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Research Article

Dietary Diversity May Play A Mediatory Role on the Association between Household Food Insecurity and Nutritional Status among Children Aged 24-59 Months

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Abstract

Background: Consuming scarce and poorly diversified diet, along with inadequate breastfeeding, contribute seriously to the complete scope of child undernutrition like stunting, wasting, underweight and micronutrient deficiency.
Objective: To determine the association between dietary diversity score (DDS) and nutritional status among children aged 24 to 59 months in Haromaya district, Ethiopia.
Methods: Children aged 24-59 months (N= 453) were enrolled in this cross-sectional study with a representative sample of households selected by a multistage sampling procedure in Haromaya district. Anthropometry and 24hr dietary recall were administered. Multinomial logistic regression models were applied to select variables that are candidate for multivariable model. Structural equation modeling was applied to test the mediatory effect of DDS on the relationship between household food insecurity (HFI) and child nutritional status.
Results: The mean DDS was 3.62 (SD 1.09), and 50% of the children indicated poor and average DDS with only 20% children in very good DDS. By logistic regression analysis and after adjusting for the confounding factors, poor DDS was highly significant predictor of wasting, stunting and underweight (AOR = 4.09, C.I = 1.31 - 12.76, p = .01), (AOR = 2.28, C.I = 1.11 - 4.69, p = .03) and (AOR = 2.48, C.I = 1.17 - 5.24, p = .02) respectively. HFI had a significant direct effect on wasting though no significant indirect effect on wasting through mediation variable, DDS, ($\beta 1$ reduced from 0.06 (S.E. = 0.027, $p < .05$) to 0.05 (S.E. = 0.028, $p > .05$).
Conclusion: Poor DDS was a predictor of wasting, stunting and underweight. Additionally, DDS had a role in the association between HFI and nutritional status.

Key Words: dietary diversity; undernutrition; child; preschool; ethiopia

Introduction

Developing countries contribute the greatest share for chronically undernourished people, especially in the sub-Saharan Africa, where 23.8% people remain undernourished which is the highest prevalence of any region in the world [1]. Result from recent DHS survey in Ethiopia portrayed high malnutrition levels for children under five years. The Survey revealed that the prevalence of stunting was 40.1% [2]. Moreover, analysis of the survey data on infant and young child feeding practices in Ethiopia showed that only 4% of youngest children aged 6-23 months are fed in accordance with IYCF practices, and 5% of children were fed according to minimum standards with respect to food diversity (four or more food groups). Furthermore, 47.9% of the children were fed at least the minimum number of times on the previous day [3].

Children are the most vulnerable to the long-term damage resulting from undernutrition between conception and their second birthday. The aftermath of under-nutrition is growth failure, weak immunity, intellectual underdevelopment and thus death results. This is caused by insufficient dietary intake, ill-health or both. These two factors interact to worsen malnutrition in a child [4]. Moreover, each of these is strongly affected by poverty [5]. It is hypothesized that higher dietary diversity score can improve the nutritional status of children, suggesting that diversity may indeed reflect higher dietary quality and greater likelihood of meeting daily energy and nutrient requirements. Furthermore, it is hypothesized that DDS can play a mediating role in the association between HFI and child undernutrition.

In the past several studies examined the association between nutritional status and dietary intake of children. For instance, the study conducted in Ghana presented that child nutritional status improved with increased DDS and resulting that children in low DDS associated with underweight, stunting and wasting [6]. Similarly, the study conducted in Iran and India showed that children with low DDS were underweight [7]. Besides, a study conducted in South African children showed there was a strong relationship between DDS, and stunting and underweight [8]. Similarly, other studies conducted in Bangladesh, Senegal, Kenya, Vietnam, and Ethiopia, as well as analysis of 11 countries demographic and health surveys, revealed that DDS had significant correlations with stunting and underweight [9-13].

However, in a study conducted in rural Bangladesh, even though a positive association was observed between DDS and wasting in children aged 12 – 23 months, there was a negative association observed in children aged 6 – 11 months [14]. Furthermore, studies conducted in Senegal, Democratic Congo and Burundi presented poor association noticed between DDS and stunting, underweight nor wasting [15,16]. In a recent study conducted in Tobago findings indicated that DDS and Food variety score were not significantly associated with any of the nutritional indices [17]. Likewise, in a study conducted in Ethiopia displayed, there was no relationship between DDS and stunting among children aged 6 - 23 months [18].

Nevertheless, the investigation on this issue has been limited and scant in Ethiopia, even though Ethiopia is known to be among countries with very high prevalence of child undernutrition. Moreover, Ethiopia is one of the countries with limited data about the association between DDS and child nutritional status among the few studies that have been done in Haromaya district. Though, such data are crucial in providing valuable evidence and information on the status of child dietary practices and its' association with child nutritional status in the study area. In addition, this result can identify areas of intervention to alleviate child malnutrition in general, and child dietary practices, in particular. Therefore, this study was initiated with the aim to explore the relationship between DDS and preschool child nutritional status and to explore the mediatory role of DDS in the relationship between HFI and child nutritional status in Haromaya district, East Hararghe Zone, Ethiopia.

Materials and Methods

Study Design:

This study was conducted in Haromaya district of the Eastern Hararghe Zone, Oromia Regional State of Ethiopia. Data for this study was collected from a community based cross-sectional survey designed to test the association between DDS and nutritional status among children aged 24-59 months in Haromaya district from July to September 2015.

The participants of this study were mothers or care takers and child with the following inclusion criteria: mothers or care takers of children who had children aged 24 – 59 months, and accepted to participate in the study. Mothers or caretakers of children who had permanent resident (more than 6 months) in the study area.

Sample Size and Sampling Procedure

The sample size was determined based on previously published Ethiopian Demographic Health Survey report (EDHS), the prevalence of stunted children aged under five years in Oromiya region was 37.5 percent [2]. Therefore, 37.5 percent was used in the sample size calculation using the formula for estimation of single proportion; the sample was multiplied by a design effect of 1.25, and a non-response rate of 20%, giving the sample size of 453**.**

A multistage sampling procedure was employed to select the required households (n=453). In the first stage six kebeles (Kebele is the smallest administrative unit of Ethiopia similar to a ward, a neighborhood or a localized and delimited group of people) were selected from a total of 33 rural kebeles by using a random sampling technique. In the secondstage, thirty villages were randomly selected with a probability proportional to their population from the six kebeles, based on data from Haromaya district health office. Within each village, households were selected by a systematic random sampling from the list of all the heads of households currently living in the village. Our sampling interval was 1,700 (i.e. cumulative population divided by number of sites). Then, choice of starting point from the households' list was carried out by a random system. If the selected household had more than one child aged 24 to 59 months, only the youngest child was included in the survey to avoid intra-household correlation in our data.

Data Collection Procedures

Data was collected by three field teams which have three persons per team through a structured coded questionnaire. All data collectors were trained for two days on the study instruments and participated in one round of field testing before the actual work commenced. The performance of the field staffs during data collection was supervised and monitored by principal investigator.

The mother of the child or other caretaker was requested to give information about socio-demographic characteristics, socio-economic status (adapted from EDHS), 24 hour dietary recall and food insecurity questions. Of the 453 children eligible for the sample household questionnaire, 453 mothers completed the interviews (response rate among sample households = 100%).

Household food security

Household food insecurity was measured by using the validated Household Food Insecurity Access Scale (HFIAS) for Ethiopia [19, 20]. The mothers were asked nine questions related to the household's practice of food insecurity in the last 30 days earlier the survey.

Anthropometric measurements

Children's height, weight, MUAC and Triceps skinfold were measured by following standard recommended procedures [21]. Weights of the children were measured by using weighing scales that were precise to 100 gram. Locally manufactured collapsible length/height boards, which were precise to 1 mm were used to measure standing height of children aged greater than or equal to 24 months. Mid Upper Arm Circumference (MUAC) was measured using non-stretchable tape on left mid upper arm to the nearest 1 mm. It was diagnosed if a bilateral depression (pitting) remained after the pressure is released. The triceps skinfold thickness were measured to the nearest millimeter with Lange skinfold caliper (Cambridge Scientific Industries, Inc, Cambridge, MD).

The nutritional status indicators, weight-for-length, weight-for-age, height-for-age, arm circumference-for-age, triceps skinfold-for-age, and Body Mass Index for age were compared with reference data from World Health Organization standards [22]. To assure data quality, at the end of each day the data collected was checked by the supervisor using ENA SMART software (ENA version 2011).

The World Health Organization's (WHO) Anthro Plus software (version 3.2.2, 2011) was used to calculate and analyze the nutritional status of the children. Six indicators were measured by this software: weight-for-height (WHZ), weight-for-age (WAZ), height-for-age (HAZ), mid upper arm circumference-for-age (MUACZ), triceps skinfold-for-age (TSZ), and Body Mass Index-for-age (BAZ). The indicators were calculated by standard deviation (SD) or Z-score for all children. Weight for age, height for age, weight for height, arm circumference-for-age and triceps skinfold-for-age less than -3SD is classified as severely underweight, severely stunted and severely wasted, respectively. Weight for age, height for age, weight for height, arm circumference-for-age and triceps skinfold-for-age between -3SD to -2SD is classified as moderately underweight, moderately stunted and moderately wasted, respectively. Children with Weight for age, height for age, weight for height, mid arm circumference-for-age, body mass index for age or triceps skinfold-for- age between -2SD to + 2SD were classified as normal weight, normal height, normal skinfold and normal Body Mass Index, respectively. Weigh-for-age, height-for-age, weight-for-height and body mass index- for-age more than +2SD are indicative of overweight, tall stature and obesity, respectively.

Dietary diversity score

(DDS) and Food Variety Score (FVS) were assessed by 24 hour dietary recall. The diet was classified according to nine food groups as recommended by FAO [23], which included: (1) Starchy staples; (2) Dark green leafy vegetables; (3) Other vitamin A rich fruits and vegetables; (4) Other fruits and vegetables; (5) Organ meat; (6) Meat and fish; (7) Eggs; (8) Legumes, nuts and seeds; and (9) Milk and milk products. Other remaining items such as salt, tea, sugar, vegetable oil and sweets were not included in DDS and FVS calculations.

The FVS is defined as the number of food items consumed over a 24 h period, from a possible total of 41 items .The possible total (n = 41) reflects all the different types of food items eaten by this sample of children, food from Starchy staples (11), Dark green leafy vegetables (2), Other vitamin A rich fruits and vegetables (7), Other fruits and vegetables (7), Meat and fish (3), Eggs (1), Legumes, nuts and seeds (7), and Milk and milk products (3). Food groups in the dietary diversity questionnaire were combined into a single food group to create the DDS. The potential score range is 0-9 for DDS.

Dietary diversity scores were computed from the quantitative dietary assessment. Mean dietary score for each child over the period was computed and divided into quartiles based on the distribution within the sample. Individuals with scores below the 25th quartiles were classified to have poor DDS; those between 25th and 50th quartile as having average DDS; 50th to 75th quartile as having good DDS and those above 75th quartile as of very good DDS.

Statistical Analyses

Statistical analysis was conducted with SPSS 18 software (SPSS Ltd, Quarry bay, Hong Kong, PASW-statistics 18). Descriptive characteristics of variables were assessed by means, frequencies and proportions. Chi square test was used to test the relationship between DDS and nutritional status in normal and undernourished. Then Multinomial logistic regression models were applied to select variables that are candidate for multivariable model. The variables that were significantly associated with the nutritional indices of the child (HAZ, WAZ, WHZ, BAZ, MUACZ and TSZ) on the bivariate analysis were used in the multivariable ordinal logistic regression model to identify their independent effect. The anthropometric results were also presented as proportions and the output of the logistic regression as adjusted odds ratios (AOR) with 95% confidence intervals (C.I). Associations were considered as statistically significant at p-values less than 0.05 ($p<0.05$).

We examined the mediating effect of child DDS in the association between HFI and child under nutrition using structural equation modeling (SEM). First, we evaluate the direct effect of HFI on the nutritional status, then after determining β value, we included the mediating variable, child DDS, into the model. Then, based on the finding of the difference on β values and the significant level, mediation effect was determined.

Ethical Consideration

The study had Ethical approval from both institutions; Tehran University of Medical Sciences (TUMS) research ethical review board (Ethical Approval code: 9313421008-145687), and Oromiya regional health office (Ethiopia) research and ethical review Committee (Ref. No.: BEFO/AHBTH1/1-8/3834). Both oral and written informed consent were obtained from each study participants after thoroughly describing the objective of the study and benefits of the study.

Results

Basic Characteristics of the Study Patricipants

The mean age, height, weight, MUAC and Triceps skin fold of the study participants was 34.87 (SD 9.17) months, 85.16 (SD 8.79) cm, 11.90 (SD 2.26) kg, 13.78 (SD 1.27) cm and 8.18 (SD 2.11) mm, respectively (Table 1).

Variables	N (%)	Mean (SD)
Sex of Household Head		
Male	422 (93.2)	
Female	31 (6.8)	
Mothers Age in year		32.12 (6.21)
< 20 years	14(3.1)	
20-24	30(6.6)	
25-29	110(24.3)	
30-34	112(24.7)	
>=35	186(41.1)	
Mother current marital status		
Married	419 (92.5)	
Separated	22 (4.9)	
Widowed	12 (2.6)	
Mother Educational Status		
None	386 (85.2)	

Primary & Secondary (Grade 1-12)	67 (14.8)	
Size of the family in the household		6.36 (2.22)
<5	174 (38.4)	
5-8	206 (45.5)	
>8	73 (16.1)	
Child Sex		
Male	221 (48.8)	
Female	232 (51.2)	
Child Age in month		34.87 (9.17)
24-35	195(43)	
36-47	174(38.4)	
48-59	84(18.5)	
Household SES		
Lowest	207(45.7)	
Middle	163(36)	
Highest	83(18.3)	

Note. SD: Standard Deviation

Table 1: Basic characteristics of study participants (n=453), Haromaya, 2015

Dietary Diversity Score

In the 24 hours earlier the survey, majority of the children had consumed food items from three or less food groups indicating low DDS. The mean DDS of this study was 3.62 (SD 1.09) and 13% of the children showed poor dietary diversity score with only 20 percent having consumed very good dietary diversity score (Figure 1).

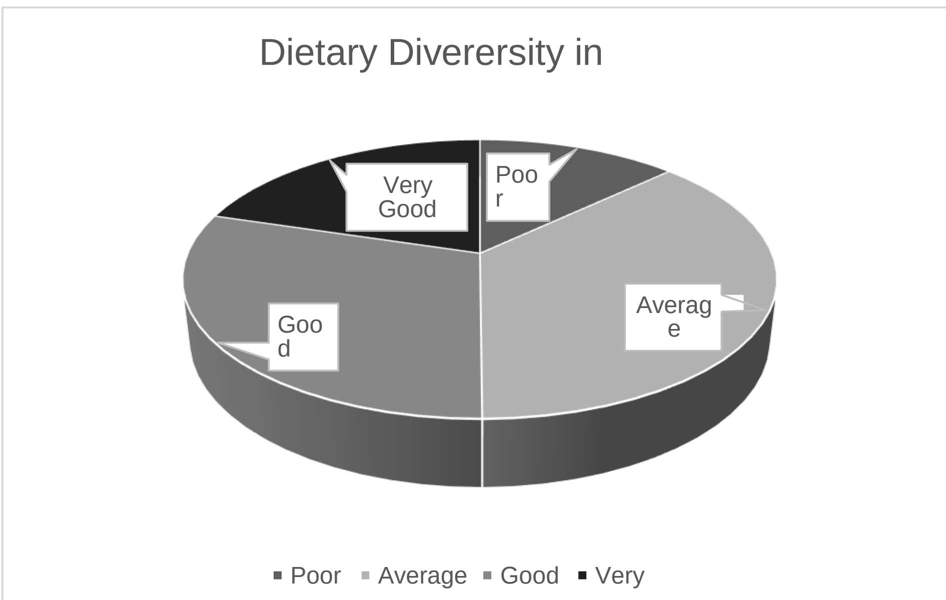


Figure 1. Dietary Diversity Score of children 24-59 months in Haromaya, 2015

Food Variety Score

Among the food groups consumed by the children, the top three highest consumptions were starchy staples (100 percent), Nuts and seeds (93.6 percent), and other fruits and vegetable groups (83.7 percent) (Figure 2).

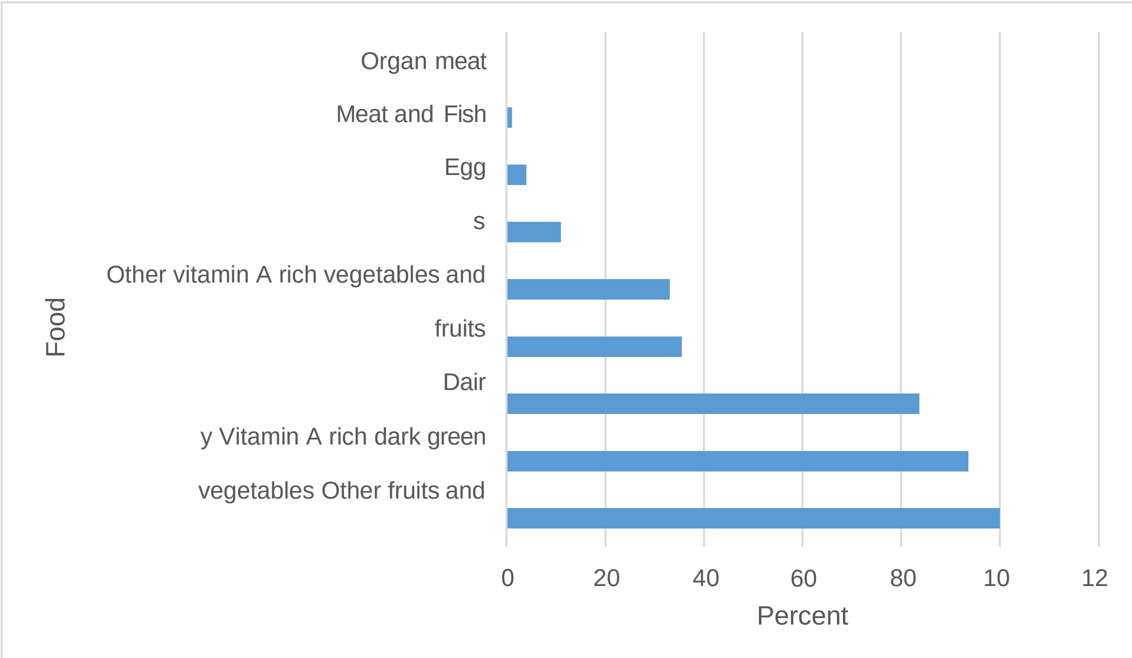


Figure 2: Percent of Food Groups consumed by children aged 24-59 months as per the 24 hours recall in Haromaya, 2015

The findings from this study showed that the mean FVS was 5.34 (SD 1.77) with ranging from 1 to 14 food item consumed within the 24 hour preceding the survey. Around 60 percent of children were consume five and less food item per a day.

The survey report showed that high prevalence of stunting and underweight was observed in children having average DDS (38.9%, both). The result also revealed that the prevalence of wasting was high in good DDS children (35 %). However, the proportion of stunting, wasting and underweight was low in children scored very good DDS (18.4 %, 12.5 % and 54.9 %, respectively).

Association between Dietary Diversity Score and Nutritional Indicators

A chi-square test of independence was executed to examine the association between dietary diversity score and child nutritional status. Accordingly, the relation between poor DDS and wasting (WHZ) was significant, $\chi2$ (df = 3, N = 453) = 10.45, p = 0.01. Children who have average to very good DDS were less likely to develop wasting than were poorly DDS children (Table 2). Moreover, there was a significant association between Body mass index for age z-score (BAZ) and poor DDS, $\chi2$ (df = 3, N = 453) = 8.03, p = 0.04 (Table 2).

Variable	**WHZ [n (%)]**			**WAZ [n (%)]**			**BAZ [n (%)]**		
	Normal	Undernourished (<-2SD)	*p*	Normal	Undernourished (<-2SD)	*p*	Normal	Undernourished (<-2SD)	*p*
Dietary Diversity Score			**.01**			**.02**			**0.04**
Poor DDS	48(81.4)	11(18.6)		34(59.6)	23(40.4)		48(84.2)	9(15.8)	
Average DDS	157(94)	10(6)		116(72.5)	44(27.5)		151(94.4)	9(5.6)	
Good DDS	121(89.6)	14(10.4)		107(81.1)	25(18.9)		119(90.2)	13(9.8)	
Very Good DDS	87(94.6)	5(5.4)		68(76.4)	21(23.6)		85(95.5)	4(4.5)	
Sex of Household Head			.50[a]			.06			.06[a]
Male	386 (91.5)	36 (8.5)		300(73.2)	110(26.8)		380 (92.7)	30 (7.3)	
Female	27 (87.1)	4 (12.9)		25(89.3)	3(10.7)		23 (82.1)	5 17.9)	
Age of Mother (Year)			.63			.22			.22

< 20	12 (85.7)	2 (14.3)		8 (61.5)	5 (38.5)		10 (76.9)	3 (23.1)	
20-24	26 (86.7)	4 (13.3)		18 (60.0)	12 (40.0)		26 (86.7)	4 (13.3)	
25-29	101 (91.8)	9 (8.2)		82 (76.6)	25 (23.4)		99 (92.5)	8 (7.5)	
30-34	100 (89.3)	12 (10.7)		77 (72.0)	30 (28.0)		99 (92.5)	8 (7.5)	
>=35	173 (93.0)	13 (7.0)		139 (77.2)	41 (22.8)		168 (93.3)	12 (6.7)	
Maternal Marital Status			.76[a]			**.03**			.09[a]
Married	383(91.4)	36 (8.6)		297(73)	110(27)		377 (92.6)	30 (7.4)	
Separated/Widowed/Others	30 (88.2)	4 (11.8)		28(90.3)	3(9.7)		26 (83.9)	5 (16.1)	
Maternal Educational Status			.67			.22			.53
None	351 (90.9)	35 (9.1)		272 (73.1)	100 (26.9)		341 (91.7)	31 (8.3)	
Primary/Secondary/More	62 (92.5)	5 (7.5)		53 (80.3)	13 (19.7)		62 (93.9)	4 (6.1)	
Child Age (Months)			.26			.98			.50
24-35	178 (91.3)	17 (8.7)		140 (74.5)	48 (25.5)		173 (92.0)	15 (8.0)	
36-47	162(93.1)	12 (6.9)		123 (73.7)	44 (26.3)		156 (93.4)	11 (6.6)	
48-59	73 (86.9)	11 (13.1)		62 (74.7)	21 (25.3)		74 (89.2)	9 (10.8)	
Child Sex			.07			**.02**			.15
Male	196 (88.7)	25 (11.3)		147 (69.3)	65 (30.7)		191 (90.1)	21 (9.9)	
Female	217 (93.5)	15 (6.5)		178 (78.8)	48 (21.2)		212 (93.8)	14 (6.2)	
Size of the Family			.56			**.05**			.41
<5	156 (89.7)	18 (10.3)		116(67.8)	55(32.2)		155 (90.6)	16 (9.4)	
5-8	191 (92.7)	15 (7.3)		153(77.7)	44(22.3)		185 (93.9)	12 (6.1)	
>8	66 (90.4)	7 (9.6)		56(80)	14(20)		63 (90.0)	7 (10.0)	

Note. a Fisher's Exact Test

Table 2: Distribution of WHZ, WAZ & BAZ by DDS in 24-59 months aged children in Haromaya district, 2015

WHZ: weight for height z-score, DDS: Dietary Diversity Score
Boldface: $p < .05$ (chi-square test [$\chi 2$])

On the other hand, underweight (WAZ) was significantly associated with poor DDS, $\chi 2$ (df = 3, N = 453) = 10.02, p = 0.02 (Table 1). Likewise, no significant relationship was found between DDS and stunting (HAZ), $\chi 2$ (df = 3, N = 453) = 5.02, p =0.17 (data not presented).

A logistic regression was conducted to determine the relationship between the main independent variables, dietary diversity score, as well other confounding factors (Sex of household head, child age, child sex and size of the family) with nutritional status of the child. Poor DDS was significantly associated with wasting and underweight (p = 0.02, both).

After adjusting for all hypothesized confounding factors, the pooled analysis revealed that child in poor DDS were four times more likely than child in very good DDS to be wasted and two times to be stunted and underweight than child in very good DDS. Therefore, poor DDS was a highly significant predictor of wasting, stunting, underweight and chronic energy deficient (AOR=4.09, C.I=1.31-12.76), (AOR=2.28, C.I=1.11-4.69), (AOR=2.48, C.I=1.17-5.24) and (AOR=4.09, C.I=1.16-14.34) respectively. (Table 3).

		Crudes OR			Adjusted OR			
	Variable	B (S.E)	Odds Ratio (95% C.I)	*P*		B (S.E)	Odds Ratio (95% C.I)	*P*
WHZ	DDS							
	Poor	1.38 (0.57)*	3.99 (1.31-2.15)	**.01**		1.41 (0.58)*	**4.09 (1.31-12.76)**	**.01**
	Average	0.10 (0.56)	1.11 (0.37-3.35)	.85		-0.01 (0.57)	0.99 (0.32-3.04)	.99
	Good	0.70 (0.54)	2.01 (0.69-5.79)	.19		0.73 (0.55)	2.07 (0.71-6.04)	.18
HAZ	DDS							
	Poor	0.64 (0.36)	1.90 (0.95-3.82)	.07		0.82 (0.37)*	**2.28 (1.11-4.69)**	**.03**
	Average	0.39 (0.27)	1.48 (0.88-2.50)	.14		0.40 (0.27)	1.49 (0.88-2.54)	.14
	Good	0.08 (0.27)	1.08 (0.63-1.85)	.76		0.13 (0.28)	1.15 (0.66-1.98)	.62
WAZ	DDS							
	Poor	0.78 (0.37)*	2.19 (1.06-4.50)	**.03**		0.91 (0.38)*	**2.48 (1.17-5.24)**	**.02**
	Average	0.21 (0.31)	1.23 (0.67-2.24)	.50		0.14 (0.31)	1.15 (0.62-2.13)	.65
	Good	-0.28 (0.33)	0.76 (0.39-1.46)	.40		-0.24 (0.34)	0.78 (0.40-1.53)	.47
BAZ	DDS							
	Poor	1.38 (0.66)*	3.98 (1.16-3.63)	**.03**		1.40 (0.64)*	**4.09 (1.16-14.34)**	**.03**
	Average	0.24 (0.62)	1.27 (0.38-4.24)	.70		0.19 (0.62)	1.21 (0.35-4.09)	.76
	Good	0.84 (0.59)	2.32 (0.73-7.37)	.15		0.87 (0.59)	2.38 (0.74-7.65)	.14

Note. Boldface: *p* < .05

Table 3: Logistic Regression predicting likelihood of reporting Under-nutrition

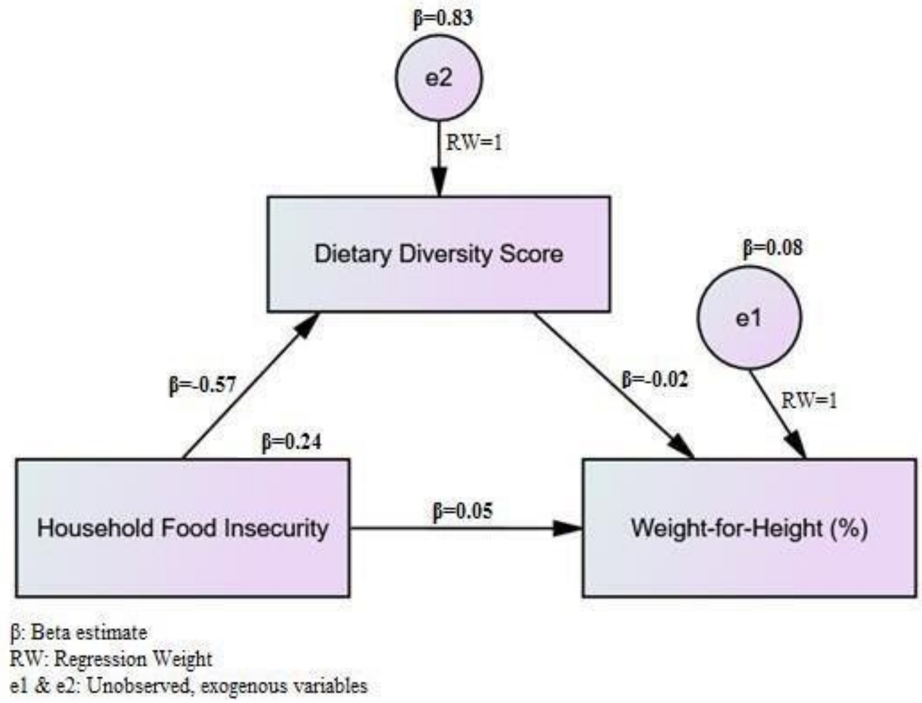
HFIA: Household Food Insecurity Access, DDS: Dietary Diversity Score

WHZ: weight for height z-score, HAZ: Height for Age z-score, WAZ: weight for Age z-score, BAZ: Body Mass Index for Age z-score, MUACZ: Mid Upper Arm Circumference for Age z-score, TSZ: Triceps Skinfold for Age z-score

Adjusted for: Sex of household head, child age, child sex and size of the family

Mediatory Effect of Dietary Diversity

The result of structural equation model showed that before dietary diversity score enters the model, the direct effect of household food insecurity on wasting was, β estimate = 0.06 (S.E. = 0.027) and the result is significant ($p < 0.05$), but after the mediator (DDS) variable enters the model, it shows that β1 reduced from 0.06 (S.E. = 0.027) to 0.05 (S.E. = 0.028) and the result was not significant ($p > 0.05$). Therefore, household food insecurity had significant effect on dietary diversity score but dietary diversity score had no significant effect on wasting (WHZ), so the type of mediation was complete mediation, since the direct effect of household food insecurity on wasting was not significant after DDS enters the model even though, β1 was reduced. Thus, we can conclude that HFI had significant direct effect on wasting though no significant indirect effect on wasting through mediation variable, DDS (Figure 3).



GFI=0.938 & AGFI=0.875; GFI & AGFI value close to 1 indicates the model proper goodness of fit.

Figure 3: Mediatory effect of DDS on the relation between HFI and WHZ

Similarly, the same result was obtained after the mediatory variable (DDS) enters the model of HFI and MUACZ (data not presented).

On the other hand, partial mediation was observed on the association between HFI and BAZ while DDS was entered into the model, β1 reduced from 0.063 (S.E. = 0.026) to 0.056 (S.E. = 0.027) and the p-value was similar and significant before and after the mediatory, and also HFI had significant effect on DDS, however DDS had no significant effect on BAZ. Thus, these showed that DDS had played a partial mediation (data not presented). However, the result for the other nutritional indices (HAZ, WAZ and TSZ) showed that the direct effect of HFI on these nutritional indices was not significant ($p > 0.05$).

Discussion

It was hypothesized that dietary diversity score had significant effect on the nutritional status of children. This result clearly showed DDS is associated with WHZ, WAZ, HAZ and BAZ after adjusting for the confounding factors (Sex of household head, child age, child sex and size of the family). On the other hand, DDS was hypothesized to have mediatory effect on the relation between HFI and child nutritional status. Importantly, these findings demonstrated that DDS had a complete mediatory effect on the association between HFI and wasting.

Child dietary diversity score reflects how different kinds of foods usually consumed by the child. On average, 83.7 percent of the children included in this study consumed 3 or less food groups the earlier day to the study. Even though, there is no exact recommendations concerning the ideal number of foods or food groups that a preschool age child should eat [24], there is an agreement that higher or very good dietary diversity score is needed and that a greater number of food groups can help meet daily requirements for a variety of nutrients [25] The result of this study showed that children with poor DDS were found to be 13% which is similar with studies conducted in other part of Ethiopia (10.8 percent) and Burkina Faso (12.9 percent) [14,26], but lower with study conducted in Bangladesh (32 percent) [10].

Moreover, the mean DDS of our study was 3.62 which is similar to South Africa and Egypt (3.6, both) [8,27], but lower than the study conducted in Ghana (4.6) [6]. Furthermore, this result showed that DDS varies with age of children, pointing the prevalence of poor DDS high in age group of 24-35 months. These might be due to different feeding practice with a custom of cooking limited varieties of food for the family, absence of adequate knowledge about nutritional requirements for children, limited household food availability, and low purchasing ability for food as well as increment on price of consumable goods in Ethiopia.

Association between Dietary Diversity Score and Nutritional Status

The analysis showed that poor dietary diversity score was a predicator of the three nutritional indices (stunting, wasting and underweight), in which children in poor DDS were four times more likely than children in very good DDS to be wasted and two times to be stunted and underweight than children in very good DDS, after controlling for all hypothesized confounding factors. In line with our findings, several studies have shown that dietary diversity score is positively related with stunting, wasting and underweight [8,9,28-31]. Likewise, it was hypothesized that higher DDS is associated with improved nutritional status, our result was also demonstrated this too, thus we accept the hypothesis.

Association between Household Food Insecurity, Dietary Diversity and Nutritional Status

It was hypothesized that DDS have a mediatory role on the relationship between household food insecurity and child nutritional status. Previous studies conducted in Ethiopia and Vietnam reported that, Dietary diversity score had mediatory effect on the relationship between food security and nutritional status in Vietnam, however a smaller effect appeared in Ethiopia [32]. Contradictory, studies conducted in Bangladesh, Ethiopia and Vietnam reported that Child DDS did not mediate the association between HFI and undernutrition [33]. However, in the present study DDS had a complete mediatory effect on the relation between HFI and wasting. Accordingly, we accepted the hypothesis that DDS have a mediatory role on the relationship between HFI and child nutritional status, only wasting.

The major strengths of the current study include the availability of information on potential confounders and mediators. In addition, this is the first study to assess the mediatory role of DDS on the association between HFI and nutritional status among preschool children in Ethiopia, particularly, Haromaya district. However, this study has some limitations. First, as it was a cross-sectional study, we cannot prove any cause-effect relations between DDS and child nutritional status; some of the variables believed to affect nutritional status are not addressed by the present study. A prospective approach is needed to determine DDS as a cause of malnutrition. Second, in this study the target age group was children aged 24 -59 months, therefore the findings of this study are representative for only this age groups.

In conclusion, the present study provided that pre-school aged children lacked diversity of food, and that the intake of animal source foods was very low as well as inadequate intake of energy and essential nutrients. The result also revealed that poor DDS was a predictor of wasting, stunting, underweight and chronic energy deficient. Furthermore, this study highlights the role of DDS in the association between household food insecurity and nutritional status.

Considering these findings, it is crucial for the national strategies on nutrition interventions to bring about substantive and sustainable changes leading to improvement of the nutritional situation of the most vulnerable groups in the poorest households as well as those in the most affected areas. In designing nutrition interventions, some practical considerations should be kept in mind and it is important to translate the national food and nutrition strategies into practical achievable goals that meet the needs of the most vulnerable households, with a view to improve inappropriate child dietary practices through creating access to and promote utilization of diversified foods.

This information can be used by the health authorities and policy makers in the area to plan health and nutrition interventions, and to alleviate child malnutrition in the country in general, and child dietary practices, in Haromaya district in particular.

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Conflict of Interest

There are no competing financial interests in relation to current study.

Authorship

Ahmed Abdulahi wrote the proposal, contacted the authorities involved in the study, supervised the data collection in the fieldwork, data entry, data analysis and wrote the initial draft manuscript. Dr. Khadijeh Mirzaei, Dr. Ahmed Reza Dorosty and Dr. A Rahimiforoushani participated and advised in the design of the study. All the participated authors approved the final manuscripts after reviewing of the manuscripts.

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