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Dietary Patterns and Risk of Micronutrient Deficiencies: their Implication for Nutritional Intervention in Ethiopia

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Abstract

Background: Dietary patterns are the quantities, proportions, variety or combinations of different foods and beverages in diets, and the frequency with which they are habitually consumed. In Ethiopia, information on the dietary patterns and association of the proxies of dietary adequacy and quality with nutritional outcomes is scarce. The aims of this paper were to assess the interactions between dietary patterns, nutritional adequacy, nutritional quality and the risk of micronutrient deficiencies, and to highlight their implications in nutritional interventions.

Methods: A community based cross-sectional study was carried out in North Shewa zone of Amhara Regional State, central Ethiopia from December 2014 to February 2015. Multistage sampling techniques were employed to recruit participants and 640 subjects involved in the study. Data were collected using structured and seven-day recall questionnaires. Chi-Square test, Kruskal-Walis test, Spearman correlation, multiple linear and multinomial regression models were used for inferential analyses.

Results: The main dietary patterns included cereals, vegetables and legumes. Animal Source Foods (ASF) was consumed by 35.4% of participants. The median (range) of Food Variety Score (FVS) and Diet Diversity Score (DDS) were 16 (8-25) and 3.43 (1.14-5.57), respectively. About 28 % of subjects were malnourished. FVS had a positive correlation with DDS (r=0.502, $p<0.001$) and Body Mass Index (BMI) (r=0.145, $p<0.001$). DDS had also a positive correlation with BMI (r= 0.19, $p<0.001$). Family size and educational status were identified as determinant factors for FVS, but the later had a significant influence on DDS. The risks of vitamin A and iron deficiencies were 60.3% and 86.3%, respectively. The consumption of food groups rich in vitamin A and haem iron were significantly different across FVS and DDS ($p<0.05$).

Conclusions: Dietary inadequacy, poor nutritional quality and high risk of micronutrient deficiencies were identified. These underlined the implications of nutritional interventions in central Ethiopia.

Keywords: dietary patterns; micronutrients; FVS; DDS; BMI; Ethiopia

Abbreviations: ASF – Animal Source Foods; BMI – Body Mass Index; DDS – Diet Diversity Score; FVS – Food Variety Score; LL – Lower Limit; OR - Odds Ratio; UL – Upper Limit; UNICEF – United Nations Children's Fund; WHO – World Health Organization.

Background

Dietary patterns are the quantities, proportions, variety or combinations of different foods and beverages in diets, and the frequency with which they are habitually consumed. The dietary patterns' approach considers the inherent interactions between foods and nutrients in promoting either health or increasing disease risk [1]. Until quite recently, there has been extensive focus on the quantity of food produced and consumed in food security rhetoric and in policy and decision-making arenas and much less attention given to the nutritional quality of foods and diets [2].

Nutritional deficiencies are not only the result of inadequate food consumed, but also of poor dietary quality and diversity despite adequate calories in many cases [3]. The prevalence of diseases associated with a poor-quality diet is increasing in Ethiopia. Even though most people consume plant based foods, diets low in fruits and vegetables are found to be the most common risk factors contributing to a large portion of diet-related Non-Communicable Diseases (NCD) [4, 5, 6, 7]. In 2013, more than a third (35.1%) of all deaths in Ethiopia was caused by NCDs [7]. The emergence of NCDs imposes another burden on the country's health system while it is still striving to address infectious diseases and under nutrition.

Understanding the dietary patterns and evaluating their qualities are essential for nutritional intervention. The quality of diet can be assessed using a simple score of foods variety and dietary diversity [8]. Food variety is expressed as the number of biologically distinct foods eaten over a designated period. It minimizes the adverse consequences of food on health; and reduces the risk of NCDs [9]. It is usually quantified by the number of food items compared with the number of nutritious food groups known as dietary diversity [10, 11].

Assessing Food Variety Score (FVS) is a quick, simple and low-cost method of determining the nutritional adequacy of a diet. It is believed that a nutritionally adequate diet is best achieved by consuming a diverse range of foods [12]. Likewise, individual Diet Diversity Score (DDS) is a simple proxy measure of the nutritional quality of individual's diets, particularly that of micronutrient adequacy of a diet [13]. Both FVS and DDS reflect the quality of the diet. Scores of dietary diversities have been positively correlated with macro and micronutrient adequacy of the adolescents and adults [9, 14, 15]. Savy et, al. described the importance of studying the association between proxies of overall dietary quality and nutritional outcomes [8]. Workicho et, al. also highlighted the need of tracking dietary quality and progress in nutritional outcomes in a population to develop timely interventions [16].

Until recent time, very few studies have been conducted in Ethiopia in relation to balanced and diversified diets. Of these studies, none has attempted to point out the implication of dietary patterns and risks of micronutrient deficiencies on nutritional intervention. Therefore, the aims of the present study were:

• to assess the dietary patterns, nutritional adequacy and nutritional quality of the populations;

• to examine their relationship with nutritional status; and

• to describe the implications of the outcomes in nutritional interventions in Ethiopia.

Materials and Methods

Study Area and Subjects

This study was conducted as a community based cross-sectional study in North Shewa zone of Amhara Regional State, Central Ethiopia from December 2014 to February 2015. Based on the 2007 census, 928,694 men and 908,796 women with a total of 1,837,490 people inhabited in this area [17]. Multistage sampling techniques were used to recruit study subjects. First, all kebeles, which are the smallest administrative unit, were stratified into urban and rural settings. Second, four kebeles from urban and three kebeles from rural settings were selected by simple random sampling technique. Third, households were included from each kebele by systematic random sampling technique. The first household was selected by a lottery system and then, every third household was included in the study. Lastly, one study subject was randomly selected from each household.

The criteria to include study subjects were age above 18 years, living in the house for at least 6 months and willing to participate in the study. Subjects who were absent during the survey, disabled, seriously ill or had some difficulty of communication were excluded. Single population proportion formula was used to determine the sample size. Taking the assumptions of 50% dietary intake below average DDS with 95% confidence interval, 4% margin of error and 10% drop out rate, a sample size of 660 was obtained. However, we recruited 100 study subjects from each kebele with a total of 700 study subjects to participate in the study.

Data collection

The data were collected by seven health extension workers who have been graduated with diploma (2 to 3 years' college training) in nursing. Questionnaires which comprised of different parts were translated into Amharic, the local language. In the structured questionnaire, there were socio-demographic and anthropometric parts, whereas; in the dietary diversity questionnaire, the dietary intake assessment part was included. All interviewers were given one-day training on the content of the questionnaires and on the techniques, how to ask the list of ingredients for composite dishes and how to probe for meals and snacks not indicated in the list of 7-day recall. Before instigating the interview, each of them practiced on the questionnaire to alleviate ambiguity and minimize errors as much as possible.

Dietary Assessment

Seven-day recall of dietary intake was carried out on the study subjects. The dietary diversity questionnaire, which was adapted from the guidelines for measuring household and individual dietary diversity, was employed for face-to-face interview [12]. Each subject was asked to describe what he or she ate and/or drank for breakfast, snack, lunch, snack and dinner whether at home or outside the home for the past seven days. The interviews included a detailed description of foods consumed, the ingredients used, the cooking method, and brand names (for packed foods). The food items were subsequently transformed into food groups and their frequencies of consumption were computed and used for further analyses Table 1.

Food Variety Score (FVS)

FVS was measured using simple count of individual food items consumed during the seven days. Food variety checklist developed by Savige et, al. was used to score the food items [12]. Each type of food consumed is scored once over a week time. The maximum score would be 57. Quantities smaller than 1-2 tablespoons (except for fats and oils) do not represent a sufficient quantity to rate FVS. The results of FVS were categorized into five dietary adequacy groups: very poor (<10 FVS per week), poor (10-19 FVS per week), fair (20-24 FVS per week), good (25-30 FVS per week) and very good (>30 FVS per week) [12].

Diet diversity score

Individual DDS was calculated as the number of food groups consumed during the first day recall. These food groups were

Table 1: Food groups used for dietary diversity score*

Number	Food groups	Subgroups	Scores (if consumption is: yes=1, otherwise: no=0)
1	**Starchy staples**	Cereals, grains, white roots and tubers	1 or 0
2	**Dark green vegetables**	Locally available vitamin A rich vegetables such as kale, lettuce, spinach and wild forms such as samma (stinging nettle)	1 or 0
3	**Other vitamin A rich fruits and vegetables**	vitamin A rich fruits (mango), vegetables (carrot) and tubers (vitamin A blended sweet potatoes)	1 or 0
4	**Other fruits and vegetables**	Fruits: such as avocados, banana, dates, etc.	1 or 0
		Vegetables: such as cabbage, onion, garlic, green pepper, tomatoes, etc.	
5	**Organ meat**	Red organ meats such as liver, kidney, heart and any processed organ meats	1 or 0
6	**Meat and fish**	Beef, lamb, goat meat, chicken and fresh fish	1 or 0
7	**Eggs**	Chicken eggs, quail eggs	1 or 0
8	**Legumes, nuts and seeds**	Legumes/pulses: such as beans, peas, lentils, peanuts, etc.	1 or 0
		Seeds: such as oil seeds and pumpkin seeds	
9	**Milk and milk products**	Dairy products such as milk, butter, sour milk, butter milk, cheese and whey	1 or 0

*Adapted from the guidelines for measuring household and individual dietary diversity [13].

based on the guidelines for measuring household and individual dietary diversity Table 1. The score for individual diet diversity goes from 0 to 9 [13]. The percentages of the consumption of food groups rich in micronutrients such as vitamin A or iron were calculated using the food groups of DDS

Anthropometric Measurements

The weights of the subjects were measured while they were dressed in light clothes to the nearest of 100g. SECA personal weighing scale (used by UNICEF) was employed for measurement. The heights of the subjects were measured using tape meter fixed on the wall without shoes to the nearest of 0.1 cm. For the calculation of Body Mass Index (BMI), the weight of the subject (in kg) was divided by the height (in meter) squared of the subject. BMI was described as underweight (<18.50 kg/m^2), normal weight (18.50-24.99 kg/m^2), overweight (25-30 kg/m^2) and obese (>30 kg/m^2) [18].

Statistical Analysis

Statistical analysis was carried out using IBM SPSS version 23 statistical program. Continuous data were checked for normality using Kolmogorov-Smirnov test. When data were not normally distributed (p>0.05), nonparametric tests were used. In descriptive summaries, median (range) and percentages were used to present the data. Inferential statistics were also employed. The difference between proportions of categorical variables was examined by Chi-Square test. Kruskal-Wallis test was used to determine the differences between socio demographic variables on FVS, DDS and BMI.

Bivariate analyses were carried out to test the links between socio demographic variables and dietary scores. The socio demographic variables which were significantly linked to either dietary scores or BMI were selected as potential confounders ($P < 0.15$). Significant variables subsequently included into the multivariate analysis in order to better identify the collinearities between variables (P < 0.05). Multiple linear regression model was employed to differentiate the independent predictors of FVS and DDS after adjusting for confounding factors.

Spearman correlation was used to examine the association between FVS, DDS, BMI, age and average meal frequency. The relationships between the groups of FVS, DDS and BMI were analysed using a multinomial logistic regression model. Odds Ratio (OR) was used to report the strength of association between the proportions of vitamin A and haem iron rich foods consumption between urban and rural areas. Unless specified, p value < 0.05 was considered as statistically significant.

Results

Socio-demographic study

The study was undertaken in seven kebeles in urban and rural areas of North Shewa zone of Amhara Regional State, Central Ethiopia. A total of 700 participants were recruited. But, 640 were involved in the study with a response rate of 91.4%. The remaining 8.6% were excluded because of their refusal and absence during the study period. Table 2 presents the socio-demographic characteristics of the study participants. Most participants belonged to Amhara ethnic group (93.5%) and Orthodox Tewahido Christian (89.8%). The median age

Table 2: Socio demographic characteristics

Variables		Percent
Living place (n=640)	Urban	54.8
Gender (n=640)	Female	44.7
Age	Median: 35, Range (18, 76)	
Religion (n=616)[a]	Orthodox Tewahido	89.8
	Muslim	3.7
	Protestants	4.4
	Others	2.1
Ethnicity (n=631)[b]	Amhara	93.5
	Oromo	3.2
	Gurage	0.8
	Tigre	2.5
Occupations (n=613)[c]	Farmers	34.6
	Government Employees	21.7
	Non-Government Employees	3.9
	Private	25
	House wife	10.6
	Retired	0.8
	Students	3.4
Education (n=620)[d]	Illiterate	15
	Primary	37.9
	Secondary	17.9
	Tertiary	27.3
	Religious teaching	1.9
Marital Status (n=610)[e]	Single	23.1
	Married	68.7
	Divorced	5.4
	Widowed	2.8
Family size (n=640)	1 to 3	57.5
	4 to 6	37.2
	7 to 10	5.3

Missed participants: 24 (a), 9 (b), 27 (c), 20 (d) and 30 (e) was 35 years (range= 18 to 76 years). A little below half of the participants were females (44.7%), 54.8% were urban dwellers, 34.6% were farmers, 62.1% had at least primary education, 68.7% were married and 57.5% had 1 to 3 family size.

Dietary patterns

About 130 food items were identified in the study areas (See additional file 1). The main dietary patterns were included cereals, vegetables and legumes. Almost all subjects consumed starchy staples (99.7%) and about 58% consumed legumes cooked with oils and fats (99.2%) for the whole week Table 3. In every day meal, 95.6% consumed the food group of other fruits and vegetables Table 4. Dairy products (62.4%), dark green vegetables (49.69%), meat (37.9%) and, other vitamin A rich fruits and vegetables (30.35%) were consumed at least once in a week Table 4, 5. On the other hand, organ meat (2.6%) and fish (3.6%) were seldom consumed by the subjects. The food consumption patterns were significantly different between urban and rural areas (*P<0.05*).

Additional file 1: Food items identified in North Shewa, Ethiopia

Cereals and grains		Legumes/ pulses
Ambasha, circular flat bread dough	Kinche, boiled splitted barley served with butter	Ashuk, roasted and boiled faba bean
Anebabero, double injera covered with butter and chilli in the middle	Kinche, boiled splitted wheat served with butter	Bokolt, germinated faba bean
Atmit, very thin barley porridge	Kita, unleavened flat barley bread	Endushdush, soaked and roasted faba bean
Atmit, very thin wheat porridge	Kita, unleavened flat teff bread	Fool, pureed stewed faba bean
Besso, roasted and milled barleyflour served with butter	Kita, unleavened flat wheat bread	Nifro, boiled chickpea
Biscuit, homemade fried dough bread	Kolo, roasted and mixed barley, chickpea and pea	Nifro, boiled faba bean
Bonbolino, homemade fried dough bread containing sugar	Kolo, roasted and mixed wheat, chickpea and sunflower	Nifro, boiled faba bean and maize
Bread, wheat	Kolo, roasted barley	Nifro, boiled faba bean and wheat
Cake	Kolo, roasted chickpea	Shorba, lentil, carrot, and macaroni soup
Chechebisa, pieces of barley bread mixed with butter	Kolo, roasted pea	Shorba, lentil, pea and carrot soup
Chechebisa, pieces of wheat bread mixed with butter	Kolo, roasted wheat	Siljo, fermented faba bean, sunflower and mustard slurry
Cukis	Macaroni	Wot, beyeayinet -varieties of stews
Dabo-kolo, very small size roasted bread dough	Nifro, boiled wheat	Wot, faba bean, chili, onion and oil stew
Fetira, fried filo dough cooked with egg and covered with honey	Pizza	Wot, pea flour, onion, chili and oil stew
Firfir, pieces of barley injera with stew	Porridge, barley served with butter and chili	Wot, splitted lentil, chili, onion and oil stew
Firfir, pieces of bread with stew containing butter	Porridge, wheat served with butter and chili	Wot, splitted pea, onion, chili and oil stew
Firfir, pieces of teff injera with stew containing beef	Sambusa	Wot, splitted pea, onion, oil and turmeric stew
Firfir, pieces of teff injera with stew containing butter	Sandwich, sliced bread with fried egg in the middle	Wot, tegabino - pea flour, onion, chili, garlic and oil stew
Firfir, pieces of teff injera with stew containing dried beef	Spaghetti, pasta	Wot, whole lentil, onion and oil stew
Fitfit, pieces of teff injera mixed with beef broth	Steamed rice	
Fitfit, pieces of teff injera mixed with pea flour, onion and oil sauce	Tirosho, flat barley bread dough covered with butter	

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Fitfit, pieces of teff injera mixed with sunflower sauce	Tirosho, flat wheat bread dough covered with butter	
Injera, barley		
Injera, teff		
Injera, wild oat		
Vegetables and tubers	Meat	Sugar / Confectionary
Atkilt, mixed vegetables and fruits	Beef with steamed rice	Sugar
Bula - false banana porridge served with butter	Dulet, semi roasted organ meat (sheep and goat) with butter	Honey
Ethiopian kale	Kikil, boiled beef	Sugar cane
Fried potatoes	Kikil, boiled egg	**Salts and spices**
Kariya, green pepper	Kikil, boiled goat meet	Salt
Kariya, sinig - green pepper stuffed with onion and oil	Kikil, boiled mutton	Bird’s eye chili
Kikil, boiled potatoes	Kitfo, raw or sautéed minced beef mixed with chili and clarified spicy butter	Bishop’s weed
Kikil, boiled sugar beet	Milas na senber, roasted cow tongue and rumen	Black cumin
Lettuce with onion, oil and aceto vinegar	Raw beef	Cardamom
Raw tomatoes with onion, green peppers and oil	Roasted beef	Cinnamon
Samma, Stinging nettle	Roasted goat meat	Cloves
Shorba, vegetables soup	Roasted mutton	Coriander seeds
Sils, roasted tomatoes with onion, oil and green pepper	Shoriba, beef broth	Rue
Swiss chard	Wot, beef with kale	**Alcohol beverages**
Wot, beetroot, onion and oil stew	Wot, minced beef and egg stew	Tela, local beer
Wot, cabbage, onion and oil stew	Wot, red beef stew	Keribo, hops free local drinks
Wot, cabbage, potatoes, carrot, onion and oil stew	Wot, red chicken stew	Tej, mead honey or sugary wine
Wot, carrot, onion and oil stew	Wot, red dried beef stew	Areke, homemade hard liquour
Wot, kale, garlic, onion, and oil stew	Wot, red mutton stew	Wine
Wot, potatoes, onion, chili and oil stew	**Eggs**	Beer
Wot, pumpkin, chili, onion and oil stew	Chiken eggs	
Wot, stinging nettle and barley flour stew	**Dairy products**	
Wot, Swiss chard, onion and oil stew	Aguat, whey	
Wot, tomatoes, chili, onion and oil stew	Arera, butter milk	
Fruits	Ayib, Cheese	
Avocado	Butter	

Banana	Milk	
Juice, mixed	Yoghurt	
Juice, avocado	**Fish**	
Juice, mango	Fresh fish	
Mango	**Fats and oil**	
Orange	Oil	
Temir, dates	Butter	
Tringo, citron		

Table 3: Percentages of the consumption frequencies of starchy staples, legumes and others per week

Food groups		**Urban (n=347)**	**Rural (n=289)**	**Total (n=636)**	**P-value**
Starchy staples	1-3 days	0	0.7	0.3	0.206
	The whole week	100	99.3	99.7	
Legumes, nuts and seeds	None	0.6	0	0.3	<0.001*
	1-3 days	6.1	1.4	3.9	
	4-6 days	50.1	23.2	37.9	
	The whole week	43.2	75.4	57.9	
Oils and fats	None	0.9	0	0.5	0.086
	1-3 days	0	0.7	0.3	
	The whole week	99.1	99.3	99.2	
Spices, condiments and beverages	None	0.3	0	0.2	0.285
	1-3days	0	0.7	0.3	
	4-6days	0.3	0.7	0.5	
	The whole week	99.4	98.6	99.1	

*Statistically significant

Table 4: Percentages of the consumption frequencies of fruits and vegetables per week

Food groups		**Urban (n=347)**	**Rural (n=289)**	**Total (n=636)**	**P-value**
Dark green vegetables	None	46.4	57.1	51.3	0.001*
	1-3 days	42.9	39.4	41.4	
	4-6 days	8.6	3.5	6.3	
	The whole week	2	0	1.1	
Other vitamin A rich fruits and vegetables	None	58.5	83	69.7	<0.001*
	1-3 days	35.2	15.9	26.4	
	4-6 days	4.6	0.7	2.8	
	The whole week	1.7	0.3	1.1	
Vegetables	None	0.6	0	0.3	<0.001*
	1-3 days	0.6	0.7	0.6	
	4-6 days	3.4	26	13.6	
	The whole week	95.4	73.4	85.5	

Fruits	None	85.1	97.2	90.6	<0.001*
	1-3 days	13.4	2.8	8.6	
	4-6 days	0.9	0	0.5	
	The whole week	0.6	0	0.3	

*Statistically significant

Table 5: Percentages of the consumption frequencies of meat, organ meat, eggs and dairy per week

Food groups		**Urban (n=347)**	**Rural (n=289)**	**Total (n=636)**	**P-value**
Meat	None	47.6	79.6	62.1	<0.001*
	1-3 days	40.3	19.4	30.8	
	4-6 days	11	1	6.5	
	The whole week	1.2	0	0.6	
Organ meat	None	95.7	99.7	97.5	0.003*
	1-3 days	4	0	2.2	
	4-6 days	0.3	0	0.2	
	The whole week	0	0.3	0.2	
Eggs	None	73.2	93.8	82.5	<0.001*
	1-3 days	25.9	6.2	11	
	4-6 days	0.9	0	0.5	
Dairy products	None	44.4	29.4	37.6	<0.001*
	1-3 days	34.3	43.6	38.5	
	4-6 days	19	26	22.2	
	The whole week	2.3	1	1.7	

*Statistically significant

Meal Frequency

The median meal frequency was 3 (range= 1 to 5). Comparing its distribution, average meal frequency had statistically significant difference across urban and rural areas (*P<0.001*).

Food variety score

The median FVS was 16 (range= 8 to 25) per week. Urban and rural dwellers had a significant difference in FVS (*P<0.001*) Table 6. More than 98% of participants had poor and fair FVS in the areas Figure 1. There was also a significant FVS difference between socio demographic variables such as occupation (P<0.001), educational status (P<0.001) and family size (P<0.001). Spearman's rank correlation showed that FVS had a positive association with DDS (r= 0.502, P<0.001) and BMI (r= 0.145, p < 0.001). However, it had a negative correlation with average meal frequency (r= -0.102, P = 0.01). The results of regression model revealed that educational status and family size had significant influences on FVS (P< 0.05) Table 7.

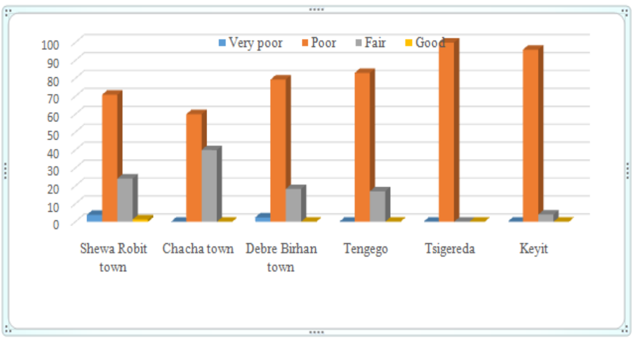

Figure 1: Food variety scores in different locations

Diet diversity score

The median DDS was 3.43 score (range = 1.14 to 5.57). The DDS of urban and rural dwellers was significantly different (P=0.004) Table 6. Nearly, 41% of subjects had 2.50-3.50 scores

Table 6: FVS, DDS and BMI distribution across urban and rural settings

Variables	Urban			Rural			P-value
	N	Mean	SD	N	Mean	SD	
FVS	348	17.09	3.35	289	15.31	2.51	<0.001*
DDS	348	3.63	0.63	289	3.45	0.38	0.004*
BMI	340	22.96	3.86	250	22.31	3.2	0.028*

*Statistically significant

Table 7: Prediction of the effect of explanatory variables on dietary scores and BMI using multiple linear regression model

Explanatory variables	FVS		DDS		BMI	
	β (standardized)	**P-value**	β (standardized)	**P-value**	β (standardized)	**P-value**
Occupations	0.046	0.247	0.01	0.811	0.075	0.082
Educational status	0.198	<0.0001*	0.122	0.004*	0.054	0.230
Family size	-0.171	<0.0001*	-0.045	0.292	-0.009	0.836
R^2	0.094		0.021		0.01	

*Significant contribution

Table 8: Vitamin A rich food groups used in vitamin A analysis

Pro-vitamin A			Pre-vitamin A		
Food group	**Food item**	**RAE (μg/100g)***	**Food group**	**Food item**	**RAE (μg/100g***
Vitamin A rich vegetables or tubers	Carrot, raw	835	**Organ meat**	Liver (cattle), raw	4968
	Carrot, cooked	852		Liver (cattle), cooked	9442
	Sweet potato (orange or dark yellow), raw	709		Liver (sheep), raw	7391
	Sweet potato (orange or dark yellow), cooked	1043		Liver (sheep), cooked	7491
	Pumpkin, raw	426		Kidney (cattle), raw	419
	Pumpkin, cooked	288		Kidney (cattle), cooked	0
Dark green leafy vegetables	Kale, raw	500	**Eggs**	Kidney (sheep), raw	95
	Kale, cooked	681		Kidney (sheep), cooked	137
	Spinach, raw	469		Chicken eggs, raw	160
	Spinach, cooked	524		Chicken eggs, cooked, fried	219
	Lettuce, raw	370		Quail eggs	156
Vitamin A rich fruits	Apricots	96	**Milk and milk products**	Milk, low fat	71
	Mango	54		Butter	684
	Papaya	47		Sour milk, cultured	124
				Butter milk, whole	47
				Cheese, fat free	11
				Whey, acid fluid	2

*USDA [42].

Table 9: Haem iron rich food groups used in iron analysis

Food groups	Food items	Haem iron (mg/10)*	Food groups	Food items	Haem iron (mg/100g)*
Organ meat	Liver (cattle), raw	4.9	**Flesh meat**	Beef (meat and by products), raw	5.67
	Liver (cattle), cooked	6.54		Beef, chuck for stew, all grades, cooked	2.96
	Liver (sheep), raw	7.37		Goat, raw	2.83
	Liver (sheep), cooked	8.28		Goat roasted	3.73
	Kidney (cattle), raw	4.6		Lamb, ground, raw	1.55
	Kidney (cattle), cooked	5.8		Lamb, ground, cooked	1.79
	Kidney (sheep), raw	6.38		Chicken meat, stewed	1.17
	Kidney (sheep), cooked	12.4	**Fish and seafood**	Catfish, raw	0.3
	Heart (cattle), raw	4.31		Catfish, cooked	1.43
	Heart (cattle), cooked	6.38		Tilapia, raw	0.56
	Heart (sheep), raw	4.6		Tilapia, cooked, dry heated	0.69
	Heart (sheep), cooked	5.52		Mixed species, raw	0.89
				Mixed species, cooked	1.14

*USDA [42].

and 55% had 3.51-4.50 scores. Altogether, 96% of subjects had scores below average DDS (4.5 out of 9 DDS). The bivariate analysis showed that there was statistically significant mean DDS difference between age group (P= 0.028), occupation (P= 0.027), educational status (<0.001), marital status (P=0.018) and family size (0.004). DDS had also a positive correlation with BMI (r= 0.190, *P< 0.001*) and average meal frequency (r= 0.219, P< 0.001). After controlling for occupations and family size, educational status had a significant influence on DDS Table 7.

Vitamin A and haem iron indicators

Table 8 and 9 indicate the food groups that were used for the analyses of the consumption of vitamin A and haem iron rich foods. Vitamin A can be obtained from foods, either as preformed retinoids (with biological activity of retinol) in animal products or as pro-vitamin A Carotenoids, mainly β-carotene in plant products. Vitamin A and haem iron intake are usually expressed as retinol activity equivalent (RAE) and mg/100g, respectively. The recently accepted conversion factor for pro-vitamin A such as β-carotene is 12, for β-cryptoxanthin and α-carotene is 24, meaning that 12μg β-carotene and 24 μg β-cryptoxanthin or α-carotene, respectively, supposedly exert the activity of 1μg vitamin A [19, 20].

Percentages for consumption of vitamin A and haem iron rich food groups were estimated using the first day data. Of 640 participants, 39.7% consumed either plant or animal source of vitamin A and 13.7% consumed organ meat, flesh meat or fish source of haem iron. In other words, the risk of vitamin A deficiency was 60.3% and about 86% of the consumers did not obtain animal source of iron. The consumption of Animal Source Food (ASF) was 35.4%.

The odds of consuming all types of vitamin A rich food groups in urban settings were 1.69 times higher than the odds of rural settings. Similarly, haem iron rich food groups were 9 times more likely to be consumed in urban settings than rural settings Table 10. As indicated in Table 11, the consumption of food groups rich in vitamin A and haem iron were significantly different across FVS and DDS (*P<0.05*).

Vitamin D rich foods and iodized salt consumptions

Vitamin D rich food sources such as fish, organ meat and sun treated mushroom were consumed by 3.6%, 2.6% and 4.0% of participants, respectively. This indicated that more than 95% of the study participants were at risk of vitamin D deficiencies. Salt iodization is basically a safe and effective strategy for the prevention and control of iodine deficiency disorders. Salt consumption rate was very high, however, only 69.5% of subjects used iodized salt in their diet. This was far below the target of WHO iodine coverage (90%) [21].

Food taboos

About 20% of participants avoided one or more food items from their diet. Bread (3.1%), milk (2.8%), fermented injera (1.7%), raw beef (1.7%) and tomatoes (1.3%) were the major food items reported as food taboos. Table 12 shows the percentages of avoided food items from consumption.

Nutritional status

Anthropometric measurements showed that the median

Table10: Indicators for the consumption of vitamin A and haem-iron rich food groups

			Urban vs Rural					95% CI	
Food groups		Percent (n=640)	Urban	Rural	Pearson Chi-Square	P-value	Odds Ratio	LL	UL
Plant Vitamin A (Pro-vitamin A)	Yes	15.8	81	20	30.78	<0.0001*	4.03	2.39	6.71
	No	84.2	270	269					
Animal Vitamin A (Pre-vitamin A)	Yes	29.5	109	80	0.78	0.377	1.18	0.83	1.65
	No	70.5	242	209					
All Vitamin A	Yes	39.7	159	95	9.84	0.002*	1.69	1.21	2.31
	No	60.3	192	194					
Animal Source Food	Yes	35.5	142	85	8.13	0.004*	1.63	1.16	2.25
	No	64.5	209	204					
Haem Iron	Yes	13.7	79	9	49.86	< 0.001*	9.04	3.61	18.2
	No	86.2	272	280					

*Statistically significant

Table 11: Vitamin A and haem iron rich food groups consumption across FVS and DDS

		Vitamin A consumption				Haem iron consumption			
Scores	Categories	Yes n=251	No n=386	Chi-square test	P-value	Yes n=88	No n=549	Chi-square test	P-value
Food variety score	< 10 FVS/week	0.8	1.3	13.15	0.004*	0.0	1.3	16.01	0.001*
	10-19FVS/week	75.3	85.5			68.2	83.6		
	20-24FVS/week	23.5	13.2			31.8	14.9		
	25-30FVS/week	0.4	0.0			0.0	0.2		
Diet diversity score	< 2.50 DDS	0.8	0	44.09	< 0.001*	2.3	0	17.6	0.001*
	2.50-3.50 DDS	27.1	50.5			29.5	43.2		
	3.51-4.50 DDS	64.9	47.9			63.6	53.2		
	4.51-5.50 DDS	7.2	1.6			4.5	3.6		

*Statistically significant

body weight, height and BMI were 60 (range= 37 to 89) kg, 1.65 (range= 1.2 to 1.9) m and 22.05 (range= 13.49 to 40.21) kg/m^2, respectively. Men and women had statistically significant difference in body weight and height measurements (*P < 0.001*). Our study revealed that 6.9% of subjects were underweight, 17.1% were overweight and 4.1% were obese. This implied that the proportion of malnutrition in the area was 28.1%. Unlike body weight and height, men and women did not have a significant difference in BMI (P= 0.164). But, there was a statistically significant difference in BMI across urban and rural settings (P=0.028) Table 6. The link between BMI and DDS was limited.

Discussion

Dietary Patterns

We identified about 130 food items. The major dietary patterns composed of cereals (teff, wheat and barley), vegetables (onion, green pepper, tomato and cabbage), legumes (peas, faba bean and lentils), oils (cooking oil) and spices (salt). All these food items are the ingredients of injera and thick stew made from flour of roasted legumes ('shiro wot'). The trend of taking hot beverages (coffee and tea) with sweets (sugar) was habituated by almost all people. In line with this finding, other studies also reported cereals, vegetables, legumes and oils as the main staples in Ethiopia [16, 22].

Relying on such dietary patterns implied that starchy staples and legumes are the predominant sources for energy and protein, respectively. Energy-dense foods, especially mixtures of sugars and fat, tend to be more palatable than foods of low energy density and high-water content [23]. Excessive intake of beverages and sweets containing added sugar could be a driving force behind obesity epidemic [24].

Less frequently, food groups containing dairy products (milk, butter, butter milk, yogurt and cheese), dark green vegetables (kale, spinach and lettuce), meat (beef, lamb, goat meat and chicken) and other pro-vitamin A rich fruits and vegetables (apricots, mango, carrots and pumpkins) were included in the dietary patterns. This was substantiated by the reports of Workicho, et al. and Amare, et al. in which they indicated that fruits and animal products were less frequently consumed in Ethiopia [16, 25]. Although the country has a very large livestock population, the availability of meat and other animal products for local human consumption is limited mainly due to economic reasons [26].

We also identified that the dietary patterns rarely entailed food groups containing fish (fresh fish) and organ meat (liver, kidney, heart and tripe). Despite abundant resources, fish consumption in Ethiopia is very limited. This is due to cultural factors and poor connections between production areas and markets. Fish is mostly consumed in large towns during periods of religious fasting [26]. There was also a limited access to organ meats. One of the reasons could be infection. Most of the time, livers from cattle and sheep are infected by internal parasites and as the result they are condemned from consumption.

Our results showed that dietary patterns were significantly different in urban and rural settings ($P < 0.05$). The difference could be attributed to availability and accessibility of food groups. Urban people are very close to the market where much variety of foods could be available. Although all people could not have equal access to food varieties because of affordability, the case for rural people is even worse. Large numbers of rural people are living at subsistence level and far away from the market so that they have less access and economic power to purchase food varieties with high price.

Meal frequency

The median meal frequency per day was 3 with a range of 1to 5. But, another study reported a range of 2 to 3 meal frequency per day [27]. This implied that the lowest consumption rate was 1 and the highest was 5. The consumption rate significantly varied in urban and rural areas ($P< 0.001$). This could be justified by the difference in food groups availability and accessibility in urban and rural settings.

Food varieties

The median FVS was 16 per week but the range varied from 8 to 25 per week. Urban dwellers had a higher FVS as compared to rural dwellers. Based on the classification made by Savige, et al. 98% of people had FVS between poor and fair dietary adequacy [12]. This result is prone to seasonal fluctuation. The scenario could be even worse during low production season in rural settings as the present study was conducted during harvesting season. FVS had a positive correlation with DDS ($r = 0.502$, $P<0.0001$) and BMI ($r = 0.145$, $P<0.0001$). But, it had a negative correlation with average meal frequency ($r = -0.102$, $P=0.01$). This inverse association suggested a monotonous type of diet. Besides, Kant explained that consuming some food items more frequently means that other food items are being consumed less frequently [28].

Socio demographic characteristics such as educational status and family size were linked to FVS, but their impacts were different. Educational status had a positive influence on FVS. This implied that educated persons better understand the health benefit of consuming nutritious foods and spend much budget on food varieties. This was corroborated by other studies done in Ethiopia and in Tanzania [16, 29]. On contrary, family size had a negative influence on FVS. Increasing the members of family without increasing income could deter the access to food varieties. Income and supply of foods had great impacts on the dietary diversity of food consumed [30].

Dietary diversity

Dietary diversity is a qualitative measure of food consumption which evaluates the dietary quality of the individuals. Based on the guideline for individual DDS nine food groups were used for assessment and the median DDS was 3.43 (range = 1.14 to 5.57). This was comparable with the mean DDS of 3.4 reported by Weldehaweria, et al. among lactating women in Tigray, Ethiopia [13]. In the same region, another study reported a median of 5 DDS, but 14 food groups were used for evaluation [22]. Hence, it is very difficult to compare the three results owing to the difference in study subjects and number of food groups used for counting. The implication of the median 3.43 DDS was that half of the people at least included 3 food groups in their diet. Mostly, starchy staples, vegetables and legumes were involved in the dietary patterns.

About 96% of people in the study areas had DDS below an average 4.5. A diet of at least 4 DDS was valid as nutritionally adequate, but below 4 DDS represented poor diversity [32, 33]. DDS was directly associated with BMI and average meal frequency. After controlling for age group, occupation, marital status and family size, the influence of educational status on DDS was significant. This was supported by Workicho, et al. and Mbwana, et al. [16, 29]. However, there were reports that showed the inverse relationship between education and DDS [25, 34, 35]. The explanation given was that although some people particularly women were educated; their employment rate was very low and have less income as the result they relied on poor nutrition.

Vitamin A and iron indicators

DDS can be used as a proxy indicator to assess the likelihood of achieving micronutrient requirements [16]. Micronutrients can be obtained from vegetables, fruits and Animal Source Foods

(ASF). Failing to consume such kind of foods regularly may impair the immune systems and prone to infectious diseases. In the present study, consumption of vitamin A and haem iron rich food groups were assessed using the first day data of food consumption.

The results showed that 39.7% of people consumed either plant or animal source of vitamin A and 13.7% consumed organ meat, flesh or fish as source of haem iron. This implied that the remaining 60.3% was at risk of vitamin A deficiency and 86.3% was unable to get haem iron sources of foods. According to WHO definition, when food groups with high vitamin A content are consumed less than three times in a week by three fourth or more of vulnerable groups, there is a high risk of inadequate vitamin A status [36]. Given this definition, the result of the present study revealed that there were high risks for vitamin A and iron deficiencies in Central Ethiopia.

Table 12: Food items avoided from the diet

Food group	Food item	Percent
Vegetables	Lettuce	0.94
	Kale	0.63
	Tomatoes	1.26
	Beetroot	0.47
Fruits	Avocado juice	0.47
Cereals	Bread	3.14
	Porridge	1.1
	Roasted wheat	1.1
	Fermented injera	1.73
Legumes and seeds	Lentils	0.47
	Linseeds	0.47
Meat and Fish	Raw beef	1.73
	Goat meat	0.47
Eggs	Fried egg	0.47
Dairy products	Milk	2.83
	Yogurt	0.63
	Cheese	0.47
Salts and sugar	Salt	0.94
	Sugars	0.47

We compared the consumption of vitamin A and haem iron rich food groups in urban and rural settings. The results showed that urban people were nearly 1.7 times and 9 times more likely to consume vitamin A and haem iron rich food groups than rural people, respectively. This, in turn, implied that the risks of vitamin A and iron deficiencies would be higher among rural communities than urban communities. This was corroborated by the report of Alaofe, et al. that vitamin A and iron deficiencies were high among rural communities particularly women and their children

in Northern Benin [37]. The consumption of vitamin A and haem iron rich food groups was significantly different across FVS and DDS ($P < 0.05$). This suggested that people who are consuming less variety of food items and diversity of food groups are less likely to incorporate food groups rich in vitamin A and haem iron in their diet.

Vitamin D and iodine indicators

Low intake of vitamin D was realized in the study areas. Very few people consumed fish (3.6%), organ meat (2.6%) and sun treated mushrooms (4%). Although vitamin D rich foods are the second sources of vitamin D next to sunshine Keflie, et al. in their review paper reported the predictors of vitamin D deficiencies in tropical African countries. Taking the predictor factors into account, the risk of vitamin D deficiencies could be anticipated to be very high. Iodine consumption was also assessed, and the result revealed that 69.4% of people consumed iodized salt albeit high salt consumption rate. This implied that salt iodization coverage did not reach to at least three fourth of the communities. However, WHO suggested 90% coverage for the prevention and control of iodine deficiency disorders [21]. In other words, more than one fourth of the people are at risk of iodine deficiency disorders.

Food taboos

Food taboos were another concern. One fifth of people avoided one or more food items from their diet. The major reasons ascribed to food taboos were culture and health related problems. Some people usually avoided consumptions of raw foods such as tomatoes, vegetables, beef and milk due to their fear for infectious diseases; fermented injera and bread for stomach ache; and eggs and goat meat for cultural reasons.

Nutritional status

The results of BMI (median=22.05; range= 13.49-40.21kg/m^2) illustrated that 28.1% of people were malnourished. Of whom, 6.9% were underweight, 17.1% were overweight and 4.1% were obese. The proportion of overweight people was larger than the proportions of underweight and obese. This suggested that overweight has become a serious public health concern followed by underweight and obesity. There is a perception among many Ethiopian communities that overweight and being obese are indicators for wealth and health status. BMI had a statistically significant difference across urban and rural settings. The proportion of overweight and obesity were like the report of Amare, et al. in Gondar town of Ethiopia (21.3%) [25]. But, the proportion of overweight alone was higher than those reported among adolescent girls in rural Southern Ethiopia (13.8%) [27]. This suggested in general that malnutrition is the major public health problem in Ethiopia.

After the socio demographic characteristics were controlled, the link between BMI and DDS became insignificant. Savy, et al. described that the socio demographic and economic context could reduce the strength of the link between nutritional status and DDS [8]. This was explained that nutritional status was not only determined by the quality of food but also the quantity of the foods consumed.

In several studies done elsewhere, height less than 1.45m was used as a cut-off point for determination of stunting in women [39-41]. Based on this threshold, the anthropometric results indicated that 4.6% of people were stunted, of whom three fourth were women. The proportion of stunted women was slightly comparable to the report of 2.2% from a study among lactating women in Tigray, Ethiopia [22]. Even though, the proportion of underweight women was higher than that of men, the nutritional status was not significantly different. This showed that both men and women were affected by malnutrition without any difference. And hence, the nutritional intervention measures should give emphasis on both genders.

Limitations

Although this study has the strength of dealing with dietary patterns, nutritional adequacy and nutritional quality, the dietary assessment instruments used to define the dietary patterns are based on self-report and may inflict some levels of report bias. This study does not contain data on seasonal variations of food consumption as it is a community based cross-sectional study.

Conclusions

In conclusion, the people of North Shewa, Central Ethiopia have cereal and legume based dietary patterns. Almost all of them have poor dietary adequacy and nutritional quality, and 28.1% are malnourished. Overweight and obesity are the upcoming nutritional problems besides under nutrition. Family size and educational status determine FVS. But, the later determines DDS. Related with low frequency of consumptions, the risks for vitamin A, vitamin D, iron and iodine deficiencies are very high. All these nutritional problems underlined the implications of nutritional interventions. Therefore, by giving emphasis on the improvement of food and nutrition security, and considering the real situations of the area, the following recommendations are made:

1. Improving meal frequency, food varieties and diet diversities;

2. Creating awareness of the nutritional benefits of consumption of locally available food items including edible wild plants like stinging nettle (Urticasimensis);

3. Demonstrating the idea of balanced diet in the garden or kitchen garden;

4. Developing food based dietary guidelines;

5. Promoting nutrition sensitive agricultural practices; and

6. Promoting micronutrient enriched staple food.

Declarations

Competing interests

The authors declare that they have no competing interest related with this study.

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Authors contributions

Design of the study: TSK, CL and HKB.

Data collection, analysis, interpretation and draft of manuscript: TSK

Critical review of the manuscript: AS, CL, DN and HKB. All the authors read and approved the manuscript.

Ethical approval and consent to participate

This study is a part of our project which has been ethically approved by Armauer Hansen Research Institute (AHRI) – All Africa Leprosy Rehabilitation Training (ALERT) Centre ethical approval committee in Ethiopia. It has also obtained permissions from zonal and district level health bureaus. The purposes and objectives of the study were explained to the study subjects. After informing about their right to withdraw from the study at any time, informed consent was obtained from each study subject

Availability of data and material

All data supporting the conclusions of this study are included in this article [and its additional file].

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