The Impact of Irrigation on the Nutritional Status of Children in the Sissala West District of Ghana

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Abstract: According to the Food and Agriculture Organization (FAO, 2006) the most sustainable way to reduce hunger effectively is to improve agriculture and rural development simultaneously. The study investigated the impact of irrigation dam projects on child nutritional status. A total of 397 mother-child pair from three communities (control, 1 year and 2 year intervention with introduction of irrigation dam) with and without irrigation dams participated in the study. Nutritional status was assessed using anthropometric indicators (height/length, weight and MUAC) and haemoglobin levels. For haemoglobin assessment a sub-sample of 200 children was used. Twenty-four h dietary recall was used to assess dietary intake. The results showed significant differences (p<0.001) in wasting rates of 11.0, 21.2 and 12.3%, respectively, among children in the control, 1 year intervention and 2-year intervention communities, respectively. Haemoglobin assessment revealed that a greater proportion of children (70.1%) were anaemic. The 1 year intervention had a significantly higher number of children (p<0.001) who had haemoglobin in the normal range. Most (95.9%) of the children did not meet their energy needs according to their dietary intake records. Child feeding practices continue to be a challenge in these communities. Currently, the impact of the irrigation dam on the livelihoods and nutritional status of the children is not obvious but more time is needed to realize the full potential. Nutrition education should target the incorporation of fish from the dam into young child feeding in these communities.

Key words: Anaemia and irrigation dams, child, nutritional status, stunting, wasting

INTRODUCTION

Malnutrition is said to be caused by the synergistic effect of inadequate dietary intake, infection, and improper care practices (Pelletier, 1994). In Ghana, about forty-five percent (45%) of the population live in abject poverty (living below US$ 1.00 per day). This situation is most prevalent in the rural areas and across the three northern regions of Ghana (Hong, 2007; UNDP, 2005; Takyi, 1999). According to Hong (2007) economic inequality is strongly associated with chronic childhood undernutrition. Bridging the gap in economic inequality in Ghana will improve overall child nutrition and health. It is, therefore, not surprising that these three northern regions of Ghana with significant disparity in economic equality are among the four regions with highest deficiency rates in iodine, vitamin A, iron, protein, and energy with the most afflicted being children and women (FAO, 2004; GDHS, 2003). This study evaluated the impact of introduction of irrigation dam projects to rural communities in Northern Ghana (to improve food security) on the nutritional status of children.

METHODOLOGY

This was cross-sectional study and post-intervention in nature. The study was conducted in the Sissala West District of the Upper West Region of Ghana from September, 2008 to September 2009. The District is located in the North Eastern part of Ghana. It shares boundaries with the Jirapa Lambussie District to the west, Sissala East District to the East and Burkina Faso to the North and Wa East District to the South. Ethical clearance for the study was granted by the Institutional Review Board of Noguchi Memorial Institute of Medical Research of the University of Ghana. Eligibility to participate in the study included the child being less than 60 months old, and mother must have lived in the community prior to the construction of the dam in the Sissala West District or 2 years before the study for the non-dam communities. The mother must be willing to participate with her child and signed an informed consent form on behalf of her child.

A total of 397 mother-child pairs were recruited randomly from eight different communities based on

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accessibility and use of irrigational dams and classified as control community (n = 100), 1-year intervention (n = 149) and 2-year intervention (n = 148). Mothers were interviewed to obtain information on child's age, sex and food intake. Measurements of Mid-upper Arm Circumference (MUAC) was taken using a non-stretch flexible tape to the nearest millimeter (mm). MUAC of >110 mm was considered normal for children between 6 to 60 months (Myatt *et al.*, 2006; Nikhil, 2000). Height/length was measured to the nearest centimeter using calibrated stadiometer/infantometer and weight to the nearest 0.1 kg using weighing scale. All these measurements were taken following standard protocol. These measurements were used to evaluate stunting (height-for-age), underweight (weight-for-age) and wasting (weight-for-height) (Gibson, 1990). Blood haemoglobin level was evaluated on a sub-sample (n = 200) using the hemocue to assess the prevalence of anaemia among the children. A pre-tested 24 h food recall questionnaire was used to solicit information from mothers on food intake of the children.

Data was analysed using SPSS for Windows version 16.0 (Chicago, IL). Data for height/length and weight of children were converted to their respective z-scores for age as indicators for underweight (Weight-for-Age; WAZ <-2), Stunting (Height-for-Age; HAZ <-2) and wasting (Weight-for-Height; WHZ <-2). The z-scores were calculated using the WHO standard for children under 60 months (WHO, 2006a, b; USAID, 1999). The categories for normal were set at ±2 standard deviation (Seal and Kerac, 2007). The Pearson Chi-square test was used to examine significant differences between the different groups. For iron nutrition, blood haemoglobin level of between 10-14 g/dL was considered normal while levels less than 10 g/dL was considered anaemic (Bruno *et al.*, 2008). Food intake was obtained by 24 h recall and analyzed using F-Pro (version 6.02) to convert foods consumed into calories. The caloric intake was further classified as higher than required, normal or less than required according to calorie-for-age (Whitney *et al.*, 1987; Juliette, 2008, 2009) as shown in Table 2.

RESULTS

Background characteristics: A total of three hundred and ninety-seven (N = 397) mother-child pairs participated in this study. Table 1 shows the demographic background of the participants and their distribution according to irrigation dam use. The distribution of the children according to group was as follows: 2 years intervention (n = 148); 1 year intervention (n = 149) and control group (n = 100). The majority of the children (26.0%) were 13-24 months old. The gender distribution of the children who participated in the study was 194

Table 1: Demographic background of particiapnts by years of intervention

| Charateristics | n (%) | | | |
	D2[*]	D1[#]	ND[&]	Total
Maternal data				
Age (years) (n = 385)				
18-29	61 (41.5)	54 (37.5)	28 (29.8)	143 (37.1)
30-40	76 (51.7)	66 (45.8)	57 (60.6)	199 (51.7)
>40	10 (6.8)	24 (16.7)	9 (9.6)	43 (11.2)
Marital status (n = 393)				
Single	4 (2.7)	3 (2.1)	1 (1.0)	8 (2.0)
Married	136 (91.9)	134 (91.8)	98 (99.0)	368 (93.6)
Divorced	3 (2.0)	2 (1.4)	0 (0)	5 (1.3)
Widowed	5 (3.4)	7 (2.7)	0 (0)	12 (3.0)
Educational status (n = 382)				
Primary School	11 (8.0)	11 (7.4)	15 (17.4)	37 (9.7)
Middle/JSS School	5 (3.6)	3 (2.0)	12 (14.0)	30 (7.9)
Secondary/Vocational	1 (0.7)	1 (0.7)	1 (1.2)	3 (0.8)
None	121 (87.7)	133 (89.9)	58 (67.4)	312 (81.6)
Parity (n = 387)				
1	18 (12.2)	8 (5.8)	2 (2.0)	28 (7.3)
2	28 (18.9)	18 (12.9)	4 (4.0)	50 (12.9)
3	24 (16.2)	25 (18.0)	11 (11.0)	60 (15.5)
4	20 (13.5)	26 (18.7)	14 (14.0)	60 (15.5)
More than 4	58 (39.2)	62 (44.6)	69 (69.0)	189 (48.8)
Child data				
Age (Mo: n = 392)				
0-12	24 (16.4)	30 (20.3)	38 (38.8)	92 (23.5)
13-24	39 (26.7)	32 (21.6)	31 (31.6)	102 (26.0)
25-36	31 (21.2)	31 (20.9)	17 (17.3)	79 (20.2)
37-48	36 (24.7)	31 (20.9)	4 (4.1)	71 (18.1)
49-60	16 (11.0)	24 (16.3)	8 (8.2)	48 (12.2)
Sex (n = 395)				
Male	78 (53.1)	71 (47.7)	45 (45.5)	194 (49.1)
Female	68 (45.9)	78 (52.3)	54 (54.5)	201 (50.9)

[*]D2: 2 years intervention; [#]D1: 1 year intervention; [&]ND: Control group; n: varies due to refusal to answer, missing values or unaplicable questions

males and 201 females. Out of this number, 149 males and 146 females were from intervention communities and the rest were from control communities.

The nutritional status of the children, using anthropometric indicators (WHZ, HAZ and WAZ) and haemoglobin levels as well as their caloric intake, are presented in Table 2. Our data according to the WHZ index (wasting) show that 78.4% of the total children in the study were of adequate nutritional status. Surprisingly, majority of these children (85.7%) were from the control communities (p<0.001). It was observed that 7.7% of the children from the 2 year intervention communities were moderately undernourished (wasted). The distribution of severe wasting was 11.0, 21.2 and 12.3% of children in the control, 1-year intervention and 2 year intervention communities, respectively (Fig. 1). For HAZ (a measure of stunting), about 80% of children in all the three groups had normal height/length for their age. About 8% of the children were severely stunted (HAZ <-2 z-score) with the highest proportion (9.1%) recorded among the 1-year intervention communities (Fig. 2). The differences in

Table 2: Child nutritional status and calorie intake by years of dam use by mothers

Frequency (percentage) Indicator	D2[*]	D1[#]	ND[&]	Total	p-value
Weight-for-height (wasting)(n = 371)					
Normal (±2 SD)	112 (81.2)	101 (71.2)	78 (83.5)	291 (78.4)	
moderate malnutrition (-2 to-3 SD)	9 (6.5)	11 (7.7)	3 (3.3)	23 (6.2)	
Severe malnutrition (<-3 SD)	17 (12.3)	30 (21.1)	10 (13.2)	57 (15.4)	p<0.001
Height-for-age (stunting) (n = 372)					
Normal (±2 SD)	117 (84.8)	114 (79.7)	76 (83.5)	307 (82.5)	
Moderate malnutrition (-2 to-3 SD)	10 (7.2)	16 (11.2)	11 (12.1)	37 (10.0)	
Severe malnutrition (<-3 SD)	11 (8.0)	13 (9.1)	4 (4.4)	28 (7.5)	p<0.001
Weight-for-age (underweight) (n = 376)					
Normal (±2 SD)	109 (77.9)	102 (70.3)	74 (81.3)	285 (75.8)	
Moderate malnutrition (-2 to-3 SD)	18 (12.9)	16 (11.1)	9 (9.9)	43 (11.4)	
Severe malnutrition (<-3 SD)	13 (9.2)	27 (18.6)	8 (8.8)	48 (12.8)	p<0.001
Haemoglobin level (n = 200)					
Normal (10-14 g/dL)	22 (14.9)	22 (28.6)	11 (22.9)	55 (27.9)	
Low haemoglobin levels (<10 g/dL)	52 (68.4)	54 (70.1)	36 (75.0)	142 (70.6)	
High haemoglobin levels (>14 g/dL)	1 (0.7)	1 (1.3)	1 (2.1)	3 (1.5)	p<0.001
Daily calories intakes (n = 167)					
Higher than required	0 (0)	3 (4.5)	1 (2.6)	4 (2.3)	
Normal	0 (0)	1 (1.5)	2 (5.2)	3 (1.8)	
Less than required	63 (100)	62 (94.0)	35 (92.2)	160 (95.9)	

[*]D2: 2 years intervention; [#]D1: 1 year intervention; [&]ND: Control group; p-value was significant at p<0.05; Pearsons chi-square was used for categorical data. For Daily Calories intakes no p-values were run due to the null cells. n varies due to refusal to answer, missing values or unaplicable questions
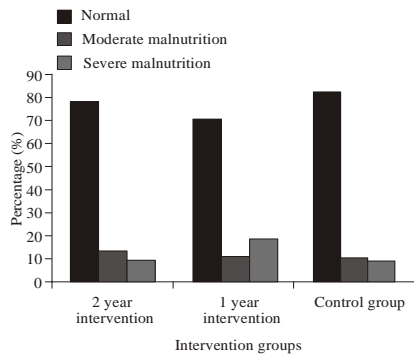

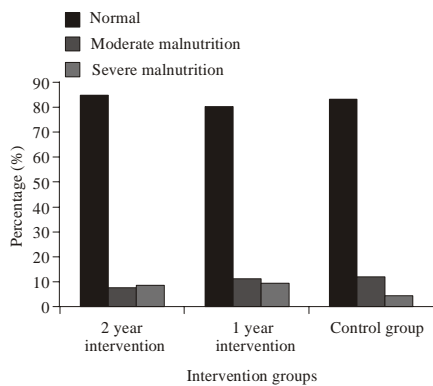Fig. 1: Distribution of wasting by intervention groups

Fig 2: Distrition of Stunting by Intervention Groups

Fig. 3: Distribution of underweight children by intervention groups

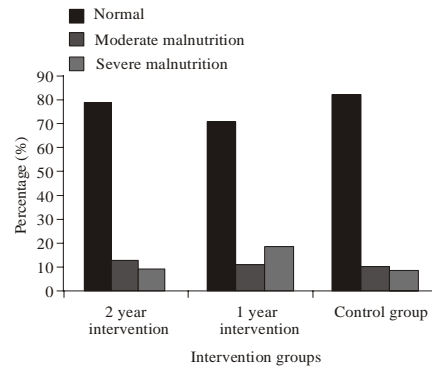stunting observed between groups were statistically significant (p<0.001). Using WHZ as a measure of underweight, we observed significant differences between the groups (p<0.001). Using a cut-off of WHZ <-2, we observed the control communities to have the highest number of normal weight children (81.3%) compared to their counterparts from the intervention communities. They also had the least number of children who were severely underweight (Fig. 3). Also, our assessment of MUACZ indicated that over 96.8% of the children were normal.

Regarding the haemoglobin levels, 28.5% of the children in the 1-year intervention communities had normal levels. The data also indicated that 70% of the total number of children in the study was anaemic (haemoglobin<10 g/dL). As expected, children in non-dam communities (control group) had significantly higher prevalence of anaemia (p<0.001) (Table 2).

The daily intake of food (macronutrients-carbohydrate, fat and protein) expressed as total caloric intake was below the recommended intake for most of the children (95.9%) across all age groups (Table 2). Surprisingly, all the children in the 2-year intervention communities, 94.0% in the 1-year intervention communities and 92.2% in the non-dam communities did not meet their daily caloric need as recommended.

DISCUSSION

All the mothers of the children in the study were actively involved in farming and other income generating activities therefore very little attention or care may be given to children. Awumbila (2003), found that mothers work outside the home impact negatively on their children's nutritional status. This is because mothers who work outside the home mostly tend to decrease the amount of time to care for their children in order to spend the time on income generating activities. Also, larger family sizes could compromise care since the mother may be overburdened with other children's needs as well as other household chores. This situation is worsened when the household has more than two children under 5 years of age. In this study, 48.8% of the mothers had more than four children. Intra-family food distribution has also been implicated in child nutrition (De Rose *et al.*, 1998), when this is not done properly, taking into account the nutrient needs of all the individual family members, it results in under-nutrition which is usually skewed towards children under five-years of age.

Chronic and acute malnutrition were assessed by height-for age (stunting) and weight-for-height (wasting), respectively. Short term food deprivation (acute undernutrition) may lead to body wasting. Severe wasting was lowest in the control communities and worst in the 1-year intervention communities. This could be due to the fact that with the introduction of the dam most mothers focused all their attention on farming to the detriment of child care. The control communities had no dam; therefore, their care giving practices and activities of everyday living may not have been affected very much. In Ghana, the prevalence of wasting is reported to be declining and currently stands at 7.1% (GDHS, 1998, 2003) which is less than what was observed in the present study. Our findings on the prevalence of wasting, however, is consistent with the findings of Van de Poel *et al.* (2008) who reported that low socioeconomic status impact negatively on nutritional status. The authors reported a prevalence range of 1.15-25.6% for wasting in developing countries. Thus, the higher values recorded in the present study than the national values could be due to the fact that the study was conducted in a region that has

been marginalized and underserved over the years. Furthermore, the majority of mothers in this region have no formal education and the literature shows that maternal education could lead to improve child nutritional status (Andrews and Prell, 2001). When mothers have access to education and information, the household food security is likely to improve which then translates into improved nutrition, particularly among children. The right to education and information also directly or indirectly impact positively on their right to access health care which further enhances nutrition and health. Interestingly, the control communities had mothers with more education than the intervention communities. This could be the reason for the higher percentage of children with normal anthropometric indices observed in the control communities compared to those of the intervention communities. Though mothers are likely to sacrifice food to feed their children in cases of food insecurity (Hoddinott, 1999), low education and poor care practices (Andrews and Prell, 2001; Pelletier, 1994; UNICEF, 1990) could be the reason for generally high wasting prevalence observed among children in this study. More research needs to be done in the area to investigate further the causes of these high levels of wasting.

Stunting, an index of chronic under nutrition, was low among the study population. These findings are consistent with reports from GDHS (2003) suggesting a decline in under nutrition since 1993. About 20% of children in both control and 1-year intervention communities were stunted (moderate to severe) compared to the country mean of 29.9% (GDHS, 2003). Using socioeconomic indictors, Van de Poel *et al.* (2008) also reported stunting rate in Ghana to be 35.6%, and a range for poor nations to be between 13 and 56%. The prevalence of stunting in the 2-year intervention communities was significantly low compared to the 1 year intervention and control communities. The observed difference cannot be attributed to the intervention alone as the control and 1-year intervention communities are fairing very similarly. Contrary to our expectation, the control group had the highest proportion of children with normal weight-for-age index. The reason for this remains obscure as such; further studies examining other environmental and household factors are needed to explain our observation. According to our findings, 3.2% of the study children were moderately to severely malnourished using MUAC indication measure of muscle mass as well as mortality risk among children (Wolfe, 2006; Myatt *et al.*, 2006; Nikhil, 2000; Briend *et al.*, 1989). This observation suggests a need for nutrition intervention to ensure these children achieve their growth potential.

However, about 70% of children (total for all 3 groups) were anaemic, although s high, it was still lower than national average of 76.6% for children in Ghana (GDHS, 2003). Among the groups, the 2-year intervention

communities had the lowest normal levels of haemoglobin while the 1-year intervention group had the highest percentage of children with normal haemoglobin levels. The difference seen could be the result of a combination of factors including inadequate feeding practices, poor dietary intake, as well as frequent and persistent malaria infection. Having the dam for two years might have established the breeding ground for mosquitoes which are the vectors for malaria parasites. It is therefore not surprising that the commonest disease reported at the health centres among the children was malaria. High rates of malaria infection could have accounted for the high anaemia levels among children (WHO, 2001). It is therefore not surprising that that childhood anaemia is rated the 7th killer of children in the district (GHS, 2008). It must be mentioned, however, that anaemia could be the result of a combination of factors. Aside persistent malaria infection, inadequate feeding practices and poor dietary intake are of critical importance. Our findings also suggest that children are fed foods high in cereals and not iron rich foods. Therefore, poor care and lack of appropriate feeding of children and quality of diet could have also contributed to the low haemoglobin levels (UNICEF, 1990). Introducing a fish like tilapia into the dams will serve a dual purpose: may eat up mosquito larvae, reducing the incidence of malaria and also provide source of animal protein for food as well as dietary iron source.

Fish is an excellent protein source as such the fish from the dam could have been used to help improve the protein intake of the children, however this was not done. Reasons given by participants for not using the fish from the dam include, "fish not matured for consumption" and "we are not fishermen and so do not fish" even though they have been given training by the Ministry of Food and Agriculture (MOFA, 2009). It has been shown that adding small amount of animal source protein food (Meat, Fish and Poultry (MFP) factor) to legume based diets, which is commonly consumed in this region, has the potential to improve iron nutrition because of the complementary effect (Hurrell *et al*., 2006). The dam could also have had a positive impact on the children's feeding since the fish or sales of produce resulting directly or indirectly from the dam may have contributed to the nutrition of the children, hence the low prevalence of severe under nutrition observed in this study.

Though data on breastfeeding was not captured, the total daily intake of food was relatively low for almost all the children in the various age categories. This could be due to poor complementary feeding practice since children between ages 13 to 24 months were the most affected. This is the age when complementary feeding is very important and must be done appropriately to ensure proper development of the children. If the high prevalence of anaemia is not addressed, it could negatively affect the

cognitive development of these children (Bowman and Russell, 2001). Malaria if not treated effectively has been shown could also lead to malnutrition among children through poor appetite and altered metabolism (Whitney *et al*., 1987). Other sicknesses likely to negatively affect child nutrition include stomach ache, headache and chest pains, and these may be due to improper care practices of children by mothers and other caregivers (UNICEF, 1998; Pelletier, 1994; UNICEF,1990).

Non-food strategies may be needed to complement dietary practices to manage the anaemia situation. According to WHO, non-food strategies may include malaria control, supplementation, and worm control through a massive deworming exercise, as well as making education information readily available to the people (WHO, 2001). Though the cost of treatment of malaria was not investigated, it could have great impact on household income. This is because money from the household food budget would be spent on buying drugs to treat malaria since about 40% of mothers were not on the National Health Insurance Scheme (NHIS) and will have to bare the entire health care cost. This extra burden is likely to impact negatively on food and nutrition situation of households and children. Other sicknesses likely to negatively affect child nutrition include stomach ache, headache and chest pains, and these may be due to improper care practices of children by mothers and other caregivers (UNICEF, 1998; Pelletier, 1994; UNICEF, 1990).

CONCLUSION

The dam project has the potential to improve the nutrition situation of children in northern Ghana if nutrition education and proper child care practices are simultaneously incorporated into the project. The high prevalence of malaria in the area may be attributed to the presence of the dams which serve as breeding ground for mosquitoes. Malaria may negatively impact on nutritional status. All stakeholders should consider the negative effects when embarking on similar projects in order to avoid creating another problem while solving one. Nutrition education should incorporate the use of fish into young child feeding in these communities.

Limitation: Daily calorie intakes for the children did not consider breast milk intake. None the less 50.5% of children were above 24 months of age, when children are no longer breast feeding.

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