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Nyasha Tirivayi and Wim Groot

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: http://mgsog.merit.unu.edu

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

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The Impact of Food Transfers for People Living with HIV/AIDS: Evidence from Zambia

Nyasha Tirivayi[a1] and Wim Groot[b]

[a] UNU-MERIT, Maastricht, The Netherlands
[b] Department of Health Organization, Policy and Economics, Maastricht University, The Netherlands

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Abstract

We estimate the impact of food transfers on diet and consumption expenditures in food insecure households with HIV positive members on antiretroviral therapy. We use primary data collected from 199 beneficiary and 179 non-beneficiary households in Lusaka, Zambia. Propensity score matching estimates show that the food transfers significantly increase dietary diversity and food consumption expenditures. Our results also show that the food transfers increased the proportion of households with optimal dietary diversity and consuming at least five food groups. The results are robust to variation in the propensity score model and matching technique. Sensitivity analysis demonstrates that our results are largely robust to substantial amounts of unobserved selection bias. We discuss the implications of our findings in the context of the growing number of HIV/AIDS treatment, care and support programmes providing food assistance in resource poor settings.

JEL-codes: D01, D12, I1, 131, 138

Keywords: HIV/AIDS, food transfers, dietary diversity, consumption, Zambia

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[1] **Corresponding author**. UNU-MERIT, Keizer Karelplein 19, 6211 TC, Maastricht. The Netherlands. tirivayi@merit.unu.edu

1. Introduction

HIV/AIDS is a major contributor to prime age adult morbidity and mortality in sub-Saharan Africa, leading to the loss of income and labour supply by prime-age adults in an affected household. Consequently an affected household experiences food insecurity which increases poverty and can have lasting effects on household welfare (Linnemayr, 2010; Cogneau and Grimm, 2008). In addition, food insecurity and malnutrition have detrimental effects on the health of the people living with HIV/AIDS. Studies demonstrate that food insecurity and malnutrition are associated with increased morbidity and mortality, higher frequency of opportunistic infections, reduced adherence to antiretroviral therapy, poor tolerability to antiretroviral therapy, poor immunologic response and diminished physical and labour capacity (Weiser et al., 2012; Weiser et al., 2011; Wang et al., 2011; De Pee and Semba, 2010; Johannesen et al., 2008).

The threats posed by food insecurity and malnutrition have led to calls for holistic approaches that do not only enhance antiretroviral therapy coverage and improve health outcomes but also alleviate food insecurity and poverty and protect livelihoods (Agnarson et al., 2007; Wagner et al., 2007). A growing number of HIV/AIDS programmes now provide food transfers to malnourished HIV/AIDS patients and those whose households are vulnerable to food insecurity (Tirivayi and Groot, 2011; Byron et al., 2006). Given the negative bidirectional interaction between food insecurity and HIV/AIDS, food transfers given to affected households may act as a safety net with short and long term positive effects on the HIV patient and household's nutrition and welfare. Since previous research has established that food insecurity is a barrier to antiretroviral therapy adherence, food transfers may also contribute to better health outcomes through improving adherence to antiretroviral therapy (ART henceforth), and thus improve the efficacy of AIDS treatment (Tirivayi et al., 2012; Cantrell et al., 2008).

Previous research on the impact of food transfers is dominated by the evaluations of generalized food aid programmes that are not tailored to the specific needs of a certain demographic. In the empirical literature, prior studies have determined the impacts of food aid on food security and nutrition. Studies find that free food distribution in Ethiopia increases food consumption and child growth and reduces wasting (Gilligan et al., 2007; Yamano et al., 2005; Quisumbing 2003). The rise in food consumption is attributed to an income effect (Gilligan et al., 2007). In Bangladesh, a food transfer programme targeted to poor women significantly increased household total calorie intake, per capita income and ownership of productive assets and also reduced extreme poverty (Ahmed et al., 2009). Hidrobo et al (2012) find that food transfers have similar positive impact on food consumption and dietary diversity like the cash transfers and vouchers in Ecuador, but have larger impacts on calorie intake. Similarly, Hoddinott et al (2013) compare the impacts of randomized cash and food transfers in Niger and find that food rations have larger positive impacts on food consumption and dietary diversity and they reduce the use of adverse risk coping strategies.

Lentz and Barrett (2013) review evidence of the impact of food assistance programmes and note that there has been a movement away from the generalized feeding programmes to targeted nutrition sensitive transfers via various modalities such as fortified micronutrient or macronutrient food supplements (corn-soy blend, ready to use supplementary foods and lipid based nutritional supplements), vouchers and cash based assistance. They identify households with HIV positive members as some of the beneficiaries of these food assistance programmes, but conclude that there is limited evidence on the costs of targeting this group. To the best of our knowledge, few studies have assessed the broader welfare impacts of food transfers targeted to HIV affected households. The type of food transfers given to households with people living with HIV/AIDS are usually either fortified food supplements or a combination of a fortified supplement and the general food aid rations. Prior studies of food transfers to households with HIV positive members have focused on the clinical outcomes of infected members such as adherence to ART, weight change, body mass index and immunologic response. These studies find positive impacts on adherence to ART, but mixed effects on other clinical measures (Tirivayi et al., 2012; Rawat et al., 2010; Cantrell et al., 2008). Rawat et al (2014) find that food transfers increased household food security for households with HIV positive members in Uganda. Smets et al (2013) find that food aid increased the number of meals consumed, prevented the distress sales of assets, and reduced food expenditures in conflict affected households in Uganda, among whom were households with HIV positive members.

In this paper we examine the impact of a food transfers programme on dietary diversity and consumption in food insecure households with HIV positive members on ART in Lusaka, Zambia. The programme sought to increase food security in these households by providing monthly food transfers in the form of a diverse food ration. Consumption is measured by per capita household and food expenditures. Dietary diversity is widely considered to be a valid indicator of diet quality and food security. Studies have established that dietary diversity scores are positively correlated with per capital energy intake, child nutritional status and micronutrient nutrient adequacy (Jones at al., 2013; Kennedy et al., 2007; Steyn et al., 2006; Almond and Ruel, 2004). Poor dietary diversity is also associated with poor immune recovery, anaemia and mortality among HIV positive adults (Rawat et al., 2013). In this study we use a frequency weighted household dietary diversity score known as the Food Consumption Score, which is correlated with per capita calorie consumption (Wiesmann et al., 2009). Additional outcomes used in the study are derived from this dietary diversity score and these are the un-weighted food consumption score, optimal level of dietary diversity, poor level of dietary diversity and the consumption of at least five food groups.

We use propensity score matching to determine the average treatment effects of the food transfers programme. We also test the sensitivity of our estimates to unobserved heterogeneity using Rosenbaum bounds (Rosenbaum, 2002). Since all households in the study have an HIV/AIDS patient, we compare households receiving food aid rations with households not receiving food aid rations. Our study takes place six months after the programme began. The data set covers 378 households with a known patient on AIDS treatment, randomly sampled from eight clinics in the low income residential areas of Lusaka, the capital of Zambia.

Our results show that the food transfers programme increases dietary diversity by 9.76 points (22%) and raises per capita food consumption expenditures by 38%. The food transfers also decrease the proportion of households with poor dietary diversity and increase the proportion with optimal dietary diversity and consuming at least five food groups. Our results are robust to variation in propensity score model and bandwidth level. Rosenbaum bounds analysis shows that most of our estimates are robust to large amounts of unobserved heterogeneity.

Our study uniquely contributes to the empirical literature by offering new insights into the dietary diversity and consumption of HIV/AIDS affected households benefiting from food transfers. The paper is organized as follows. In the next section, we briefly explain the programme context. The following section discusses the estimation strategy for measuring the effects of the food transfers. This is followed by the sections that describe the data and the empirical results. The last section concludes the paper by discussing the implications of the estimation results and the limitations of the chapter.

2. Programme Context

Our study is based on a food assistance programme implemented by the World Food Programme (WFP) in Zambia to HIV infected adult individuals on ART and their households in Lusaka the capital of Zambia. The programme commenced in February 2009 and was intended to provide beneficiaries with 12 months of food transfers. The programme aimed to protect these households from the high food insecurity in Zambia which is fuelled by rising food prices and recurrent droughts.

Beneficiaries of the programme were selected based on two targeting criteria. First, as the key identification of the households depended on having a non-pregnant HIV infected adult member on ART, and based on the available resources, four public clinics proving ART were selected in order to recruit patients and their families into the programme and serve as food distribution centres. These clinics (Mtendere, Chawama, Kanyama, and George) are located in four eponymous low income residential communities in Lusaka. Four similar clinics (Bauleni, Chipata, Matero Reference, and Chilenje) serving other low income residential communities were selected as controls[2]. Second, targeting at the household level utilized a means testing procedure to determine eligibility. The targeting criteria at household level were based on a food insecurity evaluation and vulnerability assessment using a questionnaire. This questionnaire captured information on household size, composition; presence of HIV infected members, asset ownership, employment status, earnings, income, child education, dietary diversity and housing characteristics. Households were included into the programme if their vulnerability assessment was above a minimum threshold score of food insecurity. All households that scored below this threshold were excluded. Eligible beneficiaries received a monthly ration that comprised maize (25 kg), vegetable oil (1.8 litres), peas (4.5 kg), and corn and soy blend flour (6.0 kg). This monthly food ration had an estimated market value of US$16.

3. Estimation strategy

Our main challenge is to find a credible counterfactual in order to determine the causal effect of the food transfers programme. We are interested in estimating the average treatment effect on the treated (ATT) which is expressed as follows:

$$\text{ATT}= E\left(\Delta \mid X, D=1\right)= E\left(Y^{1}{}_{t} - Y^{0}{}_{t} \mid X, D=1\right)= E\left(Y^{1}{}_{t} \mid X, D=1\right)-\left(Y^{0}{}_{t} \mid X, D=1\right) \tag{1}$$

Where D = 1 denotes the treatment group receiving food transfers, while D=0 indicates the comparison group, *X* is a vector of various observed household, HIV patient and community level characteristics, Y^1 is the outcome for the treated households and Y^0 is the outcome for

[2] Control clinics were similar to the program clinics in active patient population, duration of operation, and historical patient survival at 12 and 18 months post-ART initiation

the comparison households at time t. However, since $E(Y_t^0| X, D=1)$ is unobservable (i.e. for our treated households receiving food transfers we cannot also observe the counterfactual Y_t^0), the assumption is that $E(Y_t^0| X, D=1) = E(Y_t^0| X, D=0)$.

Propensity score matching (PSM) enables us to statistically construct a comparison group by matching observed characteristics (*X*) of treated households to controls based on similar values of the propensity score. The propensity score is defined as the probability that a household receives food transfers given observable characteristics X i.e. $P(X_h) = P(D_h = 1|X)$. Unbiased inference from propensity score matching is based on the assumptions that the potential outcomes are independent of treatment assignment conditional on a set of observable characteristics X (Heckman et al. 1998), and that there exists common support or overlap in the propensity score distributions for individuals in both groups (Rosenbaum and Rubin 1983).

A probit model is used to estimate the propensity score using *X* as covariates. The covariates used in the specification to estimate the propensity score are based on our knowledge of how the food transfers programme was targeted, and on the empirical evidence of factors that usually determine eligibility in a food transfers programme and affect the outcomes of interest but are not affected by the food transfers programme (Rawat et al., 2010; Gilligan and Hoddinott, 2007). Since 82 per centof both beneficiary and comparison patients are the head of the households, the covariates include HIV patient characteristics such as age, gender, education level, marital status, employment status. Household covariates in the model describe the demographic composition and poverty level of the household and these include; household size, percentage of disabled members, number of HIV positive members, distance from residence to public clinic (in hours), and an index of durable asset ownership (type of toilet, electricity, television ownership, type of roof material, cooking fuel used, type of drinking water facility, in-house telephone, refrigerator, vehicle and motorcycle). The asset index is computed using factor analysis. Higher values of the asset index indicate greater wealth/less poverty. The model also includes a community level variable, local population.

We employ kernel matching which uses the weighted average of the individuals in the comparison group to construct the counterfactual (Caliendo and Kopeinig, 2008). Kernel matching uses more information thereby lowering variance (Caliendo and Kopeinig, 2008). We use the Epanechnikov kernel function with a bandwidth of 0.06. PSM is implemented using Leuven and Sianesi's method (Leuven and Sianesi, 2003). The estimates are based on region of common support between treated and comparison units in the propensity score distribution (Smith and Todd 2005). We test for covariate balance by comparing the equality of means for each variable included in the probit model (Dehejia and Wahba, 2002).

We carry out two forms of robustness checks. First, we test the sensitivity of kernel matching to the choice of bandwidth parameter. We compare matching with a bandwidth of 0.06 to a higher bandwidth of 0.08 and a lower one of 0.01 since higher bandwidth values lower variance while smaller values decrease bias, which reflects a trade-off (Caliendo and Kopeinig, 2008). We also check for the sensitivity of our results to alternative propensity score models. Smith and Todd (2005) find that matching estimates can be sensitive to the propensity score estimation and model. We compare the results of our base propensity score model to two alternative models, one of which includes the baseline body mass index of the patient as an additional covariate (model 2 henceforth), while the second one includes both the baseline body mass index and disease stage of the patient as additional covariates (model 3 henceforth). Since fewer patients had complete medical records on these clinical attributes, both alternative propensity score models are from smaller sample sizes (n= 226 and n=181).

A key assumption for causal inference from PSM is conditional independence, which means that selection into the food transfers programme is entirely based on observed characteristics, X such that potential outcomes are independent of treatment assignment status (Caliendo and Koepenig, 2008). If unobservable characteristics influence selection into the programme and the outcomes, this would imply the presence of hidden bias. For example, with negative unobserved selection bias, households with initial high dietary diversity and food consumption become beneficiaries, and thus the estimated impacts are underestimated and require upward adjustment. With positive unobserved selection bias, households with initial low dietary diversity and food consumption become beneficiaries, hence the estimated impacts are overestimated and require downward adjustment. Since our study is observational, bias from unobserved variables is a concern. We test the sensitivity of our matching estimates to unobserved confounding variables using Rosenbaum bounds (Rosenbaum, 2002). Rosenbaum bounds allow us to simulate the level or strength of unobserved heterogeneity that would change the significance of our estimates and hence undermine our matching estimates (Caliendo and Kopeinig, 2008; Rosenbaum, 2002,). Our estimates would be relatively robust if large levels of unobserved heterogeneity do not weaken the statistical significance of our results (i.e. a p-value greater than or equal to 0.1).

4. Data

4.1 Survey

A total 3688 patients and their households were recruited into the food transfers programme. Our analytical sample of 378 households is derived from a survey carried out on the food transfers programme in August 2009 six months after the programme began. The sample comprises 199 beneficiary households (treated) and 179 non-beneficiaries (comparison), randomly selected from four programme clinics/communities and four control clinics/communities. Comparison households were selected using the same assessment and eligibility criteria applied to the "treated" households at recruitment. This study was conducted with the approval of the University of Zambia Research Ethics Committee and the Ministry of Health of the Republic of Zambia.

The survey instrument captured information on household demographic composition and characteristics (gender, age, education, marital status) and employment status of all members in the household. The survey questionnaire also captured information on household expenditures, income sources, dwelling conditions, productive and durable assets owned.

4.2 Outcomes

Our first outcome of interest is dietary diversity as measured by the Food Consumption Score (FCS). The FCS was developed by the WFP to measure food diversity and conduct food security assessments. We calculate the score using the frequency of consumption of nine different food groups consumed by a household in the previous 7 days before the survey (Wiesmann et al., 2009; WFP, 2007a). The food groups are staples, pulses, vegetables, fruits, meat/fish/egg, milk, sugar, oil and fortified corn soya blend (Gilligan et al., 2013). Each food group is assigned a weight based on nutrient density, macro-micronutrient content and quantities eaten. Higher weights are attached to animal source foods (meat, fish, milk, egg). The weights and the reasoning behind them are displayed in appendix A. For each food group, the sum of the consumption frequencies (ranging from 0-7) is multiplied by its weight. The resulting weighted food group scores are added together to yield the FCS. The FCS can also be converted into a categorical variable featuring three levels. The thresholds for the food consumption score are 0-21 for poor food consumption/diversity, 21.5-35 for borderline food consumption/diversity and >35 for optimal food consumption/diversity (WFP 2007a).

Our second outcome of interest is consumption as measured by per capita total household and food expenditures in the past 30 days. Aggregate food consumption expenditures are calculated for each household based on food consumed by the households from all sources (outside the home, food transfers and from home production). Other expenditure data were collected for various other household items and activities; fuel, clothing, health, personal hygiene items, education, social events, transportation, entertainment, rentals and durables. Per capita expenditures are computed by dividing expenditures with the number of all household members. The currency for Zambia is the Zambian Kwacha (ZMK). Additional data collected during the survey include demographic information for the head of the household and the patient, number of patients on treatment in the household, dwelling conditions, productive and durable assets owned, access to other social transfers and access to community assistance, patient medical information on body mass index and disease stage at baseline i.e. January 2009.

4.3 Sample characteristics

Table 1 describes the pre-matching socio-economic characteristics of the households and the HIV/AIDS patients in the unmatched sample. The majority of patients in the households are female; more than 70 per cent of both the beneficiaries and the comparison group. The average age for the majority of the patients is slightly over 40 years. Approximately 42 per cent of the patients among the participants are married compared to 47 per cent among non-participants. Approximately 17 per cent of the beneficiary patients are uneducated compared to about 15 per cent of the comparison group. A similarly minority of patients in both groups is employed (formally or informally), 34 per cent of the beneficiaries and about 36 per cent of the comparison group.

About 50 per cent of the treated households live less than an hour from the public health clinics compared to 49 per cent of the comparison households. Nearly 71 per cent of the beneficiaries households do not own the house they reside in against 61 per cent of comparison households. The comparison households have a higher average on the durable asset index than beneficiary households. The average household size for both groups is nearly 5. The results in table 1 clearly show that the treated and comparison patients and households are significantly different on three characteristics: house ownership, asset index, and local community population.

-Insert Table 1 here-

5. Results

5.1 Propensity score estimation

Table 2 reports the results of the probit estimation of the propensity score. The regression shows that having an older patient in the households negatively predicts participation in the food transfers programme (treatment). Compared to having an unmarried patient, married and divorced/separated patients negatively predict treatment. Higher values of the asset index also negatively affect treatment, while not owning a house positively predicts treatment. This indicates that poor households are more likely to participate in the programme.

-Insert Table 2 here-

5.2 Covariate balance and overlap

Table 3 reports the results for testing for the equality of means for each characteristic included in the probit model. None of the characteristics remain significantly different between the two groups after matching, implying that the treated and comparison groups are comparable and similar. In particular, the variables which were previously significantly different before matching (house ownership, asset index, and local community population) are now not statistically significant. Similarly, the t-tests in the alternative propensity score models also show that all covariates are not significant. For the sake of brevity, these results are not presented here and are available on request.

-Insert Table 3 here-

Further tests of the quality of matching also confirm that the balancing property is satisfied (see table 4). The pseudo R-squared in our base model and the alternative specifications is much lower after matching than before (Sianesi, 2004). The likelihood ratio test of joint significance is not significant in any of the models. The results also show that there is a significant reduction in the mean bias due to matching. In all matching methods and models the reduction in bias is by much more than 20 per cent, an indication that matching successfully reduced selection bias from observables (Rosenbaum and Rubin, 1985).

-Insert Table 4 here-

The propensity score distribution and common support range for the base model is shown in a histogram in figure 1. The histogram shows that there is sufficient overlap in the propensity score distributions of the treated and untreated. Histograms for the models 2 and 3 also present a similar pattern (available on request). Observations that are off-support are dropped from the matched sample (Smith and Todd, 2005).

-Insert Figure 1 here-

5.3 Main results

Table 5 shows the estimated ATT of food transfers on several dietary diversity and consumption outcomes. Results show that the food transfers improve dietary diversity in the household. Beneficiaries have significantly higher dietary diversity than the comparison group. There is a difference of 9.76 units in the food consumption score (FCS). When compared to the comparison group average of 44.723, this difference translates to a 22 per cent increase in dietary diversity among beneficiaries (9.76*100/ 44.723). Food transfers decrease the incidence of poor dietary diversity by about 14 percentage points and increase the incidence of optimal dietary diversity by about 25 percentage points. Beneficiaries are also more likely to be consuming at least five food groups in a week as indicated by the 23 percentage points difference.

The results also show that per capita food expenditures for beneficiaries are higher by ZMK 19867.67 (about USD 3.97) compared to the comparison group. Looking at the comparison group's average, this impact means an increase of 38 per cent. However, while there is a positive effect on per capital total expenditures, this is not statistically significant. Our ATT estimates are consistent in significance and sign of effect across the different bandwidth parameters. These findings suggest that the food transfers have a positive average effect on the diet quality and food expenditures of the beneficiaries.

-Insert Table 5 here-

5.4 Robustness checks

We then proceed to compare the robustness of our estimates from the base model with two alternative propensity score models which are derived from smaller sample sizes (restricted to patients with complete clinical data). Model 2 includes the baseline body mass index of the patient as an additional covariate, while model 3 includes both the baseline body mass index and disease stage of the patient as additional covariates. All the models are estimated using our preferred bandwidth parameter of 0.06.

Most of the results from our preferred specification (base model) and model 2 are similar in statistical significance, sign and magnitude of treatment effect. When we use model 3, the impacts on the incidence of normal and poor dietary diversity are of similar sign with model 1 but are not statistically significant. Overall, the matching estimates are largely robust to variation in propensity score models with smaller sample sizes.

-Insert Table 6 here-

5.6 Sensitivity analysis of hidden bias

Since PSM does not correct for bias due to unobserved characteristics, we conduct a sensitivity analysis of hidden bias. This is achieved by determining the strength or level of unobserved heterogeneity that would change the statistical significance of our ATT estimates. We use the Rosenbaum bounds approach (Rosenbaum, 2002) where we check for the critical levels of the sensitivity parameter Γ (gamma) at which our treatment effects may be questioned. The bounds are calculated for continuous variables using the rbounds routine that is based on the Wilcoxon signed rank test statistic (DiPrete and Gangl, 2004) and for binary variables using the mhbounds routine that is based on the Mantel and Haenszel (MH) test statistic (Becker and Caliendo, 2007). Table 7 shows the critical levels of gamma, Γ, at which our estimates would lose statistical significance. The Γ levels are shown for both upper (positive unobserved selection) and lower bounds (negative unobserved selection) and only for outcomes where food transfers have statistically significant treatment effects.

-Insert Table 7 here-

The results show that for the upper bound (positive unobserved selection), our estimates of the impact on the weighted and un-weighted FCS, and the proportion of households consuming at least five food groups, are insensitive to the doubling or tripling or of unobserved heterogeneity (Γ is 2.05, and 2.1 respectively). For the PSM results on the incidence of poor diversity, the results remain significant beyond Γ of 10. The lowest critical value of Γ is 1.5 for the incidence of optimal dietary diversity, which indicates that an unobserved variable would have to increase the odds ratio of participation by 50 per cent before nullifying the statistical significance. For the lower bound (negative unobserved selection), all estimates, except for the incidence of poor dietary diversity, are robust to very large amounts of unobserved heterogeneity as the estimates remain significant beyond Γ of 10. Several studies contend that insensitivity to the doubling of unobserved variables is a high threshold for robustness (Caliendo et al., 2008; DiPrete and Gangl, 2004). Overall, the sensitivity analysis demonstrates that most of our PSM results, and especially for the key outcomes (weighted dietary diversity score and food expenditures), are robust to the presence of large amounts of positive or negative unobserved heterogeneity.

6. Conclusions and policy implications

This study utilizes PSM to evaluate the impact of food transfers targeted to households with patients on antiretroviral therapy (ART) in Zambia. We find that after six months, there is a 22 per cent increase in dietary diversity and a 38 per cent increase in per capita food expenditures of beneficiaries. The food transfers also reduced poor dietary diversity by 14 percentage points and increased normal dietary diversity and the consumption of at least five food groups by about 25 and 23 percentage points, respectively. While the impact on per capita total expenditures was positive, it was not statistically significant.

Our results shows that not only are meals frequent but diet quality may be improving in the households. Despite their modest market value, the food transfers possibly have an income effect resulting in the beneficiaries having extra disposable income to spend on food. The improvements in household dietary diversity and food expenditures do not only have implications on household nutrition and food security but also on the patient's health. As mentioned earlier, studies show that low dietary diversity and food insecurity are associated with poor clinical outcomes and threaten the efficacy of antiretroviral therapy. The original aims of the food transfers programme were to increase household food security and secondarily improve the efficacy of ART. Previous studies find that such food transfer programmes also improve adherence to antiretroviral therapy (Tirivayi et al., 2012; Cantrell et al., 2008). Since hunger and food insecurity impede adherence to ART, our findings on dietary diversity (which also capture food frequency and consumption) and food expenditures help explain why food transfer programmes may also improve adherence to antiretroviral therapy.

A major limitation of our study is the lack of suitable baseline data. Consequently, we could not utilize the difference in differences approach to remove bias from time-invariant unobserved heterogeneity. Our best option was to conduct PSM and test the robustness of our results to possible unobserved heterogeneity. Due to our study design, we could not study long term outcomes. Hence, we do not know whether the positive impacts shown in this paper are sustained over time or whether they would persist after the termination of the programme. We therefore recommend further research on this issue. Further research can also assess the role of intrahousehold food sharing and allocation on the impact of food transfers on individual health and economic outcomes.

In conclusion, our study demonstrates that food transfers can be effective in boosting household food security and can thus counteract the negative bidirectional relationship between HIV/AIDS and food insecurity. While an increasing number of HIV/AIDS treatment, care and support programmes now provide food assistance; there is a dearth of evidence on the impact of such transfers on household diets and food security. Our study contributes relevant insights about the impact of such programmes.

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Table 1 Sample characteristics (before matching)

	Treated (N=199)	Comparison (N=179)	P value
Patient Characteristics			
Age (mean years)	41.69	40.28	0.116
Gender			
Female,%	77.78	72.63	0.247
Male ,%	27.37	27.37	0.247
Education			
No education, %	16.67	14.53	0.568
Primary education, %	51.01	44.69	0.220
Secondary education, %	31.31	38.55	0.141
College education, %	1.01	2.23	0.343
Marital status			
Never married, %	6.06	4.47	0.491
Married, %	41.92	47.49	0.277
Divorced or separated,%	13.64	16.20	0.484
Widowed, %	38.38	31.84	0.184
Employment status at baseline %	34.34	35.75	0.774
Household Characteristics			
Distance to public clinic (less than 0.5 hr) , %	50.51	48.60	0.136
Do not own house , %	70.71	60.89	0.045**
Asset index (mean)	-0.25	0.21	0.000***
Disabled persons, %	7.07	5.59	0.557
Number of HIV positive members	3.08	3.06	0.893
Household size (mean persons)	4.89	4.82	0.651
Local community population	115496	103869	0.000***
Dietary and consumption outcomes			
Food consumption score (FCS)	51.39	44.72	0.008***
Un-weighted FCS	30.42	27.32	0.011**
FCS above 35 (normal %)	73.23	57.54	0.001***
FCS below 21 (poor %)	5.56	15.08	0.002***
Number of food groups consumed	6.17	5.49	0.000***
At least five food groups consumed (%)	90.40	73.74	0.000***
At least seven food groups consumed (%)	39.90	27.93	0.014**
Per capita food expenditures (ZMK)	65896.59	52200.53	0.005***
Per capita total expenditures (ZMK)	82041.92	83832.64	0.808

Source: Own calculations from collected data. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$. Reported p-values are based on t-tests of means for continuous variables and chi-squares for proportions/categorical variables. Hr denotes hour. ZMK- Zambian Kwacha currency

Table 2 Probit model for propensity score

	Coefficient	Standard error
Patient variables		
Age	-0.120**	(0.051)
Age squared	0.002***	(0.001)
Female	0.186	(0.175)
Marital status[a]		
Married	-0.779**	(0.350)
Divorced/separated	-0.678*	(0.368)
Widowed	-0.571	(0.357)
Education[b]		
Primary	0.140	(0.216)
Secondary	0.0221	(0.232)
College	0.122	(0.619)
Employment status (baseline)	0.108	(0.150)
Household variables		
Do not own house	0.308*	(0.161)
Distance to public clinic (< 0.5hr)	0.180	(0.148)
Asset index	-0.280***	(0.090)
Disabled members (%)	0.230	(0.290)
Number of HIV positive members	0.0397	(0.059)
Household size	0.0509	(0.048)
Local community population	-0.000018	(0.000)
Community population squared	1.39e-10	(0.000)
Constant	1.979	(1.889)
N	364	
pseudo R^2	0.122	
LR chi2(17)	61.58	
Log likelihood	-221	
	379	
Prob>chi2	0.000	

Source: Own calculations from collected data. Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01, *** p < 0.001. Reference categories: [a] is never married, [b] is no education. Hr denotes hour.

Table 3 T-tests for equality of means of covariates after matching (model 1)

Covariate	Treated	Comparison	t	p>|t|
Patient variables				
Age	40.92	40.759	0.16	0.873
Age squared	1762.9	1751.1	0.14	0.890
Female	77.273	75.923	0.3	0.766
Marital status				
Married	42.045	43.56	-0.29	0.775
Divorced/separated	14.205	16.199	-0.52	0.604
Widowed	38.068	35.457	0.51	0.613
Education				
Primary	52.273	54.18	-0.36	0.721
Secondary	31.818	31.83	0	0.998
College	1.136	0.882	0.24	0.812
Employment status (baseline)	33.523	34.631	-0.22	0.827
Household variables				
Do not own house	71.023	72.354	-0.28	0.782
Distance to public clinic (< 0.5hr)	48.864	50.622	-0.33	0.742
Asset index	-0.234	-0.261	0.38	0.704
Disabled members (%)	6.818	6.75	0.03	0.98
Number of HIV positive members	3.057	3.067	-0.07	0.946
Household size	4.858	4.688	1.01	0.311
Local community population	1.20E+05	1.10E+05	0.48	0.631
Community population squared	1.4e+10	1.4e+10	0.32	0.752

Source: Own calculations from collected data.

Table 4 Further tests of covariate balance

Model	**Sample**	**Pseudo R^2**	**LR $\chi 2$**	**P> $\chi 2$**	**Mean Bias**
Base model (Kernel)					
Bandwidth 0.06	Unmatched	0.122	61.58	0.000	16.5
	Matched	0.012	5.71	0.997	3.2
Bandwidth 0.01	Unmatched	0.122	61.58	0.000	15.9
	Matched	0.020	9.74	0.940	4.3
Bandwidth 0.08	Unmatched	0.122	61.58	0.000	15.9
	Matched	0.011	5.46	0.998	3.5
Model 2	Unmatched	0.193	56.76	0.000	16.3
(Kernel bw 0.06)	Matched	0.014	3.36	1.000	3.9
Model 3	Unmatched	0.331	70.05	0.000	25.4
(Kernel bw 0.06)	Matched	0.035	4.86	1.000	5.0

Source: Own calculations from collected data. Bw-bandwidth.

Table 5 Impact of the food transfers on household diet quality and consumption

ATT	Kernel (0.06)	Kernel (0.01)	Kernel (0.08)
Diet quality and diversity			
Food consumption score (FCS)	9.762***	7.111**	9.884***
	(2.867)	(3.087)	(2.862)
Un-weighted FCS	4.580***	3.301**	4.674***
	(1.422)	(1.562)	(1.420)
FCS above 35 (optimal %)	24.60 ***	19.712***	24.707***
	(5.722)	(6.420)	(5.713)
FCS below 21 (poor %)	-14.356***	-9.651**	-14.511***
	(3.877)	(4.467)	(3.869)
At least five food groups consumed (%)	22.514***	21.186***	22.288***
	(4.748)	(5.423)	(4.739)
Consumption expenditures			
Per capita food expenditures (ZMK)	19867.67***	19778.59***	19871.50***
	(5677.93)	(5984.27)	5670.55001
Per capita total expenditures (ZMK)	13772.44	15337.03*	13821.74
	(8840.87)	(9303.58)	(8825.83)
N	353	349	353

Source: Own calculations from collected data. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, *** $p < 0.001$. NN-Nearest Neighbour matching. ZMK-Zambian kwacha currency. Bandwidth 0.06 and 0.01 used for kernel matching, two nearest neighbours for nearest neighbour matching. N is based on all observations on common support.

Table 6 Robustness to propensity score model

ATT	Base model	Model 2	Model 3
Diet quality and diversity			
Food consumption score (FCS)	9.762***	11.190***	12.296**
	(2.867)	(3.910)	(5.631)
Un-weighted FCS	4.580***	4.791**	4.560*
	(1.422)	(1.907)	(2.719)
FCS above 35 (optimal %)	24.60 ***	28.919***	17.632
	(5.722)	(7.739)	(11.214)
FCS below 21 (poor %)	-14.356***	-13.401**	-9.328
	(3.877)	(5.217)	(7.144)
At least five food groups consumed (%)	22.514***	21.238***	21.255**
	(4.748)	(6.543)	(9.504)
Consumption expenditures			
Per capita food expenditures (ZMK)	19867.67***	25661.46***	27101.55**
	(5677.93)	(8907.53)	(10464.66)
Per capita total expenditures (ZMK)	13772.44	24006.95*	19971.37
	(8840.87)	(12613.82)	(17844.77)
N	353	185	123

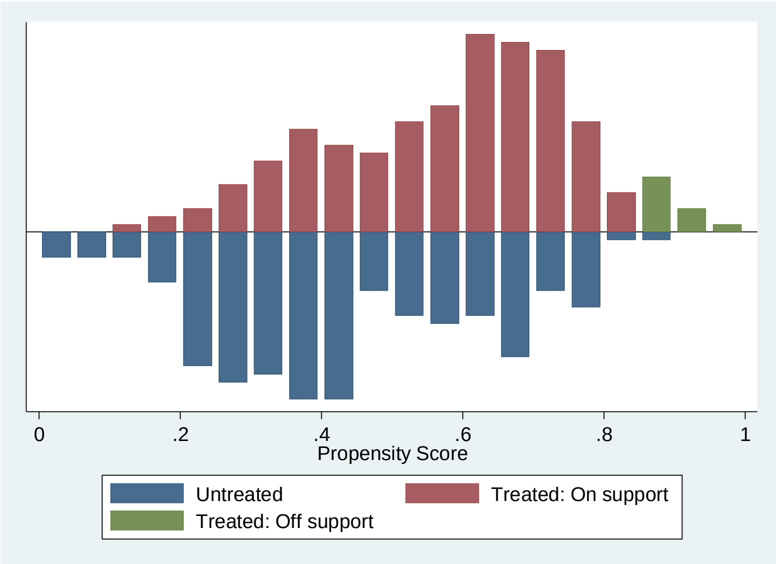
Source: Own calculations from collected data. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, *** $p < 0.001$. ZMK-Zambian kwacha currency. Matching algorithm is Epanechnikov kernel with bandwidth of 0.06.

Table 7 Rosenbaum Bounds-critical levels of gamma

Critical levels	Upper Bound Γ	Lower Bound Γ
Diet quality and diversity		
Food consumption score (FCS)	2.05	>10
Un-weighted FCS	2.05	>10
FCS above 35 (optimal %)	1.5	>10
FCS below 21 (poor %)	>10	1.65
At least five food groups consumed (%)	2.1	>10
Consumption expenditures		
Per capita food expenditures (ZMK)	1.65	>10

Source: Own calculations from collected data. Matching algorithm is Epanechnikov kernel with bandwidth of 0.06. >10 indicates that the results remained significant beyond Γ levels of 10.

Figure 1 Overlap in propensity score (model 1)



Appendix A

Food groups	Weight	Justification
Main staples	2	Energy dense, protein content lower and poorer quality than legumes, micronutrients. (bound by phytates)
Pulses	3	Energy dense, high amounts of protein but of lower quality than meats, micronutrients
Vegetables	1	Low energy, low protein, no fat, micronutrients
Fruit	1	Low energy, low protein, no fat, micronutrients
Meat and fish	4	Highest quality protein, easily absorbable micronutrients (no phytates), energy dense, fat. Even when consumed in small quantities, improvements to the quality of diet are large.
Milk	4	Highest quality protein, micronutrients, vitamin A, energy. However, milk could be consumed only in very small amounts and should then be treated as condiment, and therefore reclassification in such cases is needed.
Sugar	0.5	Empty calories. Usually consumed in small quantities.
Oil	0.5	Energy dense but usually no other micronutrients. Usually consumed in small quantities.
Corn soya blend	2.5	Energy dense and fortified with iron and other nutrients

Source: World Food Programmeme (2007a). The assigned weights for each food group were determined by a team of analysts based on the energy, protein, and micronutrient densities of each food group. Modified to include corn soya blend, weight based on WFP (2007b)

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