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Food Insecurity and CD4% among HIV+ Children in Gaborone, Botswana

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Abstract

We investigated the association between household food insecurity (HFI) and CD4% among 2-6 year old HIV+ outpatients (n=78) at the Botswana-Baylor Children's Clinical Center of Excellence in Gaborone, Botswana. HFI was assessed by a validated survey. CD4% data were abstracted from the medical record. We used multiple linear regression with CD4% (dependent variable), HFI (independent variable), and controlled for socio-demographic and clinical covariates. Multiple linear regression showed a significant main effect for HFI (beta=−0.6, 95% CI [−1.0, −0.1]) and child gender (beta=5.6, 95% CI [1.3, 9.8]). Alleviating food insecurity may improve pediatric HIV outcomes in Botswana and similar Sub-Saharan settings.

Keywords

HIV; food security; pediatric; CD4%; children; Sub-Saharan Africa

Introduction

HIV infection is a major public health problem in Sub-Saharan Africa, a region with 70.8% of the total global HIV burden.[1] Of the estimated 3.3 million children worldwide under 15 years old living with HIV in 2012, 2.9 million were living in Sub-Saharan Africa.[1] The Sub-Saharan country of Botswana has a high prevalence of HIV infection, with 23% of adults

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ages 15-49 years infected. Similarly in 2012, Botswana had an estimated 11,000 children under 15 years old living with HIV and had 120,000 children who were orphans due to HIV.[1] HIV infection has major implications for child rearing, family socioeconomic status, and the allocation of resources for meeting basic needs such as food, medical care, housing, and schooling.[2] Food insecurity, defined as the lack of physical or economic access (through socially acceptable means) to sufficient food to meet people's dietary needs for a productive and healthy life,[3] is also prevalent in Botswana where an estimated 27.9% were food insecure in 2010-2012.[4] Food insecurity is an important predictor of several adverse child health outcomes including undernutrition/nutrient deficiencies, developmental delay, and poor overall health.[5] Several pathways connect household food insecurity to HIV disease progress.[6] Food insecurity may directly lead to lack of an adequate dietary intake and subsequent macro- and micro-nutrient deficiencies that lead to an impaired immune system and further reductions to CD4%.[6] A patient's continued disease progression, in turn, worsens household food insecurity by redirecting income, assets, and time from employment or food procurement to caregiving.[2,7] Moreover, food insecurity itself may adversely influence antiretroviral (ARV) medication adherence or absorption, further contributing to disease progression.[6]

Studies among low-income HIV+ adults in developed settings,[8-13] reported associations between higher food insecurity and lower CD4 counts or higher HIV-viral loads.[6,14,15] A similar study among adolescents and young adults reported an inverse association between food insecurity and CD4 counts among HIV+ patients at Texas Children's Hospital in Houston, USA.[16] Building on these previous reports, studies are necessary examining the relationship between food insecurity and CD4% among young children, who may be especially vulnerable to the effects of food insecurity due to their dependence on caregivers for food and their unique nutritional needs. Moreover, pediatric studies are necessary in Sub-Saharan Africa, where food insecurity and HIV are highly prevalent. Thus, to fill these gaps, we conducted the present study and hypothesized that food insecurity was inversely associated with CD4% among young HIV+ children treated at the Botswana-Baylor Children's Clinical Center of Excellence (COE) in Gaborone, Botswana.

Methods

This study was cross-sectional in design. The COE is a partnership between the Government of Botswana and the Baylor International Pediatric AIDS Initiative.[17] The COE is the largest pediatric ARV therapy clinic in Botswana[18] with over 2100 children on ARVs. All study materials including consent forms and questionnaires were available in Setswana and English. Research investigators and staff members at the COE were fluent in both Setswana and English. A convenience sample of participants were recruited from October 2011 to February 2013 during routine HIV+ clinic visits at the COE by the second author on 2-3 days of the week. Eligible children were 2-6 years of age, diagnosed with perinatally acquired HIV infection, and active patients of the COE (defined as having a clinical encounter within the past six months). Eligibility for the study was not affected by the date of the clinic visit or availability of study personnel. Only one child per household was enrolled. There were 137 eligible patients for this study from the clinic, based on a review of medical records. The Botswana Ministry of Health and the Institutional Review Board of Baylor College of Medicine approved this study.

Parents/guardians completed a household demographic questionnaire that assessed the following covariates: child age, gender, and orphan status (both parents alive or one/both parents deceased); parent education; household income and location (village/rural or city); and food assistance in the past four weeks. Additionally, household wealth was estimated using a 10-item asset-based scale previously reported to be a valid indicator of wealth in a cohort study of HIV/STD prevention in Zimbabwe and related to risk of new HIV infection.[19] This wealth scale assessed “fixed” assets (e.g. running water and housing structure), and “sellable” assets (e.g. radio and car/truck).[19] The summed scores (0-10 range) were split into tertiles.[19]

Household food security, the main independent variable, was assessed using the Household Food Insecurity Assessment Survey (HFIAS) developed for cross-cultural use.[20] The HFIAS was designed to measure predictable behavioral responses related to food insecurity, rather than actual household food supply or economic status. HFIAS was also developed to provide a unified measurement of food insecurity for widespread international use among developing countries. For example, in Burkina Faso, HFIAS had good reliability during multiple assessments (Cronbach's alpha=0.81 to 0.85).[21] On multiple assessments for validity, food insecurity was negatively associated with economic status (coefficient=−0.224 to −0.438, P<0.05), dietary energy intake (coefficient=−0.185 to −0.235, P<0.05), and body mass index (−0.186 to −0.238, p<0.05).[21] In another study in Burkina Faso, HFIAS was inversely associated with diet quality.[22] Likewise, HFIAS had acceptable reliability and validity compared to household wealth in Tanzania.[23] In Ethiopia, HFIAS was inversely associated with income and dietary diversity while positively associated with receiving wheat as food support among AIDS caregivers.[24] In Bangladesh, HFIAS items had high reliability (Cronbach's alpha=0.885)[25] and were significantly correlated with food share of total household expenditures (−0.24 to −0.41, P<0.01).[25] For the present study, key informant interviews (n=4) conducted with COE staff and feasibility testing at the COE (n=6 families not included in the analytic sample) were undertaken to culturally adapt the HFIAS for the local population.[20] For the present study, HFIAS measured food security over the past 30 days, providing a continuous summed score from 0-27. Internal validity was acceptable (Cronbach's alpha=0.93).

The following clinical data were obtained from the patients’ medical records: (1) current ARV therapy as a covariate (number of ARVs), (2) length of time on the newest ARV as a covariate (days on newest ARV), and (3) CD4%, the main dependent variable, determined by using a BD FACSCalibur flow cytometer (Becton Dickson, Franklin Lakes, NJ) at the Botswana Harvard Reference Laboratory, Princess Marina Hospital, Gaborone, Botswana. CD4% was chosen at the main dependent variable, rather than absolute CD4 counts, since absolute CD4 counts may vary within an individual young HIV+ child more than CD4%.[26] Thus, the World Health Organization recommended measuring CD4% for surveillance of immune status in younger children with HIV rather than CD4 counts.[26] The mean length of time from the clinic visit to collection of CD4% labs was 87 days. Research staff obtained duplicate measures of participants’ height using a portable stadiometer (Seca model 213, Birmingham, UK) and weight using a digital scale (Tanita model BWB-800S, Arlington Heights, IL). Participants' BMI z-scores were calculated using standardized growth charts[27] and included as a covariate since CD4 counts and food security have been associated with adiposity.[5,6] For descriptive purposes, we also calculated participants' weight for height and height for age z-scores specific for this sample.

We calculated descriptive statistics, mean ± (standard deviation), median and interquartile range, or number (percentage), for the sample. We used linear regression for bivariate comparisons between each of the independent variables separately and CD4%. We used multiple linear regression with the dependent variable of CD4%, food insecurity score as the main independent variable, and controlled for covariates above. Participants with missing variables were dropped (n=5). Differences between included and excluded participants were examined using a t-test for continuous variables and Pearson's chi-squared/Fisher's exact tests for categorical variables. We used SAS 9.2 (Cary, NC) to conduct all analyses and a significance level of $p<0.05$ was chosen.

Results

A total of 83 of 137 eligible participants were recruited and enrolled in the study (recruitment rate of 60.6%). Five participants had missing data and were excluded from the remaining analyses. Included and excluded participants did not differ by age, gender, parent highest education, household characteristics (income, wealth score or location), orphan status, BMI z-score, food security category, ARV status, or CD4%.

For the analytic sample (n=78, Table 1), children's mean age was 3.9 ± 1.3 years, 42.3% were female, 66.7% of parents/guardians had a junior secondary school education or less (≤8th or 9th grade), 92.3% had household annual incomes of <3000 Pula (i.e. less than approximately 344 US dollars), 28.2% received food assistance in the past four weeks, 43.6% resided in a city/town, 15.4% were orphans, and 100% were on three ARVs (26.9% on a two tablet regimen and 73.1% on a three tablet regimen). The average number of days for the newest ARV medication was 1058 ± 623 days. The prevalence of each of the three levels of food insecurity was as follows: 16.7% mild, 21.8% moderate, and 38.5% severe. Mean BMI z-score was −0.6 ± 1.4 and mean CD4% was 32.8% ± 9.4%.

Bivariate and multiple regression models for CD4% are presented in Table 2. The multiple regression model, showed a significant main effect for food insecurity as measured by the continuous HFIAS score (beta=−0.6, 95% CI [−1.0, −0.1]), child gender (beta=5.6, 95% CI [1.3, 9.8]), and wealth score tertile (beta=5.7, 95% CI [0.3, 11.2]. For every one-unit increase in food insecurity score, the CD4% decreased by 0.6% units. Compared to males, females had a CD4% that was 5.6% units higher. Compared to children from households in the highest tertile for wealth score, those from the middle tertile had CD4% that was 5.7% units higher. The multiple regression model accounted for 34% of the variability in CD4%.

Discussion

This study reports the high prevalence of household food insecurity (76.9%) among an outpatient sample of HIV+ children in Sub-Saharan Africa, where both HIV and food insecurity are highly prevalent. This prevalence was comparable to other African countries where the HFIAS has been administered to more general populations (not exclusively HIV +) to measure household food insecurity, i.e. 83.8% in Ethiopia,[24] 79.3% in Tanzania,[23] 77%-88% in Burkina Faso,[28] and 61.8% in Nigeria.[29] This prevalence of food insecurity was higher than the prevalence in the US and Canada using a similar US Department of Agriculture household food insecurity survey for samples of HIV+ adults who were low-income and/or homeless, i.e. 48-63% food insecure,[8-11] and higher than the prevalence among a sample of HIV+ adolescents and young adults treated at Texas Children's Hospital in Houston, USA., i.e. 37.1% food insecure.[16]

Food insecurity was inversely associated with CD4%, adjusting for covariates, among HIV+ pediatric patients in a Sub-Saharan African setting, the region with the highest prevalence of HIV in the world. For every one-unit increase in HFIAS score, there was a 0.6% unit decrease in CD4%.This inverse association replicates the only other report to include pediatric patients on the association of food insecurity and CD4 counts among HIV+ adolescents and young adults in the US.[16] This inverse association between food insecurity and CD4% was also consistent with multiple previous studies among low-income HIV+ adult populations in the US and Canada.[8-13] Altogether, there is a growing body of observational studies: (1) that indicate food insecurity as a potential negative influence on HIV clinical outcomes and (2) that the HFIAS instrument may be a useful screening method to identify food insecure HIV+ individuals and target them for food supplementation. Further studies, including experimental trials, to confirm and better quantify the relationship between food insecurity and CD4% or counts among HIV+ patients, are warranted.

This study has several limitations. The study was cross-sectional and directionality cannot be assessed. Generalizability is limited due to the recruitment rate (60.6%) from one center in Gaborone, Botswana. The small sample size may lead to a type 2 error. We did not collect biomarkers of undernutrition, which may help characterize the mechanisms underlying the relationship between food insecurity and CD4%. We did not assess ARV therapy adherence or total length of time on any ARV therapy, although validated instruments to assess these variables in Sub-Saharan Africa are lacking and beyond the scope of this study. This study has several strengths, we: (1) uniquely examined food insecurity and CD4% among a young HIV+ pediatric sample in a Sub-Saharan Africa setting, (2) used the HFIAS, a well validated and a preferred instrument to assess household food insecurity, and (3) obtained CD4% from the medical record.

Household food insecurity was highly prevalent among an outpatient sample of young HIV+ children in Gaborone, Botswana. Our results suggest that addressing food insecurity may help improve outpatient HIV clinical outcomes, such as CD4% among young HIV+ patients in similar Sub-Saharan urban settings. Although studies are limited among HIV+ children,[30] ready-to-use fortified spreads, fortified blended foods, and take home rations appear promising.[31,32] Further studies including experimental trials aimed at reducing food insecurity are necessary to confirm this speculation. Regardless, screening for and addressing food insecurity among HIV+ children in Sub-Saharan Africa appears warranted given its association with multiple other adverse health outcomes.

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Abbreviations

COE	Center of Excellence
CD	cluster of differentiation
HFI	Household Food Insecurity
HFIAS	Household Food Insecurity Access Scale
HIV	human immunodeficiency virus

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Table 1

Participant characteristics from the Botswana-Baylor Children's Clinical Center of Excellence (n=78).

	Mean (SD)	Median & (IQR)
Child age (years)	3.9 (1.3)	4.0 (3.0, 5.0)
CD4%	32.8 (9.4)	33.3 (27.6, 38.0)
BMI z-score	−0.6 (1.4)	−0.7 (−1.6, 0.45)
Weight for height z-score	−0.8 (1.4)	−0.7 (−1.7, 0.2)
Height for age z-score	−1.6 (1.4)	−1.7 (−2.3, −0.9)
Days on newest ARV medication	1058 (623)	1033 (665, 1393)
Household wealth score	5.4 (2.1)	5.0 (4.0, 7.0)
HFIAS summed score	6.8 (5.9)	7.0 (1.0, 10.0)
	n (%)	
Child gender		
Female	33 (42.3)	
Male	45 (57.7)	
Orphan status		
Both parents alive	66 (84.7)	
One or both parents deceased	12 (15.4)	
Household income (Pula)		
0-1500	10 (12.8)	
>1500 – 3000	62 (79.5)	
>3000	6 (7.7)	
Parent highest education		
Primary school (1-7th grade)	8 (10.3)	
Junior secondary (8-10th grade)	44 (56.4)	
Senior secondary (11-12th grade)	21 (26.9)	
University (≥13th grade)	5 (6.4)	
Food assistance		
Yes	22 (28.2)	
No	56 (71.8)	
Household location		
Village/rural	44 (56.4)	
City	34 (43.6)	
ARV therapy		
Two tablet ARV regimen	22 (28.2)	
Three tablet ARV regimen	56 (71.8)	

Key: ARV = Antiretroviral therapy; HFIAS = Household Food Insecurity Assess Scale; SD = Standard Deviation; 3000 Pula is less than approximately 344 US dollars

Table 2

Bivariate and multiple linear regression results for CD4% among HIV+ young children in Gaborone, Botswana.

	Bivariate beta	95% CI	Multiple linear regression beta	95% CI
HFIAS summed score	−0.21	−0.54, 0.12	−0.55 *	−0.97, −0.12
Child age (years)	−0.02	−1.69, 1.65	0.41	−1.49, 2.32
Child gender				
Female	5.35 *	1.32, 9.39	5.55 *	1.32, 9.78
Male	Reference		Reference	
Orphan status				
Both parents alive	0.61	−5.06, 6.28	3.18	−3.19, 9.55
One or both parents deceased	Reference		Reference	
Household income (Pula)				
0-1500	6.30	−3.34, 15.94	3.00	−7.30, 13.31
>1500 – 3000	3.71	−4.25 11.67	1.39	−7.30, 10.08
>3000	Reference		Reference	
Parent highest education				
Primary school (1-7th grade)	0.47	−9.81, 10.75	−2.19	−13.73, 9.36
Junior secondary (8-10th grade)	3.53	−5.15, 12.21	0.23	−9.07, 9.53
Senior secondary (11-12th grade)	−1.45	−10.62, 7.73	−4.06	−14.16, 6.04
University (≥13th grade)	Reference		Reference	
Household wealth score				
Lowest tertile	2.51	−2.57, 7.59	5.10	−0.90, 11.09
Middle tertile	6.09 **	1.21, 10.96	5.74 ***	0.27, 11.21
Highest tertile	Reference		Reference	
Food assistance				
No	−1.10	−5.85, 3.65	−1.62	−6.98, 3.73
Yes	Reference		Reference	
Household location				
City	−2.01	−6.19, 2.17	−1.47	−5.82, 2.89
Village/rural	Reference			
BMI z-score	−0.85	−2.33, 0.62	−0.79	−2.40, 0.82
Days on newest ARV	2.5×10^{-3}	$-8.9{\times}10^{-4}, 5.9{\times}10^{-3}$	2.1×10^{-3}	$-1.5 \times 10^{-3}, 5.8 \times 10^{-3}$
ARV regimen				
Two tablet ARV regimen	−4.27	−9.00, 0.45	−2.49	−7.95, 2.97
Three tablet ARV regimen	Reference		Reference	

Key: ARV = Antiretroviral therapy; CI = Confidence Interval; HFIAS = Household Food Insecurity Assess Scale; 3000 Pula is less than approximately 344 US dollars

* p = .01

** p=0.015

*** p=0.04

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