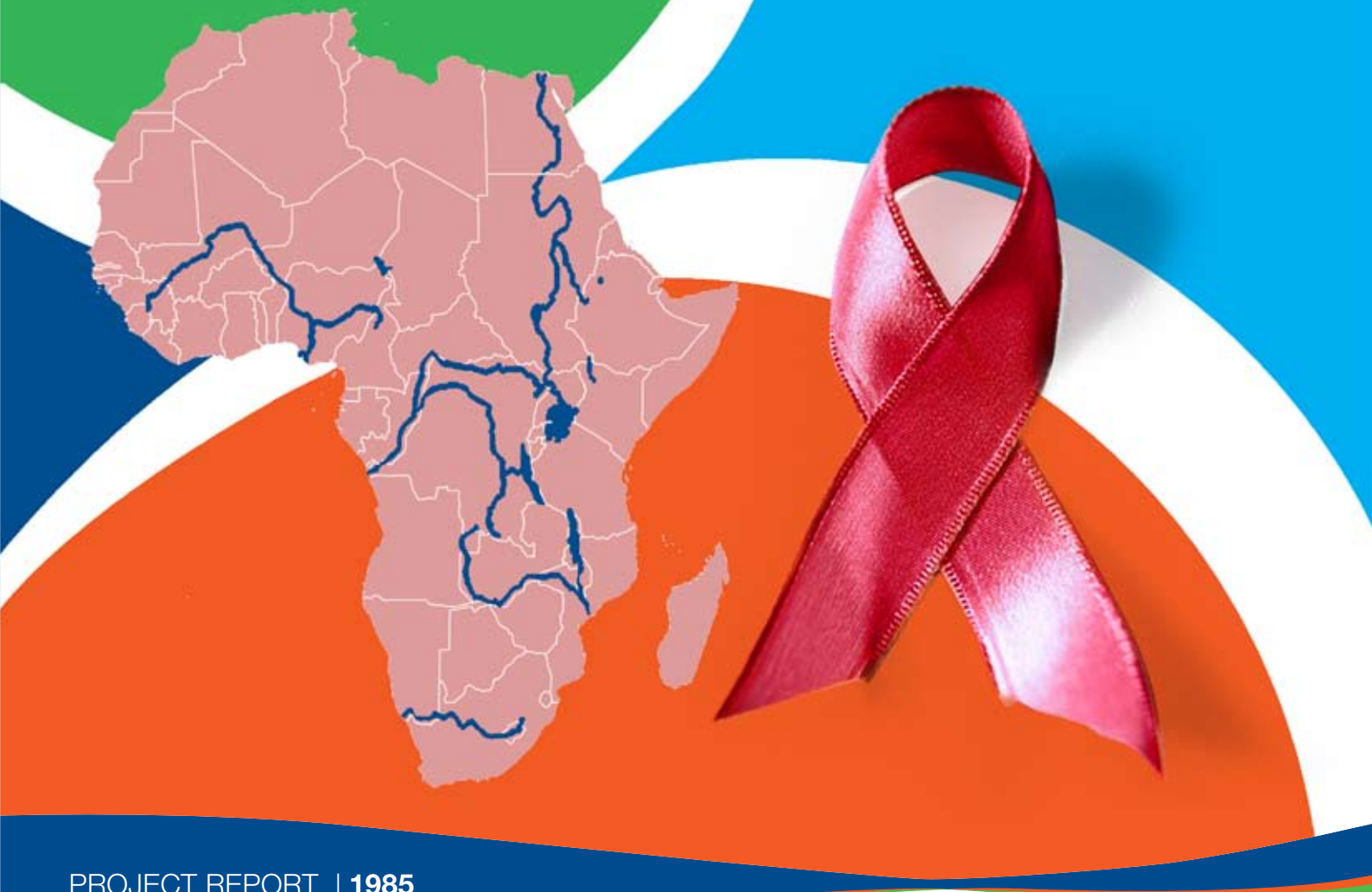


PROJECT REPORT | **1985**

The Impact of Nutrition and Fish Supplementation on the Response to Anti Retroviral Therapy, Zambia

August 2009 • A literature Review

Banda-Nyirenda, D. • Hüsken, S.M.C. • Kaunda, W.

Sida

NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

WorldFish CENTER

The impact of nutrition and fish supplementation on the response to Anti Retroviral Therapy, Zambia.

A literature review.

Banda-Nyirenda, D., Hüsken, S.M.C., and Kaunda, W.

August 2009

Fisheries and HIV/AIDS in Africa: Investing in Sustainable Solutions

This report was produced under the Regional Programme *"Fisheries and HIV/AIDS in Africa: Investing in Sustainable Solutions"* by the WorldFish Center and the Food and Agriculture Organization of the United Nations (FAO), with financial assistance from the Swedish International Development Cooperation Agency (Sida) and the Norwegian Ministry of Foreign Affairs.

This publication should be cited as:

Banda-Nyirenda, D., Hüsken, S.M.C. and Kaunda, W. (2009). Impact of nutrition and fish supplementation on the response to Anti Retroviral Therapy, Zambia. A literature review. Regional Programme Fisheries and HIV/AIDS in Africa: Investing in Sustainable Solutions. The WorldFish Center. Project Report 1985.

Authors' affiliations:
D. Banda-Nyirenda: Department of Animal Science, School of Agricultural Sciences, University of Zambia.
S.M.C. Hüsken: The WorldFish Center Zambia.
W. Kaunda: Kenneth Kaunda Children of Africa Foundation, Zambia.

Cover design: Vizual Solution

Table of Contents

List of acronyms

AIDS	Acquired Immune Deficiency Syndrome
ART	Anti Retroviral Treatment
BMI	Body Mass Index
CD4	Cluster of Differentiation 4 (glycoprotein)
CRS	Catholic Relief Services
CSO	Central Statistics Office (Zambia)
E-pap	Energy protein porridge
DHA	Docosahexaenioc Acid (omega-3 fatty acids in fish tissue)
FAO	Food and Agriculture Organization of the United Nations
GTZ	Germany Technical Aid to Zambia
HIV	Human Immunodeficiency Virus
KKCAF	Kenneth Kaunda Children of Africa Foundation
LDL	Low Density Lipoprotein
MUAC	Mid Upper Arm Circumference
NAC	National HIV/AIDS/STI/TB Council of Zambia
NEPAD	New Economic Programme for African Development
NFNC	National Food and Nutrition Commission (Zambia)
NZP+	Network of Zambian People Living with HIV/AIDS (Zambia)
PLHIV	People Living with HIV
PUFA	Poly Unsaturated Fatty Acids
RDA	Recommended Daily Allowance
RNA	Ribonucleic Acid
RUTF	Ready to Use Therapeutic Food
TB	Tuberculosis
UNAIDS	United Nations Programme on HIV/AIDS
USA	United States of America
WFP	World Food Programme
WHO	World Health Organization

1. Background

Nutrition is the study of how food nourishes the body. The human body is in a dynamic state; it renews its structures continuously, building muscle, bone, skin, blood, and replacing old tissues with new. The body needs food that provides energy and sufficient nutrients such as enough good quality water, carbohydrates, fats, protein, vitamins and minerals. Too little or too much food leads to disease. The best food for the body is the one that supports growth and maintenance of strong muscles, sound bones, healthy skin, and sufficient blood to cleanse and nourish all parts of the body (Sizer and Whitney, 2000).

Availability and intake of adequate amounts of nutritious foods is essential for people living with the Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS) to keep them healthy for a longer period. A stronger, healthier body can better resist opportunistic infections, especially for People Living with HIV (PLHIV) and particularly in resource poor communities. Lack of food security and poor nutritional status may hasten progression to AIDS-related illnesses. It may also undermine adherence and response to ART and exacerbate socio-economic impacts of HIV (UNAIDS, 2008). Nutrition is therefore an important component of comprehensive care of PLHIV. It is particularly imperative in resource limited settings where malnutrition and food insecurity are chronic or endemic, as pre-existing malnutrition exacerbates effects of HIV (Piwoz et. al., 2005).

A balanced intake of nutritious food is an important parameter in the progression and manifestation of HIV and AIDS. There is however a lack of research evidence on the best ways to test the extent of an individual's malnourishment regarding macro-nutrients (energy and protein) and micro-nutrients (vitamins and minerals). Different foods contain varying quantities of the nutrients required for normal health, growth and body repair in sickness. In addition, the quality of food is determined by the quantity and quality of nutrients the food provides. Not all the required nutrients can be found in one food type only, but some foods can provide a major part of the needed nutrients. Fish is such a food that contains high quantity and quality nutrients; it contains high biological availability of nutrients such as proteins, fats, vitamins and minerals.

In Sub Sahara Africa, there is a demand for well-designed studies on nutritional interventions for people living with HIV/AIDS and/or tuberculosis (TB), especially in poor communities where there is both high prevalence of the disease and food insecurity (Science Academy of South Africa panel, 2007). In Zambia, as in many African countries, knowledge is limited on which and how many nutrients are required at various stages of progression to mitigate the disease and how the immune system becomes dysfunctional. This has demanded the need to run statistically designed and controlled trials that are reliable, repeatable, and accurate, in order to increase our understanding of the interactions between HIV/AIDS and nutrition in the Zambian context.

The Kenneth Kaunda Children of Africa Foundation (KKCAF) has felt that a well designed evidence-based nutrition intervention trial is important to establish the significance of food supplementation in the care for people living with HIV and AIDS, and how it slows down the progression of HIV and AIDS in the human body. KKCAF's St Clare Center for Applied Nutrition has reported positive responses to drug interventions when nutritional supplements are

provided during treatment and wound healing of chronically malnourished HIV patients. The KKCAF has been providing nutritional supplementation support in their HIV/AIDS Care Centers in Zambia. This nutritional support includes distribution during clinic hours of fish powder (from Norway), Energy Protein porridge (E-pap), kapenta (small dried whole fish), cooking oil, juice and biscuits as energy supplements (Kaunda et. al., 2008).

In order to validate the KKCAF findings, a statistically controlled fish supplementation research is being undertaken by KKCAF in partnership with the University of Zambia. This work is part of the Regional Programme *Fisheries and HIV/AIDS in Africa: Investing in Sustainable Solutions*, implemented by the WorldFish Center and funded by the Swedish International Development Cooperation Agency (Sida) and the Norwegian Ministry of Foreign Affairs. The research study analyses the effects of a fish supplemented diet on HIV/AIDS patients' response to Anti Retroviral Treatment (ART). This literature review forms the background and basis for the clinical research to be undertaken in selected KKCAF centers in Zambia.

2. Nutrition and food security in the context of HIV/AIDS

Barnett and Grellier (2003) define food security as the adequate supply of and economic access to good quality food in a socially and culturally acceptable manner. Nutrition security is conceptualised in broader terms as "combining secure access to highly nutritive and quality food within a sanitary environment, adequate health services, and knowledgeable care to ensure a healthy life for all household members across time and space (Gillespie, 2006; Greenblott, 2007). This distinction highlights that food security may not necessarily lead to nutrition security, for instance due to poor health, improper care, ignorance, stigma, gender imbalances, personal or cultural preferences, or that food is not being used in a nutritionally effective and efficient manner (Te Lintelo, 2008).

Food and nutrition security are fundamental to HIV treatment. Emerging evidence shows that patients who start ART without adequate nutrition have lower survival rates (Paton et al., 2006). Early nutrition intervention and attention to nutritional needs have long term benefits for people living with HIV. As early as 1998, studies report that proactive nutrition interventions delay HIV progression, reduce cost of medical care, and reduce cases of complications and hospitalization (Fenton and Meyer, 1998). Good nutrition improves effectiveness and tolerance to treatments while increasing the patient's productivity, independence and ability to stay out of hospital. In most countries, including Zambia, governments and civil society are increasingly recognising the important role of nutrition and food security in the national response to HIV/AIDS and overall in national development.

In Zambia, like in most Sub-Saharan African countries, poverty levels are very high, affecting up to 70% of rural and 60% of urban populations. Poverty in Zambia is synonymous to poor health, food insecurity and malnutrition (Stillwaggon, 2002). Nutrition indicators in under-five children, such as stunting, wasting and severe malnutrition, have been unacceptably high and have shown little improvement in the last two decades, although stunting is beginning to show a slight upward trend, as shown in Table 1.

Table 1: Nutrition indicators – children under 5 (Zambia)

Nutrition indicator:	**1996***	**2000****	**2007****
Stunting	40%	53 %	45 %
Wasting	25%	28%	28 %
Severe malnutrition	5%	7%	5 %

*Adapted from: Prospectus for Sustainable Human Development in Zambia, Zambia Human Development Report, 1996.

** Adapted from: Living Conditions, Zambia, Central Statistical Office (CSO), 2000 and 2007 respectively.

2.1. Food insecurity and HIV/AIDS at household level

While malnutrition and hunger in both children and adults particularly in rural areas has been devastating, HIV/AIDS has exacerbated the situation in Sub Saharan Africa. In 1997, in the most-affected countries, up to 11 percent of children were orphans. By 1999, there were 13.2 million AIDS-orphans in the world, 95 percent of them in Sub Saharan Africa. Orphans in the most-affected areas are exposed to severe food insecurity, compounded by the fact that many have lost their parents before learning basic agricultural skills and nutrition or health knowledge. This implies that the elderly, who often take over the care for orphans, have an important role to play in ensuring food security at household level (Drimie, 2002).

In households affected by AIDS mortality or morbidity, women often face a double burden: gaining income and caring for sick relatives (Drimie, 2002). Female-headed households often have a higher dependency ratio than male-headed households (Baylies, 2002). Whether male- or female-headed, a household's labor availability is restricted by HIV/AIDS. Heavier workloads may induce women to plant less labor-intensive and sometimes nutritionally inferior crops. These shifts may increase household food insecurity and malnutrition (Baylies, 2002; Regional Centre for Quality of Health Care, 2003). The same applies to Zambia, where female- headed households are more vulnerable, especially when there are terminally ill family members in the household. Increasing numbers of elderly women are looking after orphans and are unable to engage in productive work to support themselves and the orphans (Schubert, 2005). This renders such households more vulnerable to food insecurity and malnutrition.

2.2. Nutritional status of women in the context of HIV/AIDS

In many Zambian households, women tend to be less food secure than men, as a result of unequal intra-household food allocation (Prospectus for Sustainable Human Development in Zambia, 1996). This is the case in various parts of Sub Saharan Africa and it can start from an early age, but is often exacerbated by women's lack of control over decisions related to food production, consumption, and sale. Traditionally, men are often served larger quantities as well as better quality of food. The resulting malnutrition makes women more vulnerable to HIV infection (Allison and Seeley, 2004). Hence, in places where women are in charge of food production, animal tending, crop planting and harvesting, illness and death of a female head of household particularly threatens household food security. A range of social factors and practices

also impoverish women and weaken their food security, enhancing their likelihood of resorting to transactional sex or other risky strategies to secure a livelihood for the household (Grellier and Omuru, 2008).

Women living with HIV who are resource poor are facing increased challenges in making daily decisions about their own and their children's health and nutrition. Women also grapple with issues of infant feeding, whether or not to breastfeed, and implications of stopping breast feeding early on the survival of the HIV-exposed children (Piwoz and Bentley, 2005). Pregnancy requires additional nutrients for adequate gestational weight gain to support growth and development of the fetus. During and after pregnancy, the nutritional status of a woman living with HIV influences her health and that of her fetus or new born child (National Academy of Science, 1989). The Body Mass Index (BMI) and Mid Upper Arm Circumference (MUAC) and or weight loss, are important predictor of mortality during postnatal period (Lindan et al, 1992; Nduati et al, 2001).

Some 90% of children living with HIV contracted the virus from their mother during pregnancy, delivery or breastfeeding (World Food Programme, 2006). Inadequate nutritional status may increase the risk of vertical HIV transmission by influencing maternal and child factors related to transmission (Gillespie, 2005; UNAIDS, 2008). Fetal low nutrient stores impair the immune function and fetal growth and make them more vulnerable to HIV when the mother is malnourished during pregnancy. Poor nutrition may also impair the integrity of the placenta, the genital mucosa barrier and the gastrointestinal tract leading to mother to child transmission of the virus (Coley, et. al., 2001).

A woman's survival determines the child's escape of HIV, growth and appropriate growth milestones. In the choice of breastfeeding a newborn, the mother has to weigh the implications of not breast-feeding at all or stopping breast feeding early on the nutritional well being of her child, against the positive contributions of breast feeding on nutrition and survival of the child (Piwoz, et. al., 2005). Nutrition education should therefore be part of the comprehensive care for people living with HIV, especially pregnant and lactating women.

2.3. Food Consumption and HIV/AIDS

Several studies have shown that the consumption of high quality animal foods in rural and poor households in Sub Sahara Africa in general is very low (Kikafunda et al., 2003; Nyambose et. al., 2003; FAO, 2007). In Zambia, body building nutrients such as proteins, vitamins and minerals are expensive and hence usually deficient in the regular diet of the poor. Understandably, HIV/AIDS affected households are worse off due to the vicious cycle of low productivity due to ill health or care giving, causing poor production, leading to food insecurity and increased vulnerability to disease and infection, which in turn leads to lower productivity again.

Once the human body develops AIDS, rapid loss of weight combined with loss of appetite exert a heavy toll on an already weak body. The efficacy of drugs on such a challenged body is lowered and may even be detrimental to the survival of the patient. Supplementing a patient

living with HIV or AIDS with nutrient dense Ready to Use Therapeutic Food (RUTF) showed positive responses to antiretroviral drugs by hospitalized an out-patient patients, leading to improved health and return to a more functional life (CRS, 2007). Supplementing such patients' diet with nutrient dense food such as fish, should improve the efficiency of the patient's response to drugs and increase his/her survival rate. Fish is cheaper than meat, hence more accessible to poor households, and can contribute significantly to readily available high quality nutrients to complement cereal based diets (Chilima, 2008).

2.4. Fish consumption in target communities

Fish makes a vital contribution to the survival and health of a significant portion of the world's population. Fish is especially important in the developing world (WorldFish Center, 2008). Fish provides income and is also an important source of food for poor fish farming families (Chilima, 2008). Fish supply in Africa has been declining for a number of reasons while the demand has increased due to the rise in population. Sub Saharan Africa is the only region of the world where scarcity of fish cannot keep up with growing demand, as shown by the decrease in per capita fish consumption from 9kgs to 7kgs less than world average between 1971 and 1997.

Fish capture from both sea and fresh water systems is done by fishing communities that have access to rivers, lakes and sea shores for making a living. It is assumed that availability of fish increases the possibility of high fish protein consumption by such communities, and it is further assumed that fish at varying levels of consumption maybe more affordable to poorer rural communities "as one fish can be shared by the whole family" (FAO, 2007). This assumption is supported by the analysis made by Te Lintelo (2008) of survey data showing less malnutrition in fishing communities around Lake Victoria than in surrounding non-fishing rural communities. This indicates that meeting the daily nutrient requirements may prove to be less of a challenge by individuals in households with fishing as main source of food.

This is why the planned clinical trials in communities in Central Province, where KKCAF provides care, will include a fishing area as study site; Nasenga community in Kafue District, on the banks of the Kafue river. The planned baseline survey will provide the research with information on how much fish the patients consume from their catch. Insights into the nutritional status of patients in this study area (with access to fish) will be gained, and a comparison made with the nutritional status of patients in the other study site (without direct access to fish); Moomba community in Chibombo District.

The pilot clinical trial will include 30 patients in a factorial design with three categories; patients from a fishing community, patients from a fishing community but without direct access to fish, and patients from a non-fishing community. The trial will include food supplementation with kapenta (small dried whole fish) to meet the Recommended Daily Allowance (RDA) of protein in the diet (50g Nitrogen per day) and oil as energy supplement. All patients participating in the study will be on Anti Retroviral Therapy (ART) and their inclusion in the study will be based on baseline information that will be collected to establish food in/security, nutritional status (through determination of Body Mass Index (BMI)), viral load, and CD4 counts. Due to difficulties of comparison, smokers and excessive alcohol consumers will be excluded from the clinical trial.

3. Nutrition policy and interventions

3.1. Nutrition policy and guidelines in Zambia

In many countries hit by the AIDS epidemic, information on nutrition is being circulated, whether this information is correct, incorrect or questionable. Chapman et al (1994) found that the importance of good nutrition in people living with HIV or AIDS facing immune deficiencies was prominent in literature and in the minds of medical practitioners in HIV care. But the lack of accuracy and consistency in nutrition information being spread is particularly worrying; hence efforts have been made by a number of institutions and countries, including Zambia, to develop nutritional guidelines for PLHIV.

National nutrition guidelines generally provide information on nutritional care practices, management of wasting in patients, HIV care and treatment standards based on the national context, treatment philosophy and patient population. People nowadays are more aware of the important role of nutrition in disease than they did in the early 1990s. PLHIV would benefit from early nutrition education and intervention (Meyer, 1993) if policy guidelines existed and were being followed by care givers.

One of the first published guides on nutritional support for PLHIV appeared in Zimbabwe, through the booklet 'Living positively: a nutrition guide for people with HIV/AIDS' (Bijlsma, 1996), produced in English and three local languages. Due to pressure on the UN system to respond to the pandemic, the Food and Agriculture Organization (FAO) took the lead and supported a participatory process to develop nutrition guidelines for PLHIV around the world. By 2000, about 16 nutrition guides for PLHIV or chapters on nutrition in more general guides were developed, each different from the other because of the specific contexts and foods available. FAO together with the World Health Organization (WHO) developed the generic booklet 'Living well with HIV/AIDS; a manual on nutritional care and support for people living with HIV/AIDS' (FAO, 2002).

In 2004, the Zambia's Nutrition Guidelines for care and support of PLHIV were launched by the National Food and Nutrition Commission (NFNC) under the Ministry of Health, and 2008 saw the launch of the Zambia National Food and Nutrition Policy. The National HIV/AIDS/STI/TB Council of Zambia (NAC) has included specific targets and objectives relating to nutrition and food security in the National HIV and AIDS Strategic Framework 2006-2010 (NAC, 2006). The Network of Zambian People Living with HIV/AIDS (NZP+) developed the practical booklet "Food for people living with HIV/AIDS" (NZP+, 2005), while at implementation level, several national and international institutions have included nutrition aspects in their HIV/AIDS care, treatment and awareness activities. A variety of nutrition trainings for health personnel and other care givers has been implemented, yet knowledge and skills on nutritional care and support for PLHIV remain limited among health care providers and the general population. This study therefore underscores the importance of the use of nutrition guidelines.

3.2. Nutrition intervention studies

There is a dearth of research information on well controlled nutrition studies on the impact of nutrition on the response of HIV/AIDS patients to ART. Most information is based on ad hoc observations when nutritional supplementary support is provided to patients. An HIV/AIDS clinical study of 50 patients living with HIV in Muhimbili National Hospital, Tanzania, who were given nutrition counselling and treated for opportunistic infections showed that 30 of them [60%], who strictly followed the counselling on diet, were found to be healthy and resumed their normal daily activities and were free from opportunistic infections. Great improvement was noted to those 30 patients after taking more than 10 fresh oranges, one egg and salads each day, and one glass of undiluted fresh carrot juice every evening before bed time. Out of the 20 clients who were not able to follow the dietary advice, 15 [75%] died and 5 clients were still surviving with poor prognosis regardless of the treatment they received for the opportunistic infections at time of reporting (Malakasuka, 2002).

The Catholic Relief Services (CRS) pilot project of supplementing Zambian Catholic hospice HIV/AIDS patients with Ready to Use Therapeutic Food (RUTF) reported positive responses in which bed ridden patients recovered and some even reported for work after three weeks of feeding the nutrient dense premixed solution (CRS, 2007). This further strengthens the outlook of improved prognosis when good nutrition is provided in a timely manner as co-treatment of HIV/AIDS patients.

There is however need for more statistically controlled scientific studies with specific nutrition interventions to establish the dietary requirement for specific foods and nutrients for improved drug response by PLHIV. There is also need to study the critical levels of nutrients in body pools of people living with HIV/AIDS in order to ascertain and compare critical levels of daily nutrient requirement levels for survival. This would help establish the most critical nutrients and their minimal levels required for survival in patients.

4. Impact of nutrition on HIV/AIDS progression

4.1. Malnutrition and HIV/AIDS

When analyzing how HIV/AIDS is being impacted by malnutrition and food insecurity, we first need to define malnutrition. Malnutrition includes deficiencies of nutrients, imbalances, and excesses, which can take a toll on the body (Sizer and Whitney, 2000). Chronic diseases such as HIV/AIDS put a heavy toll on the nutrient demand by the body due to opportunistic infections that drain body nutrients (diarrhea, vomiting), and/or reduce dietary nutrient intake (mouth and throat sores and poor appetite) and thereby contribute to reduced response to treatment. On a global scale, probably the leading cause of increased host susceptibility to infection is malnutrition (Morris and Potter, 1997).

Poverty and poor nutrition, are closely linked; poverty leads to reduced access to health services and exposes people to nutritional deficiencies, parasitic diseases, and increased susceptibility to

infections (Stillwaggon, 2002) and increased length of infection (Grellier and Omuru, 2008). Food insecure, underfed and ill health individuals have weakened immune systems and are more vulnerable to HIV infection and the eventual development of AIDS (Drimie, 2002).

Certain environmental health conditions prevalent in Africa are also implicated in the poor nutritional status of food insecure individuals, and are important co-factors for increased HIV transmission (Stillwaggon, 2002). For example, malnutrition makes one more susceptible to endemic parasitic diseases such as malaria, schistosomiasis, sleeping sickness and intestinal parasites. These, in turn, exhaust the body's immune system and further aggravate the weak nutritional and epidemiological status. People become increasingly susceptible to opportunistic infections after HIV infection.

Malnutrition is a serious morbidity syndrome and disease complication that affects the functioning of the immune system and consequently impacts on the survivability and quality of life (Meyer, 1997). Daily intake of a balanced diet rich in both macro- and micro- nutrients (including fruit and vegetables) are important to develop body resistance to diseases and thereby maintain good health . This issue is extremely important for the socioeconomic development of developing countries in Africa, where nutritional deficiencies are very high (Science Academy of South Africa panel, 2007), and in poor resource limited communities, where malnutrition and food insecurity are endemic.

Nutritional status is affected by HIV infection through increased resting energy expenditure, reduced dietary intake, nutrient mal-absorption and loss; and complex metabolic changes that result in weight loss associated with HIV/AIDS (Melchior et al, 1991; Grunfeld et al, 1992). The effects of HIV on the nutritional status begin early in the infection, even before individuals are aware that they are infected (Beach et. al., 1992; Bogden et. al., 2000).

It is important that people living with HIV avoid nutrient deficiencies and maintains a healthy body weight in order to improve medicine response (Meyer, 2000). However, due to the controversy over the use of nutritional supplements in tackling HIV and tuberculosis, there is need for scientific studies. It is also important to note that there is no evidence to show that nutritional interventions are an alternative to using the correct medication at the correct times (Wieland, 2007). Good nutrition may however slow down the development of AIDS and stave off the time when drugs are absolutely required to treat HIV related infections.

4.2. Macronutrients in HIV infection

HIV/AIDS puts increased macronutrient (protein and energy requirements) and micronutrient requirements on the patient due to the vicious cycle of reduced intake due to appetite loss and mouth sores, diarrhea, side effects of medication and opportunistic infections, and reduced absorption of nutrients (Grellier and Omuru, 2008). This may result in malnutrition if proper nutrition care is not provided. Table 2 shows the increases in macronutrients needed in the Recommended Daily Allowance (RDA) of nutritional intake in case of HIV infection.

Table 2: Macronutrient requirements in HIV infection

Nutrient	% increase above RDA needed due to HIV	Main food sources
Macronutrients		
Carbohydrates – starches and sugars	10% - 30%	Cereals, starchy roots, fruits, fats, oils, sugars
Carbohydrates – dietary fibre	No change	Vegetables, fruits
Fats	No change	Milk, eggs, meat, offal, poultry, fish, fats, oils, sugars
Proteins	No change	Low fat legumes, high fat legumes, oilseeds, milk, eggs, meat, offal, poultry, fish

Adapted from FANTA (2007); cited in Grellier and Omuru (2008).

Daily energy-protein supplementation to malnourished pregnant women has been shown to improve maternal weight gain, infant birth weight, and reduced stillbirth risk and perinatal mortality (Ceasay et al, 1997). Energy requirements are increased in HIV infection (WHO, 2003) and are compounded by common HIV- related illnesses and infections such as diarrhea, TB, and appetite loss. This places HIV- infected pregnant and lactating women at greater nutritional risk leading to intrauterine growth retardation, preterm delivery (<37 weeks) and low birth weight (2500g or less) (Brocklehurst, 1998).

4.3. Micronutrients in HIV infection

Micronutrient deficiencies such as vitamins A, B-complex, C, and E, and selenium and zinc are exhibited in people living with HIV (Kupka, 2002; Semba, 1999; Friis et al, 2001 a&b). Although the actual changes in micronutrient requirements are not well known yet (see also table 3 below), it has been reported that antioxidant vitamin and mineral deficiencies lead to oxidative stress which may increase immune cell death (Banki et al, 1998; Romero-Alvira, 1998) and increase HIV replication (Allard et al, 1998; Rosenberg, 1990; Schwarz, 1996). Further research in this area is still needed to quantify the changes in order to justify the supplementation levels. Currently in Zambia, vitamins and minerals are recommended without real understanding of efficient levels for proper immune response.

Table 3: Changes in micronutrient requirements above normal RDA due to HIV Infection

Micronutrient	% increase above RDA needed due to HIV	Main food sources
Iron	Unclear	Meat, offal, poultry, fish
Iodine	Not known	Iodized salt
Zinc	Not known	Meat, offal, poultry, fish
Vitamin A	Not known	Meat, offal, poultry, fish, fats, oils, sugars, orange vegetables, fruit
B-group Vitamins	Not known	Meat, offal, poultry, fish
Folate	Not known	Dark green vegetables
Vitamin C	Not known	Vegetables, fruits
Calcium	Not known	Milk and eggs

Adapted from FANTA (2007); cited in Grellier and Omuru (2008).

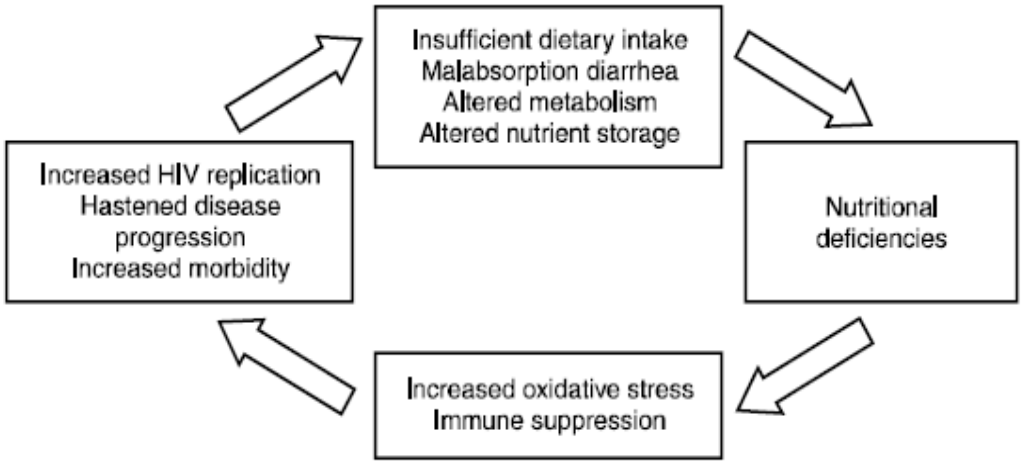
Several studies have shown that micronutrient supplementation in the short-term has resulted in improved body weight and body cell mass (Shabert et al, 1999) decreased HIV- Ribonucleic Acid (RNA) levels, improved CD4 cell counts (Muller et al, 2000), reduced incidents of opportunistic infection (Mocchegiani, 2000) and reduced hospitalization (Burbano et al, 2002) in male and female adults living with AIDS, including those on Anti Retroviral Treatment (ART). Jiamton et al (2003) reported reduced mortality in low CD4 Count ($<200x10^6$/L) patients on daily micronutrient supplementation, despite having no effect on CD4 count or plasma viral load counts.

Fawzi et al reported in several studies that multivitamin (B, C and E) supplementation during pregnancy and breast-feeding decreased the incidence of foetal death, severe premature delivery (before 34 weeks), small size baby for gestational age, and low birth weight (Fawzi et al, 1998), improved infant immune status (Fawzi et al, 2003), prevented HIV transmission in nutritionally and immunologically vulnerable women (Fawzi et al, 2002), increased CD4 cell count and delayed progression of HIV (Fawzi et al, 2004). Oosthuizen et al (2006) observed that Polyunsaturated Fat Acids (PUFA) intake, from heavily oxidized vegetable oils given to poor black South Africans by frying establishments, had an adverse effect to liver function in HIV-infected asymptomatic people. It was also hypothesized (Kock et al, 2002) that these oxidized PUFA may lead to oxidative stress and the quick progression of HIV and AIDS.

4.4. The vicious cycle of HIV/AIDS progression

Before they even know their status, the nutritional status of PLHIV is being affected by a reduced ability of the body to absorb nutrients. As the infection progresses, people's appetite is being affected due to nausea, mouth sores, diarrhea, and other illnesses. At the same time, metabolic requirements for energy, protein and micronutrients increase in order to fight infection and compensate for reduced absorption of nutrients (Grellier and Omuru, 2008). Malnutrition and HIV/AIDS progression sustain a vicious cycle, depicted in Figure 1 below.

Figure 1: HIV/AIDS Vicious Cycle



Source: Te Lintelo (2008), by Semba and Tang (1999), cited in Gillespie and Kadiyala (2005).

As people living with HIV may have to take several medications, drugs may interact with each other and further reduce food intake or affect nutrient absorption and metabolism (Regional Centre for Quality of Health Care, 2003) leading to deficiencies, reduced immunity and increased disease progression. However, the impact of medication still needs to be better understood, particularly for patients on life-long ART (FANTA, 2007, Grellier and Omuru, 2008).

4.5. Weight loss and nutritional risk factors in People Living with HIV

Energy and protein requirements are increasing in a Person Living with HIV (PLHIV), due to depressed immune system integrity, causing early weight loss in the absence of good nutrition. HIV affects nutrition through increased resting energy expenditure, decreased feed intake, presence of nutritional mal absorption, and loss and complex metabolic alterations which all lead to accelerated weight loss (Piwoz et. al., 2005).

People living with HIV or AIDS suffer significant loss of body cell mass and depletion of non-adipose tissue cell mass occur in early stages of HIV. This has lead physicians to add 10% to the desirable weight for an adult person living with HIV (Meyer, 1997). A food bank client study reported in the 1990s showed that men living with HIV weighed further below the usual body weight than women, and women were more likely to weigh above the desirable body weight for HIV positive status, meaning that men living with HIV may start out with weights that put them at higher nutrition risk. Alcohol abuse would negatively influence this weight loss further (Meyer, 1997).

Another study by Meyer identified some nutritional risk factors occurring in PLHIV. These included; eating alone most of the time, eating few fruits and vegetables, low consumption of milk, not eating enough proteins daily, loosing 5kg or more in last six months, tooth or mouth problems that made it hard to eat, being physically unable to care for themselves, facing limited financial resources, and decreased meal times. Since a large proportion of PLHIV face one or more of the above risk factors, they are at increased nutrition risk (Meyer, 1996). These risk factors need to be verified at the onset of disease diagnosis and efforts made to minimize them.

Proactive nutrition intervention and education at initial HIV diagnosis can reduce complications due to drug side effects and metabolic abnormalities. This will reduce the costs of care and enhance the quality of life by restoring lean body mass and decreasing the incidence of secondary infection and immune depletion (Meyer, 2000).

5. The importance of fish as a nutrient source

5.1. Nutrient composition of fish

The previous chapter has shown that HIV/AIDS challenged people need are in constant need of body building and nourishing food nutrients for repair and maintenance and sustaining healthy weight. Fish is a food rich in both macro and micro-nutrients, with good quality proteins and fats (macro), vitamins and minerals (micro), necessary for repair and maintenance of the human body. The nutrient composition varies between fish species and depends on the age, sex and physiological activity of the fish before capture. On average, fish contains 16-28% good quality proteins and 0.25-25% essential vitamins, minerals and lipids. The essential micronutrients include minerals such as calcium, phosphorus, iron, magnesium and selenium; and vitamins including B-complex, vitamin A and D, and essential polyunsaturated fatty acids (Murray, 2001, www.fao.org/fishery/topic/12318, 2008). These nutrients are particularly essential for people with ill health such as HIV/AIDS, TB and malaria, but are deficient in most cereal based diets that are regularly consumed by the poor.

Major components of fish are proteins and lipids, while carbohydrates are in trace or limited amounts (<0.5%). Vitamin content is comparable to that of red meat, except for vitamin A and D which are found in large quantity in fatty species of fish such as liver of cod and halibut. Fish is also rich in B-complex vitamins such as thiamine, riboflavin and niacin (vitamins B_1, B_2 and B_3).

Fish lipids are very high in Poly Unsaturated Fatty Acids (PUFA); up to 40% of long chain highly unsaturated fatty acids, containing 5-6 double bonds (www.fao.org/fishery/topic/12318). Fresh water fish are slightly lower in PUFA than marine fish, containing four, five or six double bonds (www.fao.org/fishery/topic/14826).

5.2. Nutritional benefits of fish nutrients

5.2.1. Omega-3 fatty acids

There is a large volume of evidence relating to the benefits of fish oil to human health, the actual benefit stemming from the omega-3 fatty acid content of fish oil. While these omega-3 fatty acids are present in vegetable oils, these acids are less effective in relation to human health. This makes fish, especially marine fish, one of the richest sources of these vitally important fatty acids (WorldFish Center, 2008). One of the main features of the fatty acids in fish is the contribution they make to the body's energy production. These fatty acids carry out electron transfers by attaching themselves to oxygen in the body and permit energy to be produced for various chemical processes within it. There is therefore considerable evidence that a diet rich in fish oil helps combat fatigue and increases mental and physical capacity.

Omega-3 increases the individual's powers of concentration and his or her energy levels which leads to the saying "fish is good for the brain". The main compound in brain fat is Docosahexaenioc Acid (DHA), an essential Omega-3 fatty acid found in fish tissue (Archives of General Psychiatry, 2002). The omega-3 fatty acids in fish play a role in protecting against cardiovascular disease by reducing blood pressure, cholesterol and triglyceride in the blood.

Triglyceride is a form of fat and resembles Low Density Lipoproteins (LDL, or bad cholesterol), which is high in fat and low in protein content. A raised triglyceride level, especially together with high cholesterol, increases the risk of heart disease. In addition, fish oils reduce life-threatening post-heart attack abnormal heart rhythms (Angerer, 2000; Holub, 1989).

Fish oils are also effective in reducing blood clotting by preventing the thrombocytis in the blood (blood platelets that concentrate or coagulate the blood in the event of bleeding) from adhering to one another. Omega-3 fatty acids play an important role in the production of the molecule haemoglobin, that carries oxygen in the red blood cells, and in controlling the nutrients passing through the cell membrane. They also prevent the damaging effects of fats harmful to the body such as heavily oxidized vegetables oils, which can increase oxidative stress in an already immune compromised body (Connor, 2000; Oosthuizen, 2006).

5.2.2. Fish proteins and minerals

Fish proteins are highly digestible (85 - 95% digestibility) and have a favourable taste (Hassan, 2008). They also contain all the essential amino acids, are comparable to milk and eggs, and are of high biological value. They are an excellent source of lysine, methionine and cysteine which are limited in cereal based diets. They also contain appreciable amounts of non protein nitrogen which plays a role in protein quality (Murray, 2001). This makes fish protein ideal for ill and food insecure patients. Fish meat is rich in minerals such as calcium, phosphorus, iron, copper and selenium. Salt water fish (marine fish) contains high levels of iodine and fluorine (Murray, 2001; WorldFish Center, 2008). These minerals are highly ‘bio-available’ meaning that they are easily absorbed by the body.

Iron is important in the synthesis of haemoglobin in red blood cells which is important for transporting oxygen to all parts of the body. Iron deficiency is associated with anaemia, impaired brain function and in infants it is associated with poor learning ability and behavioural problems. Due to its role in the immune system, its deficiency may also be associated with increased risk of infection, particularly, in people living with HIV.

Calcium is required for strong bones (formation and mineralization) and for the normal functioning of muscles and the nervous system. Calcium is also important in the blood clotting process. Vitamin D is required for its proper absorption. The intake of calcium, phosphorus and fluorine is higher when small fish are eaten with their bones rather than when the fish bones are discarded. Deficiency of calcium may be associated with rickets in young children and osteomalacia (softening of bones) in adults and older people. Fluorine is also important for strong bones and teeth.

Zinc is required for most body processes as it occurs together with proteins in essential enzymes required for metabolism. Zinc plays an important role in growth, development and healthy skin, as well as in the proper functioning of the immune system. Zinc deficiency is associated with poor growth, skin problems and loss of hair.

Iodine, present in seafood, is important for hormones that regulate body metabolism. In children it is required for growth and normal mental development. A deficiency of iodine may lead to goiter (enlarged thyroid gland) and mental retardation in children.

Fish is soft, easy to cook and more easily digested than meat, so even young children and sick people can be fed fish, contributing to improved nutrient intake. Fish can also be used as complementary foods especially in paste or powder form. These products can be used to enrich the maize and cassava based porridges that are normally consumed by young children and the sick in poor households and in rural communities, especially in Africa (WorldFish Center, 2008). It is evident that fish contributes more to people's diets than just the high quality protein they are known for. Fish should therefore be an integral component of the diet, preventing malnutrition by making these macro and micro nutrients readily available to the body (WorldFish Center, 2008).

5.3. Fish as a source of nutrients for People Living with HIV

Fish makes up an important part of household diets and is a cheap source of protein and other nutrients compared to other sources, especially important for infants, young children and pregnant women (NEPAD, 2003; Grellier, 2004; Gordon, 2005; WorldFish Center, 2005). Smaller fish species are especially important for poor consumers as they can be purchased in small quantities and are consumed whole, providing both protein and in particularly, minerals (calcium and phosphorus). Protein deficiencies are likely to occur in African populations that are highly dependent on cereals, roots, tubers, and bananas/plantain (Williams and Ayemon, 1998). Such diets could be complemented by fish, providing important protein and essential nutrients that are not or insufficiently present in these staples (WorldFish Center, 2005).

Little is yet known about household consumption, the role of fresh and processed fish in food consumption baskets, and the intra-household allocation of fish to individual members. For people living with HIV, who particularly require additional energy, fish may contribute indirectly to energy needs also if given in excess of protein requirements. However, as the needs of poor households are diverse, priority lies often with cash rather than fish, which means that in the majority of households, nutritious fish is being sold rather than consumed, causing the household to miss out on the source of nutrients the fish could have provided. High prices offered may also motivate fishing families to sell most of the catch (Te Lintelo, 2008). Price fluctuations may also have distinct effects on the access of the poor to fish products in non-fishing communities.

While micro-level data on fish consumption in fishing communities is sparse, FAO publishes national production level data for countries around the world, which present total fish supply per capita, and indicate the share of fish in total animal protein intake, as shown in Table 4. These figures give some indicative comparison between countries, but are likely underreporting supply for inland and coastal fishing communities, as they present averages. Differentiations between rich and poorer groups in society cannot be made based on these figures, nor do they provide an insight into intra-household allocation of fish and other animal protein intake.

Table 4: Fish supplies and share of fish protein in animal protein consumption

Country	Per capita fish supply (kg/year)	Contribution of fish in total animal protein (%)
Angola	6.6	27.1
Burundi	3.2	29.6
Congo Dem. Rep.	5.7	31.0
Equatorial Guinea	22.6	61.9
Ghana	22.5	63.2
Malawi	5.7	37.7
Senegal	36.3	47.4
Tanzania	10.3	33.6
Uganda	9.8	30.0

Adapted from the WorldFish Center (2005).

Some studies note that fish, unlike other high protein foods, is distributed more equally among household members in many parts of the world (WorldFish Center, 2005). This is particularly important in research on intra-household allocation of food, to analyse if the high divisibility of fish contributes to improved nutritional status of women, children and sick people within the household. So far, no such data is available from Zambia.

In Zambia, preliminary studies at KKCAF by Kaunda et al (2008) have demonstrated positive effects of supplementing patients on clinical treatment with food (kapenta, E-pap porridge, fish powder, mushrooms) in reducing opportunistic infections and chronic wound healing in PLHIV. These results are in line with above mentioned studies, and underscore the importance of improved nutrition in the treatment of PLHIV. KKCAF is using fish powder as nutritional support for PLHIV who are on ART, and this supplementation has received varying responses by patients, as the particular smell and taste causes some patients to have difficulties in consuming it (Kaunda et al, 2008). Kapenta is the most readily available fish to most vulnerable households in Zambia and it is eaten as a whole fish. Tilapia fish is readily available to most vulnerable people near rivers and lakes. The nutrient composition and utilization of fish powder, kapenta and tilapia in diets of PLHIV needs further study through comparative performance of patients on ART receiving these food supplements. KKCAF in collaboration with the University of Zambia, School of Agricultural Sciences, is currently undertaking clinical trials with selected patients from KKCAF centers, to determine the impact of fish supplementation on the response to ART.

6. Conclusion

While malnutrition and hunger in both children and adults particularly in rural areas of Sub Sahara Africa has been devastating, HIV/AIDS has exacerbated the situation. Rapid loss of weight through opportunistic infections exerts a heavy toll on an already weak and immune reduced body. The efficacy of drugs on such challenged bodies is lowered and may even be detrimental to the survival of the patient.

Several studies have shown that People Living with HIV would benefit from early and effective nutrition education to decrease their potential for malnutrition. Although nutrition is increasingly being acknowledged as important in preventive care and management of HIV/AIDS, many health practitioners and care givers in Zambia are still not using nutritional guidelines for the management of HIV/AIDS. The correct use of nutrition guidelines is crucial and should be integrated as co-treatment in HIV care and management. Supplementing patients living with HIV/AIDS with nutrient dense foods such as fish (KKCAF, 2008) and Ready to Use Therapeutic Food (RUTF) (CRS, 2007) showed positive responses to treatment, including ART. Nutrition support facilitates improved intake and uptake of medication, leading to improved health and return to normal daily life by hospitalized patients.

This literature review has elaborated on the impacts of nutrition on PLHIV. In view of the high nutritious value of fish, the role of fresh, processed fish and small whole fish in people's diets, especially PLHIV, is potentially large and needs to be studied further. While studies and initial trials indicate positive results, more scientific research is needed on the impact of nutrition and specific foods, such as fish, on PLHIV and their response to ART. The information outlined in this literature review will provide the background to and enable improved strategy for the design and implementation of the clinical research trials by KKCAF in Zambia. These clinical trials seek to establish the importance of fish supplementation to ART response by patients, in order to make scientifically proven recommendations on fish supplementation and providing policy guidelines on the importance of fish the in the diets of PLHIV.

7. Recommendations

This literature review has indicated that there are areas in the understanding of nutrition and HIV/AIDS that require further research, specifically on the impacts of fish in the diets of PLHIV. Areas for further study and analysis include:

1. Households affected by HIV/AIDS; there is need to gain insights into in-depth food consumption patterns in general, the role of fresh and processed fish in food consumption baskets, and intra-household food allocation, including food allocation to sick household members.
2. There is need to further analyze (a) nutritional changes in the etiology of HIV/AIDS, (b) dietary requirements, and (c) reflected minimal body nutrient pools in the survival of the patients.

3. Fishing communities; there is need for more baseline information on the nutritional and food security status of fisher folk and fish traders, specifically those living with HIV/AIDS. Further insights are needed on seasonal food insecurity in fish-dependent communities and to assess the potentials for livelihood diversification in such communities.
4. Fish consumption promotion; further analysis is needed to compare fish with alternative food sources in terms of its availability, affordability (e.g. number of nutritional units as % of recommended daily intake per price unit) and cultural acceptability to poor communities. Additionally, more insights are needed into the nutritional benefits of fish and fish products (kapenta in particular, as it is consumed as a whole), specifically looking at PLHIV's need for specific nutrients.

8. References

Africa, Success Stories - Malawi (2007). Fish Farming Eases Living with HIV/AIDS. Global Envision.

Allard,J.P., Aghdassi, E., Chau, J., Tam, C., Kovacs, C.M., Salit, I.E. and Walmsley, S.L. (1998). Effects of vitamin E and C supplementation on oxidative stress and viral load in HIV-infected subjects. AIDS 12:1653-1659.

Allison, E.H. (2003). Linking National Fisheries Policy to Livelihoods on the Shores of Lake Kyoga, Uganda. Norwich: Overseas Development Group. LADDER Working Paper No. 9. 43 pp.

Allison, E.H., and Seeley, J.A. (2004). HIV and AIDS among fisherfolk: a threat to 'responsible fisheries'? *Fish and Fisheries*. 5 (3): 215-234.

Angerer P, von Schacky C. (2000). "n-3 Polyunsaturated fatty acids and the cardiovascular system," Curr Opin Lipidol, 11 (1): 57-63.

Archives of General Psychiatry (2002). October: 59: 913-919.

Banki, K., Hutter, E., Gonchoroff, N.J. and Perl, A. (1998). Molecular ordering in HIV-induced apoptosis. Oxidative stress, activation of caspases, and cell revival are regulated by transaldolase. Journal of Biology and Chemistry. 273:11944-11953.

Barnett, T., and Grellier, R. (2003). Mitigation of the impact of HIV/AIDS on rural livelihoods through low-labor input agriculture and related activities. Norwich: Overseas Development Group. Report submitted to DFID. 107 pp.

Baylies, C. (2002). The impact of AIDS on rural households in Africa: a shock like any other? *Development and Change*. 33 (4): 611-632.

Beach, R.S., Mantero-Atienza, E., Shor-Posner, G., Javier, J.J., Szapocznik, J., Morgan, R., Sauberlich, H. E., Cornwell, P. E., Eisdorfer, C. and Baum, M.K.(1992). Specific nutrient abnormalities in asymptomatic HIV-1 infection. AIDS 6:701-708.

Bell, C., Devrajan, S., and Gersbach, H. (2003). The long run economic costs of AIDS: theory and an application to South Africa. Washington, DC: World Bank. World Bank Policy and Research Paper No. 3152.

Bijlsma, M. (1996). Living positively: a nutrition guide for people with HIV/AIDS. Second ed. 1997, Mutare City Health Department, Mutare, Zimbabwe.

Biodiversity and Natural Resource Management. Washington D.C. Population Reference Bureau.

Bogden, J.D., Kemp, F.W., Han, S., Li, W., Bruening, K., Denny, T., Oleske, J.M., Lloyd, J. & Baker, H., et al (2000) Status of selected nutrients and progression of human immunodeficiency virus type 1 infection. American Journal of Clinical Nutrition 72:809-815.

Bowie, C., Kalilani, L., Marsh, R., Misiri, H., Cleary, P. and Bowie, C (2005). An assessment of food supplementation to chronically sick patients receiving home based care in Bangwe, Malawi: A descriptive study. Nutrition Journal, 4:12doi:10.1186/1475-2891-4-12.

Brocklehurst, P. & French, R. (1998). The association between maternal HIV infection and perinatal outcome: a systematic review of the literature and meta-analysis. British Journal of Obstetric Gynaecology. 105:836-848.

Burbano, X., Miguez-Burbano, M.J., McCollister, K., Zhang, G., Rodriguez, A., Ruiz, P., Lecusay, R. and Shor-Posner, G. (2002). Impact of a selenium chemoprevention clinical trial on hospital admissions of HIV-infected participants. HIV Clinical Trials 3:483-491.

Catholic Relief Services (2008). Evaluation report on HIV/AIDS patients' response to RUTF supplementation by Valid International in health care centers.

Ceasay, S. M., Prentice, A.M., Cole, T.J., Foord, F., Weaver, L.T., Poskitt, E.M. and Whitehead, R.G. (1997) Effects on birth weight and perinatal mortality of maternal dietary supplements in rural Gambia: 5 year randomised controlled trail. British Medical Journal. 315:786-790.

Central Statistical Office (2007). House hold survey report. Lusaka, Zambia.

Chilima, D.M. (2008). Strengthening the role of fish for nutrition security in Eastern and Southern Africa: A concept note. WorldFish Center, Lusaka Office.

Coley, J.L., Msamanga, G.I., Fawzi, M.C., Kaaya, S., Hertzmark, E., Kapiga, S., Spiegelman, D., Hunter, D. and Fawzi, W.W. (2001). The association between maternal HIV-1 infection and pregnancy outcomes in Dar es Salaam, Tanzania. BJOG 108:1125-1133.

Connor, W.E. (2000). The importance of n-3 fatty acids in health and disease. American Journal on Clinical Nutrition; 71 (1 Suppl): 171S-5S.

Drimie, S. (2002). The impact of HIV/AIDS on rural households and land issues in Southern and Eastern Africa. A background paper prepared for the Food and Agricultural Organization, sub-regional office for Southern and Eastern Africa. Pretoria: Human Sciences Research Council. 31 pp.

Drimie, S., and Mullins, D. (2006). Mainstreaming HIV and AIDS into Livelihoods and Food Security Programs: The Experience of CARE Malawi. *In* S. Gillespie. (ed.) *Aids, Poverty and Hunger: Challenges and responses*. Washington: IFPRI. pp. 283-303.

FANTA (2007). Recommendation for the Nutrient Requirements for People Living with HIV/AIDS Food and Nutrition Technical Assistance (USAID). 2 pp. 37 <www.fantaproject.org/downloads/pdfs/Nutrient_Requirements_HIV_Feb07.p df >.

FAO Committee on World Food Security (2001). The Impact of HIV/AIDS on food security (http://www.fao.org/docrep/meeting/003/y0310E.hmt)

FAO (2008). Present and future markets for fish and fish products from small-scale fisheries - case studies from Asia, Africa and Latin America. FAO Fisheries Circular. Rome: Food and Agriculture Organization of the U.N. Factsheet. 87 pp.

FAO (2005). Contribution, role and importance of small-scale fisheries in poverty alleviation and food security. In: FAO Technical Guidelines for responsible fisheries 10: Increasing the contribution of small-scale fisheries to poverty alleviation and food security. FAO, Rome.

FAO (2002). Living well with HIV/AIDS. A manual on nutritional care and support for people living with HIV/AIDS. Joint publication with World Health Organization. Rome, Italy.

Fawzi, W.W., Msamanga, G.I., Spiegelman, D., Urassa, E.J., J McGrath, N., Mwakagile, D., Antelman, G., Mbise, R. and Herrera, G., et al (1998). Randomised trial of effects of vitamin supplements on pregnancy outcomes and T cell counts in HIV-1 infected women in Tanzania.

Fawzi, W.W., Msamanga, G.I., Wei, R., Spiegelman, D., Antelman, G., Villamor, E., Manji, K. and Hunter, D. (2003). Effect of providing vitamin supplements to human immunodeficiency virus-infected, lactating mothers on the child's morbidity and CD4+ cell counts. Clin. Infect. Dis. 36:1053-1062.

Fawzi, W.W., Msamanga, G.I., Hunter, D., Renjifo, B., Antelman, G., Bang, H., Manji, K., Kapiga, S., Mwakagile, D., Essex, M., and Spiegelman, D., (2002). Randomized trial of vitamin supplements in relation to transmission of HIV-1 through breastfeeding and early child mortality. AIDS 16:1935-1944.

Fawzi, W.W., Msamanga, G.I., Spiegelman, D., Wei, R., Kapiga, S., Villamor, E., Mwakagile, D., Mugusi, F. and Hertzmark, E., et al (2004). A randomized trial of multivitamin supplements and HIV disease progression and mortality. N. Engl. J. Med. 351:23-32.

Fenton M., Meyer S.A. (1998). Nutritional Care Guidelines Networking Breakfast. Fifth Annual AIDS Meal and Nutrition Provider's Conference, San Francisco, California, USA.

Friis, H., Gomo, E., Koestel, P., Ndhlovu, P., Nyazema, N., Krarup, H. and Michaelsen, K.F. (2001). HIV and other predictors of serum folate, serum ferritin, and haemoglobin in pregnancy: across-sectional study in Zimbabwe. American Journal of Clinical Nutrition, 73:1066-1073.

Friis, H., Gomo, E., Koestel, P., Ndhlovu, P., Nyazema, N., Krarup, H. and Michaelsen, K.F. (2001). HIV and other predictors of serum betacarotene and retinol in pregnancy: across-sectional study in Zimbabwe. American Journal of Clinical Nutrition, 73:1058-1065.

Geheb, K., and Binns, T. (1997). 'Fishing farmers' or 'farming fishermen'? The quest for nutritional security on the Kenyan shores of Lake Victoria. *African Affairs*. 96: 73-93.

Geheb, K., and Crean, K. (2003). Community-level access and control in the management of Lake Victoria's fisheries. *Journal of Environmental Management*. 67: 99-106. <http://www.sciencedirect.com/science/article/B6VCB-4PCXXT1-1/1/a90aa7f3ac043f35d6d2cee1e6a626bd>.

Gillespie, S. (2006). AIDS, poverty and hunger: an overview. *In* S. Gillespie. (ed.) *Aids, Poverty and Hunger: Challenges and responses*. Washington: IFPRI. pp. 1- 32.

Gillespie, S.R., and Kadiyala, S. (2005). HIV/AIDS and food and nutrition security: from evidence to action. Washington D.C.: IFPRI. Food Policy Review No. 7. <http://www.ifpri.org/pubs/fpreview/pv07/pv07.pdf>.

Gorbach, S. L., Knox, T.A. and Roubenoff, R. (1993). Interactions between nutrition and infection with human immunodeficiency virus. Nutr. Rev. 51:226-234.

Grellier, R., and Omuru, E. (2008). The potential impact of HIV and AIDS on agricultural systems and nutrition in Papua New Guinea Options. Draft report. 72 plus annexes pp.

Grellier, R., Tanzarn, N., Lamberts, D., and Howard, C. (2004). The impacts of HIV/AIDS on fishing communities in Uganda: Situation analysis. London: DFID, MRAG, Options.

Grunfeld, C., Pang, M., Shimizu, L., Shigenaga, J.K., Jensen, P. and Feingold, K.R. (1992). Resting energy expenditure, caloric intake, and short-term weight change in human immunodeficiency virus infection and the acquired immunodeficiency syndrome. American Journal of Clinical Nutrition 55:455-460.

Hassan, N. (2008). Importance of Fish in Household Nutrition. University of Florida, IFAS Extension. Florida USA.

Holub, B.J. (1989). "Fish oils and cardiovascular disease," CMAJ, 141:1063.

Jayne, T.S., Villarreal, M., Pingali, P., and Hemrich, G. (2006). HIV/AIDS and the Agricultural Sector in Eastern and Southern Africa: Anticipating the Consequences. *In* S. Gillespie. (ed.) *Aids, Poverty and Hunger: Challenges and responses*. Washington: IFPRI. pp. 141-166.

Jiamton, S., Pepin, J., Suttent, T., Filteau, S., Mahakkanukrauh, B., Hanshaoworakul, W., Chaisilwattana, P., Suthipinittharm, P., Shetty, P. and Jaffar, S. (2003). A randomized trial of the impact of multiple micronutrient supplementation on mortality among HIV infected individuals living in Bangkok. AIDS 17:2461-2469.

Kaunda, W., Chizyuka, M. and Phiri, M. (2008). The possible role of medicinal mushrooms and kapenta in wound healing: A preliminary Zambian Study.

Kent, G. (1997). Fisheries, food security, and the poor. *Food Policy*. 22 (5): 393-404.
Kikafunda, J.K., Walker, A.F. and Tumwine, J.K. (2003). Weaning foods and practices in central Uganda: A cross-sectional study. Africa Journal of Food, Agriculture, Nutrition and Development. 3:1-13.
Kissling, E., Allison, E.H., Seeley, J.A., Russell, S., Bachmann, M., Musgrave, S.D., and Heck, S. (2005). Fisherfolk are among groups most at risk of HIV: cross-country analysis of prevalence and numbers infected. *AIDS*. 19 (17): 1939- 1946.
Kock, J.L.F., Pohl, C.H., Venter, A. (2002). Super-oxidized soups and the health risks to poor South Africans. South Afr. J. Sci. 8:413-4.
Kupka, R. & Fawzi, W.W. (2002). Zinc nutrition and HIV infection. Nutr. Rev 60:69-79.
Lindan, C.P., Allen, S., Serufilira, A., Lifson, A.R., Van de Perre, P., Chen-Rundle, A., Batungwanayo, J., Nsengumuremyi, F., Bogaerts, J. and Hulley, S. (1992). Predictors of mortality among HIV infected: women in Kigali, Rwanda. Ann. Intern. Med. 116:320 328.
Lovendal, C.R. (2004). Food Insecurity and Vulnerability in Viet Nam: Profiles of Four Vulnerable Groups. Rome: FAO. ESA Working Paper No. No. 04-11. 55 pp.
LVFO (2005). Regional report on Lake Victoria Frame surveys for 2000, 2002 and 2004. Jinja, Uganda: Lake Victoria Fisheries Organization and the Lake Victoria Environmental Management Project.
Malakasuka, E.M. and Masangi, V. (2002). The impact of nutrition on HIV/AIDS clients. *International Conference on AIDS.* Jul 7-12; 14: abstract no. ThPeF8213.
Melchior, J.C., Salmon, D., Rigaud, D., Leport, C., Bouvet, E., Detruchis, P., Vilde, J.L., Vachon, F., Coulaud, J.P. and Apfelbaum, M. (1991). Resting energy expenditure is increased in stable, malnourished HIV- infected patients. American Journal of Clinical Nutrition 53:437-441.
Meyer, S.A. (2000). Nutritional Care and People Living With HIV. Arizona Dietetics Association. Mesa Arizona.
Meyer, S.A. (1997). The weight status of HIV-Challenged people. AIDS Meal's Provider's Conference. Miami Beach, Florida USA.
Meyer, S.S. (1993). The extent and sources of nutrition knowledge in People Living with HIV in Broward County Florida. Florida Dietetic Association, Tarpon Springs, Florida USA.
Mocchegiani, E. & Muzzioli, M. (2000) therapeutic application of zinc in human immunodeficiency virus against opportunistic infections Nutr. 130:1424S-1431S.
Morris, J.G., and Potter, M. (1997). Emergence of New Pathogens as a Function of Changes in Host Susceptibility. *Emerging Infectious Diseases*. 3 (4). <http://www.cdc.gov/ncidod/eid/vol3no4/morris.htm>.
Muller, F., Svardal, A.M., Nordoy, I., Berge, R.K.., Aukrust, P. and Froland, S.S. (2000). Virological and immunological effects of antioxidant treatment in patients with HIV infection. Eur. J. Clin. Invest. 30:905-914.
Mulligan, K., Tai, V. & Schambelan, M. (1997). Energy expenditure in human immunodeficiency virus infection. N. Engl. J. Med. 336: 70-71.
Murray, J. and Burt, J.R. (2001). The Composition of Fish. Ministry of Technology, Torry Research Station, Torry Advisory Note No. 38. FAO in partnership with Support unit for International Fisheries and Aquatic Research, SIFAR. http://www.fao.org/fishery/topic/12318/en

National Academy of Sciences (1989). Recommended Dietary Allowances 10th ed. 1989 National Academy Press Washington, DC.

National Food and Nutrition Commission (2004). Nutrition Guidelines for care and support of people living with HIV/AIDS. Ministry of Health publication, Lusaka, Zambia.

National Food and Nutrition Commission (2008). The Food and Nutrition Policy for Zambia. Ministry of Health publication, Lusaka, Zambia.

National HIV/AIDS/STI/TB Council (2006). National HIV and AIDS Strategic Framework 2006-2010. National HIV/AIDS/STI/TB Council publication, Lusaka, Zambia.

Nduati, R., Richardson, B.A., John, G., Mbori-Ngacha, D., Mwatha, A., Ndinya-Achola, J., Bwayo, J., Onyango, F.E. and Kreiss, J. (2001) Effect of breastfeeding on mortality among HIV-1 infected women: a randomized trial. Lancet 357:1651-1655.

NEPAD (2003). Comprehensive Africa Agriculture Development Programme. Midrand: New Partnership for Africa's Development. 102 pp.

Nunan, F. (2006). Empowerment and institutions: managing fisheries in Uganda. *World Development*. 34 (7): 1316-1332.

Nyambose, J., Koski, K.G. and Tucker, K.L. (2002). High intra/inter individual variance ratios for energy and nutrient intakes of pregnant women in rural Malawi show that many days are required to estimate usual intake. Journal of Nutrition; 132:1313-1318.

NZP+ Network of Zambian People Living with HIV/AIDS (2005). Food for people living with HIV/AIDS. Third edition. Lusaka, Zambia.

Oosthuizen W., Van Graan, A., Kruger A, Vorster H.H. (2006). Polyunsaturated fatty acid intake is adversely related to liver function in HIV-infected subjects: The THUSA study. American Journal of Clinical Nutrition. 83:1193-8.

Piwoz, E.G., and Bentley, M.E. (2005). Women's Voices, Women's Choices: The Challenges of Nutrition and HIV/AIDS. J. Nutrition. 135:933-937.

Romero-Alvira, D. and Roche, E. (1998). The keys of oxidative stress in acquired immune deficiency syndrome apoptosis. Med. Hypotheses 51:169-173.

Rosenberg, Z.F. and Foci, A.S. (1990) Immunopathogenic mechanisms of HIV infection: cytokine induction of HIV expression. Immunology Today 11:176-180.

Russell, S. (2003). The economic burden of illness for households - A review of cost of illness and coping strategy studies focusing on malaria, tuberculosis and HIV/AIDS. DCPP working papers No. 15. 46 pp.

Schubert (2005). Impact of Cash Transfers in Kalomo District of Zambia, A mid-term report. German Technical Aid to Zambia (GTZ).

Schwarz, K.B. (1996). Oxidative stress during viral infection: a review. Free Radic. Biol. Med. 21:641-649

Scrimshaw, N.S., Taylor, C.E. and Gordon, J.E. (1968) Interactions of nutrition and infection. Monogr. Ser. World Health Organization. 57:3-329.

Seeley, J.A., and Allison, E.H. (2005). HIV/AIDS in fishing communities: challenges to delivering antiretroviral therapy to vulnerable groups. *AIDS Care*. 17 (6): 688- 697.

Semba, R.D., and Tang, A.M. (1999). Micronutrients and the pathogenesis of human immunodeficiency virus infection. *British Journal of Nutrition*. 81 (3): 181-189.

Shabert, J.K., Winslow, C., Lacey, J.M. and Wilmore, D.W. (1999). Glutamine-antioxidant supplementation increases body cell mass in AIDS patients with weight loss: a randomized, double-blind controlled trial. Nutrition 15:860-864

Sizer, F. and Whitney, E. (2000). Nutrition Concepts and Controversies. Ch. 1, 8th Edition, Wadsworth Publishers.

Stillwaggon, E. (2002). HIV/AIDS in Africa: Fertile Terrain. *Journal of Development Studies*. 38 (6): 1-22.

Te Lintelo, D. (2008). Food security, nutrition and HIV/AIDS in African fisheries: emerging evidence and research directions. Literature review. Overseas Development Group & School of Development Studies, University of East Anglia, Norwich, NR4 7TJ, United Kingdom.

Torell, E., Kalangahe, B., Thaxton, M., Issa, A., Pieroth, V., Famyh, O., and Tobey, J. (2007). Guidelines for Mitigating the Impacts of HIV/AIDS on Coastal.

UNAIDS (2008). HIV, Food Security and Nutrition. UNAIDS Policy Brief.

Wieland, G. (2007). Nutrition and disease debate should shift science. SciDevNet Academy of Science, South Africa.

Williams, S.W., and Ayemon, A.O. 1998. Protein in African Diets. *African Development Review*. 10 (2): 27-38. <http://dx.doi.org/10.1111/j.1467-8268.1998.tb00109.x>.

WorldFish Center (2005). Fish and Food Security in Africa. Penang: World Fish Center.

www.fao.org/fishery/topic/ 2008 Principle elements of fish muscle

www.fao.org/fishery/topic/12253 2008. Composition of fish

www.fao.org/fishery/topic/12318, 2008. Composition of fish

www.fao.org/fishery/topic/14820, 2008. Chemical elements of fish

www.fao.org/fishery/topic/14825, 2008. Principle elements of fish muscle

www.fao.org/fishery/topic/14826, 2008. Fish lipids

www.fao.org/fishery/topic/14826, 2008. Fish vitamins and minerals

WorldFish Center (2008). Fish: A Valuable Source of Nutrition

WorldFish Center (2008). Fish and Human Nutrition.

WorldFish Center (2008). Fish Food and Energy: Balancing our approaches to meeting growing demand. WorldFish Center Penang, Malaysia. www.worldfishcenter.org

World Food Programme (WFP) (2006). HIV/AIDS & Care and treatment: Food in response to AIDS. June 2006.

World Health Organization (WHO) (2003). Nutrient requirements for people living with HIV/AIDS. Report of a Technical Consultation. May 13-15, 2003. WHO, Geneva, Switzerland.