

Nutrition for Health and Socioeconomic Development in sub-Saharan Africa

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This report is presented as received from project recipients. It has not been
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Acronyms

CIHR	Canadian Institutes of Health Research
CRC	Canadian Research Chair
DFATD	Department of Foreign Affairs, Trade, and Development
EBF	Exclusive breastfeeding
ENAM	Enhancing Child Nutrition through Animal Source Food Management
FQRNT	Fonds de recherche du Québec – Nature et technologies
HIV	Human Immunodeficiency Virus
IDRC RC	International Development Research Centre Research Chair
IRCI	International Research Chairs Initiative
IRD	Institut de Recherche pour le Développement
NRTC	Nutrition Research and Training Centre
TIPS	Trials of Improved Practices
UG	University of Ghana
UMKD	Upper Manya Krobo District
US-AID	United States Agency for International Development
WIAD	Women in Agriculture Development

i. Basic Project Information

Project numbers: 104519-009 (IDRC RC) / 104519-017 (CRC)

IDRC RC

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Abstract

Sub-Saharan Africa faces a “triple” burden of disease characterized by a high prevalence of child malnutrition, increasing incidence of diet-related chronic diseases, and the continued presence of the HIV epidemic. This program focused on two areas of priority for Ghana: (i) child under-nutrition in rural communities and (ii) childhood overweight and obesity in urban centers. When nutrition and health education are combined with social support and skill building activities for caregivers, poor growth and development of young rural children can be overcome. Similar responses are needed to improve child nutrition in urban communities where the increasing access to poor quality cheap foods and decreasing exercise is compromising child health. Our overall objective was to improve child nutrition in Ghana. This was accomplished through training activities ((i) establishment of the University of Ghana’s Nutrition Research and Training Centre that hosts education and research projects, (ii) graduate training for 5 PhD and 17 MSc students, and (iii) creation of a community-based dietetic internship for North American and Ghanaian students) and research projects on both child under- and over-nutrition. Nutrition education through multiple sectors has improved rural diets and national awareness of the growing problem of overweight among Ghanaian children has increased. Current research and interventions build on these project results.

Keywords

child malnutrition, schoolchildren, obesity, dietetics, agriculture, graduate training

ii. The Research Problem

Rationale for the IRCI project

Drs. Lartey and Marquis have worked together on diverse research projects in northern, central, and coastal areas of Ghana since 2001. This collaboration provided a wealth of experience upon which to build an integrated maternal and child nutrition training and research program. The International Research Chairs Initiative (IRCI) project funded training at all levels (from community-based workshops to graduate education) and research projects that addressed emerging questions in the field. The overall aim for the project was to improve the lives of the vulnerable populations living in Ghana.

Rationale for the research problems addressed

Early nutrition is a key determinant of child physical and cognitive development and later adult productivity and health. In Ghana, about 30% of children < 5 y are stunted and over three-quarters of preschool-aged children are anaemic.¹ These high rates of malnutrition are indicators of the high prevalence of food and nutrition insecurity, caregivers' poor knowledge and feeding practices, an environment that increases health risks, and limited support systems to mitigate risk. Evidence from our earlier research demonstrated that Ghanaian infants of HIV-seropositive mothers, regardless of their own status, were at higher risk of poor growth and health than infants of mothers who were not infected with HIV.² In addition, health staff have limited nutrition knowledge and poor counselling skills which have been identified as limitations that need to be addressed.³ Concurrent with under-nutrition in rural communities, there is an increasing prevalence of overweight and obesity in the urban setting. Today, about 30% of Ghanaian women are overweight; almost one-third of these women are obese¹. The prevalence rates among young children are much lower but they are increasing (1% in 1988 to 5% in 2008 in the national surveys). No systematic data exist for school-aged children but data on adult women demonstrate a rapid increase in women's weight, starting in adolescence⁴. Although school feeding programs started in 2006, their objective is to increase school attendance with little attention to addressing the under- and over-nutrition issues experienced by children today. Multi-sector, integrated interventions in the communities, health services, and schools are needed to improve child growth and reduce the long-term economic and social costs of poor nutrition.

Relevance of project activities to Ghana Education and Ghana Health Services

The IRCI program was focused on developing local capacity to carry out nutrition training and applied research. The use of multi-sector interventions aimed to increase equity in access to nutrition-sensitive education and programs.⁵ Because of the cross-cutting nature of nutrition, the multisectoral approach employed in our projects involving the Ghana Education Service, Ghana Health Service and rural communities was relevant to ensuring that the positive outcomes of our interventions. The activities addressed priorities of the region and were carried out

among vulnerable sectors of the population –women and young children living in a rural, HIV-affected district and school-aged children living in urban settings. The activities were consistent with the 2008 Millennium Development Goals Africa Steering Group recommendations on practical steps to meet the goals, including (i) implementing national school feeding programs; (ii) strengthening health systems; and (iii) helping primary healthcare systems provide basic and vital health services in part through community health activities.⁶

Changes in the rationale and relevance

The rationale and relevance of our project did not change over the project period. We have, however, had the opportunity to extend training and research activities beyond those originally planned. During the final project year, we were able to support training on the deuterium oxide staple isotope dilution method, the most precise method for measuring breast milk output. Building capacity in this methodology at the University of Ghana was possible because of in-kind support from the Ghana Atomic Energy Commission. In addition, we supported a doctoral thesis that was the first study in Ghana to examine the relationship between being overweight/obese and dental health.

iii. Objectives

The general objective of the project was to improve child nutritional status in Ghana through research that integrates government, non-governmental, and community stakeholders.

The specific objectives of the project were as follows:

- 1.1. to develop a Centre of Excellence for Nutrition Field Training in Ghana for dietetic students from Ghana and North America, and to serve as a research center for student researchers;
- 1.2. to provide doctoral training in nutrition and related fields for four PhD students from Ghana;;
- 1.3. to develop a community-based internship opportunity (stage) for Ghanaian and Canadian/international nutrition and dietetics students;; and
- 1.4. to design, analyse and disseminate results related to all child nutrition research activities carried out under this project (including, improving child nutrition in HIV-affected areas, childhood obesity).

Meeting the objectives

The general objective of improved child nutrition was the overarching goal of all of program activities. Change in nutrition indicators was measured in the agriculture-nutrition education intervention project. Children in the integrated (agriculture + nutrition) arm of the intervention improved dietary practices compared to the other

two study arms (nutrition only, control). The timeframe may have been too short to note differences in growth. The results from this one research project do not capture the benefit of the diverse training activities that have occurred under the IRCI program. We believe that the program's true effect on child nutrition in Ghana is much larger and long-term. The extensive training on nutrition of individuals in communities, government institutions, and academia will contribute to improve the quality of services and benefit vulnerable populations in future years.

All of the specific objectives were met. The University of Ghana (UG) inaugurated the Nutrition Research and Training Centre (NRTC) in July 2010 and it has continuously hosted training events and research projects since then. The project exceeded its objective in graduate and internship training. It has assisted 5 PhD and 17 MSc students in addition to 52 dietetic interns (post-baccalaureate) from North American and Ghanaian universities. The internship program has been expanded to three times per year and there is on-going discussion to further expand it and open the experience to other African universities. The primary limitation for the future of this program is the lack of funds for a student lodging facility at the NRTC. The UG and McGill University (McGill) have successfully collaborated on the three principal research projects for this program (prevalence study on overweight/obesity in schoolchildren, nutrition-agriculture education intervention, and intervention to decrease risk of wasting). The last project, not in the original project plans, will be completed in 2014. Additional student projects have also been supported (dental health and nutrition, measuring breast milk). The projects' results have been disseminated widely. Together, Drs. Lartey and Marquis have successfully competed for federal and provincial research grant funding to further support training and research activities at the NRTC.

New objective for 2014

A new objective has been added and will be completed during the one-year extension of the program.

- 1.5 To produce three educational films to be used to promote healthy eating among Ghanaian school age children

As a follow-up to the findings of the Ghana school survey, we propose to address poor dietary practices among schoolchildren by using an educational tool that presents nutrition information to children in a fun, interactive, and entertaining manner. The program is named *Foodies*. This will involve creating an educational cartoon series based on an animated food characters (e.g., "Mrs. Tomatoes", "Mr. Kontomire" - a Ghanaian dark green leafy vegetable). An episode will be built around a storyline on a nutritious local food ingredient- its origin, nutritional content, how it can be incorporated in the diet, and the health benefits. To make the program appealing to schoolchildren, each episode will employ the use of animated food characters in a cartoon setting intertwined with local popular songs that give a clear nutrition message. The development of the *Foodies* cartoon will be done in collaboration with Urban Republic, a small Ghanaian company with expertise in

cartoon film production. The product will be distributed for free through TV networks, as DVDs to schools, and as on-line e-learning materials.

iv Methodology

v. Project Activities

Program-specific activities

The program funds were used to (1) develop a training and research hub in the Eastern Region of Ghana, (2) carry out research activities, (3) support graduate training in nutrition, (4) develop a post-baccalaureate dietetic training program, (5) provide nutrition-related training for diverse stakeholders, and (6) disseminate results. These activities are described below. New funds were obtained as a result of successful grant applications stemming from our IRCI program that have allowed us to build further on each of these activities (please see Appendix A).

(1) develop a training and research hub in the Eastern Region of Ghana

At present all dietetic training occurs in urban cities and the University of Ghana does not have a regional presence for research and training of nutrition professionals. To overcome this limitation, the team developed UG's first research and training site for nutrition located in a rural district (Asesewa, Upper Manya-Krobo District) through external funding. During the first two years of the IRCI project, the Center was built, a two-story building with eight research offices and two work-group rooms, a one-story building with a small conference room and demonstration kitchen, and a 3-bedroom long-term living quarters. The IRCI program provided the funds to equip the demonstration kitchen and conference room, and helped support Center staff for the first four years. The Center was inaugurated in July 2010 and presently hosts the dietetic internship program and several research activities. To date, we have been unable to obtain funds for a 30-person short-term residential space that would allow the Centre to expand its training services.

(2) Collaborations from a diverse group of partners

The program was carried out with the collaboration of a diverse group of partners and agencies in Ghana: i) The Ghana Education Service (GES) was a key collaborator in our school survey. The Director-General of GES provided support letters to all the participating schools asking them for maximum collaboration with us. The Heads of schools and program coordinators of the School Health Education Program actively supported our research by providing office space and assigning teachers as focal points to coordinate the contact with parents and caregivers; ii) Ghana Health Service (GHS)- The Asesewa District Hospital has been a close partner in all our trainings and activities. First, with the provision of land for the construction of the NRTC, second, the hospitals Management Team served on the Center's building Committee. Through our program the University of Ghana signed a memorandum of understanding with the GHS to formalize our collaborations at the Asesewa District

Hospital. In return the NRTC provides free dietetic services to the hospital. The NRTC's personnel are invited to the Hospitals annual review meetings. The NRTC reports on its activities to the Committee.

iii) Ministry of Agriculture (MOA)- The IRCI project on agriculture-nutrition education intervention, was done in close collaboration with the MOA. The MOA seconded one of their Agriculture staff to the district to support our project.

iv) Elders of the Asesewa Community- The NRTC has good working relationship with the elders and chiefs of Asesewa. They willingly provided land to the Asesewa Government Hospital, the community feels ownership of the part of which was ceded for the construction of the NRTC. The Community provided two personnel to serve on the building committee.

v) Rural villages in Asesewa district- Our research and training activities in the district has included over 30 communities in the district. Our project provided health and nutrition training to community health volunteers from the villages. Community Health nurses also participated in these trainings held at the NRTC. These collaborations were effective to the achievement of the program objectives.

The program supported five main projects (see table below and discussion in section vi). The project on childhood overweight and obesity subsequently led to the study on nutrition and dental health. In the UMKD, the wasting project built on the results of the agriculture-nutrition intervention. The project on breast milk measurement was a new opportunity that arose during the final year of the program.

Research studies	IRCI program year				
	1	2	3	4	5
Child overweight/obesity					
Obesity and oral health					
Agriculture-nutrition intervention					
Risk of wasting intervention					
Breast milk measurement					

We have been successful in obtaining complementary funds for our training and research activities from international, federal, and provincial sources. These funds have supported the collaborative effort between North American and Ghanaian universities to establish the dietetic internship program (assisted by a CIHR planning grant and donations from Iowa State University [USA]) and expand the training and research agenda (through funds obtained from Conseil franco-quebecois de cooperation univers program [FQRNT], Micronutrient Initiative, and DFATD as well as smaller donations). The DFATD grant provides sustained funding for training and research activities at the NRTC through 2018. In addition, students who were supported by the IRCI program were also successful in obtaining grants for their academic and research programs from federal, non-profit, and internal funds. All of these additional resources are shown in Appendix A.

3) support graduate training in nutrition

The program has provided partial or full financial support for 5 African students in a PhD program and 17 students in a MSc program at the UG and McGill. All students have had field experiences directly related to their research topic. A list of the students is provided below. Of the 22 students, 3 PhD are still completing their program at McGill and are scheduled to graduate in the 2014-2015 academic year.

4) develop a post-baccalaureate dietetic training program

CIHR provided the funds through the Fall 2010 Planning Grants Competition for faculty representatives from seven Universities (3 Canadian, 3 USA, and 1 Ghanaian) to meet and discuss collaborative training of dieticians from North America and sub-Saharan Africa that would enrich programs in both settings. This workshop led to additional meetings and the development of an international stage experience in UMKD, hosted at the NRTC. The table below shows the sessions and participants that have taken place to date. Two additional sessions were planned for 2014. This program is well established and we continue to receive enquiries from other Universities about interest in participation. However, the number of participants/session will continue to be limited to about 10 until we are able to obtain funds to build a 30-person short-term residence at the Centre.

The IRCI program provided funds to hire a full-time dietician who coordinates training activities as well as provides the NRTC's community service in nutrition education to outpatient clinics in Asesewa. This position is supported now by other projects and is partially subsidized by Iowa State University's dietetic internship program.

Dietetic internship in Asesewa					
	IRCI program year				
	1	2	3	4	5
# of 4-week internship sessions			1	2	2
University origin of students					
North American			6	14	11
Ghanaian			5	8	8

(5) provide nutrition-related training for diverse stakeholders

Over the program period, we have provided nutrition-relevant training to staff from government and non-governmental/international organizations, community leaders, community health volunteers, project participants, residents, local project staff, and students. The table below shows the training activities of each project/program, with a conservative estimate of the number of beneficiaries.

Major nutrition-related training		
Project /program	Activities	Beneficiaries to date
Agriculture-nutrition education intervention project	Community-based group training on child feeding and agriculture	27 community health volunteers; 2 Ministry of Food and Agriculture staff; 132 community residents; 1 UG student; 1 Danish intern
Reducing risk of wasting project	Five training workshops on anthropometry, child feeding, and counselling skills	47 male and 155 female nurses, 14 male and 18 female health promotion assistants, and 204 male and 40 female health volunteers
Overweight/obesity in school children project	End of project workshop on study results	102 Ghana Education Service staff (including 100 Heads of school); 2 Ghana Health Service staff; 9 UG students; 28 staff from non-governmental organizations and the United Nations
NRTC opening (2010) Launching DFATD project (2014)	One-day events and workshop on research results	> 200 community and district leaders, government and non-governmental staff, private business staff, and UG staff attended one or both events
Dietetic internship	Five 4-wk internship sessions with community durbars	> 400 residents at community-based durbars, 52 dietetic interns
Graduate programs	Nutrition studies	17 MSc and 5 PhD students

(6) Dissemination of results

The results of the research and training have been shared through professional publications and presentations, reports, workshops, and submitted theses. These are listed in the outputs section below.

Lessons learned on implementation and management

The primary lesson that has been reinforced these years is that there is a need for programs to work with diverse sectors (agriculture, health, education, finance, civil society). Nutrition is typically in a silo of the health ministry. Integrating programs requires understanding how different sectors view problems (their conceptual frameworks), complementing competencies, and bridging funding. In the agriculture-nutrition intervention, the integrated arm provided a better environment for learning than just nutrition or the routine health clinics. Caregivers expressed more interest, attended sessions more frequently, and subsequently changed their child-feeding behaviours. The projects also demonstrated that the health sector community-based activities (including the volunteer system) are weak in rural Ghana and require substantial evaluation on how to be improved. Projects that depend solely on the government health sector may be less successful because of poor clinic attendance and quality of services – other sectors that have a presence in the communities can help. At the moment, there is little interaction between the education and health sectors for nutrition yet there are growing problems of poor nutrition in schoolchildren that requires immediate attention.

The second lesson from our program is that change takes time. Frequent, repeated training improves skills in staff. Finally, sustainability depends on having a permanent local partner who sees the intervention within their mandate. Without planning from the beginning of a project, it is unlikely that a program will be taken up and sustained. Government ministries are eager to work with academic institutions to address national problems. Such collaborations have better impact and uptake than in situations where academic institutions do the interventions alone. A good example is our work on interventions to decrease wasting in rural communities. The Ghana Health Service was brought on board right from the beginning. They granted approval for the community health nurses and community volunteers to participate in the trainings. Our preliminary findings show that it is possible to teach community health nurses and volunteers to measure length/height and incorporate this in their routine child welfare clinics. A positive outcome from this intervention is likely to be taken up by the Ghana Health Service and other health-oriented NGOs in their programs.

vi. Project outputs

Main outputs

Human capital. We consider that the principal output of our program is human capital. We contributed to the doctoral training of five young people (see

table below). Of these, one has become a lecturer at UG (Cofie), one, who is on faculty at the University of Ghana, has submitted his dissertation (Ndanu). The UG now requires that all lecturers have the basic degree of PhD or will be withdrawn from the University. The IDRC funds have made it possible for Ndanu to meet this requirement. Three PhD students will be completing their programs at McGill this academic year. Of the 17 Master's students who were supported, two work/have worked for international nutrition organizations, one entered an American doctoral program, eight work on nutrition research, and of the six who are completing their MSc programs, one is working already with a multinational company.

The Nutrition Center also serves as a training center for our UG students. Four graduate students from the UG have used the Center as their base for their data collection. The program also improved the infrastructure of the UG's Department of Nutrition and Food Science. IDRC funds made it possible to renovate a laboratory in the department to serve as a nutrition lab for graduate nutrition students. A bomb calorimeter was purchased with IDRC funds. This is the only functioning Bomb Calorimeter in the University and is being used by graduate students to determine energy content of formulated foods. Prior to this, students only had a theoretical knowledge of this equipment. These students are the future nutrition researchers for Africa.

The NRTC has been an excellent facility for capacity building for students through the training and research projects they embarked on in the community. It also served as an extension of service to the community. Adults in the communities were given nutrition education on appropriate infant feeding practices.

The program has also improved the knowledge and skills of staff that will have influence over policies and programs that affect child nutrition in rural communities and urban schools. We have worked hard to bridge the different sectors and harmonize nutrition throughout. This work continues with the new DFATD project.

Research Outputs

The methods for each research study are described below separately, as they had unique designs for the fieldwork. The instruments that were used are included in this final report. The initial research plan included the first two projects (over-nutrition in schoolchildren and an agriculture-nutrition education intervention to improve young child nutrition). We were able to also carry out three additional field projects under the scope of the program – on wasting in rural Upper Manya Krobo District, examining the relationship between nutritional status and dental hygiene, and measurement of breast milk intake. The field methods were standard designs in the field. For the quantitative data, we used cross-sectional, case-control, randomized cluster, and cohort designs. In rural as well as urban settings, the use of clusters (the community, the clinic setting, or the school) and a systematic rather than a random sampling approach may be necessary because of distance and the absence of a true sampling frame. For the qualitative data, we used interviews, focus groups, and trials of improved practices (TIPS)⁵ methodology. Our experience

tells us that a combination of qualitative and quantitative methods provides the richest information.

Project #1: Nutrition survey among in schoolchildren

Purpose: To estimate the prevalence of overweight and obesity among urban schoolchildren, determine their risk factors, and provide the basis for the development of educational approaches for improving eating habits and maintaining healthy weights among Ghanaian children.

Methods: We conducted a cross-sectional survey in 57 public and 64 private urban schools randomly selected from all primary and junior high schools located in Accra (the capital) and Kumasi (2nd largest city) in Ghana. Permission to conduct the study was obtained from the Director General of the Ghana Education Service and directors of the 60 schools in Accra and 61 schools in Kumasi. Participants 9 – 15 y of age were randomly chosen within each selected school. After informed consent was obtained from parents, data were collected on 1136 children from public schools and 1953 children from private schools. A structured, pre-tested questionnaire was used to collect socio-demographic, dietary, and physical activity data. Anthropometric measurements and body composition were taken using a bioelectric impedance scale. Blood lipid profile and glucose concentrations were collected on a sub-sample of 1632 children. The subsample included all overweight and obese children and for each overweight or obese child identified, a non-obese child of the same sex and age was randomly selected for inclusion. Haemoglobin determination was completed on every second child who reported for the interview. A total of 2237 parents and guardians agreed to be measured; 69% were female.

*The Nutrition school survey report*¹¹. The workshop and report are key outputs of our program. The results dissemination workshop and the report came out at the time Ghana was drafting its nutrition policy.¹⁰ While there was ample data on child undernutrition, prevalence data on overweight and obese children was lacking. The report provided information on the overweight and obesity prevalence among Ghanaian school children. The results of the survey were presented at a results dissemination workshop that brought together key personnel from various government ministries, UN organizations and Heads of schools. The report of the survey¹¹ has been cited in the Ghana Nutrition Policy. Ghana's nutrition policy now sees the importance of addressing both undernutrition and overweight and obesity. The survey provided the opportunity for the UG and the Ghana Education Service to work together to understand the nutritional issues for schoolchildren. A key outcome of this report is that the UG, the Ghana Education Service, and the Ministry of Food and Agriculture are going to collaborate to produce an animated cartoon series on healthy eating for school children.

Project #2: an agriculture-nutrition education intervention

Purpose: A randomized cluster trial tested whether the provision of integrated agriculture and nutrition education services to rural caregivers improved

nutrition outcomes among young children, compared to receiving only nutrition education or standard-of-care services.

Methods: Formative research was conducted to identify current complementary feeding practices, and facilitators and barriers of complementary feeding education using interviews with 28 community health workers and 3 staff of the Ministry of Food and Agriculture as well as three focus group discussions with 22 caregivers of young children. The TIPS methodology⁷ was implemented with 11 mothers to develop appropriate, feasible, and acceptable complementary feeding recommendations for the intervention trial. Thirty community centers in the Upper Manya Krobo district (UMKD) receiving routine care from Ghana Health Service were randomly assigned to one of two intervention groups (enhanced nutrition education only; enhanced nutrition education with integrated agriculture education) or to the control group. Twenty health volunteers were trained to deliver the community-based education in their area. The Ministry of Food and Agriculture seconded an extension agent to the project to provide the agriculture education. A total of 367 mother-child pairs were enrolled after obtaining informed consent and were followed for nine months. Fieldworkers collected data on household characteristics, caregivers' knowledge, feeding and health practices and infant dietary intakes, anthropometry, and morbidity during home visits. The results indicate that in this rural setting, 21.6% of households experienced food insecurity in the previous month. Household food insecurity was associated with respiratory infections in the second half of infancy, but not with diarrhea or stunting. Inclusion of animal source products, fruits, and vegetables in young children's diet was not common in the area. Poverty and maternal time constraints, and lack of teaching materials and language barrier, were identified as challenges to optimal CF practices and provision of CF education, respectively. Almost half of intervention mothers (45%) never attended an education session.

Project #3: an intervention to decrease wasting in rural communities

Purpose: Although the national Demographic and Health Survey¹ reported wasting prevalence to be higher than underweight and stunting during the first year of life, the Ghana Health Services does not collect length measurements that are needed to identify children who are wasted or at risk of becoming wasted. This nutrition intervention worked with community-based health staff to improve their ability to identify malnourished children and enhance the quality of education on infant nutrition that is provided in the rural UMKD of Ghana.

Methods: Formative research was carried out to develop an algorithm to identify predictors of wasting in infants, based on previously collected data from the Lower Manya Krobo district and data collected in a baseline survey among randomly selected 690 households with children less than 2 years of age in 30 randomly-selected UMKD communities. The predictors that emerged (weight-for-age, exclusive breastfeeding, intake of animal source foods yesterday, use of a mosquito net, and fever, diarrhoea, or cough in last month) were used to develop in the algorithm as a tool to improve nutrition services to the community.

A randomized cluster trial was used. The 30 communities were randomized into three intervention arms: (i) standard-of-care (weight measurement + weight -for-age chart), (ii) use of algorithm + weight measurement + weight-for-age chart, and (iii) weight and length measurements + weight-for-length chart. All child growth and monitoring health staff (140 nurses and health volunteers) who provide outreach services in the communities were recruited and trained in effective nutrition counselling skills and use of the study tools. The cross-sectional endline survey was completed after 12 months of intervention with 690 randomly selected households. The study analysis to be completed in 2014 will examine the change in wasting prevalence at the community level (endline vs. baseline) and examine the growth trajectory of a cohort of children who had repeated measurements at the weighing centers over the intervention period. Although still on-going, the wasting intervention has demonstrated the capability of health staff to measure length/height during the well-baby clinics. These results will be presented to the Ghana Health Services as evidence to support a change in policy concerning growth monitoring that will allow the government to begin collecting regular information on stunting. UNICEF is interested in this study and will be interested in implementing length measurements in their programs if the outcome is positive. This study will provide information on the feasibility of including length measurement in regular growth monitoring sessions in Ghana for early detection and management of wasting.

Project 4: the relationship between nutritional status and dental hygiene

Purpose: There is little information available on the prevalence of oral diseases in Ghanaian children and less evidence on whether nutritional status is associated with oral health. Some research suggests that poor oral health increases the risk of metabolic problems⁸ while others suggest that being overweight increases the risk of poor oral health⁹. This study was carried out in two phases to examine the association between overweight and oral health in school-aged children and identified dietary and oral hygiene risk factors for poor oral health.

Methods: The first phase consisted of a cross-sectional survey of Accra children between the ages of 9 and 15 years (primary 4-6 and junior high 1-3) attending eight private schools in Accra. The sample included 233 obese and 314 non-obese schools children. Dietary and oral hygiene information were collected and two dental surgeons orally examined respondents. Parents and children provided consent for the collection of demographic, anthropometric, dietary, and oral hygiene information and an oral examination. Bacteria from oral plaque samples collected from randomly selected obese (n=75) and non-obese (n=75) children with visible plaques were cultured. The second phase consisted of a case-control design of 493 public school children made of 210 cases (children with caries and gum diseases) and 283 controls (without caries or gum disease). Similar data were collected. The main findings were that obesity status was not associated with dental caries or gum disease among the Ghanaian children studied. There was no significant difference in the prevalence of oral bacteria commonly associated with dental caries and gum disease among the obese and non-obese children, except for *Streptococcus mutans* which was significantly higher among the obese than the non-

obese but this did not reflect in the prevalence of caries or gum disease between the two groups of children.

Project 5: measurement of breast milk intake

Purpose: Exclusive breastfeeding (EBF) for six months is the best infant feeding strategy. EBF among Ghanaian mothers with singletons is low (46%). This is attributed to perceived inadequate breast milk production. Although Ghana has high twin birth rates (26-33 per 1000 deliveries), no study has measured breast milk yield from mothers who are breastfeeding twins. This study estimated the duration of EBF and the volume of breast milk produced by Ghanaian mothers with twins compared to those with singletons. Breast milk intake of the Ghanaian lactating mothers was estimated by the deuterium oxide dilution technique, a two-compartment steady state model.

Methods: Thirty mother-infant pairs (15 singletons and 15 twin mothers) were enrolled. Saliva samples (2-5 ml) were collected using cotton wool from mothers and babies. Mothers were given 30 ± 0.02 g of deuterium-labeled water to drink. The dose bottle was rinsed with 60 ml of drinking water twice and given to the mother to drink to ensure that the complete dose was taken. Saliva samples of 2-5 ml were collected from both the mothers and their babies 1, 2, 3, 4, 13, and 14 days later. The samples were kept on ice until transferred to a -20°C freezer where they were kept until analysis. Prior to analysis, the samples were thawed at room temperature and centrifuged for 5 minutes at 4.4 rpm. The deuterium enrichment was measured with the Fourier Transform Infrared Spectrophotometer. The equipment was calibrated with a standard solution of deuterium at least twice a day to ensure accuracy of readings. The pre-dose saliva sample for each participant was analyzed before analyzing the post-dose samples since the former served as a background against which the latter was measured. Measurements were done in triplicate and the two closest values selected. The infrared spectra were measured in the absorbance range of $2300\text{-}2900\text{ cm}^{-1}$. The amount of breast milk and water from non-milk sources ingested by the babies were estimated by entering the deuterium enrichment concentrations (in ppm) into a model for water turnover in the mothers and infants (IAEA, 2010). An algorithm developed by the Medical Research Council was used to estimate intakes of breast milk and water from non-milk sources. Non-linear regression generated the line of best fit for the data and the average human milk and non-milk oral intakes in ml/day were calculated. Results showed that twin mothers produced between 717-2,072 ml of breastmilk per day compared to singleton mothers who produced between 644-1574 ml of breastmilk per day. This method is the most precise method for assessing breastmilk intake. To our knowledge, this is the first time this method has been used to estimate breastmilk production of mothers with twins.

The briefs, reports, research papers, and presentations are all listed in the Bibliography section below

List of Trainees

	Trainees supervised by			
	IDRC RC	CRC	IDRC RC & CRC	Other collaborators
<i>Undergraduate</i>				
Abigail Armah	X			
<i>Masters</i>				
Katherine Birks		X		
Valerie Friesen		X		
Jane Odei	X			
Emelia Ayesu	X			
Gifty-Margaret Donkor	X			
Helena Nti	X			
Naa Hammond				X
Afua Atuobi-Yeboah	X			
Christian Duut				X
William Nkoom	X			
Veronica Seddoh	X			
Joe Daare				X
Judith Ankrah	X			
Sarah Hammond				X
Prosper Pagul				X
Isabella Tangoh				X
Helena Bentil	X			
Clemence Joubert ¹				X
<i>Doctoral²</i>				
Agartha Cofie			X	
Matilda Laar			X	
Husein Mohammed		X		
Karim Bougma		X		
Tom Ndanu	X			
<i>Post-doctoral</i>				
<i>Other</i>				
¹ MSc from University of Montpellier-1, France. ² The project extension will also assist a new PhD student at UG, Laurene Boateng starting in 2014. Dr. Lartey is the mentor.				

Overall, how has the IRCI enhanced the training environment you could otherwise provide to your students?					
	Not at All	Minimal	Moderate	Significant	Don't know
CRC				X	
IDRC RC				X	

Lartey research group. The IDRC funding made it possible for me to take on a graduate student every year. Most of them are now able to finish in the expected

two years instead of three years. One Ghanaian student (Cofie) has completed her PhD at McGill and has returned to the University of Ghana as a lecturer and is also serving as the Manager of the Nutrition Research and Training Center at Asesewa. We currently have two other Ghanaian students (Laar and Mohammed) in McGill's doctoral program in nutrition and one student (Ndanu) in the University of Ghana doctoral program. This has been made possible through IRCI funds. Marquis' yearly visits to the UG have helped the Department in the following way: i) she continues to serve as examiner for the Department. Her quick turn-around time of thesis submitted to her has shortened the time students have to wait to get feedback from external examiners.

Finally, the program has made it possible to offer experiences in low-income communities to students from North America. Ghanaian dietetic students also have the opportunity, for the first time, to provide dietetic services to rural underserved communities in the Upper Manya Krobo District. The IDRC funds have made it possible to hire a Dietician for the Nutrition Center. This staff member also provides dietetic services to the only district hospital. The hospital has provided an office for him at the hospital premises and he is considered a member of the hospital's management team.

Marquis research group. The IRCI funding has provided the opportunity to have African doctoral students study at McGill and Canadian graduate students to carry out field research in Africa. Fieldwork is a key component of a graduate program – at both the master's and doctoral level. The program provided the base on which the students were able to build their individual research questions. It also provided a constant intellectual presence in the field to support students. Without the NRTC, the field costs would have been prohibitive for some students' projects. To date, in part due to this program, all of the graduate students in the Marquis Research group have completed original fieldwork in an international setting. This has been made possible due to the availability of the facilities at the NRTC (accommodation, vehicle and research equipment) that makes it possible for us to run this exchange program at a much reduced cost.

One of our long-term goals is to make the NRTC a regional resource for community nutrition. During this project, we have been able to collaborate with Dr. Kirsten Bork at the Institut de Recherche pour le Developpement (IRD) in Montpellier, France who has worked throughout West Africa. A joint grant, funded through the Quebec and French governments supported the field research in Ghana of a University of Montpellier-1 student's research. The student's thesis was chosen as the best of the program for that year. Collaborations continue with Dr. Bork and we are exploring funding for additional research and training initiatives.

A cumulative list of research outputs is shown in the table below. These include both research that was funded directly by the program as well as those that benefitted because the program existed.

Research outputs supported directly by IRCI or outputs that benefitted from association with the IRCI program¹			
Type	Total	Marquis	Lartey
Journal Articles (published / accepted)	5	3	2
Journal articles (submitted)	0	0	0
Conference Papers/Presentations	79	17 abstracts 10 talks	52
Presentations (non-academic)	1	1	0
Books	0	0	0
Book Chapters	2	2	0
Newspapers / other media	3	2	1
Theses completed ²			
- MA / MSc	11	2	9
- PhD	2	1	1
¹ Clarification of direct or indirect association with IRCI program is made in the bibliography section			
² Three additional PhD theses will be completed in 2014-15 school year.			

vii. Project outcomes

Promoting scientific collaboration between research chairs

The IRCI program has strengthened the scientific collaboration between McGill and UG, and our research teams. This can be seen in the expansion of a coherent research program on maternal and child nutrition in the two institutions. Additionally, the IRCI has opened opportunities for additional funding. Our new grant from DFATD (~3.5 million for the next 5 years to do research on agriculture-nutrition – health linkages) provides the opportunity to continue to maintain our research activities at the NRTC in Asesewa and to continue to support the district through our research in the region. We collaborated on grant applications throughout the five years; two proposals were not funded (Gates Foundation and US-AID) and three were funded (CIHR, Conseil franco-quebecois de cooperation universitaire, DFATD). Both of us have provided substantial effort in developing the NRTC and supporting the students and interns that have used the facilities. We have collaborated on the analyses and write up of project results on oral professional presentations and written publications (those related to the project are shown in the Bibliography section). Dr. Lartey serves on McGill student committees and has visited McGill and provided lectures for the School. Dr. Marquis serves as an external reviewer of UG theses and faculty tenure packages. She regularly visits UG, has provided lectures for the Department, and in 2013, she received an honorary degree for her contribution to tertiary education at UG.

Providing unique training and fieldwork opportunities for students

The program’s real contribution to “unique training” is the development of the community-based dietetic internship at the NRTC in Asesewa. The 4-week

internship brings North American and Ghanaian dietetic interns together to obtain knowledge and skills to carry out community-based nutrition education in low-income communities. To our knowledge, this is the only program of its kind in the world. The evaluation of the program has been very positive from the students, instructors, as well as the community. While training the interns, it provides a benefit to the district in two ways: (1) educational activities in the rural areas provide education to families that will contribute to the improvement of health and development of vulnerable groups, and (2) the program hires a dietician who donates time for nutrition education to hospital staff and residents to address undernutrition among children as well as the growing prevalence of nutrition-related chronic diseases in the area (obesity, diabetes, heart disease). There are no other practicing dietitians in the district.

Another aspect of unique training that was mentioned previously is the universal opportunity of our master's students to have overseas field experience. McGill faculty members often comment on the rarity of this important aspect of the program. Due to difficulty in getting funding, the University has substantially reduced previous practice of sending its brilliant students outside the country to compete in the educational system of other Universities. The result is that we now have a lot of in-breeding where lecturers do their undergraduate studies up to doctoral studies in one University. This is not the best situation for a University that seeks to be world class. The IRCI program has opened the opportunity for three Ghanaian students to do their doctoral studies in nutrition at McGill. This is a way of infusing new ideas into our program at the University of Ghana.

Identifying new avenues for knowledge, policy, or technology transfer

We have worked to have our program results influence policy over the past five years. The results of the ENAM project (PI:Marquis/coPI:Lartey) are being used to guide the US-AID Multi-year Strategic Plan for Ghana for the Feed the Future initiative, as laid out in the following website:
http://feedthefuture.gov/sites/default/files/country/strategies/files/GhanaFeedtheFutureMulti-YearStrategy_2011-08-03.pdf

New calls for proposals on the role of agriculture to improve nutritional status of women, infants and young children and the US-AID's Feed the Future program in Ghana have incorporated results from our past research.

Our training program provided opportunity for Ghanaian dietetic students to interact with dietetic students from North America for month in an internship program. Students learn from each other and are able to compare their programs. In one of the training programs, it became evident that the dietetic training program in Ghana (which has been running for only 8 years) was not strong in the Nutrition Care Process. This process enables dietitians to do counseling of patients in a standardized way, using approved accepted language terminology. The Nutrition

Care Process has been approved by the American Dietetic Association. A workshop was organized in Ghana with three dietitians coming from the USA to organize this training. The workshop was attended by 150 participants (students and dietitians in Ghana). We are happy to confirm that the Dietetics program at the University now has a full course on the Nutrition Care Process. Our collaborators arranged for books on the course to be made available to the participants at reduced cost. More than 100 representatives and coordinators of the Ghana Education Service School Health Education program participated in a results dissemination workshop that sensitized them to nutrition issues of school-going children.

Following the release of the Ghana School Nutrition Survey¹¹, the IDRC RC has held a number of radio and TV interviews on overweight and obesity and healthy eating in Ghana. She was hosted on the TV Africa's Program on "focus on women". This documentary has been aired three times on TV Africa in the past year.

The Ghana School Nutrition Survey continues to attract interest. The Ministry of Agriculture's Women in Agriculture Development (WIAD) has expressed interest in partnering with us to produce the educational animated cartoons aimed at improving the eating practices of school children. Working with a local production company, the project will coordinate with WIAD to introduce "Foodies", an animated cartoon series focusing on healthy eating among children.

The Ghana Health service has not been keen to introduce length/height measurements in its Child welfare clinics. The reason given is that length/height measurements are too complicated for community health nurses and community health volunteers will not easily pick up the skills. The other reason is that the Child welfare clinics are over-loaded with activities, the addition of length/height will be an added burden to cause the collapse of the system. Through our study on "interventions to decrease wasting in rural communities" -Project #3, we have trained 140 nurses and community health volunteers to take length/height measurements as part of their routine work. Although our study is still on-going, the preliminary results demonstrate the capacity of health staff to measure length/height during the child welfare clinics. These results will be presented to the Ghana Health Services as evidence to support a change in policy concerning growth monitoring that will allow the government to begin collecting regular information on stunting. UNICEF is interested in this study and will be interested in implementing length measurements in their programs if the outcome is positive.

viii. Concluding remarks

Comments from Marquis. The IRCI grant contributed directly to our ability to compete successfully for additional funding. The substantial resource of the NRTC, which IDRC has partially supported, provides a unique backbone for projects. This continues to enrich the research and lives of our young students and collaborating researchers. This Centre opens the possibility of research opportunities in many

different fields/areas, which will benefit our future students. We have expanded our collaborations with researchers at IRD in Montpellier France who work extensively throughout West Africa. We hope that this will open opportunities to expand the influence of the Centre in research and training for the entire West African region in the future.

The IRCI grant has allowed me to contribute substantially to the University of Ghana - in supporting the development of infrastructure (the Centre and the Department of Nutrition and Food Science facilities) and young faculty members, as well as graduate student training at McGill and the UG. In recognition of this, I was awarded this year an honorary degree by the UG for my contribution to tertiary education. For me, this has been the most significant honour I have received in my life.

We would encourage IDRC to continue to support the IRCI program as the continuity that it provides helps to strengthen collaborations and provide a base on which to expand research and training opportunities. It has been a wonderful experience for us and we believe that it will have a long-lasting benefit on the field of nutrition and the nutritional status of vulnerable populations in Ghana.

Comments from Larrey: My association with the CRC has helped in various ways. We have been able to provide information through our research that is now being used to provide background data on childhood obesity in Ghana. Our study has been cited in the draft national nutrition survey. I was able to take on students without having to worry about how to fund their thesis research. The MPhil students have completed their programs within the stipulated time. This was made possible with the support of the CRC, who also provide technical guidance to their thesis research work.

Our program has helped to bring various sectors together- The University of Ghana, Health, Agriculture, District Assembly of Asesewa, Community volunteers to address a common problem of malnutrition. The Food and Agriculture Organization Ghana office supported the printing of the Ghana School Nutrition Survey report. Our program has given much visibility to the University of Ghana in the rural district of Asesewa. The University of Ghana is proud of the work at the NRTC. This was mentioned in the Vice-Chancellor's (Prof NB Tagoe) address at congregation in 2011.

ix. Bibliography

i. Journal Articles (published/accepted)

Indirectly benefitted from IDRC

Bougma K, Aboud FE, Harding KB, Marquis GS. Review. Iodine and Mental Development of Children 5 Years Old and Under: A Systematic Review and Meta-Analysis. *Nutrients* 2013, 5, 1

Directly benefitted from IDRC

Marquis GS, Colecraft EK, Sakyi-Dawson O, Lartey A, Ahunu BK, Birks KA, Butler LM, Reddy MB, Jensen HH, Huff-Lonergan E. An integrated microcredit, entrepreneurial training, and nutrition education intervention is associated with better weight- but not height-related indicators among preschool-aged children in rural Ghana. *J. Nutr.* 2015; 145:335-343

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Ndanu TA, Aryeetey R, Sackyfio J, Otoo G, Lartey A. Oral hygiene practices and caries prevalence among 9-15 year old Ghanaian school children. *J Nutr Health Sciences* 1(4):406-413.

ii. Conference Papers

Directly benefitted from IDRC

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Gashu D, Bougma K, Harding K, Samuel A, Adish A, Desse G, Marquis G. Urinary iodine and goiter in preschool children from the Amhara region, Ethiopia (804.23) FASEB J April 2014 28:804.23

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Mohammed H, Marquis GS, Aboud F, Bougma K, Harding K, Samuel A. Poor pregnancy and birth outcomes are associated with the indicators of inadequate dietary intakes of micronutrients in rural women of the Amhara Region of Ethiopia. Micronutrient Forum. Addis Ababa. June 2014.

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Ankrah J, Lartey A, Adu-Afarwuah S, Colecraft E, Arimond M, Dewey K. Pregnancy weight gain and the determinants of postpartum weight change among Ghanaian women. Ann Nutr Metab 2013;63(Suppl 1):620. (P0751).

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Marquis GS. Mother-to-child transmission of human retrovirus via human milk. ISRHML. Trieste, Italy. September 30, 2012.

Aboud F, Marquis G, Bougma K, Harding K, Abuye C, Lemma T, Zerfu D. Iodine deficiency and infant and child cognitive development: A review of the evidence and some baseline findings. World Congress on Public Health, Addis Ababa, April 24, 2012.

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Indirectly benefitted from IDRC

Marquis GS. Adding ENAM to the intervention pot to improve young children's diets in rural Ghana. US-AID. Washington. DC. December 2009.

iv. Book Chapters

Indirectly benefitted from IDRC

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v. Books

None

vi. Completed Theses

Directly benefitted from IDRC

MSc /MPhil

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Emelia Y Ayesu. Prevalence, perception and socio-demographic determinants of overweight and obesity among Ghanaian women. MPhil Thesis. March 2014

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- vii. Media coverage (articles in local or international media)

Indirectly benefitted from IDRC

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CBC The Link. October 28, 2010. <http://www.rcinet.ca/english/column/the-link-s-top-stories/16-52-2010-10-28-microcredit-meets-nutrition-in-ghana/>

- viii. Other

Video documentary

Directly benefitted from IDRC

Lartey A. Documentary on childhood obesity in Ghana. A GTV Documentary

Documents

Directly benefitted from IDRC

Birks, K. Backgrounder No. 35: The double burden of undernutrition and overnutrition in Ghana. Africa Portal 2012. Available at: www.africaportal.org

Indirectly benefitted from IDRC

Grace S. Marquis. Review of the integration of nutrition in the Feed the Future implementation plans for the LCC-CRSP country sites. in LCC CRSP Regional Vulnerability Analysis. University of Colorado. 2012.

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Indirectly benefited from IDRC

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Appendix A - Additional Funding Related to the IRCI research program

Project title	Funding Agency	Your role in the project	Start date (year) / end date (year)	Value (indicate currency)
Collaborative workshop on international training in dietetics	CIHR	PI (Marquis)	2011-2011	CAD 24,980
Traverser les frontières pour améliorer la nutrition infantile : identification d'indicateurs pour réduire la malnutrition aiguë en Afrique de l'Ouest	FQRNT	PI (Marquis)	2012-2013	CAD 40,699
Building capacity for sustainable livelihoods and health through public-private linkages in agriculture and health systems	DFATD	PI (Marquis)	2013-2018	CAD 3.4 M
Dietetic internship	Iowa State University	PI (Lartey)	2012-2014	USD 26,000 (grant) USD 64,950 (fees)
Dietetic internship	University of Ghana/ College of Health Sciences	PI (Lartey)	2012-2014	Ghana cedis 2000 (research) In-kind transportation
Breast milk analysis	Ghana Atomic Energy Agency	PI (Lartey)	2013	In-kind (lab analyses)

Project title	Funding Agency	Your role in the project	Start date (year) / end date (year)	Value (indicate currency)
Student funding	McGill U	Birk, Friesen, Cofie, Laar, Bougma, Mohammed	2011-14	6 travel grants (about CAD500-1000 each)
	Africa Initiative Graduate Research Grant	K Birks	2011-12	~ CAD 10,000
	Ghana Educational Trust fund	H Mohammed	2012-14	~CAD 25,000
	IDRC Doctoral Research Award	A Cofie	2011-12	CAD 20,000
	Montreal Rotary Scholarship	M Laar	2012-14	~ CAD 9000