European Journal of Nutrition & Food Safety
5(4): 229-241, 2015, Article no.EJNFS.2015.020
ISSN: 2347-5641

SCIENCEDOMAIN ***international***
www.sciencedomain.org

Association of Supplemental Nutrition Assistance Program (SNAP) with Food Security and Nutrition Status among Persons Living with HIV

Irene Hatsu[1*], Fatma Huffman[2], Paulette Johnson[3], Marianna Baum[2], Barbara Thomlison[4] and Adriana Campa[2]

[1]Department of Human Science, Ohio State University, Columbus OH, USA.
[2]Department of Dietetics and Nutrition, Florida International University, Miami, FL, USA.
[3]Statistical Consulting, Florida International University, Miami, FL, USA.
[4]School of Social Work, Florida International University, Miami, FL, USA.

Authors' contributions

This work was carried out in collaboration between all authors. Author IH conceptualized and designed the study, collected data, performed the statistical analysis, and wrote the first draft of the manuscript. Author PJ performed statistical analyses and reviewed manuscript. Authors MB, FH and BT contributed to study conceptualization and reviewed manuscript. Author AC contributed to study conceptualization, manuscript write-up and revision of manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2015/10876

Original Research Article

Received 14th April 2014
Accepted 26th May 2015
Published 5th June 2015

ABSTRACT

Aims: Nutritional status can be compromised by food insecurity which is common among HIV infected persons. Providing food assistance is expected to improve food insecurity and nutritional status among persons infected with HIV. This study aimed at examining the relationship of participating in the Supplemental Nutrition Assistance Program (SNAP), the largest food assistance program in the United States, with food security and nutritional status among HIV infected adults.
Study Design: A cross-sectional study design was used in this study.
Place and Duration of Study: This study was conducted in Miami, FL, USA, between April 2011 and August 2012.
Methodology: We included 159 HIV infected individuals in this study, 113 participants were SNAP recipients while 46 were not. All study participants were, however, eligible to participate in SNAP. Each participant completed demographic and food security surveys as well as dietary and nutrition status assessment. Statistical analyses were conducted using univariate and multivariate analyses.

**Corresponding author: Email: Hatsu.1@osu.edu;*

Results: More than half (56%) of the sample experienced food insecurity and had inadequate intakes of several nutrients. There were no significant differences in food security level and nutritional status between SNAP participants and eligible non-participants, even after controlling for demographic and health characteristics. Individuals with very low food security had 4.7 times increased odds (95% CI: 1.29-17.38) of illicit drugs use, which was prevalent (38%) among HIV+ SNAP participants in Miami. Drug users were more than twice likely to have inadequate intakes of vitamins B_1, B_2, B_6, and zinc, compared to non-drug users.

- **Conclusion:** Our results do not support an association between SNAP participation and food security or nutritional status in this cohort of HIV infected individuals with prevalent substance abuse. However, it demonstrates that food insecurity and inadequate nutrient intake continues to be prevalent among HIV infected adults and it is related to drug abuse. Resources need to be identified and targeted at addressing both food insecurity and poor nutritional outcomes among populations of HIV infected adults.

Keywords: Supplemental Nutrition Assistance Program (SNAP); food security; HIV infection; nutrition status; nutrient intake.

1. INTRODUCTION

Poor nutritional status is a predictor of morbidity and mortality in the course of HIV infection [1,2], even during antiretroviral treatment (ART) [3,4]. When compared to non-infected individuals, HIV infected persons have lower serum concentration of nutrients and are more susceptible to nutritional deficiencies [5-8]. With the advent of ART, morbidity and mortality in HIV infected individuals has improved, however, poor nutritional status is still present among many populations in the United States and in developing countries [3,9].

Efforts to improve nutritional status during HIV infection, especially among those in limited resource settings, has included the provision of food assistance. These have been beneficial in improving nutritional status, however, they had no effect on immunologic outcomes [10-13]. A recent study conducted in Haiti found that HIV infected adults with low BMI, who lived in very poor socioeconomic conditions, were able to significantly increase their BMI when provided food assistance [14]. Similar findings, in addition to improvements in body composition, were reported from resource adequate settings, although the interventions only provided nutrient supplements with occasional counseling [15-18]. Nonetheless, these interventions produced significant changes in BMI and other measures of nutritional status [15,19], an indication that some forms of nutritional assistance are beneficial, especially for HIV infected persons with poor socioeconomic status.

Food insecurity "exists whenever the availability of nutritionally adequate, and safe foods or the ability to acquire acceptable foods in socially acceptable ways, is limited or uncertain" [20]. Food insecurity is prevalent among HIV infected individuals regardless of setting [21-28]. It is linked with HIV disease through poverty, poor outlook of life, diminished functional capacity and unemployment, creating a vicious cycle that affects the severity of each condition [29]. Moreover, food insecurity impacts HIV disease transmission through increases in risky behaviors [28,30-33]. Poor mental health, including drug and alcohol use have also been associated with food insecurity among persons living with HIV [33].

Food insecurity for the HIV infected person increases the risk of experiencing compromised nutrition [29,34]. In developing countries, the provision of food aid in the form of ready-to-eat therapeutic foods or food rations to persons living with HIV, has ameliorated food insecurity [13,14]. Although food insecurity rates are high among persons living with HIV in developed countries [21,24,26,28], the literature is scarce on potential benefits of providing food aid to this population. In the United States, the Supplemental Nutrition Assistance Program (SNAP), formerly the Food Stamp Program, is the largest food assistance program provided to alleviate problems of food insufficiency in low income households [35]. The program provides monthly cash benefits on an electronic benefit transfer card. This card can be used in a manner similar to a bankcard in purchasing eligible food items (excludes hot-food items, alcoholic beverages, vitamin supplements and cigarettes) with retailers authorized to participate in the program. Though not conclusive, evidence shows that SNAP is effective in ameliorating food insecurity in the general population, with demonstrated nutritional and health benefits from participation [36-40]. Due to its size, SNAP is most likely the food assistance program used by the majority of low income HIV infected adults. However, to date, there is no known study that has investigated the potential nutrition and food security benefits associated with participation in SNAP among HIV infected adults. The aim of this study is to investigate the relationship of participating in SNAP with food security and nutritional status of HIV infected adults in Miami, FL. The State of Florida has one of the highest number of HIV cases in the United States [41]. According to the Center for Disease Control and Prevention, Miami-Dade county (including the city of Miami) ranked first and third respectively, in HIV and AIDS reported case rates in 2013 [41]. Additionally, 16% of the residents of Miami-Dade County live below the federal poverty level [42]. With high incidence and prevalence rates of HIV/AIDS, and widespread poverty, Miami is an excellent site to study the relationship between HIV infection, participation in nutrition assistance programs, and nutritional health parameters. We hypothesized that participation in SNAP will be associated with significantly improved food security level and nutritional status. Parameters of nutritional status examined in this study include nutrient intake, anthropometric and body composition measurements, as well as biochemical indicators. The study was approved by the Institutional Review Board of the Florida International University (FIU).

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This was a cross-sectional study conducted between April 2011 and August 2012. Its purpose was to compare nutritional status and food security levels among HIV infected adults who were participating in SNAP and eligible non-participants. Participants were recruited consecutively through the FIU-Borinquen HIV and Nutrition Research Clinic (HNRC), located in the Borinquen Health Care Center, Miami, Florida, and other local centers that provide HIV related services to low income infected individuals in Miami-Dade County, Florida. The HNRC conducts several large HIV and Nutrition related studies, and it is attended by several hundreds of persons living with HIV. Recruitment was conducted via flyers posted around these centers, referrals from case managers, and by word of mouth. Participants were considered eligible to participate in the study if they: (1) were 18 years or older, (2) were participating in or eligible to participate in SNAP, and (3) had medical documentation of HIV seropositive status.

Informed consent was obtained from eligible participants who were willing to participate. All who consented were scheduled to complete a study visit. Eligibility for SNAP was determined by the ACCESS Florida Pre-screening eligibility tool. This gathers information on income, assets, household size, and expenditure, and is used as a basic screening tool by the State of Florida for SNAP eligibility [43]. SNAP participation was defined as having received SNAP benefits for at least one month in the last 12 months. The visit also included completing a self-administered questionnaire and dietary, anthropometric, and body composition assessments. Complete blood chemistry (obtained within three months of the study visit) was also obtained from medical records. Assessments were completed by a professional nutritionist. A $10.00 incentive was given to participants for completing the study visit.

2.2 Survey Instruments

2.2.1 Demographic, socioeconomic and lifestyle information

Several questions were used to assess the participants' sociodemographic and economic status. Information collected included age, gender, race/ethnicity, country of birth, marital status, living with a child or not, education, employment, living conditions, monthly income, smoking status, recreational drug use, alcohol use, ART medication use, vitamin use, and the use of other food assistance programs. This questionnaire was field-tested prior to the initiation of the study among 21 HIV infected individuals. These individuals were recruited from the same sources as the study population and had similar characteristics as the study population. The questionnaire was revised based on the field-testing results.

2.2.2 Food security

Recent food security status was measured using the United States Department of Agriculture's (USDA) 6-Item Short Form US Household Food Security Survey Module [44]. This brief survey was selected in order to decrease participant's response burden. Although it is a shorter version of the original 18-item questionnaire, it is able to measure food security and distinguish it from food insecurity [44]. It has enough specificity, sensitivity, and minimal bias compared to the original modules [44]. Food security scores were coded and calculated using standard methods. Responses of “often true”, “sometimes true”, “almost every month”, “some months but not every month” and “yes” were coded as affirmative (1). The total sum of affirmatives for all questions was considered the food security score [44]. The maximum score possible is 6 with higher scores indicating greater severity of food insecurity. Scores of 0-1 were classified as food secure, while 2-4 and 5-6 were classified as low food security and very low food security respectively. The latter two classifications are considered food insecurity [44].

2.2.3 Nutritional status assessment

2.2.3.1 Nutrient intake

Using a 24-hour dietary recall, a professional nutritionist assessed dietary and nutrient intake of study participants. They were each queried about foods and beverages consumed the day prior to the study visit. The brand of food, cooking method used, and the amount consumed were all recorded to ensure the comprehensiveness of information collected. Food models and measuring cups were used as props to accurately estimate the quantity of food consumed. The dietary information collected was analyzed using NutriBase Professional Nutrition Software [45] to determine caloric and micro-/macronutrient composition.

2.2.3.2 Body composition

Participants’ height and weight were measured at the time of data collection. Height was measured without shoes using a wall mounted stadiometer. The results were recorded to the nearest 0.5 inch. Each measurement was done with participants’ heels touching the base of the stadiometer. Participant’s weight was obtained with them wearing light clothing and no shoes. Weight was measured to the nearest 0.1 lbs. using a standard calibrated scale. BMI was calculated using Weight (kg)/ Height (m^2). Body composition assessments were conducted using the bioelectrical impedance analysis (BIA) method [46]. Participants’ waist and hip circumference were measured and used to calculate waist-to-hip ratio. Waist circumference (cm) was measured using a non-stretchable tape measured at the narrowest point of the waist; hip circumference (cm) was measured at the widest point of the hip [47].

2.2.3.3 Biochemical indicators

Laboratory measurements of serum albumin, hemoglobin and hematocrit concentration were also obtained to assess nutritional status. These were obtained from medical records, either provided by participants, or they signed a HIPAA authorization of medical release form with which we secured this information directly from the provider. The laboratory records were required to be less than 3 months old from the day of the study visit and needed to contain complete blood chemistry results.

2.3 Statistical Analysis

Statistical analyses were conducted using SPSS version 21.0 for Windows [48]. Descriptive statistics were used in characterizing the participants and were expressed as mean ± standard deviation, or percentages. Differences in characteristics by SNAP participation status were compared using student’s t-test for continuous normally distributed variables, chi-square test for categorical variables, and Mann-Whitney U test for continuous variables that were not normally distributed.

Average nutrient intakes were adjusted for total calorie intake [49] and the Mann-Whitney U test assessed the differences in nutrient intakes between SNAP participants and eligible non-participants. Some of the body composition and blood chemistry variables were not normally distributed; as a result, both the Mann-Whitney U test and student’s t-test were used to assess the differences in the variables between the groups. The results from both tests were similar, thus, only those from the student’s t-test were reported. Adequacy of nutrient intake was determined using the Estimated Average Intake (EAR) requirements for each nutrient and Adequate Intake (AI) for nutrients whose EAR are yet to be determined [50]. Chi-square tests were then used to compare the adequacy of nutrient intake by SNAP participation status.

Chi-square tests were also used to compare the severity of food insecurity by SNAP participation status. The associations between SNAP participation and 1) food security status and 2) nutritional status (dietary intake), were examined using logistic regression. The association between SNAP participation and nutritional status (body composition and blood chemistries) was assessed using multiple linear regression. The regression models were built using SNAP as the independent variable and food security and nutrition status as the dependent variables. Variables controlled for in the logistic and multiple linear regression analyses were: age, gender, ethnicity, country of birth, living with a child or not, work status, household size, ART use, smoking status, alcohol use, drug use, vitamin use, and use of other food assistance programs. Participants with missing data (N=16) were excluded from the final analysis. The significance level for all analysis was set at $P<.05$.

3. RESULTS

3.1 Demographic Characteristics

After providing informed consent, 175 participants enrolled and participated in the study. However, due to missing data (such as SNAP participation status, food security status, etc.) only 159 were included in analyses. Participants were mostly male (67%), African-American (75%), with a mean age of 46.81±8.03 years. Over 90% were single, with nearly half (48%) without children. Over half (52%) reported having more than a high school education, with about 45% and 42% of participants claiming unemployment and disability respectively.

The mean duration for program participation among SNAP recipients was 10.52±2.90 months. Significantly more SNAP participants (49%) were on disability than non-participants (24%), and fewer (39.8%) were unemployed compared to the non-participants (57%), $P = .015$, $\Phi = 0.23$. As shown in Table 1, more SNAP participants (84%) were on ART compared to the non-participants (65%), $P = .001$, $\Phi = 0.37$. More SNAP participants used illicit drugs (38%) than non-participants (13.0%), $P = .002$, $\Phi = 0.25$. The distribution of alcohol use also differed significantly by SNAP status, $P = .03$. Forty four percent of SNAP participants drank alcohol at least 2-3 times/week compared to only twenty six percent of non-participants.

Table 1. Demographic characteristics by SNAP participation status among HIV infected adults

Variable	SNAP (n=113)	Non-SNAP (n=46)	*P*-value
Age[a]	46.81±7.52	46.80±8.76	.99
Male	77 (68.1)	30 (65.1)	.72
Ethnicity			.27
African American	88 (77.9)	31 (67.4)	
Hispanic	17 (15.0)	7 (15.2)	
White	4 (3.5)	4 (8.7)	
Other	4 (3.5)	4 (8.7)	
US born ***	103 (91.2)	30 (65.2)	<.001
Single	102 (90.3)	43 (93.5)	.52
No children	53 (46.9)	24 (48.8)	.35
More than High School	63 (55.8)	20 (43.5)	.16
Employment status*			.02
Unemployed	45 (39.8)	26 (56.5)	
Employed	13 (11.5)	9 (19.6)	
On disability	55 (48.7)	11 (23.9)	
Monthly income < $1000	95 (84.1)	34 (73.9)	.14
Living condition			.55
Alone	44 (38.9)	18 (39.1)	
With family	52 (46.0)	18 (39.1)	
Shelter	17 (15.0)	11 (21.7)	
Uses of other food assistance	16 (14.2)	7 (15.2)	.86
Smokes cigarettes	78 (69.0)	26 (56.5)	.13
Alcohol use	63 (55.8)	18 (39.1	.06
Drug use**	43 (38.1)	6 (13.0)	.002
On ART***	106 (93.8)	30 (65.2)	<.001
Takes vitamins	51 (45.1)	21 (45.1)	.95

[a]*Reported as mean±SD; All other variables are reported as n (%); ART: Antiretroviral therapy, *P<.05, **P<.01, ***P<.001*

3.2 Association between SNAP Participation and Food Security

About 32% of the sample experienced low food security while 24% experienced very low food security. There were no significant differences in the level of food security between groups. Nearly half (46%) of SNAP participants were food secure while 39% of non-SNAP participants experienced food security. Logistic regression examined the association between food security status and SNAP participation, controlling for confounding variables (Table 2). SNAP participation status was not significant in the logistic regression model.

The logistic regression also identified relationships between levels of food security and some demographic characteristics. Individuals experiencing very low food security relative to those food secure had 4.7 times greater odds (95% CI: 1.29-17.38) of using illicit drugs, and 8.3 times decreased odds [AOR= 0.12 (95% CI: 0.02-0.85)] of having children at home. Similarly, those experiencing low food security compared to those who were food secure had 3.6 times greater odds (95% CI: 1.10-11.48) of illicit drug use, and 4.2 times greater odds (95% CI: 1.21-14.37) of using other food assistance programs.

3.3 Association between SNAP Participation and Nutrition Status

No significant differences were seen in the nutrient and fiber intakes between SNAP participants and non-participants. Mean caloric intake for both groups was approximately 2000 kcals per day. Energy adjusted protein intake for both groups was below the recommendation for healthy adults while carbohydrate intake was above recommendation. Both groups also consumed below recommended amounts for fiber. For about half of the nutrients assessed, more than 50% of the sample had intakes below the recommended Dietary Reference Intakes (DRI), whether EAR or AI. More than 90% had intakes below DRI requirements for vitamin E, potassium and magnesium. Vitamin D intake was below EAR for 100% of the study sample. In those receiving SNAP, duration of participation as a continuous variable did not significantly change nutrient intake. There were no statistically significant differences in percentages of participants with intake below DRI for any of the nutrients by SNAP participation status (Table 3).

Table 2. Logistic regression of food security on SNAP participation status among HIV infected adults

Food security status	SNAP participation			
	Unadjusted		Adjusted	
	OR	95% CI	OR	95% CI
Food secure	----	----	----	----
Low food security	0.76	0.34-1.68	0.69	0.24-1.98
Very low food security	0.75	0.32-1.79	0.45	0.14-1.46

Model controlled for age, gender, ethnicity, country of birth, living with a child or not, work status, household size, ART use, smoking status, alcohol use, drug use, vitamin use, and use of other food assistance programs

Table 3. Percentages of HIV infected adults with nutrient intakes below Estimated Average Requirements (EAR) by SNAP participation status

Nutrient	SNAP (n=113)	Non-SNAP (n=46)	*P*-value
Vitamin A *μg*	92 (81.4)	38 (82.6)	.86
Thiamin *mg*	56 (49.6)	21 (45.7)	.66
Riboflavin *mg*	53 (46.9)	21 (45.7)	.87
Niacin *mg*	43 (38.1)	17 (37.0)	.89
Pantothenic acid *mg* [a]	91 (80.5)	38 (82.6)	.77
Vitamin B_6 *mg*	60 (53.1)	27 (58.7)	.52
Vitamin B_{12} *μg*	50 (44.2)	23 (50.0)	.51
Vitamin C *mg*	75 (66.4)	33 (71.7)	.51
Calcium *mg*	82 (72.6)	33 (71.7)	.92
Vitamin D *μg*	113 (100)	46 (100)	1.00

Table 3 continued……..

Vitamin E *mg*	111 (98.2)	46 (100)	.36
Folate *µg*	70 (61.9)	28 (60.9)	.89
Magnesium *mg*	102 (90.3)	44 (95.7)	.26
Phosphorus *mg*	41 (36.3)	15 (32.6)	.66
Potassium *mg* [a]	111 (98.2)	46 (100)	.36
Sodium *mg* [a]	10 (8.8)	6 (13.0)	.43
Iron *mg*	18 (15.9)	7 (15.2)	.91
Selenium *µg*	43 (38.1)	11 (23.9)	.08
Zinc *mg*	67 (59.3)	31 (67.4)	.34

[a]AI was used; EAR for nutrient not yet determined

Logistic regressions of SNAP participation status on adequacy of nutrient intakes showed no significant results. Several demographic characteristics were associated with the ability to achieve adequacy of nutrient intakes. Adequacy of calcium intake was associated with older age (*P* = .04), while adequacy of vitamin A intake was associated with younger age (*P* = .009) and not having children at home (*P* = .02). Adequacy of vitamin B_{12} and iron intake was associated with being male (*P* = .02, .007, respectively). Of the lifestyle related variables, drug and alcohol use were found to be associated with below EAR intake for some nutrients. After adjusting for control variables, the odds of drug users having below EAR intakes were 2.9 (95% CI: 1.09-7.49) for vitamin B_1, 3.3 (95% CI: 1.20-9.01) for vitamin B_2, 2.5 (95% CI: 0.95-6.45) for vitamin B_6, and 2.6 (95% CI: 1.00-6.56) for zinc, relative to non-users. Alcohol drinkers had 2.5 times greater odds (95% CI: 1.02-6.14) of below EAR intake for copper compared to non-drinkers. Use of ART was associated with above EAR intake for iron (AOR= 5.6, 95% CI: 1.17-26.40).

The average BMI for this population was 27.81±5.82 with an average waist-to-hip ratio of 0.9. There were no significant differences in mean values of body composition and biochemical indicator variables by SNAP participation status (Results not shown). Gender was significantly related to all variables except albumin. Being female was associated with having higher body mass index (β = .34, *P*<.001), higher fat mass (β = .47, *P*<.001), lower lean body mass (β = -.50, *P*<.001) and lower waist-to-hip ratio (β = -.27, *P* = .004). Multiple linear regression analyses were conducted to assess the association of SNAP participation status on body composition and biochemical variables. About 30% of the variability of most variables (with the exception of albumin and waist-to-hip ratio) was explained by the control variables. However, SNAP participation status explained less or equal to 1.4% additional variability of body composition and biochemical variables after controlling for these variables.

4. DISCUSSION AND CONCLUSION

The current study did not find an association between SNAP participation and food security, although some [51,52] but not all studies [53,54] have found that participation in SNAP alleviates food insecurity in the general population. More than half (56%) of the participants in this study experienced lower levels of food security. This rate is higher than both the national food insecurity rate of 14.9% and the state of Florida rate of 15.4% reported in 2011 [55]. The prevalence of very low food security in our study population was more than four times that reported for the general public in the same year [55]. High food insecurity rates have consistently been reported among persons living with HIV in North America. Eighty one percent of HIV infected adults in a study conducted in Miami, with a similar population, experienced food insecurity in addition to wasting [23]. Another study by Vogenthaler et al. [26] in Atlanta and Miami, reported a 34% food insecurity rate among those living with HIV. Studies conducted in Canada and California reported rates of food insecurity between 48-64% [21,23,24,28]. It is possible that the ability of SNAP to alleviate the effects of heightened food insecurity in HIV infected people is minimal compared to that observed in the general population, due to the increased nutritional demands, poor nutritional status and the severe socio-economic conditions surrounding this population in Miami.

Illicit drug use had a strong association with lower levels of food security in our population. Drug users had more than three times increased odds for experiencing food insecurity. Our findings are consistent with those noted in other HIV infected cohorts across the country [33,56,57], and suggests the need to include food insecurity intervention with drug intervention programs for persons living with HIV. The use of other food assistance programs was also associated with food insecurity and this finding was not surprising. Individuals having difficulty to attain food sufficiency are more likely to use several food assistance programs. Demographic characteristics like income, unemployment and instability in housing were not associated with food insecurity in this study sample.

The progression and management of HIV infection is affected by several factors including diet and nutritional status. Due to the collaborative interaction between nutrient status, infection and immunity, marginal or low intake of nutrients, especially those significantly associated with HIV disease is of particular concern [58,59]. Several studies have investigated the caloric and macronutrient intake of persons infected with HIV, with varying results [60-63]. Our study shows that calorie and macronutrient intake in this population is lower than what is recommended for healthy adults. Due to the demands of the disease, individuals infected with HIV have increased caloric and macronutrients needs [64]. Resting metabolic rates (RMR) is increased by about 10% for HIV infected adults, hence inadequate energy intake can contribute to poor nutritional outcomes [65]. Among individuals infected with HIV, low serum levels of Vitamins A, E and B_{12} have been linked to neurological abnormalities, increased oxidative stress and increased risk of mortality [66,67]. Our HIV infected cohort had inadequate intake of Vitamins B_{12} (46% of participants), as well as A and E (>80% of participants). These percentages are higher than those reported for another HIV cohort, where 21%-64% of the women had below DRI intakes for several vitamins including vitamins A and E [62]. Several studies report lower intakes for vitamins A and E among persons living with HIV; however, in these studies comparison of mean/median intakes with DRI's (specifically, RDA: Recommended Daily Allowance) was made without specifying proportions consumed below the DRIs [59,60,55,68].

Vitamin D plays an important role in immunity and has been associated with disease progression, anemia and mortality among HIV infected persons [69,70]. Vitamin D deficiency is common among HIV infected adults, and Blacks or Hispanics are at increased risk for deficiency [71]. In our study, 100% of participants had below DRI intake for vitamin D. This is of concern because more than half of the standard ART combinations used in Miami include tenofovir, which has been known to contribute to altered Vitamin D metabolism [72]. In addition, 75% of our participants are African Americans and 15% Hispanics; two ethnic groups at heightened risk for vitamin D deficiency. Vitamin D status of persons living with HIV needs to be a priority, especially for Nutrition Practitioners in South Florida. Further investigation to assess vitamin D status using biomarkers is warranted for this population, as deficiency may be a mediator of disease progression and other comorbidities. Although selenium status is associated with disease progression and risk of mortality [59,66,73], supplementation is not routinely recommended during HIV infection due to lack of sufficient evidence supporting associated benefits [74]. More than a third of our participants were found to consume below DRI requirements for selenium. Selenium deficiency, however, is only prevalent among HIV infected individuals with poor dietary intakes; not all HIV cohort studies have found deficiencies [59]. Again, we found nearly 62% of our study population to have inadequate zinc intake. Recently, Baum et al. [75] showed that adequacy of zinc intake achieved through supplementation leads to a fourfold decrease in the chances of developing immunological failures. Our findings show a continued need to emphasize the adequacy of zinc intake among persons living with HIV, as deficiency is still common.

Recent HIV studies report a trend of increasing weight among several cohorts [76-78] and this was evident in our study. About 32% of our population was overweight and 30% obese, with only 1.9% being underweight. This trend reflects the participants' access to the lifesaving ART, and perhaps, the nations' obesity epidemic. The cause of overweight and obesity observed among HIV infected persons are multifaceted, however, diet and specific ART agents are the main influencers of weight gain [79]. Overall, we did not find any significant association between SNAP participation and nutritional status. However, our results may have been influenced by significant drug use among SNAP participants, which decreases the generalizability of our findings to other HIV-positive populations. To the best of our knowledge, this is the first study examining the nutrition and food security benefits derived from food assistance among persons living with HIV in a developed country. Several other studies (from developing countries) have explored the use of food assistance programs to improve the nutritional status and food security of HIV infected adults [12-14]. This research differs from the others in two ways: 1) participants received public food assistance through financial allocations to spend on food; they were not provided food rations and 2) researchers had no control on the type of food consumed. Although SNAP is not designed specifically for persons living with HIV, findings from this study could serve as basis for other studies exploring the use of food assistance programs to help improve the food security and nutritional status of HIV infected persons in developed countries. Future studies are needed to help us better understand where to invest resources to improve the lives of persons living with HIV.

The limitations of this study include its cross-sectional nature, relying on self-reported data which may weaken links between SNAP participation and better food security and nutritional outcomes. Our study did not take into account the differences in the monetary amounts received as SNAP benefits, the types of food purchased and consumed by SNAP participants and the food security and nutritional status of SNAP participants prior to participation in the program. It also did not take into account disease status of participants. The external validity of the study is also decreased because we used a small, convenience sample of HIV infected persons from Miami. The generalization of study results to other HIV infected populations therefore needs to be executed with caution. Finally, the adequacy of nutrient intakes was based on a single 24-hr recall, and may not represent usual intake. Repeated 24-hour recalls may have been more appropriate dietary assessment method, especially for the determination of micronutrients intakes. Despite these limitations, this study shows that food insecurity and inadequate nutrient intake continues to exist among persons infected with HIV. It also demonstrates that in this population, food insecurity and inadequate nutrients intake are related to drug abuse. Food insecurity increases the risk for poor nutritional status [29,34]; a known predictor of morbidity and mortality during HIV infection [1,2]. As such, our findings have implications for HIV treatment and management. Resources need to be identified and directed towards addressing food insecurity and poor nutritional outcomes among HIV infected populations in developed countries. This is especially important in drug abusing subpopulations.

CONSENT

All authors declare that written informed consent was obtained from each participants before inclusion in this study.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the Florida International University Institutional Review Board and have therefore been performed in accordance with the ethical standards laid down in the 1964 declaration of Helsinki. IRB Approval # 041111-00.

ACKNOWLEDGEMENTS

We thank all our study participants and the research staff at Florida International University (FIU) HIV and Nutrition research clinic. We also acknowledge FIU's University Graduate School for providing the Data Evidence Acquisition Fellowship which supported data collection for this study. The infrastructure for this study was partially funded by NIH grants from NIDA "HIV and HIV/HCV-Infection, Disease Progression, Oxidative Stress and Antioxidants, Grant No. R01DA023405, and from NIAAA "Alcohol & Antiretrovirals in HIV Infection, Oxidative Stress and Liver Disease Grant No. R01AA018011. The funding agencies did not have any role in the design, conduct and analyses of this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chlebowski RT, Grosvenor MB, Bernhard NH, Morales LS, Bulcavage LM. Nutritional status, gastrointestinal dysfunction, and survival in patients with AIDS. Am J Gastroenterol. 1989;84(10):1288-93.
2. Melchior JC, Niyongabo T, Henzel D, Durack-Bown I, Henri SC, Boulier A. Malnutrition and wasting, immuno-depression, and chronic inflammation as independent predictors of survival in HIV-infected patients. Nutrition. 1999;15(11): 865-69.
3. Koethe JR, Heimburger DC. Nutritional aspects of HIV-associated wasting in sub-

Saharan Africa. Am J Clin Nutr. 2010; 91(4):1138S-42S.
4. Liu E, Spiegelman D, Semu H, Hawkins C, Chalamilla AA, Nyamsangia S, et al. Nutritional status and mortality among HIV-infected patients receiving antiretroviral therapy in Tanzania. J Infect Dis. 2011;204 (2):282-90.
5. Semba RD, Shah N, Strathdee SA, Vlahov D. High prevalence of iron deficiency and anemia among female injection drug users with and without HIV infection. J Acquir Immune Defic Syndr. 2002;29(2):142-44.
6. Periquet BA, Jammes NM, Lambert WE, Tricore J, Moussa MM, Garcia J, et al. Micronutrient levels in HIV-1-infected children. AIDS. 1995;9(8):887-93.
7. Beach RS, Mantero-Atienza E, Shor-Posner G, Javier JJ, Szapocznik J, Morgan R, et al. Specific nutrient abnormalities in asymptomatic HIV-1 infection. AIDS. 1992; 6(7):701-08.
8. Lacey CJ, Murphy ME, Sanderson MJ, Monteiro EF, Vail A, Schorah CJ. Antioxidant-micronutrients and HIV infection. Int J STD AIDS. 1996;7(7):485-89.
9. Wanke CA, Silva M, Knox TA, Forrester J, Speigelman D, Gorbach SL. Weight Loss and Wasting Remain Common Complications in Individuals Infected with Human Immunodeficiency Virus in the Era of Highly Active Antiretroviral Therapy. Clin Infect Dis. 200;31(3):803-05.
10. Kadiyala S, Gillespie S. Rethinking food aid to fight AIDS. Food Nutr Bull. 2004; 25(3):271-82.
11. Ndekha MJ, Van Oosterhout JJ, Zijlstra EE, Manary M, Saloojee H, Manary MJ. Supplementary feeding with either ready-to-use fortified spread or corn-soy blend in wasted adults starting antiretroviral therapy in Malawi: A randomized, investigator blinded, controlled trial. BMJ. 2009;338: b1867.
12. Rawat R, Kadiyala S, McNamara PE. The impact of food assistance on weight gain and disease progression among HIV-infected individuals accessing AIDS care and treatment services in Uganda. BMC Public Health. 2010;10:316.
13. Cantrell RA, Sinkala M, Megazinni K, Lawson-Marriot S, Washington S, Chi BH, Tambatamba-Chapula B, Levy J, Stringer EM, Mulenga L, Stringer JS. A Pilot Study of Food Supplementation to Improve Adherence to Antiretroviral Therapy Among Food-Insecure Adults in Lusaka, Zambia. J Acquir Immune Defic Syndr. 2008;49(2):190-95.
14. Ivers LC, Chang Y, Gregory Jerome J, Freedberg KA. Food assistance is associated with improved body mass index, food security and attendance at clinic in an HIV program in central Haiti: A prospective observational cohort study. AIDS Res Ther. 2010;7:33. (DOI: 10.1186/1742-6405-7-33)
15. Clark RH, Feleke G, Din M, Yasminb T, Singh G, Khan FA, et al. Nutritional treatment for acquired immunodeficiency virus-associated wasting using beta-hydroxy beta-methylbutyrate, glutamine, and arginine: A randomized, double-blind, placebo-controlled study. J Parenter Enteral Nutr. 2000;24(3):133-39.
16. McDermott AY, Shevitz A, Must A, Harris S, Roubenoff R, Gorbach S. Nutrition Treatment for HIV Wasting: A Prescription for Food as Medicine. Nutr Clin Pract. 2008;18(1):86-94.
17. Pichard C, Sudre P, Karsegard V, Yerly S, Slosman DO, Delly V, Perrin L, Hirschel B. A randomized double-blind controlled study of 6 months of oral nutritional supplementation with arginine and 3 fatty acids in HIV-infected patients. AIDS. 1998; 12(1):53-63.
18. Stack JA, Bell SJ, Burke PA, Forse RA. High-Energy, High-Protein, Oral, Liquid, Nutrition Supplementation in Patients with HIV Infection: Effect on Weight Status in Relation to Incidence of Secondary Infection. J Am Diet Assoc. 1996;96(4): 337-41.
19. Shabert JK, Winslow C, Lacey JM, Wilmore DW. Glutamine-antioxidant supplementation increases body cell mass in AIDS patients with weight loss: A randomized, double-blind controlled trial. Nutrition. 1999;15(11):860-64.
20. Andersen SA. Core indicators of nutritional state for difficult-to-sample populations. J Nutr. 1990;120(11):1559-600.
21. Normen L, Chan K, Braitstein P, Anema A, Bondy G, Montaner JS, et al. Food Insecurity and Hunger Are Prevalent among HIV-Positive Individuals in British Columbia, Canada. J. Nutr. 2005;135 (4):820-25.
22. Weiser SD, Tsai AC, Gupta R, Frongillo EA, Kawuma A, Senkungu J, et al. Food insecurity is associated with morbidity and patterns of healthcare utilization among

HIV-infected individuals in a resource-poor setting. AIDS. 2012;26(1):67-75.
23. Campa A, Zhifang Y, Lai S, X. HIV-Related wasting in HIV-infected drug users in the era of highly active antiretroviral therapy. Clin Infect Dis. 2005;41(8):1179-85.
24. Anema A, Kerr T, Weiser SD, Montaner JSG, Wood E. Prevalence and correlates of self-reported hunger among HIV+ and HIV- injection drug users in Canada 5th International AIDS Society Conference on HIV Pathogenesis and Treatment Cape Town, South Africa; 2009.
25. Mamlin J, Kimaiyo S, Lewis S, Tadayo H, Jerop FK, Gichunge C, et al. Integrating nutrition support for food-insecure patients and their dependents into an HIV care and treatment program in Western Kenya. Am J Public Health. 2009;99(2):215-21.
26. Vogenthaler NS, Hadley C, Lewis SJ, Rodriguez AE, Metsch LR, Del Rio C. Food insufficiency among HIV-infected crack-cocaine users in Atlanta and Miami. Public Health Nutr. 2010:13(9):1478-84.
27. Wang E, McGinnis K, Fiellin D, Goulet JL, Bryant K, Gibert CL, et al. Food Insecurity is Associated with Poor Virologic Response among HIV-Infected Patients Receiving Antiretroviral Medications. J Gen Intern Med. 2011;26(9):1012-18.
28. Weiser S, Frongillo E, Ragland K, Hogg R, Riley E, Bangsberg D. Food insecurity is associated with incomplete HIV RNA suppression among homeless and marginally housed HIV-infected individuals in san francisco. J Gen Intern Med. 2009; 24(1):14-20, 2009.
29. Anema A, Vogenthaler N, Frongillo E, Kadiyala S, Weiser S. Food insecurity and HIV/AIDS: Current knowledge, gaps, and research priorities. Curr HIV/AIDS Rep. 2009;6(4):224-31.
30. Dunkle KL, Jewkes RK, Brown HC, Gray GE, McIntryre JA, Harlow SD. Transactional sex among women in Soweto, South Africa: Prevalence, risk factors and association with HIV infection. Soc Sci Med. 2004;59(8):1581-92.
31. Oyefara JL. Food insecurity, HIV/AIDS pandemic and sexual behaviour of female commercial sex workers in Lagos metropolis, Nigeria. Sahara J. 2007;4(2): 626-35.
32. Weiser S, Bangsberg D, Kegeles S, Ragland K, Kushel M, Frongillo E. Food insecurity among homeless and marginally housed individuals living with HIV/AIDS in san francisco. AIDS Behav. 2009;13(5): 841-48.
33. Weiser SD, Young SL, Cohen CR, Kushel MB, Tsai AC, Tien PC, et al. Conceptual framework for understanding the bidirectional links between food insecurity and HIV/AIDS. Am J Clin Nutr. 2011;94(6): 1729S–39S.
34. Gillespie S, Kadiyala S, International Food Policy Research I. HIV /AIDS and food and nutrition security: from evidence to action. Washington, DC: IFPRI; 2005.
35. United States Department Agriculture. Building a Healthy America: A profile of the supplemental nutrition assistance program. UDSA Food and Nutrition Service; 2012.
36. Allen JE, Gadson KE. Nutrient Consumption Patterns of Low-Income Households. USDA, Economic Research Service; 1983.
37. Beebout H, Cavin E, Devaney B. Evaluation of the Nutrition assistance program in puerto rico: Volume II, effects on food expenditures and diet quality. Washington, DC: Mathematica Policy Research, Inc; 1985.
38. Devaney B, Moffitt R. Dietary Effects of the Food Stamp Program. Am J Agric Econ. 1991;73(1):202-11.
39. Fox M, Hamilton W, Lin BH. Effects of food assistance and Nutrition Programs on nutrition and health; Volume 4 executive summaryof the literature review: Food Assisstance and Nutrition Research. FANRR19-4; 2004.
40. Fraker TM, Martini AP, Ohls JC. The Evaluation of the Alabama Food Stamp Cash-out Demonstration: Recipient Impacts. USDA, Food and Nutrition Service; 1992;1.
41. Florida Health. HIV Disease: United States vs Florida Fact Sheet. Available:http://www.floridahealth.gov/diseases-and conditions/aids/surveillance/_documents/fact-sheet/2014/2014-us-vs-fl-fact-sheet.pdf. Assessed March 12, 2015.
42. Miami-Dade HIV/AIDS Partnership. Comprehensive Plan for HIV/AIDS. 2009-2011. Available:http://www.aidsnet.org/newmain/partnershipall/partnership/0911compplan.pdf (Accessed September 10, 2012)
43. Department of Children and Families (DCF). ACCESS Florida. Available:https://dcfaccess.dcf.state.fl.us/access2florida/prescreening/welcome.do?p

erformAction=init&mode=Inter (Accessed December 10, 2012)

44. Blumberg SJ, Bialostosky K, Hamilton WL, Briefel RR. The Effectiveness of a short form of the household food security scale. Am J Public Health. 1999;89(8): 1231-34.
45. Nutribase Professional Nutrition and Fitness Software (Version 9.0) [Computer Software]. Phoenix, AZ: Cybersoft.
46. Kyle UG, Bosaeus I, De Lorenzo AD, Deurenberg P, Elia M, Manuel Gómez J, et al. Bioelectrical impedance analysis-Part II: Utilization in clinical practice. Clinical Nutrition. 2004;23(6):1430-53.
47. Chan DC, Watts GF, Barrett PHR, Burke V. Waist circumference, waist-to-hip ratio and body mass index as predictors of adipose tissue compartments in men. QJM. 2003:96(6):441-47.
48. SPSS Statistics Software (Version 21.0) [Computer Software]. Armonk, NY: IBM.
49. Willett WC, Howe GR, Kushi LH. Adjustment for total energy intake in epidemiologic studies. Am J Clin Nutr. 1997;65(4):1220S-1228S.
50. Dietary Reference Intakes: Application for Dietary Assessment. National Academy of Science. Institute of Medicine; 2000.
51. Nord M. How much does the Supplemental Nutrition Assistance Program alleviate food insecurity? Evidence from recent programme leavers. Public Health Nutr. 2012;15(5):811-17.
52. Ratcliffe C, McKernan S-M, Zhang S. How much does the supplemental nutrition assistance program reduce food insecurity? Am J Agric Econ. 2011;93(4): 1082-1098, 2011.
53. Gundersen C, Oliveira V. The food stamp program and food insufficiency. Am J Agric Econ. 2001;83(4):875-87.
54. Huffman S, Jensen H. Do food assistance programs improve household food security? Recent Evidence from the United States: Center for Agricultural and Rural Development, Iowa State Univ. Working Paper 03-WP 335; 2003.
55. Coleman-Jensen A, Nord M, Andrews M, Carlson S. Household food security in the united states in 2011. USDA, Economic Research Services; 2011.
56. Kalichman SC, Cherry C, Amaral C, White D, Kalichman MO, Pope H, et al. Health and treatment implications of food insufficiency among people living with HIV/AIDS, Atlanta, Georgia. J Urban Health. 2010;87(4):631-41.
57. Hendricks KM, Erzen HD, Wanke CA, Tang AM. Nutrition Issues in the HIV-Infected Injection Drug User: Findings from the Nutrition for Healthy Living Cohort. J Am Coll Nutr. 2010;29(2):136-43.
58. Piwoz E, Preble E. HIV/AIDS and nutrition: a review of the literature and recommendations for nutritional care and support in sub-Saharan Africa Washington, DC: Academy for Educational Development, Support for Analysis and Research in Africa Project; 2000.
59. Bogden JD, Oleske JM. The essential trace minerals, immunity, and progression of HIV-1 infection. Nutr Res. 2007;27(2): 69-77.
60. Kim JH, Spiegelman D, Rimm E, Gorbach SL. The correlates of dietary intake among HIV-positive adults. Am J Clin Nutr. 2001; 74(6):852-61.
61. Onyango AC, Walingo MK, Mbagaya G, Kakai R. Assessing nutrient intake and nutrient status of HIV seropositive patients attending clinic at chulaimbo sub-district hospital, Kenya. J Nutr Metab; 2012. (DOI: 10.1155/2012/306530)
62. Vorster HH, Kruger A, Margetts BM, Venter CS, Kruger HS, Veldman FJ, et al. The nutritional status of asymptomatic HIV-infected Africans: Directions for dietary intervention? Public Health Nutr. 2004; 7(8):1055-64.
63. Woods MN, Spiegelman D, Knox TA, Forrester JE, Connors JL, Skinner SC, et al. Nutrient intake and body weight in a large HIV cohort that includes women and minorities. J Am Diet Assoc. 2002; 102(2):203-11.
64. FANTA. Food Assistance Programming in the Context of HIV. Food and Nutrition Technical Assistance (FANTA) Project and World Food Programme (WFP). Washington, DC: FANTA Project, Academy for Educational Development; 2007.
65. Hsu JWC, Pencharz PB, Macallan D & Tomkins A. Macronutrients and HIV/AIDS: A Review of Current Evidence. Geneva: WHO; 2005. Available:www.who.int/nutrition/topics/Paper_1_Macronutrients_bangkok.pdf
66. Baum MK, Shor-Posner G, Lai S, Zhang G, Lai H, Flecher MA, et al. High Risk of HIV-Related Mortality Is Associated With Selenium Deficiency. J Acquir Immune Defic Syndr. 1997;15(5):370-74.

67. Tang AM, Smit E. Selected vitamins in HIV infection: A review. AIDS Patient Care STDS. 1998;12(4):263-73.
68. Smit E, Graham NMH, Tang A, Flynn C, Solomon L, Vlahov D. Dietary intake of community-based HIV-1 seropositive and seronegative injecting drug users. Nutrition. 1996;12(7):496-501.
69. Villamor E. A potential role for vitamin D on HIV infection? Nutr Rev. 2006;64(5) 226-33.
70. Mehta S, Giovannucci E, Mugusi FM, Spiegelman D, Aboud S, Hertzmark E, Msamanga GI, Hunetr D, Fawzi WW. Vitamin D status of HIV-infected women and its association with HIV disease progression, Anemia, and Mortality. PLoS ONE. 2010;5(1):e8770. (DOI: 10.1371/journal.pone.0008770)
71. Dao CN, Patel P, Overton ET, Rhame F, Pals SL, Johnson C, et al. Low Vitamin D among HIV-Infected Adults: Prevalence of and Risk Factors for Low Vitamin D Levels in a Cohort of HIV-Infected Adults and Comparison to Prevalence among Adults in the US General Population. Clin Infect Dis. 2011;52(3):396-405.
72. Childs KE, Fishman SL, Constable C, Gutierrez JA, Wyatt CM, Dieterich DT et al. Short communication: Inadequate vitamin D exacerbates parathyroid hormone elevations in tenofovir users. AIDS Res Hum Retroviruses. 2010;26(8):855-59.
73. Singhal N, Austin J. A clinical review of micronutrients in HIV infection. J Int Assoc Physicians AIDS Care. 2002;1(2):63-75.
74. National Institute of Health. Dietary supplement fact sheet: Selenium office of dietary supplements. Accessed October 23, 2012. Available:http://ods.od.nih.gov/factsheets/Selenium-HealthProfessional
75. Baum MK, Lai S, Sales S, Page JB, Campa A. Randomized, controlled clinical trial of zinc supplementation to prevent immunological failure in HIV-infected adults. Clin Infect Dis. 2010;50(12):1653-60.
76. Crum-Cianflone N, Roediger MP, Eberly L, Headd M, Marconi V, Ganesan A, Weintrob R, Barthel V, Fraser S, Agan BK. Increasing Rates of Obesity among HIV-Infected Persons during the HIV Epidemic. PLoS ONE. 2010;5(4):e10106. (DOI: 10.1371/journal.pone.0010106)
77. Crum-Cianflone N, Tejidor R, Medina S, Barahona I, Ganesan A. Obesity among patients with HIV: the latest epidemic. AIDS Patient Care STDS. 2008;22(12): 925-30.
78. Hendricks KM, Willis K, Houser R, Jones CY. Obesity in HIV-Infection: Dietary Correlates. J Am Coll Nutr. 2006;25(4): 321-31.
79. Dorey-Stein Z, Amorosa VK, Kostman JR, Lo Re V 3rd, Shannon RP. Severe weight gain, lipodystrophy, dyslipidemia, and obstructive sleep apnea in a human immunodeficiency virus-infected patient following highly active antiretroviral therapy. J Cardiometab Syndr. 2008;3(2): 111-14.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid= 856&id=30&aid=9611