

Structural determinants of food insufficiency, low dietary diversity and BMI: a cross-sectional study of HIV-infected and HIV-negative Rwandan women

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To cite: Sirotin N, Hoover D, Segal-Isaacson CJ, *et al*. Structural determinants of food insufficiency, low dietary diversity and BMI: a cross-sectional study of HIV-infected and HIV-negative Rwandan women. *BMJ Open* 2012;**2**: e000714. doi:10.1136/bmjopen-2011-000714

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2011-000714>).

Received 7 December 2011
Accepted 6 March 2012

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ABSTRACT

Objectives: In Sub-Saharan Africa, the overlapping epidemics of undernutrition and HIV infection affect over 200 and 23 million people, respectively, and little is known about the combined prevalence and nutritional effects. The authors sought to determine which structural factors are associated with food insufficiency, low dietary diversity and low body mass index (BMI) in HIV-negative and HIV-infected Sub-Saharan women.

Study design: Cross-sectional analysis of a longitudinal cohort.

Setting: Community-based women's organisations.

Participants: 161 HIV-negative and 514 HIV-infected Rwandan women.

Primary and secondary outcome measures:

Primary outcomes included food insufficiency (reporting 'usually not' or 'never' to 'Do you have enough food?'), low household dietary diversity (Household Dietary Diversity Score ≤ 3) and BMI < 18.5 (kg/m²). The authors also measured structural and behavioural factors including: income, household size, literacy and alcohol use.

Results: Food insufficiency was prevalent (46%) as was low dietary diversity (43%) and low BMI (15%). Food insufficiency and dietary diversity were associated with low income (adjusted odds ratio (aOR)=2.14 (95% CI 1.30 to 3.52) $p < 0.01$), respectively and illiteracy (aOR=2.00 (95% CI 1.31 to 3.04) $p < 0.01$), (aOR=2.10 (95% CI 1.37 to 3.23) $p < 0.001$), respectively and were not associated with HIV infection. Alcohol use was strongly associated with food insufficiency (aOR=3.23 (95% CI 1.99 to 5.24) $p < 0.001$). Low BMI was inversely associated with HIV infection (aOR ≈ 0.5) and was not correlated with food insufficiency or dietary diversity.

Conclusions: Rwandan women experienced high rates of food insufficiency and low dietary diversity. Extreme poverty, illiteracy and alcohol use, not HIV infection alone, may contribute to food insufficiency in Rwandan women. Food insufficiency, dietary diversity and low BMI do not correlate with one another; therefore, low

ARTICLE SUMMARY

Article focus

- What structural determinants are associated with food insufficiency, low dietary diversity and low BMI in HIV-negative and HIV-infected women in Rwanda?
- What is the prevalence of food insufficiency, low dietary diversity and low BMI in HIV-negative and HIV-infected women in Rwanda and are these outcomes correlated with each other?
- Hypotheses
 - 1: Poverty, low literacy status and alcohol use are associated with food insufficiency, low dietary diversity and low BMI.
 - 2: Food insufficiency, low dietary diversity and low BMI are highly prevalent and are correlated with one another.

Key messages

- Food insufficiency and low dietary diversity are highly prevalent (46% and 43%, respectively) and are associated with low income and illiteracy and strongly associated with alcohol use.
- BMI (kg/m²) is not correlated with food insufficiency or dietary diversity.
- Significance: food insufficiency and low dietary diversity, known contributors to poor health, are highly prevalent in HIV-negative and HIV-infected women in Rwanda. Low BMI may not be an adequate screening tool for food insufficiency. Extreme poverty, low literacy and alcohol use may contribute to food insufficiency and low dietary diversity. These structural factors may be useful targets to prevent the adverse health effects of food insufficiency and low dietary diversity.

Strengths and limitations of this study

- Large cohort of HIV-negative and HIV-infected women, very detailed tools used for food insufficiency and dietary diversity
- Cross-sectional design, our measurement of food insufficiency is solely by self-report.

BMI may not be an adequate screening tool for food insufficiency. Further studies are needed to understand the health effects of not having enough food, low food diversity and low weight in both HIV-negative and HIV-infected women.

INTRODUCTION

Undernutrition, defined as the condition of people whose food consumption is continuously below a minimum dietary energy requirement for maintaining healthy life, affects over 850 million people worldwide and 200 million adults in Sub-Saharan Africa.^{1–4} The effects of the overlap between undernutrition and HIV infection, which affects over 23 million in Sub-Saharan Africa, are not well understood.⁵ In both HIV-negative and HIV-infected individuals, undernutrition, food insufficiency and low dietary diversity are associated with poor health.^{5–8} Food insufficiency may be caused by structural factors: social, political, economic structures or institutions that affect people's ability to control the conditions of their lives and meet their basic needs. Structural determinants of health include distribution of wealth, power and goods, access to education and schools, access to healthcare and housing and environment conditions. These structural determinants play a major role in health inequities and greatly affect health status.⁹ But structural factors associated with food insufficiency in Sub-Saharan women, and how such factors may be addressed to mitigate food insufficiency in the region is not well studied.

Food insufficiency (lack of adequate food to meet daily needs) is one aspect of food insecurity, a complex phenomenon describing lack of access to sufficient quantity and adequate quality of food, and anxiety in procuring food.² Over half of all households in Rwanda are thought to be food insecure, many of which are headed by women.¹⁰ Rwanda has a significant number of female-headed households (31%), partly due to the high numbers of genocide-related widows, and 62% of female-headed households live in poverty compared with 54% of male-headed households.¹¹ Especially in vulnerable populations, such as HIV-infected women, gender disparities may prevent women from having control of family resources and the discretionary income necessary for buying food.¹²

In HIV-infected women, food insufficiency may result in low body mass index (BMI), which adversely affects health outcomes.¹³ In addition, consuming fewer nutritionally distinct food groups (low dietary diversity), which contributes to poor health outcomes in African women and children,⁷ may reinforce malnutrition and eventually result in poor health.¹⁴ Many African diets consist of a single dominant carbohydrate group, such as cassava, potato or yam, which provides calories that may maintain body weight but often does not provide the micro and macronutrients needed for proper immune function.¹⁵

In HIV-infected individuals, food insecurity has been associated with low CD4 counts, virologic failure and increased mortality.^{6–8} Low BMI (<18.5 kg/m²) is a strong predictor for mortality in HIV-positive patients starting antiretroviral therapy (ART), with higher mortality in persons who are both food insecure and underweight versus underweight but food secure.⁸ Although poverty is associated with poor health outcomes, income alone does not always reflect the status of someone's 'wealth'. In populations with very low incomes, markers for disposable or discretionary income, defined as income after all essential items are paid for, may be more useful to define an individual's socioeconomic status. These may include access to electricity and ability to buy non-essential items such as alcohol. For women with HIV, it is unclear which structural factors most influence food insecurity and therefore have the greatest impact on health outcomes.

In order to understand structural determinants of food insufficiency and elucidate potential interventions to prevent food insufficiency and malnutrition in HIV-negative and HIV-infected women, we examined the prevalence and socio-demographic associations of food insufficiency, household dietary diversity and low BMI in such women in Rwanda. We were specifically interested in the relationship between poverty, low literacy and alcohol use on food insufficiency, dietary diversity and low BMI. We further examined the relationship between food insufficiency, low BMI and low dietary diversity and whether these three outcomes were correlated with one another in these women.

METHODS

Population and setting

The Rwanda Women's Interassociation Study and Assessment (described in detail elsewhere¹⁶) is a prospective observational cohort designed to assess the effectiveness and toxicity of ART in HIV-infected Rwandan women. In 2005, 710 HIV-infected and 226 HIV-uninfected Rwandan women were recruited through community-based women's organisations and HIV clinical care sites. Eligible women were 25 years or older at study entry, willing to give informed consent and were present in Rwanda during the genocide. HIV-infected women were excluded if they had prior history of receiving antiretroviral treatment, except single-dose nevirapine to prevent mother to infant transmission of HIV. Women were compensated 2500 Rwandan francs for each visit. The Rwandan National Ethics Committee and the Institutional Review Board at Montefiore Medical Center approved this study.

At each study visit, participants provided historical information. Trained research assistants collected socio-demographic data at study entry including age, income, literacy level, number of people in households, employment, access to electricity antiretroviral use (for HIV-infected women) and alcohol use. At each visit, participants had a physical examination and

provided blood specimens for CD4 lymphocyte and complete blood counts. This analysis included 161 HIV-negative and 514 HIV-infected women who completed socio-demographic and nutritional data at the fifth semi-annual visit, between July and December 2007.

Measures

Primary outcomes

Food insufficiency was assessed using a single question, 'Do you have enough food?' with the women answering 'usually not' or 'never' classified as food insecure.^{17 18} Household dietary diversity was assessed using a modified Household Dietary Diversity Score (HDDS), a validated tool measuring household food consumption over the previous 24 h, giving one point each for having eaten an item in the following food class (total six points possible: class 1, cereals and roots; class 2, vegetables; class 3, fruits; class 4, meat protein (including meat, eggs, fish); class 5, vegetable protein (including legumes, beans, nuts); class, 6 extras (including oil, fat, sugar, condiments)). Determination of 'low household dietary diversity' is described in detail elsewhere¹⁹; briefly, the sample was divided into income terciles with the mean HDDS for the lowest income tercile (≤ 3) representing low dietary diversity.^{15 19 20} BMI was calculated using weight divided by height-squared (kg/m^2). Standing height and weight were measured while the participant was wearing light clothing and no shoes. BMI was dichotomised to ≤ 18.5 or > 18.5 for the analysis.

Independent variables

Income categories were defined as (1) $> 35\,000$ Rwandan Francs (\$US58), (2) $35\,000$ – $10\,000$ and (3) $< 10\,000$ RWF (\$US17) per month. Alcohol use was queried as "Since the last visit, have you had a drink containing alcohol?" and was dichotomised to yes versus no. Literacy was defined as 'can read all, most, some or none', and for the analysis was dichotomised to none versus some, most or all. For HIV-infected women, antiretroviral use at the current visit was assessed by self-report with verification of date of initiation and regimen by tracking cards provided to the participants by providers in the national treatment programme. CD4 counts were determined with an FACS counter (Becton and Dickinson, Immunocytometry Systems, San Jose, California, USA).

Data analysis

Categorical variables were compared using contingency tables with *p* values from exact tests. Univariate logistic regression identified factors associated with food insecurity, low dietary diversity and BMI. Multivariate logistic regression models were built using backward selection with a *p* value of 0.05 to stay in the model. Wilcoxon rank sum and kappa statistics assessed relationships between food insecurity, BMI and dietary diversity as continuous variables and as dichotomous variables (food insecurity = answering 'usually not' or 'never' to 'Do you have enough food', $\text{HDDS} \leq 3$,

$\text{BMI} \leq 18.5$), respectively. Statistical analysis was performed using SAS (V.9.1.3; SAS Institute Inc.).

RESULTS

Overall food insufficiency (top row of [table 1](#)) was highly prevalent with 46% of women reporting 'usually not' or 'never' to 'Do you have enough food?' and another 45% reporting they 'sometimes' did not have enough food (data not shown). Almost half the population reported low dietary diversity ($\text{HDDS} < 3$) and 15% of women met WHO criteria for malnutrition with a $\text{BMI} < 18.5 \text{ kg}/\text{m}^2$. The percentage of women reporting food insufficiency and low dietary diversity did not differ between HIV-negative and HIV-infected women. The percentage of women with $\text{BMI} < 18.5$ was higher in HIV-negative women as compared with HIV-infected women with $\text{CD4} > 350$, 200 – 350 , < 200 (24%, vs 11.8%, 12.4%, 14.9%, $p=0.004$), respectively.

[Table 1](#) further breaks the food insecurity outcomes down by participant characteristics. As the numbers in column 2 of [table 1](#) show, the prevalence of poverty was high; 36% reported a monthly income of $< 10\text{K}$ Rwandan Francs (FRW) (\$US17). Illiteracy was present in one-quarter of the population and another 40% reported only reading 'some'. Alcohol use was rare with 13% reporting they had at least one drink in the last month. Of the HIV-infected women, almost one-third had CD4 counts over 350 and almost 70% of participants took ART at this visit.

Structural factors associated with food insufficiency included ([table 1](#)) low income, with 52.5% of those with monthly income $< 10\,000$ FRW, 43.6% of those with monthly income $10\,000$ – $35\,000$ FRW and 31.8% of those with $> 35\,000$ FRW reporting food insufficiency, $p=0.001$; illiteracy with 57.1% of those who can not read, 44.5% of those with some literacy and 34.6% of those fully literate reporting food insufficiency, $p=0.0002$, and alcohol use with 68.9% of users vs 41.2% of non-users reporting food insufficiency, $p<0.0001$.

Structural factors associated with low dietary diversity ($\text{HDDS} < 3$) were; low income with 58.9% of those with monthly income $< 10\,000$ FRW, 39.3% with income $10\,000$ – $35\,000$ FRW, and 16.2% of those with income $> 35\,000$ FRW having low dietary diversity, $p<0.0001$; illiteracy with 55.2%, 44.4% and 31.6% of those with none, some and complete literacy having low dietary diversity, $p<0.0001$.

Only HIV status had statistically significant associations with BMI. Surprisingly, the association was in the opposite direction expected with 24.2% of HIV-negative women compared with 11.8%–14.9% of HIV-positive women of all CD4 levels having $\text{BMI} < 18.5$, $p=0.004$.

The univariate logistic regression models of [table 2](#) find the same unadjusted associations of structural factors with outcomes just described for [table 1](#), here we discuss the multivariate modes. In the final stepwise multivariate model ([table 2](#)), food insufficiency was independently associated with low income (adjusted

Table 1 Demographic, clinical and dietary characteristics of HIV-negative and HIV-infected women

Participant characteristic	Proportion of total population	Measure of food insufficiency by participant characteristic					
		Self-reported food insufficient*			Self-reported low dietary diversity HDDS ≤3		
		Per cent of subgroup with outcome	p Value	Per cent of subgroup with outcome	p Value	Per cent of subgroup with outcome	p Value
Total	N=675	45.9%		43.4%		15.3%	
HIV-positive							
CD4 count, cells/μl							
HIV negative (N=161)	24.5%	46.3%	0.24	43.5%	0.84	24.2%	0.004
HIV positive, CD4>350 (N=240)	34.8%	42.1%		44.2%		11.8%	
HIV positive, 200–350 (N=207)	30.6%	49.5%		40.1%		12.4%	
HIV positive, CD4<200 (N=67)	10.2%	37.3%		41.8%		14.9%	
Antiretroviral use†							
No (N=154)	30.7%	45.1%	0.89	39.6%	0.41	15.8%	0.12
Yes (N=358)	69.3%	44.4%		43.6%		10.8%	
Number of people in household							
0–2 (N=158)	24.5%	41.8%	0.68	41.1%	0.42	11.6%	0.18
3–5 (N=326)	50.3%	46.0%		43.9%		17.6%	
>5 (N=167)	25.2%	44.8%		37.7%		13.1%	
Age, years							
<30 (N=122)	17.9%	40.2%	0.36	38.5%	0.57	10.2%	0.02
30–40 (N=321)	47.1%	44.4%		42.7%		13.6%	
>40 (N=232)	35.0%	48.0%		44.4%		20.4%	
Income, RWF month							
Income <10 000 (N=241)	35.7%	52.5%	0.001	58.9%	<0.0001	17.0%	0.28
10 000–35 000 (N=323)	48.2%	43.6%		39.3%		15.8%	
Income >35 000 (N=111)	16.1%	31.8%		16.2%		10.4%	
Literacy							
None (N=163)	24.9%	57.1%	0.0002	55.2%	<0.0001	16.9%	0.71
Some (N=266)	40.4%	44.5%		44.4%		15.8%	
Most and read all (N=231)	34.7%	36.1%		31.6%		13.9%	
Alcohol use							
No (N=584)	86.8%	41.2%	<0.0001	44.0%	0.06	14.6%	0.14
Yes (N=90)	13.2%	68.9%		33.3%		20.7%	

*Reporting 'usually not' or 'never' to 'Do you have enough food'.

 †Body mass index (kg/m²).

‡Among HIV-positive women.

HDDS, Household Dietary Diversity Score.

Table 2 Univariate and multivariate analysis factors associated with food insecurity, household dietary diversity and body mass index (BMI)

Variable	Food insufficiency*		Household Dietary Diversity Score ≤3†		BMI‡ ≤18.5	
	Univariate, OR (95% CI), p value	Multivariate, OR (95% CI), p value	Univariate, OR (95% CI), p value	Multivariate, OR (95% CI), p value	Univariate, OR (95% CI), p value	Multivariate, OR (95% CI), p value
HIV negative	Reference	Reference	Reference	Reference	Reference	Reference
HIV positive, CD4	—	—	—	—	—	—
CD4 >350, cells/μl	0.69 (0.39 to 1.24)		0.93 (0.52 to 1.66)		0.55 (0.26 to 1.18)	0.55 (0.26 to 1.18)
CD4 200–350	1.14 (0.75 to 1.72)		0.87 (0.57 to 1.32)		0.44 (0.26 to 0.77)**	0.44 (0.26 to 0.77)**
CD4 <200	0.84 (0.56 to 1.26)		1.03 (0.69 to 1.54)		0.42 (0.24 to 0.72)**	0.42 (0.24 to 0.72)**
Antiretroviral therapy uses	0.97 (0.66 to 1.42)		1.18 (0.80 to 1.73)		0.64 (0.37 to 1.12)	0.64 (0.37 to 1.12)
Number of people in household						
0–2	Reference	Reference	Reference	Reference	Reference	Reference
3–5	1.19 (0.81 to 1.74)		1.12 (0.76 to 1.64)		1.62 (0.92 to 2.86)	1.62 (0.92 to 2.86)
>5	1.13 (0.73 to 1.76)		0.87 (0.56 to 1.35)		1.15 (0.59 to 2.25)	1.15 (0.59 to 2.25)
Age, years						
<30	Reference	Reference	Reference	Reference	Reference	Reference
31–40	1.19 (0.78 to 1.82)		1.19 (0.78 to 1.82)		1.38 (0.70 to 2.73)	1.38 (0.70 to 2.73)
>40	1.38 (0.88 to 2.15)		1.27 (0.81 to 1.99)		2.27 (1.15 to 4.47)	2.27 (1.15 to 4.47)
Low income, RWF/year						
<10 000	2.37 (1.47 to 3.81)***	2.14 (1.30 to 3.52)**	7.41 (4.21 to 13.05)***	6.51 3.66 to 11.57)***	1.77 (0.87 to 3.61)	1.77 (0.87 to 3.61)
<10 000–35 000	1.66 (1.05 to 2.62)*	1.52 (0.94 to 2.44)	3.35 (1.93 to 5.81)***	3.07 (1.76 to 5.37)***	1.62 (0.81 to 3.24)	1.62 (0.81 to 3.24)
>35 000	Reference	Reference	Reference	Reference	Reference	Reference
Illiteracy: can read						
None	2.25 (1.50 to 3.37)***	2.00 (1.31 to 3.04)**	2.61 (1.73 to 3.92)***	2.10 (1.37 to 3.23)***	1.26 (0.73 to 2.19)	1.26 (0.73 to 2.19)
Some	1.36 (0.95 to 1.94)	1.24 (0.86 to 1.79)	1.69 (1.17 to 2.42)**	1.48 (1.01 to 2.16)*	1.16 (0.71 to 1.91)	1.16 (0.71 to 1.91)
Most or All	Reference	Reference	Reference	Reference	Reference	Reference
Alcohol use						
Any vs none	3.15 (1.96 to 5.08)***	3.23 (1.99 to 5.24)***	0.64 (0.40 to 1.02)	0.60 (0.37 to 0.98)	1.53 (0.87 to 2.70)	1.53 (0.87 to 2.70)

p Value: **0.001–0.01, ***<0.001.

*'Usually not' or 'never' to 'Do you have enough food?' N=302.

†Household Dietary Diversity Score, N=186.

‡Body mass index (kg/m²), N=101.

§Was not considered for multivariate models as it was only defined for HIV-positive women and was never statistically significant in unadjusted models.

odds ratio (aOR) 2.14, 95% CI 1.30 to 3.52 for >35 000 FRW vs <10 000 FRW) and illiteracy (aOR=2.00, 95% CI 1.31 to 3.04) (table 2). Alcohol use (none vs any use) was strongly independently associated with being food insufficient (aOR=3.23, 95% CI 1.99 to 5.24). Factors independently associated with low dietary diversity (HDDS <3.0) included low monthly income (aOR=6.51, 95% CI 3.36 to 11.57 for income <10 000 vs >35 000 FRW and aOR=3.07, 95% CI 1.76 to 5.37 for income 10 000 to 35 000 FRW vs >35 000 FRW) and illiteracy (aOR=2.10, 95% CI 1.37 to 3.23). As in table 1, HIV status had the only independent association with HIV-positive women of all CD4 levels being *less* likely to have low BMI.

When analysed as continuous variables, no significant correlations were found between self-reported food insufficiency and BMI ($r=-0.05$, $p=0.29$). A statistically significant but weak correlation was found between dietary diversity and BMI, $r=0.09$, $p=0.03$, and food insufficiency and dietary diversity, $r=0.14$, $p<0.001$. When analysed as dichotomous variables, no significant correlations were found between food insufficiency and BMI, kappa (K) =0.02, dietary diversity and BMI, K=0.02, or food insufficiency and dietary diversity, K=0.12.

DISCUSSION

While HIV-uninfected and HIV-infected Rwandan women experienced high rates of food insufficiency (46%) and low dietary diversity (43%), only 15% of the women had low BMI. HIV status did not confer differences except in BMI, where the opposite of what was expected was seen, a *higher* proportion of HIV-uninfected women had BMI <18.5. Furthermore, neither food insufficiency nor lack of dietary diversity was associated with BMI, suggesting that low BMI in these women was not resulting from food insufficiency alone. Structural factors including low income and illiteracy were associated with food insufficiency, and behavioural factors, such as alcohol use, were associated with low dietary diversity. Our findings highlight three important aspects useful in the relationship between food insufficiency, dietary diversity and BMI in vulnerable populations.

First, few women had low BMI (15%), while almost half were either food insufficient or had low dietary diversity. A higher percentage of HIV-uninfected women had BMI <18.5 as compared with HIV-infected women. This is likely explained by food supplementation programmes provided by community organisations that are available exclusively to the HIV-infected women. These programmes provide additional supply of the staple foods, which may provide enough calories to prevent malnutrition but do not add to dietary diversity or change the perception of not having enough food. Additionally, BMI was not correlated with self-reported food insufficiency or dietary diversity. BMI is often measured in clinical settings and used to monitor people's nutritional status. Because of the known health

effects of food insufficiency and low dietary diversity, separate from BMI,^{6 7 14} and the lack of correlation between the three outcomes, our results support that BMI should not be considered as a sole marker for food insufficiency in HIV-uninfected or HIV-infected women. The weak association between self-reported food insufficiency and dietary diversity may reflect an inexpensive, abundant single food group, such as potatoes or cassava root, common in Rwanda, that provide a sufficient yet minimally diverse diet. Body weight may be maintainable on a low nutrient density starchy diet that includes suboptimal protein and micronutrient consumption. Additionally, if that single food group is cassava, it provides a much lower protein and micronutrient source than potato, yams or rice.

Second, women who had incomes of \$US17/month (equal to 10 000 RWF/month) were more likely to be food insecure when compared with women whose incomes were \$US60 monthly (equal to 35 000 RWF/month). The World Bank defines extreme poverty as \$US1.25/day (\$US37/month) and moderate poverty at \$US2/day (\$US60/month): significant differences exist in health outcomes for these two groups.²¹ This highlights a potentially important target for both ministries of health and international aid organisations and is consistent with the Millennium Development Goals to eradicate poverty.²² HIV-negative and HIV-infected women whose income is 1.25/day may benefit from income supplementation programmes to help prevent food insufficiency and therefore the adverse health effects of food insufficiency and low dietary diversity.²³ Alternatively, poverty reduction strategies, or job skills training programmes, may be beneficial public health interventions for these women.^{24–26}

Alcohol use has known adverse health effects and is a known risk factor for HIV transmission.¹⁷ Less is known about the relationship with alcohol use and food insufficiency. Alcohol can be used as a marker for disposable income, similar to other luxury items.²⁷ In our analysis, alcohol use was rare with only 13% of the women stating that they had at least one drink in the last month. This shows that casual alcohol drinking is not the social norm in this population of Rwandan women as compared with other nearby countries, such as Uganda, where drinking is considered a socially acceptable activity. The Ugandan Health and Demographic survey found up to one-quarter of women reporting drinking in the last month and 18% stated that they drank alcohol daily.^{28 29} Alcohol use was associated with higher rates of food insufficiency, even when controlled for by income, suggesting it reflected diversion of disposable income from food to alcohol, not just a reflection that more money is available for alcohol purchase. Data on alcohol misuse in Rwandan women are limited, with an estimated national pure alcohol use of 4.3 l per capita.³⁰ Our data further support the use of alcohol as an important point of intervention to help prevent the adverse health effects of food insufficiency and low dietary diversity.

Lastly, we found that illiteracy was independently associated with greater food insufficiency and low dietary diversity. This may be because low literacy is an important aspect of 'income-generating capacity', which is critical to ability to obtain relevant dietary diversity and food security. Gender differences in educational and literacy attainment in Rwanda may lead to men procuring non-farm jobs with increased income potential which may increase the numbers of women left to manage the family agricultural plots.³¹ Further studies need to be done to determine if literacy programmes would benefit the level of food security and health status of both HIV-negative and HIV-infected women. Improving land reform laws in Rwanda that strengthen women's positions to own and farm their own land, and empower them with alternative farming techniques, may increase their food security in both urban and rural areas and therefore improve their health.^{32–34}

Limitations of our study include its cross-sectional nature, which does not allow us to infer causality. Our measurement of food insufficiency is solely by self-report. The question, 'Do you have enough food?' does not address the quantity or quality of food or the anxiety surrounding food procurement, although this question has been used in other food insufficiency analyses in Sub-Saharan Africa.¹⁷ There was no explicit statement that this question would not alter a participant's subsequent eligibility for food aid, which may have introduced response bias. More complete information may be obtained with a different measurement tool, which would address food insecurity (insufficiency quantity, quality or anxiety in procuring food), in addition to food insufficiency (not enough food).^{18–20} A longitudinal study design would be helpful to determine the specific health effects of food insecurity on women over time.

Our findings suggest that extreme poverty, illiteracy and alcohol use are associated with food insufficiency among HIV-infected and HIV-negative women in Rwanda. Addressing these structural factors through income-generating activities, literacy programmes, substance abuse treatment, or perhaps most importantly, renewed health through improved access to ART for HIV-infected women, may help reduce the highly prevalent problem of food insufficiency in the Sub-Saharan region.

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Acknowledgements We thank the patients and staff of Rwanda Women's Interassociation Study and Assessment.

Contributors KA, EM and CJS-I designed the research. NS, QS, DH, CJS-I and KA analysed the data. NS wrote the paper with input from all authors. NS had primary responsibility for the final content. All authors read and approved the final manuscript.

Funding This project has been funded by NIH/NIDA/NIAID/NCI grant 5U01AI035004-16 (KA).

Competing interests None.

Ethics approval Ethics approval was provided by Rwandan National Ethics Committee and the Institutional Review Board at Montefiore Medical Center.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement There are no additional data available.

REFERENCES

1. *Reaching sustainable food security for all by 2020: getting the priorities and responsibilities right*. Washington, DC: International Food Policy Research Institute, 2002.
2. Bickel G, Nord M, Price C, et al. *Guide to Measuring Household Food Security*. Alexandria VA: U.S. Department of Agriculture, Food and Nutrition Service, 2000.
3. *Women in Agriculture: Closing the Gender Gap For Development*. Rome: Food and Agriculture Organization, 2011.
4. Shapouri SRS, Peters M, Tandon S, et al. *International Food Security Assessment 2011-21*. Washington, DC: Economic Research Service/US Department of Agriculture, 2011.
5. UNAIDS. *Global Report Fact Sheet*. Sub Saharan Africa Geneva: Joint United Nations Programme on HIV/AIDS, 2011.
6. Weiser SD, Frongillo E, Ragland K, et al. Food insecurity is associated with incomplete HIV RNA suppression among homeless and marginally housed HIV-infected individuals in San Francisco. *J Gen Inter Med* 2009;24:14–20.
7. Mponshane N, Van den Broeck J, Chhagan M, et al. HIV infection is associated with Decreased dietary diversity in South African children. *J Nutr* 2008;138:1705–11.
8. Weiser SD, Fernandes KA, Brandson EK, et al. The association between food insecurity and mortality among HIV-infected individuals on HAART. *J Acquir Immune Defic Syndr* 2009;52:342–9.
9. *Closing the gap in a generation: Health Equity through Action on the Social Determinants of Health in Final Report of the Commission on Social Determinants of Health*. Geneva: World Health Organization, 2008.
10. Millennium Development Goals. *Towards Sustainable Social and Economic Growth. First Edition*. Country Report 2007. Kigali: The national Institute of statistics of Rwanda (NISR), 2007.
11. Abbott P, Rwirahira J. *Millennium Development Goals Rwanda Country Report 2010*. Kigali: UNDP, 2010.
12. Karp RJ, Chang C, Meyers AF. The appearance of discretionary income: influence on the prevalence of under- and over-nutrition. *Int J Equity Health* 2005;4:10.
13. Jee SH, Sull JW, Park J, et al. Body-Mass index and mortality in Korean men and women. *New Engl J Med* 2006;355:779–87.
14. Savy M, Martin-Prevel Y, Sawadogo P, et al. Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *Eur J Clin Nutr* 2005;59:703–16.
15. Becquey E, Martin-Prevel Y. Micronutrient Adequacy of Women's diet in urban Burkina Faso is low. *J Nutr* 2010;140:2079S–85S.
16. Cohen M, Fabri M, Cai X, et al. Prevalence and predictors of Posttraumatic Stress Disorder and Depression in HIV-Infected and at-risk Rwandan women. *J Womens Health* 2009;18:1783–91.
17. Weiser SD, Leiter K, Bangsberg DR, et al. Food insufficiency is associated with high-risk sexual behavior among women in Botswana and Swaziland. *PLoS Med* 2007;4:1589–97.
18. Coates J, Swindale A, Bilinsky P. *Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide in Food and Nutrition Technical Assistance Project*. Washington, DC: Academy for Educational Development, 2007.
19. Swindale A, Bilinsky P. *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide in Food and Nutrition Technical Assistance Project (FANTA)*. Washington, DC: Academy for Educational Development, 2006.

20. Becquey E, Martin-Prevel Y, Traissac P, *et al*. The household food insecurity access Scale and an index-Member dietary diversity Score contribute Valid and Complementary information on household food insecurity in an urban West-African Setting. *J Nutr* 2010;140:2233–40.
21. The World Bank. *Poverty*. The World Bank, 2010. <http://data.worldbank.org/topic/poverty> (accessed 31 Mar 2012).
22. *The Millennium Development Goals Report*. New York: Department of Economic and Social Affairs, 2009.
23. Braine T. Reaching Mexico's poorest. *Bull World Health Organ* 2006;84:592–3.
24. Laterveer L, Niessen L, Yazbeck AS. Pro-poor health policies in poverty reduction strategies. *Health Policy Plan* 2003;18:138–45.
25. Nguyen P, Bich Hanh D, Lavergne MR, *et al*. The effect of a poverty reduction policy and service quality standards on commune-level primary health care utilization in Thai Nguyen Province, Vietnam. *Health Policy Plan* 2010;25:262–71.
26. Dodd R, Hinshelwood E, Harvey C. *Poverty Reduction Strategy Papers: Their Significance for health in Second Synthesis report*. Geneva: World Health Organization, 2004.
27. Citro CF, Michael RT, eds. *Measuring Poverty: A New Approach*. Washington, DC: National Academy Press, 1995.
28. UBOS & ORC Macro. *Uganda Demographic and Health Survey 2000-2001*. Calverton, Maryland, USA: Uganda Bureau of Statistics and ORC Macro, 2001.
29. http://www.who.int/substance_abuse/publications/alcohol_gender_drinking_problem.pdf#page=200 (assessed 2 Apr 2012).
30. http://www.who.int/substance_abuse/publications/en/rwanda.pdf (accessed 20 Nov 2011).
31. World Bank. *Education in Rwanda: Rebalancing Resources To Accelerate Post-Conflict Development And Poverty Reduction, in A World Bank Country Study. The International Bank for Reconstruction and Development*. Washington DC: The World Bank, 2004.
32. Rao N. Land rights, gender equality and household food security: Exploring the conceptual links in the case of India. *Food Policy* 2006;31:180–93.
33. World Bank. *World Development Report 2008: Agriculture for Development*. The international Bank for Reconstruction and Development/The World Bank, 2008.
34. Maxwell D. Alternative food security strategy: a household analysis of urban agriculture in Kampala. *World Dev* 1995;23:1669–81.