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Ecology of Food and Nutrition

ISSN: 0367-0244 (Print) 1543-5237 (Online) Journal homepage: https://www.tandfonline.com/loi/gefn20

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To cite this article: Mieke Faber, Friede A. M. Wenhold & Sunette M. Laurie (2017) Dietary Diversity and Vegetable and Fruit Consumption of Households in a Resource-Poor Peri-Urban South Africa Community Differ by Food Security Status, Ecology of Food and Nutrition, 56:1, 62-80, DOI: 10.1080/03670244.2016.1261024

To link to this article: https://doi.org/10.1080/03670244.2016.1261024

ECOLOGY OF FOOD AND NUTRITION
2017, VOL. 56, NO. 1, 62–80
http://dx.doi.org/10.1080/03670244.2016.1261024

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Dietary Diversity and Vegetable and Fruit Consumption of Households in a Resource-Poor Peri-Urban South Africa Community Differ by Food Security Status

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ABSTRACT

Sociodemographic, living standard measure, consumption of vegetables and fruit, and dietary diversity in relation to household food security were assessed. Using a hunger score, households were categorized as food secure (n = 125) or food insecure (n = 273). Food secure respondents had a higher mean dietary diversity score (3.98; 95%CI [3.79, 4.18] versus 3.65; 95% [CI 3.53, 3.77]), were more likely to eat vitamin A–rich foods (OR 1.15; 95% CI [1.05, 1.26]), a more varied diet (DDS ≥ 4, OR 1.90; 95% CI [1.19, 3.13]), and vegetables daily (OR 3.37; 95% CI [2.00, 5.76]). Cost limited daily vegetable/fruit consumption in food insecure households. Respondents with ≥ 8 years of schooling were more likely (OR 2.07; 95% CI [1.22, 3.53]) and households receiving social grants were less likely (OR 0.37; 95% CI [0.19, 0.72]) to be food secure. Results highlight the association between dietary diversity and household food security.

KEYWORDS

Dietary diversity; food security; South Africa; vegetables and fruit

Introduction

Although South Africa is a middle-income country, the most recent estimates indicate that 53.8% of the population lives in poverty (ZAR 779 or less per person per month; 1 ZAR = $0.066 USD, as of June 11, 2016), with 21.7% living in extreme poverty (StatsSA 2015). South Africa is one of the 34 countries with the highest burden of stunting (Bhutta et al. 2013) and, at the same time, has one of the highest rates of overweight and obesity worldwide (Ng et al. 2014). According to the 2012 South African National Health and Nutrition Examination Survey (SANHANES), 26.5% of 1- to 3-year-old children are stunted, and 30.7% of males 15 years and older and 64.0% of females in that age group are either overweight or obese (Shisana et al. 2014). Food insecurity is an underlying risk factor for maternal and child

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undernutrition (Black et al. 2008). Simultaneously, the food insecure are vulnerable to obesity (Kac et al. 2012; Martin and Ferris 2007). South Africa has an adequate food supply at the national level (du Toit et al. 2011), yet food security at the household level is not guaranteed. National data suggest that only 45.6% of South African households are food secure when measured with a hunger score index based on the Community Childhood Hunger Identification Project (CCHIP) (Shisana et al. 2014).

There is not a single universally accepted definition of food security. This is reflected in the numerous indicators that are used for measuring food (in) security (Barret 2010; Kirkland et al. 2013; Marques et al. 2014). Nonetheless, over time, food availability, accessibility, and utilization have consecutively emerged as the three dimensions of food security (Jones et al. 2013). The Food and Agricultural Organization (FAO) defines *food security* as when "… all people at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and preferences for an active and healthy life" (FAO 2009). According to Bashir and Schilizzia (2013) the utilization domain is the most neglected component in studies conducted in Asia and Africa. Utilization reflects food consumption at household and individual levels and is closely linked to nutrition security (which also considers care, health, and hygiene practices) and nutritional status—in the form of under- as well as overnutrition.

South Africa is in the noncommunicable diseases phase of the nutrition transition (Abrahams, Mchiza, and Steyn 2011), with the urban poor being disproportionately affected (Mayosi et al. 2009). In general, the population consumes a diet with little variety (Labadarios, Steyn, and Nel 2011), and intake of vegetables and fruit has been reported to be low (Labadarios et al. 2000; Nel and Steyn 2002; Schneider et al. 2007). Increasing the intake of vegetables and fruit may help prevent several noncommunicable diseases (Lock et al. 2005; Schneider et al. 2007) and contribute toward dietary intake of nutrients such as dietary fiber, calcium, and vitamins A and C (Faber, Laubscher, and Laurie 2013; Faber, van Jaarsveld, and Laubscher 2007; Steyn et al. 2006).

We recently reported low overall intake of vegetables and fruit by school children and caregivers in a peri-urban area of KwaZulu-Natal (Faber, Laubscher, and Laurie 2013). Of the nine provinces of South Africa, KwaZulu-Natal has the second-largest population size, with 19.8% of the total population living there (StatsSA 2012). The province has the highest prevalence of HIV infection (39.5% in 15- to 49-year-olds) (Department of Health 2012a), anemia in women (Shisana et al. 2014), and vitamin A deficiency in children (Labadarios, Moodie, and van Rensburg 2007). Overweight or obesity affects 69.2% of women 15 years and older, which is higher than the national figures (Shisana et al. 2014). Low vegetable and fruit intake, low dietary variety, and low vitamin A intake are all associated with an increased risk of malnutrition and/or

poor health (Boeing et al. 2012; Sommer and Vyas 2012; Steyn et al. 2006a) and are proxy indicators for dietary quality. Assessing the association between household food security and these proxy indicators for dietary quality will provide valuable insight into the utilization dimension of food security.

The aim of this article is to describe vegetable and fruit intake, dietary diversity, and intake of vitamin A–rich foods in relation to household food security status in this peri-urban community in South Africa.

Materials and methods

Study population

This cross-sectional study was part of the baseline survey of a school-based garden intervention done in four purposively selected primary schools in a resource-poor peri-urban site in the Mariannhill area, Pinetown, in the KwaZulu-Natal Province, South Africa. In each of the four schools, the class lists for grades 6 and 7 were used to select 100 children per school using systematic random sampling. The caregivers of the selected schoolchildren were interviewed. The final sample consisted of 398 caregivers. The study sample was predominantly poor, as reflected by the high number (77%) of caregivers who reportedly received a child grant, which is a social grant paid by the State to the primary caregiver of children in lower income households. All households in the study sample had access to toilet facilities (mostly pit latrines); 99% had access to tap water (own/communal/neighbor's tap); and 97% had access to electricity (Faber, Laubscher, and Laurie 2013).

Data collection, management, and analysis

The caregivers of the schoolchildren (hereafter referred to as respondents) were interviewed by trained fieldworkers using a structured questionnaire that was developed using the guidelines of Gross et al. (1997). The questionnaire included questions on sociodemographics, household gardening practices, a hunger score index, various aspects of dietary intake, and a living standard measure. The questionnaire was translated into the local language (isiZulu). The translation was verified through back translation and group discussions with people from the local community.

Hunger score index

A hunger score index, as used in the South African National Food Consumption Surveys (NFCS) of 1999 (Gericke, Labadarios, and Nel 2000) and 2005 (Gericke and Labadarios 2007) and similar to the one used in the CCHIP was used as an

indicator of food security status. In the hunger score index, *hunger* is defined as the mental and physical condition resulting from not eating enough food, due to insufficient resources (Wehler, Scott, and Anderson 1992). In the 1999 National Food Consumption Survey, the hunger score index was retrospectively assessed for internal consistency (Cronbach's alpha) and criterion-related validity against parameters that could vary by food security status (i.e., dietary intake, food procurement, household inventory, and sociodemographics). These analyses suggested that the hunger score index provided a good reflection of the household's food security status in South Africa (Gericke, Labadarios, and Nel 2000), in addition to its performance internationally (Marques et al. 2014). For the hunger score index in our study, respondents were asked a set of eight questions (table 1) related to whether adults and/or children were affected by food shortages, perceived food insufficiency, or altered food intake due to constrained economic resources within the household. If the reply to all eight questions was negative (hunger score = 0), the household was defined as food secure. Households with one to four affirmative answers (hunger score 1–4) were defined as "at risk of hunger," and those with five or more affirmative answers (hunger score ≥ 5) were defined as "experiencing hunger."

Dietary intake

A checklist was used to record which vegetables and fruits were consumed at least once per week during the past four weeks within the household. We

Table 1. Distribution of Affirmative Responses to the Questions on the Hunger Score Index.

	Total group (N = 398)	
	n	%
Does your household ever run out of money to buy food?	226	56.8
Do you ever rely on a limited number of foods to feed your children because you are running out of money to buy food?	196	49.2
Do you ever eat less than you should because there is not enough money to buy food?	152	38.2
Do you ever cut the size of your meals or skip any meals because there is not enough money to buy food?	131	32.9
Do your children ever eat less than you feel they should because there is not enough money to buy food?	141	35.4
Do you ever cut the size of your children's meals or do they ever skip meals because there is not enough money to buy food?	102	25.6
Do your children ever say they are hungry because there is not enough food in the house?	119	29.9
Do any of your children ever go to bed hungry because there is not enough money to buy food?	21	5.3
Food security status (based on the eight questions above)[1]		
Food secure (0 affirmative answers)	125	31.4
At risk of hunger (1–4 affirmative answers)	150	37.7
Experience hunger (≥ 5 affirmative answers)	123	30.9

Note. [1]For further data analysis, households at risk for hunger (n = 150) and those experiencing hunger (n = 123) were combined to create a binary variable, i.e., food secure Yes (n = 125; 31.4%) or No (n = 273; 68.6%).

ensured that all commonly consumed vegetables and fruit were included in the checklist through discussions with key informants prior to the study. The respondent was questioned regarding the schoolchild's food consumption over the past seven days using the Helen Keller International (HKI) food frequency questionnaire, and the HKI score was calculated as proxy indicator for vitamin A content in the children's diet (Rosen, Haselow, and Sloan 1993). The respondent's dietary intake was assessed using a quantitative 24-hour dietary recall, and this information was used to calculate the respondent's dietary diversity score (DDS) by summing the number of food groups from which food had been consumed. The nine food groups were (1) cereals, roots and tubers; (2) vitamin A–rich vegetables and fruit; (3) vegetables other than vitamin A–rich; (4) fruit other than vitamin A–rich; (5) meat, poultry, and fish; (6) eggs; (7) legumes; (8) dairy products; and (9) fats or oils. Each food group was counted only once. A DDS below 4 was considered low (Steyn et al. 2006a). The dietary diversity scores ranged from 2 to 7. The respondents were divided into four groups: those who consumed two foods from two groups (DDS = 2; n = 39), those who consumed foods from three groups (DDS = 3; n = 133), those who consumed foods from four groups (DDS = 4; n = 130), and those who consumed foods from five or more groups (DDS 5–7; n = 91). This was done for the total group only because of limited subsample sizes.

Living standard measure

The living standard measure (LSM) (Haupt 2006), which focuses on access to services and durables rather than income, was used as a measure of wealth. The LSM is a composite indicator that is used as a demographic segmentation tool, widely used in the South African marketing and advertising industry. A total of 29 variables, mainly looking at what assets (e.g., refrigerator and stove) and facilities (tap water and flush toilet) are available in the household, were used to create the LSM (Haupt 2006). The total score (based on the weighted 29 variables) was used to create ten LSM groups (LSM 1–10); households in the lower LSM groups are poorer and less serviced, while households in the higher LSM groups are wealthier and more serviced. According to Schönfeldt, Hall, and Bester (2013), households falling in the LSM categories 1–4 are often most affected by malnutrition and are most vulnerable to rising food prices. We therefore grouped the households into two LSM categories (lower LSM group: 1–4; higher LSM group: ≥ 5).

Data analysis

Data were analyzed using SPSS for Windows, version 20 (SPSS Inc., Chicago, Illinois). For the hunger score index, the categories "at risk of hunger" and "experience hunger" both point toward household food insecurity, although the severity of food insecurity differs between the two groups. As the aim of

this study was to compare food secure versus food insecure, regardless of severity, a binary variable for food security was created by combining households at risk of hunger and those experiencing hunger as "food insecure" according to the hunger score index. In the bivariate analysis, differences between food secure (hunger score = 0) and food insecure (hunger score ≥1) households were determined using Pearsons chi-square analysis, the Bonferroni multiple comparison test, and analysis of variance (ANOVA). Spearman correlation analysis was done to test the association between two variables. Statistical significance was set at $p < .05$. In multivariate analysis, logistic regression analysis was done with the binary outcome (food secure versus food insecure) as the dependent variable, and dietary diversity (DDS < 4 vs. DDS ≥ 4), daily vegetable and fruit consumption, HKI scores, and LSM (1–4 vs. ≥ 5) as independent variables. Then potential confounders that were statistically significant in the binary analysis (sources of income, marital status, schooling) were included in the model, through backward conditional entering.

Ethical considerations

This study was part of a larger project "School gardens to address vitamin A" that was approved by the Ethics Committee of the South African Medical Research Council. Approval and support for the execution of the overall project was obtained from the principals, teachers, and governing bodies of the participating schools before the onset of the study. Caregivers were informed verbally and in writing regarding the aim of the study, and they were asked to sign a consent form. A community liaison officer assisted with the negotiations with the schools.

Results

Household food security status

The distribution of affirmative responses to the eight questions of the hunger score is summarized in table 1. According to the hunger score index, 125 (31.4%) of the households were classified as food secure, 150 (37.7%) were at risk of hunger, and 123 (30.9%) experienced hunger. Combining the latter two categories resulted in 273 (68.6%) households being categorized as food insecure.

Caregiver and household characteristics according to food security status

The mean (*SD*) number of household members was 6.5 (2.4) in food secure and 6.6 (2.5) in food insecure households. Respondent and household

characteristics are given in table 2. Compared to respondents from food secure households, a smaller percentage of food insecure respondents were single (33.3% versus 46.4%; $p = .012$) and a larger percentage had ≤ 7 years education (41.0% versus 22.4%; $p = .001$). A higher percentage of food insecure households fell in the lower LSM category (72.2% versus 60.8%;

Table 2. Household Characteristics According to Food Security Status.

	Food secure	Food insecure	
	(n = 125)%	(n = 273)%	p value
Respondent's characteristics			
Marital status			.012
Married /common-law wife /living together	53.6	66.7	
Single /divorced /widowed	46.4	33.3	
Educational level			.001
≤ 7 years	22.4	41.0	
≥ 8 years	77.6	59.0	
Household characteristics			
LSM category			.023
Lower (1–4)	60.8	72.2	
Higher (≥ 5)	39.2	27.8	
Source of income			
Own and/or husband's salary/income	76.8	59.0	.010
Child support /maintenance[1]	16.8	16.5	.937
Living-in family, boarders	19.2	27.1	.089
Child social grant and/or social grant for orphans[2]	73.6	83.2	.027
Pension or disability	12.0	28.6	.001
Sale of vegetables, food, handwork	15.2	12.1	.393
Fruit trees at home	48.4	53.1	.382
Food from a community garden	2.4	3.3	.636
Collect food from the wild	77.4	83.5	.146
Vegetable garden at home	20.2	27.5	.120
Households who owned a home garden	(n = 25)	(n = 75)	
Confidence on growing vegetables			.010
Confident	24.0[a]	20.0[a]	
Needs a bit of advice	56.0[a]	26.7[b]	
Needs a lot of advice	20.0[a]	53.3[b]	
Problems with gardens			
Animals destroying the garden	56.0	60.0	.725
Plant diseases	32.0	54.7	.050
Insects	28.0	54.7	.021
Lack of fencing	20.0	50.7	.007
Lack of knowledge	16.0	41.3	.021
Lack of money to buy supplies	20.0	32.0	.252
Lack of seeds	12.0	32.0	.051
Lack of pesticides	20.0	18.7	.883
Lack of garden tools	4.0	16.0	.112
Lack of fertilizers	4.0	16.0	.112
Shortage of water	8.0	10.7	.700
Lack of irrigation equipment	8.0	9.3	.840

Note. LSM = living standard measure. Superscript letters in a row that are the same denote a subset of food security categories that do not differ significantly from each other, while superscript letters in a row that differ denote a subset of food security categories that differ significantly from each other at the 0.5 significance level; z-test with adjusted p values (Bonferroni method).

[1]Paid by the biological father of the child.

[2]Social grant paid by the government.

p = .023). The percentage of respondents and/or respondents' husbands earning a salary or income was lower for food insecure households (59.0% versus 76.8%; p = .010) while a larger percentage received a child support grant (83.2% versus 73.6%; p = 0.027) and old-age or disability pension (28.6% versus 12.0%; p = .001). While none of the food secure households obtained food from food aid or welfare, 2.6% of food insecure households received such food (data not shown in table).

The number of households that obtained food from their own fruit trees, home garden, community garden, or the wild did not differ according to food security status. Food insecure respondents were less confident about growing their own vegetables; 53.3% of the food insecure respondents indicated that they needed a lot of advice versus 20.0% of the food secure respondents; p = .010. Food insecure respondents also reported more problems related to insects (54.7% versus 28.0%; p = .021), fencing (50.7% versus 20.0%; p = .007), and inexperience (lack of knowledge; 41.3% versus 16.0%; p = .021) in gardening.

Vegetable and fruit consumption within households

Table 3 lists the vegetables and fruit that the households usually (most of the time/when in season) buy. For both food secure and food insecure households, at least 90% of the households usually bought tomatoes, cabbage, apples, and bananas. Some of the individual vegetables and fruits were bought more by the food secure households.

The percentage of households who consumed the various vegetables and fruits at least once per week during the month preceding the study (data were collected during March and April) is given in table 4. The percentage of households who consumed spinach, butternut, carrots, cucumber, and *imifino*, respectively, did not differ between food secure and food insecure households. In the study population, the word *imifino* is the collective local term used for African leafy vegetables. Although this was beyond the scope of this study, and thus was not investigated, a previous study in the same area showed that the African leafy vegetables mostly consumed were *Amaranth spp* and *Bidens spinosa* (blackjack) (Faber et al. 2010). A higher percentage of food insecure households consumed cabbage, pumpkin, and sweet potato, while a higher percentage of food secure households consumed apricot, naartjie (local name for mandarin), and watermelon.

Table 5 shows the usual frequency of household consumption of vegetables and fruit and the constraints prohibiting daily intake thereof. Fruit was eaten daily in 36.8% of food secure and 19.0% of food insecure households. The biggest constraints on eating fruit every day were cost (49.4% of food secure and 88.4% of food insecure households) and, to a lesser degree, seasonal variability (35.4% of food secure households). Vegetables were eaten daily in 78.4% of food secure and 45.9% of food insecure households.

Table 3. Vegetables and Fruit Usually Purchased.

	Food secure (n = 125)%	Food insecure (n = 273)%	p value
Vegetables			
No difference across food security status categories			
Beetroot	47.6	41.5	.261
Butternut	71.8	74.9	.510
Cabbage	90.3	93.4	.286
Carrot	88.7	91.5	.369
Green beans	70.2	62.5	.139
Pumpkin	40.3	36.8	.498
Spinach	61.3	59.0	.672
Sweet potato	17.7	16.2	.698
Tomato	91.9	91.9	.994
Food secure households buy more			
Broccoli	20.2	7.4	.000
Cauliflower	23.4	10.7	.001
Cucumber	36.3	25.1	.022
Lettuce	44.7	31.2	.010
Fruit			
No difference across food security status categories			
Apple	98.4	95.9	.202
Apricot	13.6	10.0	.296
Avocado	23.4	19.6	.394
Banana	90.4	91.9	.625
Grape	68.0	60.9	.173
Guava	13.6	13.0	.862
Lemon	10.4	5.9	.113
Mango	53.6	48.3	.331
Naartjie (mandarin)	25.6	20.4	.243
Orange	58.4	57.2	.822
Papaya	23.4	17.0	.132
Peach	58.4	56.1	.666
Pear	83.2	74.5	.056
Plum	59.7	54.6	.346
Food secure households buy more			
Pineapple	22.4	14.1	.039
Watermelon	19.4	11.2	.028

The biggest constraints on eating vegetables daily were cost (57.1% of food secure and 78.0% of food insecure households) and, to a lesser degree, seasonal variability (17.9% of food secure households).

Dietary diversity

Five of the respondents did not complete the quantitative 24-hour dietary recall; dietary data were therefore available for 393 respondents. Table 6 shows the food groups that were used to construct the DDS, the percentage of caregivers with a DDS of less than 4, and the mean and 95% CI for the DDS. A larger proportion of food secure respondents consumed legumes (32.5% versus 23.0%; p = .045) and eggs (16.3% versus 7.4%; p = .007) than did food insecure respondents. The mean DDS was higher in food secure

Table 4. Percentage of Households that Consumed Specific Vegetables and Fruit at Least Once per Week during the Past 4 Weeks.

	Food secure (n = 125)	Food insecure (n = 273)	p value
Vegetables			
No difference across food security status categories			
Spinach	25.6	23.1	.584
Butternut	56.0	53.5	.639
Carrots	84.8	83.2	.679
Cucumber	25.6	17.2	.052
Imifino[1]	32.8	40.7	.134
Food secure households have more frequent intake			
Beetroot	40.0	23.8	.001
Broccoli	19.2	7.7	.001
Cauliflower	19.2	5.5	.000
Green beans	73.6	61.9	.023
Lettuce	35.2	21.2	.003
Tomatoes	89.6	75.1	.001
Food secure households have less frequent intake			
Cabbage	53.6	75.5	.000
Pumpkin	25.6	40.3	.005
Sweet potato, white	2.4	8.4	.024
Fruit			
No difference across food security status categories			
Apples	72.0	72.9	.853
Avocado	31.2	23.1	.085
Banana	66.4	67.0	.901
Grapes	24.8	18.7	.161
Guava	13.6	13.2	.910
Mango	32.8	32.6	.969
Orange	29.6	23.8	.219
Pawpaw (papaya)	29.6	31.5	.703
Peach	35.2	28.6	.183
Pear	48.8	44.7	.445
Plum	30.4	22.7	.101
Food secure households have more frequent intake			
Apricot	6.4	1.1	.003
Naartjie (mandarine)	13.6	3.3	.001
Watermelon	11.2	1.8	.001

Note. [1]Local name used within the study population for a collection of African green leafy vegetables.

respondents than in food insecure respondents (3.98 versus 3.65; p = .004), and a lower proportion of food secure respondents had a DDS < 4 (35.0% versus 47.8%, p = .018). Spearman correlation analysis showed a weak but statistically significant inverse association between the hunger score and DDS (r = − 0.119; p = .018). The HKI scores (focusing on vitamin A–rich food sources) were significantly (p < .001) higher for food secure households, pointing toward a more frequent dietary intake of vitamin A–rich foods in the food secure households for both plant and animal sources of vitamin A. The vitamin A status of a population should be based on biochemical and/or clinical indicators. The HKI scores are therefore no longer used to identify populations at risk of vitamin A deficiency, but the score is useful to assess differences in consumption of vitamin A–rich foods between the two groups.

Table 5. Frequency of Household Consumption of Fruits and Vegetables and the Major Constraints for Not Eating Fruits and Vegetables Every Day for Food Secure and Food Insecure Households.

	Fruit		Vegetables	
	Food secure	Food insecure	Food secure	Food insecure
Frequency of consumption	(*n* = 125)	(*n* = 273)	(*n* = 125)	(*n* = 273)
Daily	36.8[a]	19.0[b]	78.4[a]	45.9[b]
4–6 days per week	18.4[a]	17.9[a]	11.2[a]	14.4[a]
1–3 days per week	24.8[a]	18.3[a]	8.0[a]	17.8[b]
< 1 day per week	16.8[a]	31.5[b]	2.4[a]	15.9[b]
Never	3.2[a]	13.2[b]	0[a]	5.9[b]
Biggest constraint for not eating it daily (%)[1]	(*n* = 79)	(*n* = 217)	(*n* = 28)	(*n* = 150)
Cost	49.4[a]	88.4[b]	57.1[a]	78.0[b]
Seasonality	35.4[a]	4.6[b]	17.9	8.0
Health reasons[2]	3.8	3.2	7.1	2.7
Personal preference	5.1	1.9	7.1	7.3
Availability	5.1	0.9	7.1	3.3
Unsure	1.3	0.5	3.6	0.7
Biggest constraint for not eating it daily (%)[3]	(*n* = 125)	(*n* = 273)	(*n* = 125)	(*n* = 273)
Cost	31.2[a]	70.0[b]	12.8[a]	42.9[b]
Seasonality	22.4[a]	3.7[b]	4.0	4.4
Health reasons[b]	2.4	2.6	1.6	1.5
Personal preference	3.2	1.5	1.6	4.0
Availability	3.2	0.7	1.6	1.8
Unsure	0.8	0.8	0.8	0.4

Note. Frequency of fruit consumption: $p < .001$ (chi-square). Frequency of vegetable consumption: $p < .001$ (chi-square). Constraints for eating fruit every day: $p < .001$. Constraints for eating vegetables every day: $p = .004$. Superscript letters in a row that are the same denote a subset of food security categories that do not differ significantly from each other, while superscript letters in a row that differ denote a subset of food security categories that differ significantly from each other at the .5 significance level; *z*-test with adjusted *p* values (Bonferroni method).

[1]Expressed as a percentage of those who do not eat it daily.

[2]For example, flatulence, arthritis, allergies.

[3]Expressed as a percentage of all households in the food security status category, irrespective of frequency of consumption.

The DDS ranged from 2 to 7. Respondents were grouped into four groups: those who consumed two groups (DDS = 2; *n* = 39), three groups (DDS = 3; *n* = 133), four groups (DDS = 4; *n* = 130), and five or more groups (DDS = 5–7; *n* = 91). Food groups that were consumed by more than 50% of the caregivers within the DDS groups are shown in table 7. Roots and tubers were consumed by at least 50% of the respondents in the two lower dietary diversity groups but not in the two higher dietary diversity groups. As dietary diversity increased, fats and oils were added to the diet, then meat and poultry, and then β-carotene-rich vegetables and fruit; consumption of roots and tubers decreased. The proportion of caregivers who consumed organ meat during the recall period decreased as dietary diversity increased; organ meat was eaten by 24.4% of respondents who consumed either two or three food groups, by 18.8% of respondents who consumed four food groups, and by 3.3% of respondents who consumed five or more food groups (data not shown in table).

Table 6. Dietary Diversity for the Respondent and the HKI Score for the Schoolchild.

	Food secure (*n* = 125)%	Food insecure (*n* = 273)%	*p* value
Respondent intake yesterday			
Cereals, roots and tubers	100	100	1.000
Roots and tubers	42.3	50.7	.119
β-carotene-rich vegetables and fruit	42.3	37.8	.397
Yellow vegetables	27.6	24.1	.450
Green leafy vegetables	10.6	13.7	.387
Yellow fruit	8.1	5.9	.415
Vegetables, other than β-carotene-rich	17.9	23.3	.224
Fruit, other than β-carotene-rich	18.7	14.8	.330
Legumes	32.5	23.0	.045
Meat, poultry and fish	73.2	69.5	.474
Meat, poultry	57.7	54.4	.544
Organ meat	15.4	16.3	.832
Fish	7.3	3.7	.121
Eggs	16.3	7.4	.007
Milk	23.6	20.4	.472
Fats and oils	74.0	68.9	.305
DDS < 4	35.0	47.8	.018
DDS ≥ 4	65.0	52.2	
Respondent dietary diversity			
Mean score [95% CI]	3.98 [3.79; 4.18]	3.65 [3.53; 3.77]	.004
Vitamin A–rich food intake of child[1]			
HKI animal score; mean [95% CI]	8.34 [7.92; 8.75]	7.11 [6.78; 7.53]	<.001
HKI plant score; mean [95% CI]	1.55 [1.41; 1.68]	1.27 [1.19; 1.35]	<.001
HKI total score; mean [95% CI]	9.88 [9.43; 10.34]	8.38 [8.02; 8.73]	<.001

Note. HKI = Helen Keller International (a higher score indicates more frequent consumption); DDS = dietary diversity score; CI = confidence interval.
[1]As reported by the respondent (caregiver of the schoolchild).

Table 7. Food Groups Consumed by at Least 50% of Female Caregivers, According to Dietary Diversity Score (DDS).

DDS 2 (*n* = 39)	DDS 3 (*n* = 133)	DDS 4 (*n* = 130)	DDS 5–7 (*n* = 91)
Roots and tubers	Roots and tubers		
Cereals	Cereals	Cereals	Cereals
	Fats and oils	Fats and oils	Fats and oils
		Meat, poultry	Meat, poultry
			β-carotene-rich vegetables and fruit

Household food security and nutritional vulnerability

Table 8 shows the results of the regression analysis. Food secure households were more likely to eat vitamin A–rich foods (OR 1.15; 95% CI [1.05; 1.26]; $p = .003$) and a more varied diet (OR 1.90; 95% CI [1.16, 3.13]; $p = .011$), and eat vegetables every day (OR 3.37; 95% CI [2.00, 5.76]; $p = .001$). Respondents with at least some high school education (≥ 8 years) were more likely to be food secure (OR 2.07; 95% CI [1.22, 3.53]; $p = .007$),

Table 8. Logistic Regression Analysis on Nutritional Vulnerability in Relation to Households Being Food Secure.

	Coefficient (SE)	Exp (B)	95% CI	*p* value
Constant	−3.64 (0.54)			
Daily vegetable consumption	1.21 (0.27)	3.37	[2.00; 5.76]	.001
Daily fruit consumption	0.28 (0.28)	1.32	[0.77; 2.29]	.316
Dietary diversity (DDS ≥4)	0.64 (0.25)	1.90	[1.16; 3.13]	.011
HKI score	0.13 (0.05)	1.15	[1.05; 1.26]	.003
LSM (≥ 5)	0.25 (0.26)	1.29	[0.77; 2.15]	.329
Schooling (≥ 8 years)	0.72 (0.27)	2.07	[1.22; 3.53]	.007
Old age/disability pension as source of income	−0.99 (0.34)	0.37	[0.19; 0.72]	.003

Note. Variables that were not retained: respondent and/or husband salary; marital status of respondent; % correctly classified 72.5%. DDS = dietary diversity score; LSM = living standard measure; CI = confidence interval.

while households receiving an old age and/or disability grant were less likely to be food secure (OR 0.37; 95% CI [0.19, 0.72]; p = .003).

Discussion

From a nutrition and health perspective, the utilization dimension of food security and the more proximal predictors thereof are usually of prime importance. This study showed that proxy indicators of dietary quality were associated with household food security status. Food secure households consumed a more varied diet, as evident from the DDS, and were more likely to eat vitamin A–rich foods and eat vegetables every day. The lower dietary diversity and less frequent intake of vegetables and vitamin A–rich foods indicate that food insecure households were nutritionally more vulnerable. Food insecure households also had lower educational levels, relied more on old age/disability pension, and had a lower standard of living, which may be constraining factors for strategies promoting healthier eating patterns, including increased dietary diversity and vegetable consumption.

Food secure respondents were more likely to consume a more varied diet, hence confirming findings reported by other studies (Belachew et al. 2013; De Cock et al. 2013; Faber, Schwabe, and Drimie 2009). Nevertheless, a significant proportion of respondents from both food secure and food insecure households consumed fewer than four groups during the 24-hour recall period, reflecting a diet of low variety. Similar to the 2012 SANHANES-1 study (Shisana et al. 2014), the mean DDS value was below the cutoff of 4, which was previously shown to be associated with poor dietary adequacy (Steyn et al. 2006a). Respondents with the lower dietary diversity scores consumed mostly cereals, roots and tubers, and fats and oils. Vorster, Kruger, and Margetts (2011) argued that the reliance on available and affordable staple foods and energy-dense but nutrient-poor foods, and

resultant poor dietary quality, contributes to increased vulnerability during the nutrition transition in Africa.

The South African Department of Health promotes the consumption of a variety of foods through the South African food-based dietary guidelines (Department of Health 2012b). However, lower dietary diversity in the lower LSM groups in South Africa (Faber, Schwabe, and Drimie 2009; Labadarios, Steyn, and Nel 2011) reflects poor people's inability to access a large variety of foods. Schönfeldt, Hall, and Bester (2013) argued that the cost of the recommended diet, even when made up of the most basic and low-cost foods, is beyond the reach of the poor in the country. The financial barrier to healthy eating is not unique to South Africa. A study done in Taiwan, for example, showed that a diet with higher variety was associated with higher total food expenditure (Lo et al. 2012). In addition, a meta-analysis of 27 studies from 10 countries showed that, in general, healthier diets are more expensive than less healthy diets (Rao, Afshin, Singh, and Mozaffarian 2013).

Vegetables and fruits are recognized as a core component of a healthy diet (Darmon and Drewnoski 2015). Vegetables and fruits did not feature strongly in the diets of the study participants and were prominent only in the most diverse diets, particularly those rich in β-carotene (table 7). An average per capita intake of 124 g of vegetables and/or fruit has been reported for women in the study population (Faber, Laubscher, and Laurie 2013), which is considerably lower than the recommended minimum daily intake of 400 g (WHO 1990). The DDS is based on a single day's food intake, which usually has a day-to-day variation, particularly for nonstaple foods. This may explain why the percentage of respondents who consumed vegetables and fruit during the 24-hour recall period (used to calculate the DDS) did not differ according to food security status, while the frequency of household consumption during the previous month did differ significantly.

Frequency of household consumption of vegetables and fruit was lowest in food insecure households, mostly due to financial constraints. Cost was less of a hindrance in food secure households, but, as expected in this setting and population, differences in availability across seasons was reported to be a constraint for daily consumption. Addressing both economic access and year-round availability is therefore critical to increase the frequency and variety of vegetable and fruit intake, although this may be challenging. Results of a systematic review showed that vegetables and fruit account for a large part of the diet cost and that diets higher in vegetables and fruits are associated with higher costs (Darmon and Drewnoski 2015). Schönfeldt, Hall, and Bester (2013) argued that low socioeconomic households should be equipped to improve their dietary intake through, for example, local production of nutrient-rich foods. Increasing access to vegetables and fruit through home and community gardens is one of the strategies recommended by the Centers for Disease Control and Prevention (2011).

Although home gardens are not necessarily associated with improved food security, they are associated with higher dietary diversity and higher vegetable and fruit intake (Cabalda et al. 2011). Focusing on β-carotene–rich vegetables and fruit in home gardens may result in increased vitamin A intake (Faber, Venter, and Benadé 2002). The Helen Keller International Homestead Food Production Program is an excellent example of the potential of local food production to improve dietary intake (HKI/APRO 2010). Food insecure households had a lower intake of vitamin A–rich foods and legumes; they will therefore benefit by planting these in their home gardens. However, planting vegetables and fruits may be more challenging for the food insecure as they were less confident about planting vegetables and experienced more problems with their gardens. The food insecure further relied more on an old age /disability grant as source of income and had a lower standard of living compared to the food secure. To reach the food insecure, who are nutritionally more vulnerable, differential targeting within the community may be needed. Hawkes and Ruel (2012) have pointed to the potential of targeted value chain analysis for increasing the supply of healthy foods for the insecure and their demand for such foods.

A limitation of the study is the cross-sectional design; the results reflect associations but cannot establish causality. It should further be noted that the hunger score index that was used as an indicator for food security status is a subjective measure based on eight questions reflecting food experience as perceived by the respondents. The advantages of hunger scales are the relative low cost and ease of data collection and analysis.

In conclusion, the results of this study showed that dietary diversity differed by food security status. Respondents from food secure households were more likely to eat vitamin A–rich foods and a more varied diet as reflected by the DDS and to eat vegetables every day. There is no single strategy to increase vegetable and fruit intake in all communities. The Centers for Disease Control and Prevention (2011), for example, highlights ten different strategies designed to increase access to and improve the availability of vegetables and fruit, with the expectation that these changes will lead to increased consumption. Although the food insecure households were nutritionally more vulnerable, dietary diversity and vegetable and fruit consumption were low for both food insecure and food secure households, suggesting that the entire community needs to be targeted when designing strategies to increase consumption. Differential targeting within a community may, however, be necessary as food insecure households may find it more difficult to adopt healthier eating patterns and, for example, plant their own vegetables and fruits. Strategies focusing on the challenges of the food insecure should be prioritized.

Acknowledgments

We are grateful to the nutrition monitors, Bongi Duma, Nhlanhla Hlophe†, Derick Mkhize, Lindiwe Msiya, Angeline Ndlovu, and France Phungula, for recruiting the participants, completing the questionnaires, and coding the dietary data; the fieldworkers for completing the questionnaires; Michael Phungula for community liaison and negotiations with the schools; Lee-Ann Runcie for dietary coding and data capturing; and the four schools, the caregivers, and the learners who participated in the study.

Funding

Funding for this study was obtained from the South African Sugar Association (project 196) and Nutrition Third World.

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