

ROLE OF ANIMAL SOURCE FOODS TO IMPROVE DIET QUALITY AND GROWTH AND COGNITIVE DEVELOPMENT IN KENYAN SCHOOL CHILDREN

NARRATIVE SUMMARY

The project completed its intervention feeding and data collection in September 2000 and data analysis of Cohort I have been ongoing to test the main hypotheses. This is a collaborative study of the University of California, Los Angeles (UCLA) and Davis (UCD), the University of Nairobi, and University of Hawaii. This controlled feeding intervention study is one of the first to determine if a causal effect exists between meat and between milk intake (animal source foods) and cognitive function, physical activity, school performance, and behavior, physical growth and health compared to children who receive no feeding intervention. All feeding groups received the local dish githeri, a mixture of maize, beans and greens, but in addition, one group received added meat; one group added milk and one added oil for energy. The snack furnished ~315 k Cal/serving. Twelve schools in two sub-locations of a rural area in Embu District, rural Eastern Province, Kenya were randomized into the three different feeding groups and the control group. 555 children from the first grade (Standard I) were enrolled, with 1 to 2 classrooms per school and three schools per group. A second cohort was enrolled a year later and was a replicate of the cohort I study, minus the biochemical tests for micronutrients.

Outcome measures studied were cognitive function using a variety of tests (all used extensively in this age group in Embu in a former study); physical growth included height, weight, fat folds, and arm and head circumferences;

physical activity and behavior during free play and classroom behaviors; school performance (test scores) and illnesses; and biochemical micronutrient status. The above measures were collected longitudinally at baseline and over the ensuing 2 1/2 year period. At baseline and annually, physical examinations and blood samples were obtained for biochemical micronutrient analyses, hemoglobin, malaria, and for an infection marker (C-reactive protein). Stool samples were examined for parasites and all children were dewormed every 6-8 months. Children with severe illness, severe anemia, and malaria were referred for treatment.

Usual daily food intake was collected by 24-hour recall factoring in the intervention feeding. Feeding and data collection continued for seven 3-month school terms. At baseline, children were found to have stunting and under weight in a third of the group. The prevalence of iron, zinc, vitamin A and B₁₂ deficiencies and anemia were very high.

Data analyses as of September 30, 2001 showed that the meat supplemented groups showed the greatest gain over time which were statistically significant:

- Cognitive Scores-(Ravens and arithmetic)
- Growth-Lean body mass (muscle area)
- Physical Activity- high levels of activity
- Behaviors-leadership, initiative
- Micronutrient Status- in vitamin B₁₂ with elimination of moderate and severe deficiencies after two years of feeding

In all groups, micronutrient blood concentrations were significantly lower in those



The Child Nutrition Intervention Study involved over 1,000 first and second grade children. Photo by Charlotte Neumann.

children with evidence of infection and/or malaria.

The milk group also showed statistically significant increases in vitamin B₁₂ both at the one-year and the final follow up. Also, the milk group showed a greater, but non-significant advantage, in height growth in the 6 to 7 year old children, but this was not sustained.

Thus, animal source foods in the diet, particularly meat, improves cognitive function, increase in muscle mass, and vitamin B₁₂ nutrition which have implications for maximizing the ability of the children to learn, show leadership and initiative, and be physically active. The challenge is to increase the household production and utilization of locally available sources of a variety of animal foods.

RESEARCH

Problem Statement and Approach. The original problem statement defined the problem of poor diet quality and low micronutrient content of the diet among the rural Embu people. The proximate causes identified were the lack of animal source foods in the diet and

low fat intake: poverty, lack of knowledge of child feeding and poor household food security. Baseline biochemical analyses of the study children have confirmed poor micronutrient nutritional status. Baseline anthropometry data confirmed stunting and underweight to be present in a third of the children. Poor availability and household access to animal source foods and low utilization and erratic rainfall affecting harvests were the barriers identified.

The problem analyses and statement suggested a two-phase sequence. Phase I consists of a controlled feeding intervention study of school children to test if animal source foods, particularly meat, eaten at school each day by Standard I children (ages 6 to 9 years) improves their micronutrient status, cognitive function, growth and health compared to these parameters in children who receive either added milk or extra calories (oil), or no feeding intervention. Phase two will consist of community-based interventions with food-based solutions to improve diet quality and micronutrient nutritional status.

Activities from Oct 1, 2000 to Sept 2001

Progress. The accomplishments of the third year of the GLCRSP Child Nutrition Project (CNP) formally entitled "Role of animal source foods" are described in this section. Also included are additional measurements that were included to better elucidate previous findings.

This year marked completion of the intervention feeding and data collection for both Cohorts I and Cohort II, comprised of the school-age children and the initiation of data analyses for hypotheses testing for Cohort I. Cohort I included 555 children who were enrolled in Standard I (Grade 1) and reached Standard III and included repeaters who remained in Standard II for another year but continued in the study. About 30 children left the study. Because of the continuing drought situation which resulted in serious food shortages and hunger, it was decided to continue to feed the Cohort I children for an additional term (Jan-Mar 2000), with only limited data collection – anthropometry, morbidity, and cognitive testing. The children of Cohort II, a replicate of the Cohort I design, were given intervention feeding for an additional term of feeding ending July 31, 2000. The parents and schools were extremely appreciative of the additional feeding and wished to express their gratitude to those who enabled the Child Nutrition Project to continue the feeding a term longer.

A final round of physical examinations and collection of blood samples were carried out in Cohort I children in July 2000. Blood samples were obtained for a third round of biochemical analyses, hemoglobin levels, blood smears, and tests for malaria as well.

Additional literacy and arithmetic achievement testing was administered to Cohort I children. These were used to further detect differences among the intervention groups and control group.



Dr. Neumann, right, examines one of the children as Volunteer Margaret Demment records the data.

New Measurements

Further Evaluation of Vitamin A (retinol)

Status. Two additional measures were obtained on the children to better evaluate the extent and severity of vitamin A status. Low levels in the severe range, with retinol < 10 ug/dL and values in the moderate range with retinol of 11-20 ug/dL, were found at baseline and among slightly fewer children in 1999, after one year of intervention feeding. Baseline food biochemical analyses revealed that 92.0% had deficient levels in the moderate and severe deficiency ranges.

Pupillary Response Test. In collaboration with Dr. Nathan Congdon at John Hopkins School of Medicine, a test of dark adaptation was undertaken using an apparatus developed by Drs. N. Congdon and A. Sommers. The testing had to be carried out in a dark area. We used a darkened tent, which was set up at the rear of classrooms and children were tested in groups of 3 or 4. Also a project enumerator was assigned to help with the testing and sat with the children and the tester in the darkened tent to keep them occupied with singing, conversation and riddles to allay their fears as they dark-adapted for ten minutes. A special

red light was shined into one eye and the pupillary reaction in the other eye is observed for pupillary constriction. This tested for dark vision

If the child was unable to respond to a given light stimulus, the light intensity was progressively increased until pupillary constriction was noted. Mr. Eric Schweitze, a medical student from the University of Kentucky, who was trained by Dr. Congdon joined the team and spent a month in Embu organizing and implementing the testing. He, Dr. Neumann, and a Master's Nutrition student from the applied Nutrition Program, University of Nairobi, carried out the testing. The Kenyan nutrition graduate student, Mrs. V. Betts, will use the data she collected on Cohort II children for her Master's dissertation.

The results of the pupillary response testing will be correlated with the vitamin A levels and the results of the Modified Retinal Dose Response (MRDR), carried out simultaneously. Results of the preliminary analysis of the pupillary response test are consistent with mild to moderate vitamin A deficiency. The test is more useful as a population indicator than as an evaluation tool of individual status.

Modified Retinal Dose Response (RDR) test. In collaboration with Dr. Sherry Tanumihardjo of the University of Wisconsin, a test was carried out at the time of testing for pupillary response, to better define the status and liver stores of vitamin A in the Cohort I children. Vitamin A₂, a natural analog of vitamin A, was administered by mouth 4-5 hours prior to blood drawing. Testing for pupillary response was carried out in 4-5 hour intervals between the administration of A₂ by mouth and the drawing of blood samples for vitamin A₂ and retinol levels. The ratio of A₂ to retinol indicates the level of retinol storage in the liver. The results of the MRDR test will be completed within two weeks.

A night-blindness questionnaire was administered to parents about the children. It appeared that the fear of the dark was based on non-nutritional reasons.

Data Analyses

Independent Variables and Co-Variates: Food intake data. Determining usual food intake for Cohort I children, from the baseline visit through the final visit has been an extremely labor-intensive effort, under the direction of Dr. S. Murphy and part time programmers and input from field staff, especially Constance Gewa, to obtain missing values, errors and missing food density values. The 3 baseline visits of usual nutrient intake, the first 3 intervention feeding monthly visits have been completed and ready for use as covariates in other analyses. Three other representative food intake visits are now completed and were obtained during different seasons, including the dry periods and the rainy months. Also, the daily feeding records and quantities of leftovers of the actual intervention feedings are included in the usual daily intake. To represent usual intake for a given period, three rounds of food intake data must be averaged.

The food intake data will result in a very rich and probably among the best data set obtained to date in Kenya, along with that of the previous Human Nutrition CRSP of the 1980's. Now that all programming, and many corrections have been made, the analysis should move along much more quickly and easily. Important reasons for requiring the usual food intake are the following:

- a) To see if there are differences in usual intake of animal source foods- i.e. milk, or meat, among the different intervention and control groups other than the intervention feeding. This could potentially "neutralize" or cancel out of the impact of the interventions.
- b) To see if the school feeding alters the

amount of food the target school child receives at home. Possibly the parents may reduce the food given at home because the parents may feel that the child is taken care of at school and therefore needs to eat less at home.

A redistribution of the child's food in the household may occur. The baseline food intake showed that the intake of animal protein and fat were low and that there was a substantial prevalence of deficient vitamin B₁₂, iron, zinc, calcium, and vitamin A intakes relative to recommended intakes. The mean energy intake was low normal for recommended intake.

Socioeconomic Data. Socioeconomic Status was obtained at baseline and a second round two years later to see if a change had occurred. Analyses show a very high concurrence at baseline and two years later with very little change using the same instruments.

Death of Project Children. Among cohort I and cohort II (1,050 children), five children died. The diagnoses were based on clinic records and "verbal autopsies". This is an extremely high mortality rate for 6-9 year old children. Because parents did not seek medical care until it was too late, or was not possible in some cases, several children died before they could actually be evaluated or treated. The diagnoses were: Hepatitis with cirrhoses; Sepsis-associated with a pharyngeal abscess; Severe anemia, and Malaria

Morbidity. For morbidity to be used as a covariate in analyses of the outcomes, scores were devised for each child for serious and mild illness. For morbidity as an outcome per se more analyses are under way on how best to define the outcomes.

A study just completed by the District Medical Officer showed that the leading cause of death among children for Embu District was malaria in 2000-2001.

Brief Summary of Findings to date of Selected Hypotheses

1. Animal Source Foods (ASF), particularly meat, lead to improvement in
 - cognitive function
 - physical activity
 - positive behaviors
 - classroom attention
 - physical growth
 - biochemical micronutrient status, particularly for iron, zinc, and vitamin B₁₂
2. Meat and milk intervention are not equivalent in effects:
 - meat promotes cognitive function and physical activity, improved biochemical micronutrient status of Iron, zinc, vitamin A, vitamin B₁₂, and riboflavin
 - milk promotes linear growth and improved vitamin A, vitamin B₁₂, and riboflavin status
3. Infection and malaria have a negative impact on biochemical micronutrient status

Analytic Approach. The intervention studies are analogous to a longitudinal clinical trial. A Hierarchical Random Effects Model (repeat measures) is being used to examine feeding groups and the control group for the following outcomes: cognitive performance, physical activity, behaviors, growth over time, morbidity, and biochemical nutritional status. Rate of change (slope) is estimated for each child and group for the above outcomes and the variability among the changes was estimated as well for each child. These were assigned to the fixed conditions (feeding groups) and the random components of the design comprise the children nested within schools.

Co-variables included are age, gender, time, morbidity, food intake, and parental factors

(literacy, height). At baseline the four groups showed no statistically significant differences in a number of attributes. (In this report, significantly implies statistically significant ($p < .05$))

Cognitive Function. The meat group showed the greatest rate of increase in the Raven's Progressive Matrices Test Scores. The difference was significantly higher than that for the milk, energy, or control groups: The Raven Matrices Test reflects Fluid Intelligence, which includes problem solving ability, special reasoning, and planning ahead.

The meat group and also the energy group showed the highest rate of increase on the arithmetic tests, which reflect arithmetic facts and grasp of numerical concepts (crystal intelligence).

Physical Activity and Behaviors. Children in the meat group exhibited the greatest increase for high and medium activity during free play compared to the energy, milk, and control groups. Differences were statistically significant.

Also children in the meat group displayed a significantly greater rate of increase in behaviors such as leadership, initiation of activities, and less apathy and solitary play.

Biochemical Micronutrient Status. Both the meat and milk groups showed statistically significant increases in vitamin B₁₂ blood levels compared to the energy and control groups, with the milk group having slightly higher levels after one year of intervention feeding. After two years of intervention feeding, the meat group had the highest level of vitamin B₁₂ compared to all groups but statistically significantly higher levels than the control and energy groups. In the group receiving meat, moderate and severe vitamin B₁₂ deficiencies were eliminated and only mild deficiency remained.

Body Composition. Lean Body Mass, as reflected in Arm Muscle Area (AMA) showed the greatest rate of increase in growth in the meat group. This increase was statistically greater than the slopes in the milk, energy, and control groups. A slightly higher rate of linear growth was seen in the milk group but this was not significantly greater than in the other groups and the control group.

Impact of Infection and Malaria on Biochemical Micronutrient Status. Nearly all micronutrients, particularly iron, zinc, vitamin A, and vitamin B₁₂ were found to be lower in children with infection, compared to those without infection. The marker for infection used

All feeding groups received the local dish githeri, a mixture of maize, beans and greens. Analysis of data collected is showing that the meat and milk interventions are not equivalent in effects.



was elevated C-reactive protein, an acute phase reactant, which rises with infection. Differences in the micronutrient levels among the above two groups were statistically significant.

As for malaria infection, lower concentrations of vitamin A, vitamin B₁₂, and zinc were found. Malaria was detected both by blood smear and by a relatively new antigen dipstick Test for the presence of falciparum malaria antigen in the blood. Falciparum malaria is present in 98% of the cases. The latter is better able to detect malaria infection than examining blood smears.

Thus infection and malaria both have a negative effect on biochemical micronutrient status.

Analyses Still in Progress (and not completed by September 30, 2001)

- 1) Biochemistry
 - Completion of Biochemical Analyses Micronutrients status after two years of feeding will be completed for the 3rd round of analyses in early December 2001 for retinol and vitamin A2 (the Modified Retinol Dose Response for estimating liver stores).
- 2) Food Intake
 - Complete usual nutrient intake over time for each child: The three baseline visits, the first three post intervention visits, and three representative visits throughout the study period are now completed (November). The remainder will be completed in the next few months. (The Kenyan doctoral student (C. Gewa) will now work on this)
- 3) Morbidity as an outcome measure
 - Morbidity will be examined as an outcome. Thus far it has been used as a co-variate for mild and severe illness.
- 4) Anemia will be analyzed in detail in relation to micronutrients (biochemical

and nutrient intake), malaria and parasites and functional outcomes.

- 5) Cohort II study has yet to be analyzed.

LEVERAGING OF FUNDS

Cattlemen, Year II, \$60,000

Child Survival Funds, 2000-2003, \$300,000 total

Various Donors, C.G. Neumann 2000-2001, \$25,000

GENDER

As stated in the previous annual reports, the project, at all levels, is staffed predominantly by women. This came about largely because most nutritionists and people trained in child development and health are women and very few men applied for the above positions. Many of the women were trained in the previous CRSP study in the mid 1980s and wished to be working once again to earn income of their own. Women also enjoy working with the young school children, and are more comfortable with the home visiting aspect, as they obtain information on food intake and illness. The following personnel are women:

Senior level: Principal and Co-Principal and Co-Investigators (C.G. Neumann, S.P. Murphy, M. Sigman, L.H. Allen). These are all senior professors at the University of California (UCLA and Davis) and the University of Hawaii (S.P. Murphy).

Dr. Edith Mukudi, a young Kenyan woman, received her Ph.D. from SUNY at Buffalo in 1998 and she served as Field Coordinator from 1998-2000 and held a teaching appointment of Lecturer at Kenyatta University in the Department of Education. She was recruited by UCLA to a tenure track position as Assistant Professor in African Education and the African Studies program in June 2001. Her research consists of GLCRSP

Child Nutrition Project and other research in Kenya.

Connie Gewa, Kenyan nutritionist and former field coordinator (January –September 2000) has entered a PhD program at UCLA School of Public Health. She plans to use project food intake data for her dissertation.

The senior field staff who are resident in Embu are all women. Three hold Masters and one a Bachelor's degree. Three are nutritionists and one is a psychologist/educator and educated in Kenya. The nutritionists is Susan Nyerere and the psychologist is M. Kamore. One of the Kenyan Nutritionists, who is also the Embu District Nutritionist (R. Ngaruro), was secunded to the project for its duration by the Ministry of Health and has rejoined the project after a study leave of nearly 2 years. A Community Field Nutritionist was secunded to us as well to act as a supervisor for the Food Intake enumerators.

We felt it important to recruit as many Kenyan women as possible who would assume senior positions of leadership in the University or the Government of Kenya as part of infrastructure building. The field coordinator and senior investigators also provide excellent role models and mentoring for the younger scientists who wish to carry out doctoral studies.

Dr. Charity Kabutha, well known in gender issues, especially in Women in Leadership in Agriculture, serves as a consultant to the project and will serve in an advisory role on the steering committee. Dr. Helen Ommeh, an agricultural economist with the University of Nairobi, College of Agriculture, worked on planning the grant and continues as a consultant.

POLICY

Even before the research findings are entirely known, the GLCRSP, the World Bank, BASIS CRSP, ILRI and Heifer Project International have discussed policy considerations at a number of meetings, at which

the P.I. gave invited presentations. By studying human health, growth, and cognitive development in relation to diet quality improvement through increased intake of animal source foods, the livestock, education and health communities have begun to consider linkages of livestock production with improvement of human well-being and nutrition as one of the outcomes or impacts of improved livestock production. Increasingly the above – mentioned groups are viewing human health and nutrition improvement as a desired positive outcome. Groups such as Heifer Project International (HPI), ILRI, and some of the other GL CRSPs have invited the P.I.s and others in our group to discuss such linkages, and the evidence for the role of animal products in improving diet quality and human function as economic capital investments in development.

By working closely with the school administrators, local physicians, parents and community leaders, there has been awareness raising of the need for school feeding and its improvement, particularly for young school children. Children often come long distances to school without having eaten, and teachers and administrators are becoming very concerned about this. Lack of food intake, poor nutritional status, and poor health interfere with the children's ability to benefit from their educational experience. If the large investment in primary education is to realize a return, the children must be in the best condition to learn. Successful students go on to higher education and become future leaders and contribute to social and economic development.

The health assessment activities of the children continue to have a high visibility with parents accompanying their children while a health professional examines their children for the third year. They get feedback and see their children being checked for anemia, malaria and intestinal parasites, and receiving de-worming medication at school and learning how to



Members of the Child Nutrition Project Team present goats to families in the intervention study who participated in the control group. Team members pictured from left to right, Ms. Minnie Kamore (Field Nutritionist), Mr. Z. Akula (Project Administrator) and Ms. Emmy Nyaga (Nutritionist, Ministry of Health).

prevent parasites. These activities introduce the community to the concept of the role for schools in health and nutrition promotion and community improvement.

Lastly, a food-based, rather than pharmaceutical approach is being used to improve the micronutrient content of the diet and foods available in the community are being used for the school feeding.

Thus the recent study findings call attention to the following policy issues:

Merely increasing dietary energy alone is not sufficient to improve cognitive function and improve micronutrient nutritional status. School feeding and home diet need to be improved so as to increase the micronutrient content of the diet (diet quality). This also has relevance to the USA where all degrees of vegetarianism and avoidance of “red meat” is widespread.

High infection burden, especially of malaria need to be dealt, to enhance nutrition status as infection further compromises micronutrient status. This is particularly true for iron, zinc, vitamin A, and B₁₂. The findings have implication for many developing countries

where mild-moderate PEM and multiple micronutrient deficiencies, the leading nutrition deficiencies co-exist with high prevalence of infection and malaria.

There is a need for collaboration with the livestock community to increase accessibility and availability and production of animal source foods to small holders to put “meat on the table” and as a source of income. At a more basic level, stimulation of sustainable school feeding with through parent-school partnership are also needed—School activities can help supply animal foods to increase school feeding quality.

OUTREACH

Efforts have been initiated by the CNP to stimulate the former study schools to undertake school feeding on their own, working with the parents to donate food staffs. For those not able to do so, parents would donate some work to the school feeding effort. Every school has a simple or token kitchen and a cook who usually fixes the teacher snacks and porridge for the pre-schoolers (about 30-35 per school).

Through Agricultural Extension (Home

economics) and the project nutritionists, technical advice about the composition of the feedings will be available. Several schools have been approached with teachers and parents willing to initiate this. One school in an area to the study has such a feeding program in place. One teacher takes full responsibility to ensure that the program works.

The eventual addition of adding animal source food to the feedings is under active discussion. NGO assistance may be very helpful. School rabbit projects and other projects have been mentioned involving small livestock and are under discussion.

DEVELOPMENTAL IMPACT

Contributions to U.S. Agriculture and Nutrition Policy and Practices. Iron deficiency and, to a lesser extent, zinc, vitamin B₁₂ and calcium deficiencies are problems in the USA, particularly among poorer families in inner cities and in rural areas and among strict vegetarians and groups who have drastically reduced meat in their children's diets. The less severe cognitive deficits associated with iron deficiency, poor linear growth associated with zinc deficiency, and neurological development problems associated with vitamin B₁₂ need to be addressed in American children as well. The potential findings of our study would address problems and approaches to prevent micronutrient deficiencies in the U.S.A. and counter the groundswell of negative information and "press" against inclusion of meat in the diet in modest amounts including fowl and fish.

Contributions to Host Country. The development target is to improve the ability of children to learn, to benefit from their school experience and to enjoy better health. This will enhance their ability to contribute to leadership roles and social and economic development of their community and nation. Kenya spends over a third of its budget on education. Better-

nourished children who are not iron deficient or suffer other micronutrient deficiencies will learn better, be more physically active and in better position to learn and increase the returns on Kenya's heavy investment in education. In addition to cognitive and school performance we anticipate improvements in physical growth and reduction of anemia which will increase ability to perform physical work and therefore contribute to economic development

With the study results of the controlled intervention study showing a causal relationship between intake of animal foods and aspects of the child's cognitive function and growth. Policy issues are raised in multiple areas - education, nutrition and health, and agriculture, and necessity for school feeding and overall improvement of diet quality .

Linkages and Networking. Interaction with the other East African GLCRSP projects through the common goal of nutrition improvement has been mainly at Annual Review meetings of the GLCRSP. The outcome of improvement in human health and nutrition through enhanced livestock production is a shared theme, ILRI, the BASIS CRSP, and IPFRI, and the World Bank invited the PI to give presentations. Our project still interacts with Makerere University Child Health and Development Center in a shared related project dealing with rabbit production for household consumption to improve diet quality, child growth and food security.

OTHER CONTRIBUTIONS

Support for Free Markets and Broad-based Economic Growth. Stimulation of small animal production, production of milk and local foodstuffs for school feeding, and family diet improvement support income generation and the marketing and sale of the above foodstuffs. The field staff now banks their salaries and

controls the use of their money. Some have started small businesses with their savings in their spare time.

Contribution and Compliance with Mission Objectives. Our project goals and objectives are and consistent with the 1998-1999 revised strategic framework of USAID Agency Goal #4: "World Population Stabilized and Human Health Protected", and specifically REDSO/ESA Strategic Objective #4, that of "Improved Child and Reproductive Health Systems in East and Southern Africa".

In the context of improving diet quantity-quality and growth and cognitive development and health of children, our project will strengthen the following areas:

IR4.1 Strengthening of information networks and improved policy

IR4.2 Improving technical capacity of partners in nutrition assessment and promotion.

IR4.3 Improving policy in the area of food based micronutrient approaches. Importance of school feeding in relation to enhancement of cognitive function and learning.

IR4.5 Improving family diet quality through incorporation of animal source foods, particularly for your children, schoolers and women of reproductive age.

Support for Democracy. This project promotes democracy in several ways:

1. The highly interactive and participatory style of operation of the current Research Team has set the tone for the project. Decisions are mainly by majority vote or by consensus and all experience "democracy in action."
2. In the future intervention phase:
 - Women will obtain experience in leadership skills and be given hands-on experience in the processes of organizing community initiatives.
 - Improved food security, nutrition, and

income generation allow community members to obtain better health and to become more active and creative participants in their communities. This leads to increased political stability, which fosters participation in community governance

Concern for Individuals. Children who have severe anemia, malaria or any other serious condition have been referred for medical evaluation and treatment. All children receive anti-helminthics (deworming) as hookworm and ascaris infection is present. Children have all had physical examinations and health histories taken and those with problems are referred for further evaluation and care. All children are having vision and hearing tested and those with problems are referred for further care.

Humanitarian Assistance. Many school children in the study appear to come to school hungry. The school feeding is most welcome and is the only substantial food some children receive prior to or during the school hours. After the informal study ended for cohort I, school feeding at school was continued for another term because of the drought and severe food shortage. This was supported by the GLCRSP.

LEVERAGED FUNDING AND LINKED PROJECTS

Linked Project (unofficial). The project entails a community-based approach to increase animal source food intake by households through rabbit raising. This project targets women and children in Uganda, and is a collaboration with Dr. Jitta of Makerere University's Child Health Development Center and College of Agriculture, and a Ugandan NGO, VEDCO. This NGO has already introduced rabbits into communities in Lowero District through women's credit groups, with a focus on income generation. Nutrition

education components consist of hands on demonstrations, participatory education, and recipe development to increase meat intake of the households, particularly of women and children. This project addresses diet quality improvement through increased meat in the diet, food security and in the future income generation by and for women. Impact will be evaluated by nutritional food intake and economic indicators. This year USAID had funded the project with linkage to the "Orange Sweet Potato" initiative and continuation of the rabbit work.

As mentioned earlier, we received a grant for \$60,000 to complete the feeding and data collection for cohort II.

TRAINING

C. Gewa, Ph.D., 2002-3, Nutrition, UCLA

M. Grillenberger, Ph.D., 2002, Nutrition Wageningen U.

R. Ngaruro, MSc., 2001, Nutrition, London School of Hygiene and Tropical Medicine

J. Siekmann, Ph.D., 2001, Nutrition, U.C. Davis

All of the above have or will carry out or use project data for their dissertations. A great deal of training and retraining has gone on of the field enumerators and supervisors. Over fifty have been trained in various areas of food intake, anthropometry, cognitive testing and observations, censuses, morbidity, socioeconomic status, literacy testing, computer and data entry. These are marketable skills for future research or evaluation positions or in relevant ministries.

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Central and Provincial Level

Makerere University

Kenya Agriculture Research Institute - Nairobi

Ministry of Agriculture
Home Economics and Livestock Central and
District Office

PUBLICATIONS

Siekman, J.H., Allen, L.H., Bwibo, N.O., Demment, M.W., Murphy, S.P., Neumann, C.G. "Micronutrient status of Kenyan School Children: Responses to Meat, Milk, or Energy Supplementation". Submitted to Journal of Nutrition.

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Whaley, S.E., Sigman, V.M., Neumann, C.G., Bwibo, N.O., Guthrie, D., Weiss, R.E., and Alber, S. "The Impact of dietary intervention on the cognitive development of Kenyan school children." Submitted to Child Development.

Neumann, C.G., Harris, D.M., and Rogers, R.L. "Contribution of animal source foods in improving diet quality for children in the developing world." Nutrition Research (In-press) pp. 1-28, for January 2002 (Special issue on Preventive Nutrition.)

ABSTRACTS AND PRESENTATIONS

Neumann, C.G., Siekman, J., Bwibo, N.O., Allen, L., and M. Grillenberger. Impact of infection and malaria in micronutrient status in rural Kenyan school children. Presented at XVII International Congress of Nutrition, August 27-31, 2001, Vienna, Austria Ann. Nutr. Metab 2001; 45 (suppl. 1)

Murphy, S.P., Gewa, C., Grillenberger, M., Bwibo, N.O., and C. Neumann. University of Hawaii, Honalulu, University of California, Los Angeles, University of Nairobi, Kenya. Changes in Dietary Quality for School Children in Kenyan Villages. Presented at XVII International Congress of Nutrition, August 27-31, 2001, Vienna, Austria Ann. Nutr. Metab 2001; 45 (suppl. 1)

Daley, T.C., Whaley, S.E., and M. Sigman, The Flynn Effect in Rural Kenya Paper presented at 30th Annual Meeting of The Society for Cross-Cultural Research, February 2001, San Diego, CA and at the Society for Research in Child Development, April 2001, Minneapolis, Minnesota.

Congdon, E.M., Schweitz, E.M., Neumann, C.G., and J. Siekman. Dana Center, Wilmer Eye Institute, Baltimore, MD, UCLA School of Health and of Medicine, Los Angeles CA and University of CA at Davis, Dept. of Nutrition at Davis CA Presented at the Association for Research in Vision and Ophthalmology, Ft. Lauderdale, May 2001.

COMMENTS

The Child Nutrition was extremely gratified to receive the Child Survival funds for work with the under-five age group. Although challenging, we feel that limited feeding intervention study is extremely worthwhile. Children in this age group have the highest rates of morbidity and mortality from infectious diseases as well as malnutrition and need

relatively requirements for their rapid growth. Therefore, even a short time of intervention feeding may yield some positive results. The real challenge is to keep the mothers bringing their children daily for onsite feeding at eighteen different feeding sites. This requirement is the very reason we chose to work with school children. Also in the spirit of the child survival initiative, these young children are having their growth monitored, and are being dewormed and are being treated for malaria and severe anemia as detected.

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