Practice Paper of the Academy of Nutrition and Dietetics: Nutrition Intervention and Human Immunodeficiency Virus Infection

ABSTRACT
Nutrition is an integral component of medical care for people living with human immunodeficiency virus (HIV)/autoimmune deficiency syndrome (AIDS) (PLWHA). The Academy of Nutrition and Dietetics supports integration of medical nutrition therapy into routine care for this population. Fewer PLWHA experience wasting and undernutrition, while the prevalence of obesity and other chronic diseases has increased significantly. Improved understanding of HIV infection's impact on metabolism and chronic inflammation has only increased the complexity of managing chronic HIV infection. Nutrition assessment should encompass food insecurity risk, changes in body composition, biochemical indices, and clinical indicators of comorbid disease. Side effects from current antiretroviral therapy regimens are less prevalent than with previous generations of therapy. However, micronutrient deficiencies and chronic anemia also remain significant nutritional risks for PLWHA, making vitamin and mineral supplementation necessary in cases of acute deficiency or food insecurity. Additional factors can impact HIV-related nutrition care among the pediatric population, older adults, minority groups, those co-infected with tuberculosis or hepatitis, and PLWHA in rural or underserved areas. Registered dietitian nutritionists and nutrition and dietetic technicians, registered should participate in multidisciplinary care to incorporate nutrition into the medical management of PLWHA.
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THIS PRACTICE PAPER AIMS TO provide registered dietitian nutritionists (RDNs) and nutrition and dietetic technicians, registered (NDTRs) with an overview of current research and guidelines related to nutritional care for patients living with human immunodeficiency virus (HIV)/autoimmune deficiency syndrome (AIDS) (PLWHA). HIV infection presents significant prevention and treatment challenges worldwide to health care systems. According to the Global Burden of Diseases Study 2015,[1] an estimated 38.8 million people worldwide were living with HIV in 2015. New annual infections have remained constant at approximately 2.5 to 2.6 million per year since 2005. A decline in new HIV diagnoses among children younger than 13 years was observed through 2015, largely due to decreased mother-to-child transmission. In the United States, an estimated 883,000 people were living with HIV infection in 2015. According to the Centers for Disease Control and Prevention, almost 13% are unaware of their status.[1,2] Overall, the number of PLWHA has continued to grow, attributable to population expansion and the life-prolonging effects of antiretroviral therapies (ART).[2] In addition, although the advent of ART resulted in an increase in life expectancy for PLWHA, it yielded both undernutrition/wasting and an elevated incidence of obesity and chronic disease risk.[3] The consequences of the HIV pandemic thus include a high risk for debilitation and mortality among adults during their most productive years.

RDNs and NDTRs can be instrumental in ensuring that diet and nutritional status are optimized in clients with HIV infection. Figure 1 identifies potential roles and responsibilities of RDNs and NDTRs involved in the care of PLWHA.

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NUTRITION AND HIV INTERACTIONS

Nutrition-Related Clinical Issues

A well-nourished person with HIV who has a controlled viral load is more likely to withstand the effects of HIV infection and delay disease progression.[3,4] PLWHA are still at risk for undernutrition and wasting.[5] However, use of ART has led to a dramatic shift in nutrition risk factors, including an increase in the prevalence of obesity and cardiometabolic disease.[6]

Undernutrition. Both malnutrition and HIV adversely affect immune function. When combined, the deleterious effects on immune system integrity are magnified. Death rates are higher in PLWHA, with malnutrition in both resource-poor and resource-rich countries, even those receiving ART.[7,8] HIV infection and its treatment may initiate a complex dysregulation of metabolism associated with changes in nutritional status.[9,10] Macronutrient and micronutrient needs may change significantly. Common

• Educate clients and their caregivers on the role of nutrition and diet in both restoration and maintenance of health (RDN).
• Conduct initial and periodic assessments of client nutritional status and challenges to maintain or restore nutritional status, and to develop and update nutrition-related strategies with clients and caregivers (RDN; NDTR assists with data collection).
• Provide support for maintenance and recovery of the immune function through planning and implementation of MNT and strategies with clients (RDN; NDTR can oversee implementation).
• Assist in developing nutrition-related strategies to manage nutrition-related side effects of disease and medications such as lipodystrophy, dyslipidemia, insulin resistance and diabetes, hypertension, chronic kidney disease, osteoporosis, anemias, anorexia, and gastrointestinal symptoms (RDN, NDTR under direction of RDN).
• Support medical treatment of HIV by promoting adherence to treatment and compliance with regular clinic visits; RDNs, NDTRs, and other clinicians may be involved in discussions on the psychosocial impact of weight loss, lipodystrophy, or unplanned weight gain with clients.
• Provide education for clients and caregivers on the potential impact of drug-nutrient interactions on nutritional status with antiretroviral therapy (ART), other medications, complementary and alternative medicine (CAM) therapies, supplemental nutrients, herbs, and other therapies (RDN, NDTR under direction of RDN).
• Maintain familiarity with community and other programs available to clients for referral in cases of social, economic, and psychological needs (RDN, NDTR).
• Remain knowledgeable of issues pertaining to privacy and confidentiality when providing nutritional care and providing care in an equitable and nonjudgmental fashion (RDN, NDTR).
• Update knowledge and evaluate research on both nutrient-based and non-nutrient treatments to improve nutritional status and nutrient metabolism, ranging from exercise and CAM therapies to pharmacologic modulation (RDN, NDTR).

Figure 1. Roles and responsibilities of registered dietitian nutritionist (RDNs) and nutrition and dietetics technicians, registered (NDTRs) when providing medical nutrition therapy (MNT) for people living with human immunodeficiency virus (HIV) infection.

manifestations of undernutrition include protein-energy malnutrition, anemias, and micronutrient deficiencies.

Overweight and Obesity. In the United States, the proportion of obesity has steadily increased over the past decades with approximately one-third of adults overweight and another one-third obese.[11] The prevalence of obesity in PLWHA has also risen, with 60% to 70% of this population deemed overweight or obese.[5,12] Some individuals experience significant weight gain after initiation of ART, while others are already obese at the time of HIV diagnosis. Increased focus has been placed on obesity and health outcomes. Rates for sarcopenic obesity (low lean body mass and accumulation of visceral adipose tissue) are not currently available for this population, and in a 5-year observational study, clinically meaningful differences in skeletal muscle did not differ by HIV status.[13] However, among PLWHA who did exhibit body composition consistent with sarcopenic obesity, mortality was higher.[14] Overall, obesity in HIV infection is associated with increased morbidity but not increased mortality.[7]

Chronic Disease. HIV infection is associated with cardiovascular disease (CVD), hypertension, diabetes, osteoporosis, frailty, and cognitive impairment.[15-18] The Multicenter AIDS Cohort Study found a low (<2%) prevalence of optimal cardiac health and a twofold increased risk of acute myocardial infarction. The Multicenter AIDS Cohort Study also found the age-adjusted and body mass index (BMI)-adjusted rate of diabetes was over four times greater in HIV-infected men, compared with HIV-seronegative men.[15] A comparison of the Medical Monitoring Project and National Health and Nutrition Examination Survey participants revealed diabetes prevalence of 10.3% among PLWHA compared to 8.3% among the general US adult population.[19] Multiple factors including metabolic changes, medications, and aging may contribute to the chronic disease seen in this population.[10,18,20]

Food Insecurity. Food insecurity refers to limited or uncertain availability of nutritionally adequate and safe foods, or inability to acquire these foods in socially acceptable ways.[21] During 2015, 12.7%, or 15.8 million, of US households were food insecure.[22] In the PLWHA population, food insecurity prevalence estimates range between 24% and >50%, with rates highest among those affected by mental illness, substance abuse, and poverty.[23,24] A recent systematic review reported a statistically significant association between food insecurity and sub-optimal ART adherence.[25] While the exact relationship between food insecurity and HIV treatment outcomes is unclear, the evidence suggests that screening for food insecurity and providing food assistance is likely to improve HIV-related health status.[25] A two-item food security questionnaire has been validated for PLWHA for use in a clinical setting.[26] Clinicians can link food-insecure PLWHA with community-based nutrition and food assistance programs and assist clients with making economical food choices and food preparation.

NUTRITION CARE PROCESS

The Nutrition Care Process includes nutrition assessment, diagnosis, intervention, monitoring, and evaluation.[27]

The RDN and NDTR can play a significant role is assisting PLWHA and their health care teams to address diet- and nutrition-related issues. The role of RDNs and NDTRs is outlined in the introductory section "Roles and Responsibilities of RDNs and NDTRs" and in Figure 1.

Early screening of nutritional risk in people with HIV disease is essential, yet only a few screening tools for PLWHA have been developed, including the Subjective Global Assessment-HIV and Nutrition Referral Criteria for Adults with HIV/AIDS, and Public Awareness Checklist of the Nutrition Screening Initiative.[28,29] Using the Nutrition Care Process, common nutrition diagnoses in HIV disease include: underweight, involuntary weight gain, limited access to food, nutrition-related knowledge deficit, inadequate protein intake, and food-medication interactions.[27]

Assessment

Nutrition plays an essential role in supporting the health and quality of life for PLWHA. The negative effects of malnutrition are usually not easily reversed but are often preventable. Nutrition-related alterations can occur early in HIV infection. Thus, nutrition intervention should begin soon after diagnosis.

A complete baseline nutrition assessment of the patient should be performed by an RDN with regular follow-up as appropriate to achieve goals. The RDN can perform a Nutrition-Focused Physical Exam to examine overall weight or fat and muscle loss, and should conduct visual and hands-on examination of the client along with assessment of pertinent available laboratory measurements. Following the Nutrition-Focused Physical Exam, the RDN should determine if malnutrition is present; defined as having two or more of the following: (1) weight loss; (2) decreased muscle mass; (3) decreased subcutaneous fat; (4) fluid accumulation; (5) insufficient energy intake; (6) or decreased functional status.[30]

Anthropometry and Body Composition Measurements. With the decline in AIDS-related wasting and subsequent rise in the prevalence of obesity among PLWHA, providers need to be prepared to assess patients for both under- and over-nutrition.

Wasting and Lipodystrophy. AIDS-related wasting syndrome is an AIDS-defined medical diagnosis described by the Centers for Disease Control and Prevention as a 10% weight loss from baseline in a 6-month period accompanied by diarrhea or chronic weakness and fever for more than 30 days without a known cause.[31] While previous research revealed loss of lean tissue throughout the disease process, the most recent research with current ART regimens shows either no significant change or a slight increase in lean tissue mass after ART initiation.[32] Lipodystrophy, or the abnormal metabolism and deposition of fat, includes lipoatrophy (loss of subcutaneous fat) and lipohypertrophy (gain of truncal fat). Lipoatrophy has not been associated with the current generation of ART and is a less common finding, while a gradual, progressive increase in lipohypertrophy is reported.[33] Anthropometry that may be helpful for serial measure comparisons for wasting include circumference measures of the thigh, arm, and mid-upper arm, which are better indicators of lipodystrophy than BMI alone.[34,35] Comparison of an AIDS Clinical Trial Group cohort vs the National Health and Nutrition Examination Survey found that between 1998-2007 PLWHA had smaller waist and arm circumferences compared to HIV uninfected men and women, while thigh circumference was larger in women with HIV after adjusting for BMI. Among children, measurements of the mid-arm muscle area, subscapular skinfold, and triceps skinfold can inform clinicians about growth trajectories and lean and fat mass development.[36]

Obesity. After the advent of ART, an increase in total body weight beyond the initial 6 months of reconstitution of health was observed.[5,12] However, people living with HIV and obesity remain at risk for lipodystrophy. Therefore, monitoring shifts in body composition is recommended during planned weight-loss programs. In addition, measurement of waist and hip circumference and waist-to-hip ratio are helpful to monitor risk for central obesity and lipohypertrophy.[35]

Body Composition Measurement Techniques. Body composition evaluation may include both assessments of compartment volume and fat deposition patterns. Although no single method provides all of the useful information about body composition and shape, if used appropriately each can provide valuable data and information on tracking nutritional status. BMI can be assessed with height and body weight to provide information regarding general body size (underweight, normal weight, overweight, obese). When available, bioelectrical impedance analysis (BIA) provides a low-cost, portable approach to monitor shifts in body mass and fluid status, as well as the BIA phase angle, which predicts mortality risk.[37] BIA cannot accurately measure body composition in individuals with a BMI <13 or ≥ 34, and provides information only on whole rather than regional body composition.[37] Segmental BIA measures may provide better assessments of body composition in obese individuals.[38] However, this approach has not been validated in obese individuals when HIV-specific equations are used. Because of its limitations, BIA may be used less frequently in some clinical settings. When available, dual-energy x-ray absorptiometry and computed tomography scans are the only technologies that provide additional information about compartmental body fat (truncal fat, subcutaneous and visceral fat) and soft lean mass tissue. Dual-energy x-ray absorptiometry scans may also be used to detect subclinical lipodystrophy.[39]

Biochemical Assessment. Biochemical assessment provides laboratory measurements of serum protein, lipids, glucose, and micronutrients. Metabolic abnormalities, including changes in organ or other tissues functions, leading to altered use, storage, and excretion of nutrients, may occur as a result of immune dysfunction, medication side effects, infection, hormonal alterations, or through the effects of HIV itself in adults and children.[40] In addition, metabolic abnormalities of elevated blood lipid levels and altered insulin sensitivity or glucose dysregulation have been reported.[9,41] Some of these alterations may have occurred independently and before the use of ART, concomitant with

diagnoses of hyperlipidemia, hypertension, diabetes, or renal disease. Ongoing research continues to provide insight into the increased risk of fatty liver disease among PLWHA that may promote development of CVD and type 2 diabetes.[42] Improvement in metabolic abnormalities may occur following initiation of ART. For example, Krishnan and colleagues[20] reported that 37% of people with both HIV and metabolic syndrome no longer met the criteria for metabolic syndrome after 96 weeks of ART.

Anemias. Iron may be shunted to a storage form during inflammation. Various types of anemias occur with chronic HIV infection. Some anemias are associated with nutrient deficiencies (eg, folate, vitamin B-12, iron), while others are associated with that of chronic disease.[43] Anemias of chronic disease are not due to nutrient deficiency and will not respond to nutrient repletion. If hemoglobin levels are <13 g/dL in men or <12 g/dL in women, additional evaluation should be conducted to determine whether treatment for nutrition-related anemias is required. Ferritin levels <200 ng/L or transferrin saturation <20% may indicate iron deficiency.[43]

Lipids and Blood Pressure. Total cholesterol, low-density lipoproteins, high-density lipoproteins, triglycerides, and systolic/diastolic blood pressure values can assist RDNs with assessment of CVD risk and blood pressure control, respectively. Screening for dyslipidemia should occur when HIV care is established, before ART initiation, 1 to 3 months after ART initiation, and every 6 to 12 months onwards. Major risk factors to monitor include blood pressure levels ≥140/90 mm Hg or use of antihypertensive medications, high-density lipoproteins <40 mg/dL (<1.036 mmol/L), family history of high blood pressure, stage 3 or 4 chronic kidney disease, tobacco use, high low-density lipoproteins, polycystic ovary syndrome, and age. However, treatment targets may need to be individualized based on specific pharmaceutical, genetic, and lifestyle risk factors of the patient. Hypertension may be considered present if blood pressure is elevated on two or more medical visits. According to the American Heart Association and American College of Cardiology practice guidelines, lifestyle modifications, including dietary changes, regular exercise, maintaining a healthy weight, and avoiding tobacco products, remain critical components of CVD and hypertension risk reduction.[16,44]

Diabetes. Insulin, glucose, and hemoglobin A1c (HbA1c) levels may be available to assess glycemic control in patients with prediabetes (HbA1c= 5.7% to 6.4%), and type 1 or type 2 diabetes. Current American Diabetes Association guidelines recommend screening PLWHA for diabetes and prediabetes at 6- to 12-month intervals before ART initiation, 3 months after ART initiation or a change in ART regimen, and yearly afterward. Screening for prediabetes may occur in any adults with a BMI ≥25 (≥23 in Asian Americans) who also have an additional risk factor for diabetes, and for all adults aged 45 years and older.[45] HbA1c may underestimate glycemia in patients with a lower $CD4^+$ T-cell count and is not recommended to diagnose diabetes; alternatively, fructosamine may be used as an indicator of glycemic control in these patients.[46,47] Although increasing the acceptable range for HbA1c goal in HIV-negative adults older than 65 years has been proposed,[48] similar studies have not yet been conducted for PLWHA. Hence, the current treatment goal for diabetes remains <7.0%, although individualized goals for glycemic control may vary.[47] In addition, because HIV infection is a risk factor for chronic kidney disease,[49] regular monitoring of blood pressure, glomerular filtration rate, protein, and creatinine is clinically warranted.

Hormones. Hormone levels may also impact nutritional status and chronic disease risk among PLWHA. Those with low testosterone levels experience increased CVD risk, and men with testosterone levels <2.8 ng/mL or free testosterone levels <6.5 ng/dL may receive supplemental testosterone.[50] One study of testosterone supplementation in women with low levels found that it was well tolerated and associated with increased bone mineral density and improved depression indices.[51] Male-to-female transgender individuals receiving treatment with spironolactone are at risk for elevated potassium levels. Therefore, RDNs should be aware of these additional factors in planning nutritional interventions.

Dietary Assessment. Assessment of dietary intake should be performed by an RDN or NDTR. This should include determination of actual intake compared to calculated needs, as well as identifying significant factors affecting food intake, such as food insecurity, cultural food preferences, food intolerances, anorexia, gastrointestinal symptoms, and supplement use. In addition, screening for drug and alcohol use should be included in dietary assessment, as both can impair nutrient intake and utilization.

ART Assessment. ARTs have assumed a pre-eminent position in the prevention and treatment of HIV and its comorbidities. The efficacy of ART and other medications is tantamount to maintaining nutritional status.[52] Conversely, nutrients and nutritional status can affect absorption, utilization, elimination, and tolerance of ART medications.[52] Adherence to medications may be affected by nutrition-related side effects and the potential for development/exacerbation of body fat changes.

There are currently six classes of antiretroviral medications, including nucleoside reverse transcriptase inhibitors, non-nucleoside reverse transcriptase inhibitors, protease inhibitors, fusion inhibitors, entry inhibitors, pharmokinetic enhancers, and integrase inhibitors.[53] There are also dual-class fixed-dose combination drugs that allow for fewer pills or once daily doses. Life-long pharmacotherapy with combinations of these medications is required for disease management. This presents challenges to nutritional status by introducing drug–nutrient interactions. Common ART-related side effects, including chronic diarrhea, anemia, and metabolic alterations, should be carefully considered by the RDN when planning dietary interventions.[52,54] However, side effects from current ART regimens are less prevalent than those experienced with older generations of ART.

Interventions

Medical nutrition therapy (MNT) includes setting goals and developing a

nutrition plan that includes education, counseling, dietary modulation, and, in some cases, supplemental nutrients. All nutrition and nutrition-related interventions should be routinely monitored for effectiveness and adjusted as needed.

MNT Value. MNT provided by an RDN is of significant value and is recommended for all individuals with HIV infection. Utilization of covered food and nutrition services and assistance is cost effective and may positively impact ART adherence and routine primary care utilization.[55] RDNs should provide at least one to two MNT encounters per year for asymptomatic PLWHA, and two to six MNT encounters per year for symptomatic PLWHA.[56]

Client Education and Counseling. Earlier research has demonstrated that nutrition education and counseling has a positive effect on health outcomes.[57] Updated studies reinforcing the effectiveness of RDN/NDTR nutrition counseling for PLWHA are needed. In order to improve effectiveness, nutrition counseling, and education should include comprehensive strategies that address clients' health needs, psychosocial care, and support.[55] Figure 2 lists potential topics to consider for client education and counseling.

Category	Examples
Pregnancy, lactation, infancy, and childhood	Nutrition-related issues and concerns in pregnancy and lactation
	Antiretroviral use in breastfeeding and replacement feeding alternatives
	Growth failure and developmental delay in children
	Support for normal growth trends in children
Lifestyle	Basic nutrition concepts and habits
	Physical activity levels
	Body image and altered body weight and shape
	Nutrition and food-related cultural behaviors and ethnic beliefs
Nutrition Interactions	Prevention, restoration, and maintenance of optimal body composition with an emphasis on lean tissue mass
	Medication−nutrition interactions
	Management of barriers to maintenance and restoration of nutritional status, such as nutrition-related side effects and symptoms Management of comorbidities, including hyperlipidemia, diabetes, hypertension, chronic kidney disease, osteoporosis
	Review of nutrient supplements
	Review of potential interactions with nonprescription medications and herbal supplements
	Evaluation of interactions with alcohol and recreational drugs
Life skills and socioeconomic issues	Food and water safety
	Food and nutrition security issues
	Food purchasing and label reading skills
	Food preparation skills

Figure 2. Topics to be considered during nutrition-related education and counseling of people living with human immunodeficiency virus (HIV) infection.

Macronutrients. Absolute resting energy expenditure (REE) and REE adjusted for fat-free mass (REE/FFM) may be higher in PLWHA compared to HIV-negative individuals. In recent years, studies of PLWHA compared to HIV-negative individuals (sample sizes ranging from 31 to 429 participants) have reported elevated REE with HIV ranging from 40 to 182 kcal/day.[10,58-60] Vassimon and colleagues[60] reported that compared to men without HIV, REE/FFM was 15% higher in men with HIV and lipodystrophy, and 9% higher in men with HIV but no lipodystrophy. As highlighted in a literature review of studies published before 2010, increased REE can lead to both fat and protein stores being oxidized to fuel the body's energy requirements, although increased REE may be offset by a decrease in total energy expenditure with less physical activity.[61] Energy requirements for PLWHA may be further altered by malabsorption, diarrhea, and vomiting. Successful treatment with ART promotes weight gain, while treatment failure is associated with wasting.[62] Underweight or normal weight patients may require additional calories per kilogram of estimated FFM to maintain body weight. However, as overweight and obesity become increasingly prevalent among PLWHA, total caloric reduction to prevent weight gain may be the primary focus of nutrition recommendations.

Previous guidelines recommended protein requirements of 1.0 to 1.4 g/kg for maintenance of lean mass, and 1.5 to 2.0 g/kg to increase lean mass[63]; however, no recent studies of protein needs for PLWHA have been conducted. The RDNs should recommend an individualized diet with a macronutrient composition based on the Dietary Reference Intakes. Hence, further research regarding adequate dietary protein, carbohydrate, and fat requirements for PLWHA is warranted.

Micronutrients. Few micronutrients have been investigated in recent years in the context of well-controlled HIV infection. Worldwide, micronutrient deficiencies are common in HIV-infected individuals both pre- and post-ART initiation.[64] Nutrition-related anemias may be caused by deficiencies in iron, folic acid, or vitamin B-12. Unlike earlier studies that showed widespread selenium deficiency prior to use of protease inhibitors, more recent work in the United States has found no evidence of selenium deficiency and observed that ART, specifically protease inhibitors, is associated with higher selenium levels.[65] Because HIV infection is a chronic inflammatory condition, some differences from general population recommendations may apply, particularly for calcium and vitamin D. Vitamin D and calcium supplementation may attenuate the loss of bone density that is observed with ART.[66] For any documented micronutrient insufficiency, PLWHA should be counseled to increase dietary intake of foods rich in needed micronutrients. Supplementation above the Recommended Daily Allowance should be initiated only when clinical deficiencies have been confirmed via laboratory tests and other reliable indicators of compromised micronutrient status.

Nutrition-Related Complications and Comorbidities

A combination of approaches may be necessary to address nutrition-related problems faced by PLWHA. The health care plan may combine medication therapy with diet strategies to reduce adverse effects of nutrition-related disease complications, and RDN/NDTRs can serve as an integral part of the health care team for PLWHA. RDNs and other clinicians should be familiar with both nutrient-based and non-nutrient treatments to improve nutritional status.

Wasting/Lipodystrophy. Unplanned weight loss and lipodystrophy may require combinations of nutritional counseling, supplementation, and medication therapies to accomplish appetite stimulation, hormone modulation, and symptom management.[62,67] Increased protein intake, weight-bearing exercise, and the use of growth hormone, growth hormone–releasing hormone, anabolic steroids, and insulin-sensitizing agents have been shown to positively correlate with improved body composition and quality of life parameters.[62,67]

Malabsorption resulting from chronic diarrhea or poor gut health can be addressed through a combination of medication management and nutritional counseling. Micronutrient supplementation is recommended to maintain nutritional status, while the underlying causes of diarrhea are being diagnosed and treated.[68] Therapies such as probiotic supplementation have not been widely tested in PLWHA. Gut microbial alterations have been reported with HIV infection, and one study reported that higher alcohol consumption was associated with compromised gut integrity (as measured by lipopolysaccharide-binding protein).[69-71] The extent to which dietary modifications can impact the gut microbiome in the context of HIV infection remains unclear. However, preliminary studies have identified an association of probiotic supplementation with increased expression of activation markers on $CD4^+$ and $CD8^+$ T-cell surfaces, as well as decreased gut inflammation in PLWHA.[72] However, the long-term impact and durability of supplementation, and appropriate composition/dosage of supplements have not yet been determined. Investigators recently recommended monitoring of probiotic food consumption to avoid *Lactobacillus* bacteremia in patients with $CD4^+$ T-cell counts <200 or a $CD4^+$ T-cell percentage of total lymphocytes $<15\%$.[73]

Comorbidities

RDNs and NDTRs can play a critical role in the management of comorbidities now commonly observed among PLWHA. Few studies have evaluated the impact of nutrition strategies in the treatment of chronic diseases among PLWHA, and ongoing research into this area is needed.

Osteoporosis. Although the causes are still unclear, PLWHA have an increased risk for low bone density and osteoporosis, and many have lower bone mineral density than expected for age.[17] Risk factors include low BMI, history of weight loss, low vitamin D status, steroid use, history of nucleoside reverse transcriptase inhibitor use, and smoking.[74] Bone density should be monitored via routine bone density tests, such as dual-energy x-ray absorptiometry. Beyond changing ART regimens, the following modifiable risk factors are associated with attenuated bone loss in PLWHA: maintaining an optimal weight; discontinuing or reducing smoking, alcohol, and caffeine consumption; eating foods rich in calcium and vitamin D (specifically yogurt); supplementation with calcium and vitamin D-3; and treatment with bisphosphonates.[17,66]

CVD. The American Association of Clinical Endocrinologists 2017 Guidelines for management of CVD acknowledge that risk for CVD can be associated with ART regimen, HIV-related inflammation, or lifestyle factors. Total cholesterol and low-density lipoproteins cholesterol may be increased by hypothyroidism, liver disease, steroid treatment, and protease inhibitor use. Elevated triglyceride levels can be observed with excessive alcohol intake, obesity, type 2 diabetes, hypothyroidism, corticosteroid therapy, estrogen therapy, pregnancy, antihypertensive medications (β-adrenergic blocking agents and thiazide diuretics), and protease inhibitor use. Smoking cessation and dietary management are considered the most cost-effective options for CVD prevention.[75] A combination of a high-fiber, low simple carbohydrate diet, exercise, and lipid-lowering medication has been shown to reduce blood lipid levels in PLWHA, while n-3 fatty acid supplementation, decreased *trans*-fatty acid intake, and an eating pattern higher in dietary fiber and monounsaturated fats are associated with decreased CVD risk.[76,77]

Hypertension. Dietary interventions have not been adequately tested in PLWHA. Additional research is needed to determine whether dietary modifications improve blood pressure levels in this population to the same extent observed among HIV-uninfected adults. In the general population, every 10 kg of weight lost by overweight and obese patients results in approximate reductions in systolic blood pressure of 5 to 20 mm Hg. Diets

Organization	Description	Website
Clinician resources		
AIDS Education and Training Centers National Resource Center	Client education and nutrition manual; funding for education and training	http://aidsetc.org/guide/nutrition
Association of Nutrition Services Agencies	Client educational materials and technical assistance for AIDS meal provider organizations	www.servings.org/about/ansa.cfm
New Mexico AIDS and International Association of Providers of AIDS Care Infonet	Client handout downloads	www.aidsinfonet.org
Clinician and consumer resources		
Academy of Nutrition and Dietetics	Eating Well with HIV	www.eatright.org/resource/health/diseases-and-conditions/hiv-aids/eating-well-with-hiv
Academy of Nutrition and Dietetics	Nutrition tips to keep the immune system strong for people with HIV-AIDS	www.eatright.org/resource/health/diseases-and-conditions/hiv-aids/nutrition-and-hiv-aids
AIDS Project Los Angeles	Client education materials; HIV nutrition provider certification program	www.apla.org
AIDS.gov—US Department of Health and Human Services	Client and provider education on HIV nutrition and food safety	www.aids.gov/hiv-aids-basics/staying-healthy-with-hiv-aids/taking-care-of-yourself/nutrition-and-food-safety
AIDSOURCE—National Institutes of Health	Living with HIV/AIDS: diet, nutrition, and food safety	https://aids.nlm.nih.gov/topic/1141/living-with-hiv-aids/1144/diet,-nutrition,-and-food-safety
American Academy of Family Physicians	Client education on HIV, nutrition, and exercise	http://familydoctor.org/familydoctor/en/diseases-conditions/hiv-and-aids/treatment/nutrition-and-exercise-when-you-have-hiv.html
Centers for Disease Control and Prevention	Incidence and prevalence statistics and fact sheets; case definitions and treatment guidelines	www.cdc.gov/hiv/library/factsheets/index.html www.cdc.gov/hiv/guidelines
Gay Men's Health Crisis	Client education	www.gmhc.org
HIV and Hepatitis	Conference and research updates and reviews	www.hivandhepatitis.com
Medscape infectious disease forum	Conference reviews, peer-reviewed articles, continuing education	www.medscape.com/infectiousdiseases
The Body Pro	Provider education	www.thebodypro.com

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Figure 3. Selected reliable resources on human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) and nutrition topics for clients and health care providers.

Organization	Description	Website
United Nations Food and Agriculture Organization	Living well with HIV/AIDS manual for nutrition support	www.fao.org/docrep/005/y4168e/y4168e00.HTM
WebMD	HIV and AIDS health center—nutrition and HIV/AIDS	www.webmd.com/hiv-aids/guide/nutrition-hiv-aids-enhancing-quality-life
Women, Children, and HIV	Website with information resources concentrated on maternal health, vertical transmission, and orphans and vulnerable children	www.womenchildrenHIV.org

Figure 3. *(continued)* Selected reliable resources on human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) and nutrition topics for clients and health care providers.

higher in vegetables, fruits, and dairy products are also associated with decreased hypertension risk.[16]

Diabetes. Weight loss may improve insulin sensitivity in adipose tissue, liver, and muscle among women with HIV, although they experience a greater decrease in fat-free mass compared to age- and sex-matched HIV-uninfected groups, even when total weight lost is similar.[78] Patients with prediabetes, insulin resistance, or diabetes may benefit from participation in diabetes education programs to learn strategies to regulate blood glucose levels through nutrition and exercise.[45] Factors associated with prediabetes that can be addressed with MNT include hypertension, dyslipidemia with high triglycerides, and obesity (particularly abdominal obesity).[45] Metformin, glitazones, and canagliflozin are being investigated for their potential to improve insulin sensitivity and impact body weight among PLWHA. Preliminary results indicate that these medications effectively improve insulin sensitivity in PLWHA, though possibly not to the same degree as in HIV-uninfected individuals.[79] Limited information is available regarding the impact of nutrition interventions specific to glycemic control in PLWHA, and current guidelines are based on those developed for the HIV-uninfected population.[45] These guidelines of the American Diabetes Association support provision of diabetes-specific MNT by an RDN that includes:

- tailored instruction on carbohydrate counting and possibly protein and fat gram estimation to assist with mealtime insulin dosing;
- an emphasis on foods higher in dietary fiber and lower in glycemic load; and
- minimized consumption of foods with added sugar.

Sustained weight reduction of 5% of initial body weight is encouraged among overweight/obese patients with diabetes.

Food Safety. PLWHA are more susceptible to foodborne illness due to their compromised immunity. The RDN should educate PLWHA and others involved in their care and food preparation about food and water safety.

Non-Nutrient Therapies. Non-nutrient therapies are recommended to augment HIV-related therapies. A growth hormone–releasing hormone analog has been developed to reduce central fat accumulation in PLWHA.[67] Exercise can maintain body function and prevent frailty; current exercise recommendations for older PLWHA emphasize the importance of regular aerobic and resistance activity, but suggest limiting exercise bouts to 90 minutes or less to avoid immune function compromise.[80]

Complementary and Alternative Medicine. Complementary and alternative medicine (CAM) is often used by individuals managing chronic disease, including PLWHA. The most recent study conducted in the United States (2008) revealed that approximately 60% of PLWHA reported using CAM.[81] However, with the occurrence of potential side effects associated with CAM use, it is important that RDNs become educated on both use and efficacy. Although recent studies are lacking in this area, earlier research found that Echinacea, garlic supplements, St. Johns wort, and kava were the supplements most commonly associated with adverse effects in this population.[82] In addition, vitamin C megadoses, gingko biloba, cat's claw, ginseng, licorice, and milk thistle have been reported to cause untoward effects.[82]

Co-Infections. PLWHA experience increased risk of complications from co-infection with tuberculosis (TB), hepatitis B (HBV) or C (HCV). Worldwide, 14.8% of patients with TB are co-infected with HIV, and those co-infected experience lower TB treatment success.[83] Vitamin D deficiency may impair TB treatment, and trials are underway to evaluate the effectiveness of vitamin D supplementation for TB treatment outcomes in TB/HIV co-infected clients.[84]

Co-infection with HBV or HCV is associated with chronic immune activation and fatty liver in PLWHA.[42,85] Current or resolved HBV infection is present in 4% to 34% of PLWHA exposed to HBV.[86] In addition, approximately 25% of all PLWHA in the United States, and 50% to 90% of HIV-infected injection drug users, are co-infected with HCV. Co-infection with HBV or HCV requires monitoring of liver enzymes, food–drug interactions, and counseling to avoid alcohol.[87] Medications that can effectively clear HCV from the body are now available. However, a longitudinal study of European men who have sex with men estimated that almost 25% of men with HIV were re-infected with HCV within 5 years of successful HCV treatment or spontaneous clearance of the infection.[88]

Client Education through Social Media

Websites and online health forums provide advice on a variety of topics related to HIV care, including nutrition. Social media sites may be run by health care professional organizations or patient advocates. A list of professional and client resources for HIV-related nutrition information is included in Figure 3. It should be noted that the quality of information available through social media can vary. One investigation found that the majority of HIV-related advice available through online health forums was of acceptable quality; however, no studies have evaluated nutrition-specific advice for HIV.[89] Social media users among PLWHA tend to be aged 18 to 40 years, though utilization varies by racial/ethnic group and geographical location.[90] Social media platforms can be an effective approach for information dissemination and counseling, but additional studies are required to determine the best approach to reach target groups.

MONITORING AND EVALUATION

PLWHA benefit from monitoring and evaluation of nutritional status because of enhanced risk of nutrition-related complications. Recent studies evaluating optimal parameters and time frame for monitoring and evaluation in this population are lacking. Therefore, RDNs have needed to rely on older studies on which to base guidelines, highlighting the need for future research to either confirm or redefine the parameters being utilized. Consistent with the Nutrition Care Process monitoring and evaluation step,[27] food and nutrition-related history outcomes may include:

- food and beverage intake and availability, CAM use, and food allergies;
- anthropometric measurement outcomes may include weight and body composition;
- biochemical data outcomes may include HIV viral load, serum lipids, and glucose levels; and
- physical findings that are nutritionally focused outcomes may include fat and muscle wasting.

Due to the high-risk nature of the disease as well as comorbidities, monitoring, and evaluation of PLWHA may need to occur more frequently.

MNT FOR SPECIFIC POPULATIONS

Pediatric

The most striking features of HIV disease in children are growth failure and loss of lean body mass.[36] While birth weights and gestational ages are not different for children born HIV-positive, lower weights and heights are seen by age 3 months and up to 5 years.[91] Although increased expenditure of energy contributes to wasting and failure to thrive, factors such as reduced energy intake and malabsorption seem to contribute more significantly to energy imbalance.[92]

The A.S.P.E.N. (American Society for Parenteral and Enteral Nutrition) Clinical Guidelines recommend that nutritional assessment of children with HIV/AIDS should be performed at baseline and serially.[36] Assessment should include anthropometry and body composition studies, including mid-arm muscle area, subscapular skinfold, and triceps skinfold, to better reflect fat and lean body mass compared with weight and height measurements alone.

Children with HIV/AIDS need high-energy, high-protein, nutrient-dense diets. Energy needs may vary from 50% to 200% of the Dietary Reference Intakes, and protein needs may vary from 150% to 200% of the Dietary Reference Intakes for age and sex.[93] Supplementation of multivitamins and minerals, at the required dietary allowance dosage, may be indicated in children who are HIV-infected.[20,36]

In the United States, women with HIV are currently advised to avoid breastfeeding due to increase transmission risk. As most water sources are safe and infant formula is widely available, mixed feeding is not recommended at this time.[36,94]

Aging with HIV

PLWHA who are adherent to ART regimens now experience an average life expectancy of 62 to 64 years.[95] Life expectancy varies by race/ethnicity, with a mean of 72 years for white PLWHA (77 years for white men who have sex with men and a mean of 58 years for minorities living with HIV). Clients aging with HIV experience higher rates of CVD, chronic kidney disease, and non–AIDS-related dementia compared to the general population.[18] RDNs will need to monitor laboratory assessments and assist with lifestyle counseling for primary, secondary, and tertiary chronic disease prevention. Polypharmacy is also a concern for older clients with HIV,[96] and RDNs can assist with monitoring for food/drug interactions.

Counseling and intervention needs may differ depending on whether clients have lived for several decades with HIV infection or if they were diagnosed after age 50 years. Recently diagnosed older PLWHA may have been diagnosed at a later stage of infection, leading to more systemic immune damage and worse prognosis.[97] Few studies have been conducted to adequately determine nutrition needs of older adults with HIV, and current recommendations are based on findings in the HIV-uninfected population. Assessments for malnutrition and wasting should incorporate the ability to maintain activities of daily living, frailty assessments, and consideration of cognitive function. RDNs/NDTRs should consider vision, hearing, and chewing and swallowing abilities and request referral for additional assessments as necessary.[98] Clients who transition to assisted living or long-term care facilities may need assistance adapting to new dietary regimens. For clients who live independently, assessment of food security and knowledge of services to provide meal intake can aid with maintaining nutritional status.

Minority/Underserved Populations

HIV infection disproportionately impacts minorities and underserved populations, including racial/ethnic minority groups, men who have sex with men, and rural residents. Men who have sex with men make up 4% of the US male population, but account for 63% of all new HIV infections.[2] The prevalence rate is six times higher for black men compared to white men and 18 times higher for black women compared to white women. Latinos have three times the prevalence rate of whites. The most affected minority groups are usually

diagnosed at a later stage of HIV infection when related or concurrent diseases are present.[2]

Racial/ethnic minority clients with HIV in the US experience worse HIV-related treatment outcomes and a lower life expectancy compared to white PLWHA.[2,99] These disparities may be driven by socioeconomic inequalities and structural barriers to care. Therefore, it is important for the RDN to participate in comprehensive care planning with social service and other community-based providers to support optimal HIV-related outcomes. In addition, food preferences, food preparation techniques, understanding of disease and medical treatment, educational level/literacy and language barriers should be considered to tailor the nutrition advice to the needs of patients from different cultural/racial/ethnic backgrounds.

Overall prevalence of HIV infection is lower in rural compared to urban areas of the United States, yet PLWHA in rural settings often have limited access to medical providers with expertise in infectious diseases.[100] The health care needs for HIV treatment in rural areas is similar to that required by clients in urban settings; however, clients in rural areas may need to travel farther to access treatment, limiting the total number of appointments available for MNT. Providers in rural areas may be less familiar with federal and state resources to assist PLWHA, which can impact access to treatment and food access. Stigma may prevent PLWHA in rural areas from seeking supportive care for HIV treatment, negatively impacting health outcomes.[101] Special considerations regarding food access and transportation to appointments will need to be made by the RDN/NDTR.

REIMBURSEMENT FOR NUTRITION-RELATED SERVICES

Reimbursement for health care, including MNT and nutrient supplements, is important for the access and integration of nutrition care in the United States. Several sources of payment may be available, depending on insurance coverage, enrollment in state and federal support programs, and other resources. In some cases, AIDS Drug Assistance Programs and Medicaid programs may provide for medically necessary nutrient supplementation. The Ryan White Treatment Modernization Act may include MNT via Parts A, B, or C for medical services funding and food assistance; however, provision of coverage and funding varies by state.[102] Outpatient MNT services provided for women, infants, children, youth, and their families are included in Ryan White HIV/AIDS Program Part D. Through this Act, funding may provide nutrition services, home-delivered meals, groceries, supplements, and food provided or prescribed by qualified health care providers. Medicare and other funding sources may be available for nutrition-related care for diabetes, renal disease, and CVD.

PROFESSIONAL RESOURCES

Nutrition care research in HIV infection and related disease is constantly changing, thus RDNs and NDTRs should keep updated on the evidence and practice guidelines. Figure 3 contains information on selected resources for nutrition-related information for the care and treatment of people living with HIV.

CONCLUSIONS

Nutritional status can affect the overall health and longevity of PLWHA. Goals for nutrition interventions should be individualized according to the problems identified. Goals include achieving healthy body weights, body composition, and improved laboratory values. Other goals include a reduction in nutrition-related side effects and complications, medication tolerance, food security, enhanced quality of life, and appropriate access to nutrition services. The team approach of collaboration with and referral to other specialties may help overcome challenges with mental health, drug addiction, and economic constraints.

As identified within the context of this paper, there is a paucity of recent research confirming that current practices in the nutritional management of the PLWHA population are still cutting edge. Guidelines for the RDN and NDTR are frequently based on older published studies, and the management of comorbidities and HIV has largely been extrapolated from HIV-uninfected populations. This highlights the need for additional research in these areas to confirm that current practice guidelines are still as effective, or conversely could illuminate potential new guidelines to be considered. Training on nutrition-related issues of assessment and treatment in HIV infection should be an ongoing process for RDNs/NDTRs.

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