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PROGRESS IN DEVELOPING AN INFANT AND CHILD FEEDING INDEX: AN EXAMPLE USING THE ETHIOPIA DEMOGRAPHIC AND HEALTH SURVEY 2000

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Abstract

Summary indicators for measuring and assessing infant and child feeding practices are needed for research, communication and advocacy, and program evaluation. This paper reports on progress in developing a summary measure of infant and child feeding practices that addresses the following two challenges: infant and child feeding is multidimensional, and appropriate practices vary by age of the child. Much previous research in the area of infant and child feeding has focused on single practices over a narrow age range and so has not addressed the determinants and impact of adequate or optimal infant and child feeding.

Using data from the Ethiopia Demographic and Health Survey, an infant and child feeding index is constructed, summarizing a range of key practices, including breastfeeding, bottle use, feeding frequency, and diet diversity. Because it provides age-specific scoring and incorporates various practices, the index is a useful analytic tool.

The index is associated with an indicator of child growth (height-for-age) in bivariate and multivariate analyses. Examination of individual indicators shows that this association is driven by a strong positive association between one component—diet diversity—and height-for-age. Further work is required to establish the nature of the relationship between infant and child feeding indicators, nutrient adequacy, growth, and other outcomes. But because it can be used to illustrate the association between a set of recommended practices and growth, the index may serve as a communication tool with policymakers.

Simulations show that the index accurately reflects an averaging of changes in individual component practices, and so it may also be of use to program managers who seek a summary measure for assessing program impact on a range of early feeding practices.

Contents

Acknowledgments ... vii

1. Introduction ... 1

2. Methods ... 4

    Description of Survey and Sample Selection ... 4
    Construction of the Infant and Child Feeding Index (ICFI) ... 4
        Overall Approach ... 4
        Scoring of Components ... 7
        The Feeding Index Scores and Terciles ... 11
    Socioeconomic Status Factors ... 11
    Analytical Methodology ... 13

3. Characteristics of the Sample ... 16

    Maternal and Sociodemographic Characteristics ... 16
    Child Nutritional Status ... 18
    Infant and Child Feeding Practices ... 19

4. Are Infant and Child Feeding Practices Associated With Nutritional Status in Ethiopia? ... 22

5. Which Practices Drive the Association Between the ICFI and HAZ? ... 26

    Breastfeeding ... 27
    Bottle Use ... 29
    Dietary Diversity—24-Hour and Seven-Day Recalls ... 30
    Frequency of Feeding Solids and Semisolid Foods ... 34
    Summary of "Decomposition" Exercise ... 35

6. For Which Purposes Is the ICFI Most Likely To Be Useful? ... 36

    For International Comparisons ... 36
    For Research, Communication, and Advocacy ... 37
    For Monitoring and Evaluation ... 38
        Simulations to Test Responsiveness of the Infant and Child Feeding Index to Varying Levels of Change in Components ... 38

Conclusions About the Potential Usefulness of the ICFI for Program Evaluation ... 41

7. Lessons Learned and Research Needs ... 42

Lessons Learned from the Ethiopia Analysis ... 43
Research Needs ... 47

Appendix: Summary of Methods Used for Simulation Exercise ... 48

References ... 51

Tables

1 Variables and scoring system used to create the infant and child feeding index (ICFI) for children aged 6-36 months, by age group ... 6

2 Selected maternal and household characteristics in the Ethiopia DHS 2000 ... 17

3 Ordinary least squares regression analysis of the determinants of HAZ among children aged 12-36 months (Ethiopia DHS 2000) ... 24

4 Ordinary least squares regressions: Summary of significant factors in urban and rural models ... 24

5 Mean HAZ and mean age in months, by breastfeeding status among children aged 12-36 months (Ethiopia DHS 2000) ... 28

6 Mean HAZ, by use of bottle among children aged 12-36 months (Ethiopia DHS 2000) ... 29

7 Changes in mean ICFI score for a range of hypothetical scenarios ... 39

Appendix Table

8 Low and high impact scenarios, using a hypothetical baseline ... 49

Figures

1 Mean Z-scores, by age group: Rural children (Ethiopia DHS 2000) ... 19

2 Mean Z-scores, by age group: Urban children (Ethiopia DHS 2000) ... 19

3 Mean number of times the child was fed solids/semisolids the previous day, by age group and area of residence (Ethiopia DHS 2000) 21

4 Mean number of different food groups fed to the child the previous day, by age group and area of residence (Ethiopia DHS 2000) 21

5 Types of foods given to 12-36-month-old children in the past seven days, by area of residence (Ethiopia DHS 2000) 22

6 Mean HAZ, by ICFI tercile and area of residence (children 12-36 months) (Ethiopia DHS 2000) 23

7 Mean HAZ for rural children aged 12-36 months, by number of food groups eaten in the previous week (Ethiopia DHS 2000) 31

8 Association between 24-hour dietary diversity (number of food groups) and HAZ (adjusted means) among children aged 12-36 months (Ethiopia DHS 2000) 33

9 Mean height-for-age for children aged 12-36 months, by frequency of feeding solids/semisolids yesterday (Ethiopia DHS 2000) 34

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1. Introduction

Feeding practices are one important determinant of the nutritional status of infants and children. Along with access to food, adequate sanitation, health care, feeding, and other childcare practices can help determine who thrives and who falters. It is useful to measure and describe infant and child feeding practices in a number of contexts. These include

- International comparisons of the adequacy of infant and child feeding,
- Research linking infant and child feeding to determinants or outcomes,
- Advocacy regarding the importance of adequate infant and child feeding,
- Monitoring or evaluation of interventions designed to change practices.

This document builds on our previous work on the development of an infant and child feeding index (IFCI)[1] for assessing complementary feeding practices using data from the Demographic and Health Surveys (DHS). Both here and in the previous work, we construct an index with the objective of reflecting as many dimensions of feeding as possible, within the limits of the data.

Our previous work confirmed the feasibility and usefulness of creating an infant and child feeding index using DHS data sets from five Latin American countries (seven data sets) (Ruel and Menon 2002). The construction of the index addressed two

[1] The infant and child feeding index (ICFI) referred to throughout this document covers infants aged 6–12 months as well as older children (12–36 months), but not infants aged 0–5 months. This is because for infants 0–5 months, there is only one recommended practice (exclusive breastfeeding); creation of an index for this age group is therefore unnecessary.

challenges in measuring and assessing infant and child feeding practices: these practices are multidimensional, and appropriate practices vary by age. Many past efforts to describe practices have focused on single dimensions (e.g., continued breastfeeding). The index proved useful for summarizing information on a variety of dimensions of age-specific feeding practices into one variable, which could then be used for research and analysis or as a communication and advocacy tool.

The work reported here addresses additional methodological issues related to the creation and use of an ICFI using DHS data. One of the motivations for undertaking this additional work was that the DHS questionnaire on infant and child feeding practices was modified in the late 1990s to include more detailed complementary feeding questions.[2] The most important change was the addition of a number of food groups (e.g., groups for vitamin-A-rich fruits and vegetables, fats and oils, etc.) to the 24-hour and seven-day recall questions regarding intake of complementary foods. The infant and child feeding topics currently covered in the DHS+ questionnaire include breastfeeding, bottle-feeding, frequency of feeding complementary foods, intake of liquids and foods from a variety of groups in the previous 24 hours, and the number of days the child was fed foods and liquids from these same groups in the previous seven days.

To carry out the additional methodological work on infant and child feeding practices presented in this report, we used the Ethiopia DHS+ 2000 data set. The main objectives were to

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[2] The new version is referred to as the "MEASURE DHS+" or "DHS+" questionnaire {ORC MACRO 2001 240 /id}.

1. Revise and refine the ICFI, taking advantage of the additional information available on infant and child feeding practices in the DHS+ questionnaire;
2. Confirm our previous findings from analyses of data sets from Latin America—i.e., that the ICFI is associated with child nutritional status (height-for-age Z-scores [HAZ])—in a very different, African context (Ethiopia), and to confirm that the association remains when socioeconomic factors are controlled for;
3. Determine which components of the feeding index appear to be most important in driving the association between the index and child nutritional status, and to determine whether the index could be simplified (by reducing the number of variables); and
4. Assess the potential usefulness of the index for three purposes:
    a. international comparisons,
    b. summarizing information into one variable, which can then be used for research and analysis of associations (e.g., between feeding practices and child outcomes) or for communication and advocacy,
    c. monitoring and evaluation of nutrition interventions.

The research presented here is concerned with complementary feeding practices and thus focuses on children aged 6–36 months.

2. Methods

Description of Survey and Sample Selection

The 2000 Ethiopia Demographic and Health Survey (EDHS) is a nationally representative survey, which included 15,367 women of reproductive age (15–49 years) and 10,872 children 60 months or younger. A detailed description of the survey methodology and key descriptive findings is available in the *Ethiopia Demographic and Health Survey 2000* report (Central Statistical Authority [Ethiopia] and ORC MACRO 2001). The survey was designed to gather information on a range of topics, including fertility, family planning, infant and child mortality, maternal and child health, and nutrition. This report presents additional analyses of information on infant and child feeding practices.

Our analysis focuses on infants and children under 36 months of age and excludes older children; twins and children missing key data (anthropometry or complementary feeding information) were also excluded. In households with more than one child below 36 months of age, one child was selected randomly. The final sample included 4,624 children.

Construction of the Infant and Child Feeding Index (ICFI)

Overall Approach

The ICFI included five components: (1) a breastfeeding score (mother currently breastfeeding [yes/no]); (2) a bottle use score (child was given a bottle in the previous 24 hours [yes/no]); (3) a 24-hour dietary diversity score (child received selected food groups in the past 24 hours [yes/no]); (4) a score for frequency of feeding solids/semisolid foods in the past 24 hours (number of meals and snacks); and (5) a seven-day quasi-food frequency score (number of days child received selected food groups in the past seven days).

The methodology used to create the index was similar to the approach used with the Latin American data sets, although some modifications were made in the coding of some variables (Ruel and Menon 2002). The list of variables and the scoring system used for Ethiopia to create the ICFI for the different age groups are presented in Table 1.[3] In general, a score of 0 was assigned to potentially harmful practices and a score of 1–3 to positive practices. As with the Latin America feeding index, practices were considered positive or negative based on current infant and child feeding recommendations and on available scientific evidence about benefits or risks (WHO 1995; Brown, Dewey, and Allen 1998).[4] A summary of the approach used to score different components of the index is presented below.

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[3] The main differences between the index created for Latin American countries and the index created with the Ethiopia data are as follows: (1) Both the dietary diversity (based on 24-hour recall) and the food frequency (based on seven-day recall) variables included a larger number of food groups in the Ethiopia analysis because of the improved design of the questionnaire. (2) In the Ethiopia analysis, cutoff points for the dietary diversity and the food group frequency variables were derived using sample- and age-specific terciles (see description in Scoring of Components section below). In the Latin America analysis, these cutoff points were derived arbitrarily. (3) The food frequency variable contributed five or six points (depending on the age) to the index in the Latin American analysis. For the Ethiopia analysis, the weight of this variable was reduced to two or three (depending on age) to obtain a better balance in the weighting of the different variables. (4) The maximum scores in the Ethiopia and Latin America analyses were 9 and 12, respectively.

[4] While current recommendations cover children only up to 24 months, children aged 24–36 months are still vulnerable and in need of frequent feeding and high-quality, nutrient-dense foods. Following on our previous work, we include children up to 36 months in this report.

Table 1: Variables and scoring system used to create the infant and child feeding index (ICFI) for children aged 6-36 months, by age group

Variables	6 to 9 months	9 to 12 months	12 to 36 months
Breastfeeding	No = 0 Yes = 2	No = 0 Yes = 2	No = 0 Yes = 1
Uses bottle	Yes = 0 No = 1	Yes = 0 No = 1	Yes = 0 No = 1
Dietary diversity (past 24 hours)	Sum of: Grains + Tubers + Milk[a] + Vitamin A-rich fruits/vegetables + Other fruits/vegetables/juice + Animal protein foods + Legumes + Fats (received, or did not receive each food/group). Scores were assigned reflecting the age-specific distributions observed (i.e., they reflect terciles).		
	None of the foods/groups: Score = 0 One food/group: Score = 1 Two or more foods/groups: Score = 2	None of the foods/groups: Score = 0 One to two foods/groups: Score = 1 Three or more foods/groups: Score = 2	None or one of the foods/groups: Score = 0 Two or three foods/groups: Score = 1 Four or more foods/groups: Score = 2
Food frequency (past 7 days)[b]	Each food group is scored as 0 if not given the previous week, +1 if given one to three days, and +2 if given four or more days. These scores are then summed[c] to give a possible range of 0 to 14. As above, scores were assigned reflecting the age-specific distributions observed.		
	0 (no foods previous week): Score = 0 1 or 2: Score = 1 3 or higher: Score = 2	0 or 1: Score = 0 2 through 4: Score = 1 5 or higher: Score = 2	0 through 3: Score = 0 4 through 6: Score = 1 7 or higher: Score = 2
Frequency of feeding solids/semisolids (past 24 hours)	Not at all: Score = 0 Once: Score = 1 Two or more times: Score = 2	Not at all: Score = 0 Once or twice: Score = 1 Three or more times: Score = 2	Not at all or once: Score = 0 Twice: Score = 1 Three times: Score = 2 Four times or more: Score = 3
Minimum/maximum	0 / +9	0 / +9	0 / +9

[a] "Milk" in this case is all types of milk other than breast milk. The Ethiopia DHS+ 2000 survey did not include a question asking specifically about infant formula.
[b] This is actually a modified food *group* frequency, where the questions are asked in the form "How many days in the last seven days was (name) given (food group)?" so that the number entered for each child is the number of days, with a maximum of seven, not the number of times the child ate the food group.
[c] The list of foods summed is the same as for the 24-hour diversity score, with the exception that grains have been combined with roots/tubers to form a "staple food" variable.

Scoring of Components

Breastfeeding and Bottle Use. These variables were scored according to current recommendations, which state that exclusive breastfeeding should be practiced up to six months of age and breastfeeding should be continued up to at least two years of age. Bottle use is discouraged at all ages because it can interfere with breastfeeding and introduce pathogens, thereby increasing the risk of infectious diseases. The scores used for breastfeeding and bottle use are as follows.

- A score of +2 is given for breastfeeding at ages 6–9 and 9–12 months (because it is particularly critical during the first year of life).
- A score of +1 is given for breastfeeding at ages 12–36 months.
- A score of 0 is given for *not* breastfeeding children of any age.
- A score of 0 is given for bottle use at any age, and a score of +1 is given for avoidance of bottle-feeding.

24-Hour Dietary Diversity. There are currently no specific recommendations regarding the optimal number of foods or food groups that a child should consume each day at different ages. There is, however, a consensus that higher dietary diversity is desirable and that a larger number of foods or food groups can help meet daily requirements for a variety of nutrients. In the absence of a recommendation, we used the age-specific distribution of the number of food groups consumed in the past 24 hours to select the (age-specific) cutoff points to allocate scores of 0–2 for dietary diversity.

The methodology was as follows. First, the number of food groups given to the child in the past 24 hours was summed. Food groups available in this data set included grains, roots/tubers, milk other than breast milk, vitamin A-rich fruits and vegetables, other fruits and vegetables (or juices), meat/poultry/fish/cheese/eggs/yogurt, legumes, and foods prepared with fat. Second, distributions were examined within age groups, and age-specific scores were assigned; the scores of 0–2 reflect terciles as closely as possible (see Table 1).

Seven-Day Quasi-Food Frequency.[5] As with the 24-hour diversity score, this score was based on the observed distribution of the data within age groups. The seven-day information available in the DHS is the number of days the child was offered specific food groups. The same food groups as for the 24-hour recall (used to derive the dietary diversity score) are available. However, for this score, we combined two food groups—grains and roots/tubers—into a variable for staple foods. Thus, instead of eight food groups, the food frequency score uses seven food groups.

Each food group was coded zero if not given at all in the previous week, as 1 if given on 1–3 days, and as 2 if given on 4–7 days. The scores for each of the seven food groups were summed, for a total score ranging from 0 to 14. Once this intermediate variable was constructed, distributions were examined within age groups. As with the

[5] This is actually a modified food *group* frequency, where the questions are asked in the form, "How many days in the last seven days was (name) given (food group)?," so that the number entered for each child is the number of days, with a maximum of seven, not the number of times the child ate a food from the group.

diversity variable, scores of 0–2 were assigned based as closely as possible on age-specific terciles (see Table 1).

Frequency of Feeding Solid/Semisolid Foods in Previous 24 Hours. Current international recommendations for frequency of feeding exist (Brown, Dewey, and Allen 1998), but these recommendations are to be used in combination with information on the energy density of the diet. For instance, if the mean energy density of the diet is 0.6 kilocalories per gram (kcals/g), a minimum of 3.7 meals (or feeding episodes) is required to attain the level of energy needed from complementary foods for infants 6–9 months of age. Similarly, at an energy density of 0.6 kcals/g, 4.1 meals/feeding episodes are needed for infants 9–12 months of age, and 5 meals/feeding episodes are needed for children 12–24 months of age. The number of meals required for children consuming meals higher in energy density is proportionally lower for all age groups.

Information on average energy density of complementary foods unfortunately cannot be collected in the DHS or other similar large surveys because it requires in-depth dietary information. In the absence of energy density information, we used recommendations currently available for average energy densities of at least 0.6 kcal/g as a basis for our scoring (recognizing that these recommendations may not be adequate for some children and/or some populations) (Dewey 2002). These recommendations are[6]

> Infants 6–9 months should be fed 2–3 times per day,
>
> Infants 9–12 months should be fed 3–4 times per day,
>
> Children 12–36 months should be fed 4–5 times per day.[7]

The scores allocated to the frequency of feeding variable ranged from 0 to 2 for 6–9- and 9–12-month-old children, and ranged from 0 to 3 for 12–36-month-old children[8] (Table 1). The maximum scores (2 for 6–9- and 9–12-month-old children and 3 for 12-36-month-old children) were given for children who were fed the number of times recommended above. A score of zero was given when children 6–12 months of age were not fed complementary foods at all the previous day, and when older children (12–36 months) were fed complementary foods once or not at all.

The higher score (3) for the older children was given in recognition of the increasing range in frequency of feeding, and the increasing role of complementary foods in the diet, as the contribution of breast milk declines. This additional "point" for

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[6] For diets with an average energy density lower than 0.6 kcal/g, the number of meals required to meet energy needs from complementary foods becomes excessive (especially among 12-23-month-old children). In these situations, it is recommended that interventions designed to improve complementary feeding start by focusing on increasing the energy density of the diet. Once the energy density is at an acceptable level (>0.6 kcals/g), recommendations about an optimal number of feedings per day can be made.

[7] As noted in footnote 4, current international recommendations on frequency of feeding cover children up to 24 months, whereas this analysis includes children up to 36 months.

[8] Just as there are concerns about insufficiently frequent feeding, there are concerns about overly frequent feeding and the potential this may have to compromise breastfeeding. This is particularly of concern in the younger age groups. However, we did not feel we had a basis for assigning lower scores to frequencies exceeding the recommendations. Few children fell into these categories (3–5 percent, depending on the age group).

frequency also balanced the lower score attributed to breastfeeding in this age group (1 versus 2 for infants 6–12 months), thus yielding the same total range of scores for the index.

The Feeding Index Scores and Terciles

The ICFI score was derived by summing all of the component scores:

(*breastfeeding score*) + (*bottle use score*) + (*24-hour diversity score*)
+ (*frequency of feeding score*)
+ (*seven-day quasi-food frequency score*).

The index ranged between 0 and 9. Note that each component of the score was given approximately equal weight. There is currently neither standard guidance nor an empirical basis for weighting the various dimensions of infant and child feeding relative to one another. In the absence of such guidance, we gave equal weight to each component, while recognizing that this weighting is arbitrary.

Age-group-specific terciles were constructed for the ICFI score, using the following guidelines: minimize the differences between actual percentages and 33 percent; when a choice is necessary, lump into the middle category so as not to dilute the contrast between the extremes.

Socioeconomic Status Factors

To understand and accurately represent relationships between infant and child feeding practices and child nutritional status, it is essential to control in multivariate analyses for child, maternal, and household factors, which may act as potential confounding factors. The DHS data sets do not contain data on income and expenditure, and thus other proxies for household socioeconomic conditions must be used.

In the absence of income and expenditure data, several researchers have recently used factor analysis/principal components approaches to construct measures of long-term wealth (Filmer and Pritchett1998; Stifel, Sahn, and Younger 1999) based on housing conditions, ownership of assets, and availability of basic services. We have also successfully used these types of variables to create a socioeconomic factor using DHS data from various countries in our previous work (Menon, Ruel, and Morris 2000; Ruel and Menon 2002). The variables available in the Ethiopia data set were source of drinking water; type of sanitation facility; availability of electricity; ownership of durable goods, cropland, livestock, and house; cash crop production; transportation (bicycle, car/truck); house construction material; and crowding (number of household members per sleeping room).

Factor analysis was used in the present work as a data reduction tool, with the aim of combining the information from a variety of highly correlated indicators of socioeconomic status (SES) into a small number of factors. We were therefore looking to maximize the proportion of common variation among the variables that could be explained by the factors. The analysis was carried out separately for the urban and rural sample, because the characteristics that define wealth are expected to differ between urban and rural areas.

Two factors were identified in both urban and rural areas. In urban areas, they explained 59 percent of the variation in the variables included, and in rural areas, they explained 53 percent of the variance. The selection criterion for inclusion of individual variables in the final factors was that factor loadings (defined as the correlation between the individual variable and the factor) had a value greater than 0.5 for at least one of the two factors.

The variables included in the final factors were the following.

Urban

- Source of drinking water
- Toilet facility
- Sum of all durable goods (yes/no for each)[9]
- Sum of land/livestock owned (yes/no for each)
- Main floor material
- Main roof material

Rural

- Sum of all durable goods
- Ownership of cattle or camels
- Ownership of horses, mules, or donkeys
- Ownership of sheep or goats
- Number of household members per sleeping room

Analytical Methodology

All bivariate and multivariate 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 survey. The statistical significance

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[9] No data are available on the quantity of goods, land, or livestock owned; the data are coded yes or no for each item.

of differences between means was tested using t-tests (for two group comparisons) and an adjusted Wald test for joint hypothesis testing (for comparisons of three or more groups) (StataCorp 2001 210 /id). The chi-square test was used to test differences in proportions. P-values smaller than 0.05 were considered statistically significant.

In the multivariate analyses, the dependent variable was HAZ. The independent variables were the ICFI and a series of child, maternal, and household characteristics that are known to be associated with child nutritional status. These included

Child level: age and gender;

Maternal level: maternal age, height, body mass index, education (years of schooling), parity, number of prenatal visits attended (0, 1–3, 4+);

Household level: socioeconomic factors (1 and 2: each factor was categorized into terciles), education of the mother's partner, number of children less than five years of age, area of residence (urban/rural).

The ICFI was included in the model as a categorical variable (three categories: lowest, average, and highest tercile).

The multivariate analysis also tested all two-way interactions between the ICFI and the child, maternal, and household variables included in the model. The purpose was to determine whether the magnitude of association between the ICFI and the other factors included in the model differed according to the level of these characteristics. Adjusted mean HAZ scores were computed to obtain mean HAZ by ICFI tercile, after adjusting by multivariate analysis for child age, maternal characteristics, and household socioeconomic factors.

One potential limitation of our multiple regression analyses is that the infant and child feeding practices may be endogenous to the model, i.e., they may be determined by a set of factors that also determine the outcome. For example, maternal education and household socioeconomic status are likely to influence both feeding practices and children's nutritional status. Failure to control for endogeneity leads to biased coefficient estimates (Judge et al. 1985).

One common approach to address issues of endogeneity is the use of instrumental variables (using predicted, as opposed to observed, values of a variable) and two-stage least squares methods. To use this approach, it is necessary to identify at least one variable (determinant) that is associated with the endogenous variable being predicted in the first stage of the equation (the instrumental variable—in this case, feeding practices), but that is not associated with the outcome (HAZ). None of the variables available in the DHS data sets meets this criterion. For this reason, the potential problem of endogeneity was not addressed in this analysis. Additional research is required to identify potential instruments that could be used to predict infant and child feeding practices and to address the problem of endogeneity of this variable in modeling the determinants of nutritional status.

Finally, to simulate the responsiveness of the ICFI score to varying levels of change in component indicators, a spreadsheet was constructed. Using summary statistics for each component indicator (e.g., percent still breastfeeding in each age group, percent scoring 0, 1, 2, or 3 for frequency of feeding in each age group, etc.) and using spreadsheet formulas, the ICFI was calculated for a number of different scenarios. Levels of change in component indicators were varied between scenarios (see the Appendix for more information on the method used for simulations).

3. Characteristics of the Sample

Maternal and Sociodemographic Characteristics

Table 2 presents key descriptive maternal and household statistics of the sample. With the exception of maternal height and household size, urban and rural households vary substantially on almost all basic characteristics. Differences in maternal education are particularly striking and are relevant to childcare and feeding: 38 percent of urban women report no education as compared to 84 percent of rural women; conversely, 40 percent of urban women report at least some secondary education as compared to only 2 percent of rural women.

Access to health care, as proxied by the number of antenatal visits during the last pregnancy, also varies widely between urban and rural women, as do sanitary conditions. More than three-fourths of rural women report no prenatal visits for the last pregnancy, as compared to one-third of the urban women. Most urban women (81 percent) report having access to piped water, while only 6 percent of rural women do. Similarly, most urban women (69 percent) report having access to a latrine or toilet, while only 9 percent of rural women do. Ownership of durable goods and better housing materials are more common among urban households, while ownership of livestock and homes are much more common among rural households.

Table 2: Selected maternal and household characteristics in the Ethiopia DHS 2000[a]

	Urban (n = 712)	Rural (n = 3,912)	All (n = 4,624)
Mother's age (mean)	28	29	29
Parity (mean)	3.2	4.2	4.1
Height (mean)	157.0	156.4	156.5
BMI category (percent)			
Very low (< 17.0)	5	5	5
Low (17.0 to < 18.5)	15	18	18
Normal (18.5 to < 25)	70	75	74
High (25.0+)	10	1	3
Mother's education (percent)			
None	38	84	76
Some primary	22	13	15
Some secondary	40	2	9
Number of antenatal visits during last pregnancy:			
Percent with no antenatal visits	33	78	70
Percent with four or more visits	50	6	14
Mean household size	5.9	6.0	5.9
Percent of households with more than one child under 5	52	64	62
Percent female-headed households	23	12	14
Partner's occupation (percent)			
Agriculture/unskilled labor	17	92	79
Sales/services/skilled labor	61	7	16
Professional/technical/managerial/clerical	21	1	5
Main source of water (percent)			
Surface/rain	8	37	32
Well/spring	11	58	49
Piped	81	6	19
Sanitary facilities (percent)			
None	31	91	81
Latrine	67	9	19
Flush toilet	2	0	0.4
Percent with electricity	76	0	14
Percent owning:			
Radio	69	14	24
Kerosene lamp	18	9	11
Bed or table	89	45	52
Bicycle	4	0	1
Own house	48	98	89
Percent owning:			
Cattle or camels	26	80	71
Horse, mule, donkey	7	32	27
Sheep or goats	16	41	36
Main floor material is earth/sand/dung/wood/reed (percent)	67	98	93
Main roof material is mud, thatch, reed, bamboo, plastic, or temporary (mobile) (percent)	13	87	74
Mean number of people per sleeping room (crowding)	4.4	5.0	4.9

[a] With the exception of maternal height and household size, which did not differ significantly, all urban-rural differences are statistically significant at $p < .01$ (t-tests for means and chi-square tests for proportions).

Child Nutritional Status

Figures 1 and 2 present mean Z-score values for children's anthropometric indicators (weight-for-age [WAZ], height-for-age [HAZ], and weight-for-height [WHZ]), for rural and urban areas, respectively. The patterns observed are typical of most developing countries, especially among rural children: mean HAZ and WAZ decline almost linearly from birth to 18–24 months of age, and plateau at low levels thereafter. Urban children are generally better-off, but their growth also falters, especially after 6 months of age and until approximately 24 months. WHZ averages –0.5 throughout the age range in urban areas; in rural areas it declines gradually from birth until 24 months, to reach a mean Z-score lower than –1.0, before increasing slightly among the oldest children.

As expected, the prevalence of stunting, underweight, and wasting is markedly higher in rural areas; 46 percent of rural children under 3 years are stunted (compared to 29 percent of urban children), and 13 percent are wasted (compared to 6 percent in urban areas).[10] Ethiopia ranks third of 18 countries in Africa (analysis of DHS data sets [Ruel 2001]) for the prevalence of stunting, after Madagascar and Zambia, and is at the same level as some of the poorest countries of Asia, such as Bangladesh and Nepal. Similarly, the rates of wasting in rural Ethiopia are among the highest in Africa and are similar to those found in Niger and Benin (Ruel 2001). Clearly, childhood malnutrition is a severe problem in Ethiopia.

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[10] Stunting, underweight, and wasting are defined by Z-scores < -2.00 (for HAZ, WAZ, and WHZ, respectively).

Figure 1: Mean Z-scores, by age group: Rural children (Ethiopia DHS 2000)

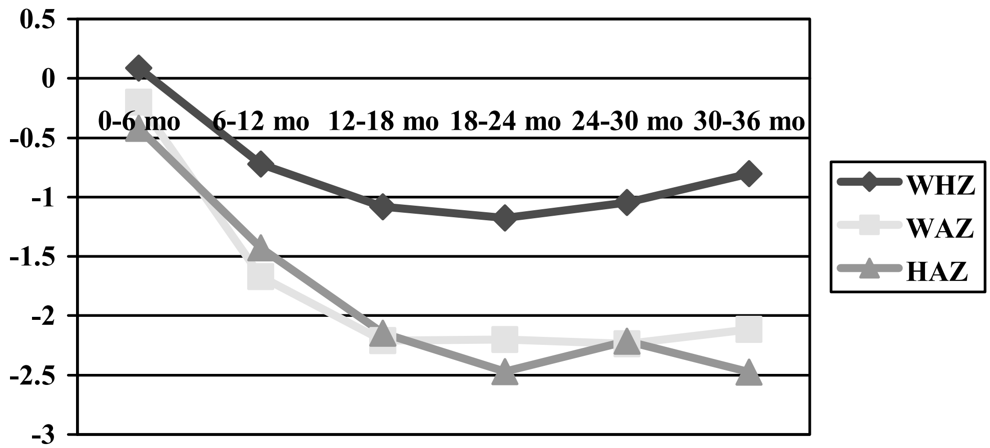
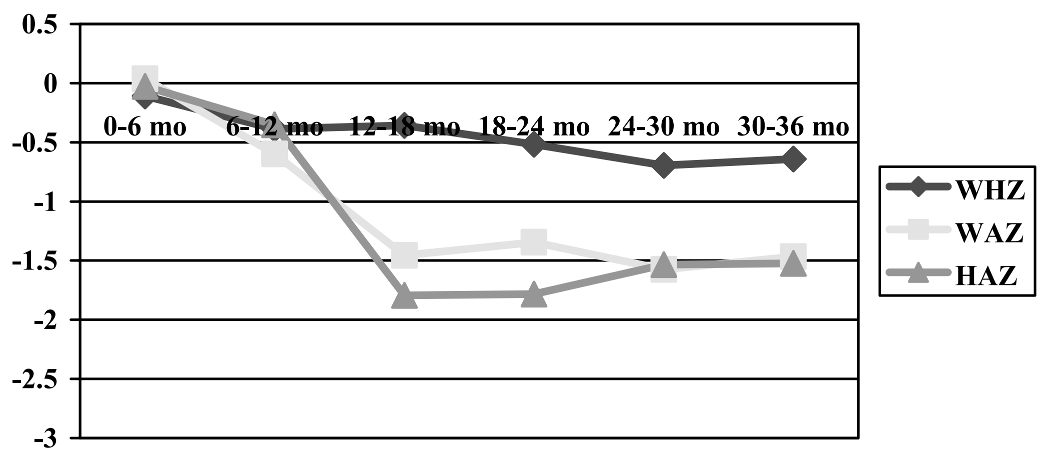


Figure 2: Mean Z-scores, by age group: Urban children (Ethiopia DHS 2000)



Infant and Child Feeding Practices

Breastfeeding is nearly universal throughout the first year of life for both urban and rural children. In the second and third years of life, breastfeeding rates decline, and they decline more rapidly in urban areas. However, rates remain high overall through the second year. Rates of exclusive breastfeeding are also relatively high; mothers reported that half of the rural children and one-third of the urban children aged 0–6 months received breast milk only in the previous 24 hours.

While breastfeeding patterns are favorable, several other infant and child feeding practices are less optimal. For example, bottle-feeding is widespread, especially in urban areas (40 percent among infants under 12 months), and complementary feeding is often delayed beyond the recommended age of 6 months in both urban and rural areas. The 24-hour recall data indicate that 62 percent of children aged 6–9 months, and 25 percent of children aged 9–12 months, had not received any semisolid or solid foods in the previous day. The extent of this problem is further demonstrated by the seven-day recall data, which show that 56 percent of the younger (6–9 month) and 23 percent of the older (9–12 month) infants received no solid/semisolid foods in the last week. Average frequency of feeding solid or semisolid foods during the previous day also tended to be low compared to recommendations—on average, less than twice for 9–12-month-old infants, less than three times for 12–24-month-old children, and less than four times for the older age group.[11] Similar patterns are observed in both urban and rural areas (Figure 3).

Dietary diversity also tends to be low, but significantly more so in rural compared to urban areas (Figure 4). Rural children consistently received a smaller mean number of foods/food groups in the previous day compared to urban children, and the differences

[11] As indicated in Section 2, current recommendations indicate that complementary foods should be given 2–3 times for infants 6–9 months of age, 3–4 times for infants 9–12 months of age, and 4–5 times for children 12–24 months of age (assuming an average energy density of 0.6–1.0 kcal/g) (Dewey 2002).

Figure 3: Mean number of times the child was fed solids/semisolids the previous day, by age group and area of residence (Ethiopia DHS 2000)

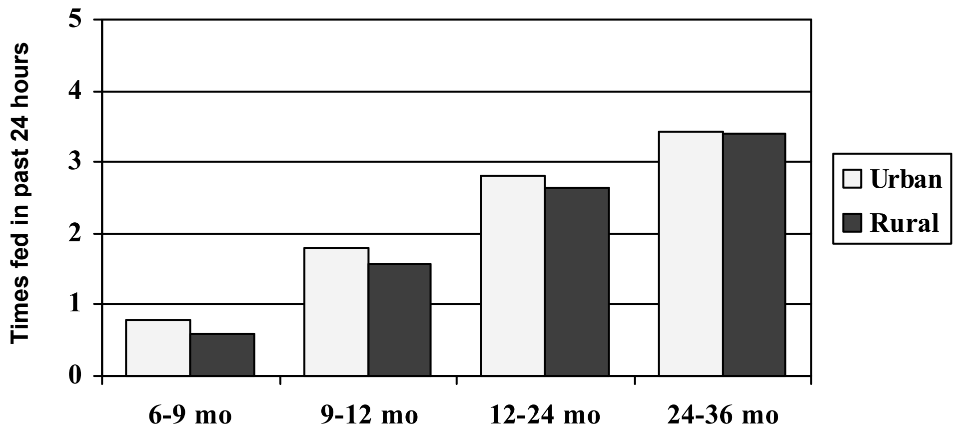
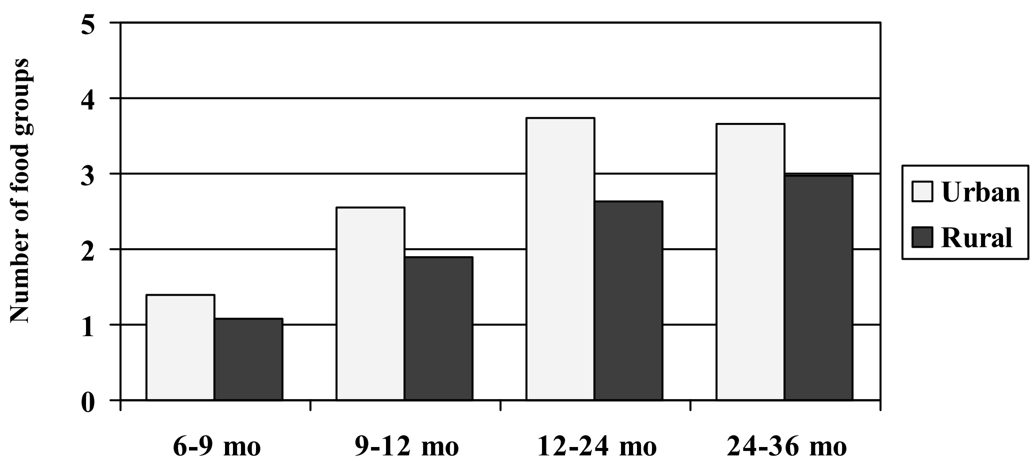
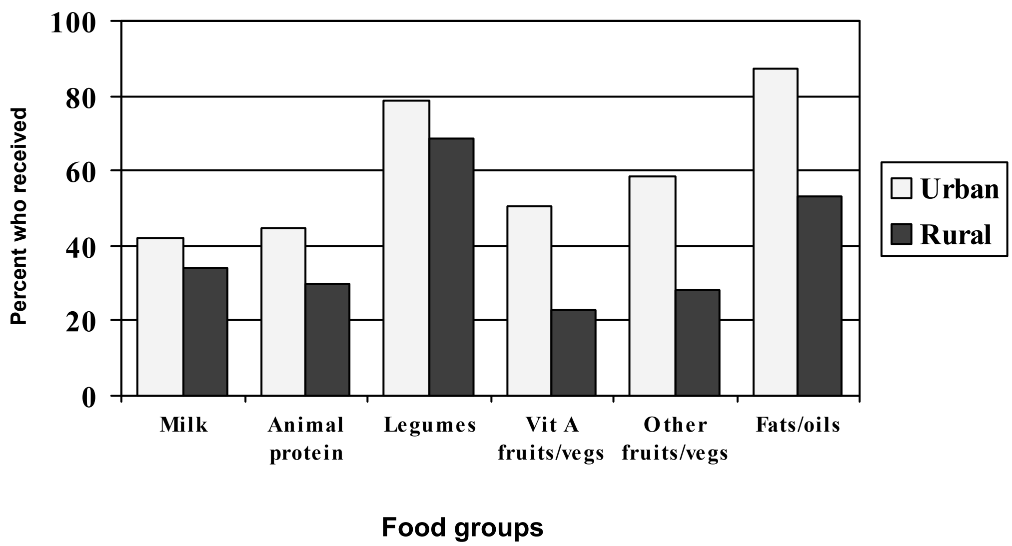


Figure 4: Mean number of different food groups fed to the child the previous day, by age group and area of residence (Ethiopia DHS 2000)



were significant among children 12 months and over ($p < .001$) (Figure 4). The food groups that appeared to account for this urban-rural difference in diversity are the high-quality (i.e., energy- and nutrient-dense) groups such as animal protein foods, vitamin A-rich and other fruits and vegetables, and foods cooked with fats and oil ($p < .01$ for each of these groups) (Figure 5).

Figure 5: Types of foods given to 12-36-month-old children in the past seven days, by area of residence (Ethiopia DHS 2000)

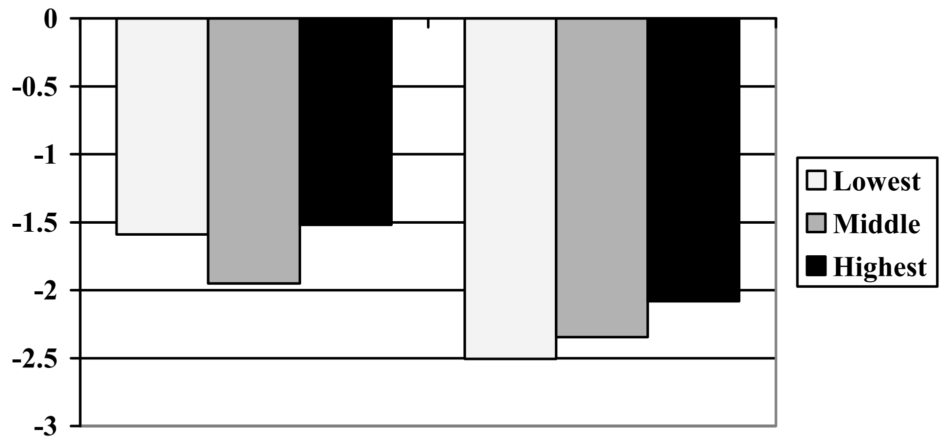


4. Are Infant and Child Feeding Practices Associated With Nutritional Status in Ethiopia?

Figure 6 shows the bivariate relationship between mean HAZ and the ICFI terciles for children aged 12–36 months in urban and rural areas. The association between HAZ and ICFI terciles is significant only among rural children. Among this group, the association is statistically significant ($p < 0.001$), linear, and shows a difference of approximately 0.43 Z-scores between the lowest and the highest ICFI tercile. The size of the difference is within the range observed in the analysis of the Latin American DHS data (Ruel and Menon 2002) and is biologically meaningful.[12]

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

Figure 6: Mean HAZ by ICFI tercile and area of residence (Ethiopia DHS 2000) (children 12–36 months)



Similar results were found when examining the association between ICFI terciles and the prevalence of stunting—no association was found in urban areas and a statistically significant difference of 12 percentage points was found in rural areas.

Results of the multivariate analysis confirm the statistically significant association between the ICFI and HAZ after controlling for a series of potentially confounding factors. Table 3 presents the regression coefficients and their statistical significance, and Table 4 summarizes these findings and shows results of analyses done separately for urban and rural areas. The joint test to determine whether the two dummy variables representing the ICFI are statistically significant confirms that the association is highly significant (p = 0.00) in the overall model (Table 3). Not surprisingly, when models were run separately for urban and rural areas, the ICFI was statistically significant only in the rural model (Table 4). This finding is in line with results of bivariate analyses, which showed no association between the ICFI and child anthropometry in urban areas.

Table 3: Ordinary least squares regression analysis of the determinants of HAZ among children aged 12–36 months (Ethiopia DHS 2000)

Independent variable	Regression coefficient	P value
Child age (18–24)	**–0.32**[a]	0.00
Child age (24–30)	**–0.12**	0.24
Child age (30–36)	**–0.29**	0.00
Child gender	–0.09	0.27
Mother's age	**0.33**	0.02
Mother's height	**0.04**	0.00
Mother's body mass index	0.04	0.07
Mother's education	0.04	0.11
Mother's partner's education	**0.03**	0.04
Parity	0.00	0.81
Attended 1–3 prenatal visits	–0.15	0.08
Attended 4+ prenatal visits	0.11	0.41
ICFI (2nd Tercile)	**0.10**[a]	0.19
ICFI (3rd Tercile)	**0.28**	0.00
Socioeconomic factor 1 (2nd tercile)	**0.20**[a]	0.02
Socioeconomic factor 1 (3rd tercile)	**0.20**	0.02
Socioeconomic factor 2 (2nd tercile)	**0.09**	0.26
Socioeconomic factor 2 (3rd tercile)	**0.17**	0.08
Number of children < 5 y	**–0.21**	0.00
Area of residence (urban/rural)	–0.12	0.45
Constant	–9.89	0.00
N	3056	
Number of strata	21	
Number of principal sampling units	525	
F	10.31	
R-square	0.12	

Note: Bolded coefficients are statistically significant ($p < 0.05$).
[a] Joint test for main effect is statistically significant.

Table 4: Ordinary least squares regressions: Summary of significant factors in urban and rural models[a]

	Urban	Rural	All
Child age		–	–
Child sex			
Maternal age		+	+
Maternal height		+	+
Maternal BMI			
Parity			
Number of children under 5 years in household		–	–
Maternal education			
Partner's education	+		+
Number of antenatal care visits			
ICFI		+	+
Socioeconomic (SES) factors		+	+

[a] The "+" indicates a positive regression coefficient, statistically significant ($p < 0.05$), and the "–" indicates a negative, statistically significant regression coefficient. An empty cell means that the variable was not statistically significant. Note that the p-value for the SES factors in the urban model was 0.0510.

The mean HAZ, adjusted for child age, maternal age, height, body mass index, education, parity, and household socioeconomic factors, show that the magnitude of difference between the lowest and the highest tercile of the ICFI is similar to the size of the difference found in the bivariate analyses, although slightly reduced. The bivariate analyses (urban/rural combined) showed a difference in HAZ of 0.46 Z-scores between 12–36-month-old children in the lowest, compared to the highest tercile of the ICFI. The multivariate analysis showed a slightly attenuated difference of 0.35 Z-scores. This suggests that at least some of the difference in HAZ found in the bivariate analysis between ICFI terciles was due to the maternal and household sociodemographic factors included in the model.

None of the two-way interactions between the ICFI and the child, maternal, and household variables included in the model were statistically significant. It thus appears that the magnitude of differences in HAZ between feeding terciles is not conditioned by the level of any of the child, maternal, and household factors tested.

The other factors that were found to be statistically significantly associated with HAZ in the overall model (Table 4) were child age, maternal age and height, education of the mother's partner, household socioeconomic factors, and the number of children in the household younger than 5 years. These characteristics are typically found to be statistically significant in similar analyses of the determinants of child nutritional status (Ruel and Menon 2002). Child gender, maternal education, maternal parity, BMI, prenatal visits (as a proxy for health care access), and area of residence were not statistically significantly associated with HAZ. The lack of statistical significance of "area of residence" was somewhat unexpected, because large differences were found in nutritional status between urban and rural areas of this country. This suggests that a significant proportion of urban-rural differences can probably be explained by the variables that were included in the model, such as feeding practices and socioeconomic factors.

5. Which Practices Drive the Association Between the ICFI and HAZ?

In this section, we "decompose" the index and examine the relationship between each component of the index and HAZ. Our purpose in doing so is to gain insight into the following questions:

1. Which individual practices are driving the relationship between ICFI scores and HAZ?
2. Could the index be simplified by reducing the number of variables (e.g., by dropping variables that may provide redundant information)?

An additional objective of the decomposition exercise was to gain insight into why the ICFI was not associated with child nutritional status in the urban subsample.

To answer these questions, we examined relationships between mean HAZ and the following individual feeding practices:

- Whether the child is still breastfed,
- Whether bottle was used in the last 24 hours,

- Number of food groups the child consumed yesterday (eight possible food groups),
- Twenty-four hour diversity score (three categories; see Table 1),
- Number of food groups consumed in the past seven days (eight possible food groups),
- Seven-day quasi-food frequency score (three categories; see Table 1),
- Number of times fed solids/semisolids yesterday,
- Feeding frequency score (three categories; see Table 1).

Each of these components was considered for children 12–36 months, for urban and rural children separately, and also for each age group separately. Results for children aged 6–12 months were examined but are not presented here.[13]

Breastfeeding

Continued breastfeeding, which is universally considered a positive practice up to 24 months and beyond, is negatively associated with HAZ for children aged 12–36 months in the Ethiopia DHS sample ($p < 0.001$). Negative relationships between breastfeeding and Z-scores have been documented before (Brown, Dewey, and Allen

[13] Results for infants 6–12 months are not presented for several reasons; in the case of breastfeeding, only 15/812 infants in this age group were not breastfed. In the case of the 24-hour and seven-day diversity variables, we chose to focus on the older children because both HAZ and dietary diversity are strongly linked to age. Infants aged 6–12 months may be on the path to severe stunting, but because stunting is a cumulative process, it takes time before mean HAZ reflects this process. Because of this, mean HAZ of infants 6–12 months is generally higher than mean HAZ for older children. At the same time, diversity will always be lowest for this age group, because mothers are just beginning to introduce solid/semisolid food. Therefore including infants with the older children will tend to diminish an association between diversity and HAZ, because of confounding by age. A focus on children 12–36 months makes the issue of age confounding less problematic. However, *within* the 6–12-month group, results followed similar patterns; i.e., higher HAZ was associated with bottle use, and with higher diversity. Frequency of feeding was not significantly associated with HAZ in this age group.

1998), and there may be a number of possible explanations. The relationship may be confounded by socioeconomic status (*not* breastfeeding is often associated with higher socioeconomic status in developing countries). An alternative explanation is reverse causality, i.e., that continued breastfeeding may be a maternal response to meet the needs of smaller, weaker children (Marquis et al. 1997).

Table 5 shows the size of the difference in HAZ observed in the Ethiopia sample. The difference in favor of *non*-breastfed children in HAZ is particularly pronounced in urban areas, reaching 0.8 Z-scores ($p < 0.01$). The 0.3 Z-score difference in rural areas is also significant ($p < 0.01$). Either confounding by socioeconomic status, and/or reverse causality, are possible explanations for these associations.

Table 5: Mean HAZ and mean age in months, by breastfeeding status among children aged 12-36 months (Ethiopia DHS 2000)

	Urban (n = 477)		**Rural (n = 2,651)**		**All (n = 3,128)**	
Still breastfed?	**HAZ**	**Age (months)**	**HAZ**	**Age (months)**	**HAZ**	**Age (months)**
Yes	–2.01	20.4	–2.40	21.0	–2.34	20.9
No	–1.20	26.7	–2.10	28.1	–1.88	27.7

Breastfeeding status was significantly associated with maternal education and with SES. Mothers who were *not* breastfeeding had more education (a mean of 1.7 years versus a mean of 1.1 years among breastfeeding mothers, $p < .001$) but the differences in education were not large (the sample was largely rural, and 84 percent of rural women had no education). Higher SES factor scores were also significantly associated with *not* breastfeeding.

The negative association between breastfeeding and HAZ provides a piece of the explanation as to why the ICFI does not relate to HAZ among urban children. Urban children are more likely to be weaned (43 percent of children over 12–36 months, compared to 29 percent of rural children), and thus receive a lower breastfeeding score and a lower ICFI score. Yet, they are likely to be better nourished because of higher maternal education, better socioeconomic conditions, and greater access to services. It is well recognized that the detrimental effects of poor breastfeeding practices may be less pronounced among households living in more sanitary conditions, as is the case in developed countries.

Bottle Use

Findings regarding bottle use provide an additional explanation for the lack of association between ICFI scores and children's height-for-age in urban areas. Table 6 shows results for children aged 12–36 months. In urban areas, 13 percent of the children aged 12–36 months were bottle-fed the previous day; 3 percent of rural children in this age group were bottle-fed the previous day.

Table 6: Mean HAZ, by use of bottle among children aged 12–36 months (Ethiopia DHS 2000)

Bottle used?	Urban (n = 477)	Rural (n = 2,651)	All (n = 3,128)
Yes	–1.06	–2.27	–1.69
No	–1.75	–2.32	–2.22

As with breastfeeding, a negative practice (bottle use) is strongly associated with higher HAZ among *urban* children ($p < 0.05$). Note that there is no association between bottle use and HAZ among rural children in this age group. However, only 3 percent of rural children in this age group were fed by bottle the previous day. As is also the case with earlier weaning, bottle use is generally associated with higher socioeconomic status; better socioeconomic status appears to be the most likely explanation for the higher Z-scores associated with bottle use in urban areas.

In this sample, bottle use was significantly associated with education and SES factor scores in both urban and rural areas ($p < .001$ for all children 12–36 months). As noted above, however, in rural areas 84 percent of women had no education, and bottle use was also more rare.

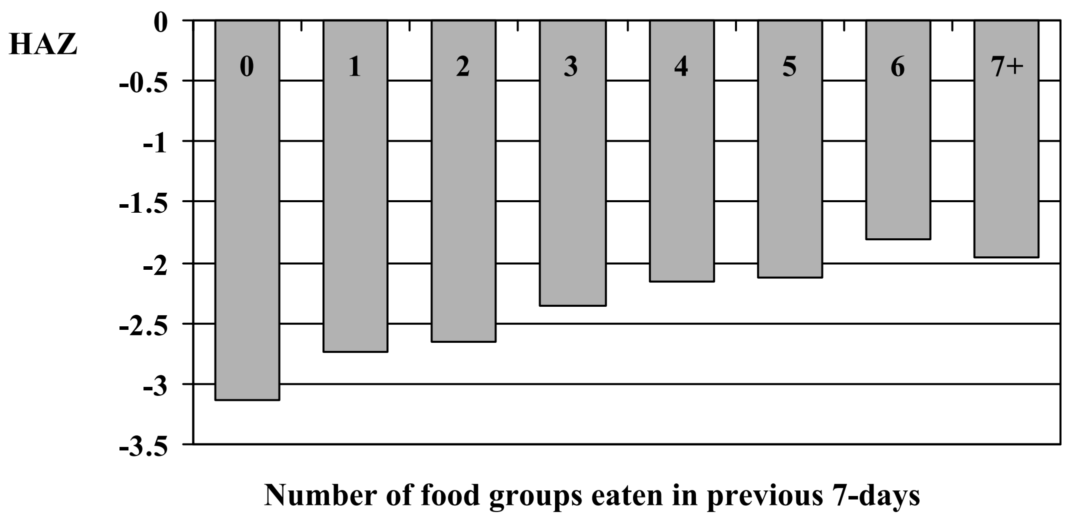
Dietary Diversity—24-Hour and Seven-Day Recalls

In assessing associations between dietary diversity and HAZ, four indicator variables were examined:

1. Number of food groups consumed in the previous 24 hours,
2. 24-hour diversity score,
3. Number of food groups consumed in the previous seven days,
4. Seven-day quasi-food frequency score.

Dietary diversity is very strongly and positively associated with HAZ, regardless of which indicator is used. In the EDHS, 24-hour and seven-day diversity are very strongly correlated.[14] Consistent with this, associations between various diversity indicators and nutritional status indicators follow very similar patterns. For simplicity, Figure 7 shows the relationship between HAZ and a seven-day indicator (number of food groups in the last week) for rural children.

Figure 7: Mean HAZ for rural children aged 12–36 months, by number of food groups eaten in the previous week (Ethiopia DHS 2000)



The difference in mean Z-scores between the extreme groups—children consuming no food groups as compared to 7+ in the previous week—is very large, at

[14] The 24-hour and seven-day recalls proved to be very consistent in the case of Ethiopia. As expected, higher proportions of children ate any given food group in the last week than in the last 24 hours. But the proportion of children reported to eat each food group on the 24-hour recall came very close to the proportion eating each food group three or more out of the last seven days (differences of 1–3 percent). Thus the 24-hour recall reflected patterns of intake over the last week very well. In addition, diversity scores constructed from the 24-hour and seven-day recalls were very strongly correlated with each other (data not shown; see Arimond and Ruel 2002).

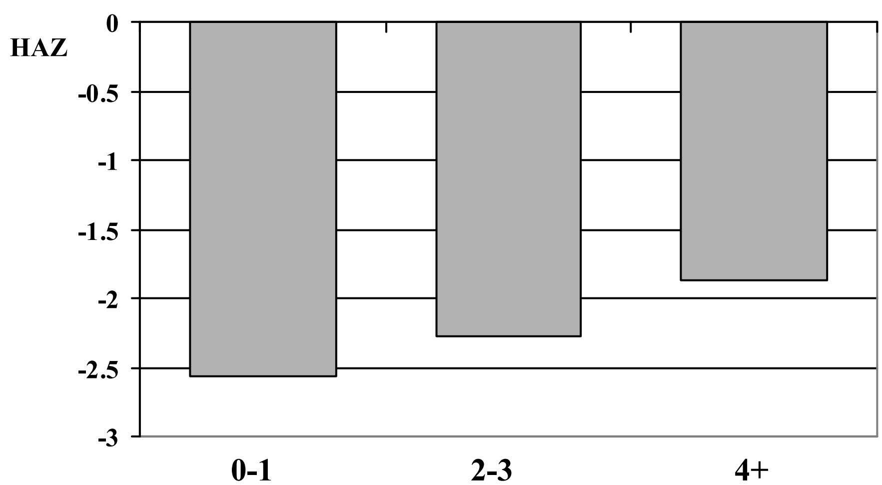
approximately 1.2 Z-scores. When the terciles of the quasi-food frequency score derived to create the ICFI are used (see Table 1), the difference in mean Z-scores between the lowest and highest tercile groups is still large and significant, at 0.64 Z-score units ($p < 0.001$).

Findings for urban children are not shown in Figure 7, because there were too few urban children in each category to give reliable results. Even the seven-day quasi-food frequency score (which had only three categories) had too few children in the two lowest terciles. Thus, for this analysis, the two lower categories of the seven-day quasi-food frequency score were combined (scores 0–1) and compared to the highest score (+2). Among urban children aged 12–36 months scoring 0 or 1, the average HAZ was –2.05, compared to –1.47 among the children scoring +2 (a difference of 0.58, very similar to the difference of 0.64 units observed among rural children).

In summary, among both rural and urban children—irrespective of the indicator of dietary diversity used—there is a strong and positive association between dietary diversity and HAZ. It appears that this association may account in large part for the association between the ICFI scores and HAZ, particularly since diversity is scored twice (for the 24-hour and seven-day recall).

One possible explanation for the strong association between dietary diversity and HAZ is that dietary diversity may act as a proxy for socioeconomic status. In other words, it may be that children with more diverse diets are from wealthier homes and have better nutritional status for reasons other than dietary diversity. In order to verify this hypothesis, we tested whether the association between dietary diversity and HAZ remained after statistically controlling for the same range of potentially confounding factors as we examined in Section 4 for the ICFI. The relationship remains very strong and significant when either 24-hour diversity or seven-day diversity is considered. In addition, as one would expect from the findings illustrated in Figure 7, the relationship between diversity and HAZ is stronger than the relationship between the ICFI and HAZ. For children aged 12–36 months, the difference in adjusted mean HAZ between the lowest and highest diversity terciles is very large, at 0.7 Z-scores (Figure 8).

Figure 8: Association between 24-hour dietary diversity (number of food groups) and HAZ (adjusted means) among children aged 12–36 months (Ethiopia DHS 2000)

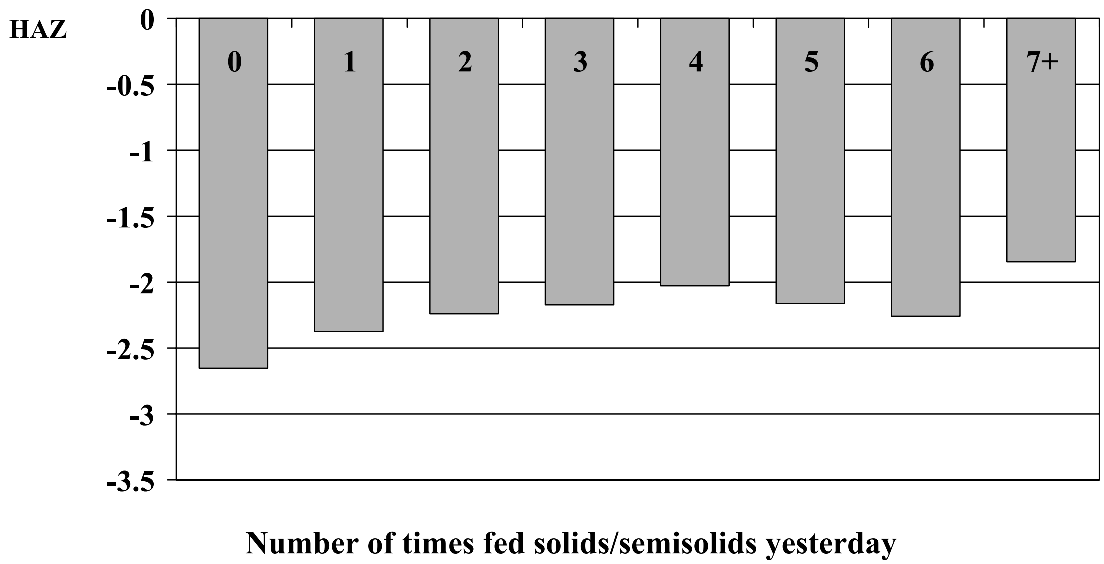


The final component of the index to be considered, frequency of feeding, may also contribute to the association, but not as strongly as the diversity indicators, as shown below.

Frequency of Feeding Solids and Semisolid Foods

Because similar patterns were seen among rural and urban children, Figure 9 presents the association between frequency of feeding and HAZ for all children (urban and rural) aged 12–36 months.

Figure 9: Mean height-for-age for children aged 12–36 months, by frequency of feeding solids/semisolids yesterday (Ethiopia DHS 2000)



The difference in mean HAZ between the extreme groups is approximately 0.8 Z-scores when the eight categories are used (Figure 9). When the responses are grouped in four categories (reflecting scores of 0–3 for frequency of feeding, see Table 1), the difference between extremes is 0.4 Z-scores. The association is strong, and the size of the difference is once again of statistical and biological significance, though it is not as large as the difference observed for the extremes of diversity variables. Also, Figure 9 shows that the pattern of increase in HAZ with frequency of feeding is not entirely consistent and linear. The suggestion of a decline in HAZ at frequencies above 4 or 5 was observed in a number of the subsets of the data we examined. It may reflect a situation where sick children or children with less appetite—and possibly poorer nutritional status—are fed more often as a compensatory maternal behavior. Alternatively, excessive feeding frequency may displace breast milk intake and have a negative effect on growth (Brown, Dewey, and Allen 1998); however, this is much more likely to be an issue for infants less than 12 months than for children 12–36 months.

Summary of "Decomposition" Exercise

Dietary diversity is clearly driving the association between the ICFI and children's HAZ. The diversity variables show the strongest relationship with height-for-age, and diversity is counted twice in the index (once by the 24-hour diversity score and once by the seven-day quasi-food frequency score). Multivariate analyses confirmed that the association between dietary diversity and HAZ remains when sociodemographic factors are controlled for. Frequency of feeding is also significantly and positively associated with HAZ. Balanced against these strong positive relationships are the negative relationships between good practices and HAZ, which are observed in the case of breastfeeding and avoidance of bottle-feeding.

Our analysis also showed that the relationship between diversity indicators and child nutritional status is very similar whether 24-hour data or seven-day data are used. The index could thus be simplified by including one, rather than both, of the sets of recall data.

Finally, the decomposition exercise also sheds light on the lack of association between the ICFI and child nutritional status in urban areas. The prevalence of two negative practices—lack of continued breastfeeding and bottle use—are each much higher in urban areas. These negative practices lower ICFI scores for urban women, yet children in urban areas have, on average, higher Z-scores. Diversity scores are positively associated with Z-scores in both urban and rural areas, but for urban children these positive associations are apparently balanced against the negative associations just described.

6. For Which Purposes Is the ICFI Most Likely To Be Useful?

Summary indicators such as the ICFI may be useful for international comparisons of the adequacy of infant and child feeding practices; summarizing information from different practices into one variable, which can then be used for research and analysis, or for communication and advocacy; and monitoring progress and evaluating the impact of programs and policies. The potential usefulness and the strengths and limitations of the ICFI for each of these purposes are reviewed below.

For International Comparisons

At this time, the lack of clear and specific international recommendations for several dimensions of infant and child feeding constrains efforts to construct an index that could be used universally. In particular, in the absence of any recommendation on appropriate or optimal diversity over 24 hours or seven days, cutoff points that define adequacy are not available. In the absence of such recommendations, the method used in the analysis reported here involved deriving sample-specific terciles of food group diversity.

For programs, this approach has the advantage of defining "high" diversity at a level that is clearly achievable for a significant proportion of the population (in contrast to a theoretical, but perhaps unachievable, ideal). However, from the standpoint of developing an index useful for international comparisons, reliance on population-specific distributions for one or more variables included in the index is inappropriate. In order to use the index for international comparisons, standard cutoff points defining "low," "average," and "high" ICFI would need to be used consistently across countries. Until recommendations exist for adequate or optimal food group diversity, there is no basis for defining internationally appropriate cutoff points, and selection of cutoff points will remain arbitrary.

For Research, Communication, and Advocacy

Our experience with analysis of DHS data sets both from Latin America and from Ethiopia confirms the usefulness of the ICFI as a tool for research, communication, and advocacy. The index summarizes information on feeding practices and can be used to illustrate the strength and magnitude of associations between feeding practices and child outcomes. This makes the index a potentially valuable advocacy tool, which can be used to communicate the importance of complementary feeding practices to policymakers.

For Monitoring and Evaluation

Programs promoting changes in specific infant and child feeding practices should always evaluate impact on the individual targeted behaviors as a first step. In addition, some program managers may be interested in evaluating the overall impact of their program on feeding practices and may therefore be interested in assessing change in a summary measure of these practices. For summary indicators to be useful for this purpose, they must be relatively simple to compute, and responsive to changes in the individual practices (e.g., continued breastfeeding, bottle use, etc.).

In the context of *monitoring*, indicators generally must be very simple so that staff can rapidly gather, summarize, and interpret information. Even in simplified form, the ICFI does not meet this requirement. In the context of *evaluation*, the simplified ICFI—using only the 24-hour data—may be considered useful. Data for breastfeeding, bottle use, and frequency of feeding are relatively simple to collect, code, and use in index construction. Data from 24-hour food group recalls require more work for variable construction (the diversity indicator) but are still relatively easy to use.

To test whether the ICFI derived from the Ethiopia DHS was responsive to changes in its individual components, we carried out a simulation exercise, summarized below.

Simulations to Test Responsiveness of the Infant and Child Feeding Index to Varying Levels of Change in Components

The methodology used for the simulations is presented in the Appendix. Briefly, the method consisted of setting up a spreadsheet with hypothetical baseline values for the different components of the index, simulating different levels of changes in the various components, and observing the resulting level of change in the index. Both low and high impact scenarios were simulated—low impact referred to changes in individual practices ranging from 5–10 percentage points, and high impact to changes of 10–25 percentage points. The size of the changes estimated for low and high impact reflects the range of actual changes reported from PVO projects (data from P. Harrigan and A. Swindale, FANTA project). An additional scenario was simulated, which included a change of 5 percentage points in each practice. A summary of the findings of the simulation exercise is presented in Table 7.

Table 7: Changes in mean ICFI score for a range of hypothetical scenarios[a]

	Level of impact				**Mean CFI score**	**Difference from baseline**	**% difference**
	Continued breastfeeding	**Bottle use**	**Frequency of feeding**	**Food group diversity**			
Baseline	–	–	–	–	4.36		
Scenario 1	Low	Low	Low	Low	4.95	0.59	14
Scenario 2	High	High	High	High	5.37	1.01	23
Scenario 3	Low	Low	None	None	4.54	0.18	4
Scenario 4	High	High	None	None	4.62	0.26	6
Scenario 5	High	High	Low	Low	5.03	0.67	15
Scenario 6	High	High	High	None	4.97	0.61	14
Scenario 7	Low	Low	High	High	5.28	0.92	21
Scenario 8	5%	5%	5%	5%	4.57	0.21	5

[a] The mean CFI scores here are out of a possible range of 0-7, as the CFI used for these simulations was a simplified version that excluded the seven-day diversity scores. The simplified version was chosen because, as noted above, 24-hour and seven-day diversity were very strongly correlated. Versions of the CFI that included only 24-hour data, only seven-day data, and both were all very strongly correlated as well (see Arimond and Ruel 2002).

As expected, the highest change in mean ICFI scores was achieved from the high impact scenario where a high impact on all four targeted behaviors was simulated. The lowest impact was achieved in Scenario 3, which simulated a program with low impact on breastfeeding and bottle use and no impact on feeding frequency and dietary diversity. The range of changes in mean ICFI scores under the various scenarios was from 0.18 to 1.01, or differences from baseline ranging from 4 to 23 percent.

Table 7 clearly highlights the fact that differences in the magnitude of impact of the program on different practices affect the responsiveness of the index. For example, in Scenario 5, a high impact on breastfeeding and bottle use coupled with a low impact on feeding frequency and diversity yields a change in mean ICFI score of 0.67 points (a 15 percent change). In the “opposite” scenario (7), i.e., a low impact on breastfeeding and bottle use and a high impact on frequency and diversity, a larger change in ICFI is achieved (0.92 points, or 21 percent change from baseline).

Thus, although both scenarios simulated a low impact on two of the components and a high impact on the other two components, they resulted in a different magnitude of effect on the mean ICFI. This is because the level of change achievable in any given practice will depend both on the baseline level (e.g., if 95 percent of women practice continued breastfeeding, little change should be expected) and on the difficulty in making change in a given practice. In our hypothetical example, baseline prevalence of bottle-feeding was set at 5 percent for children 12–36 months (see the Appendix); therefore even in a high impact scenario, little change can occur in the bottle use score (maximum potential decrease of 5 percent). This also illustrates the fact that if geographic or project areas differ with respect to baseline levels of individual component indicators, comparisons between changes in the ICFI achieved over time will not be fair.

Scenario 8 provides an interesting mathematical illustration of how changes in individual practices translate into changes in the mean index score. This scenario simulated a hypothetical case where changes were equal across practices (a 5 percentage-point change). The resulting change in the ICFI was exactly 5 percentage points, reflecting exactly the change simulated for each individual practice. Thus, these simulations show that the percentage change in the ICFI score compared to baseline levels accurately reflects an averaging of the changes in individual practices.

Conclusions About the Potential Usefulness of the ICFI for Program Evaluation

From these simulations, we conclude that the ICFI may be useful in a program context when

- *Programs are designed to change most or all component practices.* As shown in the simulations, even if a program has a high impact on some practices, if no impact is achieved on some of the practices (see, e.g., Scenario 4), the magnitude of change in the overall summary index will be small and thus will obscure the program impact on those practices that did improve.
- *Program managers are interested in a summary statistic that reflects overall progress toward improving feeding practices.* It is important to remember that the index can only represent an average summary of the changes in the individual practices. Therefore, the index will be useful only in situations where average

change is of interest as a global indicator of progress toward meeting development goals.

The ICFI, on the other hand, is *not* useful for programs when

- *Comparisons are needed between programs—or geographic areas—with differing baseline levels for individual practices.* We have shown that the sensitivity of the index to changes is highly dependent on initial baseline levels of the individual variables. Thus, comparisons between programs with differing baseline levels are inappropriate.
- *Some practices included in the index are not targeted (or affected) by the program.* In these situations, lack of change in one or more practices will obscure successes in changing other practices.

7. Lessons Learned and Research Needs

Our previous work with data from the DHS surveys for Latin America suggested that it was possible to create a useful indicator summarizing a variety of infant and child feeding practices (specifically, those for which data are available in the DHS). The construction of the ICFI addressed two challenges in measuring and assessing infant and child feeding practices: these practices are multidimensional, and appropriate practices are age-specific, within narrow age ranges. The ICFI successfully summarizes several dimensions of infant and child feeding in one variable. It also accounts for the agespecificity of feeding practices. The present analysis with the DHS+ Ethiopia data set confirms the usefulness of the index both for research and analysis and also as a summary indicator for illustrating and communicating the importance of infant and child feeding practices for nutrition and health outcomes.

Lessons Learned from the Ethiopia Analysis

The present work with the Ethiopia DHS+ 2000 extended our previous work on indicators for infant and child feeding practices in several ways. Taking advantage of the new, more detailed food group recall information in the DHS+, we refined our 24-hour and seven-day diversity indicators. In constructing the index, we also used a more systematic approach to score the diversity variables. In the absence of international recommendations for adequate or optimal dietary diversity, we used sample- and age-specific terciles of food group diversity as the basis for scoring these component indicators.

With this improved approach we confirmed that overall, the ICFI was associated with height-for-age in the same way and with a similar strength of association, as was the case with the Latin American DHS data. At approximately 0.4 Z-scores, the significant, positive association is of a size considered to be biologically meaningful, i.e., linked to functional outcomes. In the case of Ethiopia, this association was present only for the rural subsample. Nevertheless, the results support the idea that such an index may function in widely divergent contexts, as both the prevalence of various feeding practices and access by children and families to various food items are very different in Ethiopia, as compared to the Latin American countries previously studied.

As in the previous work, this association should not be viewed as causal, as clearly current practices do not determine current nutritional status. The meaning of the association depends on the possibility that current practices may represent past practices as well, i.e., that a child who is still breastfed has been breastfed throughout his/her life, or a child who is fed sufficiently frequently now may also have been fed sufficiently frequently at earlier ages.

Also, as in the previous work, we faced certain methodological constraints in modeling the relationship between practices and nutritional status outcome indicators. Specifically, the feeding practices indicator itself is likely to be endogenous in the model. The commonly used solution of substituting instrumental variables in a two-stage modeling process is not available in this context, due to a lack of good candidate variables in the DHS data sets.

Finally, as in previous work, the ICFI as constructed is intended to take advantage of the information available from the widely available *DHS+* surveys; at the same time this means that the selection of variables for inclusion in the index is constrained by data available from these surveys. Other more comprehensive summary indices could be constructed, including a wider range of complementary feeding indicators (e.g., of quantity and nutrient density of foods, active feeding, and others) when and where such indicators are available.

The work with the Ethiopia data set went further than the analysis of the Latin American data sets in that it specifically explored the nature of the association between the ICFI and height-for-age. In an effort to "unpack" and understand the nature of the association, we examined associations between each component indicator and height-for-age. This exercise showed that the association between the ICFI and height-for-age is most strongly driven by the very strong positive relationship between the diet diversity variables and height-for-age. The relationship was positive and strong regardless of which diversity indicator was used, and remained strong after statistical control for a range of potentially confounding variables. This important finding needs to be confirmed by analyses in other countries and contexts with varying levels of dietary diversity.

This exercise also revealed that—as has been documented elsewhere—several positive practices (continued breastfeeding, and avoidance of bottle use) are associated with lower height-for-age, and that this is particularly true in urban areas in Ethiopia. In urban Ethiopia, the association of good practices with worse nutritional status may be due to confounding by differences in socioeconomic status (e.g., wealthier mothers and those with more education are more likely to use bottles). The strong negative association between these positive practices and height in urban areas may also explain why the ICFI is not associated with child height-for-age among the urban children in the survey.

Finally, one of the main objectives of the Ethiopia analyses was to further assess the potential usefulness of the ICFI for three purposes: international comparisons; use in research, communication, and advocacy; and use in program monitoring and evaluation.

Because of the lack of universal recommendations regarding optimal dietary diversity at different ages, the approach used in the Ethiopia analyses to score these variables involved deriving sample-specific terciles. For this reason, the ICFI cannot be used for international comparisons because the cutoffs used to define low, average, and high dietary diversity are not universally defined. Until international recommendations or universally-accepted cutoff points are derived, the ICFI will not be suitable for international comparisons.

In regard to the second purpose, analyses of the Ethiopia data confirmed our previous experience that the ICFI is a useful tool for a variety of research applications, and in communicating and advocating the importance of infant and child feeding to various audiences.

The simulation exercise reported in the present manuscript assessed the potential usefulness of the ICFI for a third objective—program evaluation. Simulations tested the responsiveness of the ICFI to varying levels of change in component practices. The analyses showed that the ICFI accurately reflects an averaging of the changes seen in individual component practices, and that it may therefore be useful in an evaluation context when programs are designed to change most or all component practices, and program managers are interested in a summary indicator that reflects overall progress toward improving feeding practices.

The ICFI should not be used when the objective is to compare changes in practices between projects—or geographic areas—with differing baseline levels for individual practices.

Research Needs

The analysis of the Ethiopia DHS+ 2000 raised a number of questions that will require further analysis and research. The DHS data offered a rare opportunity to compare 24-hour to seven-day food group recall data, using a nationally representative sample. In the context of the ICFI, we found that the two sets of recall data were redundant. Diversity indicators constructed from the 24-hour recall data were very tightly correlated with diversity indicators constructed from the seven-day recall data; similarly, three versions of the ICFI, using only 24-hour, only seven-day, or both recalls were all very tightly correlated. These results should be confirmed in assessments of dietary diversity using DHS data from a range of countries, including countries with a higher level of dietary diversity than was observed in Ethiopia.

We also report very strong associations between simple food group diversity scores and HAZ, which remain after control for socioeconomic status. Very little work has been published relating simple food group diversity indicators to nutrient adequacy or growth outcomes in developing countries (see, e.g., Hatløy, Torheim, and Oshaug 1998; Onyango, Koski, and Tucker 1998; Onyango, Koski, and Tucker 1998). Other DHS data sets and other surveys that include similar indicators should be examined to see if an association between food group diversity and growth can be widely observed and confirmed after appropriately controlling for socioeconomic factors.

Finally, much more work is needed to determine whether simple indicators of dietary diversity can accurately reflect nutrient adequacy, and if so, efforts to develop these indicators should be pursued.

Appendix: Summary of Methods Used for Simulation Exercise

In this analysis, a simpler infant and child feeding index was constructed from four component practices: (1) continued breastfeeding; (2) bottle use; (3) frequency of feeding complementary foods; and (4) dietary diversity measured by the 24-hour recall. The seven-day recall was excluded in order to simplify the index, because it was found to be strongly correlated with the 24-hour recall.

Simulations were performed by entering summary statistics (e.g., "percent of 12-36-month-old children given bottle") into a spreadsheet; spreadsheet formulas then yielded the mean ICFI score. Two different types of simulations were performed. One used the EDHS 2000 data as a baseline, and the other a hypothetical baseline survey. For simplicity, only the hypothetical scenarios are presented here.[15]

Using the hypothetical baseline, the mean ICFI score was calculated for low program impact scenarios and high program impact scenarios (see Appendix Table 8 for description of hypothetical levels of changes under the different scenarios). In these scenarios, positive changes of 5–10 percentage points (depending on the practice and the

[15] The method used was identical, but the hypothetical examples illustrate the simulations more simply and clearly, both because round numbers are used and because baseline levels allow more scenarios. The hypothetical baseline leaves more space for change (e.g., in continued breastfeeding) than does the DHS data from Ethiopia "baseline," and therefore illustrates high- and low-impact scenarios more clearly.

baseline level) are generally considered to represent low program impact and changes of 10–20 percentage points (depending on same) to represent high program impact.[16]

Table 8: Low and high impact scenarios, using a hypothetical baseline

		Age groups		
Components	**Scenarios**	6–9 mo	9–12 mo	12–36 mo
Breastfeeding	Baseline (%)	85	85	50
	Low impact (increase in % points)	10	10	10
	High impact (increase in % points)	10	10	20
Bottle-feeding	Baseline (%)	20	20	5
	Low impact (decrease in % points)	5	5	5
	High impact (decrease in % points)	10	10	5
24-hour food group diversity	Baseline (% in each tercile)	33/33/33	33/33/33	33/33/33
	Low impact (% in each tercile)	20/40/40	20/40/40	20/40/40
	High impact (% in each tercile)	10/40/50	10/40/50	10/40/50
Frequency of feeding	Baseline (% with scores 0/1/2 for 0–12 mo and 0/1/2/3 for 12–36 mo)	50/25/25	20/60/20	10/20/40/30
	Low impact (% with scores 0/1/2 or 0/1/2/3)	25/50/25	10/60/30	5/15/45/35
	High impact (% with scores 0/1/2 or 0/1/2/3)	10/50/40	10/50/40	5/10/45/40

In addition to low- and high-impact scenarios, which are intended to illustrate real-world possibilities, we also include one scenario where each practice in each age group changes by 5 percentage points. This last scenario is meant purely as a mathematical example of how the ICFI score changes when practices change.[17]

[16] In defining low and high impact, actual changes in breastfeeding and complementary feeding that have been reported by PVOs were considered (personal communication from A. Swindale and P. Harrigan, FANTA project). For programs lasting three to five years, the size of reported changes in practices ranged widely, from no change (or even declines in positive practices) up to very large percentage-point changes in the range of 20–40 percent.

[17] In this scenario, practices that have more than two possible scores (that is, frequency and diversity) are assumed to change by decreasing the percentage scoring "0" by 5 percent and increasing the percentage scoring "1" by 5 percent; there are no changes in the proportion scoring "2" or "3" in this scenario.

For the simulations, a hypothetical survey of 900 children was used, with 150 in the 6–9 month age group, 150 in the 9–12 month age group, and 600 in the 12–36 month age group.[18]

[18] Hypothetical sample sizes by age group are needed because the spreadsheets calculate the mean CFI score as a weighted average of age-group specific means; see example spreadsheets in the appendix for details.

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