



HIV Infection and Nutrition Status: The Importance of Food in Disease Management

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Preliminary evidence suggests that improved nutrition early in human immunodeficiency virus (HIV) infection may delay progression to acquired immunodeficiency syndrome (AIDS) and delay the initiation or improve the effectiveness of antiretroviral drug therapy (ART). The scientific community has evolved in its appreciation of the value of food as an integral component of comprehensive care for individuals with HIV infection and AIDS. It is now well recognized that those who are food insecure and malnourished are more likely to fail drug treatment regimens. Body mass index (BMI) < 18 at the initiation of ART is strongly predictive of death. In addition, weight loss during the first four weeks of ART is also associated with death. A higher BMI is protective and is associated with better responses with ART. Patient response to nutrition intervention, however, may be confounded by the stage of HIV progression and other infections. That is, those who are in the earlier stages of the disease may respond better to aggressive nutrition intervention. The HIV Nutrition Project (HNP), "Increasing Animal Source Foods in Diets of HIV-infected Kenyan Women and Their Children," will evaluate the effect of protein quality and micronutrients found in meat on the health and nutritional well-being of women living with HIV in rural Kenya and the health and development of their children. By means of a randomized nutrition feeding intervention, researchers will study if the inclusion of meat added as an ingredient to a biscuit, when compared to soy or wheat, will best protect the immune system and prevent severe infection, prevent the loss of body mass and enhance the quality of life. These women are not yet receiving antiretroviral drugs and therefore not yet experiencing metabolic inefficiencies associated with AIDS.

Background

Most individuals infected with the human immunodeficiency virus (HIV) live in resource poor areas of the world, where food insecurity is common and the collective burdens of HIV-associated illnesses superimposed upon poverty target them towards the downward spiral of malnutrition that ultimately leads to death (Figure 1). In sub-Saharan Africa, over 30% of adults have insufficient food intake, and those with HIV are particularly vulnerable. The consequences of HIV (Figure 2), even in food secure populations, cause individuals to become malnourished. The malnutrition will cause the afflicted to suffer from fatigue and other infections and illnesses which worsen the degree of malnutrition and affect the ability of individuals to carry out normal functions of daily living. Ultimately, work productivity is affected, which jeopardizes independence and quality of life. The HIV-infected women who receive meat in the HNP project may better sustain themselves and their families with increased agricultural productivity.

Major Findings

Nutrition and immunity. The body's ability to resist infection and disease, also referred to as immune function, is decreased with deficiencies of protein,

energy, Vitamins A, E, D, C, the B –complex, folate, iron, zinc, copper, magnesium and selenium. A toxic state of iron and zinc will also impair immune function. Nutrient deficiencies may occur due to lack of a variety of foods in the household, the inability to eat enough food, the increased need for nutrients over and above nutrient intake or increased losses of nutrients from complications of vomiting, diarrhea or the body's inability to break down and/or absorb specific nutrients. All of these are potential causes of malnutrition in PLWHA - persons living with HIV and acquired immunodeficiency syndrome (AIDS) (Figures 1 and 2).

The effect of starvation on the human system. In 1950, Ancel Keys and others at the University of Minnesota Laboratory of Physiological Hygiene published *The Biology of Human Starvation*, a detailed description of the physiological and cognitive effects of three months of semi-starvation (about a 50% energy deficit) followed by a year of re-feeding. The study included 36 healthy men who were conscientious objectors to World War II and re-created conditions of the millions who were starving in Europe towards the end of the war. Keys was interested in what would be required to bring the starving back to normal. The studies demonstrated that both fat and muscle (lean mass) were lost when

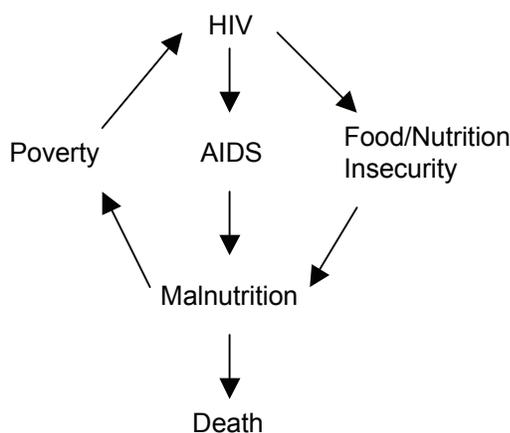
overall body weight decreased and that when weight was regained during re-feeding, fat tissue was restored much more efficiently than lost muscle. Today, millions who are impoverished in the developing world are subjected to semi-starvation. Among those most vulnerable are women and children with chronic infection.

The effect of HIV on the human system. The preferential loss of lean body mass (also referred to as body cell mass or BCM), wasting, and poor growth and development in children are strong indicators of disease progression from HIV to AIDS. Because the immune system becomes severely compromised and loses its ability to resist infections, disease progression is defined and also monitored by the level of CD4 lymphocytes, HIV viral load, opportunistic and other severe co-infections. Decreases in CD4 percent, BCM, as well as serum selenium and Vitamins A and B12 have been shown to correlate with faster progression to AIDS. Weight loss and poor growth result, in part, from decreased nutrient intakes; however, they are also a consequence of mal-absorption and/or increased requirements of energy, possibly protein and several vitamins and minerals. Nutrients of interest are those that assist in the maintenance of immune function and/or lean tissue and may become rapidly depleted from infection-induced oxidative stress.

Short term effects may be reversible because those without the additional stress of infections who maintain their muscle mass near normal or slightly reduced cell-mediated immunity may respond more favorably to consistent and aggressive nutrition support and be better able to maintain health and quality of life and delay disease progression.

Long-term effects of HIV-infection on the body may not be reversible. When food is chronically diminished in quantity and quality, the body's defenses to prevent and combat infection are also diminished, making it vulnerable

Figure 1. HIV-AIDS cycle of no return.



to severe and prolonged infections and protein and other nutrient losses. When PLWHA have lost substantial body proteins and immune function, they are stressed with opportunistic infections, metabolize nutrients inefficiently, and become similar to those subjected to semi-starvation in Keys's study - not likely to regain lean muscle with nutrition intervention.

Can food make a difference? It is necessary to review findings from other populations because the studies are lacking in those who are HIV-infected.

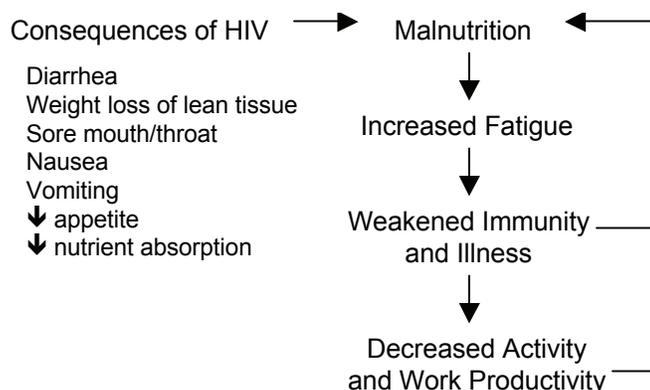
Those who are impoverished are at risk for malnutrition and immune-suppression because of food scarcity, poor diet quality, heavy infection burden, malaria and intestinal parasitic infestation. Low lysine intakes have been correlated with lowered immunity. Lysine added to wheat flour for four months, however, improved immune function and protein status in family members and weight gain and linear growth in children in rural households in Pakistan and northern China. Persons who are infested with parasites may have increased lysine requirements. In India, the lysine requirements of malnourished men were found to be 50% greater with parasite infestation.

Those who practice vegetarianism are also at risk for micronutrient deficiencies. People in the developing world, for example, mainly consume plant-based diets due largely to economic constraints. The diets are marginal not only in lysine but in total protein content and quality. Furthermore, the high phytate and fiber and low heme iron contents of plant-based diets reduce bio-availability of total dietary iron. Zinc absorption is also reduced from dietary phytate. Several researchers have observed better iron status in women who regularly ate meat compared to lacto-ovo vegetarian women who eat milk and eggs. Iron deficiency anemia is the predominant anemia among HIV-infected women and non-infected women. All women in the developing world are at risk for anemia due to vitamin B12 and other nutrient deficiencies and malaria.

A number of recent studies suggest that zinc may be another micronutrient in which there is widespread deficiency in developing countries. It is possible that great benefits can be achieved by its supplementation including: the reduction and duration of malaria, the severity of diarrhea and respiratory infections (including pneumonia), and improved immune function in susceptible children. A modest zinc supplement reduced diarrhea in HIV-infected children without increasing HIV viral load.

Researchers can apply the findings described and hypothesize that Animal Source Foods (ASF), particularly meat, are a critical component in diets of PLWHA. Specific benefits, although theoretically reasonable, remain unknown. Studies in HIV-infected men in the United States provide

Figure 2. HIV's effects on body composition and quality of life.



supportive data that suggest the amount of protein intake correlated positively, and the amount of carbohydrate intake correlated negatively with BCM. Animal source foods, particularly meat, provide proteins of the highest biological value that include high concentrations of the essential amino acids lysine and methionine and those considered conditionally essential for PLWHA, such as glutamine, cysteine and carnitine. ASF provide the sole natural source of vitamin B12, and its deficiency is linked to depression. A recent study found depression to be common among HIV-infected Tanzanian women and was associated with an increased risk of disease progression.

Other projects have contributed to this contemporary body of knowledge. Meat, when compared to other ASF, provides highly bio-available iron and zinc. Results from the Global Livestock Collaborative Research Support Program (GL-CRSP) Child Nutrition Project (CNP) showed increased arm muscle accretion in school-age children in Embu District, Kenya who received ASF, with a much greater impact from meat than from milk. Near reversal of vitamin B12 deficiency, improved weight gain, increased physical activity, improved cognitive behavior and decreased morbidity were also observed in children who received meat. CNP results provide convincing evidence that ASF, particularly meat, may be a critical component in the diets of non HIV-infected school children. Similar studies, however, have not been done in children who are affected or infected by HIV.

Practical Implications

Although the number of people with HIV has increased, deaths from HIV infection are declining. Therefore, people with HIV are living longer, making it imperative for health care providers, donors and policy makers to be aware of the special nutritional needs of this growing population. Nutrients cannot cure HIV infection, but an adequate diet may preserve immune function, improve responses to drugs, promote independence and improve quality of life.

There is a critical need to better understand the relationship of the type and timing of foods in the diet that will provide the most benefit to those with HIV at a particular stage of the infection. The typical affordable diet in rural areas provides only small amounts of ASF. Therefore, the daily inclusion of even a modest amount of meat may show benefit to persons living with HIV and AIDS. The scientific knowledge to date, as summarized above, is the basis of HNP's hypothesis that meat biscuits may result in improved outcomes when compared to soy and wheat. Meat biscuits will provide increased intakes of lysine, vitamin B12 and bio-available iron and zinc. Meat biscuits consumed over the course of 18 months may have a significant and positive impact on immune function, lean body mass, physical activity and quality of life of the HIV-infected women and the growth and development of their vulnerable children.

Further Reading

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The GL-CRSP HIV Nutrition Project (HNP) is evaluating the effect of protein quality and micronutrients in meat on the health and nutritional well-being of women living with HIV in rural Kenya and the health and development of their children by means of randomized nutrition feeding intervention. The project is led by Dr. Judith Ernst, Indiana University. Email: jernst@iupui.edu.



The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East and West Africa, Central Asia and Latin America.

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