Analyzing Household Dietary Diversity Amongst Urban Food Insecure Households

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Abstract

The high incidence of food insecurity in the City of Tshwane, South Africa, is of serious concern. The Household Dietary Diversity (HDD) index of the United States Aid (USAID) was used to scale the dietary patterns of 775 households, distributed in 73 clusters, from the 7 regions of the City of Tshwane. The Principal Component Analysis (PCA) was applied to the data to elucidate the patterns of such choices. The analysis found that due to income shocks, households adopted a fixed pattern of food group frequencies mostly cereals. This compromised nutritional safety and calls for income-based policies and nutritional awareness.

Keywords: Food security: household dietary diversity; food insecure households; City of Tshwane; South Africa

Introduction

Dietary diversity is understood to bean increase in food groups capable of providing an adequate intake of vital nutrients which can provide good health.[2] It can also be defined as the wide variety of foods consumed for a productive and healthy lifestyle over a given period.[3,1–3] Dietary diversity is a health indicator and is also linked to the quality of the diet; it is a useful tool for measuring food security and attaining the Sustainable Development Goal (SDG) Number Two of ending hunger and food insecurity.[4]

A diverse, nutritious and balanced diet prevents nutritional deficiencies in the population, thus helping prevent diseases.[5–10] A fall in dietary diversity is linked to a rise in the proportion of the malnourished population. Household dietary diversity is influenced by socio-economic factors, such as income, household size, gender and educational status.[11] Lack of access to a diversified diet is recognized as a major challenge among low-income urban households, resulting in various nutritional inadequacies [12]. In addition, low-income urban households are characterized by their low intake of micronutrients, which makes food insecurity a great challenge with implications on overall household well-being.[13]

The Household Dietary Diversity Index (HDDI) is a viable tool for measuring nutrient adequacy.[14] The HDDI comprises of food groups eaten in the 7 days by any household member at home, including food prepared at home but eaten, for example, at work (such as a sack lunch).[15] The food groups are cereals; roots and tubers; vegetables; fruits; meat [including poultry, offal, fish & seafood]; eggs; pulses/legumes/nuts; milk & milk products; oils & fats; sugar & honey and miscellaneous food.[15]

Food groups prevalent amongst urban food insecure households include cereals, fats and oils, offal and vegetables. The cereal food group consists of ordinary staple foods such as *pap*

(maize meal) and other starch related foods such as bread and rice; the offal food group consists of all animal organs; and the vegetable food group that consists of spinach and "*morogo*"; consumed as relish, as well as fats and oils.[16–21]

The South African Constitution, 1996 (Sections 27 [1], 28 [1] and 35 [2]) (hereafter the Constitution) provide for the right to access adequate food and water, the rights of children to basic nutrition as well as the right of detained persons to basic nutrition. This constitutional mandate ascribes to Agenda 2063 of the African Union; which is a 50-year strategy on ending poverty and ensuring food security through the acceleration of agricultural growth and transformation, mitigation of climate vulnerability, the empowerment of citizens in skills development and the provision of social assets on the African continent.

Despite adherence to these constitutional provisions and continental standards, as well as government's numerous efforts toward nutrition and food security, as many as 1.7 million households still experienced hunger or food insecurity in 2017.[21] Consequently, according to,[22]Regional Vulnerability Assessment and Analysis Report, South Africa was projected to have the largest number of food insecure people (13.7 million), representing about 24% of the country's population by the peak of the lean season in January 2020. These are predominantly chronically food insecure people that are already beneficiaries on domestically-funded social protection and safety net programmes. Key to this food insecurity levels are economic shocks, and poor food choices.[23]

The City of Tshwane in the Gauteng Province of South Africa has adopted numerous strategies to alleviate food insecurity. Key to these strategies is the Food Security Policy and Strategy (FSPS) implemented in 2009, which aspires to achieve a prosperous city through fairness, freedom and opportunity by promoting accelerated growth, job creation and poverty eradication. Consequently, the 2017 Climate response strategy meant to reduce food insecurity due to climate vulnerability. The 2017–2022 Integrated Development Plan (IDP) identified high levels of poverty as a binding constraint to the medium- to the long-term development of the City. To deal with this scourge, the City launched the Expanded Public Works Program (EPWP), as part of a five-year strategy for fighting poverty and building clean, healthy, safe and sustainable communities. The strategy is expected to enhance food security though the reduction of poverty owing to income relief from temporary work opportunities, and small-scale medium enterprises, utilizing the skills obtained from the programme.[24] The initiatives adopted by the City of Tshwane undoubtedly improve the food security position of the households, however a major question arises, which is key to this study on whether the dietary patterns of food groups as presented by the Household Dietary Diversity Index (HDDI) adopted by the City of Tshwane's food insecure households and their consequences on a healthy lifestyle justify the city's strategies.

This study utilizes the Principal Component Analysis (PCA) to analyze the City of Tshwane's urban food insecure dietary patterns. The HDDI, developed by United States Aid (USAID)[15] is utilized in profiling of the urban food insecure households' dietary patterns. We discuss policy implications based on our findings.

Materials and methods

The study utilized a quantitative research approach, with the aid of a structured questionnaire, developed to measure various food security aggregates. A cross section design was employed in which a proportion of the City of Tshwane's food insecure households drawn from the

Statistics, South Africa,[25] Community Survey were enumerated based on their choice of various food groups measured by the HDDI. These food groups were consumed in the 7 days preceding the day of enumeration, analyzed by the PCA.

Data collection

The data sample for this study consisted of 775 households from the 7 regions of the City of Tshwane[1] subdivided into clusters. The households were targeted at Ward level utilizing,[25]Community Survey.[25]Two-stage sampling scheme was adopted to ensure representativeness and cost-efficiency, with the first stage involving selection of clusters using Probability Proportional to Size (PPS) scheme without replacement (WOR) and the second stage involving systematic sampling of households with random start in selected clusters. 73 clusters were selected using PPS, WOR and a fixed systematic household sample with random start of 15 households per cluster. Clustering was important for reducing enumeration costs. It limits the physical movement of the enumerator from one sample point to the other (Kumar, 2014).

Ethics approval

Ethics approval for data collection was obtained through the University of Pretoria, Ethics protocol number, ***EMS060/18***, from February 2018 to January 2019.

Exploratory method

The study utilized the PCA analysis, drawing on the Simpson Index used to profile the status of the City of Tshwane food insecure households. The Simpson Index draws on the HDDI, which comprises of food groups eaten in the previous 7 days by any household member at home, including food prepared at home but eaten elsewhere, such as a sack lunch.[15] The food groups are *cereals; roots and tubers; vegetables; fruits; meat [including poultry, offal, fish & seafood]; eggs; pulses/legumes/nuts; milk & milk products; oils & fats; sugar & honey and miscellaneous food*.

The simpson index

The Simpson Index was used to profile the dietary diversity status of the City of Tshwane food insecure households by their socio-economic characteristics. The Index draws from ecological studies meant to measure diversity among species. It gives a range of data which shows a true level of variety and helps to determine how diversified or balanced the diet is (Hayden &Harris, 2005). The Simpson Index is given as:

$$S = 1 - \Sigma w_i 2$$

Where $_{wi}$ is the weight of the ith food group. The range of the Simpson Index (S) is from 0 to 1. The value of Simpson varies from 0 (only one single food group consumed) to 1 (all food groups have an equal chance of consumption) and the higher value refers to greater variety.[26–30]

Specification of the PCA

The PCA was used to analyze the City of Tshwane food insecure households' dietary patterns utilizing the HDD indicators/scales developed by the USAID, FANTA Project in 2006. The PCA is a widely used exploratory method in epidemiology[31-33] studies to derive dietary patterns from the daily eating patterns of a households. Such dietary patterns seem to originate from intakes on multiple days and eating occasions.[34] Food or nutrient pattern assessment using the PCA applied to food questionnaires. The HDDS is considered a good proxy measure of household energy availability. It reflects the households' overall ability to acquire sufficient food to meet members' nutritional and energy requirements.[35] Consumption of at least four food groups increases the chances that foods from animal sources, fruits and vegetables were consumed in addition to staple foods.[36]

Results and discussion

This section presents the study findings and analysis. First the descriptive statistics followed by the PCA analysis.

Descriptive statistics

In presenting the PCA analysis, descriptive statistics on the City of Tshwane food insecure households are provided. These are presented from the Simpson Index. The Index also presents the dietary diversity scores of these poor households. An average index score of 0.5 is used to distinguish between a household with a high diversified diet (High HDD) and a low diversified diet (Low HDD). The Simpson Index was profiled on continuous variables, age, household size, income and food expenditure. The average dietary diversity score was 0.4 and 0.3 for all the City of Tshwane poor households, thus the households were classified as very low dietary diversity (Simpson Index >/ = 0.3) and low dietary diversity (Simpson index < 0.4) Table 1 shows the dietary diversity Simpson index classification.

Table 1. Dietary diversity simpson index classification

		N	Minimum	Maximum	Mean	Std. Deviation
Very Low HDD	Age	400	0	77	37.4	0.8
	Household size	400	1	15	3.8	0.1
	Income	400	350	30000	6350	424.8
	Food expenditure	400	300	6200	1350	50.8
	Simpson Index				0.3	
Low HDD	Age	375	0	90	40	0.9
	Household size	375	1	12	4	0.1
	Income	375	350	40000	8322	510.7
	Food expenditure	375	400	5000	1642	48.6
	Simpson Index				0.4	

aIncome and Food Expenditure (Rands)
Source: Authors: SPSS Iterations

A very low-income urban household chosen at random would have 4 members with a head being 37-years-old, an average household income of R 6350 and average food expenditure of R1 350 Consequently, a low-income household chosen at random would have 4 members with a head being age 40, with the average monthly income of R8 322 and food expenditure of R1 642. Female-headed households were most affected by low dietary diversity in their dietary intake (66%) and (58%) respectively (table 2).

Table 2. Dietary diversity by socio-economic characteristics

		Very Low Dietary (n = 400)	Low Dietary (n = 375)	Pooled (n = 775)
Gender	Males	136(34)	157 (42)	293 (37)
	Females	264 (66)	218 (58)	482 (62)
Education	No formal education	27 (7)	16 (4)	43 (6)
	Primary education	28 (7)	24 (6)	52 (7)
	Secondary education	264 (66)	211 (56)	475 (61)
	Tertiary education	70 (18)	113 (30)	183 (24)
Employment	Employed	149 (37)	220 (59)	369 (48)
	Unemployed	252 (63)	155 (41)	406 (52)
Social grant recipient	Yes	251 (63)	160 (43)	411. (53)
	No	149 (37)	215 (57)	364 (47)
Animal rearing	Yes	12 (3)	7 (2)	19 (3)
	No	388 (97)	368 (98)	756 (98)
Food gardening	Yes	30 (8)	43 (12)	73 (9)
	No	370 (93)	332 (89)	702 (91)

Source: Authors' SPSS Iterations

In addition, household heads with secondary education and unemployed had a low diversified diet. This is normal as education and employment are key determinants of income. An increase in disposable income creates room for a diversified diet. Nonetheless, the employed household heads are also amongst the low dietary diverse group (59%), a trait linked to household size and cultural practices, amongst others. Recipients of the social support grant (63%) are faced with very low dietary diversity. The grants are inadequate to meet the household needs of large household sizes. Finally, animal rearing and food gardening were rarely used by both very low and low dietary diverse households (97% and 93% for very low dietary diversity and 98% and 89% for low dietary diversity, respectively).

The most popular HDD food group was cereal-related food, adopted by 53% of the households as reported in table 3. This is followed by eating vegetables (18%), oils and fatty foods (8%) and the consumption of milk and milk products (5%). The foregoing responses exhibited by the City of Tshwane households corroborate literature findings [see.[34, 37]]

Table 3. Choice of HDD food groups

Variable	Obs	Mean	Std. Dev.	Min	Max	Frequency	%
Cereals	775	3.5	.9	1	7	407	52.5
Root & Tubers	775	.3	.8	0	5	29	3.7
Vegetables	775	1.6	.7	1	5	137	17.6
Fruit	775	.2	.6	0	5	20	2.6
Eggs	775	.4	.6	0	5	20	2.6
Meat	775	.3	.7	0	5	15	1.9
Offal	775	.3	.6	0	4	7	0.9
Legumes	775	.1	.2	0	3	1	0.1
Milk & Milk Products	775	.5	.6	0	4	40	5.2
Oil and Fats	775	1.2	1.1	0	6	66	8.5
Sugar & Honey	775	.9	.8	0	5	31	4.0
Miscellaneous	775	.6	.6	0	4	2	0.3

Source: Author's SPSS Iterations

PCA findings

The PCA utilizes the Promax (Oblique) drawing from Gorsuch (1983). The Promax rotation tries to fit a target matrix which has a simple structure. The results of oblique rotations are

interpreted by looking at the correlations between the rotating axis and the original variables. These correlations are interpreted as loadings. Promax rotation permits factors to be correlated with one another to produce both factor pattern and factor structure matrices. If the simple structure is clear, any of the more popular procedures can be expected to lead to the same interpretations.[38] The PCA analysis extracted four components with Eigenvalues[2] greater than 1. The components retained accounted for 59% of the total variation as shown in Table 4 shows the Principal Component Analysis extraction. This implies the PCA explained 59% of the effects of HDD.

Table 4. PCA extraction

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.4	21.4	21.4	2.4	21.4	21.4
2	1.9	17.1	38.5	1.9	17.2	38.6
3	1.3	11.4	50.1	1.3	11.5	50.1
4	1.0	9.1	59.1	1.0	9.1	59.2

aExtraction method: Principal Component Analysis

This section provides a discussion on the dietary patterns of households drawing from the PCA. Following the recommendation of Maskey et al. (2018) and Pantouvakis et al. (2008) that loadings[3] that are greater than 0.4 can be meaningfully interpreted, the Eigenvalue of 2.354 (table 1), on the chosen component obtained from the PCA Promax rotation analysis, was positively and significantly loaded on Root Tubers (.682), Legumes (.605) and Vegetables (.634). Secondly, the Eigenvalue of 1.888 was positively and significantly loaded on Miscellaneous (.953) and Sugar and Honey (.937). Thirdly, the Eigenvalue of 1.262 was positively and significantly loaded on Milk and Milk Products (.801) and Oils and Fats (.799). Finally, the Eigenvalue of 1.003 was positively and significantly loaded on Cereals (.877). The loadings are reported in table 5.

Table 5. Promax rotated component matrix

	Component			
	1	2	3	4
Cereals	0.003	0.06	−0.028	**0.877***
Roots & Tubers	**0.682***	−0.013	−0.003	0.047
Miscellaneous	0.061	**0.953***	−0.002	−0.006
Sugar and Honey	−0.056	**0.937***	0.028	0.035
Legumes	**0.605***	0.031	0.306	−0.153
Eggs	0.363	−0.02	0.346	−0.008
Milk & Milk Products	−0.058	0.05	**0.801***	−0.043
Vegetables	**0.634***	−0.011	−0.165	0.026
Food Oil & fats	−0.161	−0.009	**0.799***	0.103
Meat	0.041	−0.092	0.345	0.437
Offals	0.022	−0.084	0.289	0.565
Fruit	**0.682***	0.014	−0.16	−0.098

Extraction method: Principal Component Analysis;

Rotation Method: Promax with Kaiser Normalization.

*The significant loadings exceeding ±0.40

Interpretation of the patterns from the loadings entails the following: the first component is associated with a group of people conscious of health eating patterns. This group accounts for 21.4% of the total variation. The second component is associated with a group of people that consume sugar, honey and miscellaneous products [coffee, tea, soft drinks and instant foods). This group accounts for 17% of the total variation. The third group comprises of people that consume fats and proteins, eggs and milk products. This group accounts for 11% of the total variation. The fourth group diet is mostly compromised of cereals, and this accounts for 9% of the total variation.

Policy implications

The PCA did not recognize a group of urban food insecure households that ate a mixed selection of all food groups. Consequently, by defining particular dietary classes, even among those who can afford more classes, such as those working, the household generally lacked adequate dietary requirements to boost nutrition regardless of their socio-economic status. Despite their income level, most households face other obstacles, such as debt and high family commitment, which limit them to low dietary diversity. This is supported by a less proportionate relationship between household income, food expenditure and household size from descriptive statistics, with high-income households spending less on food. These findings confirm,[39] findings from the City of Cape Town food insecurity, which estimated that, on average, a household spends around R1724 a month on food. As income increases, so the proportion spent on food declines. In the lowest income quintile, two-thirds of expenditures are on food (66%]. In the second lowest income quintile it is 30%. Consequently, 17% and 8% in the fourth- and fifth-income quintiles. At times, the food lacks the requisite nutritional requirements due to consistent cultural patterns.

It is recommended that municipalities establish food security policies addressing dietary diversity and nutritional needs in the most impoverished populations. In addition, education mechanisms for nutrient intake must be established among the most vulnerable urban poor households. Educational awareness must be given in an organized way to ensure that the right to a healthy diet is implemented. Thus, in line with FAO (2014), the City of Tshwane needs to ensure that its food security policy has mechanisms to track the food security situation of vulnerable groups, particularly women, children and the elderly, and their nutritional status, including the prevalence of micronutrient deficiencies. The City's food policies must include inclusiveness in the design, implementation, management, monitoring and evaluation of programs to increase the production and consumption of healthy and nutritious foods, particularly those rich in micronutrients. Food policies in the City of Tshwane must allow for innovative approaches to increase dietary diversity in disadvantaged communities. For example, municipalities such as the City of Johannesburg have encouraged food gardens at home and in schools as well as roof gardening as a means of combating micronutrient deficiencies and encouraging healthy eating. The results of the study have illustrated affordability as a contribution to persistent low dietary diversity, which in turn serves as an obstacle to human development. Food policies that increase access to food are necessary for improved dietary requirements for food-insecure households in the City of Tshwane. We therefore advocate food policies that cater to food banks, where emergency food is delivered to food-insecure households in distress.

Conclusions

This article utilized the PCA analysis to analyze dietary patterns among the City of Tshwane food insecure households. The Simpson Index was used for profiling the HDD categories, a prerequisite for the PCA analysis. Findings from the Simpson Index classified the households as either low dietary diverse or very low dietary diverse. Interpretation of the patterns from the PCA loadings showed four components. The first component was associated with vegetarians. The second component was associated with people that consume sugar, honey and miscellaneous products [coffee, tea, soft drinks and instant foods). The third group comprised of people that consume fats and proteins, eggs and milk products. The final group was associated with the consumption of mostly cereals. It is clear from the results that the HHD patterns adopted by the City of Tshwane urban food insecure are in income shocks and the households' struggles to stretch limited resources. This confirm the findings of,[40] that the urban South African populations have limited dietary intake and are more food insecure because of high levels of poverty, unemployment, and lack of land. These urban dwellers are therefore more sensitive to changes in incomes and food prices because they lack safety nets to absorb income or price shocks as they purchase more, rather than growing their own food. This compromises nutritional safety, mostly of the vulnerable household members including women and children, as they have limited access to diverse foods. Awareness of nutritional adequacy and a balanced diet is necessary for instances of income inadequacy. Optimal remedial measures may be those that provide some income relief and improve their disposable income and increase consumption to reduce the potential of malnutrition as a result of eating smaller food portions. In instances where the City of Tshwane is incapacitated due to other service delivery challenges, other indirect measures might be necessary. These include adjusting access to public works employment, adjusting wage rates paid on such employment and possibly adjusting the level of social grants received by the poor, to increase households' disposable income. Finally, community feeding schemes should be initiated for poor households. The existing Basic Education feeding scheme only caters for the school-going children, neglecting the other vulnerable members of society. Additionally, the feeding schemes provide a single meal per day and do not cater for weekends.

Notes

1. This study was carried out in City of Tshwane Metropolitan Municipality, also known as Pretoria. Pretoria is the capital city of South Africa with a total population of 74 651, and a total area of 687.5 km2. City of Tshwane Metropolitan Municipality falls under the Gauteng Province of South Africa. The province is divided into nine districts namely, Tshwane, Johannesburg, Ekurhuleni, Lesedi, Midvaal, Emfuleni, Merafong, Rand West and Mogale. The total area of the province is 18 176 km2 with an estimated population of 3 676 300.[29]

2. Eigen values are simply the coefficients attached to eigenvectors (principal components) ranked in descending order of their Eigen values to arrive at the principal components in order of significance. The Eigen values measure the data's covariance (correlation) (Yang, 2015).

3. The rotated component matrix, also called the loading(s), is the key output of PCA. It contains estimates of the correlations between each of the variables and the estimated components.

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