Effect of Household food Insecurity on the Nutritional Status of Children under Five in North Kassala

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Abstract

Background

Malnutrition and anemia are still major health problem in Sudan .This study aim to assess the magnitude of household food insecurity and its consequences on the nutritional status and anemia of children 6–60 months in north localities in Kassala State (Eastern Sudan)

Method

We administered a cross-sectional survey to 445 households in 16 villages. We used specially designed structured questionnaire. We measure household food insecurity by food consumption score (FCS)

Data were analyzed using SPSS version 20.0 statistical package. Frequencies and Chi2 was performed. Multivariable logistic regression was used to develop the final model indicating the predictors of the outcome variable.

Results

Food insecurity and vulnerability for food insecurity was found in 181 (38.7%) of household .There was significant associations ($P < 0.001$) between household's food insecurity and income, household size, number of children, eating habits and avoidance of certain types of food. the overall prevalence of stunting , wasting and underweight was 52.1%, 35.6% and 53.9% respectively. The result showed that the relationship of nutrition status of children and HH food security was statistically insignificant although stunted and underweight were increased by 8% and 7% respectively in food insecure HH, though the prevalence of wasting was almost similar in food secure and insecure households. The study showed that 262 (76.4%) of children had HB level less than 11g/dL. Mild anemia was reported in only 9.3% while moderate and sever anemia in 34.4% , 32.7% respectively. This study revealed that there is negative association of HB level with HH food security ($P < 0.05$). Among those who had normal HB level 30 (37%) were food insecure, whereas 51 (63%) where food secure in contrast to 195(75.6%) who had low level of HB were food secure.

Conclusion

According to the study findings, more attention is needed to improve household food security in the study area .Good eating habits can be achieved by designing education programs to improve knowledge, skills, and attitudes related to healthy eating and food preparation and overall, increasing household income through improving the farming methods, and finding the alternative sources of income. Other risk factors of malnutrition and anemia also should be corrected , such as improving maternal education, improving feeding practices regarding avoiding certain type of food and controlling childhood infections.

1. Introduction

Food security is the basic human needs and it occurs when “all people at all times have physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life^[1] Food insecurity remains a serious problem in developing and developed countries and is associated with the physical wellbeing of the households ^[2-4]

Globally more than eight hundred million people were unable to meet their dietary energy supplies in 2012- 2014 .^[4]

Household food access is defined as the ability to acquire sufficient quality and quantity of food to meet all household members’ nutritional requirements for productive lives. Different indicators are used to measure food access such as household food insecurity access scale (HFIAS), the household dietary diversity score (HDDS), and food consumption score (FCS). Both the HDDS and FCS were assessed using 7-day reference period, whilst the HFIAS is based on a 30-day recall period. Dietary diversity at the household level gives a measure of household food security.

In Africa, the proportion of the population that has experienced food insecurity is increasing. Food insecurity was mainly due to the impact of conflict and adverse climatic conditions, such as repeated droughts, often linked to the El Niño phenomenon, which resulted in poor harvests and the loss of livestock^[5] The situation in Sudan does not differ. It remains low in human development. Approximately 5.5 million people were food insecure in early 2018. It is estimated that more than 80 percent of the population may already be unable to afford the food they need daily to live a healthy life. The chronic malnutrition rate is 38 percent, with 11 out of 18 states recording the stunting prevalence among children at above 40 percent ^[6]

Many factors are accountable for this, including limited access to food, due to the low productivity of crops and severely increase of food prices^[7]. Climatic change with conflict and economic downturns are accountable for food insecurity worldwide.^[8]

Kassala state, which relies heavily on agriculture and agro-pastoral activities, has long suffered chronic poverty, lack of adequate access to essential services such as healthcare and education, high levels of malnutrition and widespread unemployment. Furthermore, the state suffered the reduction of livestock production due to low rainfall and climatic changes that affect economic opportunities and contribute to the chronic vulnerability in the region.^[9]

The fodder gap in the state is estimated at around 3.5 million ton ^[10] In 2012, an estimated 22% of the households were suffering from chronic food insecurity, while 26% are chronically moderately food insecure. The most chronic food insecure localities were Hamashkorib, North Delta and Telkok ^[11] The state was affected by the instability in Eritrea that increase the burden of food insecurity.

Malnutrition is defined as 'the cellular imbalance between supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions'.^[12] Malnutrition is a significant public health problem in developing countries; more than 50% of the 10 million deaths each year are attributed either directly or indirectly to malnutrition in children younger than 5 years. In sub-Saharan Africa, 30% of children have protein-energy malnutrition (PEM).^[13]

Lack of access to highly nutritious foods, especially in the present context of rising food prices, is a common cause of malnutrition. Poor feeding practices, such as inadequate breastfeeding, offering the wrong foods, and not ensuring that the child gets enough nutritious food, contribute to malnutrition. Infection – particularly frequent or persistent diarrhea, pneumonia, measles and malaria also undermines a child's nutritional status.^[14]

Chronic malnutrition has been a persistent problem for young children in Sub-Saharan Africa. A high percentage of these children fail to reach the normal international standard height for their age; that is, they are "stunted" In contrast, the percentage of children stunted in Southeast Asia dropped from 52 percent to 42 percent between 1990 and 2006. The number of undernourished (low weight for age) people of all ages in sub-Saharan Africa increased from about 90 million in 1970 to 225 million in 2008, and was projected to add another 100 million by 2015, even before the current world food price hikes.^[15]

Sudan has one of the highest malnutrition rates in the Middle East and North Africa region.^[16] For the last forty years, one third of the population has suffered from irreversible chronic malnutrition - a life-long growth condition that has consistently plagued Sudanese children since 1987. Now, more than two million children are already stunted and unlikely to ever reach their full growth potential. 17% of Sudanese children are acutely malnourished and over half a million will suffer from life-threatening severe acute malnutrition during one year.

Many factors are implicated in this high rate of malnutrition : exclusive breast feeding during the first six months of life is not common; children are more likely to use the outdoors for a toilet—open defecation—than a proper toilet; access to water and hand washing with soap is limited, resulting in deadly diseases such as diarrhea; and very young mothers are more likely to deliver low weight babies. Exclusive breastfeeding for the first six months is critically important to a child surviving and thriving. But there is a belief amongst mothers in Sudan that breast milk turns bad once the mother get pregnant, so it should no longer be used to feed young children.^[16]

In kassala state the percentage of stunted (low height for age) children under five is 55% ,where as 15% are wasted.^[16] The etiology of malnutrition is very complex and it appears that food insecurity does not necessarily result in malnutrition especially among children. This study aims at determining the effect of households food insecurity and related factors in the nutritional status in children in North Kassala localities; namely: Hamishkoreib, Telkook, and North Delta.

2. Methods

A cross-section- community based study was conducted in three localities in North Kassala State (Hamiskoreib, Telkok, North Delta and Rural Aroma), during 2016- 2017. as part of the project titled “Effect of Household food security on the nutritional status of women and children in North Kassala localities” that is funded by Ministry of higher education and scientific researches . This paper is concern only about children.

These three localities are rural, It cover some of (15376) sq kms, or about 36% of the total area of kassala state. The total population of the area (northern localities) is about (924642) that is 41% of the total population of the state which about (2283054).The area is characterized by dry hot climate, and too low rainfall. The main livelihood strategy is small-scale farming, in addition to animal production. Livelihoods are suffering from underdevelopment and the effect of climate change^[11]

2.1 Sampling procedure

Sample size was calculated used the OpenEpi software <http://www.openepi.com>. Assuming the average utilization of common food items is 30%, design effect of 1.2, 1.96 for Z value and 95% confidence level and sampling error 15%. Considering the total household number in three localities, the calculated the sample size was 445 households. Sample size was calculated according to the following equation:

$$\text{Sample size } n = [DEFF * Np(1-p)] / [(d^2 / Z^2 (1-\alpha/2) * (N-1) + p * (1-p))]$$

Multi-cluster random technique was used to collect data from 445 HH from three localities. Participation from each locality depends on the proportionality of the number of HH in each locality.

2.2 Data collection

The data was collected by well trained individuals selected from the community and university of Kassala. Structured questionnaire was designed to collect data . The training agenda included survey purpose, sampling procedures, field procedures (random household selection, introduction, and systematic data collection), techniques in interviewing, and taking measurements (height and weight). This was aimed at pretesting of questionnaire and achieving high data precision and accuracy.

General information including demographic characteristics, socioeconomic status, dietary habits, pattern of food consumption, and housing assets were collected. All participating households were informed that their responses would remain confidential. Food consumption score (FCS) was used to assess HH food security using 7-day reference period. Height and weight for children under five was measured to assess their nutritional status. Blood samples to assess anemia was also collected. The collected data was cleaned, analyzed using SPSS software (v20.0). Anthropometric measurements such as height, weight, and age of children 6–59 months were converted into z-scores using the WHO reference growth curves. Weight-for-height, height-for age, and weight-for-age were calculated. Frequencies, logistic regression and chi-square tests were used to assess statistical significance.

2.3 Assessment of Households food security

Food consumption score was selected to assess HH food security. FCS accounts for nutritional value of food and the number of different types of food consumed, thus it is expected to provide accurate measurement of quality of HH diet. The respondents were asked about frequency of consumption (in days) of selected type of food over a recall period of the past 7 days.

FCS was calculated using the formula proposed by Interagency Workshop Report WFP – FAO Measures of Food Consumption ^[17] In this formula, FCS was derived by multiplying the weight for each food type by the frequency (number of days). The values for all food types consumed during the seven days were summed up to give the FCS.

2.4 Assessment of nutritional status

2.4.1 Anthropometric Measurements and reference indices

Health scales were used for anthropometric measurement. They were standardized before used. The instruments were checked and calibrated on a daily basis. Height measurement was in centimeters (cm) to the nearest 0.1 cm and weight was measured in kilogram (kg) to the nearest 0.5 kg. All measurements were taken in light clothes without shoes to children in age 24- 59 months. For children in age 6 to 23 month, the measurement of length was done using a portable infanto-meter (specialized wooden device) . The child was placed on his/her back and the head was placed so that it is against the top end. The knees were gently pushed down by a helper. WHO AnthroPlus was used to compute nutrition indices and the results were classified according to World Health Organization cut-off points. Underweight, wasting, and stunting among children were defined as WAZ, WHZ, and HAZ less than 2 SD below the WHO growth standards, respectively.

2.4.2 Blood sampling: 15 µL of blood samples was collected from children to determine the hemoglobin level. HB level was determined using Sysmex machine.

3. Results

3.1 General characteristics of households

The study included four hundred and forty five households. Hamishkoreib 183 (41.1%), North Delta 80 (18.0%), and Telkook 182(40.9%). The total populations of HHs was 2436 individuals ranged between 3 and 15 with the average size 5.5 and median 5 members. The ratio of males to females in the studied groups is approximately 1:1. All the households were headed by males except two households (0.4%) were headed by females. Their age ranged from 20- 72 years with mean 42.05 ± 8.807 , Most of them 340 (76.4%) their age ranged between 30- 59 years. 778 were children in age range from 6 to 59 months.

The main source of income was agriculture and pastoralization (31.5%) of HH, 128 (28.8%) were non skill worker, 59 (13.3%) were skill worker, 35 (7.9%) were employee. Most of the respondents had poor

education level, informal education represented by more than half of studied population. Only 48 among the adult group complete secondary school or university.

Analysis of educational level of head of households, which is significantly correlated ($P = .000$) with localities, is determined as; only 104 (23.4%) had got formal education (basic, 14.4%, secondary 5.8%, university, 3.1%), while the remaining 341 (76.6%) had informal education or illiterate.

Most of HH 380 (85.4%) mentioned that the income directed for food, while 58 (13%) try to balance the distribution of income between food, education and health. Only 2 (0.8%) of them had priority to education and health. Poor consideration for education (6%) was highly reported in HK followed by North Delta (15%) and Telkook (20.3%). On the other hand 3 (0.8%) of them had prior to store it.

They living in small houses 416 (93.5%) had one or two rooms, while only 29 (6.5%) had more than two rooms. Brish (local material including palm leaves and wood) and/ or mud is the main constructions of (94.3%) of HH, only 7 (1.6%) made from brick, the others 17 (3.8%) had used different materials for their houses construction .Ventilation, which is insignificant correlated with the type of residence, was good in 301 (67.6%) of HH, and 144 (32.4%) had bad ventilation. Poor assets was observed in the houses. The house was provided by big bed made of palm wood and Only 5 (1.1%) houses had television, butagas was recorded in 10 (2.2%). 162 (36.4%)had nothing besides the bed. Among all HH, only 143 (32.1%) had special place for cooking. Charcoal and wood were the main fuel used for cooking 431 (96.9%) of HH. 225 (50.9%) had pit latrins, and 330 (74.2%) preferred to use it. Hand washing was practiced in 78.5% of HH.

Thirty eight (8.6%) of HH depend on general electricity or generators as source of light, while, 138 (31%) of them had no source of light. The remaining 269 (60.4%) used different sources as candle, torch, etc.

Forty four (9.9%) had a tap inside the house, while 182 (40.9%) depend on general tap in the area. Unprotected well, which is exposed to contamination by human and animal waste, was used by 129 (29.0%) of HH, tanker and other sources were used by 90 (20.4%) of HH. They used jercan for bringing water and storage, besides pot and permil. Only 8 (1.8%) of them were not stored water. Bad storage was observed among 330 (71.9%) of HH.

Toilet was present in 225 HH , while 220 had no toilet, among them 99 dislike to use it.

3.2 Food security

3.2.1 Households' Dietary patterns

Most of the HH 355 (79.8%) took three meals per day, while 70 (15.7%) took four meals per day, and 20 (4.5%) took two meals per day. 175 (39.3%) of HH took these meals by gathering all members, while 199 (44.7%) of HH took these meals by grouping the members of HH children and adults, 71 (16.0%) distributed the food separately. Certain types of food as chicken, fish and egg, which are protein rich, were

avoided by 319 (71.1%) of HH. They mentioned different reasons but ; culture 285 (89.3 %%), illness 6 (1.9) and poverty 28 (8.8%) were the main responses.

Milk and diary products, cereals, tea and coffee are the most prominent types of food items consumed by all of HH members. Cereals , mainly sorghum and wheat are grinded, fermented to make Kisra (a thin fermented sheets of flour) and porridge . Another type of food, which is locally known as Tenoor Hadeep was also made from flour. It is specialized to Eastern Sudan. Milk and diary products were highly consumed by all of HH in three localities.

3.2.2 Food consumption score (FCS)

Our questions were directed to recall all foods consumed by any member in the past 7 days . Nine food groups were selected . The food consumption score (FCS) was calculated by assigning a score of 0 if not consumed during the previous week, 1 if once per week and 2 if consumed if consumed more than 4times . This composite index of dietary diversity takes into account the weekly food frequency and it varied from a minimum of 4 to a maximum of 18. There are no internationally accepted cut off points and thresholds below those cut off points to assist in making judgments on whether households below a certain HDDS score have low dietary diversity or not. We classified households into two categories: low HHDDS if HHDD is less than 10 and high if equal to or more than 10 .The cutoff of 10 was chosen because it was the mean HHDDS in our sample.

Food security was reported in 274 (61.6%) of HH while 181 (38.7%) of them were food insecure or vulnerable to be insecure.

Table(1) : factors affecting HH food security

Dependent variable: food security	Coefficient	Std. Err.	z	P>z
Education	.428	.3106	1.38	0.168
Household size	1.975**	.7822	2.53	0.012
Number of children/ household	-1.566**	.5650	-2.77	0.006
Source of light	2.136***	.2733	7.82	0.000
Source of drinking water	-0.336	.2509	-1.34	0.180
Water storage	-0.004	0.052	-0.08	0.929
Eating habit	0.996***	.2716	3.67	0.000
Avoiding consumption of certain food	-1.001***	.2789	-3.59	0.000
Income distribution	1.284**	0.4532	2.83	0.005
Consumption of food rich heme	0.279***	0.447	6.11	0.000

Expectedly the source of light, which is measured by using electricity, and increase the number of members of HH appear to be positively and highly significant indicating that using electricity as source of light improves the HH food security. On the other hand, avoiding the consumption of certain types of food (as chicken and fish) and increase the number of children / HH appear to be negatively and highly sig. affecting the HH food security. Although source of drinking water and the way of storage were insignificantly associated with HH food security, they appear to affect it negatively; ie poor method of water storage and collection of water from unprotected well will reduce the food security. Regardless to the source of protein, all the HH were consumed food rich proteins and also food rich vitamin A. However food rich heme was highly significant and positively affect the HH food security.

3.3Children under 5 year's age

3.3.1 General information and food security

A total of 778 of children were eligible to assess their nutrition status, however, 119 (15.3%) were excluded due to incomplete data, leaving 659 (84.7%) for assessment. The assessed children sex ratio was 1.1 male to female, their age ranged from 6-59 M with mean (30.18 ± 14.34 M); they grouped in ≤ 24 months 294 (44.6%) and > 24 months 365 (55.4%). Table () showed the general characteristics of studied group. Their HH sized ranged from 3-15 with median 6. Among the total children, 457 (69.35%) were food secure

Table (2):

Character	Children age 6- 24 months	Children age 25- 59 months	Total
Sex: male	156	182	338
Female	138	183	321
Locality: Hamishkoreib	102	158	260
North Delta	58	64	122
Telkook	134	143	277
HH size: ≤ 6 members	94	125	219
>6 members	200	240	440
Food security: secure	212	245	457
insecure	82	120	202

3.3.2 Nutrition status

3.3.2.1 Anthropometric measurement

Height and weight were measured for 659 of total number of children. Statistically there were significant differences ($P = .000$) in mean of height (82.376 ± 12.0 cm) and weight (9.967 ± 2.9 kg) at 95% CI (-73.17, -71.64).

A total of 315(47.9%) of children had Normal height for age, while stunted was prevalent in 344(52.1%) of children that ranged from moderate 19.4% to severe 32.8%. It is high among girls (55.1%) with significant difference ($P=0.049$) compared to boys, and it was little bit greater in age ≤ 24 M with insignificant difference.

Among the food secure HH 54.5% of children were stunted, contrary the prevalence of stunted was less in food insecure HH (47%). Fig. (9) illustrates the height for age among children according to sex, age, localities, HH size and food security.

Weight for height

The normal weight for height among studied group was 424 (64.3%), while 235 (35.7%) were wasted that ranged from moderate 91(13.8%) to severe 144(21.9%). The prevalence of wasted looked similar between boys and girls. The prevalence was little bit high among the group of age >24 M. Surprisingly, it was significantly ($P < 0.01$) high(36.8%) among children from food secure HH compared to 33.1% of children from food insecure HH. Fig (10): illustrates the weight for height among children according to sex, age, localities, HH size and food security.

Weight for age

Weight for age was normal for 304 (46.1%) while 355 (53.9%) were underweight. The prevalence of underweight was little bit high among boys (57.1%) compared to girls (51.5%), and greater in age >24 M. The prevalence of underweight among children from food secure HH was (53.4%) , which was relatively near to those from food insecure HH (55%) Fig. 11: illustrates the weight for height among children according to sex, age, localities, HH size and food security.

Among the studied children, only 130 (19.7%) of them were not suffered from any form of malnutrition, while 84 (12.7%) had experience of all forms of malnutrition (stunted, underweight and wasted), the remaining (67.6%) had experience of one or two forms of malnutrition.

3.3.2.2 Nutrition status and related factors

Coefficient of correlation was used to test for relationship of nutrition status of children (z-scores of height for age, weight for height and weight for age) with mother education, HH size, HH illness, assets, avoidance of certain type of food and overall HH food security.

The result showed a negative correlation of mother education with prevalence of malnutrition, as expected improving of mother education will decrease the prevalence of stunting and underweight by 47% and 21% respectively

Avoiding certain type of food that rich of animal protein for example chicken and fish will increase the prevalence of stunted, wasting and underweight by 11.3%, 28.0% and 65.0% respectively.

The prevalence of illnesses will increase the prevalence of stunted and underweight by 11.6% and 12.0% respectively. On the same way stunted and underweight were increased by 8% and 7% respectively in food insecure HH

Table (3): prevalence of malnutrition and related factors.

Nutrition status	Stunted		Wasted		Underweight	
Factor	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Mother education	-0.47	0.06	-0.011	0.966	-0.21	0.41
Household Size	-0.27	0.12	0.26	0.16	0.094	0.58
HH illness	0.116	0.49	-0.22	0.21	0.12	0.99
HH assets	-.054	0.05	-0.022	0.49	-0.01	0.7
Food avoidance	0.113	0.55	0.28	0.16	0.65	0.001
HH Food insecurity	0.08	0.65	-0.07	0.67	0.07	0.68
Constant	-0.01	0.9	-0.78	0.004	-0.4	0.11

3.3.2.3 Assessment of hemoglobin level

Hemoglobin level was assessed for 343 of children 165 (48.1%) were males and 178 (51.9%) were females. The hemoglobin level ranged from 2.5 to 19 g/dL with mean 8.58 ± 3.1 . Most of children 262 (76.4%) had Hb level less than 11g/dL (121 males in comparison to 141 females), while 81(23.6%) had normal level of Hb that includes 44 males and 37 females. Ninety seven (37%) of children with Hb level less than 11g/dL were in age 25-36 M. 44.3% of children with Hb level less than 11g/dL were in age 6-24 M. It was insignificant associated with nutrition status ($P > 0.05$).

Table (4)

Character	Normal	Mild	Moderate	Severe anemia
Gender (339)				
Male	44	17	53	49
Female	37	15	63	61
Age (month) (339)				
≤ 24	27	15	56	45
> 24	54	17	60	65
Child ordered (339)				
≤ 2	20	10	22	26
≥ 3	61	22	94	84
HH size (339)				
≤ 6	59	24	77	77
≥ 7	22	08	39	33
Mother education (314)				
Formal education	06	08	17	24
Poor/ informal education	66	23	94	82
Locality (339)				
Hamishkorieb	35	10	29	40
North Delta	17	05	09	25
Telkook	29	17	78	45
Food security (339)				
Food secure	51	27	92	76
Food insecure	30	05	24	34

The coefficient correlation approved positive relationship of HB with HH size and food – rich heme. Increase of HH size and increase intake of food –rich heme, followed by increasing the Hb level. On the other hand, mother education and avoiding of certain type of food, which were statistically associated with Hb level ($P<0.05$), they showed negative correlation with Hb level.

Statistically the study revealed negative association of HB level with HH food security ($P < 0.05$). Among those who had normal Hb level 30 (37%) were food insecure, whereas (51) 63% were food secure in contrast to 195 (75.6%) who had low level of HB were food secure.

Table (5): Factors related to hemoglobin level

Dependent variable : HB				
Factor	Coefficient	S. Error	Z	P-value
Mother education	-0.3681**	0.1623	-2.27	0.023
Log Household Size	0.4758**	0.2337	2.04	0.042
Asset	-0.1401**	0.1639	-0.85	0.393
Food avoidance	-0.3526**	0.1884	-1.87	0.061
Heme- rich food	0.0296	0.1819	0.16	0.871
Nutrition	-0.243	0.270		0.370
Food security	-0.599	0.272	0.549	0.028
Constant	-0.1354	0.4692	-0.29	0.773
Number of obs	775			
LR chi2(12)	77.86			
Prob > chi2	0.000			
Pseudo R2	0.0785			

There is insignificant association between Hb level and nutritional status ($P > 0.05$). Among the anemic children; 161 (62.4%) were malnourished while 97 (37.6%) had normal weight for age and height for age.

4. Discussion

The purpose of this study is to determine the magnitude of household food insecurity and its relationship with nutritional status of mothers and their children aged 6– 59 months in North Kassala Localities. Inadequate food security is one of the underlying causes of malnutrition and one would therefore expect to see a link between indicators of food insecurity and that of malnutrition. This study shows a high prevalence of food insecurity (38.7%) in the study area.. Early survey in Kassala State reported food insecurity where the study area was the most chronic food insecure in the state .^[18] The study approved that some factors such as household income, household size, number of children per household, eating habit, in addition of avoiding certain type of food had impact on food security in the studied population. The rate of food insecurity in the study area is analogous to the finding in the study carried in Kenya^[19] Ethiopia^[20]. However, the prevalence of food insecurity was 5.3% among all households studied in

Republic of Korea^[21] and 58.8% in Southeastern Iran^[22]. One study conducted in Northeast of Iran reported the prevalence of food insecurity was 40.9% that related to income, infrastructure and rural distance^[23]. Also in the Southeast Iran^[22] who related the food insecurity to socioeconomic status of the households, ethnicity, education, age, and employment status of the head of the household and the mother of the household. Same findings was reported in Ethiopia^[24] unemployment, no job, low household income and living in a leased or rented home was found associated with HH food insecurity^[21]. HH with larger family size was more secure than those of small size which is unlike the finding of ^[20] who showed HH of small family size was more secure compared to large one. Increase the HH size in studied areas; increase the number of workers that increase the HH income as the studied population depends on agriculture and pasture as the main source of income or they depend on unskilled works.

One main aim of this study was to see the independent association of HHFI and related factors with nutritional status of children aged from 6 to 59 months and their mothers in Sudan. Coefficient of correlation was used to test for relationship between household food insecurity and the three indices of nutritional status of children controlling the effect of other independent variables. It is one of the few studies which assess this relationship in Sudan.

Children in the present study had growth retardation, where the overall prevalence of stunting, wasting and underweight was 52.1%, 35.6% and 53.9% respectively. This high rate of malnutrition in the study area is higher than the global rate which reveal that the prevalence of stunting, wasting and underweight for children under-five was estimated as 26%, 8% and 16% respectively.^[25]

It was also higher than the Sudan National survey S3M 2018 which reveal malnutrition rate about 36.6% and 14.1% for stunted and wasting respectively all over the country. Even in Kassala state the rate was 43.8%, 8.1% for stunted and wasting respectively in the same survey^[26]. According to WHO classification this rate of stunting among the study group is classified as very high (more than 40%).^[27]

Wasting, stunting and underweight were higher in the present study than in other comparable studies. One study done in Ethiopia show that the overall prevalence of malnutrition among under-five children was 45.6% for stunting, 14.6% for wasting and 26.3% for underweight^[28]

The rate was also higher than study done in Nigeria which showed that the rates of stunting, wasting and underweight were 39.3%, 6.3% and 14.1% respectively.^[29]

Another study done in Nepal indicate that the rate of malnutrition among children in is one of the highest in the world. Recent data from the 2011 Nepal Demographic and Health Survey (NDHS 2011) indicate that 41% of children under 5 years of age were stunted, 11% were wasted, and 29% were underweight^[30], but it is still lower than the rate in our study.

Again in Bangladesh the rate was less where they indicate that about 36% children were stunted, 8% were wasted and 24% were underweight.^[31]

Only one study carried in India was analogous to the finding in our study where stunting was observed in 53% of children, wasting in 28% and underweight in 60% of children.^[32] This is because both areas are suffering from hot, dry climate and decrease rainfall season .

Coefficient of correlation was used to test for relationship of nutrition status of children and HH food security. The result showed that the relationship was statistically insignificant although stunted and underweight were increased by 8% and 7% respectively in food insecure HH, though the prevalence of wasting was almost similar in food secure and insecure households. The above study from Ethiopia shows that household food insecurity was associated with stunting and underweight but not with wasting. Children living in food insecure households had higher risk to be underweight and stunted than children living in food secure households.^[28]

Whereas in study from Nigeria Household food security was significantly associated with wasting. Households that were food insecure were five times more likely to have wasted children than the households that were food secure.^[29]

Again in Bangladesh household food insecurity was found to be associated with underweight and stunting but not with wasting.^[31]

Also in Nepal stunting and underweight were significantly associated with household food insecurity. The association between household food insecurity and wasting was not significant.^[30]

This insignificant correlation between nutrition status of children and HH food security, indicates that other contributing risk factors are implicating to this high rate of malnutrition . Beside severe poverty which is predominant in this area ,one of these factors is mother education which has a negative correlation with prevalence of stunted ,as improving of mother education will decrease the prevalence of stunting by 47% . On the other hand avoiding certain type of food that rich in animal protein will increase the prevalence of stunted by 11.3%.

It is clear that improving food security is necessary but not sufficient to improve the nutritional status of children. These findings indicate that other risk factors of malnutrition should be corrected , such as improving maternal education, improving feeding practices regarding avoiding certain type of food and controlling childhood infections. Information on the association between household food insecurity and nutritional status of children and women is insufficient in Sudan.

A second aim of this study is to investigate the effect of H.H. food insecurity and other related factors on the Hb level in children under five years of age. The study showed that 262 (76.4%) of children had Hb level less than 11g/dL. Mild anemia was reported in only 9.3% while moderate and severe anemia in 34.4% , 32.7% respectively. According to the 2011 WHO report , globally the prevalence of anemia in children aged 6 – 59 months was 42.6%. The highest prevalence was in Africa, South East Asia and Eastern Mediterranean, these three regions account for 62.3, 53.8 and 48.6% anemia prevalence, respectively.

^[33]According to the World Bank collection of development indicators, prevalence of anemia among children under 5 in Sudan was reported at 57.2 % in 2016.^[34]

One study done in Wad Medani Great Locality, Gezira State, the overall prevalence of anemia in the study population was 58.4% .^[35] On study conducted in Karma Albalad village Northern state, Sudan the prevalence of anemia among preschool children was 80.4%.Anemia was graded as mild in 81 (49.7%), moderate in 47 (28.8%) and severe in 3(1.8%).^[36]

To our knowledge no study has been conducted in Sudan to address the effect of HH food security on the Hb level in children under five years of age. This study revealed that there is negative association of HB level with HH food security ($P<0.05$). Among those who had normal HB level 30 (37%) were food insecure, whereas 51 (63%) were food secure in contrast to 195(75.6%) who had low level of HB were food secure. This inverse relationship indicates the presence of other factors other than food security that interfere with rates of iron deficiency anemia, and this is what needs further researches.

This result is similar to one study done in Brazil found no significant association between household food insecurity and alterations in Hb levels in children.^[37] Another study done in Philippine reveal that anemia affected 57.8% of the children, with a similar prevalence among children from food-secure and food-insecure households.^[38]

One study conducted in Ethiopia reveal different result in which HH food insecurity was identified as an associated factor for childhood anemia which implies children from food insecure household were 2.34 times greater at risk of developing anemia.^[39]

Conclusion

The prevalence of food insecurity, malnutrition and anemia among households in North localities was high . Improving household food security may be necessary but not sufficient to improve the nutritional status .Good eating habits can be achieved by designing education programs to improve knowledge, skills, and attitudes related to healthy eating and food preparation and overall, increasing HH income through improving the farming methods, and finding the alternative sources of income. More attention is needed towards education and electrical supply. The relationship between food insecurity and nutritional status has implications for improving child health status .

Malnutrition and other associated factors are a common source of considerable morbidity and mortality of children. If food insecurity is a contributing or causal factor in malnutrition, preventing it might reduce the stunting or underweight and other associated diseases. We should take necessary steps to ensure food security of these poor households to prevent highly prevalent under nutrition in this population and in similar settings elsewhere in Sudan.

limitations of the study:

First , although our hypothesis was that food insecurity leads to malnutrition and anemia , it must be emphasized that the cross-section nature of the study do not allow us to state the associated factors are the definitive related risk factors.

The study was not designed to assess the effect of seasonal variation in household food insecurity .Other related aspects such as genetics related information and the access to prenatal and child health services was not included in the study. Nevertheless, this study is the first in Sudan which describe the association food insecurity with child and mother nutritional status and further researches are needed find out the dimensions of this issue and find appropriate interventions

Abbreviations

HH: household/s, FCS: food consumption score

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the University of Kassala and health office at August 2016. Communication was through formal official letters to localities under study that provided an official letter to local authorities of all selected areas. Informed verbal consent was obtained from each participant before the interview. The rights of members not to take part and not to answer the query they do not want to answer were ensured. To ensure the confidentiality of participants, anonymous coding was used.

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Conflict of interest

No conflict of interest

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

MAD, FAK, AKM, MAA and AAM had contribution on Study design. Data collection: AMH, SSM, AOA, IMM , FAK and MAD. Data management and analysis were performed by FAK and MAD. Analyzed data were revised and approved by all the authors. Manuscript was written by FAK and MAD, revised by AAM and approved by all authors.

Consent for publication

Not applicable

Competing interests

No conflict of interest

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Figures

Figure 1

Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Figure 2

Determination of Height for age (HAZ) according to age (month), sex, localities, food security and HH size

Figure 3

Determination of weight for height (WHZ) according to age (month), sex, localities, food security and HH size

Figure 4

Determination of WAZ according to age (month), sex, localities, food security and HH size