Infant and Young Child Feeding Practices as Associated with Child Nutritional Status in Nepal

Analysis of the Nepal Demographic Health Survey, 2011

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This report is based on a further analysis study undertaken as a follow-up to the 2011 Nepal Demographic and Health Survey (NDHS). Funding for the further analysis of the survey was provided by the European Union (EU), through the Regional Maternal and Young Child Nutrition Security Initiative in South Asia (MYCNSIA) covering five countries in addition to Nepal and United Nations Children's Fund (UNICEF). Tulane University, School of Public Health and Tropical Medicine, provided technical assistance for this analysis. UNICEF provided in-country coordination in liaison with the Infant and Young Child Feeding Working Group under Nutrition Technical Committee (NUTEC) of the Child Health Division, Ministry of Health and Population (MoHP), as well as with New Era, which undertook the 2011 NDHS. The opinions expressed are those of the authors and do not necessarily reflect the view of the EU or other funding agencies.

Additional information on this analysis based on the 2011 NDHS data maybe obtained from the Nutrition Section, Child Health Division, MoHP; telephone (977-1) 4225558, 4261660 or from Nutrition Section, UNICEF Nepal Country Office; telephone (977-1) 5523200; fax (977-1) 5572780 or 5535395. Information about the DHS program maybe obtained from MEASURE DHS, ICF International, 11785 Beltsville Drive, Suite 200, Calverton, MD 20705, USA; telephone: 301-572-0200; fax: 301-572-0999; e-mail: reports@measuredhs.com; Internet: http//www.measuredhs.com.

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Foreword

The 2011 Nepal Demographic and Health Survey is a nationally representative comprehensive survey, the fourth survey of its kind, conducted as part of the worldwide Demographic and Health Surveys (DHS) project in the country. The standard format of the main report includes only a descriptive presentation of the findings and trends, without using analytical statistical methods to ascertain the significance of the change and causative association between the variables. Though largely sufficient, the standard report is limited, particularly in providing answers to 'why,' which are very essential in re-shaping important policies and programmes. Therefore, following the dissemination of the NDHS 2011, MoHP, particularly the child health division and the partners working on Infant and Young Child Feeding (IYCF) programs convened and agreed on key areas further analysis work that are very important to undertake on IYCF in Nepal for key sub-population groups, to serve as input towards development of the national IYCF strategy. In this context, the analyses and report on 'Infant and Young Child Feeding Practices as Associated with Child Nutritional Status in Nepal' has been carried out by the MoHP with the technical support of UNICEF and generous funding from the European Union (EU).

The primary objective of the NDHS further analysis is to provide a more in-depth knowledge of and insights into key emerging issues from 2011 NDHS data, and this is expected to provide guidance in planning and implementing, re-focusing, monitoring, and evaluating health and nutrition programmes related to these issues in Nepal. The specific objective of this analysis is to examine the association between IYCF practices with child nutritional outcomes – in terms of underweight, stunting, wasting and anemia, and to inform future policy and programmatic decisions for addressing undernutrition in Nepal through improved IYCF practices. The study also aimed to shed more light on the variations in infant and young child feeding as these differ among sub-population groups, by ecological zones, regions, caste, ethnicity, household characteristics – such as wealth quintiles and mother's education. These findings will help suggest options for potential targeting, and should be incorporated in the upcoming national comprehensive IYCF strategy.

This study and report is the concerted effort of various individuals and institutions, and it is with great pleasure that I acknowledge the work that has gone into producing it. I would like to extend my appreciation to the European Union (EU) and the United Nations Children's Fund (UNICEF) for providing financial support for this further analysis. I would also like to acknowledge the rigorous further analysis by the research team from Tulane University and reviews by the members of the IYCF working group of NUTEC, which is highly regarded. My sincere thanks especially go to NUTEC's IYCF core working group and the UNICEF team for the overall contribution, and, support, management and coordination of the whole process. Lastly but not least I would like to thank the Child Health Division of the Department of Health Services, MoHP as well as the Population Division, MoHP for its overall guidance, effort and dedication in the completion of this analysis and the report.

Dr. Praveen Mishra
Secretary, Ministry of Health and Population
Government of Nepal

MESSAGE

I would like to extend my congratulations to the Child Health Division, DoHS, MoHP for this very useful and timely further analysis of the 2011 Nepal Demographic Health Survey (NDHS), with technical support from UNICEF and generous funding of the European Union (EU).

I firmly believe that the report on the associations between Infant and Young Child Feeding (IYCF) practices with child nutritional outcomes will inform policy decisions on addressing the prevailing high levels of child undernutrition in Nepal through improved IYCF practices. The study has also shed some light on the differences in IYCF practices among sub-population groups, by ecological zones, regions caste, ethnicity, as well as household characteristics – such as wealth quintiles and mother's education, which will serve as input to programmatic decisions with regards to targeting potentials. This report is timely, as the findings will be incorporated in the draft national comprehensive IYCF Strategy (2013-2017), which is being finalized by the MoHP currently.

The 2011 NDHS have revealed that only one in four children are fed with the minimum acceptable diets, which is a serious concern. This is largely due to the inadequate quality of the diets in terms of food diversity as well as relatively low age-appropriate meal frequencies. This further analysis of the 2011 NDHS has demonstrated the significance of diet diversity and minimum meal frequency for reducing stunting and underweight among children 6-23 months. Furthermore, it is evident that low hemoglobin among young children is a serious public health problem; with as high as 70% of children ages 6-23 months suffering from anemia. This report has highlighted the importance of intervening early – starting with mothers during pregnancy so as to tackle this issue effectively, further confirming that the nutrition specific programs through the health sector should focus on the critical window of opportunity or the first 1,000 days of life, from conception up to 24 months of age. Additional efforts will thus be focused by the MoHP to improve the nutrition (including anemia) status of adolescents and pregnant and lactating women.

I would like to appreciate the Child Health Division and UNICEF team, as well as researchers from Tulane University, and expert reviewers for the rigorous further analysis, which is highly regarded. I would also like to thank the EU and UNICEF for their financial support. Lastly, I would like to thank the Child Health Division, DoHS, MoHP for its overall guidance, and dedicated effort in the completion of this important analysis and report.

Dr. Badri Pokharel
Chief, Population Division
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ACKNOWLEDGEMENTS

Multi-Sector Nutrition Plan (2013-2017) was approved and launched by the National Planning Commission, Government of Nepal in September 2012. In line with this plan, the Ministry of Health and Population initiated the process of developing a comprehensive Infant and Young Child Feeding (IYCF) Strategy through its Nutrition Technical Committee (NUTEC) and IYCF technical working group. This analysis on the association between IYCF practices and child growth was undertaken using the 2011 Nepal Demographic Health Survey (NDHS) data. It complements other studies which were undertaken at about the same time, to serve as input to the drafting of the IYCF strategy - comprehensive program review, formative research on IYCF, analysis on the trends and determinants of breastfeeding and complementary feeding practices using data from the NDHS, which are presented as separate reports.

This assignment was undertaken under the lead of the then Director of Child Health Division, Dr. Tara Pokharel. It was managed by Dr. Saba Mebrahtu, Chief, Nutrition Section, UNICEF Nepal Country Office. The data analysis and initial drafting of the report was undertaken by Jennifer Crum and John Mason, as part of a consultancy with UNICEF Nepal Country Office. The draft report was reviewed by members of the IYCF core technical working group under NUTEC namely Rajkumar Pokharel, Saba Mebrahtu, Pradiumna Dahal, Kalpana Tiwari, Sumit Karn, Pooja Pandey, Sujay Nepali, and Neera Joshi. The draft report was revised incorporating the reviewers' comments, and presented to the MoHP's NUTEC IYCF technical working group by Dr. Saba Mebrahtu. The final draft was then reviewed by Mr. Basanta Adhikari, Sr. Public Health Officer, CHD, Mr Giri Raj Subedi, Chief, Nutrition Section, CHD, and Dr. Senendra Raj Uprety, the then Director, Child Health Division. The final report has incorporated comments received by all the key reviewers. I would also to thank the Population Division, MoHP for efforts on overall guidance and coordination of this work.

This assignment and the report was made possible with the funding support of the European Union (EU) through the regional Maternal Young Child Nutrition Security Initiative in Asia (MYCNSIA) project and UNICEF, to whom we would like to extend our appreciation for this generous and valuable assistance.

Dr Shyam Raj Uprety
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ABBREVIATIONS AND ACRONYMS

BMI	Body Mass Index
CBS	Central Bureau of Statistics
EU	European Union
GoN	Government of Nepal
HAZ	Height-for-age z-scores
HDI	Human Development Index
Hgb	Hemoglobin
IYCF	Infant and Young Child Feeding
JAR	Joint Annual Review
MDG	Millennium Development Goal
MoHP	Ministry of Health and Population
MYCNSIA	Maternal Young Child Nutrition Security Initiative in Asia
NCHS	National Center for Health Statistics
NDHS	Nepal Demographic and Health Survey
OLS	Ordinary least squares
Ppm	Parts per million
SD	Standard Deviation
SES	Socio-economic status
SPSS	Statistical Product and Service Solutions
STATA	Data Analysis and Statistical Software
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UN/SCN	United Nations Standing Committee on Nutrition
USAID	United States Agency for International Development
WAZ	Weight-for-age z-scores
WHO	World Health Organization
WHZ	Weight-for-height z-scores

ABSTRACT

Background. Child undernutrition remains a serious problem in Nepal with 41 per cent stunting, 29 per cent underweight and 11 per cent wasting among children less than five years of age in 2011. Effective interventions must be identified to further improvements made thus far. Appropriate infant and young child feeding (IYCF) practices have the potential for improving undernutrition of children in Nepal.

Objective. This project aimed to analyze associations of IYCF practices with child nutrition outcomes of underweight, stunting, wasting and anemia to contribute to policy and programmatic decisions for addressing undernutrition in Nepal. Assessment of practices among population subgroups can suggest options for potential targeting.

Methods. Analysis of 2011 Nepal Demographic and Health Survey (NDHS) data was performed using a dataset with 971 children ages 0-23 months. Indicators of child nutritional status were examined with selected variables of IYCF practices using bivariate and multivariate analyses.

Results. Diet diversity and minimum meal frequency are significantly, positively associated with weight-for-age and height-for-age among children 6-23 months, with the greatest effect among ages 6-11 months, even when controlling for maternal education, maternal nutritional status, water and sanitation and child age and gender. Diversity and meal frequency are positively associated with weight-for-height for children 18-23 months using the same factors in analysis. The combination of adequate diversity and meal frequency had the greatest effect on all three indicators of child growth. Low hemoglobin is a serious problem; 70% of children ages 6-23 months had anemia. Hemoglobin was not associated with IYCF practices investigated. Maternal nutritional status was strongly, positively associated with all indicators of child growth and for almost every age range investigated. The lowest prevalence estimates of good IYCF practices were found in the Terai ecological zone, Central region, and among the Madhesi ethnic group/caste.

Discussion. In Nepal adequate diet diversity and minimum meal frequency have positive effects on child growth, particularly among the youngest children ages 6-11 months. The largest effect occurs when both are present simultaneously. Counseling for good IYCF practices should begin early in infancy, at the critical time of weaning from breastfeeding and introduction of foods, thus maximizing potential for adequate growth through two years of age. Good maternal nutrition is vital for optimizing child growth; interventions aimed at improving child undernutrition should begin with mothers. This is likely true for micronutrient deficiencies as well, as anemia among the youngest children is extremely high and not associated with food intake. Potential targeting options for improving IYCF practices include the Terai ecological zone, Central region and Madhesi ethnic group/caste.

INTRODUCTION

Poor nutritional status impairs physical and cognitive development, limiting social and economic potential and increasing risk for mortality and morbidity. Undernutrition of children less than five years of age in Nepal is significant, with 41 per cent of children stunted (low height-for-age), 29 per cent underweight (low weight-for-age) and 11 per cent wasted (low weight-for-height) in 2011 (Ministry of Health and Population, 2012) . Micronutrient deficiency is alarming, as almost half (46 per cent) of children under five, and 69 per cent ages 6-23, months were found to have anemia in 2011 (MOHP, 2012). High prevalence of undernutrition among children in Nepal and subsequent risk for lifelong negative effects necessitates study of factors contributing to improvement in child nutritional status, so that effective interventions may be implemented.

Appropriate feeding during infancy and early childhood is vital for optimizing nutritional status and health of children (World Health Organization and UNICEF, 2003) . Infant and young child feeding (IYCF) practices have been associated with child nutrition outcomes. Suboptimal feeding of complementary foods has been identified as a risk factor for stunting, and recommendations for improving quality, frequency and energy density of diet were made (Black, et al., 2008) . Individual and group breastfeeding promotion has the potential to greatly reduce child morbidity and mortality, and improvement in complementary feeding through counselling (with food and/or cash supplements if food-insecure) may reduce stunting and associated disease burden (Bhutta ZA, et al., 2008) .

Previous studies have demonstrated positive associations of appropriate IYCF practices and child nutrition outcomes. In a multi-country analysis, diet diversity was associated with increase in HAZ in more than half of countries studied (Arimond and Ruel, 2004) . Multiple complementary feeding indicators (timely introduction of complementary foods, diet diversity, minimum acceptable diet and iron-rich food consumption) have also been positively associated with HAZ in two African countries .

Given the persistent undernutrition among children in Nepal, the Government (GON) has developed a Multi-sector Nutrition Plan (MSNP) designed to accelerate improvement in maternal and child nutrition . IYCF strategy is a major component of this plan. The objective of this study was to analyze the association of IYCF practices with child nutrition outcomes, thereby supporting policy and programmatic aims to further reduce undernutrition among children in Nepal. Additionally, analysis of practices by sub-groups of the population (e.g. geographic location, ethnic group) were undertaken to identify differences in child feeding, and assist in targeting of interventions.

METHODS

Data source.

The source for this secondary data analysis was the 2011 Nepal Demographic and Health Survey (NDHS), conducted by the Ministry of Health and Population in conjunction with New Era and ICF International. Survey design and methodology are described in detail elsewhere (MOHP, 2012). Questionnaires were used to collect information from women ages 15-49 years concerning infant and young child feeding (IYCF) practices. For living children currently residing in the households of these women respondents, anthropometric measures of height and weight were taken (children ages 0-59 months) for development of indicators used to assess nutritional status. In a selection of households hemoglobin of children ages 6-59 months was tested as well, using the HemoCue system. This analysis was restricted to the youngest children, ages 0-23 months; the total weighted sample size was 971.

Variables used for analysis.

Indicators for breastfeeding and complementary feeding were calculated and assessed according to recommendations put forth by the World Health Organization (WHO) . Definitions of indicators used in these analyses are as follows:

Early initiation of breastfeeding

Proportion of children born in the last 24 months who were put to the breast within one hour of birth.

Minimum diet diversity

Proportion of children ages 6-23 months who receive foods from four or more food groups. The food groups used for calculation of this indicator were: grains, roots and tubers; legumes and nuts; dairy products (milk, yogurt, cheese); flesh foods (meat, fish, poultry and liver/organ meats); eggs; vitamin-A rich fruits and vegetables; other fruits and vegetables.

Minimum meal frequency

Proportion of breastfed and non-breastfed children 6-23 months of age who receive solid, semi-solid, or soft foods (but also including milk feeds for non-breastfed children) the minimum number of times or more. Minimum for breastfed children is defined as two times for ages 6-8 months and three times for 9-23 months. For non-breastfeed children minimum is four times for ages 6-23 months.

Minimum acceptable diet

Proportion of breastfed children 6-23 months of age who had at least minimum dietary diversity and minimum meal frequency and non-breastfed children 6-23 months of age who received at least two milk feedings and had minimum diet diversity (not including milk feeds) and minimum meal frequency.

Outcomes of interest used for analysis of child nutrition were derived from anthropometric measures of child growth (weight, height, age). Height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) had been calculated as continuous variables using World Health Organization (WHO) standards; prevalence of less than -2SDs were calculated for presentation of results of stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height). Hemoglobin (Hgb) and anemia prevalence (less than 11g/dl) were considered as outcomes of nutritional status in addition to anthropometry.

Statistical analysis.

Indicators of IYCF practices as described here are calculated as categorical variables, taking the values of 0 and 1 (0 meaning not meeting recommendation for indicator). It is necessary to study the association of both diet diversity and meal frequency with child nutrition, in addition to using the summary variable of minimum acceptable diet. Diet diversity and minimum meal frequency cannot be studied simultaneously in one regression model due to collinearity ($r = 0.201$, $p < 0.001$, $n = 681$). There are various methods used for investigating both variables, a conventional way being to combine the separate indicators into a single variable. For this analysis, a single index was created in which diet diversity and minimum meal frequency were added together, and allowed to take the value of 0, 1 or 2 (0 if neither was present, 1 if either diversity or frequency was present and 2 if both were present). This allowed for construction of more robust models with both variables and controlling factors.

Continuous outcomes of HAZ, WAZ, WHZ and Hgb as associated with IYCF practices were assessed both descriptively and by multivariate method using regression (OLS) models. All descriptive results were weighted by sample weights to provide population estimates. Multivariate analyses were performed controlling for education, maternal nutritional status (body mass index (BMI) or height), water and sanitation, child age and gender. Data analysis was performed using SPSS version 20 .

RESULTS

Association of selected infant and young child feeding (IYCF) indicators with nutritional outcomes of children.

Descriptive results.

Initial results described differences in child nutrition outcomes of height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), weight-for-height z-scores, hemoglobin (Hgb) and anemia prevalence by selected infant and young child feeding (IYCF) practices (Tables 1-7).

Significantly higher WAZ scores were found among children receiving an adequately diverse diet versus those not for ages 12-17 months (p= 0.037), 18-23 months (p< 0.001) and 6-23 months (p= 0.001) (Table 1). Among children receiving an adequately diverse diet, WAZ scores were approximately the same for each category of age. In contrast, decreasing WAZ was found with increasing child age for those receiving inadequately diverse diets; thus, there are possible cumulative negative effects of inadequate diversity. Put otherwise, it appears that an adequately diverse diet prevents continuing underweight, from 6 months on.

TABLE 1. Mean WAZ by child age and diet diversity status

Age in months	Adequate diversity WAZ (n)	Inadequate diet diversity WAZ (n)	*p-value*
6-11	-1.08 (41)	-1.20 (199)	0.547
12-17	-1.15 (85)	-1.43 (179)	0.037
18-23	-1.10 (79)	-1.73 (136)	<0.001
Total	-1.11 (204)	-1.42 (515)	0.001
p-value	0.938	<0.001	

Appropriate minimum meal frequency was associated with higher WAZ scores of children 6-11 (p= 0.040), 12-17 (p= 0.069) and 6-23 (p= 0.070) months of age (Table 2). However in this case underweight continues with age in both groups.

TABLE 2. Mean WAZ by child age and meal frequency status

Age in months	Adequate meal frequency WAZ (n)	Inadequate meal frequency WAZ (n)	*p-value*
6-11	-1.05 (152)	-1.37 (87)	0.040
12-17	-1.32 (223)	-1.67 (32)	0.069
18-23	-1.46 (178)	-1.63 (27)	0.500
Total	-1.29 (553)	-1.48 (146)	0.070
p-value	*0.005*	*0.298*	

Diet diversity was also associated with higher HAZ scores (Table 3). Children ages 6-11 months receiving diverse diets had significantly higher HAZ scores (p= 0.006) as compared to those with poor diet diversity. A similar association was found among children 12-17 months of age (p= 0.071) and those 6-23 months of age (p= 0.065). Here, in contrast to underweight, the significant effect was in the youngest age group (6-11 months).

TABLE 3. Mean HAZ by child age and diet diversity status

Age in months	Adequate diversity HAZ (n)	Inadequate diet diversity HAZ (n)	*p-value*
6-11	-0.37 (41)	-0.96 (198)	0.006
12-17	-1.27 (80)	-1.59 (177)	0.071
18-23	-1.54 (77)	-1.79 (136)	0.206
Total	-1.19 (198)	-1.40 (512)	0.065

The distribution of HAZ scores for children ages 6-11 months receiving adequate diet diversity has a mean of approximately -0.40, in contrast to a mean of approximately -1.00 for those with inadequate diversity. Correspondingly, the distribution of z-scores for those with inadequate diversity is left of (i.e. less than) that for adequate diversity on comparative x-axes (Figures 1, 2).

FIGURE 1. Frequency distribution of height-for-age z-scores for chidren ages 6-11 months with adequate diet diversity

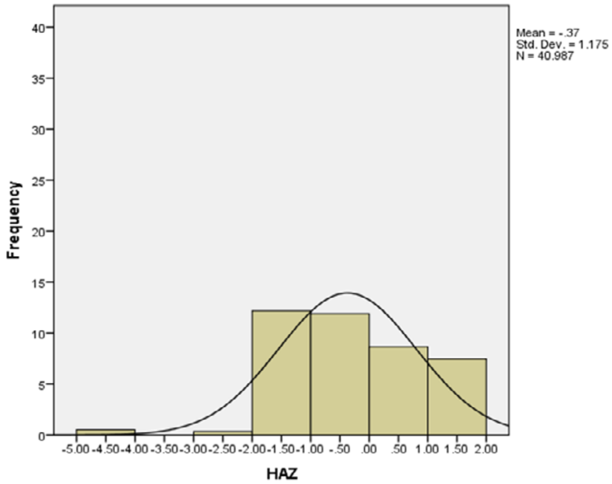
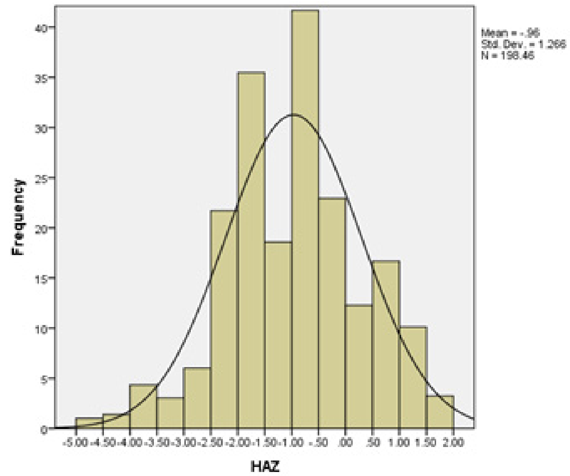


FIGURE 2. Frequency distribution of height-for-age z-scores for chidren ages 6-11 months with inadequate diet diversity



Minimum meal frequency was not associated with HAZ (results not shown).

WHZ score was significantly higher among children ages 18-23 months (p< 0.001) receiving adequately diverse diets versus those not (Table 4). Among children receiving diets with adequate diversity, WHZ scores improved with increasing child age while those with inadequate diversity were found to have decreasing z-scores. As with WAZ, diet diversity may have an effect of preventing continuing wasting, though this is limited to children 18 months and older.

TABLE 4. Mean WHZ by child age and diet diversity status

Age in months	Adequate diversity WHZ (n)	Inadequate diet diversity WHZ (n)	*p-value*
6-11	-1.15 (41)	-0.80 (202)	0.111
12-17	-0.86 (85)	-0.94 (179)	0.594
18-23	-0.53 (79)	-1.15 (136)	<0.001
Total	-0.79 (204)	-0.94 (518)	0.123
p-value	*0.016*	*0.023*	

Proper minimum meal frequency was associated with higher WHZ scores among children 12-17 months (p= 0.079), but not for other age ranges (Table 5). Wasting increases among children receiving diets with adequate meal frequency as well as those with inadequate frequency.

Higher mean Hgb was found among children ages 6-23 months receiving adequately diverse diets versus those with inadequate diversity (p= 0.049) (Table 6). A similar association was found for anemia prevalence; 63% of children ages 6-23 months with adequately diverse diets were anemic versus 71% for those with inadequate diversity (p= 0.038) (Table 7).

TABLE 5. Mean WHZ by child age and meal frequency status Age in months Adequate meal frequency

Age in months	Adequate meal frequency WHZ (n)	Inadequate meal frequency WHZ (n)	*p-value*
6-11	-0.79 (154)	-0.96 (88)	0.335
12-17	-0.90 (223)	-1.25 (32)	0.079
18-23	-0.89 (178)	-1.09 (27)	0.414
Total	-0.87 (555)	-1.05 (147)	0.102
p-value	*0.654*	*0.436*	

TABLE 6. Mean Hgb by child age and diet diversity status

Age in months	Adequate diversity Hgb (n)	Inadequate diet diversity Hgb (n)	*p-value*
6-11	10.4 (42)	10.1 (181)	0.187
12-17	10.3 (84)	10.2 (175)	0.710
18-23	10.8 (79)	10.6 (133)	0.361
Total	10.5 (204)	10.3 (490)	0.049

TABLE 7. Anemia prevalence by child age and diet diversity status

Age in months	Adequate diversity % anemia (n)	Inadequate diet diversity % anemia (n)	Total	*p-value*
6-11	66 (42)	78 (181)	76 (223)	0.106
12-17	70 (84)	73 (175)	72 (259)	0.658
18-23	53 (79)	58 (133)	56 (212)	0.455
Total	63 (204)	71 (490)	68 (693)	0.038

IYCF practices were assessed by geographic location, and found to be different when disaggregated by ecological zone and region. By ecological zone, diet diversity was inadequate for at least 65% of children (Table8); the Hills had the highest prevalence of diversity (36%). There was a 12ppt difference (p= 0.003) between this zone and the Terai, where the prevalence of diet diversity was lowest at 24%. Minimum meal frequency was 75% or greater in all three ecological zones, though highest in the Hills at 85%. At best, one-third of children received diets of minimum acceptability (Hills); at worst 20% received acceptable diets (Terai), demonstrating a 13ppt difference (p= 0.001). Prevalence of early initiation of breastfeeding was also lowest in the Terai at 43%, though differences among all three zones were not significant for this indicator (Table 8).

TABLE 8. Selected indicators of IYCF practices by ecological zone

In cells: percent meeting recommended practice (n)

Ethnic group/caste	Diet diversity	Minimum meal frequency	Minimum acceptable diet	*Early initiation of breastfeeding*
Mountain	28.1 (58)	75.4 (57)	23.5 (58)	50.4 (73)
Hill	35.5 (291)	85.4 (289)	33.0 (293)	47.2 (369)
Terai	23.5 (391)	75.4 (374)	20.0 (391)	42.8 (526)
Total	28.6 (740)	79.4 (719)	25.4 (742)	45.1 (968)
p-value	*0.003*	*0.005*	*0.001*	*0.272*

Less than 20% of children received diverse diets in the Central region, which was 18ppts less than those with the most diversity found in the Far-western region (p< 0.001) (Table 9). Minimum meal frequency was received by at least 70% of children (Mid-western region), though it was 15ppts greater (p= 0.001) in the Eastern region. The prevalence of children receiving a minimum acceptable diet was lowest in the Central region (16%), 19ppts lower (p< 0.001) than in the Eastern region. The Central region also had the lowest prevalence of early initiation of breastfeeding at 37%, 16ppts less (p= 0.006) than the highest prevalence found in the Far-western region.

TABLE 9. Selected indicators of IYCF practices by region

In cells: percent meeting recommended practice (n)

Ethnic group/caste	Diet diversity	Minimum meal frequency	Minimum acceptable diet	*Early initiation of breastfeeding*
Eastern	36.7 (181)	87.1 (180)	35.4 (181)	47.9 (227)
Central	19.8 (256)	74.0 (242)	16.4 (256)	36.9 (321)
Western	37.0 (129)	86.0 (126)	31.7 (131)	50.3 (182)
Mid-western	19.9 (106)	71.6 (106)	17.7 (106)	46.7 (140)
Far-western	37.7 (67)	77.9 (65)	33.4 (67)	53.3 (98)
Total	28.6 (740)	79.4 (719)	79.4 (719)	45.1 (968)
p-value	*<0.001*	*0.001*	*<0.001*	*0.006*

Significant differences in prevalence of children fed according to recommended IYCF practices were found among ethnic groups/castes (Table 10). Diet diversity was poorest among the Madhesi group (5%), 44ppts lower (p< 0.001) than the highest prevalence of diversity among the Brahman/Chhetri group. Importantly, at best only half of children received adequately diverse diets. Minimum meal frequency was provided more often as at least 64% of children received meals of adequate frequency (Madhesi group), though this was still 30ppts lower (p= 0.001) than the highest prevalence of adequate frequency among the Newar group. Minimum acceptable diet was lowest among the Madhesi group at 5%, 37ppts lower (p< 0.001) than the prevalence of acceptable diets provided among the Brahman/Chhetri group. Less than one-third of children in the Madhesi group had early initiation of breast-feeding (31%), in contrast to the Brahman/Chhetri group with 52% (21ppt difference, p= 0.005).

TABLE 10. Selected indicators of IYCF practices by ethnic group/caste

In cells: percent meeting recommended practice (n)

Ethnic group/caste	Diet diversity	Minimum meal frequency	Minimum acceptable diet	*Early initiation of breastfeeding*
Brahman/Chhetri	48.8 (204)	81.4 (205)	42.4 (206)	52.4 (279)
Madhesi	4.5 (87)	63.8 (85)	4.5 (87)	30.6 (100)
Dalit	20.1 (126)	83.4 (119)	18.9 (126)	41.7 (185)
Newar	35.2 (20)	94.1 (20)	29.3 (20)	47.3 (28)
Janajati	27.6 (249)	82.1 (243)	25.9 (249)	46.8 (303)
Muslim	11.5 (50)	69.8 (45)	6.5 (50)	35.8 (69)
Other	32.7 (4)	49.3 (2)	0.0 (4)	61.4 (4)
Total	28.6 (740)	79.4 (719)	25.4 (742)	45.1 (968)
p-value	*<0.001*	*0.001*	*<0.001*	*0.005*

Note: 'Other' group not considered in reporting of difference in prevalence estimates (ppts).

Multivariate results.

The associations described above were studied using regression models controlling for potentially confounding factors associated with IYCF practices and outcomes of interest. Tobacco use has an important effect on child growth in Nepal, but was excluded as a control variable due to its collinear relationship with both education (r= 0.259, p< 0.001) and wealth, especially middle and higher quintiles (r= -0.119, p= 0.002; r= -0.145, p< 0.001; r= -0.120, p= 0.002 for middle, richer and richest quintiles, respectively). Diet diversity and minimum acceptable diet (a summary indicator which includes diversity and frequency) are highly associated as well; the correlation coefficient between these variables is 0.910 (p< 0.001). Diet diversity and minimum meal frequency were explored separately in the combined index as described in addition to the summary variable of minimum acceptable diet.

Weight-for-age

Using the calculated index, diet diversity and minimum meal frequency were both positively associated with WAZ of children ages 6-23 months in the full model controlling for education, maternal BMI, water and sanitation and child age and gender (Table 11, Model 1). The coefficient for either adequate diversity or minimum meal frequency was 0.168 (p= 0.014). Therefore the coefficient for both adequate diversity and minimum meal frequency is double that, approximately 0.336. This indicates a positive effect on WAZ of either good IYCF practice, but that both diet diversity and minimum meal frequency are important for maximum positive effect on outcome as associated with diversity and meal frequency.

TABLE 11. Regression models showing differences in mean WAZ by index measure of diet diversity and minimum meal frequency, controlling for education, maternal BMI, water, sanitation and child age and gender

In cells: Coefficient (B) (t, p-value)

Independent variable	Dependent variable=*WAZ* Child age category (months)			
	6-23	**6-11**	**12-17**	**18-23**
	Model 1	**Model 2**	**Model 3**	**Model 4**
Diet Diversity and minimum meal frequency (index)	0.168** (2.47, 0.014)	0.233** (1.98, 0.049)	0.110 (1.05, 0.297)	0.163 (1.21, 0.228)
Poor education (dummy)	-0.375 (-3.96, <0.001)	-0.425 (-2.53, 0.012)	-0.444 (-3.08, 0.002)	-0.230 (-1.24, 0.216)
Respondent BMI	0.083 (5.09, <0.001)	0.032 (1.13, 0.258)	0.082 (3.27, 0.001)	0.144 (4.49, <0.001)
Unimproved drinking water source (dummy)	-0.203 (-1.92, 0.055)	-0.178 (-0.96, 0.340)	-0.186 (-1.12, 0.266)	-0.257 (-1.28, 0.202)
Unimproved toilet (dummy)	-0.150 (-1.60, 0.110)	-0.164 (-0.95, 0.343)	-0.146 (-1.06, 0.291)	-0.146 (-0.79, 0.429)
Age	-0.063 (-1.22, 0.224)	-0.185 (-0.36, 0.719)	-0.243 (-0.31, 0.754)	-0.509 (-0.38, 0.704)
Age squared	0.001 (0.64, 0.525)	0.002 (0.07, 0.945)	0.006 (0.22, 0.827)	0.012 (0.38, 0.701)
Gender of child (dummy female)	0.368 (4.35, <0.001)	0.537 (3.58, <0.001)	0.284 (2.18, 0.031)	0.339 (2.10, 0.037)
N	616	217	209	190

(*) denotes significance at p< 0.10; (**) at p< 0.05.

Note: Interaction between poor drinking water source and poor toilet was not significant.

The composite index for diversity and meal frequency was positively associated with outcome for children ages 6-11 months (Table 11, Model 2) with a coefficient of 0.233 (p= 0.049). Thus, the coefficient for both diversity and meal frequency together would be 0.466, again demonstrating the most effect when both IYCF practices are present. This is supported by findings that minimum acceptable diet is positively associated with WAZ of children 6-23 and 6-11 months (Table 12).

The coefficients for WAZ by age range and IYCF indicator are summarized in Table 12. For the overall sample (6-23 months) WAZ was associated with diet diversity, minimum meal frequency and minimum acceptable diet when controlling for education, maternal BMI, water and sanitation and child age and gender. The coefficient for minimum acceptable diet was 0.213 (p= 0.036), equivalent to about 9 ppts of underweight prevalence. This association was significant among children 6-11 months of age (0.423, p= 0.00), but not in the older age groups.

Diet diversity was associated with improved WAZ for children 6-23 months with a coefficient of 0.173 (p= 0.081). A similar relationship was found in this age range for minimum meal frequency and outcome with a coefficient of 0.184 (p=0.081).

Early initiation of breastfeeding was not found to be associated with WAZ of children by category of age.

From tables 11 and 12 we can conclude that both diet diversity and minimum meal frequency are positively and significantly associated with better weight-for-age. These effects are additive, not interactive, as the interaction term is not significant (not shown). The effects are clearly concentrated in the younger age group.

TABLE 12. Regression models showing differences in mean WAZ by individual indicators of IYCF practices; overall and by category of child age

In cells: Coefficient (B) (t, p-value)

Age of child (months)	Dependent variable=*WAZ*			
	Diet Diversity	**Minimum meal frequency**	**Minimum+ acceptable diet**	**Early initiation of breastfeeding**
0-5	--	--	--	0.206 (1.21, 0.227)
N				188
6-11	0.333 (1.56, 0.119)	0.254 (1.50, 0.135)	0.423* (1.97, 0.050)	-0.090 (-0.58, 0.563)
N	219	217	219	218
12-17	0.060 (0.41, 0.681)	0.203 (1.16, 0.249)	0.111 (0.76, 0.451)	-0.044 (-0.33, 0.745)
N	213	210	214	211
18-23	0.154 (0.87, 0.383)	0.155 (0.69, 0.490)	0.178 (1.00, 0.318)	0.065 (0.37, 0.710)
N	197	190	197	198
Total (6-23)	0.173* (1.75, 0.081)	0.186* (1.75, 0.081)	0.213** (2.10, 0.036)	--
N	629	617	630	
Total (0-23)	--	--	--	0.046 (0.59, 0.553)
N				815

Note: Models controlled for education, maternal BMI, water, sanitation, child age and gender.

Note: (*) denotes significance at p< 0.10; (**) at p< 0.05; (+) combines diet diversity and minimum meal frequency.

Height-for-age

The composite index of diversity and meal frequency was positively associated with HAZ (Table 13, Model 1) among children ages 6-23 months when controlling for education, maternal height, water and sanitation and child age and gender; the coefficient was 0.125 (p= 0.122). The index was more significantly associated with outcome for children 6-11 months of age with a coefficient of 0.258 (p= 0.039) for either diversity or frequency (Table 13, Model 2). Thus, the combination of diversity and frequency would have a significant effect as well, with a coefficient of 0.516.

TABLE 13. Regression models showing differences in mean HAZ by diet diversity and minimum meal frequency, controlling for education, maternal height, water, sanitation and child age and gender

In cells: Coefficient (B) (t, p-value)

Independent variable	**Dependent variable=*HAZ***			
	Child age category (months)			
	6-23	6-11	12-17	18-23
	Model 1	Model 2	Model 3	Model 4
Diet Diversity and minimum meal frequency (index)	0.125	0.258**	0.164	-0.105
	(1.55, 0.122)	(2.08, 0.039)	(1.19, 0.236)	(-0.63, 0.529)
Poor education (dummy)	-0.376	-0.271	-0.338	-0.553
	(-3.35, 0.001)	(-1.53, 0.128)	(-1.78, 0.076)	(-2.46, 0.015)
Respondent height	0.046	0.076	0.043	0.021
	(5.02, <0.001)	(5.07, <0.001)	(2.79, 0.006)	(1.14, 0.254)
Unimproved drinking water source (dummy)	-0.257	-0.201	-0.217	-0.316
	(-2.06, 0.040)	(-1.03, 0.305)	(-0.99, 0.322)	(-1.28, 0.201)
Unimproved toilet (dummy)	-0.174	-0.289	-0.058	-0.104
	(-1.59, 0.113)	(-1.64, 0.103)	(-0.32, 0.747)	(-0.47, 0.643)
Age	-0.162	-0.097	-0.365	0.149
	(-2.66, 0.008)	(-0.18, 0.858)	(-0.36, 0.720)	(0.09, 0.928)
Age squared	0.003	-0.004	0.007	-0.005
	(1.41, 0.159)	(-0.12, 0.906)	(0.20, 0.842)	(-0.12, 0.906)
Gender of child (dummy female)	0.383	0.541	0.166	0.489
	(3.82, <0.001)	(3.43, 0.001)	(0.97, 0.334)	(2.46, 0.015)
N	*615*	*217*	*209*	*189*

(*) denotes significance at p< 0.10; (**) at p< 0.05.

Note: Interaction between poor drinking water source and poor toilet was not significant.

HAZ was associated with diet diversity, minimum acceptable diet and early initiation of breastfeeding in the full model; coefficients by age range and IYCF indicator are found in table 14. Among young children (6-11 months) diet diversity was significantly positively associated with HAZ with a coefficient of 0.457 (p= 0.041). Within the same age range minimum acceptable diet was significantly associated with HAZ; the coefficient was 0.533 (p= 0.019), a coefficient almost identical to that found using the index. Among children ages 6-23 months minimum acceptable diet was positively associated with HAZ; the coefficient was 0.186 (p= 0.018).

The association of these IYCF measures is concentrated in the youngest age group, much the same as weight-for-age, though greater association was found for the entire range of 6-23 months for weight-for-age. Weight-for-age is the summary measure, and the conclusions from weight-for-age remain the same, with confirmation here that

6-11 month children should be included in IYCF behavior change interventions. Nonetheless, this age differential, and the large effect size on HAZ (approximately 20ppts stunting), merits careful further investigation.

TABLE 14. Regression models showing differences in mean HAZ by individual indicators of IYCF practices; overall and by category of child age

In cells: Coefficient (B) (t, p-value)

Age of child (months)	Dependent variable=*HAZ*			
	Diet Diversity	**Minimum meal frequency**	**Minimum+ acceptable diet**	**Early initiation of breastfeeding**
0-5	--	--	--	0.033 (0.18, 0.860)
N				183
6-11	0.457** (2.05, 0.041)	0.226 (1.28, 0.204)	0.533** (2.37, 0.019)	0.063 (0.39, 0.699)
N	219	217	219	218
12-17	0.181 (0.95, 0.343)	0.200 (0.87, 0.387)	0.171 (0.88, 0.381)	0.028 (0.16, 0.873
N	213	210	214	211
18-23	-0.161 (-0.75, 0.454)	-0.098 (-0.36, 0.722)	-0.033 (-0.15, 0.879)	0.449** (2.13, 0.034)
N	196	189	196	197
Total (6-23)	0.124 (1.05, 0.293)	0.149 (1.19, 0.237)	0.186** (2.38, 0.018)	--
N	628	616	629	
Total (0-23)	--	--	--	0.141 (1.57, 0.117)
N				809

Note: Models controlled for education, maternal height, water, sanitation, child age and gender.

Note: (*) denotes significance at p< 0.10; (**) at p< 0.05; (+) combines diet diversity and minimum meal frequency.

Early initiation of breastfeeding was associated with outcome among children 18-23 months of age (0.449, p= 0.034). The finding that this shows up after 18 months, and not before, is somewhat surprising and also merits further study.

Minimum meal frequency was not found to be associated with HAZ for children by age range.

Weight-for-height

Diet diversity and minimum meal frequency were associated with WHZ for children ages 6-23 months using the index measure in the full model (Table 15, Model 1); the coefficient was 0.108 (p= 0.137). For children ages 18-23 months a positive association was found, with a coefficient of 0.262 (p= 0.051) for either diversity or frequency (Table 15, Model 4).

TABLE 15. Regression models showing differences in mean WHZ by index measure of diet diversity and minimum meal frequency, controlling for education, maternal BMI, water, sanitation and child age and gender

In cells: Coefficient (B) (t, p-value)

Independent variable	Dependent variable=*WHZ*			
	Child age category (months)			
	6-23	6-11	12-17	18-23
	Model 1	Model 2	Model 3	Model 4
Diet Diversity and minimum meal frequency (index)	0.108	0.048	0.050	0.262*
	(1.49, 0.137)	(0.36, 0.716)	(0.46, 0.649)	(1.96, 0.051)
Poor education (dummy)	-0.280	-0.441	-0.390	0.057
	(-2.77, 0.006)	(-2.33, 0.021)	(-2.8, 0.011)	(0.31, 0.757)
Respondent BMI	0.094	0.030	0.100	0.169
	(5.45, <0.001)	(0.95, 0.343)	(3.81, <0.001)	(5.33, <0.001)
Unimproved drinking water source (dummy)	-0.067	-0.087	-0.033	-0.127
	(-0.60, 0.549)	(-0.41, 0.679)	(-0.19, 0.849)	(-0.64, 0.524)
Unimproved toilet (dummy)	-0.084	-0.024	-0.195	-0.095
	(-0.84, 0.401)	(-0.13, 0.900)	(-1.34, 0.180)	(-0.52, 0.602)
Age	-0.110	0.060	-0.073	-1.160
	(-2.00, 0.046)	(0.10, 0.917)	(-0.09, 0.929)	(-0.88, 0.382)
Age squared	0.004	-0.013	0.002	0.030
	(1.91, 0.056)	(-0.38, 0.705)	(0.09, 0.929)	0.93, 0.355)
Gender of child (dummy female)	0.248	0.391	0.226	0.189
	(2.76, 0.006)	(2.33, 0.021)	(1.65, 0.100)	(1.18, 0.239)
N	618	219	209	190

(*) denotes significance at p< 0.10; (**) at p< 0.05.
Note: Interaction between poor drinking water source and poor toilet was not significant.

TABLE 16. Regression models showing differences in mean WHZ by individual indicators of IYCF practices; overall and by category of child age

In cells: Coefficient (B) (t, p-value)

Age of child (months)	Dependent variable=*WHZ*			
	Diet Diversity	Minimum meal frequency	Minimum+ acceptable diet	Early initiation of breastfeeding
0-5	--	--	--	0.218
				(1.05, 0.293)
N				189
6-11	-0.083	0.142	-0.003	-0.190
	(-0.35, 0.725)	(0.76, 0.451)	(-0.01, 0.989)	(-1.11, 0.269)
N	221	219	221	220
12-17	-0.095	0.248	-0.013	-0.043
	(-0.63, 0.531)	(0.148, 0.883)	(-0.09, 0.932)	(-0.31, 0.761)
N	213	210	214	211
18-23	0.277	0.260	0.208	-0.220
	(1.58, 0.116)	(1.16, 0.246)	(1.17, 0.244)	(-1.27, 0.204)
N	197	190	197	198
Total (6-23)	0.061	0.169	0.076	--
	(0.58, 0.565)	(1.50, 0.135)	(0.71, 0.479)	
N	631	619	632	
Total (0-23)	--	--	--	-0.038
				(-0.45, 0.656)
N				818

Note: Models controlled for education, maternal BMI, water, sanitation, child age and gender.
Note: (*) denotes significance at p< 0.10; (**) at p< 0.05; (+) combines diet diversity and minimum meal frequency.

Coefficients for WHZ by age range and indicator of IYCF are summarized in Table 16. None of the four indicators were not found to be associated with outcome controlling for education, maternal BMI, water and sanitation and child age and gender.

Maternal nutritional status (maternal BMI for models with weight-for-age and weight-for-height, maternal height for height-for-age) is significantly associated with outcome in the full models (Tables 11, 13 and 15). This is true for children ages 6-23 months, and for almost all disaggregated age ranges as well. The positive associations of infant feeding practices described with child nutrition outcomes occur beyond (i.e. controlling for) maternal nutritional status, a primary determinant of child growth.

Associations by ecological zone

Weight-for-age as associated with diet diversity and minimum meal frequency was assessed within ecological zone (Table 17) for children ages 6-23 months (to maintain adequate sample size). Positive association with either diversity or meal frequency was found in the Terai; the coefficient was 0.225 (p= 0.055). Thus, the coefficient for both diversity and frequency is 0.450. Significant associations were not found in either the Mountains or Hills. Exploration of these associations with height-for-age and weight-for-height did not yield significant results (not shown).

TABLE 17. Regression models showing differences in mean WAZ by diet diversity and minimum meal frequency, controlling for education, maternal BMI, water, sanitation and child age and gender: by ecological zone

In cells: Coefficient (B) (t, p-value)

	Dependent variable=*WAZ*		
	Child age category (months)		
Independent variable	**6-23**	**6-23**	**6-23**
	Mountain	**Hill**	**Terai**
Diet Diversity and minimum meal frequency (index)	0.104	0.154	0.225*
	(0.74, 0.462)	(1.41, 0.159)	(1.93, 0.055)
Poor education (dummy)	-0.495	-0.306	-0.286
	(-2.64, 0.010)	(-2.00, 0.047)	(-1.75, 0.081)
Respondent BMI	0.114	0.098	0.064
	(2.91, 0.004)	(3.67, <0.001)	(2.56, 0.011)
Unimproved drinking water source (dummy)	0.117	-0.230	-0.240
	(0.60, 0.551)	(-1.51, 0.133)	(-0.77, 0.443)
Unimproved toilet (dummy)	-0.083	-0.184	-0.251
	(-0.45, 0.655)	(-1.27, 0.206)	(-1.49, 0.138)
Age	0.064	-0.035	-0.186
	(0.63, 0.533)	(-0.41, 0.684)	(-2.17, 0.031)
Age squared	-0.002	0.000	0.005
	(-0.63, 0.532)	(-0.11, 0.914)	(1.76, 0.079)
Gender of child (dummy female)	0.279	0.395	0.341
	(1.63, 0.107)	(2.92, 0.004)	(2.41, 0.017)
N	128	250	238

(*) denotes significance at p< 0.10; (**) at p< 0.05.

Hemoglobin

Neither diet diversity nor minimum meal frequency was associated with Hgb controlling for child age and gender (Table 18). A significant interaction between these variables was found (p= 0.027) but is probably an artifact of the data associated with small sample size (n=18) of those with adequate diet diversity, but less than adequate minimum meal frequency (Table 19). The similarity of the three cells with 10.2-10.4 g/dl Hgb strongly indicates that there is no association here with IYCF measures.

However, the finding that the mean Hgb itself is quite low, and the associated very high prevalence estimates of anemia in children (< 11 g/dl Hgb), of around 70% (Table 7) is itself a cause for concern, and for seeking solutions.

TABLE 18. Regression models showing differences in mean hemoglobin (Hgb) by index measure of diet diversity and minimum meal frequency, controlling for child age and gender

In cells: Coefficient (B) (t, p-value)

	Dependent variable=*Hgb*
Independent variable	Age: 6-23mos
Diet Diversity and minimum meal frequency	0.072
	(1.00, 0.317)
Age	-0.099
	(-1.66, 0.098)
Age squared	0.005
	(2.57, 0.010)
Gender of child (dummy female)	-0.002
	(-0.02, 0.983)
N	650

TABLE 19. Hemoglobin by diet diversity and minimum meal frequency status

In cells: mean Hgb (n)

	Inadequate diet diversity	**Adequate diet diversity**	***Total***
Less than minimum meal frequency	10.2 (116)	11.0 (18)	*10.3* *(134)*
Minimum meal frequency	10.3 (328)	10.4 (188)	*10.4* *(516)*
Total	10.3 (444)	10.5 (206)	10.3 (650)

DISCUSSION

In Nepal, good IYCF practices have positive effects on child growth, particularly weight-for-age. Diet diversity and minimum meal frequency are positively associated with WAZ among children 6-23 months of age, and among those ages 6-11 months; the effect is greatest when both adequate diversity and meal frequency are present. Diets that are adequately diverse and provided with at least recommended frequency also have positive effects on HAZ among children ages 6-23 and 6-11 months. As with WAZ, the combination of both indicators had a greater effect on HAZ when either diversity or frequency alone was adequate (Tables 11-14).

It follows that minimum acceptable diet is positively associated with both WAZ and HAZ of children in the same age ranges as those for diet diversity and minimum meal frequency. The coefficient sizes for minimum acceptable diet are similar to those for the index combining diversity and frequency (and larger than that of either diversity or meal frequency); thus further suggesting the importance of both adequate diversity and frequency in children's diets (Tables 12, 14). It would probably be reasonable to suggest that behavior change interventions should focus particularly on these two features of IYCF, for all ages from 6-23 months.

Adequate diet diversity and minimum meal frequency were most strongly, positively associated with weight-for-age and height-for-age for children ages 6-11 months. The coefficients using either the calculated index or minimum acceptable diet were largest for this age range; approximately 0.4 for WAZ and 0.5 for HAZ (Tables 11, 13). These findings reinforce the importance of sound IYCF practices early in infancy. This is not to say that good IYCF practices are not important at one year of age and later, rather that counseling should begin early, during the critical period of weaning from breastfeeding and introduction of foods.

Minimum diet diversity and meal frequency were positively associated with WHZ for children 6-23 months of age, though concentrated in those 18-23 months of age (Table 15). Further work is needed to better understand factors associated with wasting among children in Nepal due to the high prevalence.

Mean hemoglobin is low (and anemia prevalence high) among children 6-23 months of age, particularly among those in the youngest age range of 6-11 months. Child diet was not associated with hemoglobin. This may suggest poor iron stores, likely associated with poor iron stores of the mother during pregnancy and period of breastfeeding, which has important implications for maternal nutrition assessment and intervention. Interventions should start with addressing maternal anemia, as children are clearly born with very low iron stores. In the interim, measures for directly addressing infant and child anemia are needed.

Though not the focus of this study, the importance of good maternal nutritional status in improving child growth was found repeatedly in these analyses. Maternal BMI and height were significantly, positively associated with WAZ, WHZ (BMI) and HAZ (height) among children in almost every age range investigated (Tables 11, 13, 15). The coefficient for BMI was 0.083 for WAZ and 0.094 for WHZ (children 6-23 months), both of which were highly significant ($p < 0.001$). These findings suggest that improvement in maternal nutritional status is vital to improving child growth; thus mothers should be a focus and appropriate interventions should be examined (e.g. counseling, supplementation, etc.). The coefficient for height was 0.046 for HAZ ($p < 0.001$) for children ages 6-23months. Since height is a long-term measure of nutritional status, this reflects the intergenerational effect of short (i.e.

undernourished) mothers giving birth to children with low height-for-age. Again, the importance of improving maternal nutrition is reflected here, as only then will height-for-age be improved moving forward.

Infant and young child feeding practices were found to have positive effects while controlling for the strong relationship between maternal and child nutritional status, thus demonstrating the potential for good practices to further improve child growth.

Exploration of IYCF practices among sub-groups of the population by geographic location and ethnic group/caste revealed significant differences in prevalence of those following recommended practices. For potential targeting of interventions to improve IYCF practices (and thus, child growth) by geographic location, priority should be given to the Terai ecological zone, where children had the least diet diversity, minimum meal frequency, minimum acceptability and early initiation of breastfeeding. The Central region should also be considered for priority targeting for the same reasons. Targeting by ethnic group/caste should be prioritized for the Madhesi group, which exhibited the poorest IYCF practices considered here; this confirms the recommendation for targeting the Terai as the majority of Madhesi people dwell there.

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