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RURAL – URBAN PROFILE OF NUTRITIONAL STATUS OF SUDANESE CHILDREN LESS THAN TEN YEAR OLD: RURAL WESTERN KORDOFAN AND URBAN KHARTOUM STATE

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ABSTRACT

This paper objects to assess nutritional status of children less than ten year old in rural and urban Sudan as based upon two field surveys. The first one was carried out during 2005 in rural western Kordofan to assess the nutritional status of children less than 10 years old, and the second one took place during February 2009 in the three central children hospitals in Khartoum State to assess nutritional status of children suffering anemia and night blindness. The main findings of the fieldwork in rural western Kordofan depicted an average contribution of each of the carbohydrates, protein and fat with 58.2%, 9.5%, and 32.3%, to the total energy with fat slightly higher and carbohydrates lower than the recommended values. Cereals products provided 45.7% of total consumption and 45.2% of total protein. About 58.3% of the children suffered from underweight and 72.8% were moderate underweight while 80.6% suffered from severe underweight. Wasting prevalence was 37.9% (19.6% as moderate and 18.3% as severe). Stunting prevalence was 23.7% (12.3% moderate and 11.4% as severe). The second fieldwork in Khartoum State depicted that physical symptoms of anemia are loss of appetite (87.7%), paleness (93.5%), exhaust, and eating clay (29%), while for night blindness they were xerophthalmia (20%); Pinot spots (52%); karatomalacia (12%), and Cornea ulceration (4%). Severe malnutrition constituted 63% of cases of children suffering anemia and night blindness. Children suffering anemia and night blindness distributed among different age groups have very low percent of hemoglobin concentration below 60% standard, confirming for prevalence of Iron deficiency anemia. Malnutrition was highest among children aged 1-3 year old, and females are less malnourished compared to males. There was low energy (calories), Iron and Vitamin A levels of intake among these children. Both surveys depicted prevalence of malnutrition and confirms for a similar problem facing rural and urban Sudan. The authors suggested some recommendations to improve nutritional status of children in both geographic settings.

Keywords: Rural setting, undernutrition, malnutrition, stunting, wasting, poverty, food insecurity, nutrition security; anemia, night blindness, malnutrition, poverty, Khartoum State

INTRODUCTION

Although Sudan is rich in natural and human resources, 77.5% of the households surveyed in north Sudan were on or below the poverty line (MoL/ILO, 1997). The UNDP (2005) reported 75% of north Sudan population as poor. The majority (80%) is concentrating in rural areas where 30% of them suffered from extreme poverty. However, malnutrition is a real health problem in the country. Nutrition security strongly connected with food security, and is achieved at the household level when its members' food intake provides the recommended levels of protein, vitamins, minerals and energy. Food security is "a situation exists when all people at all times have sufficient access to sufficiently safe and nutritious for a healthy and active life" (FAO, 1996). Food insecurity is "a limited or uncertain access to foods of sufficient quality or quantity to sustain a healthy and active life" (Mohamed *et al.,* 2004). Moreover, Thomas *et al.,* (1997) differentiated between chronic and transitory food insecurity. The first type occurs when individuals or groups suffer from food insecurity at all times. The second type associates with a temporary decline in access to food due to

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temporary adverse circumstances. Transitory food insecurity was further divided into temporary and seasonal types. The first one is unpredictable, e.g. drought, unemployment. The second one usually follows a regular pattern of inadequate accessibility to food, i.e. agricultural season. Food insecurity can be related to fluctuation of production and price affecting the food or non-food sector leading to fluctuations in real income producer within the community (Valdes *et al.,* 1981). Natural disasters, armed conflicts and hunger are also responsible for food insecurity (Alexander, 1997; Young, *et al.,* 2001; Hinrichs, 2002).

Nutrition insecurity leads to protein – energy malnutrition. Nutrition status is measured directly by dietary surveys, biochemical data, and anthropometric and clinical examination methods. Food adequacy is necessary for a household to achieve nutrition security, but it is not in itself sufficient. This is because some other key contributors to good nutrition are also important, such as poverty reduction, female education and a healthy environment. Nutrition deficiency diseases are worldwide spreading. In Sudan, one child out of ten dies before completing five years due to these diseases (UNICEF, 2008). Malnutrition due to micro nutrients deficiency (hidden hunger) represents the most prevailing form of nutrition deficiency diseases where more than two billions are suffering from it in the world; in addition to more than 250,000 children are affected by night blindness every year and more than half dies approximately (UNICEF, 2008). In Sudan, the estimated rate of prevalence of hidden hunger is 4.8% while the rate of anemia (iron deficiency anemia) for children less than five years old is about 55.1% (National Ministry of Health, 2008; World Health Organization, 2009). In Khartoum State, anemia due to Iron deficiency is distributed as 76% in Khartoum town, 75.3% in Khartoum north town, and 23.9% in Omdurman town (National Ministry of Health, 2008; World Health Organization, 2009). However, nutritional deficiency diseases as causes of death during early childhood, have contributed by around 51% among overall causes of death during this period (UNICEF, 2008).

Areas nutritionally insecure in Sudan include rural areas of low crop and animal production; areas of low purchasing power and education and knowledge; and areas of low access to health facilities, in addition to areas with low access to water especially during dry season (Cambrez *et al.,* 1998; FAO/WFP, 2006). However, some researchers view poverty as the main cause of malnutrition while some others believe in malnutrition eradication without reduction in poverty pointing to well nourished children living in very poor households. Female education is positively correlated with reduction in infant mortality rate (UNICEF 1990; Devads, 1980; Bhuiya *et al.,* 1986; Brahman, 1988). Environment health largely determines nutritional status either through infections, depletion of nutrients and illness or vice versa. (UNU, 1979; Osmani, 1997; Biesel, 1984).

This paper objects to assess nutritional status of children less than ten year old in rural and urban Sudan and to suggest some recommendation to improve nutritional status of children in both geographic settings.

MATERIALS AND METHODS

Field Survey in Rural Western Kordofan

Data was collected during August – October 2005. The villages were selected randomly and included Abu Serour; Rahad el Selik; Wad Gudiem; Um el Badri; el Karanik and Maryoud (Figure 1). The area was chosen due to its fragile environment with expected food problems. Population number is 92368 persons distributed in 14512 households. Cluster sampling is used for selection of rural villages by using probability proportional to size (PPS), and also used for the selection of the households from the ever selected villages. The sample size was calculated by the formula:

$n = t^2\ pq/d^2\ x\ deff.$

Where:

n is the sample size,

t = 1.96,

q= 0.50,

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p=0.05,

d =0.08

Deff. =1.5 (design effect).

Therefore: n = $(1.96)^2$ x0.05x0.50/ $(0.08)^2$ x1.5=225

Clusters = sample size/desired number of households in a cluster = 225/20= 11.25 (all clusters).

Since there are 92368 persons distributed in 14512 households, this gives 25431 households.

Then rural clusters= 14512/11.25/25431=ca.6. So rural households included = 20x6=120

The study covered dietary and anthropometric assessments of children less than 10 years old. Dietary assessments determined individual and household food consumptions. Anthropometric assessments involved physical measurements of the body such as weight, height, etc. Therefore, there are weight/height, weight for age, height for age and weight for height data, in addition to their sub-classifications (WHO 1995, Waterlow *et al.,* 1977). Underweight, wasting, and stunting, in addition to measuring food frequency as consumption patterns during a week, were used to assess the nutritional status of children less than 10 years in the study area. Underweight is a measure of wasting or stunting or both. Weight measurements, which were taken to the nearest 0.1 kg, were taken by electronic scale. Subjects were weighted barefooted wearing minimum clothing. Salter scale was used for children less than two years old who are unable to stand. Height of children less than 2 years old was measured while they are lying on their backs with stretched legs and heads up. A wooden scale is used for children whose ages were 2 to less than 10 years old. Evaluation of nutritional status for children less than 10 years old was done by Z- score for the parameters of underweight (weight/age); wasting (weight/height); and stunting (height/age). The criteria used is normal (≥I SA) and undernourished (≤ - I SA). The (≤ - I SA) criterion is further divided into mild (-1 to – 2 SD); moderate (12 to -1 SD) and severe (≥ -3 SD).

Measuring food frequency as consumption patterns during a week was recorded as consumption/day; every other day; twice/week; one/week; rarely or none. Household food intake (the 24-hour recall) was recorded in domestic measures and converted to weights. Nutrients intake were calculated using food consumption tables (Sukkar 1985, Boutros 1986). Individual food intake is calculated as an average per individual since all family members eat together, and it was evaluated as energy and protein intake.

Recommended allowance "RDA" calculation is based on FAO (1994^B) RDA, and the figure for protein intake based on high fiber diet was applied since it represents the dietary pattern of the subjects covered by the study. An average figure was calculated from the RDA of household members above five years old to obtain the RDA per household for energy and protein. Adequacy intake based on households' RDA was calculated by: adequate ≥ 80% and inadequate ≤ 80%.

Field Survey in Khartoum State

The fieldwork took place during February 2009 through to February 2010 in central specialized children hospitals in each of the three towns, including Ga'far Bin Oaf Hospital in Khartoum, Child Emergency Outpatient of Omdurman Hospital, and Ahmad Grasim Hospital in Khartoum north. A questionnaire was designed to collect relevant nutritional data of children suffering anemia and night blindness, as well clinical data on symptoms of anaemia and night blindness. To estimate the sample size, based on that rate of prevalence of nutritional deficiency diseases in Khartoum State which is 10% (Khartoum State, Ministry of Health 2009), the following formula is used:-

$$n = \frac{Z^2 Pq}{d^2}$$

n = sample size; Z = 1.96; P = prevalence rate of nutritional deficiency diseases; q = 1 – P; d = 0.05

The 10% prevalence rate of nutritional deficiency diseases in Khartoum State is used to get q which gave 138 individuals, as follows:

$$n = \frac{(1.96)^2 \times (1 - 0.1)}{(0.05)^2}$$

$n = \frac{3.8416 \times (0.9)}{(0.05)^2} = \frac{3.8416 \times 0.9}{0.0025} = 138$

To determine the share of each Hospital from this sample size, the equation of distribution in proportion to size of population (children suffering nutritional deficiency diseases) in each hospital is used, as follows:

Cases of malnutrition in Khartoum (15628) = $\frac{100 \times 15628}{49003}$ = 32%

Cases of malnutrition in Khartoum north (12602) = $\frac{100 \times 12602}{49003}$ = 26%

Cases of malnutrition in Omdurman (20773) = $\frac{100 \times 20773}{49003}$ = 42%

The total cases of malnutrition in Khartoum State = 49003

The share of each town (hospital) of the sample size is determined as:

Khartoum = $\frac{138 \times 32}{100}$ = 44

Khartoum north = $\frac{138 \times 26}{100}$ = 36

Omdurman = $\frac{138 \times 42}{100}$ =58

Before conducting the fieldwork, anemia and night blindness were determined by testing blood samples of the sick children which is executed by Technicians working in each of the three hospitals, and by one of the authors. In addition, files of sick children were used. Symptoms of anemia and night blindness were specified by Doctors during their routine rounds in the hospital. Following that, the questionnaires were filled with mothers of the sick children whom were chosen purposively. Hemoglobin measurement was done by Colorimeter, by taking 20 micro millimeter of the blood of the 138 sick children in a test tube, and 4 milliliter of Drabakin was added with 14.8 15 gram/deciliter concentration and fully mixed, left for five minutes to be read by Colorimeter. This gave that: Hemoglobin gm/Deciliter X 6.8 (constant factor) = Hemoglobin %

Anthropometric measurements are done using Salter's scale to measure weight versus age for all the 138 children to determine their nutritional status. The nutritional status index of weight versus age is a quick and accurate method to determine the nutritional status of children less than five year old.

The evaluation of the nutritional status of children less than five year old was done using tables of estimation of rate for children less than five year old which is published by World Health Organization. The most indexes used to measure body to estimate nutritional status is weight for age index. Taking the measurement of weight is easier compared to measuring height and enable for more precision. Therefore, this measure is used into observing gradual growth in body volume and organs and helps into detection of early malnutrition.

Food weight measurement was also done which weights for 3 kilograms (electronic scale) to measure the amount of food consumed during the day. To determine average of energy, protein, iron and Vitamin consumed relative to the size of the household, children under study were divided into age groups including less than one year, 1-3 years, and 4-6 years; and -1 year + 1-3 years, -1 year + 4-6 years, (1-3)+(4-6) years and another age group including all age classes of 1 year + (1-3) + (4-6) years. This classification facilitates comparison between food consumption according to age groups of

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children less than five year old. Nutrients intake were calculated using food composition tables for population in Sudan, provided by Sukar (1985). Conditions for rejection included all children transferred from other States of Sudan hospitals during fieldwork, and the study has restricted to those who live permanently in Khartoum State during the time of fieldwork. The data was statistically analyzed to calculate frequencies, percentages and Chi – square test.

The Areas under Study

Rural western Kordofan (figure 1) has a semi arid environment with climatic fluctuations and average annual rainfall of 200 mm. Sand dunes and sandy soils are dominant and natural vegetation is sparsely. Children less than 10 years constituted 36.5% of the total population distributed as 17.8% males and 18.7% females. Average household size of 4-6 person included 50.8% of total households surveyed, while 7-10 person households represented 36.7%. Male headed households represented 44.1% of total households. Illiteracy is high by 75.9% among households surveyed, who are mainly peasants. They cultivate sorghum (Dura) and bulrush millet (Dukhn), sesame and groundnuts. Monthly income is distributed as 59.2% earns less than 200 SDG, 30.0% earns 200-300 SDG. They generally fall below poverty line as their incomes are far less than one USD per day. The so called higher income groups (301-500 and ≥ 500 SDG) totaled 10.8%

Khartoum States consists of the three towns of Khartoum, Khartoum north and Omdurman (Fig.1). Rate of population increase in Greater Khartoum was 4.92 in 1956, 7.76 in 1973, 8.75 in 1983, and 13.7 in 1993 (MFEP 1956–1993). The number of persons per square kilometer was 55.6 persons in 1973, 85.5 in 1983 and 169 in 1993. In addition Khartoum state accepted 39% of internal migration of the country in 1983 and 45% in 1993 (MFEP 1956 – 1993). This population increase is reflected in the expansion of informal squatter areas (El Bushra, 1995) and consequently higher demand for public services.

Figure 1. Location of rural western Kordofan and Khartoum State

RESULTS

Dietary Evaluation

Rural Western Kordofan

In rural western Kordofan, the average contributions of carbohydrates, protein and fat to total energy were 56.2%, 9.3%, and 34.5% respectively (table 1). Less meat was consumed here but, the higher fat figure was due to consumption of more groundnuts and groundnuts oil as it is produced, pressed and refined locally. Cereals highly contribute to energy and protein intake in the study area. Frequency of daily cereals' product consumption was higher for sorghum porridge "Asida", which provides less energy due to its high moisture content. This seems the only viable explanation for higher cereal

products in rural households but there is less energy and protein intake. Cereals products provided 42.7% of total energy and 45.2% of total protein (table 1). Here, meat is consumed by 70.5% of the surveyed households. Moreover, nutritional adequacy can be roughly assessed from energy and protein content of the daily diet relative to the recommended allowances (RDA). Inadequate energy intake means that the quantity of food consumed was below optimum need as the energy value is derived from all three macronutrients. The rural households of the study area consume diets low in quantity and intermediate in protein quality as the major source was plant protein which produced locally.

Table 1. Parameters of Nutrients' contribution (%) to total energy intake & recommended range (R); Macronutrients' mean daily intake and Cereals contribution to total energy (kcal) and protein (g) intake in the study area

(1) Nutrients' contribution (%) to total energy intake & recommended range (R)		
Carbohydrates	56.2	R= 55-60
Protein	9.3	R= 10-15
Fats	34,5	R= 25-30
(2) Macronutrients' mean daily intake		
Energy (kcal)	1663±383*	1803±449
Protein (g)	37.7±11*	42.0±14
Carbohydrates (g)	232.6±70*	261.4±80
Fat (g)	63.5±23**	64.5±25
Animal protein (g)	9.8±4.6*	13.1±6.3
Animal fat (g)	7.5±9*	12.2±11
(3) Cereals contribution to total energy (kcal) and protein (g) intake		
Energy	774.7±163*	824.3±172
% of total energy	46.5	45.7
Protein	16.1±3.9**	19.0±6.8
% of total energy	42.7	45.2

Source: Fieldwork (2005)

Khartoum State

The majority of the mothers (61.6%) perceive that breast feeding is important and prevents childhood diseases, while some others (38.4%) ignore that. However, 97.1% of the mothers used to breast feed their sick children after three days following their delivery. The average period of breast feeding is eleven months. Mothers who did not breast feed their children; have attributed that to death of a mother (25%), infection of mother with tuberculosis or psychiatric diseases (50%), or the child being sick (25%). During the early 2 months of a new born baby, 89.9% of the mothers used to breast feed their children and give supplementary food, while few mothers (7.2%) depend solely on breast feeding, and still very few mothers (2.9%) wholly depend on supplementary food. During the second half of the first year of a child (6 - 12 months), very few mothers (0.41%) depend on breast feeding as the main source of feeding their children, while 87.7% of them combine breast feeding with supplementary food, and 10.9% give their children supplementary food only. This means that, the majority of mothers did not change their behavioral pattern of child feeding throughout the first year of a child life. However, children prefer biscuits (14.3%), soft drinks (25.4%), and chips (12.3%), juice (9.4%), cakes (5.8%), and sweets (8.6%) as supplementary food types. The majority of children (63.8%) take three meals a day, 21.9% take four meals a day, 2.9% take more than four meals a day, and 11.6% take two meals a day. More numbers of meals does not necessarily mean more amounts of

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food given to a child as mothers have used to distribute a child meal within a day hours. The majority of the households' members shares the same dish (84.8%), or eats separately (15.2%).

Table 2 depicts average daily intake of energy, protein, iron, and vitamin A among children suffering anemia and night blindness. From the table, children aged less than one year old ranked first in energy intake compared to other two groups of 1-3, and 4-6 year old. Taking two age groups of children together, children aged -1 year old + 4 - 6 year old ranked first and followed respectively by those aged -1 + 1- 3 year, with very small difference between them. The general average intake of energy for the three age groups reveals low energy (calories) intake among children aged less than five year old in Khartoum State. Taking daily protein intake by age group of these sick children, children aged less than 1 year old ranked first, followed by 4-6 year old, and lastly 1- 3 year old. Taking two age groups together, had ranked children aged -1 year old + 4-6 year old first, and those aged -1 + 1- 3 year old second, while children aged 1-3 + 4-6 came lastly. The general average intake of protein for the three age groups reveals low protein intake among children aged less than five year old in Khartoum State. Moreover, ranking daily intake of iron by age groups of these sick children puts children aged -1 year old first, 4-6 year second, and 1-3 year old last. There is slight difference in daily iron intake when two age groups of children are taken together. This is more seen among children in the age groups of -1 + 1- 3 and 1-3 + 4-6 year old. The general average of daily iron intake depicts very low level among these children. This picture is also seen when daily intake of Vitamin A is taken into consideration.

Average daily intake of energy, protein, iron, and vitamin A by age groups of children suffering anemia and night blindness had identified children aged less than one year as the most advantageous group compared to the other two groups. In addition, the general average of each of these nutrients is far below the recommended level for children to remain healthy in Arica and Sudan.

Table 2. Average daily intake of energy, protein, iron, vitamin A by age among children suffering anemia and night blindness

Age groups	No.	Energy (calorie)	Protein (g)	Iron (milligram)	Vitamin A (microgram)
- 1	50	11277.7	326.5	53.6	1239.7
1-3	153	8542.3	248.7	40.0	858.0
4-6	106	9756.6	279.4	45.7	979.7
-1 + 1- 3	66	5476.0	155.5	25.7	534.4
-1 + 4-6	74	5484.3	159.7	26.5	638.9
1-3 + 4-6	176	4900.6	140.0	22.7	462.8
-1 + 1-3 +4-6	76	3715.4	106.7	17.5	366.4

Physical symptoms of anemia are loss of appetite (87.7%), paleness (93.5%), exhaust, eating clay (29%) and snow (2.9%). The symptoms of night blindness are night blindness (12%); xerophthalmia (20%); Pinot spots (52%); karatomalacia (12%), and Cornea ulceration (4%). Hemoglobin measurement for children suffering night blindness (Table 3) revealed that children aged 1-3 year old have less hemoglobin concentration compared to those aged less than one year and 3-5 years old who have equal concentration of hemoglobin. This means that children aged 1-3 year old suffers Iron deficiency anemia compared to the two other two groups. This contrasts children suffering anemia, where children aged 1-3 and 3-5 year old are almost have equal concentration of hemoglobin which exceeds that for children aged less than one year old who might differ significantly than the previous two age groups. This means that, children -1 year old are more anemic compared to those aged 1-3, and 3-5 year old. The general striking feature of distribution of night blindness and anemia among these three age groups is that, each age group has acquired ⅓ of incidence of a disease and the differences might be quite minor. The distribution of children suffering night blindness by sex by percent of hemoglobin concentration (Table 3) depicts males to have higher level than females, which is also applicable to anemia. However, the differences might not be significant. Children suffering

anemia and night blindness distributed among different age groups have very low percent of hemoglobin concentration below 60% standard (National Ministry of Health, 2004), confirming for prevalence of Iron deficiency anemia.

Table 3. Hemoglobin range measurement (%) among children suffering anemia and night blindness by age and by sex

Age / sex	Night blindness		Anemia	
	frequency	%	frequency	%
-1 year	3	37	31	32.2
1-3years	18	34.8	73	38.8
3-5 years	4	37	9	39.1
Males	60	43.5	15	10.9
Female	53	38.4	10	7.2
Total	113	81.9	25	18.1

Anthropometric Evaluations

Rural Western Kordofan

Table (4) shows anthropometric evaluations for children less than ten years old in rural western Kordofan. Wasting prevalence was 37.9% (19.6% as moderate and 18.3% as severe). Wasting was prevalent in the study area (41.0%). Within each level of wasting, 74.4% is moderate, and 67.5% is severe. Since the survey was carried out during the pre- harvest season (August/October), a period of food scarcity in such rural areas, there will be less food intake and by so more incidence of wasting is expected as the index indicated to recent low food intake in addition to poverty. Stunting prevalence in the study area was 23.7% (12.3% moderate and 11.4% as severe).Under weight was prevalent by 54.1% and constituted the majority within the moderate (68.1%) and severe cases (81.8%). Wasting for all children was 55.9%, 32.2% moderate and 23.7% severe. Wasting was higher for children less than five years old at all the three levels especially severe wasting, which is probably an indication of even lower food intake at the fieldwork time. Wasting prevalence was higher (60.5%), and within these rural households, it was found to be higher within the moderate (67.6%) and the severe (74.0%) cases. Stunting prevalence was 11.4% (7.1% moderate and 4.3% severe). Generally, higher prevalence rates for moderate and severe stunting were recorded for these rural children.

Table 4. Nutritional status of children less than ten in rural western Kordofan

Parameter	Nutritional status	No.	%
Wt/age[a]	Normal	60	41.7
	Moderate	59	40.9
	Severe	25	17.4
P=0.194	**total**	144	100.0
Wt/height	Normal	85	59.0
	Moderate	32	22.2
	Severe	27	18.8
P=0.003	**total**	144	100.0
Height/age	Normal	100	69.4
	Moderate	20	13.9
	Severe	24	16.7
P=0.001	**total**	144	100.0
Wt/age[b]	Normal	63	45.9

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	Moderate	47	34.3
	Severe	27	19.7
P=0.025	**total**	137	99.9
Wt/height[b]	Normal	54	39.5
	Moderate	46	33.5
	Severe	37	27.0
P=0.064	**total**	137	100.0
Height/age	Normal	118	86.1
	Moderate	12	8.7
	Severe	7	5.1
P=0.121	**total**	137	99.9

A=≤ 5, b= ≤ 10 , Source: Fieldwork (2005)

Khartoum State

Table 5 depicts state of malnutrition as indicative by weight of children. Severe malnutrition was the most prevalent type of malnutrition with significant difference than the other three types of malnutrition shown in table 5. The difference between normal and simple types of malnutrition is quite small. Severe malnutrition is a reflection of low nutritional status which makes children vulnerable to childhood diseases. The distribution of rate of malnutrition by age groups of these children suffering anemia and night blindness (Table 6), identified the highest rate of malnutrition among children aged 1-3 year old, then followed by children aged less than one year old and lastly by those aged 3-5 year old. This means that severe malnutrition remarkably prevails among children aged 1-3 year old, which significantly differs than the other two age groups. Furthermore, the difference between children aged -1 year old and children aged 3-5 year old is more than doubled. The distribution of malnutrition by sex by age depicted that males are more suffering than female, but both males and females aged 1-3 year, are the most suffering than the other age groups. However, females are generally less malnourished than males with a percent difference of 8.6 between them (Table 6).

Table 5. malnutrition indicated by weight of children less than 5 year old in Khartoum State

Malnutrition state	frequency	%
Normal	11	8.0
simple	13	9.4
Medium	27	19.6
Severe	87	63.0
total	138	100.0

Table 6. Malnutrition by sex by age

Age	Sex				Total	
	Males		Females		Frequency	%
	frequency	%	frequency	%		
-1 year	18	13	16	11.6	34	24.6
1-3years	47	34.1	43	31.2	90	65.3
3-5 years	10	7.2	4	2.9	14	10.1
total	75	54.3	63	45.7	138	100

Factors Influencing Nutritional Status of Children

Rural Western Kordofan

In these rural households, energy and protein intakes also increased with increasing income. The level of significance was lower for energy, probability 0.042, and was significant for protein with probability of 0.053. Comparison between lowest income group and highest one depicts an increase by 34.6% in energy and 41.3% in protein. Higher income groups (301-500 and ≥ 500 SDG) totaled 10.8%. By that way, 89.2% of the rural household did not benefit from increasing income that lead to increasing intake of energy and protein. Increased food expenditure had significantly increased energy and protein intakes in the study area for both energy, probability of 0.042, and for protein with probability of 0.025. In the later case, such an increase is not as important as that for those whose food expenditure amounted to ≥ 100 SDG, who constitutes 9.1% of the households, while for the remaining 90.9% there was practically no increase.

A significant relationship exists between food expenditure and undernutrition prevalence in the study area with probability of 0.004. This commensurate with the fact that food expenditure positively affected energy and protein intake and thus the energy status of the body. As far as number of meals per day is concerned, it is expected that more energy and protein will positively correlate with three meals per day other than with two meals. Meals provided more energy was not detected in these rural villages where the probability was 0.104. Increase in protein intake was not significant for these rural households where the calculated probability was 0.145. The noticeable increase in energy here can be attributed to poverty, where 95.8% of the households earned ≤ 5 US$/ day (table 7). Number of meals per day influences energy and protein intakes, a positive relationship confirmed in the study area by a probability of 0.006.

Energy intake reversibly decreased with increasing household size, where the calculated probability was 0.042 (table 7). The decrease in kcal was slightly low here (17.3%). Protein intake also decreased with increasing household size, probability was 0.000. Decrease in protein was high in these poor rural areas (26.7%) as they had big families. These factors point out to decreasing protein intake with increasing number of persons sharing the common dish which its protein content was originally low. Positive relationship exists between household size and nutrition status in these rural areas and the calculated probability was 0.018. Since energy and protein intakes were less and the households are big enough, it is expected to have positive relationship between household size and nutrition status.

Table 7. Factors determining the nutritional status of children less than 10 years old in rural western Kordofan

parameters	Rural	
	No.	**%**
1- **Income** (SDG)		
≤200	71	59.2
200-300	36	30.0
301-500	10	8.3
≥ 500	3	2.5
Total (P=0.000), P means probability	120	100.0
2- **Food expenditure** (SDG) / day P= 0.000		
≤ 5	29	24.2
5- ≤ 10	80	66.7

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10- ≤ 15	10	8.3
≥ 15	1	0.8
total	120	100.0
3- **Number of meals/day**	P= 0.000	
Two	96	80.0
Three	24	20.0
total	120	100.0
4- **Household size**	P= 0.223	
1-3	8	6.7
4-6	61	50.8
7-10	44	36.7
≥ 10	7	5,8
total	120	100.0
Poverty classification US$/ day		
≤ 5	115	95.8
5 - ≤ 10	-	-
10 - ≤ 15	5	4.2
≥ 15	120	100

Source: Fieldwork (2005)

Table 8 depicts highly significant probability confirming the relationship between household monthly income and number of meals a child takes per day. This implies increased food expenditure and higher level of energy; protein; iron; and vitamin intake, as well as consumption of better quality protein, with increasing income. Less income will of course result in prevalence of anemia and night blindness in the study area. However, the relationship between nutritional status of children suffering anemia and night blindness and type of food of a mother during pregnancy gave highly significant probability (Table 8). The food types during pregnancy (table 4) reflect household monthly income level, educational attainment, and other socioeconomic characteristics of the surveyed households in the study area. The relationship between sex – age structure of children suffering anemia and night blindness and frequency of daily intake of bread and cereals (P = 0.0008), milk and milk products (P= 0.0008); legumes (P = 0.0007); vegetables (P = 0.0001); fruits (P = 0.0005); and other food types (p = 0.0004); are positive and highly statistically significant which suggests for influence of food nutrients on anemia and night blindness during early childhood. There is highly significant relationship between nutritional status of children suffering anemia and night blindness and number of children under five year old in the household (P= 0.0002). This points out to decreasing food nutrients intake with increasing number of persons sharing the common dish which its protein content was originally low. This is further depicted by the relationship between nutritional status of these sick children and ideal method for food distribution in the family (P = 0.027). Since energy and protein intakes (Table 6) were less and the households are big enough, it is expected to have positive relationship between household size and nutrition status of these sick children. In addition, relationship between hemoglobin level (%) and amounts of animal protein consumed is positively statistically significant (P= 0.01); and similarly with plant protein (P= 0.03).

Table 8. Chi-Square test for relation between some socioeconomic factors and nutritional status of children suffering anemia and night blindness in Khartoum State

Parameters	Probability
Monthly income and number of meals per day by child Monthly income (-300; 300-750; 750+) Number of meals (-2;3;4; 4+)	0.002
Nutritional status and type of food during pregnancy Nutritional status (normal; simple; moderate; Severe) Type of food during pregnancy (see table 4)	0.0056
Age-sex structure of children – 5 year old and frequency of bread and cereals intake / day Age –sex structure (see table 3) Frequency of bread and cereals (daily, once a week; twice a week; trice a week)	0.00080
Age-sex structure of children – 5 year old and frequency of milk and milk products intake / day Age –sex structure (see table 3) Frequency of milk intake (daily, once a week; twice a week; trice a week)	0.0008
Age-sex structure of children – 5 year old and frequency of meat and meat products consumed / day Age – sex structure (see table 3) Frequency of meat and meat products intake (daily, once a week; twice a week; trice a week)	0.0003
Age-sex structure of children – 5 year old and frequency of legumes intake / day Age – sex structure (see table 3) Frequency of legumes intake (daily, once a week; twice a week; trice a week)	0.0007
Age-sex structure of children – 5 year old and frequency of vegetables consumed / day Age – sex structure (see table 3) Frequency of vegetables intake (daily, once a week; twice a week; trice a week)	0.0001
Age-sex structure of children – 5 year old and frequency of fruits consumed / day Age – sex structure (see table 3) Frequency of fruits intake (daily, once a week; twice a week; trice a week)	0.0005
Age-sex structure of children – 5 year old and frequency of other food types (dates, Karkadh, Gongolaiz) consumed / day Age – sex structure (see table 3) Frequency of other food types intake (daily, once a week; twice a week; trice a week)	0.0004
Nutritional status and number of children under five year old living with family and outside family Nutritional status (normal; simple; moderate; Severe) Children under 5 year old (living with the family; outside the family)	0.0002
Hemoglobin and amounts of animal protein consumed Hemoglobin (see table 1) Animal protein (see tables 6 and 7)	0.01
Hemoglobin and amounts of plant protein consumed Hemoglobin (see table 1) Plant protein (see tables 6 and 7)	0.03
Nutritional status and ideal method for food distribution in the family Nutritional status (normal; simple; moderate; Severe) Ideal method of food distribution (sharing one dish, separately)	0.027

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DISCUSSION

The study investigated nutritional status of children less than ten year old in a rural and an urban geographic setting of Sudan. In rural western Kordofan, daily intake of protein, carbohydrates and energy for children less than ten year old is below FSU (2005) results (1803 kcal vs. 1962 kcal). Energy obtained by higher protein and carbohydrates intakes by FSU study was more than double the value obtained by excess fat intake in rural western Kordofan. Cereals highly contribute to energy and protein intake in rural western Kordfan, a situation similar to rural Philippines where 361g/person/day are consumed there (Florentino, 1999). The investigation of nutritional status of children suffering anemia and night blindness in Khartoum State suggests low hemoglobin rate; inadequate food intake and prevalence of malnutrition by age and sex with major and minor differences. Males suffering anemia and night blindness are more malnourished compared to females. This agrees with the fact that, generally children suffer night blindness between second and fifth year of childhood, with more emphasis to males than females, but the situation is different concerning anemia which prevails more between 6 to 8 months of a childhood, but with more emphasis to males than females (Hassan *et al.,* 2002). Comparing macronutrients daily intake in Khartoum State with the study by Ministry of Agriculture and Forestry of Sudan (FSU, 2005) puts the study area below by that there are less protein, carbohydrates and lower energy intakes. There is less animal protein; vitamins, minerals consumed and abundant cereal are consumed. In the study area, fat and carbohydrates (calories) consumed were lower than the recommended values (Katch, 1983) and for population in Africa which is 2041.7 calories (Latham, 1997). This study agrees with Mohammed's study in Al Shigla area in east Khartoum State, which indicated to imbalanced intake of food types where legumes and cereals are abundantly consumed while meat, fish and chickens are less consumed among surveyed households (Mohamed, 1999). It also agrees with Ali's study in north state of Sudan where cereals are the main source for poor households although cereals are deficient in vitamin A, and 41% of the sample suffers vitamin A deficiency (Ali, 2005). Energy obtained by higher protein and carbohydrates intakes was more than double the value obtained by excess fat intake in this study (FSU, 2005).

Prevalence of breast feeding in Khartoum State is attributed to the awareness of mothers to its nutritional value to a newborn child, and to the inherited Islamic culture which enhances mothers to breast feed their children for two complete years. It might be also attributed to that, the majority of urban households are incapable to purchase readymade food for their children where 70 to 80% of urban population live below the poverty line (Hamid, 2000), and also many of the mothers are mainly housewives who have fully devoted themselves to child bearing. The low rate of hemoglobin concentration among children suffering anemia and night blindness is below 60% standard rate, and confirms prevalence of Iron deficiency anemia. This might be attributed to illiteracy of mothers and poverty and also to some food habits. Sudanese mothers used to give children tea directly after a meal. Tea contains Phenols components which reduces Iron absorption (Sudan National Ministry of Health, 2003).

In rural western Kordofan, underweight children represented 58.3% here, which is almost similar to the 50.0% cited by FAO/WFP (2006) for pre-2001 studies for north Kordofan state. However, it was higher than the most recent report (SHHA, 2006) of 42.9% (35.0% moderate and 7.9% severe) for north Kordofan state. The result was also higher than all previous studies carried out in Sudan, although it is similar to that of Al Jaloudi (2000) for children less than five years old living in poor urban Khartoum state. Yet, severe under nutrition was reported higher in west Kordofan than in north Kordofan (MICS, 2000). Wasting prevalence was 37.9% (19.6% as moderate and 18.3% as severe) while in the SHHS (2006) for north Kordofan state it was lower (16.0% total: 13.5% moderate and 2.5% severe). Figures obtained in this study were also higher than those obtained previously by Al Jaloudi (2000) which were, 18.7% moderate and 2.2% severe. In all relevant studies severe wasting was $\leq$ 3% but, however our study shows higher level. A stunting as measure of chronic undernutrition prevails in the study area as it was 23.7% (12.3% moderate and 11.4% as severe) which was lower than all previous studies for total or severe cases, which were 51.0% for north Kordofan and 47.7% for whole the Sudan (SHHA,2006). It was even lower than the figure of Sub-Saharan Africa of 38.0% (UNICE, 2008), or the 55.9% for rural Ethiopia (Yousuf, 2000). However, one in every seven children was wasted and one in every three was stunted in north Sudan (SERISS, 1988). Prevalence of

low weight and malnutrition among children less than 5 years old in Khartoum State is almost similar to the 50 % cited by FAO and WFP for pre-2001 studies for North Kordofan state (FAO/WFP, 2006). However, it was higher than the most recent report Sudan household health survey of 42.9% (SHHA, 2006). The result was also higher than all previous studies carried out in Sudan, although it is similar to that by Al Jaloudi for children less than five years old living in poor urban Khartoum state (Al Jaloudi, 2000). In addition, the difference in malnutrition is possibly due to geographic reasons. In Khartoum State, squatter areas have expanded rapidly in recent decades, occupied by poorest people who are generally facing inadequate food intake and unhygienic residential environment (Alredaisy & Davies, 2003; Babiker & Alredaisy, 1997).

Rural and urban communities in Sudan are generally suffering from lack of socioeconomic and community development projects, a situation further exacerbated in rural Sudan by adverse climatic conditions. The majority of rural population of Sudan lives in areas characterized by fragile environments and vulnerable to crop failure and animal loss. These situations determine the nutritional status of the population in general and children of less than 10 years old in particular who are mostly risky to malnutrition and infectious diseases. Environmental factors in rural western Kordofan somehow determine food production, food availability and population affordability to buy food. Rural western Kordofan is environmentally fragile. It lies within "very high risk" zone of desertification designated by the United Nations (UN, 1977). Its average annual rainfall values decreased markedly since early sixties (El Gamri, *et al.,* 2009). Natural vegetation has deteriorated and total biomass gets over-exploited by grazing and browsing animals (Davies, 1987). Resident population of the study area used to increase their cultivation area since coefficient of variation of the annual rainfall is about 30% the area cultivated and the productivity varies widely from one year to another (MOIWR, 1999), causing desertification (Iskander, 1989) and deterioration of the food system (Alredaisy & Davies, 2001).

Fieldwork results in rural western Kordofan depicted higher level of protein intake implies consumption of better quality protein with increasing income. There is significant increase in energy and protein intakes with increasing incomes and a similar increase that was highly significant were recorded for protein (Ibrahim, 2008). This similar to the fieldwork results in Khartoum State which depicted positive relationship between numbers of meals a child takes per day and household monthly income. Some researchers are convinced that increasing income leads to increasing food intake (Strauss, 1984, Maxwell *et al.,* 2000) while some others believe that poor households spend their additional incomes on more expensive foods such as finer cereals, meat or dairy products which do not necessarily yield more energy. The fieldwork results support the first assumption that increasing income had positively increased energy intake, and therefore increased protein intake. Income was also positively correlated, probability of 0.000, with the nutritional status. Less income resulted in prevalence of undernutrition in rural western Kordofan. Thus decreasing income led to marginal or sub-optimal intakes of energy and protein resulting in more prevalence of undernutrition. In addition, it is expected that more energy and protein will positively correlate with three meals per day other than with two meals.

The growth of towns and cities in Sudan has been accompanied by growing numbers of poor and vulnerable urban dwellers (Sara Pavanello, 2011). The majority of the urban poor are dependent upon marginal livelihood activities in the informal economy, and their access to safe and sustainable livelihoods is extremely unstable (Sara Pavanello, 2011). However, many studies in Sudan referred low weight, stunting and wasting among young children to unequal income distribution, vertically between incomes and horizontally between rural and urban areas (UNDP, 2006), and to mothers' literacy which positively effects low weight- for- age compared to illiterate mothers who have more stunted children in Sudan (FAO/WFP, 2006). Many studies in Sudan referred low weight among young children to unequal income distribution, vertically between incomes and horizontally between rural and urban areas (UNDP, 2006). Furthermore, increased income will increase food expenditure in the study area as has been confirmed in rural western Kordofan State (Alredaisy & Suleiman, 2011) that had significantly increased energy and protein intakes in the study area for both energy, probability of 0.042, and for protein with probability of 0.025, and significant relationship exists between food expenditure and undernutrition prevalence in the study area with probability of 0.004.

The relationship between nutritional status of children and type of food consumed during pregnancy is highly significant (0.0056). This might be attributed to household monthly income, educational level of a mother or a father where the majority has attained religious or basic education. Mothers' literacy positively effects low weight- for- age compared to illiterate mothers who have more stunted children in Sudan (FAO/WFP, 2006), and in Khartoum State (Magboul *et al.,* 2000), SERISS (1988), SMCH (1995) results where mothers' educational level was remarkably influential.

One of the main reasons for generally declining levels of food consumption in the study area is attributed mainly to the high living costs and high inflation rates in Sudan. The high expenditure on food in situations of low income, big households and illiteracy has many consequences. One consequence is that, a low-income household's consumer surplus for food is very high, amounting to a substantial proportion of its total income. This has important consequences for the economic appraisal of food supply. With regard to affordability, households are unable to pay for food at the current cost. High proportion would be unable to pay the actual costs of food. The revenue that may realistically be expected to be recovered from these households in the future lies somewhere between what they are able to pay and what they are presently willing to pay. Another consequence is the lack of elasticity and repercussions on expenditure for food would imperatively be retarded. The high price of food in urban Sudan is probably a major cause of the malnutrition prevalent in the squatter areas (Sandy *et al.,* 1992). Decreasing income led to marginal or sub-optimal intakes of energy and protein resulting in more prevalence of under-nutrition in rural western Kordofan of Sudan (Alredaisy & Suleiman, 2010).

CONCLUSIONS AND RECOMMENDATIONS

The general findings of this study are as follows:

1. This study gave an example on nutritional problems in rural and urban Sudan.
2. General nutritional status of children less than ten year old in rural and urban settings is below the recommended level for individual to remain healthy.
3. Malnutrition, underweight, stunting, and wasting and are prevalent in rural and urban Sudan.
4. There are no significant differences between rural and urban children concerning their nutritional status
5. Poverty, illiteracy, big household size, and environmental factors operate in rural and urban Sudan to determine nutritional status of young children.
6. Promotion of community and child nutrition is a necessity in the study area.

Based on that, some suggestions could be presented. Firstly, breast feeding should be enhanced from delivery up to six months of a child age, and should be accompanied by supplementary feeding thereafter up to the completion of two years of a child age. Secondly, more care should be devoted to qualitative and quantitative complementary feeding. Thirdly, introduction of balance diets rich in vitamin A, and Iron when a child completes six months of age, and during pregnancy and lactation is a necessity. Fourthly, nutrition education should be introduced and enhanced among mothers to accept knowledge about good child feeding. Fifthly, rural urban poor should be supported by small – finance projects to curb financial inflation which adversely depriving this segment of the society. In addition, rural communities improvement of community nutrition could include crop diversification to increase cash income among peasants; utilization of native food for child nutrition; benefit of seasonal food surplus by storage, combating desertification, reducing overgrazing and over wooding by introduction of solar energy and reclamation of forests, female education, health education and child spacing; developing youth capacity for social.

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