (% of total)				Percent of children (% of total)		
	Low	25	6	1		25	6	0
	Middle	8	23	11		10	19	13
	High	1	4	22		0	6	22

Total percent classified identically:	70%	66%
Total percent in opposite extremes:	2%	0%
Percent of low yesterday low last week:	80%	81%
Percent of high yesterday high last week:	82%	79%

Table A30. Cambodia: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
		Low	Middle	High		Low	Middle	High
Number of food groups yesterday		Percent of children (% of total)				Percent of children (% of total)		
	Low	24	8	3		24	9	1
	Middle	4	17	10		5	22	4
	High	3	8	24		0	14	21

Total percent classified identically:	65%	67%
Total percent in opposite extremes:	6%	1%
Percent of low yesterday low last week:	70%	70%
Percent of high yesterday high last week:	69%	61%

Table A31. Nepal: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
		Low	Middle	High		Low	Middle	High
Number of food groups yesterday		Percent of children (% of total)				Percent of children (% of total)		
	Low	24	4	1		23	4	2
	Middle	4	26	6		10	17	9
	High	2	8	25		0	7	28

Total percent classified identically:	75%	68%
Total percent in opposite extremes:	3%	2%
Percent of low yesterday low last week:	83%	79%
Percent of high yesterday high last week:	71%	80%

Table A32. Colombia: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
		Low	Middle	High		Low	Middle	High
Number of food groups yesterday		Percent of children (% of total)				Percent of children (% of total)		
	Low	21	7	2		22	3	6
	Middle	5	19	8		14	6	13
	High	3	15	21		5	3	30

Total percent classified identically:	61%	58%
Total percent in opposite extremes:	5%	11%
Percent of low yesterday low last week:	69%	71%
Percent of high yesterday high last week:	55%	80%

Table A33. Peru: Comparing classification into diversity terciles based on the 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days				Number of food groups eaten in the last 7 days		
		Low	Middle	High		Low	Middle	High
Number of food groups yesterday		Percent of children (% of total)				Percent of children (% of total)		
	Low	25	6	2		23	6	3
	Middle	5	18	9		6	17	9
	High	2	7	28		0	13	23

Total percent classified identically:	71%	63%
Total percent in opposite extremes:	4%	3%
Percent of low yesterday low last week:	76%	70%
Percent of high yesterday high last week:	77%	64%

Fixed cut-offs for diversity

Finally, Tables A34-A43 present similar comparisons between yesterday and three or more days using fixed cut-offs for diversity. These tables address a slightly different question; that is: "If a child ate 0-2 food groups yesterday (or 3-4, or 5-7) how likely are they to be in the same group over the past week?" In these tables we present results for food groups eaten three or more days in the last seven.

In general, the tables show that the "prediction" of last week based on yesterday works best when there are a substantial number of children in a given group yesterday. Unlike the tables above, where roughly one-third of the children are in each diversity group, in the tables using the fixed cut-offs some cells represent few children. For most countries, this means that low diversity yesterday (0-2 groups) predicts low diversity three or more days in the last seven reasonably well. The range is from 81%-93%, except in Colombia (74%) and Peru (77%); few children are in the low diversity group in these last two countries. In contrast, high diversity is "predicted" better in Colombia (87%) and Peru (87%) where many children are in the high diversity group (5-7 food groups). In other countries, 45%-82% of the children in the high diversity group yesterday are also in that group for last week.

Table A34. Benin: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
Number of food groups yesterday		0-2	3-4	5-7
		Percent of children (% of total)		
	0-2	35	6	2
	3-4	3	20	10
	5-7	0	4	20

Total percent classified identically: 75%
Total percent in opposite extremes: 2%
Percent of low yesterday low last week: 82%
Percent of high yesterday high last week: 82%

Table A35. Ethiopia: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
Number of food groups yesterday		0-2	3-4	5-7
		Percent of children (% of total)		
	0-2	56	5	0
	3-4	5	25	2
	5-7	0	3	4

Total percent classified identically: 85%
Total percent in opposite extremes: 0%
Percent of low yesterday low last week: 92%
Percent of high yesterday high last week: 58%

Table A36. Malawi: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
Number of food groups yesterday		0-2	3-4	5-7
		Percent of children (% of total)		
	0-2	40	6	0
	3-4	16	27	2
	5-7	1	4	4

Total percent classified identically: 71%
Total percent in opposite extremes: 1%
Percent of low yesterday low last week: 87%
Percent of high yesterday high last week: 45%

Table A37. Mali: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
		0-2	3-4	5-7
		Percent of children (% of total)		
Number of food groups yesterday	0-2	67	8	1
	3-4	3	11	2
	5-7	1	2	5

Total percent classified identically: 83%
Total percent in opposite extremes: 2%
Percent of low yesterday low last week: 88%
Percent of high yesterday high last week: 63%

Table A38. Rwanda: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
		0-2	3-4	5-7
		Percent of children (% of total)		
Number of food groups yesterday	0-2	33	7	1
	3-4	8	31	5
	5-7	0	5	10

Total percent classified identically: 74%
Total percent in opposite extremes: 1%
Percent of low yesterday low last week: 81%
Percent of high yesterday high last week: 66%

Table A39. Zimbabwe: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
		0-2	3-4	5-7
		Percent of children (% of total)		
Number of food groups yesterday	0-2	30	6	0
	3-4	8	32	5
	5-6	0	6	13

Total percent classified identically: 75%
Total percent in opposite extremes: 0%
Percent of low yesterday low last week: 83%
Percent of high yesterday high last week: 68%

Table A40. Cambodia: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
		0-2	3-4	5-7
		Percent of children (% of total)		
Number of food groups yesterday	0-2	30	2	0
	3-4	11	29	2
	5-7	3	10	13

Total percent classified identically: 72%
Total percent in opposite extremes: 3%
Percent of low yesterday low last week: 93%
Percent of high yesterday high last week: 51%

Table A41. Nepal: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
		0-2	3-4	5-7
		Percent of children (% of total)		
Number of food groups yesterday	0-2	36	5	0
	3-4	7	35	3
	5-7	1	5	8

Total percent classified identically: 79%
Total percent in opposite extremes: 1%
Percent of low yesterday low last week: 86%
Percent of high yesterday high last week: 59%

Table A42. Colombia: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
		0-2	3-4	5-7
		Percent of children (% of total)		
Number of food groups yesterday	0-2	8	2	1
	3-4	3	15	9
	5-7	0	8	55

Total percent classified identically: 78%
Total percent in opposite extremes: 1%
Percent of low yesterday low last week: 74%
Percent of high yesterday high last week: 87%

Table A43. Peru: Comparing classification using fixed cut-offs, 24-hour food group recall compared to the 7-day food group recall

		Number of food groups eaten 3 or more days in the last 7 days		
Number of food groups yesterday		**0-2**	**3-4**	**5-7**
		Percent of children (% of total)		
	0-2	9	3	0
	3-4	3	20	8
	5-7	0	7	49

Total percent classified identically:	78%
Total percent in opposite extremes:	0%
Percent of low yesterday low last week:	77%
Percent of high yesterday high last week:	87%