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ORIGINAL PAPER

Impacts of HIV / AIDS on food consumption and wild food use in rural South Africa

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Abstract HIV/AIDS can affect household food consumption in many ways, including through reductions in availability and quality of labour, reductions in earned income, and increased expenditure on medications. In rural South Africa, these negative effects can be buffered by social safety net programs provided by government and collection of wild foods. Despite some acknowledgement of the potential safety net role of wild foods, however, their contribution relative to other food sources in the context of HIV/AIDS remains underexplored. Here we report empirical findings from two rural communities in the Eastern Cape province of South Africa. Qualitative and quantitative methods were used to characterise food sources, intake and calories from 68 HIV/AIDS afflicted households and 87 non-afflicted households every quarter over 12 months. Results show that diets were moderately well-balanced though limited in variety, with cereal items contributing 52 % to total calorie intake. The bulk of food consumed by households was purchased, with supplementation from own production, collected wild vegetables and collected wild fruits. Up to 20 % of respondents from both HIV/ AIDS afflicted and non-afflicted households had insufficient daily caloric intake. Multivariate analyses show that, all else equal, individuals living in households afflicted by HIV/AIDS consumed fewer calories, had less diverse diets, and were more dependent on wild foods than those living in non-afflicted households. Given the detrimental effects of HIV/AIDS on income and home production, wild foods represent a free and readily available food source for vulnerable households.

Keywords Calories · Dietary diversity · Food security · HIV/ AIDS · Seasonality · Wild foods

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Introduction

Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) is one of the greatest challenges faced by sub-Saharan Africa, including South Africa (Gillespie et al. 2010; Niehof et al. 2010; Kaschula 2011; Shackleton and Shackleton 2012). In 2011 South Africa had a total population of about 50.6 million people, of whom some 6.1 million (12.5 % of all people) were living with HIV (UNAIDS 2014). No country in the world has more people living with HIV/AIDS. Among women attending antenatal clinics, the prevalence rate was 37.4 % in 2011, down slightly from the historic high of 40.7 % in 2004 (National Department of Health 2012). In 2012, it is estimated that 240,000 people died and that there were 2.5 million orphans aged 0–17 years due to AIDS (UNAIDS 2014). The Government of South Africa was slow to respond to the country's HIV/AIDS pandemic and finally launched an aggressive program of HIV/AIDS testing, awareness, prevention and treatment in 2010. HIV/AIDS has pervasive impacts on individuals, households, public services, communities and the overall economy.

HIV/AIDS greatly affects food security in South Africa and has increased the vulnerability of rural communities to existing risks and stressors such as poverty, high unemployment, variable and extreme weather events, and inadequate government services and infrastructure (SADC FANR VAC 2003; Twine and Hunter 2010; Shackleton and Shackleton 2012). However, studies show variation within and between communities with regards to the impacts of HIV/AIDS on food security (Kaschula 2008; McGarry and Shackleton 2009a, b). Such disparities indicate that there is a need to disaggregate analyses based on spatial and temporal scales (Masuku and Sithole 2009). Agro-ecological, environmental, geographic and socio-economic conditions, for example, determine the levels of vulnerability and intensity of shocks such as HIV/AIDS on food security, and ultimately the interventions that can be used to alleviate food insecurity (Drimie and Casale 2009; Masuku and Sithole 2009 l; Talman et al. 2013).

This paper seeks to improve understanding of the relationships between HIV/AIDS, food consumption and food sourcing patterns in rural South Africa, accounting for other factors that vary at the individual, household and community levels. In doing so, the paper also focuses on the contribution of wild foods to individual and household diets. Quantitative and qualitative methods are applied to a rich data set on household and individual food consumption from rural and peri-urban communities in the Eastern Cape of South Africa. However, unobserved heterogeneity of individuals and households that can impact both food security and HIV/AIDS status simultaneously, such as ability and risk preference, causes econometric challenges (e.g. simultaneity and endogeneity) in identifying cause-effect relationships. In the absence of time-variant panel data and instrumental variables that are often used to account for unobserved heterogeneity, we are not able to identify cause-effect relationships between HIV/AIDS and food consumption in this paper.

Background

Food security and HIV/AIDS status

An increasing number of studies find that HIV/AIDS negatively impacts households' and individuals' food security in both developed and developing countries (e.g. Barnett and Whiteside 2002; Chapoto and Jayne 2008; Anema et al. 2009; Kadiyala and Chapoto 2010). HIV/AIDS can compromise households' and individuals' food security through multiple pathways (Niehof et al. 2010; Talman et al. 2013). HIV/AIDS increases medical expenditures and associated transaction costs, thereby decreasing the income available for purchasing food (Barnett et al. 1995; Shackleton et al. 2006). Although the cost of antiretroviral (ARV) drugs has been subsidized in South Africa, its treatment remains a significant proportion of expenditure for low-income households in travelling to and from clinics (especially in rural areas) and basic clinic fees (Onwujekwe et al. 2009). HIV/AIDS can impact food security by depleting the quality and quantity of households' labour supply and thereby households' cash and subsistence incomes (Barnett et al. 1995; Cohen 2002). HIV/AIDS can cause nutritional deficiencies by decreasing food intake, increasing malabsorption and increasing demand for and excretion of nutrients (Gillespie and Kadiyala 2005) along with increased energy demands from increased metabolic rates (Kulstad and Schoeller 2007). In addition, HIV/AIDS can also create food insecurity by decreasing agricultural productivity, depleting capital stocks, and increasing out-migration of the productive individuals of the households (Loevinsohn and Gillespie 2003; Talman et al. 2013). This may be exacerbated by environmental decline through land degradation or climate changes potentially resulting in a reinforcing negative spiral (Shackleton and Shackleton 2012), which Talman et al. (2013) label as a syndemic.

HIV/AIDS can also be an effect or consequence of food insecurity. To this end, women are more likely to be exposed to HIV/AIDS risks than men. In most developing economies, including South Africa, women are disadvantaged in accessing productive resources such as land, and in finding employment (Meinzen-Dick et al. 1997; Gray and Kevane 1999; Deininger and Castagnini 2006). As a result, women and female-headed households are likely to have less income and to be less food secure than their male counterparts. As a coping mechanism, women may respond by trading sex to gain cash, food or access to food-related resources (Gillespie and Kadiyala 2005). In addition to women, migrants and orphans are also more susceptible to HIV/AIDS as a result of food insecurity (Gillespie and Kadiyala 2005; Young et al. 2014).

Wild food consumption in South Africa

South Africa's food system is divided into a large-scale industrial food system that serves the majority of food needs throughout the country and for export, and a smallholder system that produces small amounts of food for home or local consumption. There are about 40,000 large-scale commercial farms that produce the vast majority of food and perhaps 1.3 million small-scale farms that produce food for home consumption or local sale (Greenberg 2010). Besides large-scale commercial farms and small-scale farms, a third food source for people living in rural and peri-urban areas is the natural environment where people gather or hunt wild foods.

Previous studies of wild food consumption in South Africa indicate that relatively high proportions of households consume some wild foods (e.g. Shackleton and Shackleton 2004; Dovie et al. 2007; Kaschula 2011) and that consumption may increase in the face of HIV/AIDS (e.g. Hunter et al. 2007; Kaschula 2008; Drimie and Casale 2009; McGarry and Shackleton 2009a, b).

Wild foods are non-domesticated species of flora and fauna that are gathered or hunted by humans for consumption or trade (Muller and Almedon 2008; Bharucha and Pretty 2010). Wild foods include various forms of both plant and animal derived products such as fruits, green leafy vegetables, woody foliage, bulbs and tubers, cereals and grains, nuts and kernels, saps and gums which are eaten or used to make wine, mushrooms, invertebrates such as insects and snails, honey, bird eggs, bush meat from small and large mammals, reptiles, birds, fish and shellfish. A few examples include wild vegetables in West Africa (Weinberg and Pichop 2009), bushmeat in central Africa (van Vliet et al. 2012) and mopane worms in southern Africa (Greyling and Potgieter 2004). Wild foods are an essential and preferred dietary component in many rural and urban households throughout the world driven by cultural preferences, ease of access, low costs and nutritious status (Bharucha and Pretty 2010). Across a sample of 14 rural villages in South Africa, on average, 96 % of households consumed wild spinaches, 88 % ate wild fruits, 54 % ate edible insects, 52 % consumed bushmeat and 51 % ate wild honey (Shackleton and Shackleton 2004). It is not just rural communities that make use of and even prefer wild foods. South Africa has many vibrant urban markets for many kinds of wild foods. These examples show that the consumption of wild foods is not driven solely by need or poverty, but also by culture, tradition and dietary preference (Trefry et al. 2014). Additionally, they are not used just as a safety net in time of need, but are also consumed by those who have the means to afford them. Wild foods rarely make up most of the staple items in individual and household diets, yet in many rural households wild foods supplement what they obtain from own production and purchase (Arnold et al. 2011; Pasquini et al. 2009).

Study sites

This study was conducted in two sites of the Eastern Cape province of South Africa, i.e. Lesseyton, which is an inland area in Lukhanji Local Municipality, and Willowvale, which is a coastal area in Mbhashe Local Municipality (Fig. 1). The Eastern Cape is the poorest province in South Africa, with a largely rural population and the lowest rates of services and infrastructure development in the country (Stats SA 2011). The leading causes of death in the province are HIV/AIDS-related opportunistic infections such as tuberculosis (Makiwane and Chimere-Dan 2010).

Lesseyton is a peri-urban region located 15 km west of Queenstown (Table 1). It is a semi-arid area that receives an average of 400 mm rainfall per annum (Mucina and Rutherford 2006; Lukhanji Local Municipality 2011). The bulk water supply system is frequently interrupted which hinders the growing of crops and rearing of livestock (Chris Hani District Municipality 2010). Lesseyton is made up of eight villages (Ekuphumleni, Engonjini, Tabata, Toisekraal, Trust, Vrijin, Xuma and Zola) all of which were sampled in the study. In terms of housing, Lesseyton has both formal, mostly government low-cost houses, and informal housing with every household having access to a ventilated pit latrine. Residents have access to electricity, tap water and those in government provided houses also have rainwater tanks. Lesseyton residents access most of their financial, health and administrative services in nearby Queenstown. Unemployment and poverty are high and consequently the primary source of cash income for many households is government social grants (Table 1).

The Willowvale area consists of dispersed rural villages and homesteads between the town of Willowvale and the coast (Table 1). It is one of the poorest districts in the country (Stats SA 2000), and over 90 % of households have cash incomes below the national poverty line (Table 1). Livelihoods are regarded as largely agrarian, with households engaged in a mix of arable farming, home gardening, livestock husbandry and collection of non-timber forest products, supplemented by ad hoc employment, remittances from migrant family members working in urban centres and government social grants (ARDRI 2001; Palmer et al. 2002). The main crops grown are maize, beans, pumpkins and a variety of vegetables, including nurturing of wild vegetables. The villages sampled were Bonde, Bojini, Qhora, Qwaninga, Ngxutyana, Ncalukeni, Nakazana and Gojela. The mean annual rainfall is approximately 1000 mm. Vegetation is a mosaic of forest patches, grasslands and pseudo-savannas on old field sites. The area does not have electricity (although it is soon to be installed) nor household bulk water supply. There are communal stand pipes for water.

While most people in the Eastern Cape live in rural areas, the contribution of agriculture to local livelihoods is low in the entire province and has been in decline for several decades (Hebinck and Lent 2007). The decline of agriculture has accelerated over the last two decades with increasing dependence on state social grants and relocation to urban areas (Ngcaba 2002; Timmermans 2004). Thus, only a small minority of households still cultivate large fields (Shackleton et al.

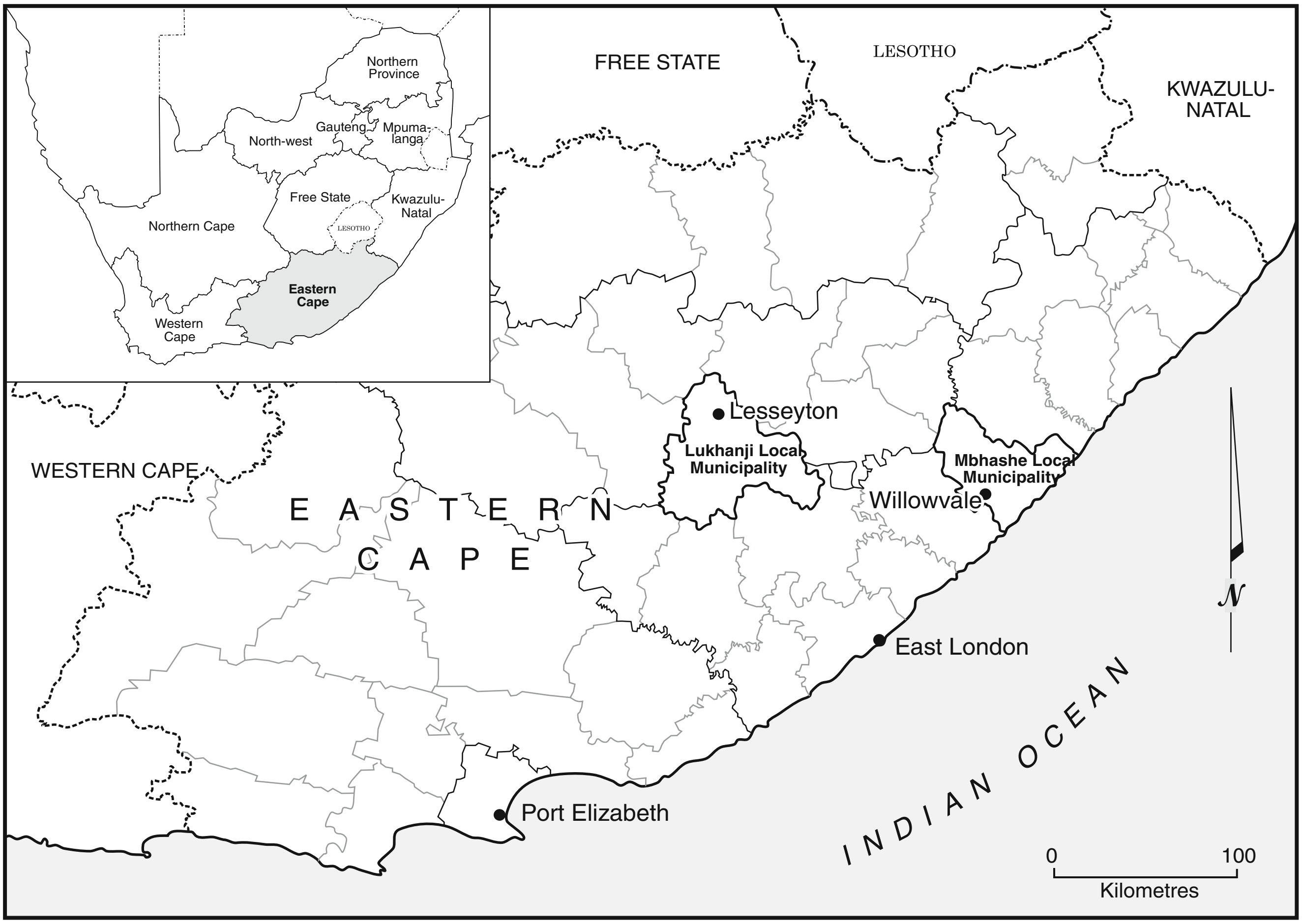

Fig. 1 Location of Lesseyton and Willowvale study sites

2013). However, many households have increased the size and intensity of cropping of homestead gardens (Andrew and Fox 2004; Fay 2013).

A possible consequence of these changes is that rural residents have become more dependent upon purchase of foods from external sources and are less reliant on

Table 1 Socioeconomic and biophysical aspects of Lesseyton and Willowvale

Characteristic	Coastal Site Willowvale	Inland Site Lesseyton
Closest town	Willowvale	Queenstown
Coordinates	32°15′46.33″S, 28°28′50.15″E	31°50′40.96″S, 26°46′34.18″E
Mean Annual Rainfall (mm)***	1000	400
Vegetation***	Transkei Coastal Belt	Queenstown Thornveld
Population Density (persons/km^2)	26.1 *	47.4 **
Gender: Male	44.5 % *	48 % **
Female	55.5 % *	52 % **
People living in poverty	90.4 % *	65 % **
Household Income <R1 500/month	96 % *	45 % **
Unemployment	78.5 % *	50 % **
Dependent on social grants	66 % *	57 % **
Household Size (no. of people)	4.4*	4.1**
Type of energy used for cooking, heating, lighting	Paraffin, Fuel wood, Gas	Electricity, Fuel wood

(Sources: * Mbhashe Municipality 2010, ** Lukhanji Municipality 2011, *** Mucina and Rutherford 2006, **** ECSECC 2009) growing their own food. Dependence on wild foods is less certain: reduction of cultivation and population density may have the effect of increasing the supply of wild food from uncultivated plots, but also reducing demand for wild food sources. The effect of HIV/AIDS on wild food consumption is also uncertain. On one hand, HIV/AIDS will reduce the availability of reliable labour and thus the supply of both own-produced and gathered food. On the other hand, HIV/AIDS may reduce income and increase health-related expenses, thus reducing the amount of money available to purchase food from external sources and increasing reliance on free wild foods. Findings of greater reliance on wild foods for HIV vulnerable households may indicate that the income effect is greater than the labour effect, and vice versa.

Methods

Data collection

At each site households were purposively selected from an existing pool of 340 randomly selected households (170 at each site) for a livelihoods study by Cobbing (2012) on the basis of their HIV/AIDS vulnerability status. Proxy indicators developed by the SADC FANR Vulnerability Assessment Committee (2003) for HIV/AIDS vulnerability were recorded for each household. The indicators were (i) presence in the household of a person aged 0–59 with chronic illness (over three months), (ii) presence in the household of a person aged 0–59 with chronic illness (over three months) and receiving free treatment, (iii) recent (last two years) death in the household of someone between the ages 0–59 years, (iv) recent death in the household of someone between the ages 0–59 years who experienced at least three months of chronic illness before death and (v) presence of children under 19 years with both parents deceased. Households were grouped depending on the number of affirmative responses to the indicators. Those that responded negative to all the proxy indicators were classified as non-afflicted by HIV/AIDS and those with three or more positive responses were classified as afflicted by HIV/AIDS. Households that responded positively to one or two proxy indicators were classified as undetermined and excluded from subsequent data collection and analyses. Using these indicators, 28 afflicted and 44 non-afflicted households were investigated in Lesseyton and 40 afflicted and 43 non-afflicted households in Willowvale for a total of 155 households and 794 individuals.

The contribution of different sources of food to individual and household diets in terms of intake and diversity was investigated using a 48-h dietary recall[1] (Hirvonen et al. 2006). The 48-h dietary recall survey was administered quarterly to all individuals in the 155 sample households to gather information on: the number of eating occasions, type of dish, ingredients of each dish, approximate amounts and source of each ingredient which was classified as purchased, grown, gathered from the wild, or donated. Information was gathered for all members of each household to facilitate intra-household analysis and this was later combined to derive household information. For household meals, the person responsible for preparing and cooking the meals was interviewed. For food items consumed between meals (snacks) each household member above five years old was interviewed. The mother responded to questions regarding diets of children less than five years old. The Individual Dietary Diversity Index (IDDI) and Household Dietary Diversity Index (HDDI) are indicators of food consumption that measure individual and household dietary access to different food types and nutrient adequacy (FAO 2007, Swindale and Bilinsky 2005).

An Individual Dietary Diversity Score (IDDS) was determined for each household member and a Household Dietary Diversity Score (HDDS) was determined for each household. IDDS and HDDS capture the variety of foods consumed by an individual or household over 48 h and a score is calculated by adding up the number of foods groups consumed out of a possible eleven (cereals, milk and milk products; eggs; pulses and legumes; sugar and honey; fruits; meat and offal; fish and sea food; vegetables; roots and tubers; and oils and fats). A well-balanced diet scores between eight and eleven (FAO and WHO 2002; Swindale and Ohri-Vachaspati 2005). A dietary score between one and three was classified as unbalanced and a score between four and seven was classified as moderately balanced. Research is ongoing and there is currently no international consensus on which food groups to include in the scores at the individual or household level for different age or sex groups (FAO 2011). However, the rationale for these guidelines is to provide

[1] The 48-h recall approach that was taken is a modification of the more commonly used 24-h recall approach. The 48-h period has been used in other food consumption studies (eg Hirvonen et al. 2006; Kaschula 2008; McNaughton et al. 2005; Pietinen et al. 2008). The study of British adults by McNaughton et al. (2005) found that data from 48-h recall period were more consistent than those from a 24-h recall period. McNaughton et al. (2005) concluded that the 48-h recall period was an appropriate compromise between the more variable 24-h recall period and a week-long diet diary. .

a standardized format of universal applicability from which various dietary diversity scores can be calculated (FAO 2011). As such they are not culture, population, or location specific and therefore need to be adapted to suit the local context (FAO 2011). HDDS and IDDS were used so as to capture all food intake by individuals. In the study context, people sometimes eat food outside the household. For example, between lunch and the evening meal a member of the household may visit a friend or relative and have tea with bread or a fruit. When the HDDS is used, the food items consumed outside the household are omitted thus giving biased results of dietary diversity.

Actual observations on food preparation were done quarterly for all sample households. Meal observation was used to estimate the approximate amounts of food prepared so that total energy intake per individual can be derived. During the dietary recalls, meal observations were used to give the researchers an appreciation of the amounts of food consumed by individuals. Data was collected in August 2011 (late dry season), November 2011 (early wet season), February 2012 (late wet season) and May 2012 (early dry season). Two meals were sampled per household per quarter, for a total of 1240 meals. Weighing of the raw ingredients per meal prior to cooking was done using a digital scale and measuring cylinder (volume) to get the actual amounts of food consumed by the household. Snack items that were consumed by individuals within and out of the household were also recorded, including products harvested from the wild such as fruits and bush meat. Usually individuals from the same household ate a relatively similar diet and there were negligible differences in dietary composition between household members. The only food variations were observed for foods in the same food group such as a choice of cereal, e.g. where a person ate rice instead of samp (coarse crushed maize), or wild green leafy vegetables instead of cultivated spinach. A meal was defined as any regular occasion when any form of food is served and eaten together by most members of the household. A household was defined as "one person who lives alone or a group of persons, related or unrelated, who live together and share food or make common provisions for food and possibly other essentials for living" (Cogill 2001).

Data analysis

Data analysis focused on food consumption in terms of dietary diversity and source, and observed gap in individual's calorie consumption (calorie gap or G_i) in relation to HIV/AIDS status of the household. Prior to undertaking the multivariate estimation procedures, a bivariate analysis based on Chi-square tests was used to test for potential differences between afflicted and non-afflicted households and between the two study sites with respect to dietary diversity, food source, and individual's calorie consumption.

Multivariate analysis

Dietary diversity

IDDS for the first meal, which ranges from 1 to 11 food groups, was used as the dependent variable in the dietary diversity model. Due to the discrete non-negative integer nature of the dependent variables, a count modelling framework was adopted. Two types of count models are frequently used in the literature: Poisson and Negative Binomial (NB). A limitation of the Poisson model is the assumption that the mean is equal to the variance (Greene 2008). The NB model allows for over-dispersion, where the variance of the dependent variable exceeds its mean, and under-dispersion, where the variance of the dependent variable is less than the mean. Therefore, NB was chosen over Poisson. The NB model for IDDS is specified as follows.

$$E[T_i|X_i,\varepsilon_i] \quad = \exp(\alpha + \mathrm{X_i}\beta + \varepsilon_i) = v_i\mu_i \tag{1}$$

where T_i denotes the IDDS of an individual i. X is a vector of explanatory variable given earlier and βs denote parameters to be estimated. The value of v_i is equal to exp.(ε_i), which is gamma distributed with mean 1 and variance 1/θ (Greene 2008). The gamma distribution has a scale parameter θ (where θ > 0). μ_i is the Poisson distribution expectation for the conditional mean, which can vary by the unobserved heterogeneity v_i. Accordingly, the expected value of T can be written as:

$$E[T_i|X_i] = \mu_i \tag{2}$$

and

$$Var\left[T_i|X_i\right] = \mu_i[1 + (1/\theta)\mu_i] = \mu_i[1 + k\mu_i]\,\mathrm{where}\kappa = \mathrm{Var}[v_i] \tag{3}$$

Alternatively, a log-linear regression model which serves as a baseline was also estimated in analysing the factors affecting individual's dietary diversity. The dependent variable for this model was specified as the log value of the average IDDS between the two meals. Based on previous theoretical and empirical literature (e.g. Kyereme and Thorbecke 1991; Case and Deaton 1996; Aromolaran 2004; Nord et al. 2010), five types of explanatory variables were included: individual specific variables, households' socio-demographic variables, households' capital

Table 2 Description and descriptive statistics of variables ($N = 1929$)

Variable	Description	Mean	Std Dev
Dependent variables			
Calorie gap	The difference between the FAO/WHO recommended daily calorie intake for an individual and his or her actual/observed daily calorie intake (Kcal)	390.7	435.5
Calorie intake	An individual's actual/observed daily calorie intake (Kcal)	1837.2	353.3
IDDS	Individual Dietary Diversity Score	4.9	1.02
Individual specific variables			
Gender	1 = Female, 0 = otherwise	59.0 %	NA
Age	Age of the respondent (years)	29.2	24.1
Below Primary	1 = Below primary level, 0 = otherwise (Base category)	11.9 %	NA
Primary education	1 = Primary level, 0 = otherwise	15.9 %	NA
Secondary education	1 = Secondary level, 0 = otherwise	39.4 %	NA
Metric education	1 = Metric, 0 = otherwise	18.4 %	NA
Tertiary education	1 = Tertiary, 0 = otherwise	14.5 %	NA
Socio-demographic variables			
HIV status	1 = Afflicted, 0 = otherwise	47.6 %	NA
No of Children below 5	Number of male children aged below 5 years	0.8	1.0
No of Male children 5–9	Number of male children aged 5–9 years	0.4	0.6
No of Female children 5–9	Number of female children aged 5–9 years	0.5	0.7
No of Male children 10–18	Number of male children aged 10–18 years per adults	1.0	1.3
No of Female Children 10–18	Number of female children aged 10–18 years per adults	0.8	0.9
No of Male adults	Number of men aged above 19 years	1.6	1.1
No of Female adults	Number of women aged above 19 years	2.2	1.3
Gender of the head	1 = Male, 0 = otherwise	47.8 %	NA
Education of the head	Years of education of the head	5.3	4.2
Cash income	Cash income per capita during the season (South African rand)	1085.1	900.0
Capital stock variables			
Physical asset	Indicator for physical capital generated by principal component analysis	0.2	1.1
Plot size per capita	Size of the garden plot (acres) per capita	0.1	0.2
Cattle per capita	Number of cattle per capita	0.3	0.6
Goat per capita	Number of goats and sheep per capita	0.4	1.1
Location			
Site	1 = Lessyton, 0 = Willowvale	48.6 %	NA
Seasonality			
Season 1	1 = late dry, 0 = otherwise	15.6 %	NA
Season 2	1 = early wet, 0 = otherwise	27.4 %	NA
Season 3	1 = late wet, 0 = otherwise	31.0 %	NA
Season 4	1 = early dry, 0 = otherwise (Base category)	26.0 %	NA

stock variables, seasonality and location. The sample size of the models consisted of 1929 individual observations in 146 households. Data were collected for a total of 155 households, 68 HIV / AIDS afflicted and 87 non-afflicted. There was a total of 694 individuals in those 155 households. Nine of those households were excluded from the multi-variate analysis due to problems of missing data. Consumption data were collected for individuals actually present at the time of the enumerator visit each quarter, which resulted in variable numbers of individuals interviewed each quarter. Individual-level data were collected for the following numbers of individuals: 301 for quarter 1, 529 for quarter 2, 597 for quarter 3, and 502 for quarter 4. Table 2 shows the descriptions and descriptive statistics of the variables used in model estimation.

Calorie gap

An individual's calorie gap is measured as the difference between the FAO/WHO recommended daily calorie intake for an individual of a particular age and sex, and his or her observed daily calorie intake.[2] The FAO/WHO recommended daily calorie intake (i.e. food reference database in this study) measures account for the gender and age differences in individuals' energy requirements (Appendix Table 7). A positive calorie gap indicates that an individual is calorie poor, and a negative gap means an individual is calorie rich (Kyereme and Thorbecke 1991). Individuals' calorie gaps were used as the dependent variable in the multi-level model. The hierarchical nature of the data allows a two level model. The level 1 represents 1929 individual responses that are nested within 146 households at level 2. The multilevel modeling approach econometrically accounts for the potential presence of household-level unobserved heterogeneity by allowing for residual components at each household level. The model is specified as follows.

$$G_{iht} = \delta_0 + \beta X_{iht} + u_h + \varepsilon_{iht}, \qquad i = 1, ..., I \leq 597 \ ; \ \mathrm{h} = 1, ..., \mathrm{H} \leq 146 \ ; t = 1, ..., T \leq 4, \tag{4}$$

where G_{iht} denotes the calorie gap of the individual i living in the household h, at time period t. δ_0 is the non-random intercept at the individual level, and u_h is the household level random intercept. X indicates a vector of explanatory variable given earlier, β denotes a vector of the parameters to be estimated, and ε is a vector of error terms of the model. For comparison purposes, a second model was also estimated by specifying an individual's daily calorie intake as the dependent variable. The same set of explanatory variables used in the dietary diversity models were used in the calorie gap models.

Results

Bivariate analysis

Dietary diversity and source

Breakfast was usually tea with home-made bread but there was variation in the composition of meals served for lunch and supper, usually one of (1) samp and beans, (2) *umphokoqo* (crumbed maize meal porridge) and *amasi* (sour milk), (3) stiff maize meal porridge and cabbage or spinach, or (4) rice, tomato and onion soup and potatoes. These meals were sometimes served with meat, typically one of chicken, mutton, tinned pilchards or offal. Cereals made the highest contribution to individual and household caloric intake in both Lesseyton and Willowvale (Fig. 2). The bulk of food consumed by households was purchased, especially at Lesseyton, and the only foods collected from the wild in measureable quantities were fruits and vegetables.

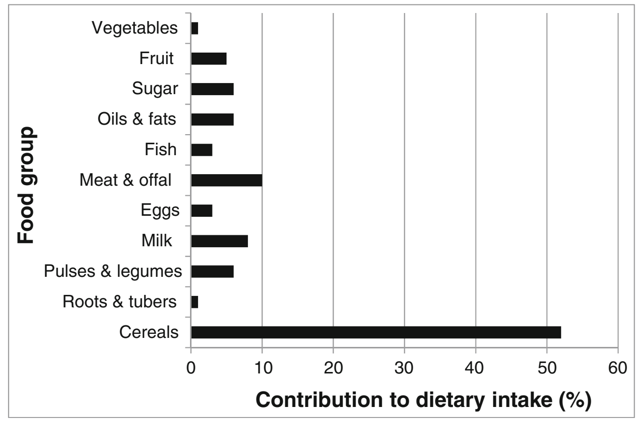

Fig. 2 Contribution of various food groups to respondents' diets at Lesseyton and Willowvale (combined)

More than 80 % of respondent households from the two study sites had moderately balanced diets with IDDS and HDDS between 4 and 7. There were no significant differences in IDDS between respondents from afflicted and non-afflicted households in Lesseyton (χ^2 = 1.3; df = 6; p = 0.97) or Willowvale (χ^2 = 8.5; df = 6; p = 0.21). However, there was a higher proportion of non-afflicted households with HDDS between 4 and 7 in Lesseyton (χ^2 = 24.7; df = 6; p < 0.001) than in Willowvale (χ^2 = 45.25; df = 6; p < 0.001). Generally, there were no significant IDDS (χ^2 = 2.5; df = 2; p = 0.28) and HDDS (χ^2 = 1.4; df = 2; p = 0.51) differences between the two sites.

Leafy vegetables were sourced via purchase, home production or wild collection, with marked differences between affliction status and site (Table 3). At both sites, afflicted households obtained a higher proportion through wild gathering than did non-afflicted households, whilst the opposite applied with respect to home production, i.e. home production was significantly higher for non-afflicted households. This suggests that wild collection substituted for home production in afflicted households.

At the drier, more peri-urban site (Lesseyton), there was relatively little wild collection or home production, whereas at the coastal site of Willowvale, approximately 60 % of vegetables were procured by these two means. A greater proportion of households in Willowvale ate wild leafy vegetables than in Lesseyton (χ^2 = 89.2; df = 1; p < 0.001).

[2] We do not have data on weight of the individuals or activity levels. Accordingly, FAO/WHO recommended daily calorie intake were not accounted for in the individuals' actual weights and activity levels in this study.

Table 3 Proportion of vegetables procured from different sources

	Lesseyton		Willowvale	
Source	Afflicted (%; *n* = 28)	Non-Afflicted (%; n = 44)	Afflicted (%; n = 40)	Non-Afflicted (%; n = 43)
Purchased	94	83	39	40
Production	-	13	15	28
Wild gathered	6	4	46	32
	χ^2 = 15.458; df = 2; p < 0.001		χ^2 = 12.816; df = 2; p = 0.002	

The aridity and strong seasonality of rainfall in Lesseyton meant that wild vegetables were only available in the mid to late wet season, and during that period were consumed by 14 % of afflicted households and 7 % of non-afflicted households (χ^2 = 7.5; df = 1; p < 0.01). In Willowvale, wild leafy vegetables were consumed all year by 75 % of afflicted households and 53 % of non-afflicted households (χ^2 = 19.4; df = 1; p < 0.001). Generally, the amounts consumed were lower in Lesseyton, averaging 60–70 g per person per day compared to 80–90 g in Willowvale (t = 14.1; df = 2086; p < 0.001). Mean daily intake varied between seasons at both sites but with no clear patterns between sites or household affliction status.

At Lesseyton fruits were procured via purchase (bananas, oranges and apples), wild collection (prickly pear) and harvest of home grown fruits (peaches). In Willowvale, all fruit was reported to be from home grown trees (peaches, guavas), with no purchases or collection from the wild. At Lesseyton, the percentages of consumption of wild, purchased and grown fruit was significantly different between afflicted and non-afflicted households (χ^2 = 30.0; df = 2; p < 0.001). In afflicted households the fruit basket was 63 % wild collected, 35 % grown (peaches) and 2 % purchased, while in non-afflicted households it was 41 % wild collected, 35 % grown and 22 % purchased. For fruit at Lesseyton, therefore, afflicted households substituted wild collection for purchase.

A pooled analysis between the two sites regardless of household affliction status and season showed that Willowvale respondents consumed an average of approximately 230 g of fruit per day which was more than the 130 g consumed by respondents in Lesseyton, despite the fact that household members did not consume any fruit during the late dry or early wet seasons. In Lesseyton, wild and home

Table 4 Mean (± SD) caloric intake for HIV / AIDS afflicted and non-afflicted households in Lesseyton and Willowvale (values in bold reflect significant differences between afflicted and non-afflicted households; M = male and F = female)

	Lesseyton			Willowvale			Between sites p-value
	Afflicted Mean Kcal	Non-Afflicted Mean Kcal	*p*-value	Afflicted Mean Kcal	Non-Afflicted Mean Kcal	p-value	
2-3 yrs. M,F	1189.9 ± 26.7	1197.9 ± 41.2	0.211	1165.2 ± 27.1	1306.9 ± 29.7	0.037	0.003
4-8 yrs. M	1603.4 ± 25.9	1632.4 ± 34.1	0.724	1467.9 ± 29.9	1476.9 ± 22.1	0.886	0.021
4-8 yrs. F	1442.1 ± 35.4	1529.7 ± 23.5	0.038	1441.5 ± 30.6	1484.0 ± 34.7	0.729	0.472
9-13 yrs. M	1723.1 ± 45.3	1968.6 ± 31.1	0.015	1852.4 ± 70.6	1857.5 ± 38.5	0.851	0.292
9-13 yrs. F	1748.1 ± 31.4	1797.5 ± 34.8	0.530	1692.2 ± 36.2	1688.4 ± 23.3	0.682	0.009
14-18 yrs. M	1954.6 ± 66.1	2295.2 ± 71.5	<0.001	1727.1 ± 59.1	2160.3 ± 67.0	<0.001	0.843
14-18 yrs. F	1722.8 ± 43.6	2020.4 ± 37.9	<0.001	1745.4 ± 80.4	1920.4 ± 59.8	<0.001	<0.001
19-30 yrs. M	1921.2 ± 52.4	2289.5 ± 45.0	<0.001	2153.7 ± 80.5	2315.0 ± 50.0	<0.001	0.023
19-30 yrs. F	2114.1 ± 33.5	2126.0 ± 30.8	0.519	2073.6 ± 39.9	2017.2 ± 33.5	0.334	0.092
31-50 yrs. M	2188.3 ± 76.4	2352.1 ± 39.8	0.034	2179.0 ± 74.3	2210.6 ± 62.3	0.853	0.023
31-50 yrs. F	2036.5 ± 33.4	2051.3 ± 27.9	0.557	1884.3 ± 39.0	1869.9 ± 30.4	0.659	<0.001
51+ yrs. M	2060.0 ± 38.3	2117.8 ± 40.9	0.548	1960.7 ± 32.6	2070.1 ± 37.0	0.048	0.340
51+ yrs. F	1989.7 ± 24.2	1968.1 ± 29.9	0.488	1685.8 ± 19.4	1760.1 ± 20.1	0.044	<0.001
Overall	1828.8 ± 13.1	1960.6 ± 13.1	<0.001	1753.7 ± 11.3	1800.7 ± 10.3	0.002	<0.001

grown fruits were consumed during the late wet season whilst purchased fruit were consumed throughout the study period.

Individual's calorie consumption

Table 4 presents results on average individual-level caloric intake for people in 52 cohorts of survey respondents: 13 age-sex cohorts for afflicted / non-afflicted in Lesseyton / Willowvale. The results show consistently lower calorie intake for individuals living in afflicted compared to non-afflicted households. Of the 26 comparisons across the two communities, only one showed higher average intake in Lesseyton and only four show higher average intake in Willowvale. About half of the differences are statistically significant as measured by the chi-squared test at the 5 % level of significance. The results also show lower average caloric intake at Willowvale than Lesseyton, most of which are statistically significant at the 5 % level of significance.

Multivariate analysis

Dietary diversity

Signs of the estimated coefficients are consistent between the NB and linear regression models. In both cases, the results can be interpreted in terms of the marginal effects of changes in the explanatory variables. Since the coefficient of the NB model cannot be interpreted directly, "factor" values were calculated and are reported in Table 5. A factor [*exp(coefficient)*] shows the change in expected IDDS by a unit change in the corresponding predictor.[3] All else held constant, individuals living in HIV afflicted households had lower IDDS relative to non-afflicted households. Specifically, according to the NB model results, individuals in afflicted households have about 4 % (or factor of 0.96) lower dietary diversity score than non-afflicted households. This result suggests that individuals in afflicted households have lower diet quality than their counterparts. Age of the individual showed a non-linear relationship with the IDDS. IDDS decreases with individual's age initially and then increases before decreasing again at older ages. Individuals in male-headed households show higher dietary diversity scores than individuals in female-headed households. This result may imply that individuals in male-headed households and male-heads have relatively more purchasing power and access to natural resources such as land, forests and grazing lands. The number of children aged below five years had a positive impact on IDDS. In addition, the results of the linear regression model also showed that the number of male and female children aged between 5 and 9 years had a positive impact on individual's dietary diversity score. These results might suggest household food providers seek out more diverse diets when their households include young children, or that children are important in collecting wild foods or providing some labour for own cultivation. There were location and seasonal variations in individuals' dietary diversity scores. The multivariate analysis showed that individuals living in Lesseyton have higher dietary diversity than individuals living in Willowvale. The other factors that affected individual's dietary diversity positively were household's cash income, physical capital, and number of cattle owned.

Individual's calorie gap

Table 6 shows the parameter estimates of the calorie gap (G_i) and calorie intake models estimated based on the multi-level (hierarchical) linear framework. These two models generate similar results. For a given variable, a negative (positive) coefficient in the calorie gap model will usually be accompanied by a positive (negative) coefficient in the calorie intake model. However, when comparing the estimates of the two models, it is important to note that the calorie gap accounts for the gender and age of the individuals and calorie intake is the gross value of individual's calorie intake (i.e. not accounting for age or gender). Accordingly, for gender and age variables, it is possible to have coefficients with the same signs in the two models. For example, a higher calorie intake by females relative to males does not necessarily indicate a calorie surplus among females. The random intercepts specified at household level have statistically significant variances in both models, indicating that, due to unobserved heterogeneity, G_i an individual's daily calorie intake can vary across households. This result also justifies the use of the multi-level modelling approach. Due to space limitations, only the results of the calorie gap model are discussed below. Overall, 78 % and 22 % of individuals had a positive or negative calorie gap, respectively, in afflicted households. Corresponding figures for unaffected households were 83 % and 17 %. There were no households with a neutral (or zero) gap.

As mentioned earlier, a negative coefficient indicates a calorie surplus and a positive coefficient indicates a calorie deficit. Everything else equal, the calorie gap is about 75 kcal (kcal) higher among individuals in afflicted households than in non-afflicted households. The G_i of a male respondent is about 290 kcal more than the G_i of a female respondent, while individuals living in Lesseyton have about 147 kcal higher G_i than individuals living in Willowvale. Similar to its effects on dietary diversity, age shows a non-linear relationship with G_i. Calculation of turning points shows the relationship between age and G_i is positive up to about 30 years, negative between

[3] The % change can be calculated by using the formula, Pj = 100 [exp(cj) − 1] where cj is the estimated coefficient for a given variable. This formula can apply to both NB and linear regression models.

Table 5 Parameter estimates of the individual dietary diversity model

Variable	NB Model Coefficient	NB Model P-Value	NB Model Factor	Linear Regression model Coefficient	Linear Regression model P-Value
Gender (female = 1)	0.013 (0.011)	0.247	1.013	0.061(0.047)	0.198
Age	-0.007 (0.003)**	0.040	0.993	-0.022 (0.014)	0.102
Age-squared	0.000 (0.000) **	0.050	1.000	0.000 (0.000)	0.141
Age-cubic	0.000 (0.000) ***	0.050	1.000	0.000 (0.000)	0.160
Primary education	-0.020 (0.028)	0.469	0.980	-0.131(0.119)	0.273
Secondary education	0.010 (0.020)	0.611	1.010	-0.021(0.085)	0.801
Metric education	0.018 (0.024)	0.470	1.018	-0.006 (0.102)	0.956
Tertiary education	0.057 (0.027)	0.034	1.058	0.144 (0.112)	0.201
HIV status	-0.045(0.013) ***	0.000	0.956	-0.191(0.052) ***	0.000
No of Children below 5	0.021 (0.006) ***	0.000	1.021	0.069 (0.026) **	0.010
No of Children 5–9 male	0.015 (0.009)*	0.093	1.015	0.142 (0.039)***	0.000
No of Children 5–9 female	0.013 (0.008)	0.108	1.013	0.077 (0.033) **	0.020
No of Children 10–18 male	-0.002 (0.005)	0.730	0.998	0.010 (0.022)	0.670
No of Children 10–18 female	-0.004 (0.006)	0.520	0.996	0.016 (0.023)	0.476
No of Male adults	-0.006 (0.005)	0.254	0.994	0.004 (0.021)	0.842
No of Female adults	-0.008 (0.005) *	0.099	0.992	-0.028 (0.021)	0.168
Gender of the head (male = 1)	0.043 (0.012) ***	0.000	1.043	0.237 (0.050) ***	0.000
Education of the head	-0.001(0.001)	0.446	0.999	-0.004 (0.006)	0.541
Cash income	0.000 (0.000)***	0.000	1.000	0.000 (0.000) ***	0.000
Cash Income squared	0.000 (0.000)***	0.000	1.000	0.000 (0.000) ***	0.000
Physical asset	0.077 (0.010)***	0.000	1.080	0.391 (0.040)***	0.000
Plot size per capita	-0.019 (0.034)	0.583	0.981	-0.001 (0.135)	0.991
Cattle per capita	0.018 (0.011)*	0.090	1.019	0.145 (0.043)***	0.001
Goat per capita	-0.001(0.006)	0.863	0.999	-0.014 (0.025)	0.559
Site (1 = Lessyton)	0.058 (0.022)	0.010	1.060	0.327 (0.090)***	0.000
Season 1	-0.065 (0.019)***	0.001	0.937	-0.381(0.074)***	0.000
Season 2	-0.124 (0.013)***	0.000	0.884	-0.416 (0.056)***	0.000
Season 3	-0.049 (0.013)***	0.000	0.952	-0.146 (0.059)**	0.014
Intercept	1.591(0.042)***	0.000	NA	4.619 (0.182)***	0.000
R-squared	*0.18*			NA	
Sample size	*1929*			1929	

Standard errors are reported in parentheses. Significance levels: * for significance at the 10 % level, ** for significance at the 5 % level and ***for significance at the 1 % level

ages 30 and 85, and positive thereafter. Education of the individual has negative impacts of G_i. Specifically, relative to the individuals with below primary education, individuals with primary, secondary and tertiary education have 235 kcal, 71 kcal, and 108 kcal less G_i, respectively. This result indicates that education can be used as a policy tool to reduce food poverty. Individuals in male-headed households have 80 kcal lower G_i than those in female-headed households. Among the household composition variables, only the number of female children aged between 10 and 18 years had a significant effect on G_i. In addition, the results also indicate that G_i varies across the seasons.

Discussion

Impacts of HIV/AIDS on food security

Sub-Saharan Africa is characterised by a large proportion of poor households with high levels of malnutrition (FAO 2008; Faber et al. 2010; Uusiku et al. 2010). Most households depend on diets that are cereal-dominated and nutrient deficient with limited animal products, fruits and vegetables (Oniang'o et al. 2003; Faber et al. 2010; Msaki and Hendriks 2014). In this study, cereals comprised 52 % of the energy of individual and household diets in both Willowvale and Lesseyton, echoing other work in rural South Africa (Kaschula 2008; Msaki and Hendriks 2014).

The proportion of non-afflicted households with moderately and well balanced diets was higher than that of afflicted households at both sites even though mean IDDS showed no significant differences in the bivariate analysis. However, the multivariate analysis revealed that, everything else equal, IDDS is significantly lower among individuals in afflicted households. This may be a consequence of the ability of non-afflicted households to spend more money on food items such as eggs and meat and the consumption of an additional food item increases the IDDS and HDDS thus improving dietary quality. On the other hand, the differences in the results obtained from HDDS and IDDS could be a weakness in the methodologies (Kirkland et al. 2013). At the household level, results from HDDS may lead one to conclude that non-

Table 6 Parameter estimates of the food security model

	Calorie gap model		Calorie intake model	
Variable	Coefficient	*P*-value	Coefficient	P-value
Gender (female = 1)	-291.71(20.14)***	0.000	-159.57 (15.13)***	0.000
Age	73.31 (7.51)***	0.000	62.51 (5.26)***	0.000
Age-squared	-1.67 (0.20)***	0.000	-1.37 (0.13)***	0.000
Age-cubic	0.01 (0.00)***	0.000	0.01 (0.00)***	0.000
Primary education	-235.42 (54.05)***	0.000	-32.27 (56.73)	0.569
Secondary education	-71.64 (34.95)**	0.040	62.23 (40.41)	0.124
Metric education	-4.84 (46.40)	0.917	71.30 (35.78)**	0.046
Tertiary education	-108.27 (48.58)**	0.026	75.50 (37.56)**	0.044
HIV status	75.12 (37.16)**	0.043	-59.00(27.80)**	0.034
No of Children below 5	7.39 (18.94)	0.697	-8.42 (13.72)	0.540
No of Children 5–9 male	-32.35 (26.07)	0.215	-2.08 (21.82)	0.924
No of Children 5–9 female	5.26 (26.68)	0.844	-13.46 (20.22)	0.506
No of Children 10–18 male	5.11 (14.14)	0.718	16.99 (11.40)	0.136
No of Children 10–18 female	39.15 (18.63)**	0.036	-5.85 (14.24)	0.681
No of Male adults	22.56 (16.83)	0.180	4.30 (12.60)	0.733
No of Female adults	-7.85 (15.42)	0.611	-4.67 (12.70)	0.713
Gender of the head (male = 1)	-80.33 (31.29)**	0.010	39.53 (26.14)	0.131
Education of the head	1.10 (4.24)	0.795	-3.91 (3.42)	0.253
Cash income	-0.03 (0.03)	0.400	0.04 (0.02)	0.115
Cash Income squared	0.00 (0.00)	0.719	0.00 (0.00)	0.210
Physical asset	14.46 (32.40)	0.655	16.23 (24.97)	0.516
Plot size per capita	14.83 (62.91)	0.814	-22.59 (43.35)	0.602
Cattle per capita	-12.44 (27.21)	0.648	26.28 (16.34)	0.108
Goat per capita	10.58 (12.86)	0.411	-17.38 (9.93)*	0.080
Site (1 = Lessyton)	146.85 (69.92)**	0.036	-81.31(53.63)	0.129
Season 1	2.02 (27.39)	0.941	4.60 (26.24)	0.861
Season 2	59.40 (18.02)***	0.001	-61.98 (17.46)***	0.000
Season 3	99.55 (16.21)***	0.000	-95.52 (16.23)***	0.000
Intercept	-103.45 (99.34)	0.298	1365.22 (95.15)***	0.000
σ^2_{uh}	21,706.76 (4100.40)***		13,370.61(2629.68)***	
Residual deviance	65,240.55 (5000.55)***		38,327.78 (3440.28)***	
Log-likelihood	-13,542.984		-13,032.594	
Sample size	1929		1929	

Standard errors are reported in parentheses. Significance levels: * for significance at the 10 % level, ** for significance at the 5 % level and ***for significance at the 1 % level

afflicted households are more food secure than afflicted households which may not necessarily be the case. At the individual level, IDDS results may show that respondents from both afflicted and non-afflicted households are either food secure or food insecure because it disaggregates food consumption patterns from the household level and narrows down to particular individuals who have different dietary needs and preferences, thus giving a more detailed result than the HDDS.

Afflicted households obtained a higher proportion of their vegetables and fruits (Lessyton only) through wild gathering than did non-afflicted households. HIV/AIDS afflicted households are likely to have fewer economically active members and more dependents, and sometimes productive time is spent caring for the ill thus reducing the ability of a household to earn income or cultivate gardens or fields (Batchmann and Booysen 2004; Gillespie and Kadiyala 2005). Decreased cash and subsistence income can increase households' and individuals' dependence on wild foods. This shows the safety net aspect of wild foods (Shackleton and Shackleton 2004) as their consumption is an important food security coping strategy.

Individuals living in afflicted households show a higher calorie gap than those living in non-afflicted households. HIV/AIDS afflicted households are likely to have less income due to decreased labour supply and increased expenses, and thus have lower ability to purchase or produce foods. However, the difference in calorie gap is relatively small. Specifically, it is about 4 % of the average daily calorie intake of an individual (1837 kcal), albeit it will be marginally higher than this because of the higher maintenance energy demands of HIV/AIDS patients (Kulstad and Schoeller 2007), which is not reflected in the reference tables. A higher consumption of wild foods may have helped afflicted households to reduce a potentially larger calorie gap. Despite its small size, the difference in calorie gap indicates the importance of food security and poverty policies and interventions that target support to HIV/AIDS afflicted households. On the other hand, the higher calorie gap among afflicted households may indicate an underlying reverse causality between food insecurity and HIV/AIDS affliction. Women in particular may engage in unsafe sex work to gain access to food-related resources. For example, Dunkle et al. (2004) found that in South Africa women who reported hunger were more likely to engage in transactional sex. However, the use of cross-sectional data in this paper precludes any possibility of differentiating causes and effects in the relationship between HIV/AIDS and food security.

Contextual differences

Households and individuals in Lesseyton showed a higher dietary diversity than those in Willowvale, although diets at both sites were moderately balanced. In other words, the advantages that Lesseyton has due to greater access to food markets, urban services and higher incomes more than offset the disadvantages of poorer conditions for agricultural production and wild food gathering. A number of reasons underlay this difference. Firstly, many in rural communities cannot afford purchased food from nearby towns due to long distances to markets, high and unaffordable transport costs and high levels of poverty (McGarry and Shackleton 2009b). Secondly, the absence of electricity in Willowvale makes it unviable for households to purchase perishables such as meat which would increase their dietary diversity. Thirdly, villages in Willowvale are serviced by a gravel road that is graded regularly but degrades easily because of rain and the high volume of traffic that uses it. The cost of transport for a return trip to the nearest town is R60 (R30 × 2) per person and extra fees are charged for every piece of luggage. In Lesseyton a return trip to the nearest town costs R20 (R10 × 2) and there is no charge for luggage. The fourth reason is that the cost of certain food items differs between the two sites, which potentially affects what households consume. For example, a cabbage cost R5 in Lesseyton and R10 in Willowvale as at 10 May 2012. This means that for the same amount of money, a household in Lesseyton could buy twice as many cabbages or cabbages plus other food items. Willowvale residents have compensated to some extent by growing a greater proportion of their own foods, but cultivation effort is directed to staple crops (Fay 2013), largely maize and several vegetables. A wide range of vegetables does not increase the IDDS or HDDS because they are considered to be close substitutes.

Consumption of wild foods

The consumption of wild leafy vegetables is common throughout rural and some urban parts of South Africa (Shackleton 2003). However, there are marked differences at regional and local levels, driven by numerous factors such as dietary preferences, culture, urbanisation, agro-ecological context, poverty, proximity to markets and time of year (Shackleton et al. 1998; Jansen van Rensburg et al. 2007; Uusiku et al. 2010). In this study, more than 50 % of households in the more remote site (Willowvale) and 20 % of households in the more peri-urban site (Lesseyton) consumed wild leafy vegetables during the study period. Shackleton et al. (2007) found that more than 90 % of households made use of wild leafy vegetables in Ntubeni and Cwebe villages, which are located just north of Willowvale. The difference in wild vegetable use between Willowvale and Lesseyton could be due to a number of reasons which include the different climatic conditions of the two study sites, site-specific factors, or proximity to markets. The average rainfall for Willowvale is approximately 1000 mm per annum with some rain expected every month of the year, whereas in Lesseyton it is approximately 400 mm per annum and concentrated between October and March. This climatic difference probably means there are fewer species at Lesseyton and that availability is restricted to the peak rainy season. At Lesseyton households consumed only one species of wild leafy vegetable (*Amaranthus lividus*) (in the late rainy season) while those in Willowvale consumed twelve different species and during all seasons. The characteristics of *Amaranthus lividus*, such as drought tolerance (Jansen van Rensburg et al. 2007), allow it to persist in Lesseyton.

The second contributory factor may be the high costs of transport and vegetables in Willowvale which thereby limit the opportunity to access more purchased vegetables if they were desired. This is in line with the South African context as shown by Vorster et al. (2007) that, in areas where the cost of transport to formal markets is high, households tended to increase heavily their dependence on wild leafy vegetables rather than conventional vegetables to meet their dietary needs.

In Willowvale, wild vegetables were the most common source of vegetables for afflicted households. Similarly, Kaschula (2008) found that wild leafy vegetables were the most consumed wild food by afflicted households. McGarry and Shackleton (2009a) also showed higher reliance on wild foods, in that case bushmeat, by afflicted households relative to non-afflicted ones. Similarly, Challe and Price (2009) in Tanzania found that individuals from HIV/AIDS afflicted households gathered wild edible orchids more frequently than those from non-afflicted households. Many species of wild leafy vegetables can grow on nutrient-deficient soils, do not need a lot of resources and inputs for production and are available for consumption when conventional vegetables such as spinach and cabbage may be limited (Dweba and Mearns 2011).

The findings pertaining to use of wild fruits echo those for use of wild vegetables. Overall, fruit consumption was much higher at Willowvale than Lesseyton, but this was all from home grown fruits. There was no wild collection. Households at Lesseyton did consume wild collected fruit, all from one species, i.e. prickly pear (*Opuntia ficus-indica*). Afflicted households procured a greater proportion of their fruit consumption from the wild than did non-afflicted households, reinforcing the findings for wild leafy vegetables. The lower contribution of purchased fruit for afflicted households could be due to lower household income as previously argued. The absence of wild fruits from the diet in Willowvale is anomalous in light of previous work in the region and nationally. Shackleton and Shackleton (2004) summarised data for 14 different villages across three provinces in South Africa and found that 88 % of households used wild fruits to some degree (the range across the studies was 48–100 % of households). Indeed, slightly north of Willowvale, Shackleton et al. (2007) reported that just under half (44 %) of households used wild fruits and consumed them about six times per week in summer and three times per week in winter. Because smaller wild fruits are typically eaten as snacks when walking through forests, they would not be detected in the household meals, but should have been evident in the 48-h recall data. Perhaps the amounts consumed were so small that they were deemed to be irrelevant by the respondents even though we did emphasize the need to record all food items during meals and in between meals.

Conclusion

It can be concluded that the bulk of food consumed by HIV / AIDS afflicted and non-afflicted households was purchased, and provided the basis for reasonable food security in terms of calorie intake and dietary diversity. However, afflicted households had significantly lower calorie consumption, presumably due to having less labour time available to grow food and/or incomes to purchase food. The findings also indicate a significant contribution from wild leafy vegetables and to a lesser extent, wild fruits, to dietary diversity and to cash savings that could be used for other necessary purchases. Disaggregating the results showed that food security and diversity varied markedly between sites, between households with different HIV/AIDS status, and within households in terms of adolescent males. Wild foods also clearly provided a safety net to some extent with higher consumption in the more rural and biodiverse areas and and amongst HIV/AIDS afflicted households. These results indicate that public agencies need to consider wild foods as components of an overall approach to reducing vulnerability due to HIV/AIDS. Agencies concerned with land use, agriculture and nutrition should promote the values of wild foods so as to maintain their availability and acceptability during times of need.

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Appendix

Table 7 Recommended daily caloric intake by age and sex

Age (years)	Female energy requirements (Kcal / day)	Female physical activity index	Male energy requirements (Kcal / day)	Male physical activity index
1 to 2	865	1.42	948	1.43
2 to 3	1047	1.42	1129	1.45
3 to 4	1156	1.44	1252	1.44
4 to 5	1241	1.49	1360	1.49
5 to 6	1330	1.53	1467	1.53
6 to 7	1428	1.56	1573	1.57
7 to 8	1554	1.60	1692	1.60
8 to 9	1698	1.63	1830	1.63
9 to 10	1854	1.66	1978	1.66
10 to 11	2006	1.71	2150	1.71
11 to 12	2149	1.74	2341	1.75
12 to 13	2276	1.76	2548	1.79
13 to 14	2379	1.76	2770	1.83
14 to 15	2449	1.75	2990	1.84
15 to 16	2591	1.73	3178	1.84
16 to 17	2503	1.73	3322	1.84
17 to 18	2503	1.72	3410	1.86
18 to 30	2400	1.79	3300	1.75
30 to 40	2350	1.83	2950	1.78
40 to 50	2350	1.89	2950	1.84
50 to 60	2350	1.75	2700	1.60
60 to 70	2100	1.69	2250	1.61
70 to 80	1950	1.55	2250	1.62
80 to 90	1600	1.21	2050	1.17
> 90	1600	1.17	2050	1.38

Source: Based on FAO / WHO (2008) and Institute of Medicine (2005)

Note: Physical activity index for children based on FAO / WHO (2008) Table 4.2 for boys and Table 4.3 for girls. Physical activity indices and weights for adult men and adult women based on mean activity levels for non-overweight men and women observed in the United States as reported by Institute of Medicine (2005)

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