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EFFECT OF SOYBEAN (*Glycine max)* SUPPLEMENTATION ON NUTRITIONAL STATUS OF SCHOOL CHILDREN AGED 6-9 YEARS FROM HIV AFFECTED HOUSEHOLDS IN SUBA DISTRICT, KENYA

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ABSTRACT

Objective: This study investigated the effect of soybean supplementation on the nutritional status of school children from HIV affected households in western Kenya.

Methodology and Results: A research design was used with 54 and 56 randomly selected subjects in the experimental and control groups, respectively. The experimental group received corn-soy blend porridge for three months at school. A structured questionnaire and anthropometry were used to collect data. Malnutrition levels among the experimental group reduced from 10.2, 28.9 and 5.6% for underweight, stunting and wasting, respectively, to 6.2, 16.7 and 3.4%, respectively. The control group registered 11.4, 28.5 and 8.7% underweight, stunting and wasting, respectively at baseline. Underweight and wasting rose to 14.3 and 9.5%, respectively, while stunting dropped to 21.5%, which were insignificant changes.

Conclusion and application of findings: The feeding trial using corn-soy blend improved the nutritional status of school children in Suba District. It is likely that significant improvement of the pupils' nutritional status would be realized with extended feeding periods. Soybean has potential to curb protein energy malnutrition and its utilization should be promoted in HIV and AIDS affected areas to alleviate malnutrition.

Key words: soybean, corn-soy blend, nutritional status, HIV and AIDS, school children

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INTRODUCTION

The HIV and AIDS pandemic has adversely affected livelihoods, child survival, nutrition and health of school children. More than 12 million school children have lost one or both parents to AIDS in Sub-Saharan Africa. Some of the impacts of HIV and AIDS on school children include orphanhood, illness and malnourishment (UNAIDS/WHO, 2006).

Adult mortality adversely affects school children's nutritional status. In Tanzania, as elsewhere in Africa, school children whose parents have died are more likely to be stunted (Urassa, 2002). Those from the poorest households, with uneducated parents, or with limited access to healthcare are the most severely affected (Ainsworth & Semali, 2000; Gillespie & Kadiyala, 2005). Problems among school children and families affected by HIV include psychosocial distress, death, school children without adult care, discrimination, exploitative child labor and even sexual harassment which may all compromise their nutrition status (Jackson, 2002). Before death, many parents suffer long term decline in health and reduced income, which compels children to engage in productive work when they are younger than appropriate. Some children may be taken in by extended family members who are unable to take good care of them. A survey by UNICEF/WFP (1996) involving 1000 households in Zambia found that 72% of households care for at least one orphan or vulnerable child, an increase compared to 37% households recorded in an earlier survey in 1993. In Zambia the number of school children of up to 14 years orphaned as a result of AIDS in 2001 was estimated to be 650,000 (ACC/SCN, 2001). According to Njeru and Kioko (2004), the proportion of orphaned school children in Kenya rose from about 43,359 in 1990 to 965,975 in 2004, and might rise to 2,189,593 by 2010. AIDS is occurring in a situation where many school children are already malnourished and impoverished thus exposing them to infectious diseases and general lack of care (Jackson, 2002). After the death of their parents, siblings may be split up, evicted by relatives and some may end up destitute on the streets. Majority of the orphans in Kenya are with families in rural areas living below the poverty line, while the wealthier urban relatives do not keep much contact (Gillespie & Kadiyala, 2005).

In 1992, an estimated 192 million children suffered from protein energy malnutrition (PEM) and other micronutrient deficiencies (FAO/WHO, 1992). About 31% of children under 5 years old are stunted and 20% are underweight, with the rates being higher in rural than in urban areas. According to Sifri and Bendech (2006), the school age children especially in developing countries face health and nutritional problems that may affect their individual physical development, their capacity to attend school and ability to learn. These children need food that satisfies the high demands for rapid growth, mental development and physical activity.

Soybean has been a food of choice in nutrition intervention due to its high nutrient content (Dilger *et al.*, 2004). Soybean contains complete protein (40%), oil (20%), carbohydrate (35%), and dietary fiber. A study by Takahashi *et al* (2003) showed that soybeans are also rich in vitamin B_6 which is important in building amino acids, as well as the other B vitamins. When added to an ordinary carbohydrate dish that is affordable and acceptable such as maize, soybean could help to reduce the level of protein energy malnutrition experienced by school children infected or affected by HIV and AIDS.

The objective of this study was to establish the effect of soybean (*Glycine max)* supplementation on nutritional status of school children aged 6-9 years from HIV affected households in Suba district, an area that has continually reported high prevalence of HIV infection in Kenya (GoK/MoH, 2006).

Materials and Methods

Based on results from a previous baseline survey (Ohiokpehai *et a*l., 2007), an experimental study was conducted between November 2006 and May 2007. Schools with similar characteristics and nutritional status at the beginning of intervention were randomly selected, after which systematic sampling was used to select the specific children for the study. A total of 110 households and children participated in the study. Fifty four (54) children from Sindo primary school were selected as the experimental group while fifty six (56) children were selected as controls from Ong'ayo primary school. The children in the experimental school

(Sindo) were fed on porridge made from corn-soy blend 100 grams once a day at school during the mid morning break for a period of three months. This blend provided 11-14% protein and 380-400 kilocalories. The recommended daily allowance (RDAs) for this age group is 10-35 grams protein and 840-2,170 kilocalories. In addition, the supplement provided 5.0 mg zinc and 8 mg iron. The subjects also got a take home ration every Friday to ensure continuity in the feeding during the weekends. Those from the control school did not receive any food. All children in the study (both experimental and control groups) were issued with insecticide treated mosquito nets to protect them from mosquito bites that could cause malaria (an endemic disease in the area). In addition, the children received Vitamin A supplementation to reduce the risk of deficiency and de-worming tablets to control confounding factors such as worm infestation. Water was chemically treated using Water guard®. Nutrition and health education was offered to the parents/guardians of pupils in the study schools and the pupils themselves in order to improve their knowledge and promote understanding of the feeding trial.

A structured questionnaire was used to obtain socio-demographic data, dietary intake of the children and their nutritional and health status. Anthropometry was used to assess children's nutritional status through weight and height, both parameters controlled for age and sex. A weighing scale (CAMRY model BR 9012 calibrated to zero after each measurement was used to weigh the children to the nearest 0.1kg, while dressed in minimal clothing. A height stadiometer model 26SM 200 cm (Germany) was used to take the height of the children when standing straight against a wall with their hands to the sides. The measurement was recorded to the nearest 0.1cm. Three measurements were taken and the average was calculated and recorded. Height, weight and age values were used to calculate Z-scores for height-for-age (HAZ), weight-for-height (WHZ), and weight-for-age (WAZ) based on the National Center for Health Statistics (NCHS) standard. HAZ, WHZ and WAZ measure stunting (Height for Age- an indicator of chronic malnutrition since it measures linear growth); wasting (Weight for Height - is an indicator of acute malnutrition as it measures body weight compared to length); and underweight, (Weight for Age - a combination of stunting and wasting and therefore does not distinguish between acute malnutrition and chronic malnutrition). This was repeated every month during the three months feeding trial. A child was considered malnourished if he/she fell below - 2 SD of the reference child NCHS. If a child was below -3 SD, the child was considered to be severely malnourished (WHO, 1986).

Food frequencies and the 24-hour recall were used to assess the children's daily and usual food consumption, their sources and adequacy. Observation checklist was used to collect information on any confounding factors that may affect the nutrition and health status of the children. The instruments were pre-tested in a nearby division which was exempted in the main study. Data was analyzed using statistical package for social sciences (SPSS) and Nutri Survey computer packages and expressed in descriptive and inferential statistics. A P-value of <0.05 was considered significant. Informed consent was obtained from the respondents who were the parents/guardians of the children in the study and the children themselves and confidentiality was assured.

RESULTS

Profiles of study children: Of the 110 school children that were included in the study more than three quarters (85%) had their mothers alive with 73.7% living together (Table 1). About 15% of the children were maternal orphans while one pupil's mother's whereabouts was unknown. Over half of the pupils (68.5%) had their fathers alive with 56.7% living with them in the households (Table 1). A total of 29.1% of the pupils were paternal orphans while 2.8% of the pupils did not know their father's whereabouts.

The results show that majority of the children in Sindo live with their fathers. However, paternal orphanhood is noticeably higher at 32.1% than maternal orphan-hood at 13.2%. The situation was not significantly different (p>0.05) in the control school whereby slightly more than half of the children (55.4%) live with their fathers. Paternal and maternal orphanhood was lower at 19.6 and 12.5%, respectively. However, there is a higher number (23.2%) of fathers that are alive but do not live with their children, possibly because they are migrant workers or in polygamous unions, a common practice in this area.

Table 1: Orphanhood and vulnerability status of children in Sindo and Ong'ayo primary schools.

Variable	Sindo (Experimental)	Ong'ayo (Control)
Mother		
Alive and lives with child	81.4[a]	75
Alive but does not live with child	5.3	12.5
Not alive	13.2	12.5
Does not know	0	0
TOTAL	100	100
Father		
Alive and lives with child	66	55.4
Alive but does not live with child	0	23.2
Not alive	32.1	19.6
Does not know	1.9	1.8
TOTAL	100	100

[a] Values are percentage.

Demographic and socio-economic characteristics of pupils' households: Majority (75.5%) of the households were male headed as compared to 24.5% that were headed by females. In the study area more than half of the mothers (67.4%) only have primary education, with only 18.9 and 1.2% having secondary and post-secondary education, respectively. No mother among the study population had university education. Maternal monthly incomes varied from Ksh. 70 (1 USD) to Ksh. 13,000 (186 USD) per month with a mean of Ksh. 1,550 (22 USD), which reflects the high poverty levels in Suba District. The modal monthly household income was Ksh. 3,000 (43 USD) with a mean household income of Ksh. 4,724 (67 USD). Paternal educational attainment was not significantly better ($P>0.05$) than that of mothers.

School children's food consumption patterns (7-day food frequency before and after the feeding trial): Food consumption patterns usually reflect the nutritional and health status of a population especially children. There were no significant changes ($P>0.05$) in food consumption patterns before and after the intervention among the experimental and control pupils. Soybean consumption remained low even after the intervention especially in the control school (Table 2).

Among the cereals, maize, millet and fermented porridges had the highest daily consumption rates averaging 76.4, 46.1 and 36.2%, respectively. Groundnuts were consumed by half of the households (50%) while green grams were consumed by 27.8%. Peas were hardly consumed, possibly because the crop is not grown in the area. Consumption of tubers was average whereby sweet potatoes, Irish potatoes, cassava and arrow root consumption averaged 67.3, 46.1, 38.6 and 17.7%, respectively. Slightly over half of the households (52.4%) consumed kales on a daily basis, which is more than any other vegetable. Consumption of traditional vegetables on a daily basis was relatively high at 26%. Carrots, mushroom, pumpkin and spinach were hardly consumed while consumption of fruits was generally low possibly because they were not in season at the time of the study, except mangoes which had weekly consumption averaging 59.5%. Fish was the most consumed protein (49.2%) on a daily basis possibly because the households are traditionally fishermen. Consumption of meat was low at 15.7% weekly while fresh milk was mostly consumed in tea.

Food consumed by school children in both experimental and control schools was generally bought except maize, millet and African leafy vegetables of which 36.7, 38.7 and 31.7%, respectively, were own produced. Soybean porridge consumed by experimental children was made available through a grant from the Rockefeller Foundation. Most of the children in both experimental and control schools reported that the food they consumed was not adequate except for cereals, legumes and fish.

Table 2: Distribution of school children by a 7-day food frequency before the feeding trial

Food	Frequency % N=110				
	Daily	>Thrice	Twice	Once	None
Cereals and legumes					
Maize	76.4	13.0	5.5	2.0	3.1
Millet	46.1	8.3	11.8	5.1	28.7
Soybeans	3.1	1.6	4.7	11.0	79.5
Sorghum	27.2	5.9	6.7	7.5	52.8
Beans	5.5	9.4	31.1	39.4	14.6
Groundnuts	3.1	4.7	8.3	33.9	50.0
Fermented porridge+ any cereal	36.2	6.7	6.3	10.2	40.6
Tubers and roots					
Irish potato	1.6	3.1	10.6	30.7	53.9
Sweet potatoes	2.8	2.0	16.1	46.5	32.7
Cassava	4.7	1.6	9.8	22.4	61.4
Arrow roots	1.6	1.2	2.8	12.2	82.3
Vegetables and fruits					
Kales	52.4	25.6	13.0	6.7	2.4
Carrots	1.2	-	0.4	3.5	94.9
Mush rooms	-	-	-	3.9	96.1
Pumpkins	2.0	-	0.8	9.8	87.4
Green bananas	1.6	2.8	11.4	33.1	51.2
Spinach	0.4	1.6	5.1	6.7	86.2
African green leafy vegetables	26.4	18.5	24.8	22.0	8.3
Fruits	2.4	4.7	9.4	26.8	56.7
Meats and milk					
Beef, pork & chicken	1.6	3.5	15.7	46.1	33.1
Small fish (omena)	35.4	30.7	20.9	10.6	2.4
Large fish	13.8	21.3	27.2	23.2	14.6
Fresh milk	26.0	10.2	10.2	27.2	26.4

24-hour recall for school children: Based on the pupils' 24-hour recall, especially those from the control school, results showed that the school children consumed the three traditional meals (breakfast, lunch and supper) from the family pot possibly because they are old enough and do not warrant special meals. Changes were however reported by children from the experimental school indicating consumption of soybean porridge in the mid morning snack. The study indicated that nearly all children except 5.6% had breakfast, with 47.7% consuming porridge made from mixed flours. Nearly all the pupils (98.1%) did not consume a mid morning snack before the feeding trial while all children in the experimental school reported to have consumed soybean porridge for mid morning snack. Generally, majority of the children from both experimental and control schools (71.2%) were reported to consume breakfast, lunch and supper.

Pupils' nutritional status: Anthropometric measurements, i.e. height and weight, controlled for age and sex, were carried out to determine the nutritional status of school pupils. Forms of malnutrition under study were underweight, stunting and wasting as already defined above. A comparison of nutritional indices between the experimental and the control groups at baseline showed no statistically significant differences (Table 3), which is expected since supplementation had not begun.

Slightly more than 25% of the children in the study were stunted; an average of 10.9 % underweight and an average of 7.2% were wasted before the feeding trial. The nutritional status of children in the experimental school showed some significant improvement in the underweight and wasted malnutrition levels after intervention. There was, however, improvement in terms of Z scores. The control school also showed slight reduction in stunting levels but the rate of underweight and wasting increased (Table 4). At baseline the stunting levels were 28.9 and 28.5% for experimental and control groups, respectively, but these levels had dropped to 18.7% (P=0.304) and 21.5% (P=0.357) for the experimental and control groups, respectively, at the end of the trial. The experimental school had a higher drop in stunting levels as compared to the control, though not statistically significant (P>0.05).

With regard to underweight levels, there was no statistically significant difference (P>0.05) between pupils in the experimental and control groups at baseline. The experimental group registered 10.2% underweight children as compared to 11.4% among pupils in the control school. Underweight levels in the experimental school dropped to 6.2% (P=0.012) by the end of the soybean supplementation. On the contrary, the level went up in the control school from 11.4 to 14.3%. The prevalence of wasting at baseline was 5.6% but dropped to 3.4% (P=0.019) after the feeding trial, which was statistically significant (P=0.0499). On the other hand, the control school had a prevalence of

8.7% at baseline which increased to 9.5% (P=0.308) by the end of the three months study period.

The results indicate that the mean Z-scores for underweight and wasting improved after the intervention among experimental group pupils from -0.59 to 0.79 and 0.01 to 9.06, respectively. The reverse was also true for the control school whereby the WAZ and WHZ Z-scores dropped from -0.36 to -0.64 and -0.27 to -0.7, respectively (Table 5). The mean Z score gain across the three months among the experimental group was 1.5 while that of the control school was 0.8.

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Table 3: Distribution of school children by malnutrition levels before the feeding trial.

Experimental group	Malnutrition level	Underweight %	Stunting %	Wasting %
	Mild	3.8	14.0	3.7
	Moderate	5.7	11.3	1.9
	Severe	0.9	3.6	0
	Total	10.4	28.9	5.6
Control group	Mild	4.8	7.1	4.3
	Moderate	6.6	19.6	3.0
	Severe	0	1.8	1.4
	Total	11.4	28.5	8.7

Table 4: Distribution (%) of children in the experimental and control groups by malnutrition level before and after the feeding trial.

Forms of malnutrition	Levels	Before %		After %	
		Cases N= 54	Control N= 56	Cases N= 49	Control N= 54
Stunting	-1.5 to -1.99 SD (Mild malnutrition)	14.0	7.1	10.4	3.6
	<-2 to-3SD (Moderate malnutrition)	11.3	19.6	8.3	17.9
	<-3SD (Severe malnutrition)	3.6	1.8	-	-
	Total	28.9	25.8	18.7	21.5
Underweight	-1.5 SD to -1.99 (Mild malnutrition)	3.8	4.8	2.0	9.5
	<-2 to-3SD (Moderate malnutrition)	5.7	6.6	4.2	4.8
	<-3SD (Severe malnutrition)	0.9	-	-	-
	Total	10.4	11.4	6.2	14.3
Wasting	-1.5 SD to -1.99 (Mild malnutrition)	3.7	4.3	3.4	7.1
	<-2 to-3SD (Moderate malnutrition)	1.9	3.0	-	2.4
	<-3SD (Severe malnutrition)	-	1.4	-	-
	Total	5.6	8.7	3.4	9.5

Table 5: Mean Distribution of Height for Age (H/A), Weight for Age (W/A) and Weight for Height (W/H) of experimental and control groups by Z scores

Z-scores	Before intervention		After intervention	
	Experimental school	Control school	Experimental school	Control school
Height for Age	-0.99	-0.66	-0.48	-0.43
Weight for Age	-0.59	-0.36	0.79	-0.64
Weight for Height	-0.40	-0.27	-0.35	-0.70

*Mean Z-score significant at P<0.05 (Independent T- tests)

DISCUSSION

Nationally, 11% of children aged less than 15 years in Kenya are orphans (KDHS, 2003). Of this number, a national average of two percent are double orphans due to AIDS, while an average of 6% are double orphans in Nyanza province where Suba is situated (National AIDS Control Council, 2005). Suba District

has exceeded these levels by about 30% due to the high prevalence of HIV and AIDS with paternal orphans being more than maternal orphans. Nationally, the male headed households average 68%, with an average of 63.4% in Nyanza province where Suba District is situated (KDHS, 2003). Orphanhood has been shown to have a great impact on children's health and nutritional status (Gillespie & Kadiyala, 2005). Orphans are also more predisposed to HIV and AIDS infection, they have higher school dropout rates and they experience more psychosocial deprivation. Further, research has revealed that maternal orphans have a 15% probability of being wasted than paternal orphans (Ainsworth & Semali, 2000).

Although this study showed that there are still a higher number of male headed households, it is worthy to note that polygamy is rife in Suba District and therefore, the male heads may not be always physically present in the home. Some fathers and, even one mother, seem to have deserted their families. This state of affairs could have contributed to the high rate of malnutrition among the studied children, especially before the feeding trial. This is consistent with the findings of a previous study by Tharakan & Suchidra (1999) which showed that children from male-headed households are less likely to be malnourished, especially wasted or underweight, as compared to their counterparts in female-headed households. This may be because of the economic vulnerability of female-headed households, in which children are likely to be raised by single-parents. The problem may be compounded by the fact that in Suba District, a large number of women/caregivers are semi-literate and have minimal incomes.

Maternal income and education levels usually reflect the quality of child care practices such as complementary feeding practices, nutritional and health status. Furthermore, mothers are more concerned with the welfare of their children and will usually influence decisions that affect food security of the household. The situation in Suba District is however grim because a majority of the mothers only have primary education. The low education levels attained by parents or guardians could have contributed to the high stunting, underweight and wasting rates among children in the study. These findings agree with those of Tharakan and Suchindra (1999) who found that chances of being underweight are less for children whose mothers have attained higher levels of education. In addition, stunting levels decrease as the father's educational level increases although wasting may occur if there is negligence. Furthermore, in Suba the general household and maternal income levels are too low to be able to provide all the basic needs especially good quality balanced meals, health care and other necessary services. To compound the situation, the low income situation could be happening on a background of frequent illness due to HIV and AIDS, a sickly spouse or a situation where the spouse has already succumbed to the HIV scourge.

The food intake revealed high consumption of starchy foods especially maize, millet and porridges and an average consumption of tubers such as sweet potatoes, Irish potatoes, cassava and arrow roots. There was no significant difference in soybean consumption between the experimental and the control groups, possibly because the feeding was done in school and the take home rations did not make a significant impact. The main protein source in the area is fish which was consumed by majority of the studied population. However, most of the foods consumed by the school children are not sufficiently nutrient dense to take care of all their daily nutrient requirements. The low consumption of fruits in an area with a high disease burden including HIV and AIDS is worrying since fruits provide vital vitamins and minerals that boost the body's immunity among other key functions. It is worthy to note that most of the foods consumed in this district including fruits are imported from the nearby districts. Fish is more available because Suba district residents are traditionally a fishing community. The results show that the area is food insecure as people do not produce enough food to meet their daily requirements.

A close link has already been demonstrated to exist between food (quality and quantity) and nutrition. Tharakan and Suchindra (1999) have reported that uptake of milk and dairy products, staple food and cereals, and beverages have significant effects on child malnutrition. In Suba, majority of the children were found to take the three traditional meals i.e. breakfast, lunch and supper with most of them having breakfast daily. This is encouraging since studies have shown that children who consume breakfast are attentive in class during the morning session and that they perform better in intelligence tests (Pivik & Dykman, 2007). Further, children who skip breakfast show deficits on memory and behavioral tests. The low consumption of the afternoon and evening snack was possibly because of unavailability of food at home since the children were already out of school. Food consumption patterns also

showed lack of variety in the diets with most children repeatedly consuming the same staple food of ugali and fish or vegetable, which does not provide well balanced diets.

In our study, improvements in stunting were not significant which is more likely due to the short period of feeding. The meal provided was also not a major meal of the day such as lunch or supper but a mid morning snack. According to a USAID study (2005) involving school children, stunting levels among school children in Kenya was 18%. Suba District exhibits much higher levels due to HIV and AIDS vulnerability, food insecurity and orphanhood among other factors.

The drop in the stunting level after three months of the feeding trial was however higher for the experimental school compared to the control school. However, there was a higher dropout in the experimental school compared to the control school and further; those who dropped out were likely to be malnourished (stunted). Therefore the apparent improvement in stunting levels in experimental school was not wholly due to the feeding trial. In addition, stunting measures linear growth which could not have been achieved in three months. Longer feeding periods would be needed to realistically assess changes in stunting levels.

While the proportion of underweight children reduced in the experimental school, the reverse was true for the control school. This could have been caused partly by the dwindling supplies of food especially dagaa/omena (fish) in the area due to the ban on fishing of this species that was imposed for a period of four months, coinciding with the feeding trial. A majority of people in this area rely on omena as the main protein source, and the little that was available from across the borders (Uganda and Tanzania) and through illegal fishing was too expensive for the households.

This study begun with high levels of underweight, stunting and wasting among the children in both experimental and control schools. Although the effects of Corn-soy blend supplementation were not statistically significant, marked improvements were realized in the nutritional status of children in the experimental school. Based on the outcome of the three months study period, it is expected that significant improvements in nutritional status would have been realized if the feeding trial had continued for a longer time, at least one year. The results of this study have demonstrated that soybean has the potential to address protein energy malnutrition among vulnerable school children in Kenya. The authors recommend promotion of soybean production and utilization in HIV and AIDS affected areas to alleviate malnutrition.

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