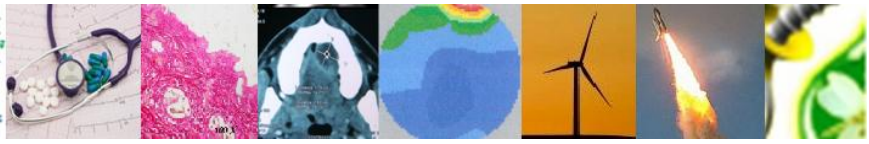

IIOAB ISSN: 0976-3104

RESEARCH ARTICLE

ASSESSMENT OF NUTRITIONAL STATUS OF CHILDREN LESS THAN 10 YEARS OLD IN RURAL WESTERN KORDOFAN

Samir Mohammad Ali Alredaisy* and Hashim Suleiman Ibrahim

University of Khartoum, Faculty of Education, SUDAN

Received on: 2nd-Oct-2010; **Revised on:** 16th-Dec -2010; **Accepted on:** 29th-Dec-2010; **Published on:** 19th-May- 2011

***Corresponding author:** Email: samiralredaisy@yahoo.com

ABSTRACT

This paper is based upon a field survey carried out in 2005 to assess the nutritional status of children less than 10 years old in rural western Kordofan. The main findings 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). Factors considered responsible for determining the nutritional status of these children were modeled and the paper recommended a strategy for promotion of the nutritional status in the study area.

Keywords: *rural setting; under–nutrition; malnutrition; stunting; wasting; poverty; food insecurity; nutrition security*

Abbreviations and acronyms: ***FAO,*** *Food and Agriculture Organization;* ***FSU,*** *Food Security Unit;* ***ILO,*** *International Labor Organization;* ***MOL,*** *Ministry of Labor;* ***PPS,*** *Probability Proportional to Size;* ***RDA,*** *Recommended Dietary Allowance;* ***SD,*** *Standard Deviation;* ***SDG,*** *Sudanese Gene;* ***SERISS,*** *The Sudan Emergency and Recovery Information and Surveillance;* ***SMCHS,*** *Sudan Maternity and Child Health Survey;* ***UNDP,*** *United Nations Development Program;* ***USD,*** *United States Dollars;* ***WFP,*** *World Food Program*

[I] 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 [1]. The study by the United Nations Development Program in 2005 reported that 75% of north Sudan population as poor and the majority (80%) is concentrating in rural areas where 30% of them suffered from extreme poverty [2]. Malnutrition is a real health problem in the country **[Table–1]**. Vulnerable groups to nutrition insecurity in Sudan are those whose food intake provides less than that recommended for refugees and internally displaced groups [3]. Camber and el Magboul's study excluded areas of armed conflict and identified areas nutritionally insecure in Sudan as to include rural areas of low crop and animal production; areas of low purchasing power and education and knowledge; areas of low access to health facilities and areas with low access to water especially during dry season [4]. Food insecure groups in Sudan were identified as those internally displaced people; vulnerable residents who were indirectly affected by the influx of internally displaced population in their communities and returnees numbering 4 million internally displaced population and 600,000 refugees almost all from south Sudan [5].

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" [6]. Food insecurity is "a limited or uncertain access to foods of sufficient quality or quantity to sustain a healthy and active life" [7]. Moreover, Thomas and Metz differentiated between chronic and transitory food insecurity [8]. The first type occurs when individuals or groups suffer from food insecurity at all times.

ISSN: 0976-3104

The second type associates with a temporary decline in access to food due to 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 [9]. Natural disasters, armed conflicts and hunger are also responsible for food insecurity [10, 11].

Table: 1. Malnutrition in Sudan

Low weight/age		Wasting		Stunting		References
Prevalence	Severe	Prevalence	Severe	Prevalence	Severe	
-	-	14.1	1.7	32.1	12.6	[12]
34.0	11.3	13.0	3.0	33.0	17.0	[13]
26.6	-	9.8	-	32.3	-	[14]
41.0	15.0	-	-	41.0	15.0	[5]

Nutrition insecurity leads to protein – energy malnutrition and usually assessed by surveys. Nutrition status is measured directly by dietary surveys, biochemical data, and anthropometric and clinical examination methods. While 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. 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 [15, 16]. Environment health largely determines nutritional status either through infections, depletion of nutrients and illness or vice versa [17, 18, 19].

[II] MATERIALS AND METHODS

2.1. Data collection

Data was collected during August – October 2005 in rural western Kordofan [**Figure–1**] by selecting six villages randomly. The villages selected included Abu Serour; Rahad el Selik; Wad Gudiem; Um el Badri; el Karanik and Maryoud. The area was chosen due to its fragile environment with expected food problems. Population number is 92368 persons distributed in 14512 households [20]. Cluster sampling is used for selection of rural villages by using PPS, and secondly for selection of the households from the ever selected villages.

The sample size was calculated by the formula:
$n = t^2\, pq/d^2 \times deff.$

Where: n is the sample size, t = 1.96, q= 0.50, p=0.05, d =0.08 and Deff. =1.5 (design effect).
Therefore: $n = (1.96)^2 \times 0.05 \times 0.50 / (0.08)^2 \times 1.5 = 225$
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 [21, 22, 23]. 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 SD) and undernourished (≤ - I SD). The (≤ - I SD) criterion is further divided into mild (-1 to - 2 SD); moderate (-2 to - 3 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 composition tables [24, 25]. 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 RDA calculation is based on FAO [26] 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%.

ISSN: 0976-3104

2.2. The study area

The study area is part of north Kordufan state **[Figure–1]**. It 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%.

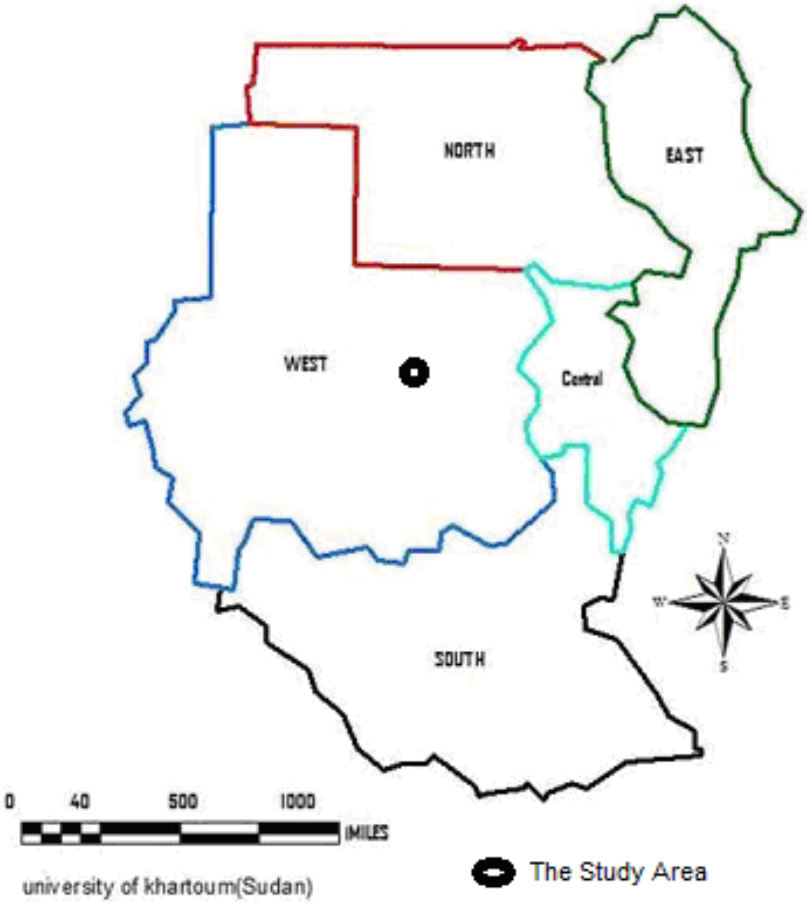

Fig: 1. Location of the study area in western Sudan

[III] RESULTS

Dietary and anthropometric evaluations are used to assess the nutritional status of children less than 10 years old in the study area. Factors considered responsible for the nutritional status are also presented.

3.1. Dietary evaluation (macro level)

Average contributions of carbohydrates, protein and fat to total energy were 56.2%, 9.3%, and 34.5% respectively **[Table–2]**. 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–2]**. Animal protein sources such as meat and milk have less contribution since 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 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

ISSN: 0976-3104

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.

3.2. Anthropometric evaluations (micro level)

Table–3 shows anthropometric evaluations for children less than ten years old in rural western Kordofan. Underweight children represented 58.3% here. Wasting prevalence was 37.9% (19.6% as moderate and 18.3% as severe. Wasting was prevalent in the study area by 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.

A stunting is a measure of chronic under–nutrition. Stunting prevalence in the study area was 23.7% (12.3% moderate and 11.4% as severe). The prevalence of underweight was rather similar to those found for fewer children aged less than five years old in the study area. Under weight was prevalent by 54.1% and constituted the majority within the moderate (68.1%) and severe cases (81.8%).

Table: 2. 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

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]

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.

3.3. Factors influencing nutritional status

Factors influencing the nutritional status of children less than 10 years old in the study area are modeled in **Figure–2**. Fieldwork results depicted higher level of protein intake implies consumption of better quality protein with increasing income. 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 **[Table–4]**.

The fieldwork results support the 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 under–nutrition in the study area. Thus decreasing income led to marginal or sub-optimal intakes of energy and protein resulting in more prevalence of under–nutrition **[Table–4]**.

ISSN: 0976-3104

Table: 3. Nutritional status of children underten in rural western Kordufan

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
	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]

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 under-nutrition prevalence in the study area with probability of 0.004 **[Table–4]**.

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–4]**. Number of meals per day influences energy and protein intakes, a positive relationship confirmed in the study area by a probability of 0.006 **[Table–4]**.

Energy intake reversibly decreased with increasing household size, where the calculated probability was 0.042 **[Table–4]**. 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. Positive relationship exists between household size and nutrition status in these rural areas and the calculated probability was 0.018.

However, other factors influencing nutrition status of children less than 10 years old in the study area might include mothers' level of education and environmental degradation as well as those factors which are work at the Country level, such as absence of social development programs, insufficient productive capital investment in agriculture and industry, inappropriate development policies neglecting rural development and armed conflicts in southern and western Sudan.

[IV] DISCUSSION

The general findings of this study depict low weight, prevalence of wasting and stunting among children less than 10 years old in rural western Kordofan. They are thoroughly affected by their households' income and size and high illiteracy where less animal protein, vitamins, minerals, and abundant cereal are consumed. In the study area, fat consumed was slightly higher and carbohydrates were lower than the recommended values [27]. Comparing macronutrients daily intake in the study area with the study by Ministry of Agriculture and Forestry of Sudan [28] puts the study area below by that there are less protein, carbohydrates and lower energy intakes (1803 kcal vs. 1962 kcal) and above as there is more fat intake. Energy obtained by higher protein and carbohydrates intakes was more than double the value obtained

ISSN: 0976-3104

by excess fat intake in this study [28]. Cereals highly contribute to energy and protein intake in the study area, a situation similar to rural Philippines where 361g/person/day are consumed there [29]. Animal protein sources such as meat and milk provide less than the recommended value which is 55.3g [28].

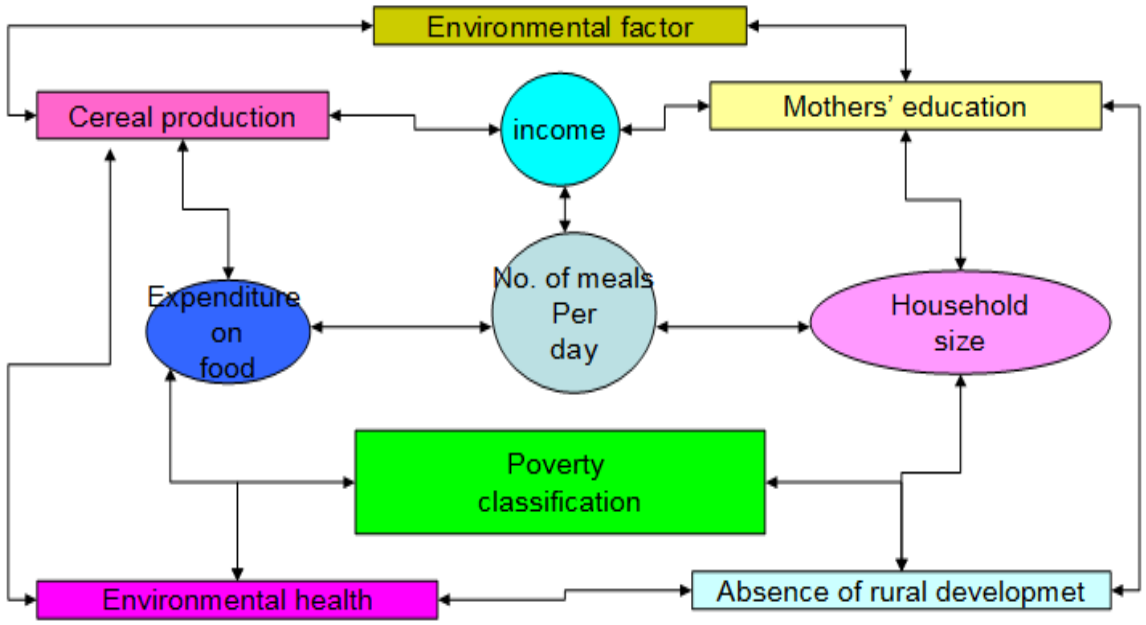

Fig: 2. Factors influencing nutritional status of children >10 years old in a rural environment of western kordofan. Adopted from Fieldwork [2005] and UNDP\FWP [2006]

Underweight children percent is almost similar to the 50.0% cited by FAO and WFP for pre-2001 studies for north Kordofan state [5]. However, it was higher than the most recent report *Sudan household health survey* of 42.9% (35.0% moderate and 7.9% severe) for north Kordofan state [30]. 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 [31]. Yet, severe under nutrition was reported higher in west Kordofan than in north Kordofan [32]. In addition, the difference in prevalence rate is possibly due to geographic reasons. A drop from 50.0% to 42.9% indicated to better food intake and less infectious diseases [32], so probably this was not the case in our study area as 51.8% of the total households were food insecure.

Wasting prevalence rate in the study area is higher compared to north Kordofan state which was 16.0% as total and 13.5% as moderate and 2.5% as severe [30]. Figures obtained in this study were also higher than those obtained previously by Al Jaloudi [31] which were, 18.7% moderate and 2.2% severe. In all relevant studies severe wasting was ≤ 3% but, however our study shows higher level. Stunting prevalence in the study area is lower than all previous studies for total or severe cases **[Table–1]** which were 51.0% for north Kordofan and 47.7% for whole the Sudan [30]. It was even lower than the figure of Sub-Saharan Africa of 38.0% [33], or the 55.9% for rural Ethiopia [34]. However, one in every seven children was wasted and one is every three was stunted in north Sudan [12].

Environmental factors somehow determine food production, food availability and population affordability to buy food. The study area is environmentally fragile. It lies within "very high risk" zone of desertification designated by the United Nations [35]. Its average annual rainfall values decreased markedly since early sixties [36]. Natural vegetation is deteriorated and total biomass gets over-exploited by grazing and browsing animals. As a result, vegetation may still appear quite dense after heavy grazing, whereas in fact selective grazing has eaten out many of the palatable species and reduced the carrying capacity dramatically [37]. 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 [38]. They clear wide areas to grow crops and so compete with livestock for both land and water. In 1973, the Agricultural Conference recommended rainfed cultivation south of 300 mm rainfall line to stop environmental degradation. However, people are still cultivating areas north of that line [39], causing desertification [40] and deterioration of the food system where about half the population of sub-Saharan Africa is living below the poverty line, with both numbers and percentage on the increase [41].

ISSN: 0976-3104

Table: 4. Factors influencing 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
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

Adopted from Fieldwork [2005]

Fieldwork results 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 [42]. 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 [43]. Some researchers are convinced that increasing income leads to increasing food intake [44, 45], 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 with the nutritional status. Less income resulted in prevalence of under-nutrition in the study area. Thus decreasing income led to marginal or sub-optimal intakes of energy and protein resulting in more prevalence of under-nutrition. Increased food expenditure had significantly increased energy and protein intakes in the study area for both energy and for protein.

A significant relationship exists between food expenditure and under-nutrition prevalence in the study area. 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. Energy intake reversibly decreased with increasing household size. Protein intake also decreased with increasing household size. Decrease in protein was high in these poor rural areas 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. 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.

Mothers' literacy positively effects low weight- for- age compared to illiterate mothers who have more stunted children in Sudan [5]. The study by Magboul, et al. [14] revealed that wasting was 11.3% in Khartoum and Omdurman towns, while it was 4.9% in Khartoum north, a result similar those by the

ISSN: 0976-3104

Sudan emergency and recovery information and surveillance [12] and Sudan maternity and child health survey [13] where mothers' educational level was remarkably influential. However, other factors influencing nutrition status of children less than 10 years old in the study area might include those operating at the national level. They are absence of social development, insufficient productive capital investment in agriculture and industry [46], ill-conceived development policies neglecting rural development **[Figure–2]** and armed conflicts and drought [47].

[V] CONCLUSIONS AND RECOMMENDATIONS

The general conclusions of this study are as follows:

1. General nutritional status of households is below the recommended levels for population to remain healthy.
2. Children less than ten years old suffer malnutrition, underweight, wasting and stunting.
3. Poverty, big household size and illiteracy are as well as environmental factors highly influencing the nutritional status of this age group..
4. Promotion of community and child nutrition is a necessity in the study area.

Recommendations for promotion of the nutritional status of this vulnerable age group of the population in the study area require local and national collaboration and integration. This paper suggests a strategy of six integrated parts **[Figure–3]**. These are agricultural development; environmental conservation; community development; economic development; family development and village development.

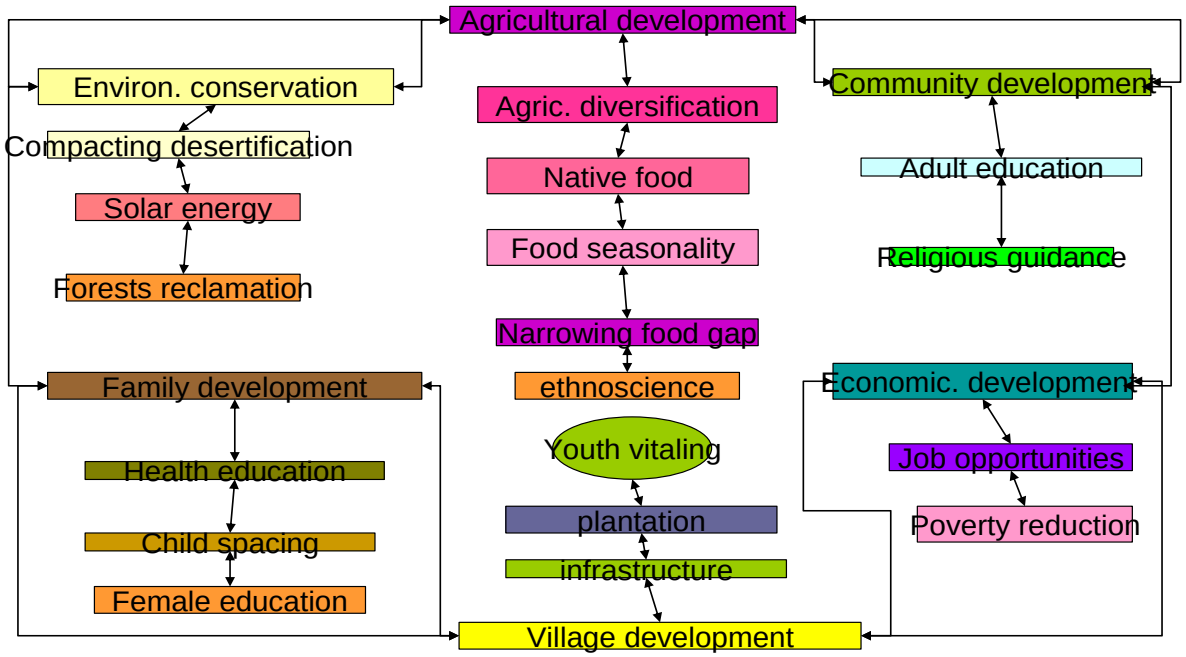

Fig: 3. A proposed model for the promotion of the nutritional status of children under 10 in rural western Kordofan. The application of this integrated strategy for promotion of child nutrition in the study area can work to assess nutrition in order to decide on appropriate methods through activation of the inputs, processes, and outputs outlined by the strategy with the ultimate result of reducing malnutrition in the study area and in Sudan. However, this strategy can also be applied for any other similar places facing similar problems of nutrition in Africa, Asia, and Latin America.

Agricultural development strategy adopted crop diversification to increase cash income among peasants; utilization of native food as a cheap and nutritive source for child nutrition and to benefit from food surplus during harvest as a reserve for times of shortage or deficiency and at times when household money reserve is depleted to the minimum. The strategy of enhancing traditional knowledge into agricultural practice and food preparation and conservation will help to avoid crop failure, combating insects and pesticides and improve households' food intake.

Environment conservation strategy will help to improve agriculture as it included combating desertification, reducing overgrazing and tree logging through the introduction of solar energy and reclamation of forests. Community development strategy can work to integrate family development strategy with female education, health education and child spacing to aware household on better use of food and for proper feeding of young children with qualitative food required at all stages of their growth. Economic development strategy will promote

ISSN: 0976-3104

household incomes by creating job opportunities and poverty reduction through small credit finance and micro investment. Village development strategy can work towards enhancing capacity of local youth for social work and environmental awareness such as trees plantation around their settlements, awareness creation on nutrition and children feeding and educating of mothers on child feeding and nutrition. In addition, Basic infrastructure including schools, youth clubs, and medical dispensaries will promote social life and interaction while building roads and highways will link the study area with other parts of the Sudan.

REFERENCES

[1] Ministry of Labor. (MoL/ILO). [1997] Trends and profiles of poverty in Sudan [1990–2008]. Ministry of Labor and International Labor Organization, Khartoum.
[2] United Nations Development Program. [2005] Human development report. Oxford University Press, Oxford.
[3] IOM. [1995] Estimated mean per capita requirements for planning food aid rations. National Academy for Science, Committee on International Nutrition, Washington, DC.
[4] Cambrez C, el Magboul b1. [1998] Food security and nutrition situation in north Sudan. FAO/WFO Crop assessment mission for Sudan, Khartoum, Sudan.
[5] FAO/WFP. [2006] Special report, crop and food supply. Assessment mission to Sudan, 8–27/10/2005, FAO, Rome.
[6] FAO [1996] Declaration of World food security and World food summit plan of action. 13–17/11/1996, FAO, Rome.
[7] Mohamed AE, Zziwa S. [2004] IGAD Food Security Strategy (2005–2008). Agricultural and Environmental Division, IGAD, Djibouti.
[8] Thomas JA, Metz M. [1997] Implication of economic policy for food security, a training manual for agricultural planning. No. 40, prepared by AO and GTZ. FAO, Rome.
[9] Valdes A, Siamwalla A. [1981] In "Food security in Developing Countries". Westview Press, Boulder, Colorado, 4-6.
[10] Alexander D. [1997] The study of natural disasters, 1977–1997: some reflection on a changing field of knowledge. *Disasters* 21(4):284–304.
[11] Hinrichs K. [2002] Nutrition in the context of crises and conflicts. ACC/SCN 5:97–108.
[12] SERISS. [1988] The Sudan emergency and recovery information and surveillance. Ministry of Health, Directorate of primary health care/ nutrition Department, Department of Statistics. Workshop, Friendship Hall 22–25 Feb, Khartoum, Sudan.
[13] SMCHS. [1995] Sudan maternity and child health survey. Ministry of Health, Khartoum, Sudan.
[14] Magboul BI, Mohammad KA, El Khalifa MY. [2002] Dietary iron intake and prevalence of iron deficiency anemia among underfive children in Khartoum state. Report to EMRO/WHO, Project EM/ICP/RPS/002.
[15] UNICEF. [1990] Strategy for improved nutrition of children and women in Developing Countries. UNICEF, New York.
[16] Brahman GNV. [1988] Intra family distribution of dietary energy- an Indian experience. *Ecol of Food Nutr* 22: 56–64.
[17] United Nation University "UNU". [1979] The nutritional consequences of acute and chronic infections. Protein energy requirements under conditions prevailing in Developing Countries: current knowledge and research needs. *Food Nutr Bull* S(1): Tokyo.
[18] Osmani SR. [1997] Poverty and nutrition in south Asia. ACC/SCN Symposium, Katmandu, March 1997. *Nutrition Policy Report* 16: 23–51.
[19] Biesel WR. [1984] The metabolic effects of infection. Progress in Food. *Nutr Sci* 8:43–5.
[20] Central Bureau of Statistics [1997] Sudan Census Report. Khartoum, Sudan
[21] Gomez F, et al. [1955] Malnutrition in infancy and childhood with special reference to Kwashiokor. In " Advances in Pediatrics", Vol. V11, 84. Ed., S. Levine, Yearbook Publisher, Chicago.
[22] WHO. [1995] Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. *WHO tech Rep Se* 854: WHO, Geneva.
[23] Waterlow JC, et al. [1977] The presentation and use of height and weight data for comparing the nutritional status of groups of children under age of 10 years. *Bul. WHO* 55:489–498.
[24] Sukkar MY. [1985] In "Human nutrition". Khartoum, Sudan.
[25] Boutros JZ ed. [1986] Sudan food composition tables, 2nd ed National Chemical Laboratories, Ministry of Health, Khartoum, Sudan.
[26] FAO. [1994] Body mass index, a measure of chronic energy deficiency in adults, Food and Nutrition paper, no.56, FAO, Rome.
[27] Katch FI, et al. [1983] In nutrition, weight control and exercise. 2 nd edition, Lea and Bebiger, Philadelphia.
[28] FSU. [2005] Food security annual report. Food Security Unit, Ministry of Agriculture and Forestry, Khartoum, Sudan.
[29] Florentino RF. [1996] Contribution of major food items on calorie and protein in takes in Filipinos. Joint technical workshop of the micro impacts of macroeconomics adjustment policies and the Philippine Institute of Development Studies technical resources project, 11-12/4/1996, Calatagen, Phillip.
[30] SHHA. [2006] Sudan household health survey. National report, Government of Sudan, WFP/UNEFPA/WHO/USAID/UNICEF, Khartoum, Sudan.
[31] Al Jaloudi AE. [2000] Assessment of the nutritional status and household food security in the poor urban areas in Khartoum state: case study "Marzouk in Omdurman". Unpub. PhD. Thesis, University of Khartoum, Sudan.
[32] MICS.[2000] Multiple indicator cluster survey on child health and nutrition. National Nutrition Department, Ministry of Health, Khartoum, Sudan.
[33] UNICEF. [2008] *UNICF Statistics.* March 2008, New York.
[34] Yousuf ME. [2000] Nutritional status of preschool children in north-west Ethiopia. *East African Med J* 77(8):425–427.
[35] United Nations. [1977] Desertification: its causes and consequences. Pergamon, Oxford.
[36] ElGamri T, Saeed AB, Abdalla KA. [2009]Rains of the Sudan: Characteristics and Prediction. ADAB, no. 27, 18–35.University of Khartoum, Faculty of Arts, Sudan.
[37] Davies HRJ. [1987] After the famine in the Sudan: can Australian experience help? *The Geographical Journal* 153 (2): 181–194.
[38] MOIWR, Ministry of Irrigation and Water Resources. [1999] Sudan national water policy. MOIWR, FAO, UNDP.
[39] Ibrahim Fouad, AGhani AA. [1983] The problem of desertification in Sudan. *Tasahour magazine* 1: 15–30.
[40] Iskandar W. [1989] A strategy of using water resources for desertification combating. *Arab Centre for Arid Lands Studies*. IKSAD/DM/T 115)

ISSN: 0976-3104

[41] Alredaisy SMA, Davies HRJ. [2001] Food insecurity in Sub-Saharan rainlands: Um Sial, a village in White Nile state, Sudan. *The Arab World Geographer* .3(1): 19–30.
[42] Ibrahim HS. [2008] Poverty, food security and malnutrition in an urban – rural setting: case study the former west Kordofan state. Unpublished PhD thesis, University of Khartoum.
[43] UNDP. [2006] Macroeconomic policies for poverty reduction, the case of Sudan. Khartoum.
[44] Strauss J. [1984] Joint determination of food consumption and production in rural Sierra Leone, estimate of a household mode. *J of Develop Econ* 14:19–103.
[45] Maxwell D, et al. [2000] Urban livelihoods and food nutrition security in Greater Acccra, Ghana. IFPRI/Noguchi Memorial Institute for Medical Research/WHO. Accra, Ghana.
[46] UNDP. [1998] Sudan- Common Country Assessment. UNDP, Khartoum.
[47] Zeng N. [2003] Drought in the Sahel. *Science* 302: 999–1000.