RESEARCH IN APPLIED NUTRITION IN DEVELOPING COUNTRIES: CHALLENGES AND EXPECTATIONS

International Symposium
Brussels
3 December, 2004

THE ROYAL ACADEMY OF OVERSEAS SCIENCES
&
NUTRITION THIRD WORLD

Financially supported by
FNRS & FWO-Vlaanderen

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ACADEMIE ROYALE
DES
SCIENCES D'OUTRE-MER

rue Defacqz 1 boîte 3
B-1000 Bruxelles (Belgique)

Tél. 02.538.02.11
Fax 02.539.23.53
E-mail: kaowarsom@skynet.be
Web: http://www.kaowarsom.be

KONINKLIJKE ACADEMIE
VOOR
OVERZEESE WETENSCHAPPEN

Defacqzstraat 1 bus 3
B-1000 Brussel (België)

Tel. 02.538.02.11
Fax 02.539.23.53
E-mail: kaowarsom@skynet.be
Web: http://www.kaowarsom.be

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FOREWORD

The Symposium "Research in Applied Nutrition in Developing Countries: Challenges and Expectations" took place in Brussels at the "Palais des Académies" on December 3, 2004. It was jointly organized by the Royal Academy of Overseas Sciences and Nutrition Third World, on the occasion of the 20th anniversary of this association.

The Royal Academy of Overseas Sciences responds to one of its missions, which is to consider from an independent and multidisciplinary angle, the broad spectrum of problems faced by developing countries and related research. In that light the present publication — assembling papers coming predominantly from the South — should be seen as a contribution to "development research" in general.

The scientific programme of the symposium included two parts. In the first part six scientists, present or past grantees of Nutrition Third World, submitted their research, answered questions, and briefly commented on their challenges and expectations. The organizers had left time for questions and discussions: the public participated actively.

The second part was a Round Table, introduced by Prof. Ruth Oniang'o from Kenya and dedicated to the main theme of the symposium. The guests, all specialists or researchers in applied nutrition, had a brief exchange of views, which they then shared with the public during a lively discussion.

About eighty people belonging to public and private organizations concerned with development issues (including NGOs, foundations, universities, private companies, Belgian and foreign researchers on the subject) attended the meeting, among whom participants representing twenty different developing countries. Such a high level of attendance by researchers and students from the Third World is another noteworthy feature of the symposium.

On behalf of the organizers, I would like to express my thanks to Mr Armand De Decker, Minister for Development Cooperation, for his presence and stimulating talk; to the speakers and discussants, some of whom had come a long way. We are grateful to FNRS and FWO-Vlaanderen for the financial support.

Yola VERHASSELT
Hon. Permanent Secretary
Royal Academy
of Overseas Sciences

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Introduction

by

Ivan BEGHIN*

The organizers of this Symposium had three purposes in mind when they decided to hold it:

— To make the concept of "applied nutrition research" better understood;
— To show that high-quality research in that area is now performed successfully, in the South, by researchers from such countries;
— To give researchers from developing countries the opportunity to express their perceptions and expectations regarding research.

Applied nutrition research, the main theme of this conference, lies between fundamental research and actions aimed at improving or solving nutritional problems of developing countries. Its goal is to suggest and then to test, in a scientific manner, possible solutions to such problems.

Research in applied nutrition therefore focuses more on *how* to combat or prevent malnutrition, than on generating new knowledge that would tell us *what* to do (although, as experience shows, it also generates new knowledge). In other words, it translates the results of fundamental research into feasible, efficient and acceptable practical action. It builds a bridge between the laboratory or the metabolic unit and intervention programmes.

Applied nutrition research has three major characteristics:

— It is necessarily conducted locally, *i.e.* in the country or the region where the problem lies, preferably with participation of the population;
— It is conducted by researchers trained in research, belonging mostly to universities or research institutes;
— It rigorously meets all the criteria of scientific research, from the points of view of both the concepts and the methods being used.

* Member of the Academy; Managing Director Nutrition Third World.

However, its object is different: it starts from observations and/or results from fundamental or clinical research (conducted in laboratories, hospitals, metabolic units, etc.), and puts hypotheses forward concerning the relevance and the way of applying such results in the field, in order to alleviate or correct nutritional problems. In addition, it puts this application to testing. In the particular case of this Symposium the central theme deals with such questions in countries from Africa, Asia and Latin America, the problems of which are different from those of industrialized countries. Such problems are not only expressions of underdevelopment, but they are also constraints to sustainable development.

In the last ten or fifteen years applied nutrition research experienced a quite promising development, thanks to the increasing involvement of established researchers from both the North and the South in areas such as the prevention and treatment of child malnutrition; micronutrient deficiencies (mainly iodine, iron, vitamin A, and zinc); young child feeding; the "food-based" approach in tackling nutritional deficiencies; the planning and evaluation of nutrition interventions; the promotion of growth and development of young children; maternal health and nutrition; the "nutritional transition" phenomenon, etc.

The Symposium's second goal was to illustrate with facts that good research in this area is performed in developing countries. The papers presented at the Symposium do indeed confirm this hypothesis and, moreover, that such quality research is the output of researchers from these countries. All guest speakers came from a developing country. Their presentations and contributions to the discussions arouse a feeling of deep respect for those scientists who, sometimes despite strong difficulties, succeed in conducting relevant research of high quality.

The speakers at this Symposium have all published in well-known international journals. Yet, since "applied nutrition" does not have a specialized publication of itself, they are obliged to submit their manuscripts to a wide range of journals: medicine, nutrition, food science, paediatrics, epidemiology, etc. Hence the importance of giving them a chance to present their results and discuss them with their peers, and an additional reason for holding this meeting.

In recent years substantial progress has been achieved in the development of methodologies for studying nutritional problems and for assisting operational agencies: methods for conducting applied nutrition research; for training doctors and other health personnel; for planning and implementing interventions; lastly for evaluation.

The papers presented at this Symposium will provide the reader with a clear illustration of the range of topics understood as "research in applied nutrition".

The third — but not least important — purpose of the Symposium was to give these scientists the opportunity of expressing their perceptions and expectations regarding the difficulties of research in developing countries. They did so in a lucid, pragmatic and articulate way. Similarly their expectations are realistic, moderately optimistic, yet very much to the point. A synopsis of their points of view is presented at the end of this volume.

An interesting observation is the consistency of these scientists' remarks and the similarities between the challenges they face, regardless of their place of work or individual speciality. It seems indeed that the hypothesis put forward by the Academy's President, Dr de Lame, in her welcome speech, when she pointed out that these nutritionists' remarks do apply to her own discipline, anthropology, and perhaps to other disciplines as well, finds here strong support. In other words, there is here a particular case of development research in general.

Seen in that light the Symposium provides a fresh look at development research and its problems, and offers new insights which will be useful to government agencies, NGOs, foundations, development workers, decision-makers and, of course, other scientists.

Researchers in fundamental sciences should be encouraged to pay more attention to applied research. Operators (governments, NGOs) should be convinced that a little research, properly conducted, might substantially contribute to the improvement of their projects and their services. This Symposium provides them with relevant examples.

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Welcome

by

Danielle DE LAME*

The interests of our Academy are broad and deal with almost all aspects of development, and particularly development research. One of the underlying assumptions of our Company's thinking and work is that relevant and scientifically sound research, when applied to problems of development, can — and in actual fact often does — help break barriers, suggest courses of action, and prove well-tested responses, thereby contributing to overall development. The results of development research are among the elements (public, private, associative) decision-makers use, or perhaps should be using more often, to guide their action.

The universities in Belgium, and of course the specialized institutions such as the Institute of Tropical Medicine in Antwerp, or the Royal Museum for Central Africa in Tervuren — to which I belong — are engaged in a wide variety of development research ventures in the South. Many of these projects aim, often explicitly, to strengthen the researchers and the research institutions in these countries. This is indeed another manner of contributing to development: helping the Third World countries to build their own research capacity and becoming more autonomous in the field of research. The present symposium provides a good illustration of this double approach to development through research.

"Applied nutrition research" is an area that lies within development research. We are privileged, at this symposium, that the illustration of this point will be provided by scientists who come from the South. They will show us how they are looking for practical solutions to the nutritional problems that affect the people, first of all the poor, in their countries.

* President of the Royal Academy of Overseas Sciences, rue Defacqz 1/3, B-1000 Brussels (Belgium).

Nutrition Third World, our partner in organizing the symposium, is fully dedicated to supporting research in applied nutrition and to building capacity in this field. It was a pleasure to be associated with them, and I wish them, on the occasion of their 20th anniversary, many decades more of productive life.

Yet development research in the South still meets severe constraints. We did invite our guest speakers of today to each write a short note about the challenges they are facing and about their expectations — actually the major focus of this meeting. When reading their brief texts, I am struck by the similarity of their perceptions as nutritionists with my personal observations in my own field of research: social and cultural anthropology. Their remarks probably also do apply to other disciplines as well. I am therefore looking forward to participating in the discussions we will have today, and I believe that at the end of the day we will go home, hopefully with a few answers, but certainly with many more questions.

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Opening Speech

by

Armand De Decker*

Madam Chairman,
Mesdames et Messieurs,
Dames en Heren,
Ladies and Gentlemen,

It is an honour for me to address you here on the occasion of this international symposium.

The symposium deals with nutrition in developing countries. Having a nutritionally adequate diet is vital for a healthy and active life. In this respect, research focused on nutrition has a key role to play.

Malnutrition is responsible for more than half of all children's deaths in the world. Eradicating hunger and malnutrition is a central objective of the international community, as confirmed among others in the Millennium Development Goals.

The objective of halving hunger and malnutrition by 2015, will most probably be reached in eastern and south-eastern Asia and in Latin America. In south-central Asia and in sub-Saharan Africa however, we are clearly not on track. In both these regions malnutrition, as measured for example by the prevalence of underweight children, remains very high, and is declining at a very slow pace only.

The Belgian Development Cooperation shares the objective of halving hunger and malnutrition by 2015, and we are committed to contributing to it. Indeed, improving nutrition and fighting hunger are key areas in our development cooperation policy. We are contributing to it by rural development projects, by policy dialogue and institutional reforms, and through funding for research.

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* Minister for Development Cooperation.

Already in the 1980s, the Belgian Parliament itself took the initiative of creating the Belgian Survival Fund, a strong signal to policy-makers to make more means available to combat poverty, eradicate hunger and tackle malnutrition, especially in sub-Saharan Africa. As part of the Belgian Development Cooperation, the Fund has so far supported one hundred and twenty-five long-term integrated field projects for food security, including their nutritional aspects. It has, in the meantime, developed partnerships with twenty multilateral and non-governmental organizations, as well as governmental institutions. However, much more effort is needed both from national governments and from the international community to bring down malnutrition.

There cannot be proper development without research. Countries in the South need to build their own research capacity. This is a long-term challenge. Exchange of knowledge and experiences through networking is one of the very basic mechanisms to build such a capacity. I thus express my support to the Royal Academy of Overseas Sciences and to Nutrition Third World, and I thank them for calling this scientific meeting on the most relevant and important topic of nutrition.

The most welcome, innovative and "unusual" feature of this Symposium is that all guest speakers come from the South. I said "unusual" because we, in the North, have the tendency to believe too easily that we have most of the answers for sustainable development. Yet, in the present case, the organizers have decided to invite only scientists from developing countries, and give us a chance to listen to their own perceptions of their difficulties and expectations. There is little doubt that at the end of the day we will come out richer, with a better understanding of the issues at stake, and better prepared to face them.

The examples of research in *applied nutrition* that will be reported today do correspond to a real and insufficiently attended need. I understand this area of scientific research to be located between, on the one hand, fundamental or basic research — that is the kind of research that generates new knowledge —, and on the other hand development action itself. In other words *applied nutrition research* helps us identify *how* to prevent or cure malnutrition in a practical manner, in the field, under real conditions. I am sure that the NGOs attending this meeting, as well as the Government services, will benefit from the lessons brought to us by scientists from the South. Well-targeted, duly tested, cost-effective interventions can significantly reduce the various forms of malnutrition and their consequences. We should indeed be grateful to these scientists who dedicate their work and talent to show us the way.

Ladies and Gentlemen,

The Academy is once again displaying its imagination and its capacity to innovate, while at the same time guaranteeing the scientific quality of this Symposium.

Nutrition Third World is celebrating its 20th anniversary this year. A good illustration of their work is the fact that all the guest speakers today are, or were at some time grantees from this organization. The fact that Nutrition Third World is fully funded by the private sector should be commended: private companies, foundations and associations need to be involved in a concerted, well-coordinated set of actions, with the development cooperation policy.

I wish Nutrition Third World a long life, and I assure the Academy that we will continue in the future to look eagerly at its initiatives, suggestions and recommendations.

I wish this meeting the greatest success.

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Food Fortification as a Strategy to Combat Iron Deficiency / Iron Deficiency Anaemia in Developing Countries

by

Shafiqul SARKER*, Shamima SULTANA* & Lena DAVIDSSON**

KEYWORDS. — Anaemia; Iron Deficiency; Iron Fortification; Iron Sulfate; Ferrous Fumarate; Iron Phosphate.

SUMMARY. — Iron deficiency anaemia is the most widespread public health problem affecting millions of people, primarily infants, children and women in developing countries. The negative impact of anaemia on health, which includes reduced growth and increased morbidity, is well known, and is in fact an important issue to resolve as indicated by the United Nations and their different agencies. However, there was virtually no progress achieving successful intervention programmes for infants and children. Fe food fortification is currently considered the most cost-effective approach to combat Fe deficiency. Different potential fortificant compounds including ferrous sulfate, ferrous fumarate, ferric pyrophosphate, elemental iron, and Na_2 EDTA, have been investigated. However, while Fe fortification programmes have been relatively successful in industrialized countries, little development has been made in developing countries. It is assumed that the success of food fortification programmes may be limited because of high prevalence of low gastric acid output, high phytate content in diet and low intake of ascorbic acid in those populations. Therefore, there is a need to find out suitable iron compounds that would be well absorbable in populations with low gastric acid output without causing unwanted sensory changes in selected food. There would be the need also to overcome the barriers of inhibitor of Fe absorption, *i.e.* phytic acid in the food vehicle, or in the diet with which such fortified compounds would be consumed. Effective and sustainable iron fortification programmes could contribute in achieving the goal of reducing by one third the prevalence of anaemia by 2010, which the United Nations General Assembly adopted at its special session on children in 2002.

* Clinical Sciences Division, International Centre for Diarrheal Disease Research (ICDDR), Centre for Health & Population Research, Dhaka (Bangladesh).

** Swiss Federal Institute of Technology, Zurich (Switzerland).

Introduction

Anaemia is one of the most widespread public health problems of both developing and developed countries in the world. It has important health and welfare, and social and economic consequences. Review of the prevalence of anaemia globally reveals large variations among regions; however, its prevalence is the highest in developing countries. With the exception of Japan, Korea, and perhaps Singapore and Malaysia, the prevalence of anaemia is relatively higher in most other Asian countries (FLORENTINO *et al.* 1984). Nutrition Surveys in Bangladesh (1995-1996) noted prevalence of anaemia (Hb <11.0 g/dl) in 78 % of children aged 6-11 months, and 64 % among children aged 12-23 months (HKI/IPHN 1999). A National Family Health Survey in India (1998-1999) also reported somewhat similar prevalence of anaemia (72 %) in children aged 6-35 months (NFHS 2000). The proportion of anaemic children in Indonesia and in the Philippines was reported to be 37-73 % and 42-47 % respectively (FLORENTINO *et al.* 1984). Prevalences of anaemia have, however, decreased in developed countries during the last two decades indicating that the problem can be reduced substantially. A nationally representative UK sample suggests current anaemia prevalence of 12 % among children aged 1.5 to 2 years (GREGORY *et al.* 1995). However, in socioeconomically disadvantaged populations in UK, the prevalence of anaemia varies from 25 to 40 %. Iron deficiency (ID) is by far the most common single cause of nutritional anaemia in the world that affects over 3.5 billion people (United Nations 1992, WHO 1997). Differences in consumption of meat, availability of iron supplements, iron-fortified foods, health care, and the frequencies of infections and gastrointestinal parasites are likely to contribute to the differences observed in the prevalence of anaemia in developed and less developed countries. In general, anaemia appears to be more common in young children (0-5 years) compared to older children (6-12 years) (LONNERDAT & DEWEY 1995).

The most vulnerable groups for iron deficiency are infants, children, women and adolescent girls (DE MAEYER & ADIELS-TEGMEN 1985) who also have higher iron requirements. The consequences of Iron Deficiency Anaemia (IDA) are particularly severe in these vulnerable groups, which include increased perinatal morbidity, mortality among mother and child, and impaired immune functions, increased susceptibility to infections, decreased work performance, poor growth and poor cognitive functions. According to KWIATKOWSKI *et al.*, iron deficiency is a multisystem disorder, with profound effects on the central nervous system or brain development. Numerous studies over the past twenty years have clearly defined an effect of iron deficiency on mental development

and often on motor function (LOZOFF *et al.* 1987, 1991; SCRIMSAW 1984; PALTI *et al.* 1985). The reduced activity of iron-containing enzymes observed in the central nervous system, based on animal studies and a number of observations in young children, appears to be irreversible, *i.e.* non-responsive to iron therapy (COOK & LYNCH 1986, LOZOFF *et al.* 1996).

Aetiology of Iron Deficiency / IDA

The high prevalence of IDA observed in infants in developing countries is accounted for by several overlapping factors. However, Fe bioavailability from poor-quality diets is undoubtedly the most important among them (TAYLOR *et al.* 1995). Diets consumed in many developing countries are cereal-based and thus high in phytic acid, a potent inhibitor of Fe absorption (HALLBERG *et al.* 1987, HURRELL *et al.* 1992, DAVIDSSON *et al.* 1994) and low in major promoters of Fe absorption such as ascorbic acid and animal tissue (LAYRISSE *et al.* 1984, HALLBERG *et al.* 1989, TAYLOR *et al.* 1986). The overall Fe bioavailability from these diets can thus be expected to be low or very low, resulting in inadequate Fe absorption to meet the relatively high requirements of infants, children and women of child-bearing age. As iron is very sensitive to total energy intake, inadequate or lowered energy intakes, prevalent in most developing countries (PATTERSON *et al.* 1998), coupled with low Fe bioavailability, put the population at increased risk of micronutrient deficiencies including iron. Early introduction of unmodified cows' milk at around six months of age is also considered a cause of iron deficiency at one year (SADOWITZ & OSKI 1983).

Iron stores at birth is a major factor influencing growth and occurrence of IDA in infancy. Maternal iron deficiency results in large placental size and small babies (low birth weight) with iron stores inadequate to sustain their rapid early growth (HINDMARSH *et al.* 2000). Low birth weight, which is highly prevalent in developing countries (MA LACHLAN 1999), is therefore an important cause for iron deficiency in infants. A recent Indian study observed early cord clumping is a risk factor for IDA in infants (GUPTA & RAMJI 2002). Apart from low bioavailability from the diets, the high prevalence of infections and other nutritional deficiencies in developing countries can also contribute to the development of IDA. Early introduction of unmodified cows' milk at around six months of age was found to be the most common dietary characteristic of infants, which leads to development of IDA at one year. Gastrointestinal parasites such as hookworm (STOLTZFUS *et al.* 1997), malaria (STOLTZFUS *et al.* 1997) and vitamin A deficiency (WEST 1996) are also important contributors to anaemia and IDA.

Helicobacter pylori Infection and Iron Deficiency Anaemia

Helicobacter pylori infection rate is very high in children in developing countries and in many of them it occurs in early infancy (Sarker *et al.* 1997). The vast majority of the population does not present with any overt symptoms and signs attributable to this infection. It is known that this kind of infection can cause gastritis and has been found to be associated with altered gastric acid secretion in a study performed in Bangladesh (Sarker *et al.* 2000, 2002). The infection has been found to be associated with iron deficiency and IDA; however, the mechanism of causality is poorly defined (Kostaki *et al.* 2003, Marignani *et al.* 1997). It has been proposed that *H. pylori* may have an iron acquisition mechanism *in vivo* by forming a parasitic relationship and competing with host for iron. It is well known that microorganisms need host's iron to grow (Otto *et al.* 1992). Furthermore, the possibility of *H. pylori*-associated hypochlorhydria as observed in children and women in Bangladesh (Sarker *et al.* 2000, 2002), leading to impairment of non-heme iron absorption, may be linked to anaemia in this population. However, our recently concluded study with a double iron isotope technique indicates that *H. pylori* infection does not influence iron absorption from water soluble and non-water soluble iron compound. Eradication of *H. pylori* however did result in an improvement in haemoglobin concentration indicating an important role of *H. pylori* infection in the aetiology of anaemia (Sarker *et al.* 2004).

Prevention

Given the magnitude of the problem, prevention and treatment of anaemia and IDA have been identified as important goals of nutritional intervention programmes by the United Nations and various international agencies. However, much to the dismay of policy-makers and paediatricians, little progress has been made during the last decade towards achieving successful intervention programmes for infants and children in the developing world. There are numerous strategies to address iron deficiency. For the first six months breast feeding is suggested to be the best strategy. Although human breast milk contains little iron (< 1.0 mg/l), its bioavailability is considered to be high with 50 % absorption of breast milk iron. By six months of age iron stores are depleted in exclusively breast-fed children, and by nine to twelve months of age they exhibit frank IDA. This needs provision of additional sources of iron to infants.

There are three possible approaches for the prevention of anaemia in infants older than six months: dietary diversification, individual supplementation and food fortification. Dietary diversification involves promotion of foods with a wider variety of iron content, especially meat or fish. This intervention needs education to change feeding practices, and is often not affordable to poor populations of developing countries due to the high cost of foods rich in higher amounts of bioavailable iron.

Oral supplementation of ferrous sulfate drops or elixir has been the primary source of iron for the treatment and prevention of IDA for the past hundred and fifty years (ANDREWS 1999). When a soluble form of elemental iron (such as ferrous sulfate) is ingested in adequate dose (3-6 mg/kg.d in two divided doses), this inexpensive intervention is effective in most cases. However, compliance to long-term ingestion of oral iron is often poor because of the unpleasant metallic taste of such formulations. Moreover, iron drops can stain teeth unless wiped out immediately after administration, and administration of a higher dose might lead to abdominal discomfort or vomiting in infants. To date, there is little evidence for large-scale effectiveness drops or elixir formulation of iron supplementation. In order to enhance or ensure the compliance, avoid change in colour, texture or taste, UNICEF consultants suggested developing a potentially viable new method of delivery of micronutrient including iron supplement (NESTEL & AINWICK 1996, PISACANE 1996). Responding to the UNICEF directives, the Metabolic Research Group at the Hospital for Sick Children, University of Toronto, Canada, developed the microencapsulated ferrous fumarate in powder form (plus ascorbic acid), which can be sprinkled over any complementary food at the table of the caregiver. Recent studies in Ghana demonstrated that the sprinkles are as efficacious in preventing and treating iron deficiency anaemia in infants as the standard drops (ZLOTKINS *et al.* 2001).

As ferrous fumarate needs dissolution by gastric acid before absorption (HURRELL *et al.* 1989), its efficacy is likely to be uncertain in populations with compromised gastric acid output. Large-scale clinical trials along with evaluation of safety and cost effectiveness are necessary before this could be considered as useful strategy for treating and preventing iron deficiency anaemia in infants.

Food Fortification as a Strategy to Combat Fe Deficiency

Food fortification is often suggested as the best sustainable and cost-effective approach to increase iron intake and thus combat iron deficiency in children.

The success of Fe fortification programmes largely depends on careful choice of the Fe compound (HURRELL 1998). There were few common iron fortificant compounds investigated for their bioavailabilty during the last few decades. They differ both in their relative bioavailability (RBV) and potential to cause unacceptable sensory changes in the fortification matrix. Their RBV depends on their solubility in the gastric juice during digestion. Water-soluble compounds, such as ferrous sulfate, dissolve readily and have the highest RBV. Being water soluble, they do not require gastric acid for digestion. Water-insoluble compounds, such as ferrous fumarate, may be as well absorbed as ferrous sulfate, but they require dilute acid of gastric juice for complete dissolution. The other groups of compounds are poorly soluble in dilute acid; they have lower bioavailability since they never dissolve completely in the gastric juice.

FERROUS SULFATE

Being water-soluble compound, ferrous sulfate has the highest bioavailability (HURRELL 2002). It has been successfully used to fortify infant formula, bread and pasta (HURRELL *et al.* 1991) and can be added to wheat flour stored for shorter periods. It may, however, cause fat oxidation and rancidity in cereal flours stored for longer periods, and has been reported to cause unwanted colour change in infant cereals with fruit and salt. Encapsulated ferrous sulfate may exhibit excellent potential for overcoming unwanted sensory changes while maintaining high RBV. Encapsulated ferrous sulfate sprinkle supplement has already been reported to be effective in treating and preventing iron deficiency anaemia in children in Ghana. Fortification of cereals with microencapsulated ferrous sulfate would be an interesting programme in combating iron deficiency in the near future. The bioavailability of encapsulated ferrous sulfate has been found to be similar to ferrous sulfate in rat assays (HURRELL 1989), but still requires confirmation in human studies.

FERROUS FUMARATE

This compound is often used to fortify infant cereals and chocolate powder drinks. Being poorly soluble in water it causes less organoleptic changes in the food vehicle than water-soluble compounds like ferrous sulfate do. Ferrous fumarate requires dissolution in gastric acid before absorption from the intestine can occur. Although this appears to occur in healthy adults, it has not been demonstrated in children or population from developing countries where gastric acid secretion may be less efficient due to infections or nutrient deficiencies. If gastric acid output is compromised in a large proportion of

the target population, the effect of food fortification with fumarate might be less than expected as a result of reduced capacity to absorb iron from fortified foods. We have recently conducted studies to measure gastric acid secretion and iron absorption from ferrous fumarate and ferrous sulfate in children with and without *Helicobacter pylori* infection (SARKER *et al.* 2004). Gastric acid secretion was significantly lower in *H. pylori* infected children compared to non-infected children (tab. 1). Contrary to observations in healthy western adults, it was found that iron absorption from ferrous fumarate was significantly lower than that of ferrous sulfate in both *H. pylori* infected and non-infected children. The geometric mean relative absorption of ferrous fumarate (absorption of ferrous fumarate compared to that of ferrous sulfate) was approximately 25 % by these young children (SARKER *et al.* 2004) (tab. 2), indicating that the effect of iron fortification programmes that use fumarate or other non-water soluble iron compounds to prevent iron deficiency in similar population needs to be defined.

IRON PHOSPHATE COMPOUNDS

European companies use ferric pyrophosphate and ferric orthophosphate to fortify infant cereals and chocolate drink powder. In a recent study using stable isotope, the absorption of ferric pyrophosphate was reported to be only a third of that of ferrous fumarate from wheat-soy infant formula (DAVIDSSON *et al.* 2000). Although consumption of fortified cereals with ferric pyrophosphate or ferrous fumarate in Pakistani infants resulted in an increase in haemoglobin and ferritin level in both groups compared to those receiving non-fortified cereals, both groups remained iron deficient, indicating the possible need for higher level of fortification. Further investigations are needed

Table 1

Gastric acid output before (BAO) and after stimulation (SAO) with pentagastrin in *Helicobacter pylori* infected and uninfected children with iron deficiency anaemia*

	BAO (mmol/h)	SAO (mmol/h)
H. pylori infected children before anti-*H. pylori* treatment (n = 12)	0.2 ± 0.2	1.6 ± 0.9
H. pylori infected children after anti-*H. pylori* treatment (n = 12)	0.8 ± 1.3[2]	3.3 ± 2.4[2]
Uninfected children (n = 11)	0.9 ± 0.7[2]	3.1 ± 0.9[2]

* Adapted from SARKER *et al.* 2004.

Table 2
Iron absorption from ferrous fumarate and ferrous sulfate in uninfected children with iron deficiency anaemia (IDA) and in *Helicobacter pylori* infected children with IDA before and after treatment*

	H. pylori infected children before treatment (n = 12)		*H. pylori* infected children after treatment (n = 12)		*H. pylori* non-infected children (n = 11)	
	Ferrous fumarate (%)	Ferrous sulfate (%)	Ferrous fumarate (%)	Ferrous sulfate (%)	Ferrous fumarate (%)	Ferrous sulfate (%)
Geometric mean	5.3	19.7	6.4	22.5	5.4	5.4
+1 SD	13.5	32.9	12.9	33.0	12.7	12.7
–1 SD	2.1	11.8	3.2	15.4	2.3	2.3
P	< 0.0001		< 0.0001		< 0.0001	

* Adapted and modified from SARKER *et al.* 2004.

to define its role and optimal dose for its possible use in fortification programmes.

BARRIER FOR EFFECTIVE IRON FORTIFICATION

Apart from bioavailability of fortification by Fe compounds, the composition of meal, *i.e.* presence of promoters and inhibitors of Fe absorption, needs to be considered for successful food fortification programmes. Phytic acid, phenolic compounds, calcium, and certain milk and soy proteins are common dietary inhibitors of iron absorption. They can significantly reduce the absorption of both native food iron and fortification iron by forming unabsorbable complexes in the gastrointestinal tract. Phytic acid is present in cereal and legume-based foods, which are often used as vehicles of iron fortification. As cereals contain phytate and constitute staple food in most of the developing countries, the Fe added to such diets could also be poorly absorbed unless protected from the inhibitors of Fe absorption.

COUNTERACTING BARRIER OF FE ABSORPTION

There are three different ways to counteract inhibitors of iron absorption: addition of Na_2EDTA or ascorbic acid together with iron compound, addition

of fortification iron in a form that is protected from combining with dietary inhibitor (Na_2Fe EDTA, ferrous bisglycinate, heme iron), or degradation or removal of phytic acid from fortified food products.

The action mechanism of Na_2EDTA is not known; however, it is thought that EDTA binds iron in a soluble complex in the gastrointestinal tract, preventing it from forming insoluble non-absorbable complex with dietary inhibitors or hydroxyl ions. Sodium EDTA has been observed to increase iron absorption in adults from ferrous sulfate-fortified rice meal (MAC PHALL *et al.* 1994). EDTA is also capable of preventing sensory changes. Therefore, there is a potential for use of Na_2EDTA in ferrous sulfate-fortified rice for longer storage in the developing world. In the presence of phytic acid, iron is two to three times better absorbed from NaFeEDTA than from ferrous sulfate (HURRELL *et al.* 2000). There are a number of studies demonstrating an improvement of the iron status of the target population consuming NaFeEDTA-fortified fish sauce (THUY *et al.* 2003) or NaFeEDTA-fortified sugar (VITERI *et al.* 1995).

The use of NaFeEDTA for fortification exhibits less lipid oxidation during the storage of cereal flours, further it does not cause peptide precipitation. These properties offer more potential for long-term storage stability. However, its higher cost could limit its use in food fortification programmes in developing countries.

Enzymatic degradation of phytic acid in cereals and legumes could improve iron absorption, which is likely to be suitable for manufacturing low-cost complementary foods. Commercial phytase can completely degrade phytic acid within one-two hours, when added in an aqueous slurry of cereal, held at the optimum temperature and pH for phytase activity. Phytate degradation with phytase is technologically possible and should be considered especially for low-cost complementary food for the developing world.

Ascorbic acid appears to act as both solubilizing and reducing agent. It reduces ferric to ferrous state and preserves its solubility as the pH rises in the duodenum. Ascorbic acid has been reported to increase the absorption of many iron compounds including ferrous sulfate and ferric pyrophosphate from fortified cereal (DAVIDSSON *et al.* 1997), breakfast meal (DAVIDSSON *et al.* 2001) and drink (DAVIDSSON *et al.* 1998, NESTEL & AINWICK 1997). Few studies, however, observed that ascorbic acid might have little or no effect on absorption of ferrous fumarate (HURRELL *et al.* 1991). Moreover, ascorbic acid added to fortified foods might not remain stable during storage in hot and humid climates. Further studies are, therefore, required to define its role on absorption of ferrous fumarate and other iron compounds.

Role of Breast Milk as a Source of Ascorbic Acid on Iron Bioavailability

Although ascorbic acid rich foods are readily available in many communities, the intake of fruit and fruit juice by infants and young children might not be encouraged according to traditional feeding practice. Moreover, in resource-poor countries, it has been observed that the intake of fruit juice by young infants is virtually nil (Daneel 2003). Therefore, we have recently evaluated human milk as an alternative source of ascorbic acid for enhancing iron bioavailability from *khichuri*, a traditional Bangladeshi complementary food based on rice and lentils. Erythrocyte incorporation of stable iron isotopes 14d after administration was used as a proxy for iron bioavailability. A cross-over design was used to compare iron bioavailability from labelled test meals followed by either breast feeding or water intake in thirty-one infants and young children. Although human milk contributed significant quantities of ascorbic acid, no significant difference in iron bioavailability was found between *khichuri* consumed with water and that consumed with human milk (6.5 % vs 6.2 % respectively, $p = 0.76$, paired t-test) (Davidsson *et al.* 2004). These results indicate either that the molar ratio of ascorbic acid to iron was not sufficiently high to overcome the inhibitory effect of phytic acid in *khichuri* or that components of human milk modified the influence of ascorbic acid on iron bioavailability.

Challenges and Recommendations

The tragedy related to iron deficiency anaemia is well recognized in developing countries and should not occur. Traditionally, iron deficiency anaemia is prevented by increasing the use of iron-rich food, iron supplementation and targeted food fortification for infants and children. Unfortunately, none of these interventions have yet been proven to be successful in developing countries. Therefore, programme strategy will have to be redefined to be more comprehensive and include strategies for reproductive women, infants, and young children.

Food fortification is a promising strategy and should be an important component in forging effective strategies to combat IDA.

There are multiple challenges in the delivering and selection of suitable iron compounds for fortification of foods in a population with a high prevalence of infection and low gastric acid output. These compounds should provide meaningful levels of bioavailable iron without altering the acceptability and stability of the enriched food vehicle.

In the areas of food processing and product formulation, multiple issues like overcoming the barrier of Fe absorption inhibitors like phytic acid in both the food vehicle and diet need to be addressed.

Eradication of iron deficiency anaemia can be feasible by implementing an effective and sustainable iron fortification programme based on local conditions overcoming technical and practical barriers. Accompanied with a political commitment and strong partnerships involving all relevant sectors, such a programme could achieve, by 2010, the goal of reducing by one third the prevalence of anaemia that the United Nations' General Assembly adopted at its special session on children (May 2002).

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Nutrition Planning at the District Level in Uganda: Challenges and Expectations

by

Francis BYEKWASO*, Roselline NYAMUTALE** &
Emer MATHEW***

KEYWORDS. — Nutrition Planning; Decentralized Planning; Local Actors; Participation; Social Learning.

SUMMARY. — Malnutrition remains a common problem in Uganda, particularly among young children. Under decentralization, resource allocation to nutrition activities has increased through direct support to district-based programmes by both the central government and international development agencies. Efficient and equitable use of resources is however impeded by poor planning at the district and sub-district level. The main problems are related to inadequate analysis of nutritional problems, lack of integration of nutrition interventions into overall district development plans, failure to prioritize interventions, lack of effective guidelines in planning and inadequacy of staff skills necessary for participation of the local actors in planning. A study was carried out between 1996 and 2000 to examine the factors that influence decentralized planning and, based on the findings, suggest activities for improving planning at the district and sub-county level.

The research involved the adaptation of common planning tools/approaches to the decentralized context at district and sub-county level. The study made three important contributions to decentralized planning: (a) identification and documentation of the main practices in decentralized planning; (b) development of a conceptual framework for decentralized planning; (c) development of a method for planning at the district and sub-district level. This paper presents an overview of the research and the subsequent application of the research results under practical field conditions.

* Planning, Monitoring and Evaluation Manager, National Agricultural Advisory Services, Ministry of Agriculture, Kampala (Uganda).

** Agricultural Management Specialist, District Development Support Programme (IFAD), Agricultural Component, Hoima and Kibaale Districts (Uganda).

*** District Director of Health Services, Hoima District (Uganda).

1. Introduction

Uganda is one of the countries of East Africa where malnutrition remains very common, particularly in young children. Infant mortality is high. The 1999 report on "The State of the World's Children" showed that Uganda's infant mortality rate was 86 per 1,000 live births in 1997, and under-five mortality was 137 per 1,000 live births. Malnutrition is a major contributing factor to mortality and morbidity.

The Government, Non-Governmental Organizations (NGOs) and international agencies are well aware of the problem, and numerous projects are undertaken in the areas of public health, agricultural development, supply of cheap credit to the poor and creation of income generation activities. In spite of numerous interventions, malnutrition remains a common problem in Uganda, particularly among young children and the rural poor. Decentralization has increased the allocation of funds to sectors that have a direct bearing on nutrition improvement, *i.e.* health services (OKUONZI & MACRAE, 1995, PARIYO 1999) and agricultural extension. Efficient and equitable use of resources is however impeded by poor planning at the district and sub-district level.

A study was conducted to examine the factors that influence decentralized planning and, based on these findings, action was proposed for improving the design of decentralized nutrition interventions. The specific research hypotheses were:

— Current decentralized planning practices in Uganda do not allow the integration of the priority concerns of the people involved in planning at the district and sub-district level;
— The lack of an organizational framework to plan for nutrition in the district contributes to poor design of nutritional projects;
— A comprehensive and participatory approach compatible with the approach developed by the Institute of Tropical Medicine (ITM) in Antwerp in Belgium (LEFEVRE & BEGHIN 1991, LEFEVRE 1999, LEFEVRE *et al.* 1999) is applicable at the district level in the formulation of district nutrition plans and the design of development projects;
— The application of such a method will contribute to improving nutrition intervention planning and development;
— The application of such a method will contribute to the rationalization and strengthening of development planning at the district level in Uganda.

Two lines of work were undertaken to test these hypotheses:

— Retrospective case studies to examine the main factors that influence decentralized planning in Uganda;

— Prospective studies to adapt common planning tools/methods to the decentralized context in Uganda.

2. Case Studies

In order to understand how decentralized programmes are planned and the perception of local actors related to planning, this study investigated three decentralized programmes: the Mukono District Plan of Action for Children, the Rakai District Development Programme and the Mubende District Plan of Action for Nutrition. The objective of the case studies was to understand both the technical and social aspects of decentralized planning.

2.1. Project Profiles and Formulation

— *Mukono District Plan of Action for Children*. The programme's overall strategy was aimed at strengthening the capacity of government and NGOs at sub-county and district level to plan and implement interventions that effectively targeted families and communities on health and nutrition, environmental sanitation and water, basic education, child protection, and economic policy and improved human welfare.
— *Rakai District Development Programme* began in 1992 as a decentralized programme contributing to the overall development of the district through supporting priority projects, especially planning and management, capacity building, health and nutrition, primary education, and feeder roads construction.
— *Mubende District Nutrition Action Plan* was part of the overall national development strategy to emphasize nutrition as a core in district development. The experiences and lessons learned from the exercise were to be used for replication of the strategy in other districts in the country. A participatory approach was followed at all the stages of the plan formulation during 1994-95.

2.2. Data Collection and Case-Study Findings

Information on how the three projects were formulated was assembled from documents (inception reports, progress reports, and monitoring and evaluation reports), discussions between the author and project officials, focus groups with project beneficiaries, key informant interviews and self-admin-

istered questionnaires. The case studies established that, in many respects, decentralized planning practices fall short of meeting the expectations of local actors. The extent to which the current practices meet the local criteria is illustrated in table 1.

In all the three cases, institutional set-up for planning at sub-county was lacking. In particular, technical staff at sub-county did not have basic know-how in planning, especially in problem analysis, collection and compilation of basic data and record keeping. From the findings, some courses of action were suggested to strengthen institutional capacity for decentralized planning: skills needs assessment to identify vital skills required for planning at district and sub-county level; adoption of appropriate participatory approaches by district institutions at all levels; setting up mechanisms that ensure that sub-county development committees are functional; further decentralization of skilled personnel to the sub-county to match additional roles and responsibilities created by decentralization.

3. Prospective Studies: Development of a Conceptual Framework and Systematic Steps and Procedures for Decentralized Planning

The study took the form of an action research carried out on three programmes: Masindi District Food Security and Nutrition Plan, Pakanyi Sub-County Development Plan and Uganda Women's Efforts to Save Orphans (UWESO) Development Programme. The aim of this phase of research was to examine how the planning instruments could be applied in the light of the existing institutional capacity for planning under the decentralized context in Uganda. No influence was exerted on the district departments or institutions to provide extra resources that would ordinarily not be available under routine planning. Specifically, the purpose of the action research was to identify aspects in which the Comprehensive Participatory Planning and Evaluation (CPPE) approach was suitable for decentralized planning.

— *Formulation of Masindi District Food Security and Nutrition Action Plan.* The objective of the study was to test the suitability of the CPPE tools for nutritional assessment and the design of nutritional interventions in a decentralized context. This was done through a quantitative and qualitative nutrition survey followed by the selection and prioritization of interventions. The author stayed in the rural setting for over four months and had an opportunity to interact with different actors involved in planning at district and sub-county level. This case improved our understanding of

Table 1
Fulfilment of local criteria by existing planning practices

Planning criteria	Mukono	Rakai	Mubende
Analysis and conceptualization of the problems prior to data collection	III	III	I
Linkage of planning to policy-making	IV	IV	II
Rationalization of data collection and utilization, with emphasis on existing data	III	II	III
Prioritization of interventions using local criteria	IV	IV	IV
Rationalize time and cost of planning	III	III	III
Cost-effectiveness analysis of interventions	IV	IV	IV
Effective knowledge and skills of local actors	III	III	II
Effective integration of nutritional concerns into development plans and programmes	IV	IV	II
Flexibility and complementarity with other planning methods	III	II	II
Methods and tools that are simple and clear to local actors	II	III	II
Strong intersectoral collaboration and integrated planning	II	I	II
Genuine participation of local actors in planning	IV	II	II

I: criteria fully fulfilled; II: criteria moderately fulfilled; III: criteria poorly fulfilled; IV: criteria not fulfilled.

decentralized planning and the insights obtained provided important inputs into the subsequent development of planning tools.

— *Formulation of Pakanyi Sub-County Development Plan*. The objective of the study was to test the provisional method by applying it to the formulation of the Pakanyi Sub-County Development Plan. The focus of the study was to test the suitability of the tools in development planning, especially the integration of nutritional concerns into development activities at the local level. The exercise consisted of workshops conducted at Pakanyi sub-county headquarters, facilitated by the author and technicians from the district headquarters. The workshops were followed by a desk exercise to finalize the writing of the plan before it could be submitted to the local council at sub-county level.

— *Formulation of UWESO Development Programme*. The objective of the study was to test the provisional method on a project that is implemented by an NGO, *i.e.* UWESO. Table 2 summarizes the various processes of the action research undertaken in each of the three programmes.

Table 2
Programmes formulated and the various stages of the action research

Steps and procedures of the action research	Masindi	Pakanyi	UWESO
Linking policy to planning		√	√
Analysis of the determinants of household food security and nutritional problems	√		
Analysis of development problems of the sub-county		√	
Determination of data needs	√	√	
Data collection through a complementary nutrition survey	√	√	
Selecting interventions	√	√	
Prioritization of interventions	√	√	
Integration of nutrition outcomes into development plans; plus cross-cutting issues — gender and environment		√	√
Systematic analysis and differentiation of programme inputs, activities/processes, outputs and outcomes	√	√	√
Identification of indicators		√	
Identification of external factors			√

3.1. Data Collection and Findings of Prospective Studies

Data collection methods included self-administered questionnaires, key informant interviews, direct observations by the author and document reviews. From the findings of the action research, the three following new elements were identified for integration into the CPPE:

— *Policy analysis at the local level.* The use of the method would strengthen understanding of policies and decision-making at the district and sub-district level.
— *Integration of nutrition into development planning.* The technique proved useful in identifying the effects of development activities on nutrition. Using this technique, it is possible to identify nutritional outcomes of programmes that are primarily not targeted for nutritional improvement. This is an effective way of ensuring that the effects of such programmes are monitored. The technique can be applied at project design or later at project review. In doing so, planners will ensure that the interventions selected will improve the nutritional status of target groups. It is considered that the technique is applicable to the integration of other cross-cutting concerns, such as gender and environment, into development programmes.

— *Focus on social learning as an integral part of planning*. It was found necessary to consider how the application of the method influences people's attitudes, knowledge, skills and management practices.

3.2. Conceptual Framework for Decentralized Planning

The conceptual framework is a theoretical basis to guide planning at district and sub-county level. The conceptual framework developed by the current study contains five elements:

— *Technical assistance* is necessary to improve the skills of local actors in problem analysis, data collection and analysis, and policy-making. Technical assistance should, among others, aim at improving the local actors' knowledge and skills in planning. The implication is that approaches, which enhance a continuous learning-by-doing process, should be adopted since they foster sustainable utilization of skills acquired from technical assistance.
— *The contribution of local actors to planning* should be based on their ability to contribute to problem analysis, information generation and policy-making. This ensures that the local actors' skills and experiences are put to rational use at the district, sub-county and the village level. The study shows that district planners follow traditional approaches that are too technical, non-participatory and not integrated.
— *Analysis of problems.* Analytical tools need to meet local planning needs. Of necessity is the training of district planners to acquaint them with analytical tools that are applicable to emerging problems that were not foreseen decades ago when the common planning methods were developed. How, for instance, does gender analysis (Moser 1993) fit into the Logical Framework Approach?
— *The management information system* should be continuously strengthened through improved data quality and availability as a result of planning events. This implies that data accumulation by experts and from routine planning and implementation should be seen as part of overall efforts to enrich the management information system for the various sectors. The case studies revealed that district management information systems functioned inadequately.
— *Policy analysis at the local level.* The study found that many interventions were designed without correlating them to relevant policies at both central and local government levels. Participatory planning increases people's understanding of the local situations, and this understanding enables them to question a number of policies.

4. Evaluation of the Method

The method was evaluated continuously during its development through action research. The evaluation aimed at assessing whether the objective of the study to contribute to the improvement of decentralized planning was achieved. The planning needs identified by local actors at the start of the research process guided the formulation of the evaluation questions, analysis of responses and interpretation of results. The main evaluation questions are summarized in table 3.

At the end of each phase of research, instruments were administered to different actors to obtain their perception and practical experiences regarding

Table 3
Evaluation questions

1. Was the causal analysis tool effective in leading to a correct problem diagnosis?
2. Did the analysis result in improved programme design?
3. Was the policy analysis tool effective in leading to a correct policy analysis?
4. Did the use of the tool lead to improved linkage of planning to policy-making?
5. Simplicity of the tool, *i.e.* the skills required to use the tools (implication for continued use of the tools).
6. Did the method contribute to the rationalization of data collection and utilization?
7. Did the method contribute to the strengthening of the district management information system?
8. Were the prioritization criteria objective?
9. What was the reaction of the participants to the use of criteria?
10. Is the ranking technique simple to apply?
11. Was the time adequate to complete the planning exercise?
12. If planning workshops are expensive, how to reduce the costs?
13. What skills were acquired?
14. Who acquired the skills?
15. Were the acquired skills beneficial to the programme or design?
16. How does the method enhance the integration of nutritional concerns into development plans and programmes at district and sub-county level?
17. How can the effects of development programmes and policies on the nutritional status of the population be monitored?
18. How is the method compatible with the methods commonly used in decentralized planning?
19. How is the method compatible with the LogFrame (Logical Framework Approach) and the ZOPP (Ziel Orienterte Projekt Planung = target-oriented project planning)?
20. How is the method compatible with the Participatory Rural Appraisal (PRA) method?
21. How does the method enhance intersectoral collaboration and integrated planning?
22. Was participation achieved?
23. How can participation be improved further?
24. Did participation contribute to improving the design of the programmes and plans?

Table 4
Summary of evaluation procedures used

	Prospective studies		
Evaluation method	**Masindi Nutrition Plan**	**Pakanyi Development Plan**	**UWESO Development Programme**
Evaluation questionnaire	90	22	93
In-depth interviews	10	nil	nil
Focus groups	5	nil	2
Observation	√	√	√

the suitability of the method in addressing their local planning needs. Information was collected from different respondents through focus group discussions, interviews of key informants, self-administered questionnaire and direct observations made at the various phases of the action research. The main evaluation procedures that were followed are presented in table 4.

5. Evaluation Findings and General Discussion

The evaluation demonstrated various ways in which the application of the method improved the design of decentralized planning, including the design of nutrition interventions.

5.1. Strengthening Development Planning

The application of the method contributed to the rationalization and strengthening of development planning in several ways:

— *Development of integrated sector plans at district level*: responses of local actors who participated in the analysis of the factors that affect the utilization of health services in Masindi District revealed that district health services planning was poor. The district health management team was not able to "see the big picture" of district health problems, due to lack of effective tools for comprehensive analysis and integration of all the elements of health services. The team tended to focus on health units instead of the entire health services. The use of the causal analysis approach to analyse health problems revealed the comprehensive picture of health sector issues in a global way. This enabled the health sector management team to visualize what a district health sector plan should entail.

— *Articulation of data needs in the process of programme design*. The case studies showed that planners often pay too much attention to quantitative data collection, resulting in low use of qualitative techniques. Secondly, the Masindi case showed that the use of the method improved the local actors' skills in data collection analysis. This was a significant contribution towards improving the district management information system. These benefits suggest that a more process-oriented approach be adopted, and particularly allocate sufficient time to enable local staff to learn.

— *Integration of nutritional concerns into development plans and programmes:* one of the greatest contributions of the study to advancing nutrition and development planning is the elaboration of simple and workable techniques to integrate nutritional objectives into development plans and programmes (BEGHIN 1983). In the Pakanyi development plan, for instance, the effects of the various interventions on nutrition were identified during the formulation of the plan. This ensured that actions to address negative effects of the development plan on nutrition were identified and integrated in the plan. In the case of the UWESO Programme, nutritional outputs, outcomes and indicators had not been identified at the initial project design stage. The application of the method in the start-up workshops ensured that nutrition processes and outcomes were identified and contained in the work plan, including relevant monitoring and evaluation (M&E) indicators. Thus, in both cases — Pakanyi and UWESO — nutritional concerns were effectively integrated into development activities. In general, the application of the method strengthens decentralized planning in several ways: preparation of sectoral and development plans is improved by adopting a comprehensive approach to analysing problems; district health management information system is strengthened; district health management teams obtain a better view of the health services delivery system; local actors obtain an opportunity to contribute to the elaboration of development plans and programmes; the dominant role of experts in development planning is reduced; key development concerns, such as nutrition, are effectively integrated into the mainstream development planning.

— *Creation of demand for policy analysis at the local level:* the case studies revealed that district planning and policy-making were not linked, especially due to: (a) lack of information on policies; (b) poor definition of policy outcomes; (c) lack of effective tools for policy analysis; (d) attitude that policy-making is only for the central government; (e) tendency to confine policy-making to economic analysis (*e.g.* cost-benefit analysis). The involvement of the local people at Pakanyi Sub-County in analysing

policies (sanitation, education, and agricultural extension) was innovative, introduced as a result of this research. Participants analysed the impact of selected policies at the local level. They were able to identify policy outcomes as they perceived them. This was a departure from policy analysis by economists who focus on a "so-called" scientifically sound method of assessing cost-benefit analysis or social impact. The method provides simple operational tools that are useful in gaining knowledge and insights about policies that affect people in their real life. Therefore, the research led to an increased understanding of policies and formulation of plans that are congruent with policies, and to the realization by local actors that it is possible to analyse the effects of policies at the local level.

— *Social learning:* participatory planning is a social activity that brings several stakeholders together. The study showed that a planning event results in several benefits, especially learning by participants, team building and attitudinal changes on the part of local actors. The tools developed in this research were found to be suitable for social learning, which is a key element to the empowerment process. The method shifts the emphasis from planning as a technical exercise to a people-centred development initiative in which the people's values, benefits and concerns are put at the centre (KORTEN 1980, BRINKERHOFF & INGLE 1989, World Bank 1997).

5.2. IMPROVING THE DESIGN OF NUTRITION INTERVENTIONS

The Masindi Food Security and Nutrition Action Plan addressed a wide range of concerns that affect the entire food system, *i.e.* agricultural, health, economic, institutional and behavioural aspects, including both biological and sociological aspects. Important nutritional deficiencies such as micronutrient deficiencies were considered but were not given prominence. The focus was mainly on intermediate outcomes such as improved growth monitoring, increased access to safe water, improved personal hygiene, increased involvement of the people in development initiatives and increased household food availability, *i.e.* processes and intermediate outcomes that are discernible at the local level (BEATON 1982, LEFEVRE & BEGHIN 1991). The use of a combination of tools, the participation of local actors, and effective technical guidance were instrumental in identifying relevant processes, outputs and outcomes. This underscores the importance of selecting development indicators that are more sensitive to nutritional interventions than traditional impact indicators (LEFEVRE *et al.* 1999, PAPPAS 1998).

The main features of the method that ensure improved design of nutritional interventions are: analysis of problems is comprehensive, participatory and

takes into consideration the context and the needs of local actors, thus ensuring that the selection of interventions considers the social, economic and biological aspects of malnutrition; technical disease investigation is based on indicators that are agreed upon by main local actors, including technicians and potential programme beneficiaries; policy analysis brings into focus policy concerns that deserve to be addressed in the project design; emphasis on identifying processes, outputs and intermediate outcomes increases the plausibility of the interventions having a positive influence on impact. For instance, in nutritional microprojects targeting income generation, the expected nutritional outputs and outcomes need to be identified at the design stage.

5.3. Further Research

The evaluation of the method points to the following areas of research:

- *Effectiveness of nutritional interventions:* nutrition improvement is a priority concern for the government of Uganda and development agencies have responded by supporting a number of programmes targeting nutrition. The amount of resources is often huge. The effectiveness of the interventions is usually not analysed at the design stage, nor is post-project evaluation carried out. Thus, there is an information vacuum concerning the effectiveness of nutritional interventions. Studies are needed to determine the effectiveness and benefits of nutritional interventions.
- *Effects of development policies and programmes on nutrition:* frequently, many development programmes do not have specific nutritional objectives although they influence the income and nutritional status of target groups. The nutritional benefits of such programmes are usually mentioned in reports, without any factual evidence. Yet, programmes may have negative nutritional effects. There is a need to study the nutritional impact of development programmes. This could be incorporated into regular government planning as a requirement for the approval of projects by the District Council.
- *Social learning aspect:* the application of the method suggests that the "human" factor is the most important determinant of the success of a planning process. When people come together in a workshop to formulate a plan, they expect to interact in various ways, establish working norms and learn new things. Often, the technicality enshrined in the method (tools and techniques) does not recognize these social or interactive aspects. There is a need to investigate social learning perspectives that optimize both planning and learning.

— *Simple ready-to-use planning materials:* this concerns specific issues raised by different actors on the need to develop simple ready-to-use planning materials on the main tools. The main concern is to develop effective, yet flexible, planning materials (manuals, guidelines, etc.) that provide details on how to use the above tools at the local level. The materials should cover topics such as effective communication in planning, adult learning, social learning perspective of participatory planning, etc. The materials would be useful to experts, field technicians and development workers.

6. Conclusion

The objectives of this research were (i) to examine factors that influence decentralized planning and (ii) to develop effective techniques/tools for improving the design of decentralized nutrition interventions. The research results, as discussed above, do provide practical and innovative techniques/tools that enhance decentralized district planning when applied at district or sub-county level. The five main research innovations are discussed below.

— *Development of a conceptual framework for decentralized planning*. In doing so, the linkages or interactions among the elements of the method are explained. In particular, the conceptual framework considers that actor-oriented factors (their skills, knowledge and attitudes) have a great bearing on project design. Influencing actor perspectives implies adoption of a system approach to decentralized planning.

— *Practical technique for integrating nutritional concerns into development programmes*. Literature abounds on the integration of nutritional considerations into development programmes (ACC/SCN 1991, FAO 1983). Given that nutrition is a cross-cutting issue, the emphasis is the integration of nutritional (or environmental and gender) concerns into development rather than specific interventions. Integrating nutritional considerations into development programmes ensures that nutritional effects of development activities are monitored in the implementation. However, ways of achieving this are rarely mentioned. The present study provides a simple practical procedure. The technique is effective in identifying nutritional outcomes of interventions that primarily do not target nutrition improvement. This approach broadens the scope for improvement of nutritional status by monitoring the effects of development activities on the nutritional status of the people affected by the programme.

— *Development of planning steps into self-containing modules.* The development and presentation of the method into self-contained modules is a departure from "single workshop" planning approaches. The modules are not a rigid format to be applied at the same time. They only constitute a package of tools and procedures from which to select what to use as demanded by the nature and scope of planning.
— *Policy analysis.* The analysis of the strengths, weaknesses, opportunities and threats (SWOT analysis) of a policy or a programme provides insights on what interventions are necessary. The method makes it possible to bring policy-making into the planning arena. The experiences in the three prospective studies show that policy analysis is feasible at the local level, and it leads to improved programme design.
— *Social learning dimension.* This experience with the research suggests that one of the keys to genuine empowerment is social learning. The method provides an effective tool for social learning at the local level. The main emphasis is that planning is a highly iterative process with varying influences on the actors and the entire system. In addition to the traditional characteristics of the ITM approach (participation, comprehensiveness, flexibility and implementation-oriented), it was found necessary to consider how the application of the method influences people's attitudes, knowledge, skills and management practices. By integrating these considerations, the method makes a significant contribution to the improvement of existing decentralized planning practices in which the concerns and expectations of the local actors were not emphasized.

7. Practical Application of the Research Results

Over the last four years since the conclusion of this research, government and development partners in Uganda have continued to support initiatives that aim at strengthening decentralized service delivery. A major element in the improvement of service delivery is the increase in stakeholder participation in planning, monitoring and evaluation of development projects/programmes. Consequently, the results of this research have been found to have practical relevance to a number of planning, monitoring and evaluation contexts in Uganda. To-date, the research results have been applied in three ways: planning (design) of interventions or strategies at the district level (Hoima and Kibaale); development of M&E Systems for National Agricultural Advisory Services (NAADS) and the Decentralization Programme at Makerere University; evaluation of UWESO Development Programme.

7.1. Formulation of Nutrition Strategies for Hoima and Kibaale Districts

The author was requested by the two districts to guide the district technical planning team in formulating comprehensive nutrition strategies. In both cases, he provided technical guidance to the planning process through facilitating i) a three-day multistakeholder workshop in each district to analyse the causes of malnutrition. Participants were drawn from various district departments, including health, agriculture, administration, community development, farmers, NGOs and the private sector; ii) a nutrition survey for Hoima district, including both qualitative and quantitative assessment; iii) a two-day multistakeholder workshop to select interventions and formulate a comprehensive district nutrition strategy for Hoima district. The nutrition strategy was not the only important result of the exercise. The other results were related to the learning aspect in which district officials were able to visualize the role of each sector in the improvement of nutrition. The complementary roles of agriculture and health sectors became particularly clear. Henceforth, staff from the two sectors worked amicably in identifying activities relevant to each sector. As a result, it was agreed to hold joint review of the progress made in implementing the nutrition strategy, after one year of implementation.

The Hoima experience shows that the application of the techniques strengthens government's efforts to develop strategies and programmes that address the needs of the rural poor. It also strengthens teamwork, and encourages experts to work with local people as facilitators, *i.e.* to participate in providing answers to questions that increase the likelihood of programme success, rather than emphasizing the techniques. This creates more incentives for participants to learn.

7.2. Development of Monitoring and Evaluation Frameworks

The National Agricultural Advisory Services (NAADS) is a national programme mandated to guide the delivery of agricultural advisory services to farmers. As the programme planning M&E manager, the author is directly responsible for guiding the head office and local governments in undertaking the M&E function. The author has guided the planning team to apply the research results (methods, tools and knowledge) in the elaboration of an M&E framework, containing programme inputs, processes, outputs, outcomes and relevant indicators. NAADS staff, personnel from other agencies, ministries and donors have appreciated this approach, the major strength being that it is comprehensive and encourages participation. Following from the framework,

a baseline survey was designed, focusing on key output and outcome indicators. This made the survey focused on relevant indicators. The design of the baseline survey was conducted by the district and sub-county teams, the secretariat staff only providing the necessary technical guidance. District personnel have also been directly responsible for the collection and analysis of the baseline data, a principle objective of this approach being to build the capacity of local government staff.

Makerere University is implementing a three-year pilot training project for capacity building at Makerere and other tertiary institutions, for improving decentralized service delivery. The major focus of the project is to build sustainable capacity in the local governments for improved service delivery. The project targets personnel of local governments, students and staff from universities and other training institutions, to establish a practical oriented curriculum to improve service delivery. The project has four components: enhancing academic institutional capacity building; support to local government staff capacity building by universities; enhancing decentralization policy research; monitoring and evaluation. The author has guided a task force responsible for developing a comprehensive M&E system and carrying out a baseline survey among participating institutions and local governments. The team elaborated an M&E framework detailing project inputs, processes, outputs and outcomes; this was followed by the identification of output and outcome indicators. The participatory approach was intended to strengthen internal monitoring processes, not only through the articulation of indicators but also passing over knowledge and skills to people involved in implementing the programme at various levels.

7.3. Evaluation of UWESO Development Programme

The method has also been applied in the pre-midterm review of UWESO Development Programme funded by the Belgian government and the International Fund for Agricultural Development (IFAD). The programme is implemented in five districts (Lira, Soroti, Kumi, Masaka and Mbarara). The overall objective of the programme is to improve the status of needy orphans in rural areas, including nutrition education. UWESO relies on the local government staff to implement activities, especially in technical areas that the programme staff is not able to provide. In 1999, prior to implementation of the programme, the author facilitated start-up workshops in the five participating districts to elaborate the activities of the programme and to formulate a workplan. The current method was applied in all the four workshops (Soroti and Kumi had a joint workshop). The exercise demonstrated the utility of the

method in elaborating activities and defining the outputs and outcomes of a programme that is already designed. The exercise was particularly useful to implementers who sometimes find it difficult to translate programme designs into consistent operational plans. It also provided an opportunity for the stakeholders to analyse the programme objectives. As a result, they obtained a comprehensive understanding of the programme. In 2002, the author was again requested to guide the UWESO secretariat in conducting internal review of the programme, prior to the midterm review by the sponsors. A comprehensive and participatory approach was used to evaluate programme processes, outputs and outcomes building on the work done at the start-up workshops in 1999. The indicators and external factors identified in 1999 were used as the basis for reviewing programme components.

7.4. Challenges Encountered in the Application of Research Results

As presented above, the author has had several opportunities to apply the research results. To a great extent, the author has successfully responded to the demands of different agencies to provide technical support in planning and evaluation. However, an institutional framework within which the research results — at least the best practices — would be sustainably up-scaled does not back these efforts. There is no forum that would enable the author to share the research results widely at national and district level. Sharing of the results would also include a systematic mechanism to popularize the innovations of this research, through the application of relevant tools in the design and/or review of development and/or specific nutrition strategies. Operationalizing such an arrangement would include among others, the generation of a cadre of trainers at central and district level to scale up the application of the results. This would however be feasible within an existing institutional arrangement. To some extent, this may be done within the existing NAADS institutional arrangement, but greater scope for utilizing the research results (especially the research component) would necessitate active engagement with institutions involved in applied nutrition research, including institutions of higher learning. Opportunities therefore exist to develop and implement a research agenda focusing on applied nutrition and decentralized planning. The exploitation of such opportunities will only be possible if additional efforts are made to catalyse these initiatives. It appears that a feasible way to start is to identify a host or "nuclear" institution that would kick-start the replication of the research results, starting with the identification of the elements of the research that can be implemented jointly with existing institutions. This initiative would also entail popularization of the research

results through publications locally and internationally; this has not been possible to-date.

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Evaluation rapide des troubles dus à la carence en iode: le projet ThyroMobil dans six pays d'Afrique de l'Ouest

par

Théophile NTAMBWE KIBAMBE*, Alfred ACAKPO*,
André OUEDRAOGO* & Machikourou SALAMI*

MOTS-CLES. — Afrique de l'Ouest; Echographie thyroïdienne; Iode urinaire; Sel iodé; Troubles dus à la carence en iode.

RESUME. — Il y a une décennie, la carence en iode affectait de manière particulière toute l'Afrique. Depuis 1994, la plupart des pays africains ont mis en œuvre la stratégie d'iodation universelle du sel pour prévenir les graves manifestations de cette carence nutritionnelle. Au seuil de l'an 2000, peu de données fiables étaient disponibles sur l'évolution de cette lutte en Afrique de l'Ouest.

Doté d'un camion équipé notamment d'un échographe, le projet ThyroMobil a permis d'évaluer l'efficacité de la lutte contre la carence en iode dans six pays d'Afrique de l'Ouest, à savoir le Bénin, le Burkina Faso, le Ghana, le Mali, le Niger et le Togo. Les principaux indicateurs de l'évaluation ont été: la disponibilité du sel iodé dans les ménages, la teneur en iode du sel, la concentration de l'iode urinaire et la prévalence du goitre. Dans chaque pays, l'enquête a été menée en moyenne dans dix sites différents. Par site, la population d'étude était constituée d'environ cent enfants d'âge scolaire (6-12 ans) des deux sexes. Au total, dans les six pays, l'évaluation a porté sur 6 111 enfants pour le dépistage du goitre par échographie thyroïdienne, et sur 2 322 enfants pour le dosage de l'iode urinaire. La disponibilité du sel iodé au niveau des ménages a été établie sur le terrain à l'aide des kits de test rapide détectant l'iode dans le sel sur 3 202 échantillons de sel rapportés par les enfants, et la teneur du sel en iode a également été déterminée en laboratoire par titrimétrie sur 614 d'entre eux.

Cette évaluation a montré une bonne consommation d'un sel suffisamment iodé et une médiane d'iode urinaire au-dessus de 100 µg/l indiquant l'absence de déficience iodée dans tous les pays enquêtés, sauf au Niger. Le dépistage par échographie a permis d'établir une prévalence du goitre en dessous de 6 % au Bénin, au Ghana et au Togo, mais une prévalence au-dessus de 10 % dans les autres pays.

De manière générale, ces résultats établissent une nette réduction des troubles dus à la carence en iode au regard de la situation épidémiologique qui prévalait avant

* International Committee for Combating Iodine Deficiency Disorders, Montreal (Canada).

l'introduction du sel iodé. Toutefois, il est nécessaire de renforcer le contrôle de qualité du sel iodé et le suivi du statut iodé de la population dans chaque pays.

1. Introduction

La carence en iode est la cause la plus fréquente du retard mental évitable dans le monde; elle a de graves conséquences sur la croissance, sur les capacités d'apprentissage et de travail, et sur la productivité. Eu égard à leurs conséquences et au grand nombre de personnes affectées, les troubles dus à la carence en iode (TDCI) constituent un problème majeur de santé publique dans le monde, qui frappe particulièrement l'Afrique; en effet, en 1990, l'OMS estimait que 180 millions d'Africains, soit 32,8 % de la population de ce continent, étaient affectés par la carence en iode, que 15,6 % avaient un goitre et que 0,2 % souffraient du crétinisme (WHO, UNICEF & ICCIDD 1994).

En 1990, le Sommet mondial pour les Enfants, suivi par l'Assemblée mondiale de la Santé, le Sommet mondial pour l'Alimentation et d'autres organisations internationales, avait adopté l'élimination des TDCI comme objectif à atteindre en l'an 2000, spécialement par l'iodation de tout sel destiné à l'alimentation humaine et animale (WHO, UNICEF & ICCIDD 1994). Durant la dernière décennie, des efforts importants ont été déployés dans le monde en vue de l'atteinte de cet objectif, y compris en Afrique où la quasi-totalité des pays ont adopté des textes législatifs et réglementaires rendant obligatoire l'iodation du sel ou l'importation du sel iodé (WHO, UNICEF & ICCIDD 1999, DELANGE *et al.* 2001). Dans certains pays africains, des stratégies de supplémentation iodée, par l'huile iodée ou l'iodation de l'eau, avaient également été utilisées au début des programmes, comme mesures d'urgence, dans des zones d'endémie sévère. Cependant, au seuil de l'an 2000, les données sur les programmes de lutte contre les TDCI en Afrique étaient généralement anciennes, fragmentaires et souvent peu fiables.

En vue de pallier cette carence de données épidémiologiques fiables sur la lutte contre les TDCI, une étude a été menée dans six pays d'Afrique de l'Ouest, selon un modèle (ThyroMobil) déjà utilisé dans vingt-quatre pays d'Europe, d'Asie et d'Amérique latine (DELANGE *et al.* 1997, 2001), utilisant des méthodes modernes d'évaluation: échographie thyroïdienne pour le dépistage du goitre par un même investigateur, dosage de l'iode urinaire et titrimétrie du sel par les mêmes laboratoires; un camion doté d'un appareil à ultrasons pour les mensurations de la thyroïde ainsi que d'un congélateur pour la conservation des échantillons, a permis de collecter sur le terrain dans les six pays des données selon une méthodologie standardisée, permettant des

comparaisons valides des résultats obtenus dans ces différents pays africains et même dans différents continents.

Le présent rapport offre les résultats obtenus dans les six pays, à savoir le Bénin, le Burkina Faso, le Ghana, le Mali, le Niger et le Togo. Il complète une publication préliminaire sur le même sujet (DELANGE *et al.* 2002). Le financement de cette étude a été assuré par la Fondation Nutrition Tiers Monde, l'OMS, l'UNICEF et l'*International Council for the Control of Iodine Deficiency Disorders* (ICCIDD).

2. Objectifs

L'étude visait les objectifs suivants:

— Evaluer le statut iodé de la population dans des régions d'endémicité des TDCI, en utilisant des méthodes d'évaluation recommandées par l'OMS, l'UNICEF et l'ICCIDD (1994, 2001);
— Proposer des valeurs normatives du volume thyroïdien des populations africaines non carencées en iode, telles que celles habitant les régions côtières d'Afrique de l'Ouest;
— Accroître la prise de conscience de la population, des autorités et des leaders d'opinion sur le problème des TDCI.

3. Méthodes

3.1. Sujets d'etude

La population d'étude était constituée des enfants d'âge scolaire (6-12 ans), des deux sexes. Par site, cent enfants ont été sélectionnés de manière aléatoire en milieu scolaire pour le dépistage du goitre, en observant un pas de sondage sur la liste actualisée des écoliers répondant au critère d'âge de six à douze ans, et quarante de ces enfants ont été choisis aussi de manière aléatoire pour donner des échantillons d'urine.

3.2. Indicateurs de l'etude et choix des sites

Les principaux indicateurs de l'évaluation ont été la disponibilité du sel iodé dans les ménages, la teneur en iode du sel, la médiane de la concentration de l'iode urinaire et la prévalence du goitre chez les écoliers. Dans chaque pays, les données ont été collectées sur le terrain, en moyenne, dans dix sites différents, choisis en fonction de leur situation dans une zone d'endémicité connue des TDCI et de leur accessibilité au véhicule ThyroMobil, dont le châssis est

assez bas (à 20 cm du sol). En plus des zones endémiques, les villes côtières de Lomé et Cotonou ont également été sélectionnées comme sites d'enquête, pour obtenir une base de référence des volumes thyroïdiens dans des zones africaines non carencées en iode.

3.3. Volume de la thyroide

Le volume de la thyroïde a été mesuré en utilisant un appareil à ultrasons à temps réel avec une sonde linéaire de 7,5 MHz. Afin d'éviter des différences entre observateurs, toutes les mesures thyroïdiennes ont été assurées par un même investigateur (TNK), qui a suivi une formation intensive en échographie thyroïdienne au département de radiologie de l'Hôpital universitaire Saint-Pierre à Bruxelles, Belgique.

Pour mesurer le volume de la thyroïde, des coupes longitudinales et transversales ont été réalisées afin d'établir en centimètres l'épaisseur (e), la largeur (l) et la longueur (L) de chaque lobe de la thyroïde. Le volume (V) d'un lobe thyroïdien en cm^3 a été calculé par la formule: $V = (e) \times (l) \times (L) \times (0.479)$. Le volume total de la thyroïde était obtenu par l'addition des volumes des deux lobes. Le goitre était dépisté en retenant les volumes thyroïdiens supérieurs au percentile 97 pour l'âge et le sexe, utilisant les critères de l'OMS et l'ICCIDD (1997) adaptés par Zimmermann *et al.* (2001).

3.4. Iode urinaire

Les concentrations d'iode urinaire ont été mesurées au moyen d'une digestion acide, et la détection de l'iode par réduction de l'ammonium sérique suivant la réaction de Sandell & Kolthoff (1937). Toutes les analyses de l'iode urinaire ont été effectuées par un même laboratoire à Cape Town, Afrique du Sud, en vue de la standardisation des données.

3.5. Iode dans le sel

Les échantillons du sel de ménage apportés par les écoliers ont été testés sur le terrain à l'aide des kits semi-quantitatifs (MBI Kits, Madras/India), et une solution de contrôle était utilisée chaque fois que l'iode n'était pas détecté avec le premier réactif. La teneur de l'iode dans le sel a été analysée, tel que recommandé par l'OMS, l'UNICEF et l'ICCIDD (2001) en titrant avec du thiosulfate, dans des conditions acides, l'iode libéré du sel. Toutes les analyses de l'iode dans le sel ont été effectuées par le laboratoire du Centre régional de Recherche en Alimentation et Nutrition (CRAN) à Lomé, au Togo.

Selon l'OMS, l'UNICEF et l'ICCIDD (2001), la nutrition iodée d'une population est adéquate lorsque plus de 90 % de la population a accès à du sel iodé à plus de quinze parts par million (ppm) et que la prévalence du goitre et la médiane de l'iode urinaire chez les enfants en âge scolaire sont moins de 5 % et de 100 à 200 µg/l respectivement.

3.6. Methodes statistiques

Des statistiques usuelles (proportions, moyennes, écarts-types, médianes, domaines de variation) ont été utilisées pour présenter les résultats de l'étude.

4. Organisation générale de l'étude

La coordination de l'étude a été assurée par une équipe conjointe du Conseil international de lutte contre les troubles dus à la carence en iode (ICCIDD) et du Centre régional de Recherche en Alimentation et Nutrition (CRAN) basé à Lomé, au Togo. La base logistique pour l'organisation de l'étude était implantée au CRAN.

Le véhicule ThyroMobil, précédemment utilisé en Europe, équipé d'un échographe, d'un ordinateur pour l'enregistrement des mensurations thyroïdiennes sur le terrain, d'un congélateur et d'autres matériels pour la collecte et la conservation des échantillons, a visité les écoles sélectionnées dans les différents sites des six pays, suivant le calendrier ci-après: d'octobre à décembre 1999 dans quatre pays (Bénin, Burkina Faso, Mali, Togo), en décembre 2000 au Niger et en mai 2001 au Ghana.

L'investigateur principal de l'étude sur le terrain (TNK) était médecin de santé publique et membre de l'ICCIDD; il était secondé sur le terrain par un médecin nutritionniste du CRAN. Dans chacun des six pays, un responsable du Ministère de la Santé a participé à l'étude comme investigateur national; il a notamment conduit la sélection des sites d'étude dans des zones, jadis endémiques, essentiellement accessibles au véhicule du projet.

Dans chaque site, il a été demandé aux élèves des écoles sélectionnées d'apporter un échantillon du sel consommé dans leur ménage, et un test rapide de l'iodation du sel a été effectué sur le terrain devant les élèves et leurs enseignants.

En vue d'accroître la prise de conscience sur le problème de la carence en iode, les autorités administratives, les responsables de santé ainsi que les enseignants ont été invités à visiter le véhicule ThyroMobil et aux conférences tenues sur le terrain dans les différents sites ainsi que dans les capitales des pays visités.

Cette recherche a été approuvée par le comité d'éthique de l'Université Libre de Bruxelles et par les Ministères de la Santé et de l'Education des six pays.

5. Difficultés rencontrées

La principale difficulté rencontrée est celle de la perte au siège du CRAN à Lomé de quelques données collectées sur le terrain, notamment les mesures des volumes thyroïdiens effectuées au Niger ainsi que les résultats des tests rapides de l'iodation du sel effectués sur le terrain au Niger et au Ghana. En effet, la fermeture du CRAN, conformément à la nouvelle structuration de la CEDEAO (Communauté Economique des Etats de l'Afrique de l'Ouest) en matière de santé, a entraîné la dispersion du personnel et n'a pas garanti la bonne conservation des archives et des données de cette enquête.

La faible distance du châssis du véhicule au sol n'a pas permis de sélectionner les sites d'enquête de manière représentative dans chaque pays, et ainsi les zones endémiques situées dans des régions enclavées (routes impraticables, sablonneuses, ...) n'ont pas été sélectionnées; pour le Mali par exemple, tous les sites sélectionnés sont situés dans la ceinture du sud du pays.

6. Résultats

Au total dans les six pays, soixante sites ont été visités, 6 111 enfants âgés de six à douze ans ont été examinés pour le dépistage du goitre, 2 322 analyses d'urine ont été effectuées pour le dosage de l'iode, 3 202 échantillons de sel ont été testés (test rapide) sur le terrain pour la détection de l'iode, et 614 échantillons de sel ont été analysés en laboratoire pour le dosage de l'iode.

6.1. Donnees epidemiologiques sur les indicateurs de suivi de la lutte contre les TDCI

Les résultats globaux de l'étude sont résumés dans le tableau 1 et discutés en détail dans les sections 6.1.2. à 6.1.4.

6.1.1. Principaux indicateurs de suivi de la lutte contre les TDCI

L'accès des ménages au sel iodé dans les sites visités est de plus de 90 % dans trois des quatre pays (Bénin, Burkina Faso et Mali) où les données sur cet indicateur sont disponibles. Il est légèrement en dessous de ce seuil au Togo. La teneur en iode du sel et l'iode urinaire sont insuffisants au Niger et

Tableau 1
Synthèse des résultats sur les indicateurs de la lutte contre les TDCI

Pays	Accès des ménages au sel iodé (test rapide)	Moyenne d'iode dans le sel (titrimétrie)	Médiane d'iode urinaire	Prévalence du goitre
Bénin	97,9 %	58,0 ppm	289,4 µg/l	1,2 %
Burkina Faso	97,8 %	48,3 ppm	113,9 µg/l	22,4 %
Ghana	–	35,1 ppm	196,3 µg/l	5,4 %
Mali	94,2 %	60,5 ppm	203,3 µg/l	13,4 %
Niger	–	8,5 ppm	54,1 µg/l	–
Togo	83,7 %	3,2 ppm	116,2 µg/l	4,3 %

normaux ou même au-dessus de la normale dans les cinq autres pays. La prévalence du goitre n'est inférieure au seuil de 5 % que dans trois pays (Bénin, Ghana et Togo) et est encore élevée au Burkina Faso (22,4 %) et au Mali (13,4 %) en dépit d'iodes urinaires satisfaisants.

6.1.2. Teneur du sel en iode

La teneur moyenne du sel en iode varie de 8,5 ppm au Niger à 60,5 ppm au Mali. La distribution de fréquence des valeurs observées est indiquée dans le tableau 2.

Plus de 90 % des échantillons du sel consommé au Niger sont faiblement iodés (< 15 ppm) et une proportion non négligeable (≥ 10 %) des échantillons du sel consommé au Mali et au Burkina Faso a une teneur en iode supérieure à 100 ppm au niveau des ménages, ce qui est largement excessif.

Le tableau 3 compare les distributions de fréquence obtenues sur les 614 échantillons de sel testés pour leur contenu en iode simultanément par test

Tableau 2
Résultats du dosage de l'iode par titrimétrie

Pays	Distribution de fréquence des résultats de la titrimétrie				
	0 ppm	1-14 ppm	15-49 ppm	50-100 ppm	> 100 ppm
Bénin	0,0 %	4,5 %	39,1 %	50,9 %	5,5 %
Burkina Faso	2,0 %	18,0 %	40,0 %	30,0 %	10,0 %
Ghana	0,0 %	34,9 %	43,1 %	17,4 %	4,6 %
Mali	0,0 %	25,6 %	18,6 %	37,2 %	18,6 %
Niger	6,7 %	87,7 %	3,4 %	2,2 %	0,0 %
Togo	0,0 %	22,6 %	47,8 %	27,0 %	2,6 %

Tableau 3
Tableau comparatif des résultats du test rapide et de la titrimétrie

Méthodes d'analyse	Distribution de fréquence des taux d'iodation du sel		
	0 ppm	1-49 ppm	50-100 ppm
Test rapide	13,8 %	34,9 %	51,3 %
Titrimétrie	1,3 %	64,1 %	34,6 %

rapide et par titrimétrie. Il apparaît de grandes différences entre les résultats de ces deux méthodes d'analyse: le test rapide surestime à la fois la fréquence des valeurs élevées et des valeurs nulles (absence d'iode).

6.1.3. Concentrations urinaires d'iode

La médiane d'iode urinaire va de 54,1 µg/l pour le Niger à 289,4 µg/l pour le Bénin (tab. 2).

Le tableau 4 montre la distribution de fréquence des concentrations de l'iode urinaire. Plus de la moitié (72,1 %) des échantillons d'urine collectés au Niger ont moins de 100 µg/l d'iode et, d'autre part, près de la moitié (48,8 %) des échantillons d'urine prélevés au Bénin ont une teneur en iode supérieure à 300 µg/l, reflétant un excès d'iode; la proportion des échantillons dans cette catégorie (> 300 µg/l) est supérieure à 20 % pour le Ghana et le Mali.

6.1.4. Prévalence du goitre

La prévalence du goitre va de 1,2 % pour le Bénin à 22,4 % pour le Burkina Faso (tab. 1). Dans les cinq pays où cet indicateur est bien documenté,

Tableau 4
Résultats des concentrations urinaires d'iode par catégories

Pays	Distribution de fréquence des concentrations d'iode urinaire				
	< 20 µg/l	< 100 µg/l	100-200 µg/l	> 200 µg/l	> 300 µg/l
Bénin	1,0 %	8,3 %	18,0 %	73,7 %	48,8 %
Burkina Faso	13,3 %	47,1 %	23,3 %	29,7 %	12,8 %
Ghana	1,5 %	27,3 %	24,5 %	48,2 %	27,6 %
Mali	9,7 %	34,1 %	28,7 %	37,2 %	21,9 %
Niger	20,2 %	72,1 %	17,6 %	10,3 %	2,6 %
Togo	42,6 %	42,6 %	26,1 %	31,3 %	13,4 %

la prévalence du goitre va de 3,6 % chez les enfants de six ans à 10,4 % chez ceux de douze ans et elle est plus élevée chez les filles (57,6 %) que chez les garçons (36,9 %).

6.2. Valeurs normatives du volume thyroidien des enfants africains non carences en iode

Les villes de Lomé (Togo) et Cotonou (Bénin) ont été retenues dans l'étude, en dehors des zones endémiques; sur 289 enfants examinés dans ces deux sites, les médianes d'iode urinaire étaient respectivement de 124,6 et 379 µg/l. Aucun goitre n'a été dépisté par échographie chez les enfants examinés dans ces villes côtières, représentant des zones africaines non carencées en iode. Chez les garçons, les volumes thyroïdiens vont de 2 à 3,8 cm pour le percentile 50, et de 3,1 à 6,6 cm pour le percentile 97 (tab. 5a), et chez les filles de 1,9 à 3,3 pour le percentile 50 et de 3,4 à 7,6 pour le percentile 97 (tab. 5b).

Tableau 5a
Comparaison des volumes thyroïdiens chez les garçons avec les normes internationales

Age	P 50 OMS/ICCIDD adapté	P 50 Etude actuelle	P 97 OMS/ICCIDD adapté	P 97 Etude actuelle
6 ans	2,3	2,0	3,8	3,1
7 ans	2,4	2,1	4,0	3,1
8 ans	2,6	2,4	4,3	3,4
9 ans	2,9	2,5	4,8	3,5
10 ans	3,2	2,6	5,5	4,3
11 ans	3,6	3,1	6,4	4,7
12 ans	4,0	3,8	7,4	6,6

Tableau 5b
Comparaison des volumes thyroïdiens chez les filles avec les normes internationales

Age	P 50 OMS/ICCIDD adapté	P 50 Etude actuelle	P 97 OMS/ICCIDD adapté	P 97 Etude actuelle
6 ans	2,1	1,9	3,6	3,4
7 ans	2,4	2,2	4,2	3,5
8 ans	2,8	2,2	4,9	3,6
9 ans	3,1	2,3	5,7	3,6
10 ans	3,6	2,4	6,5	3,7
11 ans	4,0	3,2	7,4	4,5
12 ans	4,5	3,3	8,3	7,6

Ces tableaux (5a et 5b) comparent les volumes thyroïdiens par âge et par sexe obtenus dans les deux villes côtières aux valeurs obtenues en Europe auprès de populations non carencées en iode (ZIMMERMANN *et al.* 2001). Ces tableaux comparatifs montrent que les volumes des thyroïdes examinées dans ces zones africaines non carencées en iode sont plus bas que dans des populations européennes.

7. Discussion

La présente étude a permis d'obtenir des données épidémiologiques standardisées sur la situation des TDCI et de faire des comparaisons valables sur l'évolution des indicateurs de suivi de la lutte contre ce problème de santé publique dans six pays africains qui étaient dans un passé récent des foyers traditionnels de goitre endémique et qui ont mis en œuvre la promotion de la consommation du sel iodé au cours de la dernière décennie. Cependant, elle ne doit pas être considérée comme une évaluation nationale approfondie de la lutte contre les TDCI dans chacun des pays visités, eu égard au choix non représentatif des sites d'enquête ayant dû se situer dans des zones accessibles au véhicule ThyroMobil.

Les résultats du test rapide effectué sur le terrain ont montré une large disponibilité de sel iodé dans les ménages (> 80 % dans les quatre pays où les données sont disponibles). La titrimétrie du sel a révélé des teneurs moyennes en iode élevées (> 35 ppm) au Bénin, au Burkina Faso, au Ghana, au Mali et au Togo, sauf au Niger où la moyenne du sel en iode est très faible (8,5 ppm). Ces résultats ont également montré une importante hétérogénéité de la teneur en iode du sel d'un pays à l'autre ou d'un site à l'autre dans un même pays. On retrouve, d'une part, une proportion importante de sels faiblement iodés (< 15 ppm) et, d'autre part, des sels iodés au-delà des normes admissibles (> 100 ppm) traduisant des lacunes dans le contrôle de qualité du sel iodé depuis la production, Enfin, cette étude indique que les kits de test rapide sont dangereusement imprécis, y compris même pour la détection de présence ou d'absence d'iode dans le sel.

L'analyse des urines a établi une médiane d'iode urinaire comprise entre 100 µg/l et 300 µg/l au Bénin, au Burkina Faso, au Ghana, au Mali et au Togo, sauf au Niger où elle est de 54,1 µg/l. Ces résultats témoignent d'une correction de la carence en iode dans la quasi-totalité des sites des pays visités. Cependant, la distribution de fréquence des concentrations urinaires d'iode montre qu'une proportion importante de sujets (> 20 %), en particulier au Bénin, au Ghana et au Mali, ont des valeurs d'iode urinaire au-dessus

du seuil critique de 300 µg/l, qui est associé au risque d'effets secondaires dus à l'excès d'iode (WHO, UNICEF & ICCIDD 2001).

Le dépistage par échographie montre une prévalence du goitre allant de 1,2 % au Bénin à 22,4 % au Burkina Faso. Ces taux traduisent une nette réduction des TDCI dans les différents pays où les données sont disponibles, par rapport à la situation épidémiologique qui y prévalait il y a une décennie. La persistance du goitre endémique au Burkina Faso et au Mali, malgré des taux élevés d'iode urinaire, pourrait être expliquée par le fait que l'importation et le contrôle du sel iodé ont connu un grand retard dans ces pays, en dépit de l'adoption officielle de cette stratégie depuis 1996. Par contre, le Bénin, qui a la prévalence de goitre la plus basse, est parmi les premiers pays d'Afrique de l'Ouest qui ont mis en œuvre la stratégie du sel iodé. Ceci confirme que la normalisation de la prévalence du goitre prend un peu plus de temps que celle de l'iode urinaire (WHO, UNICEF & ICCIDD 2001).

L'absence de goitre dans les sites de Cotonou et de Lomé confirme que ces zones côtières d'Afrique ne sont pas carencées en iode. Les données comparatives permettent de constater que les valeurs des volumes thyroïdiens des populations africaines non carencées en iode sont inférieures aux valeurs de référence issues des populations européennes.

La présente étude témoigne globalement d'une bonne évolution des indicateurs de suivi permettant de conclure que la lutte contre les TDCI en Afrique de l'Ouest est effective et prometteuse, à l'exception du Niger où les résultats indiquent une nette régression du statut iodé de la population par rapport aux données antérieures (DAOUDA 1998).

8. Recommandations

Les résultats de cette étude recommandent que des mesures de pérennisation de la prévention des TDCI soient développées dans tous les pays, notamment la coalition des différents partenaires pour une mobilisation soutenue des ressources, le renforcement du contrôle de qualité du sel iodé depuis la production, le suivi régulier des indicateurs de la lutte contre les TDCI et la poursuite inlassable des activités de promotion du sel iodé, en vue de l'élimination durable des TDCI en tant que problème de santé publique par la consommation d'un sel adéquatement iodé.

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Tracking the Nutritional Transition in Bolivia. A Descriptive Study

by

Armando PEREZ-CUETO*, Fanny VELASCO**,
Magaly ALMAZA** & Patrick KOLSTEREN*

KEYWORDS. — Bolivia; Women; Adolescents; Nutritional Transition; Overweight.

SUMMARY. — The objective of the present study is to identify some of the characteristics of the nutritional transition in Bolivia. Using data from the Development and Health Surveys (DHS), the changes in the nutritional status of Bolivian women in childbearing age could be determined. While undernutrition almost disappeared in this group, an important increase of 10 % in the prevalence of overweight was observed in the period between 1994 and 1998. A gap of information on the nutritional status of other population groups was also identified. Therefore, a survey was carried out in a sample of 525 adolescents attending public and private schools of La Paz, the main Bolivian city. The findings suggest that overweight is highly prevalent in this age group (22 %). The results also suggest that female adolescents are more likely to cluster stunting and overweight.

The present study also shows the trends in food availability at household level that were obtained from the data provided by the Household Surveys of 1999, 2000, 2001 and 2002. The methodology proposed by the European Data Food Networking Initiative (DAFNE) was applied.

Disparities in food availability within the country could be observed. Rural households have systematically fewer amounts of food available than urban households do. The wealthier the households are, the higher the availability of most food groups except for potatoes and cereals. These findings suggest that Bolivian poorer households will prefer the more energy-dense and cheaper food sources.

In conclusion, overweight and stunting coexist in the same population; however, obesity is still very low. The most alarming finding is the steadily increase in energy-dense sources of food, accompanied by a decrease mainly in food of plant origin. All together, the observed changes in availability of the main food groups suggest that

* Nutrition and Child Health Unit, Institute of Tropical Medicine, Antwerp (Belgium); Laboratory of Food Science and Nutrition, Ghent University, Ghent (Belgium).

** Asociación de Promoción, Investigación y Acción Social para el Desarrollo (PIAS), La Paz (Bolivia).

the nutritional transition is incipient in Bolivia. Therefore, interventions are urgent in order to prevent undesirable nutrition-related health outcomes such as obesity and other chronic diseases.

Introduction

The Need of an Improved Approach to Nutritional Surveillance

Many are the reported causes for the dysfunction of what has been understood as "Nutritional Surveillance" during the past decades. The three main aspects responsible for this dysfunction are *inefficiency*, *high cost* and *lack of sustainability* (Maire *et al.* 2001, Beghin *et al.* 2002). Therefore, an improved approach to Nutrition Surveillance has been developed in order to extend the concern from the undernutrition issues to three new domains: micronutrient deficiencies, food security and the nutritional transition where a relevant role can be played (Maire *et al.* 2001).

Data on nutritional status of the population is scarce worldwide. Thanks to the regular health surveys, information is mainly available in children and women of childbearing age. This is true for Bolivia and many other developing countries where the undernutrition-related problems are still of concern. Despite the availability of data, very few studies in Bolivia focused on the overweight-obesity prevalence at a population level. The prevalence of obesity worldwide is considered as an epidemic. Hence, this study lies within the philosophical frame of the World Health Organization's "Global strategy for the prevention and control of non-communicable diseases" (Director-General WHO 2002) and the newly developed approach to nutritional surveillance (Beghin *et al.* 2002).

Bolivia is one of the poorest countries of Latin America with more than half of the total population living under the national poverty line and in urban areas. In this context, the Bolivian National Institute of Statistics carried out three health surveys, in 1988, 1994 and 1998, from which up-to-date information on nutrition, demographics and health is available. Anthropometrics are available for children in all survey years, and only in the latter two for women who have had a child in the previous 3-5 years. Since datasets were available for secondary analysis and no previous reports existed on the changes in prevalence of overweight and obesity in the adult population, an opportunity was open to investigate these features and their associated socioeconomic and ecological factors (Perez-Cueto & Kolsteren 2004, Martorell *et al.* 1998).

Nutritional surveys are the most specific tool for nutritional surveillance. However, they are time, labour and resources consuming. In Bolivia, the household surveys developed by the MECOVI (Measurement of Living Conditions in Latin

America and the Caribbean) programme provide valuable information on sociodemographic characteristics that can be linked to food availability and hence they can be used for surveillance purposes (PEREZ-CUETO 2003).

The idea to use Household Survey for monitoring food availability and nutritional information in Bolivian households is based on the experience of the European Data Food Networking that has been using Household Budget Surveys (HBS) data, which contain similar information than Household Surveys, for the assessment of nutritional information. This methodology makes use of HBS to estimate and monitor food availability at individual level having as a main objective the between and within countries comparison (LAGIOU & TRICHOPOULOU 2001).

The main methodological differences between the MECOVI surveys and the HBS are that an interviewer records the former, while a household member records HBS. Food availability is registered in a Food Frequency type of Questionnaire in the MECOVI surveys, while in HBS the households record food purchases, own production and gifts during a specific period.

DEFINITION OF THE NUTRITIONAL TRANSITION

The concept of nutritional transition comes within the general frame of the epidemiological transition, both in developed and developing countries. The nutritional transition is characterized by an increase in the prevalence overweight and obesity at a population level. The main cause for this increase is an imbalance of energy due to a shift from traditional and probably healthier eating patterns towards the so-called Western diet, and a reduction in physical activity due to urbanization and lifestyle (BERNSTEIN *et al.* 2004). The main consequence of this transitional situation is the dramatic increase in the prevalence of chronic non-communicable diseases such as cardiovascular disease (FREEDMAN *et al.* 1999), type II diabetes (BARCELO *et al.* 2001) mellitus and a certain number of cancers (BIANCHINI *et al.* 2002).

The objective of this paper is to describe some of the characteristics of the nutritional transition in Bolivia, in terms of the epidemiology of overweight coexisting with undernutrition-related problems, and in terms of the current food availability patterns at household level.

Nutritional Status of the Population

WOMEN IN CHILDBEARING AGE

Shifts towards greater BMI (Body Mass Index) and coexistence of underweight and overweight in the same society have been observed in the Bolivian

population (PEREZ-CUETO & KOLSTEREN 2004). Table 1 shows the mean values of the Body Mass Index in Bolivian women according to their age group. The observed differences are statistically significant between the two years ($P < 0.05$) in all groups except the 40-44 one.

Table 1
Mean values of the Body Mass Index in Bolivian women according to their age group

5-year age groups	Survey 1994 Mean (*SD*)	Survey 1998 Mean (*SD*)	P value *
15-19 years	23 (2)	23 (3)	0.003
20-24 years	24 (4)	24 (3)	<0.001
25-29 years	24 (4)	25 (4)	0.014
30-34 years	25 (4)	25 (4)	0.003
35-39 years	25 (4)	26 (4)	0.007
40-44 years	25 (4)	26 (4)	0.250
45-49 years	24 (2)	26 (6)	0.036

* ANOVA Test.

Table 2 shows the prevalence of underweight, overweight and obesity among Bolivian women in childbearing age. Differences are statistically significant between both surveys with the exception of obesity. These findings, in agreement with those displayed in table 1, suggest that an important increase in the prevalence of overweight has happened in a short period. In general terms, overweight and obesity together were present in 45 % of the surveyed women, while the prevalence of underweight was almost irrelevant. These figures suggest also that obesity and other chronic and degenerative diseases

Table 2
Prevalence of underweight, overweight and obesity
among Bolivian women in childbearing age 1994-1998

Nutritional status	Survey 1994	Survey 1998	P value*
Undernutrition BMI < 18.5 kg/m^2	2%	1%	< 0.001
Normal 18.5 ≤ BMI < 25 kg/m^2	63%	54%	< 0.001
Overweight 25 ≤ BMI < 30 kg/m^2	26%	35%	< 0.001
Obesity BMI ≥ 30 kg/m^2	9%	10%	0.246

* χ^2 Test at the 0.05 level.

(BIANCHINI *et al.* 2002, MARTORELL *et al.* 1998) may become a burden for public health budgets in the near future (THOMPSON & WOLF 2001). Obesity impairs quality of life (KOLOTKIN *et al.* 2001) and has been identified as a strong predictor of mortality from all causes combined (SOLOMON & MANSON 1997) amongst which cardiovascular disease (MURRAY & LOPEZ 1997) and some cancers (BIANCHINI *et al.* 2002).

ADOLESCENTS

In Bolivia, the availability of anthropometric data of adolescents is scarce. The only sources of representative information on female adolescents who had had a child in the past three years are the regular Development and Health Surveys. However, nutritional status in terms of BMI may be confounded by the recent birth of the child. Therefore, between August and September 2003, a survey was carried out in a sample of adolescents attending public and private schools of the Capital city of La Paz (PEREZ-CUETO *et al.* 2004).

The main findings of the study are that female gender and wealth are associated to overweight. Overweight was defined using the cut-off points suggested by the International Obesity Task Force (IOTF) (COLE *et al.* 2000). Stunting was defined according to the World Health Organization's recommended cut-offs (WHO Expert Committee 1995). Table 3 shows the nutritional status of a sample of 525 adolescents from La Paz, Bolivia. The table describes two important aspects of the nutritional transition: first, the coexistence of a non-neglectable proportion of stunted and overweight subjects in the same population; secondly, it shows that 7.6 % (± 1.3) of the adolescents in the sample are both stunted and overweight, but also that girls are more likely to cluster both characteristics.

Table 3
Nutritional status of a sample of 525 adolescents from La Paz, Bolivia

Nutritional status	Boys prevalence (95 % CI)	Girls prevalence (95 % CI)	*P* value of the difference between boys and girls[a]
Stunted	23.5 (18.1-28.9)	35.8 (30.6-41.2)	<0.001
Overweight[b]	12.2 (8.0-16.4)	26.1 (21.0-31.2)	<0.001
Obesity[b]	3.4 (1.1-5.7)	1.4 (0-2.8)	0.13
Overweight & stunted	3.8 (1.3-6.2)	8.7 (3.4-14)	0.022

[a] χ^2 test of two proportions at the 0.05 level.
[b] Overweight and obesity were defined using the IOTF cut-off points (COLE *et al.* 2000).

The coexistence of stunting and overweight in the same population and even within the same household has been documented as one of the symptoms of the nutritional transition in developing societies. Wealthier Chinese households consuming a diet high in fat and protein were more likely to have overweight and underweight members at the same time (DOAK *et al.* 2002). Adolescent BMI predicts cardiovascular risk in later life (JEFFREYS *et al.* 2003, OREN *et al.* 2003, RAMAN 2002). Even more, overweight in adolescence has been suggested as a more powerful predictor of morbidity risks than overweight in adulthood (MUST *et al.* 1992, DIETZ 2004). Therefore, the present findings suggest that female adolescents living in La Paz may be almost four times more at risk of obesity and therefore of chronic disease later in life than their male peers, and that the high prevalence of overweight may affect their later social and economic status (GORTEMAKER *et al.* 1993, SOBAL 1994).

Therefore, urgent actions in the field of nutrition should be undertaken in Bolivia in order to prevent future undesirable health outcomes, focusing particularly on females. These findings also reveal the need of enhanced surveillance of the nutritional status of Bolivian males and elderly people, for whom the risk of nutrition-related chronic diseases may be of greater concern.

Food Availability and Westernization of Diet

The next step in the study was to find some possible ecological explanations to the current nutritional status of women and adolescents. Therefore, a thorough analysis of the food available at household level was performed using the MECOVI datasets.

Based on the data provided by the four national representative surveys (1999, 2000, 2001 and 2002), and applying the methodology proposed by the European Data Food Networking Initiative, the availability of thirteen food groups has been estimated. Figure 1 shows the trends in mean availability of selected food groups for the survey years. Food availability in Bolivian households has shown a regular behaviour in the studied period (1999-2002). Dramatic changes have not been observed. The preferred food groups are cereals, tubers, fruits, vegetables, meat and milk. The high levels of the first four food groups suggest a preference for foods of plant origin, while national availability of meat & meat products and milk & dairy products is moderate.

Of concern is the steady increase observed in availability of added lipids while the availability of milk, meat, fruits, vegetables and cereals decreased in Bolivian households in the period and taking 1999 as reference. These figures reveal another feature of the nutritional transition: a steady increase in energy-dense sources of food, accompanied by a decrease mainly in foods of

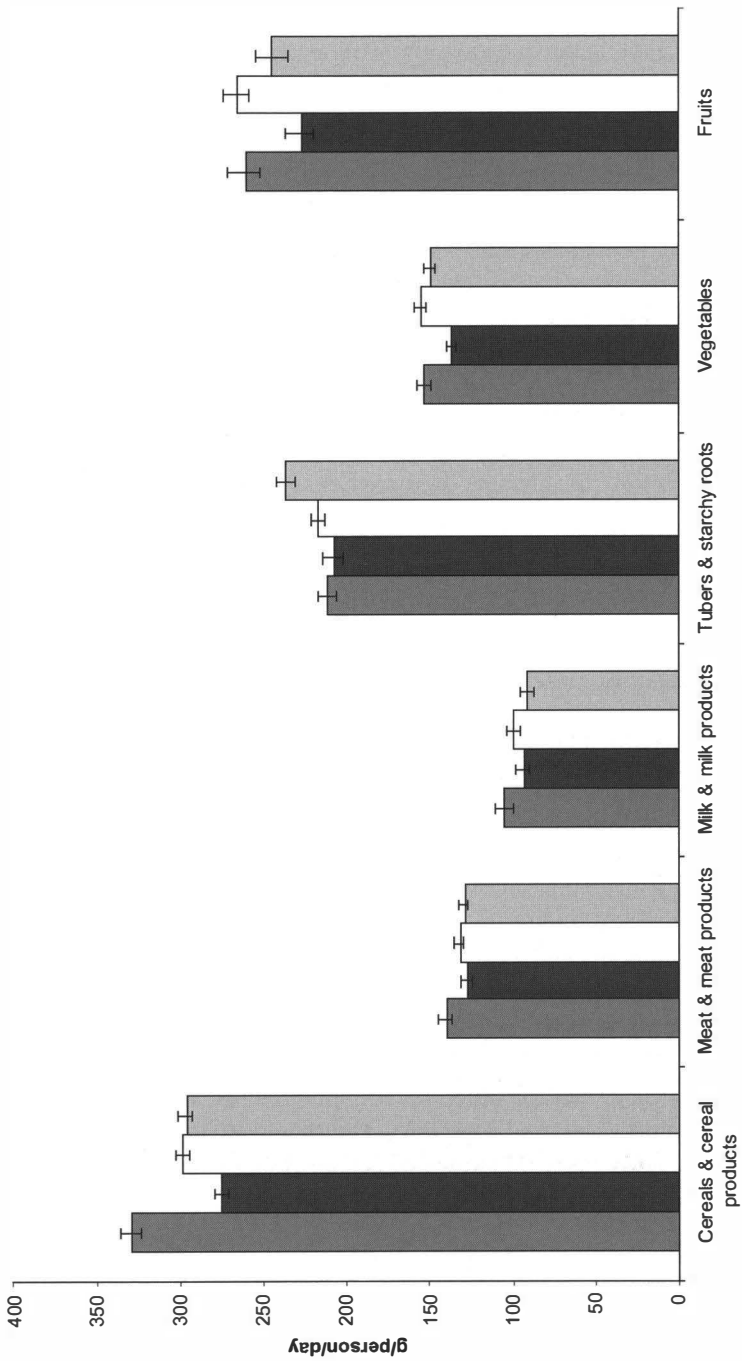

Fig. 1. — Trends in food availability of selected food groups (1999-2002).

vegetal origin. However, the changes observed in availability of the main food groups suggest that the nutritional transition is incipient in Bolivia. This agrees furthermore with the findings in prevalence of overweight and obesity. Obesity is still low prevalent in the country, which may be ecologically associated with the traditional food pattern available at household level.

Food Disparities within the Country

The analysis of the data obtained from the HS allows depicting disparities in food availability at household level by region, locality, educational level (LAGIOU & TRICHOPOULOU 2001, LIBERATOS *et al.* 1988) of the household head and by quintile of proportion of food expenditures (JAMES *et al.* 1997).

In rural Bolivia, the availability of most of the food groups remained steady in the period; therefore, the changes are mainly explained by the purchases of urban households. However, in contrast to the national aggregated trend, rural households increased significantly their availability of cereals, tubers and meat.

The Bolivian highlands and valleys show a similar behaviour. In both regions, a tendency to decrease the availability of cereals, meat, milk, fruits and vegetables, together with a tendency to increase potato availability, was observed. In the low lands of the country, the contrary trends were observed.

The most striking disparities in Bolivia are found in the availability of foods according to the educational level of the household head. Figure 2 reveals a proportional gradient of availability: the higher the educational achievement of the household head, the higher the availability of food at home. This is true for all food groups except for tubers and starchy roots. Lower educated households will purchase significantly more potatoes and cassava than those with higher education.

A similar observation can be taken from the analysis of the quintiles of the proportion of food expenditures. Wealthy households spend proportionally less of their budgets on foods, while poorer ones devote most of their income to food (JAMES *et al.* 1997, TRICHOPOULOU *et al.* 2002). The households in the lower quintiles of the proportion of food expenditure (hence the wealthier ones) have more meat, milk, fruits and vegetables. Households in the higher quintiles will have significantly more quantities of cereals, tubers and added lipids.

Conclusions

The present study allows to classify Bolivia as a country in early stages of the nutritional transition: low prevalence of obesity, and a still traditional food

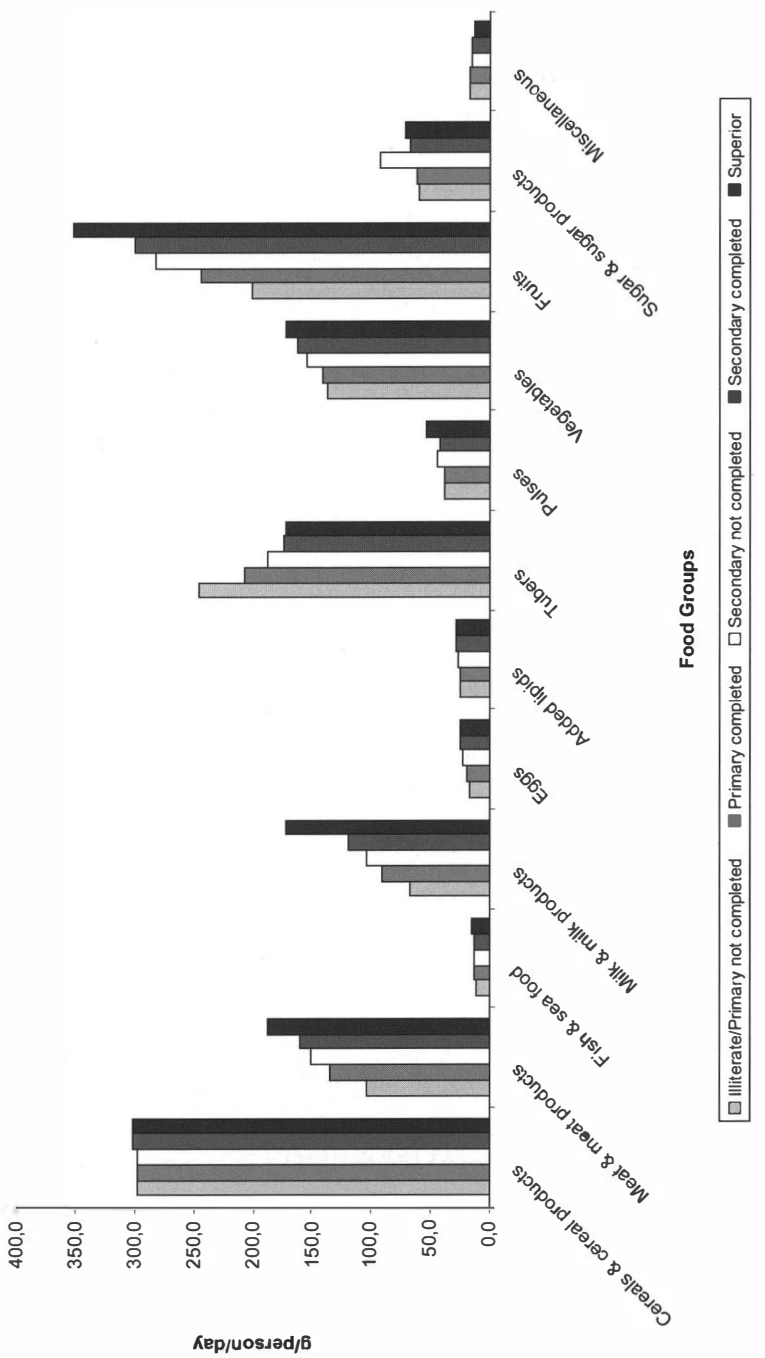

Fig. 2. — Food availability in Bolivian households according to the educational achievement of the household's head.

consumption pattern. The coexistence of overnutrition- and undernutrition-related problems in the same population is also a fact of concern, since it has been previously associated with the clustering of unhealthy eating and lifestyle patterns (DOAK *et al.* 2002). Therefore, the alarming prevalence of overweight in females should bring the attention to the danger of developing an epidemic of obesity and other chronic diseases (BIANCHINI *et al.* 2002, BJORNTORP 1998) that impair the quality of life (KOLOTKIN *et al.* 2001) and may reduce life expectancy (GOTTLIEB 2003). Based on these findings, it would be in the Bolivian population's best interest to implement policies and programmes aiming at the revalorization of traditional foods and the prevention of obesity (BLAIR & NICHAMAN 2002).

Disparities in food availability have been observed. Regional disparities were not as striking as the differences between the wealthier and the poorer Bolivians. The most economically disadvantaged people are, nevertheless, much more efficient in the use of their income (MAXWELL & FRANKENBERGER 2003). They will therefore prefer the cheaper sources of energy to the detriment of fruits and vegetables. However, the wealthier people and regions (the Low Lands) are more likely to show the characteristics of the nutritional transition (PEREZ-CUETO & KOLSTEREN 2004).

Of concern is the compromise of quality of the diet in favour of energy-dense and filling foods that was observed amongst the less wealthy households purchasing mainly tubers and cereals, to the detriment of fruits and vegetables. These findings support the need to enhance interventions aiming at the increase of food security, in terms also of quality, in the poorer groups of the population (MAXWELL & FRANKENBERGER 2003).

This study also provides evidence supporting the new approach to nutritional surveillance: finding and exploiting cheaper sources of data and focusing on the emerging overnutrition-related health concerns (BEGHIN *et al.* 2002). Even more, it also provides support for the use of alternative methodologies for the estimation of food availability at more disaggregated levels, in order to identify disparities within the country (BYRD-BREDBENNER *et al.* 2000, TRICHOPOULOU *et al.* 1999, TRICHOPOULOU 2001).

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Influence of a Complementary Food on the Growth and Iron & Zinc Nutritional Status of Children 6 Months – 1 Year Old in Kilosa District, Tanzania

by

Martin KIMANYA[1],[2], Peter MAMIRO[3], Patrick KOLSTEREN[1],[4], John VAN CAMP[1], Dominique ROBERFROID[4], Simon TATALA[5] & Anne OPSOMER[1]

KEYWORDS. — Anaemia; Complementary Feeding; Iron Deficiency.

SUMMARY. — A study, set up as a double-blind randomized, placebo-controlled trial, was conducted from March 2001 to March 2002 involving 309 infants who received either a processed Complementary Food (CF) or a placebo from six to twelve months of age. Both groups were comparable in baseline characteristics. The study took place in Kilosa district, Tanzania. The processed CF contained germinated, autoclaved and dried finger millet (65.2 %), kidney beans (19.1 %), roasted peanuts (8 %) and mango puree (7.7 %). The same blend, but not processed, served as placebo. Processing increased energy density for the same viscosity and solubility of iron and zinc. Mean length for age, weight for age, haemoglobin, zinc protoporphyrin and hair zinc concentration at six and twelve months were not different between the two groups. The results show that the processed food was not superior with regard to improving growth or iron and zinc nutritional status of infants when given under the study conditions. The control group consumed equal amounts of macronutrients, and the higher energy density, in this study, did not seem to have any benefits. In our study there was a very intensive follow-up with at every encounter an intensive motivation of mothers to give the required amounts and add extra lipids. In those conditions a

[1] Department of Food Technology and Nutrition, Faculty of Agriculture and Applied Biological Sciences, Ghent University, Ghent (Belgium).
[2] Tanzania Food and Drugs Authority (TFDA), Ministry of Health, Dar es Salaam (Tanzania).
[3] Department of Food Science and Technology, Faculty of Agriculture, Sokoine University of Agriculture (SUA), Morogoro (Tanzania).
[4] Nutrition and Child Health Unit, Institute of Tropical Medicine, Antwerp (Belgium).
[5] Department of Food Science, Chalmers University of Technology, Göteborg (Sweden).

well-balanced complementary food with additional lipids can cover the energy needs of young children. The observed reduction in phytates by 34 % and improved solubility of iron and zinc due to processing, might not have been enough to compensate for the rather low iron and zinc content of the complementary food.

Introduction

Growth and chance of survival at birth is to a large extent determined by the intrauterine period (MARTORELL *et al.* 1998). Exclusive breastfeeding in the first four-six months protects the child from nutritional deficiencies and decreases infection pressure. Young infants are most vulnerable at the time complementary foods are introduced. Traditional complementary foods are often bulky, have a low energy density and contain too small amounts of micronutrients, in particular iron and zinc (BENNETT *et al.* 1999, LARTEY *et al.* 1999). Complementary foods are largely cereal-based and contain considerable amounts of phytate, which affect micronutrient bioavailability greatly and so induce deficiencies in minerals. They are also not without risk of contamination (WHO 1998). Low child feeding frequency further contributes to undernutrition of children. Surveys carried out in Tanzania (UNICEF 1998) have indeed shown that most children are fed only two or three times a day.

Iron Deficiency Anaemia (IDA) is an important nutritional problem in Tanzania. It is estimated that 45 % of the children under the age of five years are suffering from nutritional anaemia (UNICEF 1999). It is more prevalent in infants and pregnant women and is usually the result of low bioavailability of dietary iron (FOX *et al.* 1998). Although the effects of iron deficiency anaemia are reversible, including impaired intellectual development, in the local suboptimal conditions this will rarely be the case. So, despite the fact that the diagnosis of anaemia is fairly simple and treatment cheap, prevalence of anaemia remains high (KOLSTEREN *et al.* 1999).

Zinc deficiency is common in developing countries (WHO 2002) where it affects mostly infants and children (FAO/WHO 2002, SALGUEIRO *et al.* 2002). Zinc is an essential component of a large number of enzymes involved in the synthesis and metabolism of nutrients in the human body (PRASAD 1996). Its role in stabilizing the molecular structure of cellular components and membranes, hence contributing to the maintenance of cell and organ integrity, is very well known. Zinc is involved in gene expression and plays a role in the central immune system (SHANKAR & PRASAD 1998). Deficiency of zinc during pregnancy may therefore lead to intrauterine growth retardation (SALGUEIRO *et al.* 2002), and as a consequence poor growth in the first years

of life. Some researchers have shown that even mild zinc deficiency may impair child growth (RIVERA *et al.* 2003).

The most frequently used strategies to correct micronutient deficiencies are food fortification and/or supplementation (STOLTZFUS *et al.* 1998). Local staples have been fortified with ferrous sulphate (MENDOZA *et al.* 2001), zinc sulphate (FAIRWEATHER-TAIT *et al.* 1995), or vitamin A and vitamin C (DAVIDSSON *et al.* 2001, ZLOTKIN *et al.* 2001, MCLAREN & FRIGG 1997). Effectiveness of large-scale fortification programmes, however, has been reduced due to factors such as cost, constant availability, timely distribution of fortificants, and compliance with the prescribed fortificant (THU *et al.* 1999). Similar experiences have been observed in many places with iron supplementation (SCHULTINK & GROSS 1996).

The above-mentioned limitations of fortification and supplementation underline the importance of preventing growth faltering and micronutrient deficiencies, such as iron deficiency anaemia, through a food-based approach (FOX *et al.* 1998, HALLBERG 1999). Food modification approaches employing natural processes such as germination to combat micronutrient deficiencies and improve growth of infants deserve more attention, since they are likely to be more sustainable in the long run (WHO 1998).

Based on the knowledge of the traditional complementary foods (CFs) in Tanzania collected by the authors earlier, a processed CF prepared from locally produced crops was formulated.

The present study aimed to compare growth, iron and zinc nutritional status of Tanzanian infants, from six to eleven months, provided processed and non-processed CF. The main hypothesis was that a processed CF with higher energy density and lower concentration in phytates and tannins would improve growth of infants and decrease iron and zinc nutritional deficiency.

Materials and Methods

The study was conducted from March 2001 to March 2002 in Kilosa District in the Morogoro Region, Tanzania. Morogoro is located about 300 km west of Dar es Salaam. Kilosa is a district with a population of ± 350,000 inhabitants. Kilosa was chosen for this study as it is among the districts in Morogoro Region which have a high prevalence of iron deficiency anaemia (Kilosa Hospital Annual Report 2000).

DESIGN OF THE STUDY

The study was set up as a double-blind randomized controlled trial in which the main investigator and the mothers were blinded with regard to the

type of food given to the infants. Processed complementary food constituted the intervention group and the non-processed food served as control. Infants were continuously enrolled when they reached the age of six months and assigned to the respective groups on the basis of their previously determined allocation. For this, all parents with children below the age of six months were contacted and invited to participate in the study. Parents of 364 children agreed to participate and were randomized. We expected a considerable change of opinion in the period between randomization and actual enrolment so increased the number to be sure to reach the minimal required number of children for the study. Allocation to the treatment or control group was determined using a bloc randomization technique. The code was broken to the main investigator at the end of the data collection. The two types of CF were distributed until the infants reached the age of twelve months. Mothers were free to give their infants any other food of their choice in addition to the CF provided during the study. Measurements were taken twice, at the age of six and twelve months with a malaria blood smear at nine months. Verbal consent was sought from mothers for their infants to participate in the trial. The Ethics Committees of the Tanzania Food and Nutrition Centre and of the University of Ghent reviewed the protocol and gave approval of the trial.

The sample size for the trial was computed to detect a haemoglobin difference of 8 $g.L^{-1}$ (equivalent to $\frac{1}{2}$ standard deviation) between the two groups with a significance level of 0.5 % and power of 95 %. A pilot study conducted in the area prior to the trial revealed that the mean Hb concentration among children aged between four-twelve months was 84.0 ± 17.0 $g.L^{-1}$. The calculated minimum sample size for the experimental and placebo groups was 117 infants (fig. 1).

The processed CF consisted of 65.2 % finger millet, 19.1 % kidney beans, 8 % peanuts and 7.7 % mango puree. Finger millet and kidney beans were washed and soaked in pre-boiled water for 2 and 7 h respectively, and germinated for 48 h at 30 °C. Later the lot was autoclaved and then solar-dried for about 6 h. Peanuts were roasted in an oven at 150 °C for 20 minutes. Mangoes were washed, peeled, sliced and puree extracted. Later the puree was dried in the solar drier for 12 h. The ingredients were mixed and milled to composite flour. The non-processed CF was a blend of finger millet, kidney beans, peanuts and dried mango puree, mixed in the same proportion as the processed CF and then milled to composite flour. The director at the production site did the packing and labelling. Packages and labels were identical and the two preparations were visually indistinguishable. The label contained preparation (cooking) instructions. Before the intervention, an acceptability trial for the CF was done involving fifty mothers with their infants.

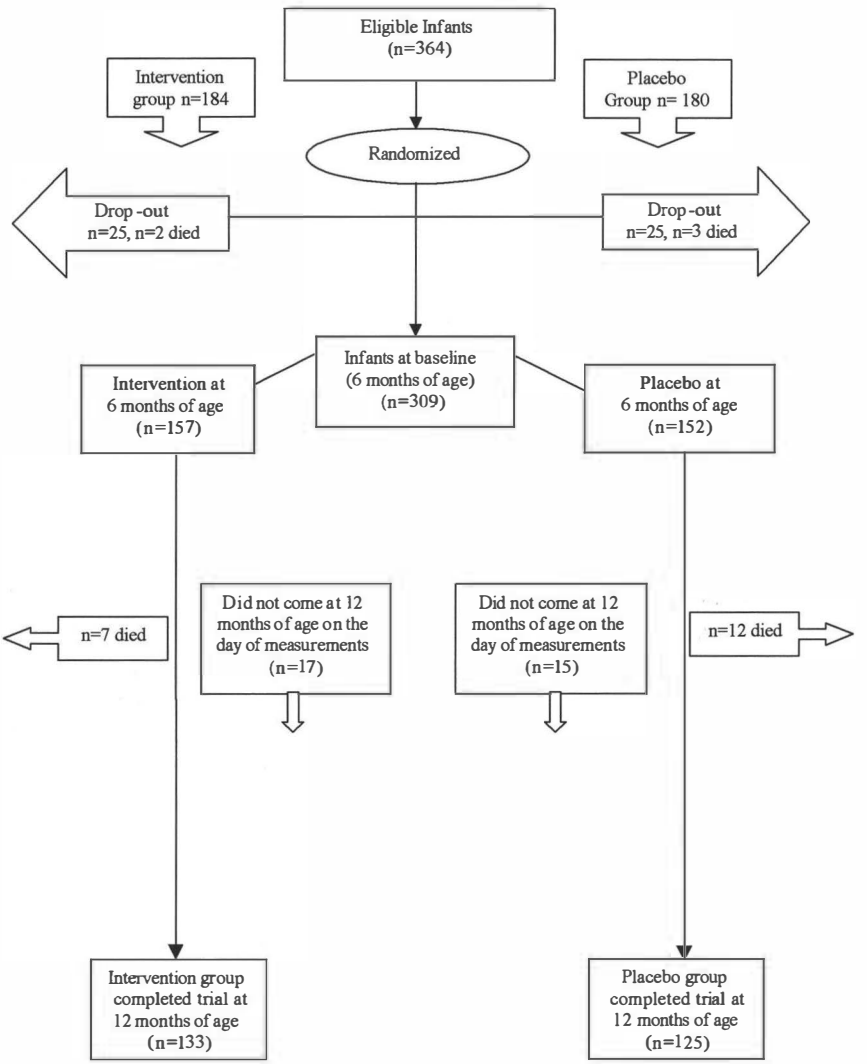

Fig. 1. — Study design. Infants (n = 309) in Tanzania received either a processed CF or an unprocessed CF (placebo) from 6-12 months of age.

Quality control was observed from purchase of raw materials through processing and distribution. For qualitative and quick checking of aflatoxin contamination an Ultra-Violet (UV) lamp (Type B-4 watt Kurtz-und Langwellig) was used. At various CF production stages samples were checked for

contamination with fumonisins (RIDASCREEN® FAST Fumonisin kit, Biopharm), aflatoxins (RIDASCREEN® FAST Aflatoxin Kit, Biopharm) and cyanides (AOAC 1995). Fumonisins and aflatoxin concentrations were less than recommended limits of 1 $mg.kg^{-1}$ and 2 $mcg.kg^{-1}$ respectively, while cyanides were not detected. Outgrowth of pathogens including *Bacillus cereus, Staphylococcus aureus* and *Clostridium perfringens* was investigated for each batch of CF following the HACCP plan (National Advisory Committee on Microbiology Criteria for Foods 1998) and found to be less than 100 $cfu.g^{-1}$ (KIMANYA *et al.* 2003).

Every two weeks, 1 and 1.6 kg of CF were allocated for infants six-eight months and nine-eleven months old, respectively. On a daily basis this means that each child was supplied with 69 g and 113 g dry matter of CF, providing 1,194 $kJ.d^{-1}$ and 1,956 $kJ.d^{-1}$ for infants aged six-eight months and nine-eleven months, respectively (DOP *et al.* 1999). The detailed formulation of the CF is described in MBITHI-MWIKYA *et al.* (2002).

Mothers came to collect the food every two weeks. The MCH nurses supervising the mothers had a list of the infants and recorded every food collection. They demonstrated to the mothers how to prepare the CF (although the packets had a self-explanatory label) and reminded them how much in local measures (tablespoons) of the CF powder to use each day. The CF for one day was prepared once. The nurses also advised the mothers to add one-two teaspoonfuls of oil to the preparation. So, at least about 1,151 $kJ.d^{-1}$ (275 kcal) and 1,883 $kJ.d^{-1}$ (450 kcal) from CF were aimed at. In case of absence, the nurse made certain that a message was sent to the responsible mother to collect her consignment on the same day. Nutrition officers from the centre followed up the mothers in their homestead at least twice a week to make sure the CF was prepared correctly.

Weight and length were recorded at enrolment (age six months) and at the end of the trial (age twelve months). Recumbent lengths of the infants were measured using an infant measuring board to the nearest 0.1 cm (Perspective Enterprises, Portage, MI). Weight of infants was measured by a Salter scale to the nearest 100 g (Model 235 6S – England) with a capacity of measuring up to 25 kg. The infant's birth weight was obtained from his/her clinic card: the MCH nurse is the one responsible to measure the child's weight immediately after birth.

Haemoglobin concentration was measured from a finger prick blood sample by the Hemocue B-Hemoglobin System (Hemocue AB Angelholm, Sweden) (VAN DEN BROEK & LETSKY 2000, PEHRSSON *et al.* 2001). Zinc protoporphyrin was determined on a drop of blood with a portable hematofluorometer (Aviv Biomedical Inc, Lakewood, NJ). The instrument was standardized using

control solutions from the same company (JACKSON & AL MOUSA 2000, ASOBAYIRE *et al.* 2001). The analyses were performed at a later date.

Blood smears, stained with Giemsa sample, were analysed within 10 h for quantitative determination of malarial parasites. Malaria parasite counts were made per two hundred white blood cells. Infants found infected with malaria and those who fell sick at any time during the trial were treated free of charge at the respective health centres.

Scalp hair was collected at baseline when the infants were six months old and at the end of the study when they were twelve months old and analysed for zinc concentration. All measures were taken to avoid external sources of adventitious contaminations during collection and preparation of the hair samples. The hair was cut with stainless steel scissors from the occipital region of the head as close to the scalp as possible. Since zinc levels vary along the length of hair (KRUSE-JARRE 2000), only the proximal 1-2 cm of the hair shaft was used. This part reflects recent trace element uptake by the follicles. The samples were collected in small clean sterile plastic envelopes with a self-adhesive mechanism. The envelopes were coded and kept in one securely closed plastic bag and transported by airfreight to the Department of Food Technology and Nutrition, Ghent University, in Belgium, for analysis.

Samples of the infants' hair were analysed by use of Atomic Absorption Spectroscopy (AAS). The wet digestion extraction for hair mineral analysis by AAS was adopted as a reference method for the determination of Zn in the infant hair samples. Selection of the wet digestion method was based on results of a preliminary recovery study which compared wet digestion and dry ashing methods and showed that the wet digestion method gives better results than the dry ashing method. All reagents used during the analysis were of ultra pure analytical grade. The glassware was washed with acid and thoroughly rinsed with deionised water.

In order to reduce measurement error, hair of six months and twelve months old infants was analysed concurrently. Because of the limited amount of hair that could be obtained from the infants, Zn analysis could not be performed in duplicate.

A twenty-four hour dietary recall was conducted on 137 randomly selected infants aged between six and eleven months, being about 50 % of the total number of infants equally distributed among the two intervention groups. A new appointment was fixed for others who were not found at home at the time of visit. Random numbers were used to select infants from each group. The dietary recall interviews were conducted at the homestead by a nutritionist accompanied by a village health worker. The mother was requested to show the type and amounts of foods the infant had actually consumed over

the last 24 h. The amount of food consumed by the infant was weighed using a digital weighing scale (Tefal scales UK) with an accuracy of 0.5 g or measured by a measuring cylinder (Pyrex-UK) with an accuracy of 0.5 ml in case of volumes. Spilled food was not estimated. Macro and micronutrient contents of the foods were calculated using the FAO food composition table (FAO 1984) with Excel Office 2000.

Samples of CF weighing 250 g from each production batch were analysed for protein (Kjedahl AOAC method 920.87 (AOAC 1995)), fat (Weibull method (EGAN *et al.* 1981)), and iron (atomic absorption spectrophotometry AOAC method 970.12 (AOAC 1995)). The nitrogen protein conversion factor for millet was 5.83 and 5.3 for beans and peanuts. Solubility of iron was determined by the method of SVANBERG & SANDBERG (1993), and phytate using the technique of HAUGH & LANTZSCH (1983).

Infants were excluded from the trial if they had received blood transfusions or presented a health condition that needed further treatment as assessed by a medical doctor at the time of enrolment. These excluded infants were referred to the local health facilities for appropriate treatment. All children were investigated for malaria at six months of age and treated accordingly. Given that all children are breastfed and that Kilosa is a malaria endemic area, anaemia is considered to be due to malaria in the standard protocols. At the end of the trial, the children were re-evaluated and treated for the most likely aetiology of anaemia by the supervising medical doctor.

STATISTICAL ANALYSIS

Data were entered in EPI-INFO (version 6.04d; Centers for Disease Control and Prevention, World Health Organization 1996), and analysis was done by using Stata 8.0 package *(Stata version 8.0; STATA, College Station, Texas)*. Z scores, weight-for-length and length-for-age were computed using EPINUT according to the National Centre for Health Statistics Standards of 1977.

Descriptive statistics were done on each variable to identify outliers and assess the normal distribution of continuous variables.

Outliers were defined from the box plot as values more extreme than three-interquatile range of the box. In the presence of outliers, a new variable was created excluding these values. However, in case of doubt, the dataset was cross-checked with original data in the rosters. All tests were done first with the original variable, and then redone with the new variable to assess influence of such outliers. Normal distribution of continuous variables was appraised by a Kolmogorov Smirnoff test. In case of severe departure from normality, the variables were log-transformed.

The α error was set at 5 % in all tests. The strategy of data analysis was set in two steps. First, a difference at twelve months of age between the two intervention groups was assessed for each primary outcome. These primary outcomes were mean zinc protoporphyrin and mean haemoglobin. Differences in anthropometric indicators, *i.e.* mean weight-for-length Z score and length-for-age Z score at twelve months of age were also looked at. A standard t-test was used for continuous variables, and a chi square test for categorical ones. Likewise, the general trend in main outcomes, between the beginning and the end of the trial, was assessed by applying a paired t-test or a McNemar test for categorical variables.

Secondly, a logistic regression analysis was applied using the EVW model (KLEINBAUM 1994). Continuous variables were transformed in categorical ones as indicated below. The dependent variables were: *i)* high zinc protoporphyrin at twelve months of age (ZP > 5 $\mu g\ g^{-1}$ Hb, coded 0/1) for the first set of models; *ii)* anaemia (Hb < 110 $g.L^{-1}$, coded 0/1) for the second set of models; *iii)* length-for-age Z score (LAZ < –2 SD, coded 0/1) for the third set of models [1]*.

The exposure variable was the type of CF received. The following covariates were inserted in the initial model because they were potential confounding factors or effect modifiers (biological or environmental): *i)* child parameters: zinc protoporphyrin > 5 $\mu g\ g^{-1}$ Hb at baseline (0 = no, 1 = yes), Hb < 110 $g.L^{-1}$ at baseline (0 = no, 1 = yes), blood smear positive for malaria at age nine months (0 = no, 1 = yes), birth weight < 2,500 g (0 = no, 1 = yes), length-for-age < –2 Z score at baseline (0 = no, 1 = yes), sex (0 = girl, 1 = boy), season at entry in the study (0 = harvest season, 1 = other season); *ii)* mother's parameters: mother's education lower than primary school (0 = no, 1 = yes), mother living alone (0 = no, 1 = yes), mother's age < 20 years (0 = no, 1 = yes), parity ≥ 3 (0 = no, 1 = yes), BMI (0 = more or equal to 18.5, 1 = under 18.5), income lower than 10,000 shillings (0 = no, 1 = yes).

All covariates were considered as potential effect modifiers and introduced in the initial model as product terms involving E (exposure to processed food). The presence of multicolinearity and other numerical problems in regression analyses was appraised by verifying the presence of high estimated standard errors for the regression estimates (HOSMER & LEMESHOW 1989). Then a hierarchical backwards elimination procedure was applied to eliminate non-significant variables.

Removal of variables was at $p > 0.05$ for the likelihood ratio test. First effect modifications were tested using a likelihood ratio test for the entire

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* The number between brackets [ ] refers to the note, p. 92.

collection of interactions term (KLEINBAUM 1994). Then variables were removed one by one according to the likelihood ratio test. The model including the remaining covariates was considered the gold standard. Then confounding was assessed by monitoring changes in the effect measure (odds ratio) for subsets of covariates. The subset of covariates included in the final model was the one allowing the best gain in precision.

Results

SUBJECTS AND COMPLIANCE

Of the 364 children randomized, 309 presented themselves for participation in the trial. 157 children started in the intervention group and 152 in the control group. At the end of the trial the respective groups had 133 and 125 participants (fig. 1). The drop-out rate did not differ significantly between the two groups.

A total of 60 infants from the intervention group and 58 from the control group did not have sufficient hair for analysis at baseline. At twelve months, 137 infants were able to provide hair samples of whom 71 were from the intervention group and 66 from the control group.

To check for compliance, nutrition officers from the centre followed up the mothers in their homestead to make sure the CF was prepared in the correct way. Compliance was regarded good if the mother collected the CF, correctly prepared and consumed it according to instructions. Surprise visits to the home were made once or twice a week. However, we were not able to monitor full compliance in the strict sense.

BASELINE CHARACTERISTICS

The characteristics of infants, mothers and household variables in both groups were similar at enrolment of the infants, aged six months (tab. 1) with the exception of WLZ (weight-for-length Z score). Mothers education ($p = 0.11$), marital status ($p = 0.36$) and family income ($p = 0.43$) was not significantly different between the intervention and control group (χ^2 test).

NUTRITIONAL CHARACTERISTICS OF THE COMPLEMENTARY FOOD

The random samples from each month's CF production unit and traditional CF had an energy, fat and protein content, which was not significantly different (tab. 2). However, the porridge prepared with the processed CF had a higher energy density, significantly higher iron and zinc solubilities and a

Table 1
Baseline characteristics

Variables	Processed food (157)	Placebo (152)	P-value
	Mean[1]	Mean[1]	
Birth weight (kg)[2]	2.9 ± 0.5	3.1 ± 0.5	0.06
Weight (kg)	6.7± 1.0	6.9 ± 1.0	0.93
Length (cm)	62.7± 3.1	62.8 ± 3.1	0.06
Haemoglobin concentration ($g.L^{-1}$)	91.4 ± 1.9	94.4 ± 21	0.27
Zinc protoporphyrin ($\mu gZP\ g^{-1}$ Hb)	9.9 ± 6.1	9.9 ± 5.8	0.97
Hair zinc concentration ($\mu g\ g^{-1}$)	250.6 ± 102.0	277.0 ± 112.5	0.05
WLZ[3]	0.45 ± 1.24	0.72 ± 1.14	0.04
LAZ[4]	− 1.53 ± 1.16	− 1.54 ± 1.11	0.96
Household size (persons)	5.8 ± 2.3	5.4 ± 2.1	0.11
Maternal Body Mass Index ($kg\ m^{-2}$)	21.9 ± 2.5	21.9 ± 2.7	0.96
Live children (persons)	2.7 ± 1.9	2.7 ± 1.8	0.86
Mother age (years)	25.6 ± 7.0	25.3 ± 6.6	0.63
Maternal parity (No. of births)	3.4 ± 2.3	3.3 ± 2.1	0.63
Sex ratio of infants (male:female)	1.01	0.95	

[1] Mean ± SD. No significant differences between the groups.
[2] Based on 280 infants, 29 infants were home deliveries.
[3] WLZ: weight-for-length Z score.
[4] LAZ: length-for-age Z score.

Table 2
Composition of the field complementary food

Parameter	Complementary food[1]		P-value
	Processed	Non-processed	
Energy (kJ/100 g DM)[2]	1731 ± 11	1731 ± 18	0.89
Protein (g/100 g DM)	12.87 ± 0.57	12.64 ± 0.56	0.33
Fat (g/100 g DM)	4.64 ± 0.52	5.08 ± 0.74	0.11
Ash (g/100 g DM)	2.38 ± 0.08	2.88 ± 0.4	0.001
Zinc (mg/100g DM)	2.52 ± .0.09	2.40 ± 0.08	0.01
Total iron (mg/100 g DM)	4.74 ± 0.41	5.89 ± 0.87	0.0002
Energy density of porridge (kJ/ml)	6.1	1.7	–
Soluble iron (%)	18.83 ± 0.72	4.76 ± 0.80	0.0001
Soluble zinc (%)	6.24 ± 2.47	2.74 ± 1.49	0.0028
Solids % (w/v) in pap at optimum viscosity	35	10	–
Phytates (% DM)	0.66 ± 0.02	1.15 ± 0.03	0.04

[1] Mean ± SD of 12 production batches.
[2] DM: Dry Matter.

lower concentration of phytates when compared to the porridge prepared with the non-processed CF. There was a small but significant reduction in total iron content in the processed CF compared to the non-processed CF probably due to leaching in the course of processing the CF (WATZKE 1998). This disadvantage was counterbalanced by the higher amount of soluble iron in the processed CF compared with non-processed CF (18.83 % versus 4.76 %), respectively.

Food consumption data from the 24 h dietary recall showed no significant difference in daily energy intake, proteins, lipids, and iron intake from the processed and non-processed CF between the two groups of children (tab. 3). The mean number of meals was, however, considerably higher in the non-processed group. The energy intake from the project CF was 1,752 kJ and 1,679 kJ in the processed and non-processed CF groups. This was increased to 1,922 kJ and 1,943 kJ in both groups, respectively due to the addition of oil. Overall the project complementary food contributed more than 50% of the total daily energy intake. The energy intake from CF exceeded the WHO recommendations. Other foods consisted of plain maize flour porridge, porridge made from family food, mixture of maize, rice, peanuts and finger millet flour and milk. Only two children received fruits (banana or mango). Other foods and breast milk contributed substantially in total daily energy, lipids and protein. Using a conservative approach and taking a low minimal breast milk contribution, the estimated total energy intake in comparison with the recommended daily energy requirements was on average 96 % and 107 % for infants six-eight months and 106 % and 103 % for infants nine-eleven months respectively (tab. 3).

Effect of Complementary Food on Growth

No differences could be observed between the groups at twelve months of age (tab. 4). The differences in weight gain were not significant between the two groups with an increase of 1.4 ± 0.6 kg versus 1.3 ± 0.7 kg for the supplemented and placebo group respectively ($p < 0.001$). Likewise, mean weight-for-length and length-for-age Z scores did not differ significantly between the two groups ($p = 0.12$ and $p = 0.78$ respectively). Length-for-age Z scores dropped from age six to twelve months in both groups from -1.60 Z score to -2.06 ($p < 0.001$). A similar trend was observed in weight-for-length, which declined from $+0.57$ to -0.17 ($p < 0.0001$).

Effect of Complementary Food on Haemoglobin and Zinc Protoporphyrin

Concentrations of Hb and ZP were not significantly different between groups at twelve months of age (tab. 4). Although both groups significantly

Table 3
Twenty-four hour dietary recall of six to twelve months old infants[1] receiving processed and non-processed (placebo) complementary food

Mean daily intake	Infants receiving processed food (n = 71)	Infants receiving placebo (n = 66)	P-value
Total energy intake ($kJ.d^{-1}$)[1]	3,427 ± 915	3,426 ± 784	0.99
6-8 months infants % recommended energy intake[1,2]	95.7 ± 26.0	105.9 ± 22.7	0.20
9-12 months infants % recommended energy intake[1,2]	106.7 ± 24.0	103.4 ± 22.5	0.49
Energy from project CF + oil ($kJ.d^{-1}$) [1]	1,922 ± 793	1,943 ± 691	0.47
Energy from other CFs ($kJ.d^{-1}$) [1]	657 ± 333	636 ± 345	0.49
Total proteins (g) [1]	18.3 ± 6.3	17.9 ± 5.5	0.68
Total fats (g) [1]	29.9 ± 7.2	31.3 ± 6.4	0.24
Total iron intake (mg)	68 ± 2.7	65 ± 2.4	0.55
Total zinc intake (mg)	3.3 ± 0.12	2.9 ± 0.8	0.31
Frequency of meals day^{-1}	1-2	5-6	

[1] Mean ± SD.
[2] Based on minimum milk production by women in developing countries (4).

Table 4
Comparison of haemoglobin (Hb), zinc protoporphyrin (ZP), WLZ and LAZ of infants at twelve months of age by intervention group

Variables at age 12	Processed[1] (n = 133)	Placebo[1] (n = 125)	Mean difference	T test p-value	Overall[1] (n = 258)	T test[3] p-value
Hb ($g.L^{-1}$)[1]	96.6 ± 17.4	96.5 ± 16.2	0.1	0.96	–	–
ZP ($\mu g\ g^{-1}$ Hb) [1,2]	5.8 ± 3.5	6.2 ± 3.1	0.4	0.34	–	–
WLZ[1,2]	– 0.27 ± 0.97	– 0.07 ± 0.98	0.19	0.12	–	–
LAZ[1]	– 2.08 ± 1.02	– 2.04 ± 1.07	0.04	0.78	–	–
Changes between age 6 and age 12						
Change Hb ($g.L^{-1}$) [1]	4.8 ± 1.8	1.5 ± 2.0	3.3	0.19	3.2 ± 1.3	0.014
Change of ZP ($\mu g\ g^{-1}$ Hb) [1,2]	– 4.4 ± 0.5	– 3.6 ± 0.5	0.77	0.39	– 4.0 ± 0.4	< 0.0001
Change in WLZ[1]	– 0.67 ± 0.10	– 0.81 ± 0.10	0.14	0.31	– 0.74 ± 0.07	< 0.0001
Change in LAZ[1,2]	– 0.50 ± 0.06	– 0.42 ± 0.07	0.08	0.40	– 0.46 ± 0.05	< 0.0001

[1] Mean ± SD.
[2] t-test applied on zero-skewness log-transformed variables.
[3] Comparing values at age 12 with values at age 6 (baseline) by a paired-t test.

increased in Hb and decreased in ZP from six months to twelve months of age ($p < 0.014$ and $p < 0.0001$ respectively) the difference in both groups from six to twelve months was not significant (p for Hb change = 0.19 and 0.39 for ZP). The majority of infants (76 %) were still anaemic according to WHO standards at the end of the study. ZP declined significantly from a mean of 10.1 $\mu g\ g^{-1}$ Hb at the age of six months to a 6.0 $\mu g\ g^{-1}$ Hb at the age of twelve months ($p < 0.001$), but without differences in the two groups.

No significant interaction between covariates and the type of CF was detected (likelihood ratio test for set 1, p-value 0.20, likelihood ratio test for set 2, p-value 0.11, likelihood ratio test for set 3, p-value 0.11) with the logistic regression.

Effects of Complementary Food on Zinc Status

There was no significant change in hair zinc concentration from six months to twelve months of age in the processed CF group ($P = 0.53$), whereas in the unprocessed CF there was a slight significant decrease in hair zinc concentration ($p = 0.03$) (tab. 5). However, there was no significant difference in hair zinc concentration between the two groups.

Association of Zn Status with Growth

Hair zinc status was positively correlated with the length-for-age Z score (LAZ) and the weight-for-age Z score (WAZ) in both groups. However, the correlation coefficients were not statistically significant ($p > 0.05$) (tab. 6).

Discussion

The results show that the processed food was not superior with regard to improving growth, haemoglobin, and iron and zinc status of infants when given under the study conditions. Weight gain was not significantly different between the two groups, and stunting increased. The control group consumed equal amounts of macronutrients, and the higher energy density, in this study, did not seem to have any benefits. In our study there was a very intensive follow-up, with at every encounter, an intensive motivation of mothers to give the required amounts and add extra lipids. In those conditions a well-balanced complementary food with additional lipids can cover the energy needs of young children. Both groups were comparable in energy intake from complementary foods. Age specific energy and protein intake from CF was

Table 5
Mean (± SD) hair Zn concentration (μg/g) at baseline and end of the study

Timing	Intervention (n = 71)	Control (n = 66)
Baseline (6 months)	250.6 ± 102.0	277.0 ± 112.5
End of study (12 months)	241.8 ± 107.5	246.9 ± 119.8
P-value	0.53	0.03

Table 6
Correlation coefficients of hair zinc and anthropometric indices

	Processed CF		Unprocessed CF	
	Correlation	P-value	Correlation	P-value
LAZ	0.092	0.47	0.038	0.79
WAZ	0.037	0.77	0.013	0.92

according to WHO recommendations. The complementary food intake was higher during the study, compared with information obtained from a baseline study, where in the six-eight and nine-eleven age group complementary foods only covered 81 and 75 % of the recommended energy that complementary foods should provide.

We cannot exclude, however, that in less supportive conditions the energy-denser food would yield different results. Indirect evidence for this can be found in the considerable higher feeding frequency in the non-processed food. Two meals suffice to provide the necessary amount of complementary food, compared to five-six meals in the non-processed one. We introduced a bias in the study by emphasizing continuously the amount of CF to be eaten per day. In settings where time constraints of mothers limit feeding frequency, differences in total intake can be expected. The study has also certain limits: we cannot exclude with certainty that food was shared. However, there are other studies that also documented negative results. In Ghana, the effects of feeding "Weanimix" and three other locally formulated, centrally processed CFs, on nutritional status of breastfed infants (six-twelve months of age), found no significant differences between intervention groups in weight or length gain, haemoglobin and hematocrit values (LARTEY *et al.* 1999).

STEVENS & NELSON (1995) investigating the effect of feeding six months old infants a milk formula with no iron against one with 12.0 mg $Fe.L^{-1}$ for

twelve months, found no differences with respect to mean haemoglobin, ferritin concentrations and growth between the two groups of infants. Furthermore, a multicountry study, investigating the effect of supplementation with high energy density CF fortified with minerals and vitamins, on weight and linear growth of four-seven months old infants in four developing countries, found no significant difference in overall linear growth, although there was an effect of the micronutrients in stunted children but not in non-stunted children (SIMONDON *et al.* 1996).

Some studies did find a difference but they differed in a number of important aspects. In the study of CHINAMMA & GOLPALDAS (1993) two groups of children aged six – twenty-four months were either fed a high-energy low viscosity complementary food or a high-energy high viscosity one for six months. The former group increased significantly in weight and length over the latter. The difference of this study with ours is that the children were restricted to one experimental meal per day although they were allowed to eat *ad libitum* in that single meal. In a sense therefore one group was getting less experimental food than the other per day. In our study the mothers were encouraged to feed their infants the entire daily-allocated CF amount, which means they could have increased the feeding frequency up to five-six times a day.

Stunting is a very complex multicausal problem, and it is probable that other nutrients were limiting, or that the local conditions did not allow reversal of the trend or stabilization. Similar trends were observed by MARTORELL *et al.* (1998), whereby 25 % of infants at baseline (four months old) were already stunted, presumably due to intrauterine growth retardation (IUGR). They concluded that infants who experience IUGR usually never completely catch up in size to their normal birth weight peers even when raised under optimal conditions. Similar observations were made in Indonesia (MSUYA & CURTIS 1991, HURRELL 1992).

Despite an overall significant rise in mean haemoglobin, a large proportion of infants were still anaemic at the end of the study, even when low birth weight was controlled in the analysis. An important cause of anaemia is definitely malaria in the present population. At six months we found malaria parasites in 50 % of the samples. The Hb concentration was 1.29 $g.L^{-1}$ lower at month twelve in children with a positive blood smear at month six and month twelve (t-test $p < 0.0001$), while ZP concentration was 1.84 $\mu g\ g^{-1}$ Hb higher (t-test $p < 0.0001$). Mortality in the study population was also very high with nineteen deaths among the 309 (61 per thousand) supplemented children. Failure to restore haemoglobin concentrations to normal could be explained by the continuous malaria re-infection among infants despite the

treatment given when they fell sick. MSUYA & CURTIS (1991) indeed showed that in Tanzania, almost all children became re-infected within two to four weeks after effective malaria parasite clearance with sulphadoxine (Fansidar).

Iron status, as defined by erythrocyte zinc protoporphyrin, was not significantly different between the processed and non-processed feeding groups, although iron status improved in general. This was rather unexpected since both groups consumed equal amounts of complementary food and the laboratory results showed an important increase in solubility, a parameter commonly used as a proxy for bioavailability. The iron content in both processed and non-processed complementary food was low while a minimal bioavailability of 10 % is needed in them to provide the recommended daily amount of 0.6-0.7 mg absorbed iron. The observed reduction of phytates in the processed CF by 34 %, which improved iron solubility to 19%, might not have been enough to make a clinical difference. For bioavailability to improve with metabolic significance, HURRELL (1992) postulated that phytates need to be reduced by more than 95 %. Finally, infants might have covered their basic iron needs, but the food content was not adequate enough to show any significant increase with regard to covering their needs and allowing for recovery from iron deficiency (DOMELLOF 2001).

Hair zinc levels were not significantly different between the two groups after intervention, although the processed CF had improved zinc solubility (tab. 2). Moreover, the intake of Zn by the infants in both groups was found to be less than the adequate amount for normative physiological requirement of 5 mg/day (WHO 1998) (tab. 3). Probably the infants had a reduced demand for Zn compared to health children with positive linear growth, because of their small body size and possibly greater intestinal stores of endogenous Zn (LEE *et al.* 1993, YEUNDALL *et al.* 2002). The latter may have arisen as a result of an adaptation to the low content of absorbable Zn in their habitual high phytate cereal-based CF.

The correlation between hair zinc and both LAZ and WLZ for infants in both groups was not significant ($p > 0.05$). This is in contrast to a study by UMETA *et al.* (2000) who found a strong positive correlation between hair zinc concentration and growth in stunted Ethiopian infants. The difference between that study and our study is that they used zinc supplementation and not dietary modification, and that Zn was the primary growth limiting nutrient in the infants' diet. These findings emphasize that only in circumstances when Zn is the first limiting nutrient can significant relationship between hair Zn concentration and physiological functional indices of Zn status such as linear growth be expected (CAVAN *et al.* 1993, UMETA *et al.* 2000).

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NOTE

[1] Weight-for-height indicator was not considered as 99 % of the children were in the normal range (mean ± standard deviations).

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Le projet MISAME. Prévention du retard de croissance intra-utérine dans le district de Houndé, Burkina Faso

par

Hermann LANOU[1], Dominique ROBERFROID[2], Jean-Pascal KI[1], Virginie KOUDOGBO[1], Drissa SIA[1],[3], Marie-Claire HENRY[1],[4], Nicolas MEDA[1], Pascal KORGO[5], Isabelle SIOEN[6], Céline TERMOTE[6] & Patrick KOLSTEREN[2],[6]

KEYWORDS. — RCIU; Micronutrients; Pregnancy; Infant; LBW; Morbidity.

SUMMARY. — Intrauterine Growth Retardation (IUGR) is the most important determinant of mortality and morbidity in the neonatal period. It is also a very important factor in predicting nutritional status, health and development in childhood. It even influences health in adult life, contributing to the vicious cycle of disease and poverty. The high rate of IUGR in developing countries represents therefore a major public health problem. Matemal malnutrition and malaria during pregnancy are usually assumed to be major determinants of the problem. In Houndé district, 17 % of hospital deliveries are low birth weight (LBW). Anaemia during pregnancy is highly prevalent, general diet is of poor quality and malaria transmission is perennial. Therefore, it is expected that covering needs of pregnant women by a multivitamin-mineral supplement and providing effective malaria prevention will have an effect of public health importance on children's health.

The overall objective is to study ways to improve children's health by preventing IUGR through the provision of an improved package of prenatal care in Houndé medical district, Burkina Faso. The package includes multivitamin-mineral supplements and intermittent preventive treatment by sulfadoxine-pyrimethamine.

This research includes two constituents:

— An exploratory phase during which socio-anthropological, nutritional and epidemiological aspects of IUGR are assessed through qualitative and epidemiological methods.

[1] Projet MISAME, Centre Muraz, Bobo-Dioulasso (Burkina Faso).
[2] Projet MISAME, Institut de Médecine Tropicale, Anvers (Belgique).
[3] Institut de Recherches en Sciences de la Santé, Ouagadougou (Burkina Faso).
[4] Ministère Français des Affaires Etrangères, Paris (France).
[5] District Sanitaire de Houndé (Burkina Faso).
[6] Université de Gand (Belgique).

— A double-blind randomized controlled trial (RCT) including 1,200 women. This is a 2×2 factorial trial where each pregnant woman is allocated to receive:
  – Iron (60 mg) and folic acid (400 mcg) versus UNMMAPP (a mix of 15 micronutrients recommended by UNICEF);
  – Weekly chloroquine (300 mg) versus sulfadoxine-pyrimethamine (500 mg ×3, once in trimester 2&3).

Efforts are made to detect pregnancy as early as possible through a network of home visitors (monthly visits of 3,000 women 15-45 years). The UNMMAPP tablets are taken daily under direct supervision of home visitors. Newborns are followed up until their first birthday. Main outcomes are: newborn and infant anthropometry and morbidity/mortality; IGF-I and haemoglobin at birth, age 6 and 12 months; maternal anthropometry; haemoglobin and serum Transferrin receptors (sTfR) at 20 and 32 weeks of pregnancy.

The main findings of the exploratory phase are presented in the text. The RCT is on the trail. The randomization process began in March 2004. So far, 417 pregnant women have been included. Nearly 25 % of pregnancies are detected during the first trimester. 90 % of tablets are effectively taken. Results on pregnancy outcomes are expected by end 2006.

In conclusion, the MISAME project will yield important information on how to alleviate the IUGR burden in developing countries. It is also a strategy to reinforce research capacities in Burkina Faso.

1. Introduction

Le Retard de Croissance Intra-Utérine (RCIU) constitue un important facteur de mortalité et de morbidité dans la période néonatale (Ashworth 1998, Bakketeig 1998, McCormick 1985). C'est aussi un important prédicteur du statut nutritionnel, de la santé et du développement pendant l'enfance. Il influence même la santé à l'âge adulte, contribuant ainsi à perpétuer le cercle vicieux de la maladie et de la pauvreté. Les statistiques sur le RCIU sont parcellaires mais le poids de naissance est une mesure approchante souvent utilisée parce que dans les pays en voie de développement, la grande majorité des nouveau-nés avec un petit poids de naissance (PPN < 2 500 g) est due au RCIU (Villar & Belizan 1982). Cet important problème de santé est extrêmement répandu. Pas moins de 16 % de toutes les naissances vivantes dans le monde souffrent de RCIU, et plus de 90 % des cas de RCIU sont dans les pays pauvres (de Onis *et al.* 1998). Les taux sont particulièrement élevés en Asie et en Afrique subsaharienne (Pojda & Kelley 2000). Au Burkina Faso, la prévalence du PPN est estimée à 17-21 % de toutes les naissances.

Il est donc attendu que des interventions efficaces dans la prévention du RCIU auront un effet important de santé publique sur la croissance et la santé

des enfants, avec des effets potentiels à long terme sur la santé des adultes et le développement socio-économique (HUFFMAN *et al.* 1998). Les facteurs influençant le développement fœtal sont nombreux (KRAMER 1987, PRADA & TSANG 1998). Parmi ceux-ci, la malnutrition maternelle, et en particulier les carences en micronutriments, et la malaria pendant la grossesse sont considérées comme les facteurs les plus importants dans les pays en voie de développement.

De fait, un nombre croissant d'informations scientifiques pointe vers le rôle potentiel joué par les carences en micronutriments pendant la grossesse. L'effet négatif de l'anémie ferriprive, de la carence en zinc et en iode sur le poids de naissance a été bien démontré (RAMAKRISHAM *et al.* 1999). Il existe par ailleurs des arguments sérieux pour penser qu'un supplément en zinc, en calcium et en magnésium pourrait améliorer le poids de naissance (RAMAKRISHAM *et al.* 1999). Un effet similaire est suspecté pour la vitamine A, les vitamines B, le cuivre et le sélénium. Qui plus est, les femmes enceintes dans les pays en voie de développement souffrent souvent de carences multiples et sévères. Il est dès lors attendu que la couverture de tous les besoins en micronutriments de ces femmes aura un impact de santé publique sur la croissance et la santé des nouveau-nés. Sur base de ces éléments, l'UNICEF a proposé de tester l'utilisation de comprimés contenant la quantité journalière recommandée pour quinze micronutriments. Ce projet de recherche s'inscrit donc dans une vaste initiative internationale promue par l'OMS et l'UNICEF. Au Burkina Faso, il répond également à un des objectifs prioritaires définis dans le Plan d'Action National pour la Nutrition (PNAN, août 2001). La réduction de la malnutrition dans les groupes vulnérables est en effet un objectif du PNAN, et un des indicateurs choisis pour vérifier la réalisation de cet objectif est la réduction de 50 % de la prévalence du retard de croissance d'ici à 2010. Parmi les stratégies proposées figurent le renforcement du système d'approvisionnement en micronutriments et l'amélioration de l'offre de soins intégrés de santé.

La malaria pendant la grossesse est aussi un déterminant crucial du RCIU. Elle augmente le risque de PPN, de mortalité infantile et de morbidité pendant la première année de vie en provoquant le retard de croissance, la prématurité et l'anémie chez l'enfant (MENENDEZ *et al.* 2000, NOSTEN *et al.* 1994). L'anémie durant la grossesse, dont la malaria est une importante cause dans les pays en voie de développement (BRABIN *et al.* 1990), est aussi associée au PPN (BRABIN 1991). L'administration d'un médicament antimalarique efficace pendant la grossesse a un effet bénéfique sur la santé de la mère et de l'enfant en prévenant l'infection palustre et ses conséquences. Les *primi-and-secundi* gestes, «première et seconde grossesses», représentent le groupe qui

bénéficie le plus d'un tel traitement. Il y a dès lors la nécessité de mesurer le bénéfice relatif d'introduire le traitement préventif intermittent (TPI) avec la sulfadoxine-pyriméthamine (SP) dans un pays promouvant encore l'usage de la chloroquine hebdomadaire et où le niveau de chloroquino-résistance dans certaines régions peut être élevé, et de trouver des moyens pour améliorer la couverture et l'adhérence.

La malaria et la malnutrition combinent leurs effets délétères sur la croissance fœtale. Par exemple, les micronutriments jouent un rôle essentiel dans le fonctionnement du système immunitaire, et leurs déficiences influencent la fréquence, la durée et la sévérité des infections (ALLEN 2001). Il est donc difficile d'obtenir des résultats probants sur la santé en testant une intervention unique à la fois dans des pays où la malaria et d'autres parasites, la malnutrition et l'anémie coexistent. Pour réduire un phénomène multicausal tel le RCIU, des combinaisons appropriées d'interventions doivent être évaluées (DE ONIS *et al.* 1998, POJDA & KELLEY 2000).

2. Objectifs du projet MISAME

MISAME (**Mi**cronutriments et **Sa**nté de la **M**ère et de l'**E**nfant) est un projet de recherche conjoint de l'IMT-Anvers et du Centre Muraz (Burkina Faso).

Son objectif principal vise à améliorer l'état de santé des enfants en prévenant le retard de croissance intra-utérine par la fourniture d'un paquet de soins prénatals amélioré.

Ses objectifs spécifiques sont de:

— Tester l'effet bénéfique des suppléments de multi-micronutriments (UNMMAPP) pendant la grossesse sur la croissance fœtale. Il est attendu que cet effet augmentera lorsque les suppléments sont donnés dès les premières semaines de la grossesse.
— Déterminer l'incidence de l'infection palustre chez les femmes enceintes suivant deux stratégies préventives différentes (prophylaxie hebdomadaire par la chloroquine *versus* traitement intermittent par la SP) et ses conséquences sur la croissance fœtale.
— Investiguer la diminution de la mortalité, de la morbidité et du retard de croissance chez les enfants lorsque la croissance fœtale est améliorée.
— Etudier l'effet des suppléments de multi-micronutriments pendant l'allaitement sur la mortalité, la morbidité et la croissance, particulièrement chez les enfants nés avec un retard de croissance intra-utérine.

3. Méthode et cadre de la recherche

3.1. Phase exploratoire

La méthodologie suivie est multidisciplinaire, associant des investigations de type qualitatif (modèle causal, interviews semi-dirigées) et quantitatif (enquêtes de santé, enquêtes nutritionnelles et de consommation alimentaire, enquête de sécurité alimentaire).

— Enquêtes de consommation alimentaire: en octobre 2002 et en juillet-septembre 2003, deux enquêtes de consommation alimentaire ont été réalisées auprès d'un échantillon non probabiliste de femmes enceintes de la zone (n1 = 40, n2 = 72), suivant la méthodologie de la pesée des ingérés (enquête 1) et du rappel de vingt-quatre heures (enquêtes 1 et 2) (Biro *et al.* 2002, Gibson & Ferguson 2002). Au cours de la seconde enquête de consommation alimentaire, une évaluation de la charge physique des femmes enceintes a été réalisée.
— Elaboration d'un modèle causal (Tonglet *et al.* 1992, Wilson 1989). Un atelier a été organisé à Houndé, au mois de juin 2003, pour appréhender en profondeur les facteurs déterminant la sous-nutrition des femmes enceintes au niveau régional, ainsi que pour envisager, dans une approche multisectorielle, les stratégies possibles afin de réduire l'ampleur du problème. Cet atelier a rassemblé des représentants des différents segments de la société potentiellement engagés dans la compréhension et/ou la prise en charge du problème. La méthodologie suivie est celle présentée dans «A guide to Nutritional assessment» (Beghin *et al.* 1988).
— Enquête d'incidence du IUGR à l'hôpital de Houndé. Les données de routine 2000-2001 de la salle d'accouchement ont été collectées à partir des registres de la maternité du CMA de Houndé. Les données concernant 1 870 nouveau-nés ont été entrées dans EpiInfo 6.0 et analysées dans Stata 7.
— Enquête de sécurité alimentaire: réalisée en concomitance avec l'enquête de consommation alimentaire de 2002, auprès de quarante ménages de femmes enceintes. Un questionnaire concernant la production et la gestion alimentaire a été soumis séparément à la femme enceinte et à son conjoint.
— Enquête par interviews semi-dirigées à propos des croyances, attitudes et pratiques en rapport avec l'alimentation des femmes enceintes. L'interview a été menée en langue locale (bwamu et mooré) auprès de quarante femmes enceintes par deux sociologues burkinabés. Les maris ont à leur tour été interviewés (de façon séparée). Tous les entretiens ont été enregistrés, traduits en français (par les interviewers eux-mêmes) et transcrits.

Tableau 1

Procédures MISAME pendant la grossesse, l'accouchement et la première année de vie*

Niveau services de santé

		CPN1		CPN2		CPN3		ACC.		6 mois		12 mois
Test de grossesse		X										
Recueil consentement éclairé		X										
Randomisation		X						X				
Examen clinique (+ CN, + goitre)		X		X		X		X		X		X
Anthropométrie mère (poids, taille, PB)		X		X		X		X				
Biométrie fœtale (8-12, 28-32)			X		X							
Anthropométrie enfant** (poids, taille, PB, PC, PT)								X	X	X	X	X
Goutte épaisse + confetti PCR systématique		X***						X				
Mesure hémoglobine		X				X		X		X		X
Collecte sang papier filtre (IGF-I, RsT)		X				X		X		X		X
Collecte urine		X						X				
Collecte sang cordon								X				
Biopsie et apposition placentaire								X				
Déparasitage				X		X						
Traitement chloroquine****												

* CPN 1: 8-12; CPN 2: 18-22; CPN 3: 28-32.
** Une fois par mois.
*** Dans groupe chloroquine uniquement.
**** Dans groupe chloroquine uniquement.

Traitement pathologies		X		X		X		X		X		X
Consommation alimentaire				X		X				X		
Mesure morbidité/effets secondaires				X		X				X		X

Niveau domiciliaire

		CPN1		**CPN2**		**CPN3**		**ACC.**		**6 mois**		**12 mois**
Recensement	X											
Sensibilisation	X		X		X		X		X		X	
Référence vers CSPS/CMA si signes d'alerte			X		X		X		X			
Supplémentation micronutriments			X	X	X	X	X	X	X *			
Prophylaxie paludisme chloroquine			X	X	X	X	X	X	X **			
Prophylaxie paludisme Fansidar			X		X							
Traitement présomptif quinine si paludisme suspecté				X	X	X	X	X	X			
Goutte épaisse + confetti PCR si paludisme suspecté			X	X	X	X	X	X	X			
Goutte épaisse + confetti PCR systématique***			X									
Autopsie verbale ****			X		X		X		X	X	X	X
Enquête causes abandon *****			X		X		X					

* Jusqu'à trois mois après l'accouchement.
** Jusqu'à six semaines post-accouchement.
*** Uniquement dans groupe Fansidar.
**** Réalisée par médecins MISAME.
**** Réalisée par sociologues MISAME.

Les données ont été transférées dans NUDIST 4.0, et analysées en recourant à l'analyse thématique (MILES & HUBERMAN 1994, PATTON 1990).

3.2. ESSAI RANDOMISE

La recherche repose sur la réalisation d'une étude randomisée en double aveugle, avec contrôle placebo, incluant 1 200 nouveau-nés dont la mère aura reçu pendant la grossesse une supplémentation quotidienne en micronutriments (multi-micronutriments UNMMAPP ***contre*** 60 mg fer + 400 µg acide folique) et une prévention antipalustre (prophylaxie hebdomadaire à la chloroquine, 300 mg, ***contre*** traitement intermittent sulfadoxine-pyriméthamine, 3 × 500 mg aux trimestres deux et trois de la grossesse). Les mères sont à nouveau randomisées à l'accouchement (multi-micronutriments UNMMAPP ***contre*** 60 mg fer + 400 µg acide folique pour une durée de trois mois). Un réseau de visiteuses à domicile (accompagnantes) assurent la détection précoce des grossesses et la supervision directe de la prise des médicaments pendant la grossesse (jusqu'à trois mois post-partum). Les enfants sont suivis jusqu'à l'âge de douze mois. Des paramètres anthropométriques, biologiques, de morbidité, et la mortalité sont enregistrés. Le tableau 1 ci-devant résume les activités et les paramètres pour chaque couple mère-enfant.

La recherche se déroule dans le district sanitaire de Houndé, dans le sud-ouest du Burkina Faso, en pleine collaboration avec les services de santé. Le projet a démarré en septembre 2002. L'inclusion des femmes enceintes se terminera en décembre 2005. Les résultats concernant la croissance fœtale et la santé néonatale seront disponibles en décembre 2006, et les résultats finaux en décembre 2007.

4. Etat d'avancement et résultats préliminaires

4.1. ETAT D'AVANCEMENT

Une équipe administrative (secrétaire, logisticien, *data manager*) et scientifique (trois médecins, deux sociologues) et une équipe de visiteuses à domicile (quinze accompagnantes) au niveau des différents quartiers de Houndé ont été constituées. Neuf cent vingt-neuf habitations ont été cartographiées et trois mille femmes de 15-45 ans recensées et suivies mensuellement.

La randomisation et le suivi des femmes enceintes/allaitantes ont débuté en avril 2004. Actuellement, quatre cent dix-sept femmes participent à l'étude. 22 % (34/153 en juillet-août) des grossesses sont détectées pendant le premier trimestre. La proportion de prises médicamenteuses directement observées

est supérieure à 90 %. Près de 70 % des nouveau-nés naissent au centre de santé et sont pesés et mesurés immédiatement après l'accouchement. A peu près la moitié des enfants nés à domicile sont présentés au centre de santé dans les vingt-quatre heures suivant l'accouchement.

4.2. Resultats preliminaires

4.2.1. *Consommation alimentaire*

4.2.1.1. Quantité insuffisante de la ration calorique

L'évaluation de la consommation alimentaire des femmes enceintes a montré que l'apport énergétique moyen était de 7,041 MJ (± 3,3554) (voir tab. 2). Or les besoins énergétiques moyens théoriques pour cet échantillon de femmes est de 10,497 MJ (± 0.582) [1]*. Il y a donc un déficit clair de l'apport énergétique. Les rappels de vingt-quatre heures comme la méthode de pesée montrent que 50 % des femmes enceintes mangent moins de 1 355 kcal/jour (24 h-recall) ou moins de 1 528 kcal/jour (pesée). Cet apport énergétique repose essentiellement sur les hydrates de carbone (73 ± 10 %). Pour 59 % des femmes examinées, au moins trois quarts de l'énergie alimentaire viennent des hydrates de carbone. La consommation de graisses est très faible, ne représentant en moyenne pas plus de 16 ± 8 % des apports énergétiques.

La quantité sous-optimale de l'apport alimentaire a bien sûr aussi des répercussions sur les autres nutriments, en particulier les micronutriments. La vitamine B12 (2,6 µg par jour, 7 % de la quantité recommandée), la vitamine D (0 ± 0,50 µg par jour) et le calcium (380 ± 206 mg par jour, 38 % de la quantité recommandée) sont largement déficitaires.

4.2.1.2. Qualité insuffisante de la ration alimentaire

Le régime alimentaire des ménages, et donc des femmes enceintes, est monotone. Seulement cinq recettes de sauces suffisent à constituer 95 % des sauces consommées au cours de l'année. L'alimentation est aussi de qualité faible, essentiellement constituée de plats à base de céréales (to de mil ou de maïs, riz) accompagnés d'une sauce à base de légumes.

Pendant la saison pluvieuse, la majorité des sauces est à base de produits frais, mais dans la saison sèche (huit mois par ***an***), ce sont les légumes séchés (essentiellement le gombo sec) qui constituent l'ingrédient principal des

* Les chiffres entre crochets [ ] renvoient aux notes, pp. 112-113.

Tableau 2
Comparaison des consommations moyennes par la méthode du rappel de 24 heures (R) et la méthode pesée des ingérés (W) (n = 21) (SIOEN 2003)

Energie (MJ)	Protéine (mg)	Hydrate de carbone (mg)	Graisse (mg)	Phytate (mg)		
R 7,041	± 45,6	± 300 ± 143	33,2	± 3 074 ± 1 508		
3,554	21,9		30,7			
W 6,760	± 42,1	± 282 ± 99	35,7	± 2 784 ± 1 091		
3,047	20,6		35,2			
Ca (mg)	**Cu (mg)**	**Fe (mg)**	**Zn (mg)**	**Vit A (RE)**	**Vit D (µg)**	**Vit E (mg)**
R 386±235	1,44	± 28,06 ± 17,26	8,53	± 410 ± 423	0,19	± 5,71 ± 5,21
	0,93		4,44		0,60	
W 385±231	1,28	± 25,91 ± 9,63	8,13	± 404 ± 579	0,05	± 5,52 ± 4,37
	0,62		3,42		0,22	
Vit C (mg)	**Vit B1 (mg)**	**Vit B2 (mg)**	**Vit B3 (mg)**	**Vit B6 (mg)**	**Vit B12 (µg)**	***Folates* (µg)**
R 27,7±20,0	1,42	± 0,89 ± 0,46	15,29	± 1,36	± 0,23	± 246 ± 147
	0,71		7,79	0,65	0,60	
W 29,1±25,7	1,33	± 0,85 ± 0,35	13,81	± 1,34	± 0,37	± 209 ± 143
	0,49		7,14	0,71	0,81	

sauces. L'étude de la composition de ces sauces montre que leur composition en micronutriments (par 100 g) est pauvre, alors qu'elles constituent une des principales sources alimentaires de micronutriments.

Le repas est essentiellement composé de céréales qui fournissent 74 % de l'apport énergétique, 64,5 % des protéines totales, 37,5 % de la graisse et 86,6 % des hydrates de carbone. Ceci amène un apport faible en protéines (besoin protéique théorique moyen: 63 ± 6 g par jour, consommation réelle sur base des rappels de vingt-quatre heures: 43 ± 20 g par jour). Cette qualité basse de l'alimentation ne permet pas d'apports suffisants en vitamine A (361 ± 346 RE, 45 % de la quantité recommandée), vitamine C (25 ± 17mg par jour, 36 % de la quantité recommandée), acide folique (253 ± 174 µg par jour, 42 % de la quantité recommandée), fer (27,24 ± 14,77 mg par jour, 36 % de la quantité recommandée) [2] et zinc (8,10 ± 3,89 mg par jour, 30 % de la quantité recommandée).

4.2.1.3. Faible disponibilité alimentaire au niveau du ménage

L'enquête de sécurité alimentaire a été menée en octobre 2002. Cette période correspond à la période de plus grande vulnérabilité pour les ménages:

d'une part les stocks céréaliers se vident, d'autre part le travail physique dans les champs de culture est intense.

Au niveau macro (niveau provincial), il existe un important excédent de production céréalière (49 641 tonnes de surplus pour la campagne 2001-2002). La culture du maïs et du coton prédomine, avec un accroissement important de la culture du riz au cours des dernières années. La culture du maïs présente un rendement beaucoup plus élevé (1 944 kg/ha) que la moyenne nationale (1 324 kg/ha). Ceci dit, l'excédent alimentaire est surtout lié à la culture du maïs, et le prix des autres aliments de base sur le marché de Houndé n'est pas assoupli. Il s'agit en réalité d'une monoculture de fait, qui rend la zone très dépendante de l'extérieur pour les autres cultures.

A l'échelle du ménage, la disponibilité alimentaire se joue à plusieurs niveaux. Premièrement, si on considère la disponibilité en céréales de base, qui sont l'élément central pour mesurer la sécurité alimentaire au Burkina Faso, on distingue essentiellement trois configurations familiales. Il y a d'une part les ménages qui ne produisent pas suffisamment pour couvrir les besoins théoriques [3] de leurs membres au cours de l'année; parmi ceux-ci, il y a les ménages qui disposent de revenus additionnels pour acheter de la nourriture et il y a ceux qui n'en disposent pas. Dans l'enquête de sécurité alimentaire menée auprès de trente-cinq ménages, 40 % (12/30 [4]) des ménages produisent moins de 80 % des besoins alimentaires théoriques d'***autoconsommation***. Cependant, parmi ces ménages présentant une production vivrière insuffisante, seul un d'entre eux ne disposait pas de revenus complémentaires lui permettant d'acheter la quantité de nourriture nécessaire pour répondre aux besoins alimentaires du ménage [5]. Il y a d'autre part les ménages avec une ***autoproduction*** vivrière adéquate ou excédentaire. Il est cependant important de noter que les ménages, en ***autoproduction*** alimentaire satisfaisante ou non, utilisent une partie de la production vivrière comme source de revenus monétaires. Il en résulte qu'un ratio production/consommation satisfaisant pour l'année considérée masque des variations saisonnières dans la disponibilité alimentaire. C'est ce que soulignent les participants à l'atelier causal quand ils parlent de gestion inadéquate des stocks. Certains ménages se retrouvent en situation d'insécurité alimentaire dans la période juillet-octobre non parce qu'ils ont globalement produit de trop faibles quantités de céréales, mais parce qu'ils en ont vendu une partie juste après la récolte et ne disposent pas de moyens suffisants lors de la période de soudure, lorsque les prix du marché sont au plus haut, pour acheter le complément alimentaire pour le ménage. La monétarisation d'une partie de la récolte est aussi la cause la plus souvent mentionnée par les interviewés eux-mêmes pour expliquer les déficits alimentaires saisonniers de leur ménage. L'argent liquide peut servir

à payer des dettes, à traiter un malade, à résoudre divers problèmes, ou à acheter des biens de consommation.

4.2.2. *Analyse causale de la sous-nutrition maternelle à Houndé*

L'organisation d'un atelier causal a permis d'atteindre les résultats suivants:

— Une compréhension globale des déterminants de la sous-nutrition des femmes enceintes, et en particulier une meilleure appréhension de l'articulation entre les déterminants (voir modèle causal en annexe);
— Une participation de personnes-ressources au processus d'analyse de la problématique, avec un possible renforcement de leur capacité en ce domaine, notamment par l'acquisition de l'outil modèle causal;
— Une identification de thèmes importants à explorer ultérieurement;
— Une définition d'éléments qui devraient permettre de rendre les études d'intervention ultérieures les plus adéquates possible par rapport à la problématique locale.

4.2.3. *Epidémiologie du RCIU à l'hôpital de Houndé en 2000-2001*

Les résultats principaux sont les suivants:

— Concernant l'utilisation des services de santé, on remarque que les femmes sont surtout originaires de Houndé, et non des autres départements du district sanitaire, et majoritairement d'ethnie mossi. Le nombre de consultations prénatales moyen est de deux au cours de la grossesse présente. Très peu de femmes ne consultent pas du tout (2,4 %) mais près d'un quart d'entre elles n'ont consulté qu'une seule fois. L'index vaccinal est complet dans 67,4 % des cas chez les nullipares, mais seulement dans 40,5 % de la totalité des cas.
— 29,3 % des femmes sont nullipares. L'âge moyen est de 24,1 années et 26,4 % des femmes ont moins de vingt ans. L'âge moyen à la première grossesse est de 19,2 (± 2,8) années. Près de 6 % des accouchements étaient dystociques et une césarienne a été nécessaire dans 3,8 % des cas. 5,7 % de l'ensemble des nouveau-nés sont déclarés mort-nés. Dans le groupe des enfants nés à terme d'une grossesse unigémellaire (n = 1 625), près de 17 % des bébés ont un petit poids de naissance (< 2 500 g), mais 74,7 % ont un poids compris entre 2 500 g et 2 999 g, ce qui porte à 91,5 % le pourcentage d'enfants d'un poids inférieur à 3 000 g. 11 % des nouveau-nés ont une taille inférieure à 47 cm et l'indice de Rohrer moyen est de 2,44 (± 0,3). 4,0 % des enfants étaient mort-nés.

— Concernant la petite taille du bébé (< 47 cm), l'analyse multivariée montre que les facteurs suivants sont associés de façon indépendante: la taille de la mère (OR: 1,79, IC 95 %: 1,22-2,63); l'IMC de la mère (OR: 1,83, IC 95 %: 1,38-2,38); la primiparité (2,44, IC 95 %: 1,68-3,55); une faible fréquentation de la CPN (< 2 CPN) (OR:1,83, IC 95 %: 1,24-2,71); la saison (accouchement entre août et novembre) (OR:1,92, IC 95 %:1,33-2,78); le sexe féminin de l'enfant (OR:1,64, IC 95 %: 1,13-2,39).
— Le périmètre crânien du nouveau-né est influencé par les mêmes facteurs que la taille, excepté la saison.
— La corpulence du bébé est influencée par la primiparité (OR: 1,91, CI 95 %: 1,5-2,5), par la taille de la mère (OR: 1,43, CI 95 %: 1,1-1,9) et par l'IMC de la mère (OR:1,3, CI 95 %: 1,0-1,8).

4.2.4. *Perceptions et connaissances de la population en rapport avec l'alimentation et la nutrition de la femme enceinte*

Les principaux résultats sont les suivants:

— La diminution de la consommation alimentaire pendant la grossesse est rapportée de façon quasi générale. La diminution est essentiellement d'ordre quantitatif. La nausée, le manque d'appétit ou la compression de l'estomac par le fœtus sont invoqués comme étant les causes les plus communes.
— Des messages (et peut-être aussi des représentations) contradictoires en apparence circulent dans la communauté. D'une part, de nombreuses personnes rapportent qu'il est important d'avoir une alimentation de bonne qualité pendant la grossesse pour préserver la santé du bébé. Cette alimentation idéale comporte le lait, les produits carnés, le poisson, et tous les aliments contenant des vitamines. D'autre part, la relation entre l'alimentation et la «grosseur de la chose», et par conséquent la possibilité d'un accouchement difficile, est citée par plusieurs personnes. Ce dernier élément pourrait constituer une motivation importante à la modification du régime alimentaire pendant la grossesse, bien que cette motivation ne soit pas explicitée spontanément, sauf chez une personne. Soit les recommandations de bonne alimentation sont de l'ordre d'un discours socialement valorisé, et manipulées en tant que telles par les personnes interrogées sans être traduites dans une pratique, soit donner naissance à un bébé est désirable mais peu admissible par rapport à des enquêteurs liés à un programme de santé. On retrouve d'ailleurs le même genre d'ambivalence dans le discours des femmes gourmantchés, lors d'une étude similaire à la nôtre dans la province de la Gnagna (avril 2003).

— Il apparaît donc que les mères établissent un lien organique entre leur alimentation et l'état de santé du bébé. Ceci est assez surprenant quand on considère que dans la ville voisine de Bobo-Dioulasso, la malnutrition infantile est plutôt vécue en termes de contamination ou comme la conséquence d'une transgression (ROGER-PETITJEAN 1999). On retrouve aussi cette notion de transgression chez certaines personnes interrogées de notre échantillon concernant la malnutrition infantile. L'étiologie des bébés serait-elle construite sur des bases entièrement différentes de celles de la malnutrition infantile? Ou bien s'agit-il plutôt de niveaux de causalité différents? (ZEMPLENI 1985).
— Les aliments prohibés sont variés. On trouve une cohérence essentiellement autour des aliments sucrés chez les Mossis, ce qui correspond au mythe de la procréation décrit par Doris Bonnet, où le miel est la nourriture des génies de la brousse (BONNET 1988); et autour des aliments froids, vraisemblablement à rapprocher du système des humeurs, la grossesse étant assimilée à un excès de chaleur. Comme l'explique Christiane Bougerol, le chaud est source de grande vulnérabilité. Dans cette situation, le corps est menacé par son contraire, c'est-à-dire par l'irruption du froid (BOUGEROL 1985, MANDERSON 1987, POOL 1987).
— Les interdits touchent des aliments finalement rarement consommés même en dehors de la grossesse. De plus, il existe des stratégies d'évitement de ces interdits (non-prise de connaissance de l'interdit, consommation individuelle sur le marché). De telles stratégies ont aussi été décrites dans d'autres contextes, démontrant la capacité des femmes à minimiser l'effet des contraintes écologiques et culturelles sur leur état nutritionnel (BENTLEY *et al.* 1999).
— La cécité nocturne est considérée quasiment comme un signe normal de grossesse (... «cela passe quand la grossesse finit»). Il existe un terme dans chacune des langues pour la désigner (*gnissibié* en bwamu, *soufienya* en dioula, *yungzondo* en mooré), ce qui atteste de sa fréquence. L'origine en est inconnue. Le traitement traditionnel chez les Mossi consiste à jeter un foie d'animal grillé (hérisson, bœuf, ... selon les personnes) dans une case obscure. Si la personne atteinte le retrouve et le mange, elle guérira.
— Comme pour la cécité nocturne, il existe un terme pour désigner le goitre dans chacune des trois langues de la région (*wohahoun* en bwamu, *folon* en dioula, *kokolougo/kolkondo* en mooré). Dans ce cas-ci non plus, aucun lien étroit n'est établi avec le facteur alimentaire. L'étiologie du goitre est pensée comme la conséquence d'une consommation d'eau contaminée (par des microbes). Aucun traitement traditionnel n'est proposé.

— Les signes cliniques de l'anémie sont bien connus de la population. L'explication étiologique de l'anémie («manque de sang») est liée à des «maladies» (infections?), à l'alimentation, à l'exposition de longue durée au soleil. Les traitements cités englobent les transfusions, la prise de médicaments et une alimentation de qualité. Les comprimés de fer et acide folique fournis à la consultation prénatale sont identifiés comme de «la vitamine» qui donne «le sang».
— Les modes de gestion du stock alimentaire, d'organisation culinaire et de partage des plats au niveau familial sont extrêmement variés. Les facteurs de variation sont l'ethnie, l'intégration relative des ménages au sein du lignage en tant qu'unités de production et unités de consommation, la structure du ménage, et même la saison. Quoi qu'il en soit, la femme enceinte s'inscrit dans un réseau familial où son autonomie en termes de choix alimentaires est réduite.
— La sécurité alimentaire, telle que rapportée par les personnes interrogées, est de bon niveau. En période de soudure, il est commun d'acheter des céréales sur le marché grâce à l'argent provenant des cultures de rente, essentiellement le coton. La plupart des chefs de ménage déclarent avoir augmenté leur surface de production par rapport à l'année précédente.
— Parmi les facteurs affectant la sécurité alimentaire des ménages, outre les conditions climatiques, l'appauvrissement du sol, le manque de technologie agricole, il est fait mention avec insistance de la nécessité de devoir monétariser une partie du stock pour des dépenses familiales ou des obligations sociales. Ceci fait le jeu des spéculateurs qui revendent les céréales au prix fort en saison des pluies.
— Il existe un véritable discours moral autour de la gestion des stocks familiaux de nourriture. Ceux qui souffrent du manque de nourriture pendant la période de soudure sont «des buveurs de dolo», qui vendent de façon inconsidérée une partie de la récolte. Il est de la responsabilité du chef de ménage d'assurer l'approvisionnement de la famille. Par ailleurs, «la dabaa ne trahit pas»: si tu travailles, il ne peut pas y avoir de problèmes de pénurie.
— Les femmes disposent le plus souvent d'un petit jardin où elles cultivent des légumes ou des arachides. Les produits sont souvent utilisés pour la vente et l'utilisation de cet argent est laissée à la discrétion de la femme, ce qui lui confère une certaine marge de manœuvre au niveau des achats, y compris des achats de snacks pour sa consommation personnelle lors du marché. Cependant, cet argent n'est pas utilisé pour acheter des services de santé, car cela relève essentiellement, comme pour l'alimentation, de la responsabilité du chef de ménage.

5. Conclusion

Le projet de recherche MISAME, dans sa phase exploratoire, a permis de mieux comprendre la problématique et les déterminants du IUGR, notamment en ce qui concerne la sous-nutrition des femmes enceintes. L'essai randomisé se terminera en 2007 et produira des informations précieuses quant à l'effet d'un paquet de soins prénatals amélioré (multi-micronutriments et SP en traitement intermittent) sur la croissance fœtale et infantile ainsi que sur la meilleure santé materno-infantile. MISAME constitue également une formidable opportunité pour renforcer les capacités de recherche en nutrition au Burkina Faso, en favorisant les échanges scientifiques Nord-Sud. Ce dernier point se traduit par des stages, des formations académiques et la rédaction de thèses (ingénieur, médecin, nutritionniste, sociologiste) tant en Belgique qu'au Burkina Faso.

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NOTES

[1] Besoin énergétique de la femme enceinte = (BMR × PAL) + Y. Le PAL est estimé à 1,67 pour les femmes des PVD. Et Y, correspondant au supplément énergétique dû à la grossesse, est fixé à 1,192 MJ par jour.

[2] C'est-à-dire que même si la quantité ingérée était augmentée pour couvrir les besoins énergétiques, des déficiences dans ces cinq micronutriments demeureraient, à la différence de la vitamine D, de la vitamine B12 et du calcium.

[3] Ces besoins théoriques sont estimés par la FAO à 190 kg par personne et par an au Burkina Faso.

[4] Pour cinq ménages sur les trente-cinq enquêtés, on ne peut conclure quant à la sécurité alimentaire, car la production et la consommation alimentaire se font à l'échelle du lignage.

[5] Il est à noter que ce ménage à risque d'insécurité alimentaire bénéficiait d'un réseau social ayant contribué à pallier le manque d'autoproduction au cours de l'année 2001.

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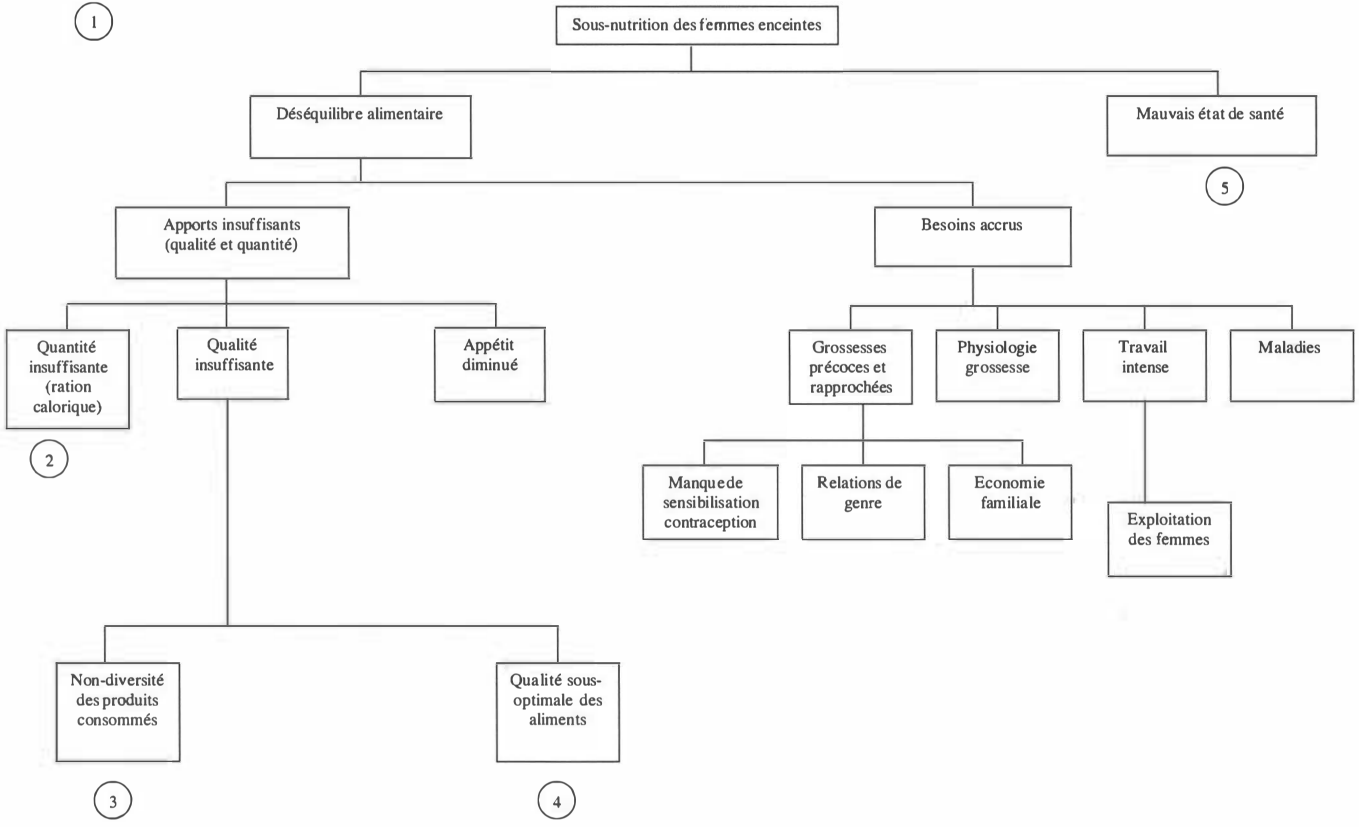
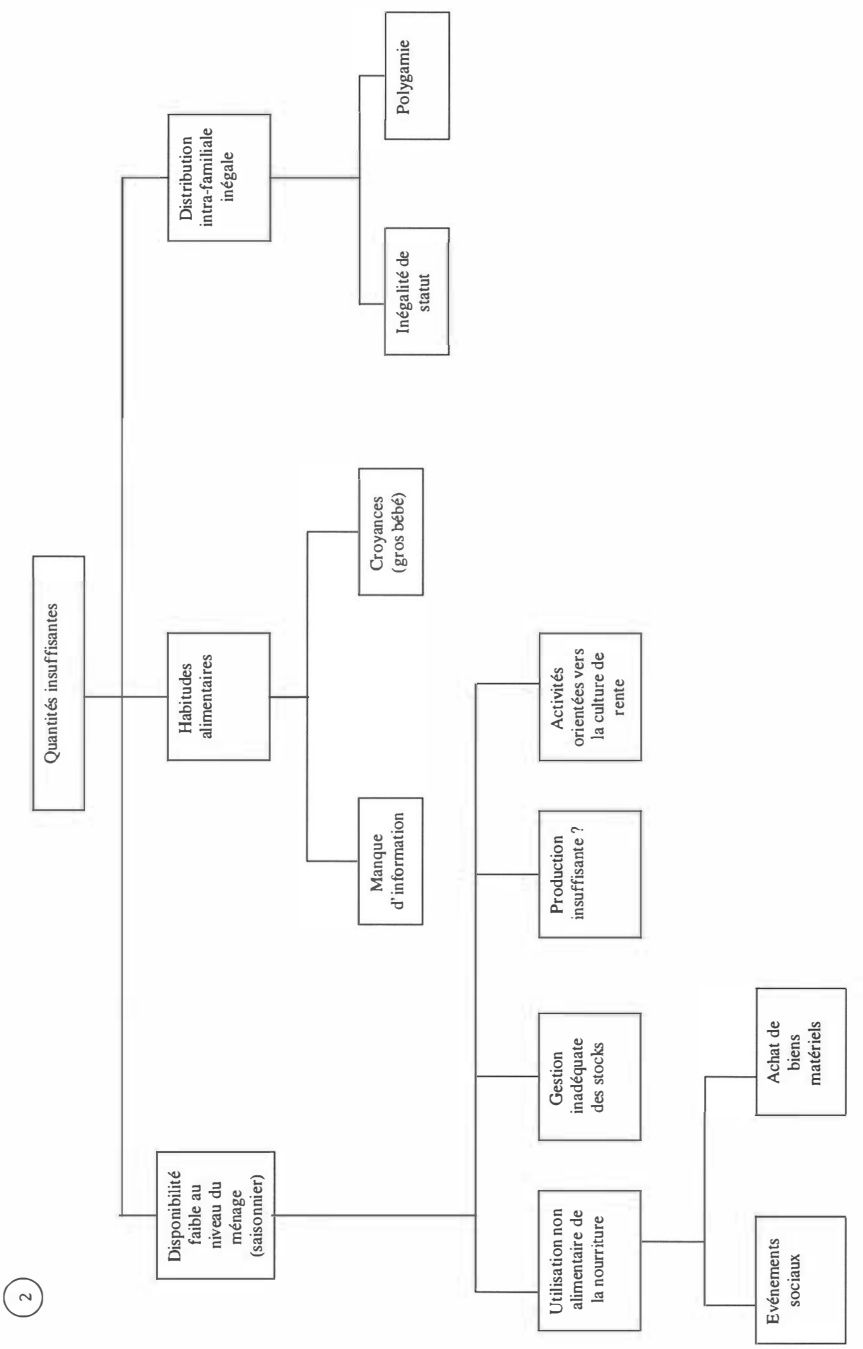
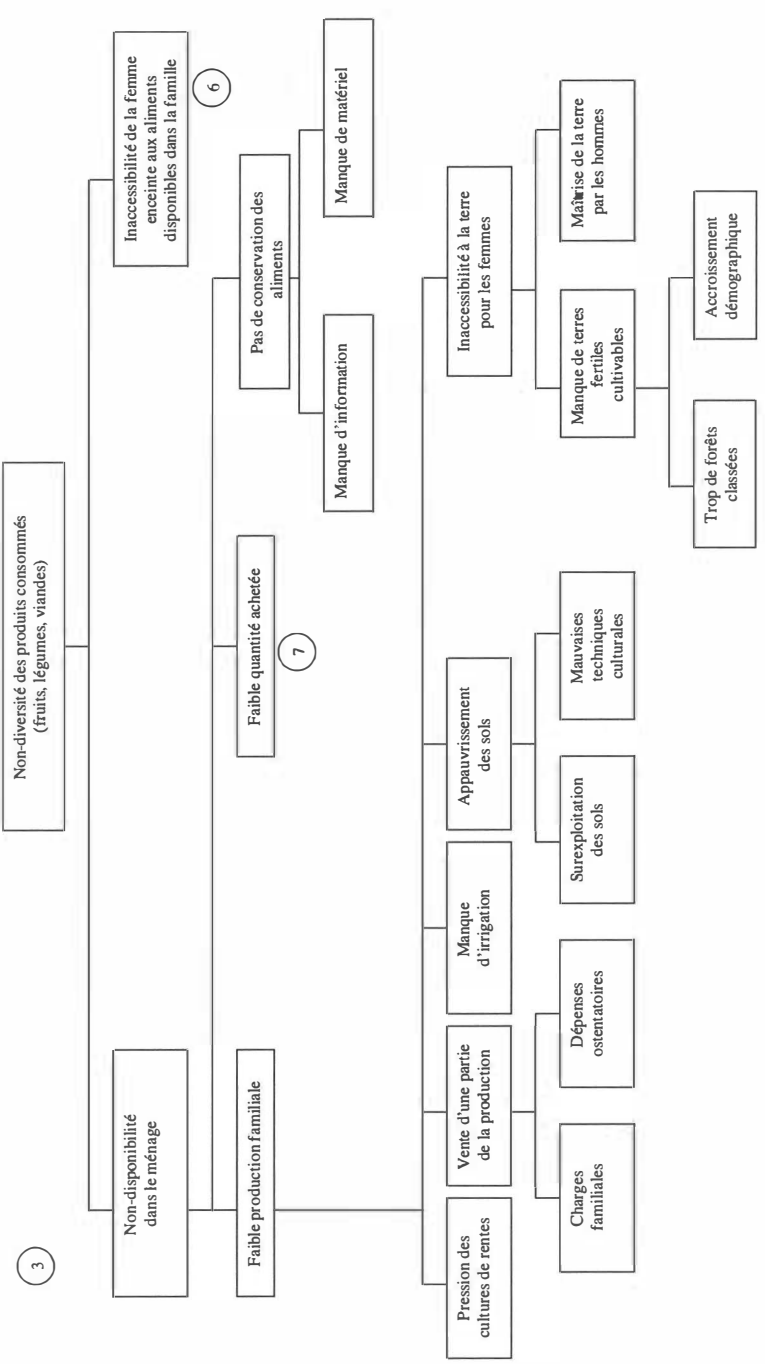
ANNEXE

Modèle causal



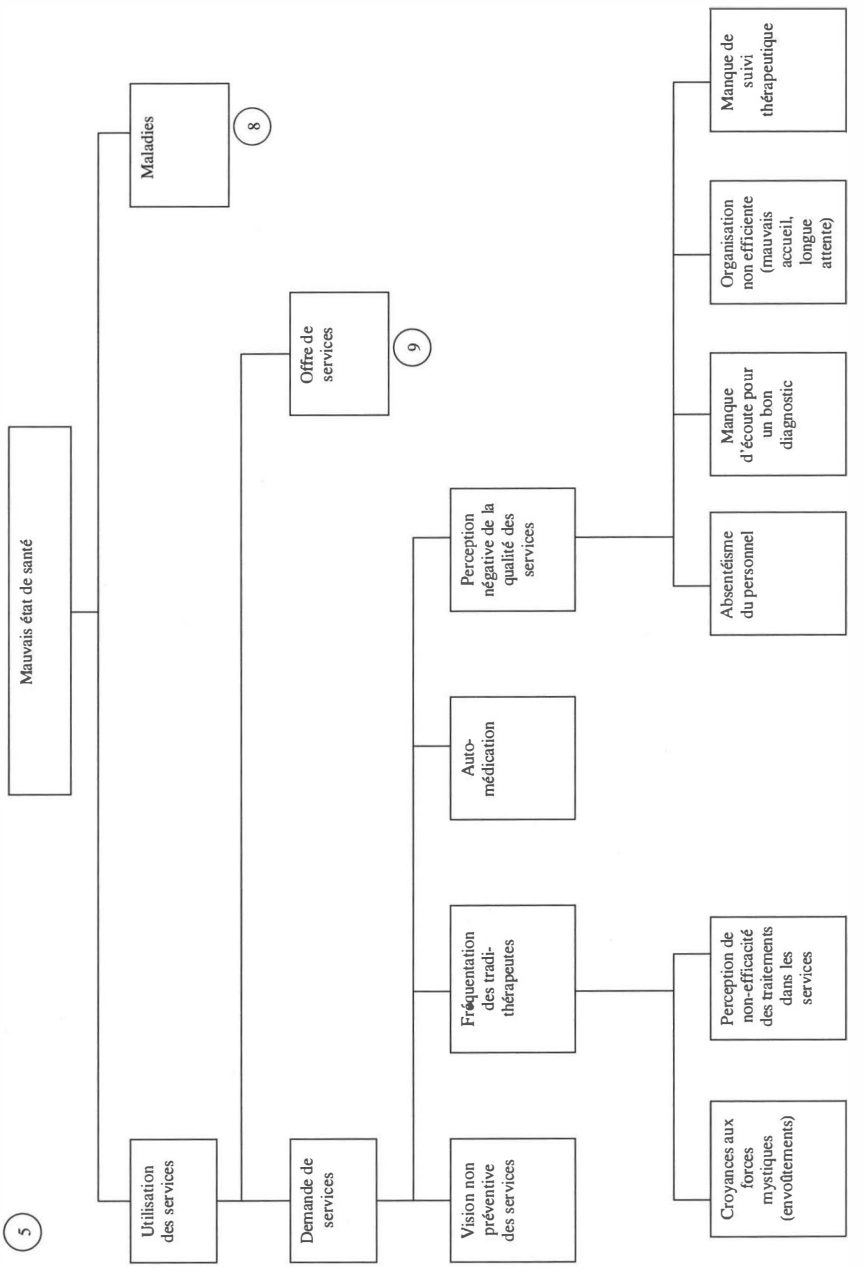

Quantités insuffisantes
Disponibilité faible au niveau du ménage (saisonnier)
Habitudes alimentaires
Croyances (gros bébé)
Manque d'information
Distribution intra-familiale inégale
Polygamie
Inégalité de statut
Utilisation non alimentaire de la nourriture
Gestion inadéquate des stocks
Production insuffisante ?
Activités orientées vers la culture de rente
Evénements sociaux
Achat de biens matériels

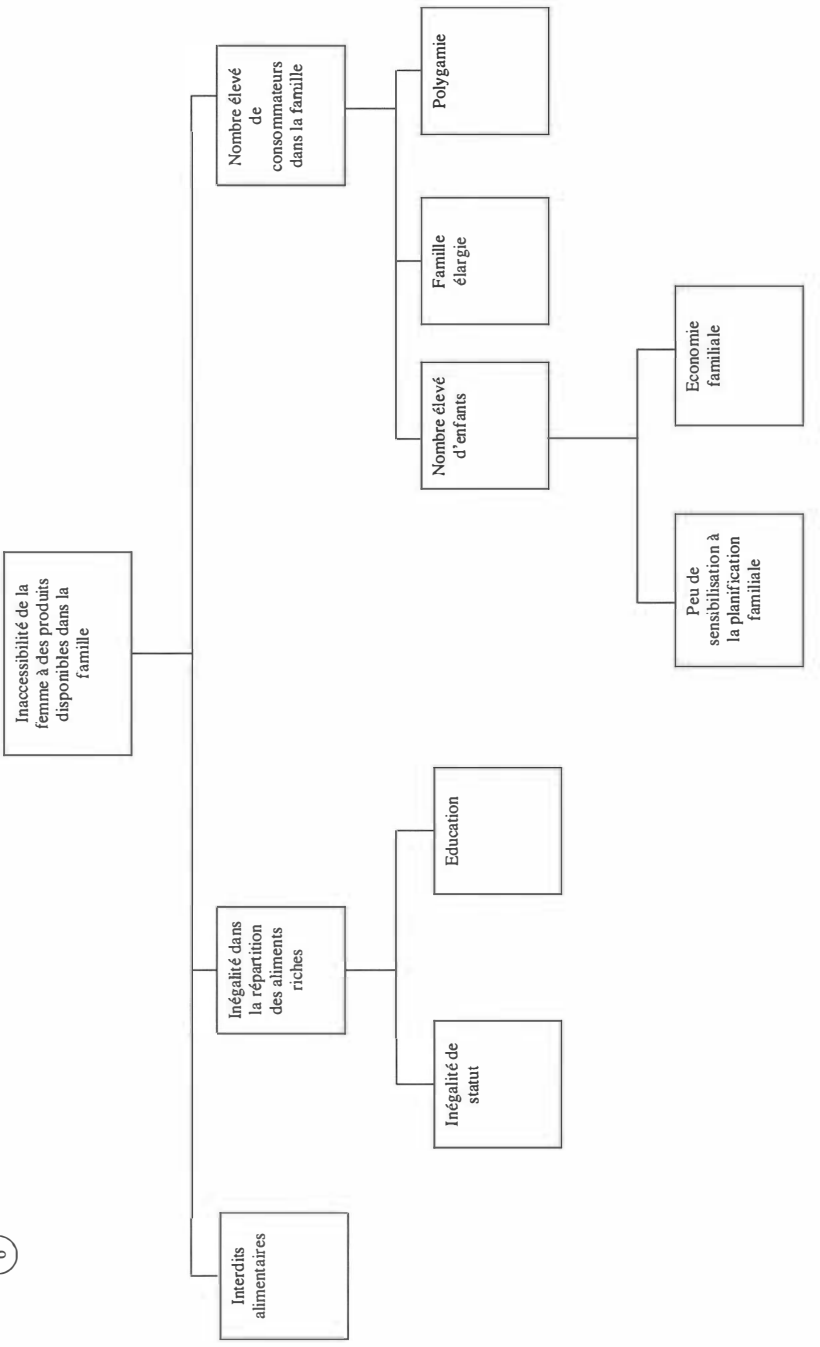
(2)


3
Non-diversité des produits consommés (fruits, légumes, viandes)
Non-disponibilité dans le ménage
Inaccessibilité de la femme enceinte aux aliments disponibles dans la famille
6
Faible production familiale
Faible quantité achetée
7
Pas de conservation des aliments
Manque d'information
Manque de matériel
Pression des cultures de rentes
Vente d'une partie de la production
Manque d'irrigation
Appauvrissement des sols
Inaccessibilité à la terre pour les femmes
Charges familiales
Dépenses ostentatoires
Surexploitation des sols
Mauvaises techniques culturales
Manque de terres fertiles cultivables
Maîtrise de la terre par les hommes
Trop de forêts classées
Accroissement démographique

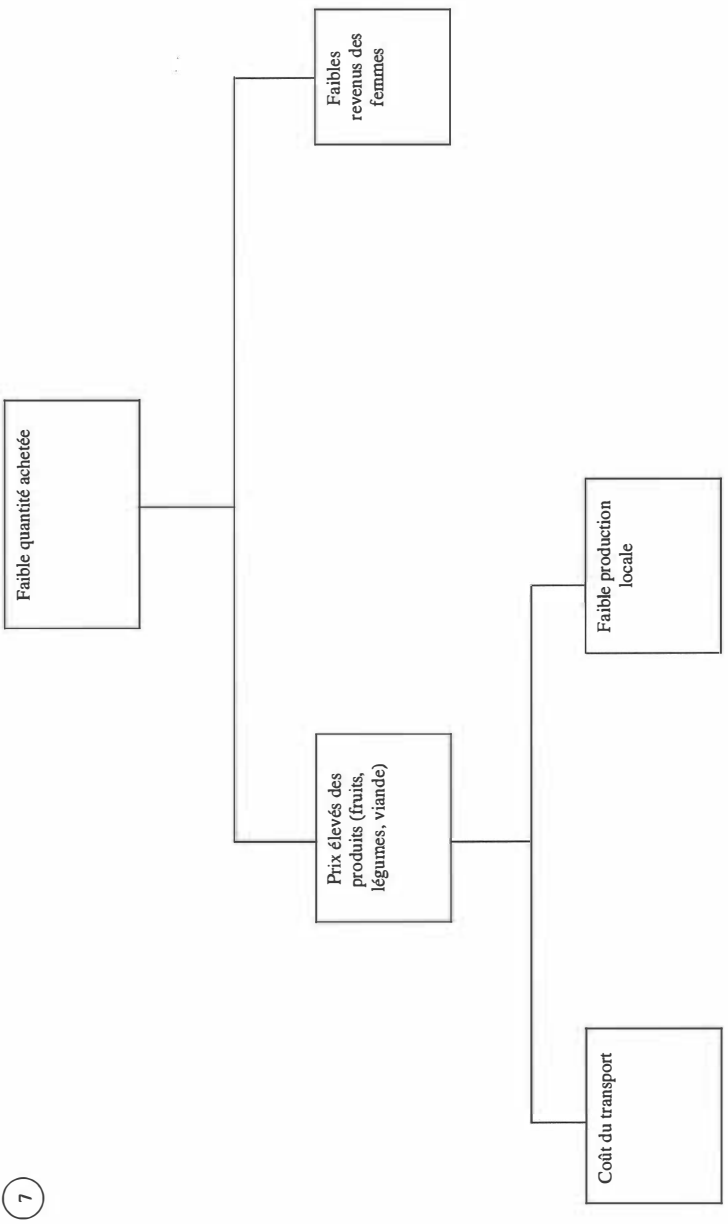
Qualité sous-optimale des aliments
Manque de minéraux dans le sol
Mauvaise conservation des aliments
Hygiène dans la conservation
Ignorance des techniques de conservation
Modes de préparation (décorticage du maïs, cuisson prolongée)
Manque d'information sensibilisation
Habitudes alimentaires
Utilisation des conservateurs, pesticides, toxiques

④

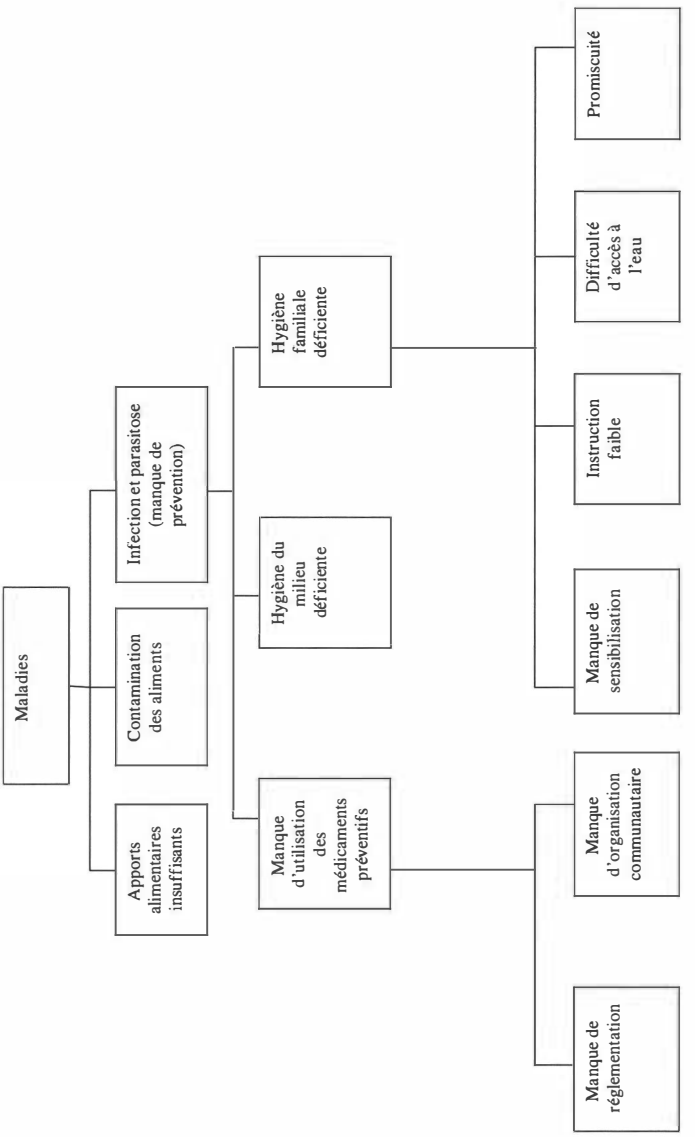

5
Mauvais état de santé
Utilisation des services
Maladies
8
Demande de services
Offre de services
9
Vision non préventive des services
Fréquentation des tradi-thérapeutes
Auto-médication
Perception négative de la qualité des services
Croyances aux forces mystiques (envoûtements)
Perception de non-efficacité des traitements dans les services
Absentéisme du personnel
Manque d'écoute pour un bon diagnostic
Organisation non efficiente (mauvais accueil, longue attente)
Manque de suivi thérapeutique


Inaccessibilité de la femme à des produits disponibles dans la famille
Nombre élevé de consommateurs dans la famille
Polygamie
Famille élargie
Nombre élevé d'enfants
Economie familiale
Peu de sensibilisation à la planification familiale
Inégalité dans la répartition des aliments riches
Education
Inégalité de statut
Interdits alimentaires

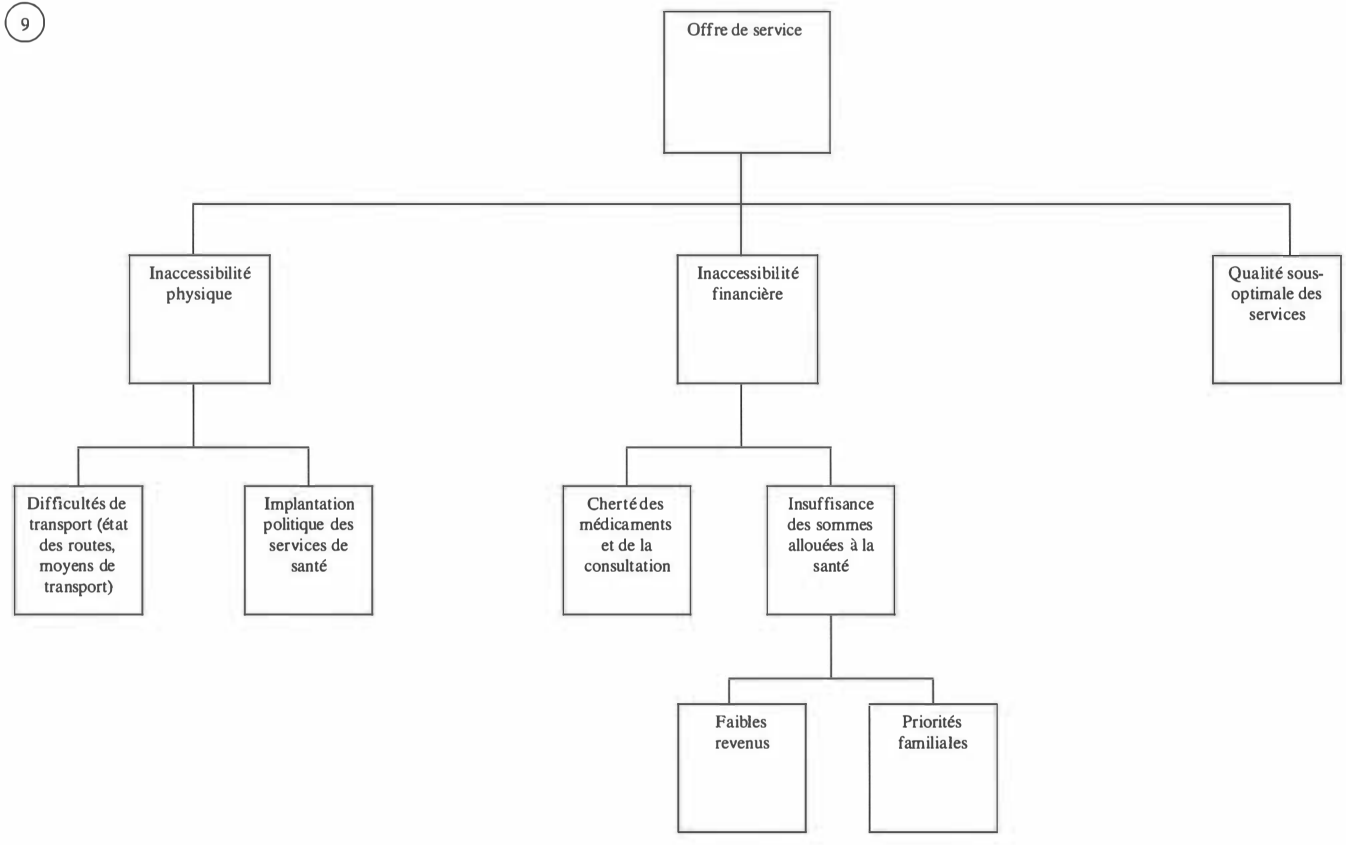
⑥


Faible quantité achetée
Faibles revenus des femmes
Prix élevés des produits (fruits, légumes, viande)
Faible production locale
Coût du transport

7


Maladies
Apports alimentaires insuffisants
Contamination des aliments
Infection et parasitose (manque de prévention)
Manque d'utilisation des médicaments préventifs
Hygiène du milieu déficiente
Hygiène familiale déficiente
Manque de réglementation
Manque d'organisation communautaire
Manque de sensibilisation
Instruction faible
Difficulté d'accès à l'eau
Promiscuité

9


Offre de service
Inaccessibilité physique
Inaccessibilité financière
Qualité sous-optimale des services
Difficultés de transport (état des routes, moyens de transport)
Implantation politique des services de santé
Cherté des médicaments et de la consultation
Insuffisance des sommes allouées à la santé
Faibles revenus
Priorités familiales

International Symposium
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Royal Academy of Overseas Sciences
Nutrition Third World
Brussels, 3 December, 2004
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Challenges and Expectations in the Third World Applied Nutrition Research: the Kenyan Experience

by

Ruth ONIANG'O*

Introduction

Rural Outreach Program (ROP), a non-profit organization based in Kenya, has conducted many applied nutrition research projects in the country. Kenya being a third-world country is beset with typical problems of these countries, starting with poverty, among others. Poverty is a major contributor to poor nutrition and food insecurity for the majority of the population. ROP is involved in a wide range of projects, but mainly those that support the provision of clean water and improvements in food and nutrition security, health care, employment and income generation. In the food and nutrition field, ROP has implemented research projects in micronutrients such as vitamin A since its intake is affecting food intake among under-fives while people affected by HIV/AIDS tend to suffer deficiency. In this connection, ROP has been running research projects to assess the reliability and sustainability of local foods in providing adequate vitamin A to the target populations. The Program has also conducted a base-line assessment of the effects of HIV/AIDS on household nutrition and food security in parts of western Kenya. All these research activities have provided ROP and its staff with insightful experiences and recommendations for implementation. In the next sections we will review some of the challenges and expectations faced by ROP in applied nutrition research.

* Nominated Member of the Kenyan Parliament, Professor of Food Science and Nutrition, Jomo Kenyatta University of Agriculture and Technology, Nairobi (Kenya).

Poverty

Poverty and poverty eradication in Kenya are now tired passwords. Despite all the prescriptions and models emanating from the Bretton Wood institutions (World Bank and IMF) since the 1990s, little has changed in the country's economy. In 2004, it is reported to have grown by a meagre 1.8 % vis-à-vis a population growth rate of 2.9 %. Unemployment is still very high even with the new government's promise to create 500,000 jobs annually, retrenchments are still rampant, insecurity is well out of control and transport, communication and power costs are expensive for business driving them out of the country to cheaper destinations. At the same time, in 2004 over 3.3 million Kenyans are facing starvation due to bad weather conditions.

Communities in rural areas are as affected as those in urban areas, if not worse. For some households the food situation is really dramatic. This is sometimes due to large family sizes with inadequate resources to support new-born children, more so in places where family planning services are lacking or the community is ignorant of the need to use devices. Cases of basic infections that would require very simple medical attention are common but would require the health services personnel to be part of the research team. This brings us to the challenge of developing a multidisciplinary approach in community research. Such approaches are ideal but not easy to implement. In addition, more often than not, available research funds are specifically allocated for data collection, without any side funds to deal with immediate problems that could be tackled on sight, like vitamin A supplementation, distribution of mosquito nets and simple drugs to treat the under-fives, pregnant, lactating women and other vulnerable groups in the community.

Unemployment contributes directly to the poor economic status of families in third-world countries. Without a reliable income, many families are forced to resort to extreme measures for daily survival. For women, the problem is compounded where husbands have migrated to urban areas in search of employment opportunities. Women in this case become both care-givers and breadwinners for their families. This is quite a challenge for researchers because most data on food and nutrition concern mothers. In this regard, it is important the researchers plan the interviews in such a way that they respect their (mothers) time schedules and avoid stressing them further.

HIV/AIDS

The latest statistics indicate that HIV/AIDS infections in the country have fallen from 15 to 8 %. This is good news, considering that the country has

already lost 188,000 people through AIDS and related ailments. In fact, the drop in the infection figures implies that so far, only Kenya and Uganda have registered any real drop in HIV/AIDS infection in Africa. However, the foregoing information has not in any way modified the terrible effects of the disease in affected communities. To conduct a research on HIV/AIDS and involving communities, is truly a humbling experience, especially as one witnesses the devastating effects of the disease on families and particularly on children.

It is agonizing when confronted with a fresh grave of a young family head who has just been buried, a bed-strapped wife with full-blown AIDS symptoms, and looking on forlornly are three, eight and twelve year-olds with their age-stricken grand-parents.

Obtaining information in such a situation is difficult, if not outright insensitive. HIV/AIDS, as many people now agree, is more than just a medical problem. It is a social as well as an economic problem. The stigma that is associated with HIV/AIDS also makes data collection very difficult. Few families are ready to disclose the disease and they will to a great extent cover up the causes of deaths. This has affected the credibility of HIV/AIDS infections and prevalence figures. Hence efforts to address the problem suffer from a lack of credible information for decision-making. The long and short of this is that research on HIV/AIDS must have a budget component allocated to cover the basic needs of affected families: drugs, food items, clothes and other requirements. Research is not all about figures: it is about people. Of course such short-term support is not sustainable in the long term. However, governments must be advised of the reality and they surely can no longer hide their face and remain indifferent to the suffering of people.

Culture

There is no society without a culture. Culture is dynamic and in some cases can also be a barrier to development. Culture defines and distributes responsibilities to various members of the society. There are cultures that allow polygamous marriages; others have customs and traditions that support wife-inheritance, early marriages for young girls, circumcision rites for both genders, etc. However, there are specific cultural practices that affect nutrition and food intake of community members. Polygamous marriages tend to be a drain on family resources, and children born in such families are unlikely to have quality nutrition and health care. They suffer from numerous diseases and do not grow to achieve their potential due to inadequate care in their early years.

Other cultural practices are so stifling that in some cases mothers in particular, are not allowed to give out information without the consent of their

husbands. Some communities promote the boy-child education at the expense of the girl-child; the outcome of such gender-biased education, is a community with women folks who are poorly educated, and are not empowered to act as agents of change to improve nutrition and general livelihood for their families.

Research Fatigue

Let me quote a statement once made by a mother who felt that scientists were somehow becoming a bother to her peace: "Why are you asking me what I ate yesterday, how is that important to you? You people come here, asking us a lot of questions then you go away and there is no help we get from you".

The above statement captures vividly the dilemma a researcher encounters in the field, especially in applied research. Some communities have become "research-fatigued". There are many groups of people asking all sorts of questions in the community, and the sad part of it is that, until very recently, it was not even considered necessary to explain to the community the purpose and the outcome of the research. This has created disillusionment and apathy among communities who have participated in many research projects that have not in any way benefited their overall quality of life. If anything, their situation has moved from bad to worse.

Research, unfortunately or fortunately, will be here for a long time to come. But some fundamental changes are needed to motivate communities to participate in it. It is true that to design and implement a community-based project, which at the same time generates scientific findings that add to the overall information and knowledge base of a science like nutrition, is quite a challenge. But it is an obvious fact that what interests the scientists might not necessarily be in line with the community needs. The challenge is to ensure that research is designed to include community concerns and that needs are well catered for while at the same time ensuring that the scientific aspects of the research are not watered down.

It is crucial that research involves community members whenever possible, including government and other opinion leaders (such as faith-based leaders, youth and women leaders as well as school heads). The study would likewise insist that only local people are used in data collection and as guides when these skills are available locally. The project can also substantially minimize operational costs when using local people as far as accommodation and transportation expenses are concerned, as they can operate from their homes and

within walking distances. It would be prudent for the research team to share with the community the research findings with emphasis on aspects of the study which are relevant and useful to the community.

Conclusion

To get the communities to participate in research, giving them feedback has an ultimate effect of building confidence between community members and scientists. It is an open secret that so many good research findings have taken place in third-world countries, but very few get to reach the people who actually need to use them. Therefore, when a researcher decides to share the findings, at least with the studied community, he does, in a small way, contribute to the paradigm shift that is quickly beginning to interest many researchers in the developing countries: taking the university to the community as the way forward for future research. That is exactly one of the driving forces behind ROP's work. We set out to take the university to the people.

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Central Bureau of Statistics 2004. Economic Survey. (http://ww.cbs. go.ke)

International Symposium
Research in Applied Nutrition in Developing Countries: Challenges and Expectations
Royal Academy of Overseas Sciences
Nutrition Third World
Brussels, 3 December, 2004
pp. 131-134.

Round Table: Challenges and Expectations. Synthesis

by

Ivan BEGHIN

The symposium speakers have been asked to complete their scientific presentation with a short statement on their perception of the difficulties they are facing and on their expectations as researchers in applied nutrition in a developing country [1]*. These contributions were distributed in advance to the Round-Table members.

The Round Table was introduced by Professor Ruth Oniang'o from Kenya. Then the other panel members made brief comments, and a general, very lively discussion with the audience followed.

The paper by Dr Oniang'o and the contributions from the speakers and the panel are the basis for the synthesis presented below. The consistency of this material — among people coming from widely different places and situations —, its depth, and its articulateness, are quite remarkable.

This synthesis is divided into two sections, following a scheme adopted by quite a few contributors: the first is on challenges and expectations of researchers in developing countries in general, while the second is specific to research in applied nutrition. A few items below do not explicitly list "expectations" as such, when these were not mentioned by the contributors. The reader will infer the author's expectations from his diagnosis of the problem.

1. Research in Developing Countries, in general

The difficulties and challenges faced by researchers in the South can easily be grouped under five headings, the first three of which are recurrent in the participants' contributions.

* The number in brackets [ ] refers to the note, p. 134.

1.1. Isolation

- Insufficient access to information:
  - Articles, journals,
  - Internet,
  - Sources of funding.
- Lack of forum for sharing experiences, results and difficulties;
- Lack of assistance in the planning and implementation of research, in the analysis of data, and in the competitive writing of articles.

1.1.1. Expectations

- Easier access to scientific literature;
- Networking: within countries, between countries, and with international organizations;
- Tutoring, coaching by senior researchers from the North or from the South;
- Provision, in projects, for mutual visits.

1.2. Lack of Adequate Research Infrastructure

- Lack of an institutional framework for research;
- Excessive dependency on the North;
- Shortage of trained and motivated researchers (due partly to the lack of recognition).

1.3. Low Competitiveness in getting Financial Support

- Funds are in the hands of a few people: there is a monopoly of a very few who have the right contacts;
- Difficulty, lack of assistance in writing grant requests;
- Sometimes researchers from industrial countries are required by funding agencies to be partners.

1.3.1. Expectations

- Support, coaching in getting access to sources of funding;
- Special privileges (positive discrimination) for researchers from developing countries.

1.4. Research Priorities often Established in the North

Researchers in the South are unable to establish their own priorities.

1.4.1. Expectations

— Research subjects should be problem-oriented, chosen and defined by the researcher, and not donor-driven.

1.5. Difficulties in Disseminating, Popularizing and especially Operationalizing Results

— No forum where results can be shared, and then applied;
— Operational agencies are not generally committed to using research results;
— Shortage of instruments to evaluate research impact.

2. Research in Applied Nutrition

2.1. Poor Understanding and/or Lack of Recognition of Applied Nutrition Research

— Research in applied nutrition is not recognized, more generally nutrition is not sufficiently recognized;
— Researchers in fundamental or clinical nutrition are seldom engaged in applied research;
— Health and nutrition personnel are not interested in research;
— Research projects are not perceived as an opportunity for training operational personnel (managers, staff) and therefore as an opportunity to improve the operations.

2.2. Shortage of Researchers trained in Applied Nutrition Research

This also applies to researchers in fundamental nutrition.

2.3. The Rapidly Changing Scene in Nutrition in Developing Countries

Examples given were:

— The consequences of early weaning (and inadequate child feeding) because of AIDS;

— The rise in chronic non-communicable diseases linked to nutrition;
— The increased consumption of processed food.

2.4. Difficulty (and Ethics) in Studying People if there is no Intervention to Assist them

— Research "fatigue";
— Ethical obligation of assisting people when studying them: earmarking additional funds for meeting some of their basic needs;
— Need to motivate communities, offering them something meaningful, using local manpower when possible, and involving them;
— Poor availability of already collected data.

2.4.1. Expectations

— Need for more contribution of social sciences and of social communication to improve the interface with people;
— Research budgets should include funds that would help motivate the communities;
— More participation of the study population in applied research.

2.5. Difficulties in Applying Results

— Insufficient coverage of health services, in addition to the issues raised above, concerning the lack of understanding and recognition of applied nutrition research.

2.5.1. Expectations

As one of the contributors pointed out: we need "more the introduction of sustainable ways of managing malnutrition, and less of *nutritional studies*".

NOTE

[1] Written contributions were received from speakers and from other guests: Francis Byekwaso, Martin Kimanya, Patrick Kolsteren, Herman Lanou, Stephen Mbithi, Theo Ntambwe, Ruth Oniang'o, Armando Pérez-Cueto, Leonor Pacheco Santos, Shafiqul Sarker, and Wim Van Lerberghe.