Mapping food access across Cape Town, South Africa

Cassandra da Cruz

19 May 2020

Introduction

Cape Town is a multicultural metropolitan and the second most populous city in South Africa, home to some 3.7 million people [1]. Despite the end of Apartheid in 1994 with the first multiracial democratic elections, inequality across the city is still profoundly evident. Historically racially separated suburbs have remained demographically homogeneous and underprivileged areas have stayed impoverished. As the city's economy has grown and supermarket chains have expanded across the city, this has not necessarily led to an increase in food security or easier access for all citizens in the metropolitan. The State of Household Food Security Survey in 2018 revealed that almost half of Cape Town households were moderately or severely food insecure [2]. Despite post-Apartheid South Africa's increasing participation in the global economy and an average annual economic growth of 2.8% from 1994 to 2018, 25% of South African citizens lived below the food poverty line in 2015 [3], [4].

The Sustainable Development Goals prioritise ending hunger, achieving food security and improving nutrition [5]. Food security is therefore a focus for South Africa, a middle-income emerging economy with extensive inequality. Food security is defined by the United Nations as "all people, at all times, having physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" [6]. Access to economic resources is not the only barrier to food security for residents of Cape Town. The geography of a city influences the livelihood strategies a household can employ as well as their proximity to sources of food [7]. Furthermore, different food sources provide varying access to fresh and affordable food.

Problem

This short report seeks to describe the relationship between the geography of Cape Town, the location of poor households and their access to different types of food sources. Malnutrition in the city is a hidden hunger, partly due to wide access to energy-dense, nutrient-deficient foods. Many residents can reach their energy intake requirements, but not their macro- and micro-nutrient requirements for a healthy lifestyle [8]. As the State will shoulder the majority of the burden of diabetes, heart disease and obesity associated with poor diet, it is in the best interests of policymakers to address food insecurity across the city.

Approach

Census data from 2011 will be used to determine the number of people, number of households and percentage of indigent (impoverished) households per voting ward in the City of Cape Town municipality. A household is classified as indigent if their combined monthly income is R3 200 or less (about $175). A GeoJSON file will be used to construct a choropleth

map of the 111 wards and the percentage of indigent households per ward. The Foursquare Places API will be used to search for all venues around the center of each ward with a 2 500 m radius and a limit of 1 000 venues. The venues data returned is refined by removing all non-food venues and then classifying the food venues into fresh food (supermarkets, green grocers, butchers), fringe food (fast food, tuck shops) and restaurants. The wards will then be k-means clustered according to quintiles of indigent households and the number of food venues per category (fresh food, fringe food, restaurants). This will then be plotted over a map of Cape Town.

Background

History of segregation in Cape Town

Cape Town was first colonised by the Dutch East India Company in 1652, bringing with them slaves from Indonesia, Philippines, Madagascar, East Africa, India, and Sri Lanka. The British invaded the Cape in 1795, taking control of the area from the Dutch and forming the Cape Colony.

After the onset of British rule, many Dutch-speaking pastoral settlers, “Boers”, came to resent the administration. From 1836 onwards, Boers from the Cape migrated eastwards into the interior of the country in *The Great Trek*, founding three autonomous Boer republics and displacing tribal kingdoms [9]. The national economy flourished with the discovery of diamonds in Kimberley in 1867 and gold in Witwatersrand in 1884. Under colonial rule, official segregation and movement laws based on race were passed in 1923 [10]. This formed the precursor to Apartheid.

After the end of World War II, the South African economy enjoyed industrialised growth and many Black and Coloured people then moved to Cape Town for newly created jobs. Coloured people represent the multi-racial descendants of the ex-slave population [11]. This movement led to the emergence of shanty towns (“townships”) on the periphery of the city in the Cape Flats [10]. The location of the Cape Flats is indicated in an extract map from Cape Town Tourism, shown in Figure 1 [12].

In 1948, the pro-Afrikaner National Party won the national election whilst promoting the ideology of Apartheid. This set off the forced evictions of Black and Coloured people from “mixed” areas around the country, including suburbs of Cape Town. Before these removals began, one third of Cape Town residents lived in a mixed-race area. By 1982, under the Group Areas Act, 200 000 Black and Coloured people out of 1 million Cape Town residents were moved to purpose-built ghettos in the Cape Flats [10]. Figure 2 shows the suburbs Black, Coloured and Indian residents were evicted from and the suburbs they were moved to. The racial makeup of Cape Town in the 1980s was 55% Coloured, 30% White and 15% Black [10]. This is important to note, as Apartheid gave many social and economic preferences to Whites first, Coloureds second and Blacks last.

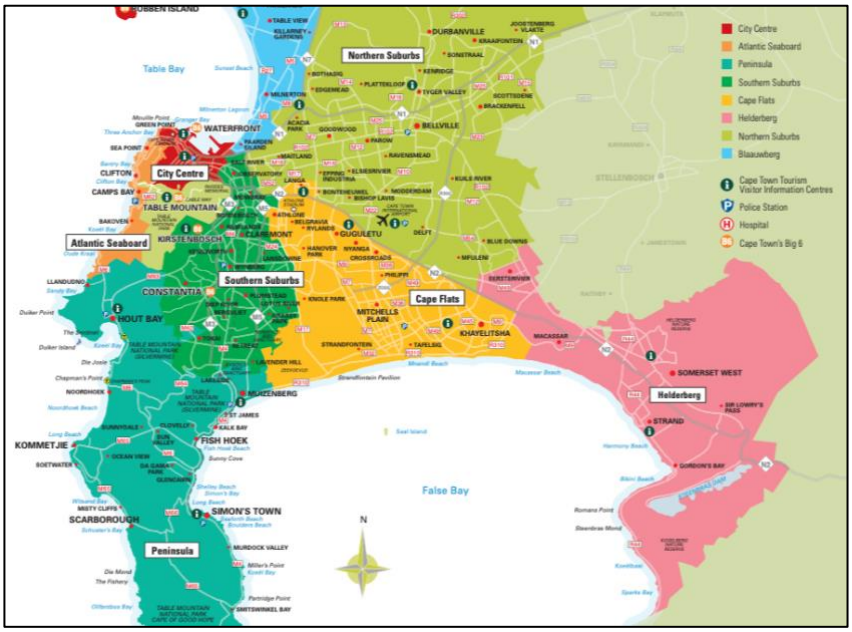

Figure 1: Map of Cape Town indicating the location of the city centre (red) and the Cape Flats (yellow) (retrieved from Cape Town Tourism)

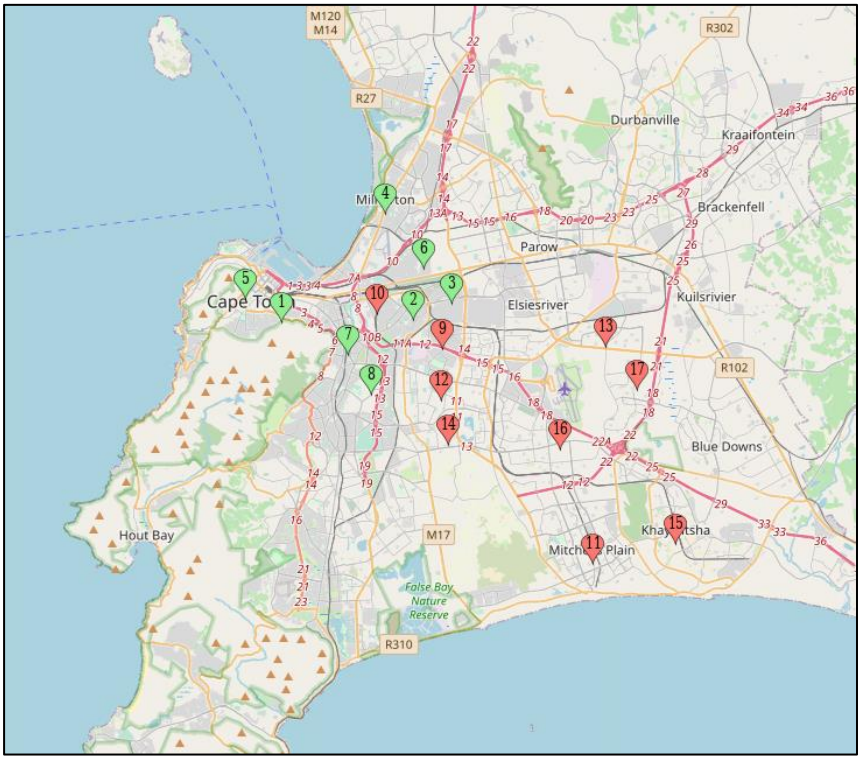

Figure 2: Map of Cape Town showing mixed race suburbs (green) that Black, Coloured and Indian residents were evicted from and the suburbs they were moved to (red) from 1948 - 1982 under the Group Areas Act [13]

By 1986, limited reforms of Apartheid were being rolled out and the Pass laws (movement restriction rules) were repealed. Many Black South Africans from the Eastern Cape moved to Cape Town in search of better opportunities, fleeing deliberately underdeveloped "Bantu homelands". Townships on the outskirts of Cape Town, such as Khayelitsha, expanded because of this influx of migrants [10].

Despite the end of Apartheid, present day Cape Town suburb demographics still reflect Apartheid-era forced removals, enforced – in part – by the sustained economic exclusion of these groups. The Cape Flats and peripheral townships remain poorer and more densely populated than historically white suburbs [1].

Present day socioeconomics of Cape Town

Out of 1.07 million households in Cape Town, 48% have a combined household income of R3 200 a month or less (approximately $175 a month) [1]. This classifies the household as indigent (requiring social assistance with municipal services) and at the edge of the poverty line. The poverty line is defined as enough money to buy the minimum amount of food required for every household member as well as essential non-food items, such as toiletries [14].

Food deserts in Cape Town

A food desert is defined as an area with limited access to affordable and nutritious food and is often used to describe an economically-disadvantaged urban area [15]. Studies in food deserts often place an emphasis on the "proximity and density of retail food outlets in a specific neighbourhood as markers of access to affordable, healthy food" [16].

Supermarket expansion

As supermarkets and other food retail outlets have expanded across Cape Town in the last two decades, the effects of these on food security in the city are of interest. By the early 2000s, supermarket sales in South Africa already made up between 50% to 60% of food retail sales, despite only accounting for 2% of outlets [17]. The major drivers of supermarket expansion in the city have been urbanisation, economic growth, and improved household storage capacity. Improvements in transport infrastructure in townships have also made accessing large centralised stores easier [18].

Not all South African supermarkets are equal. Woolworths, Checkers, Pick n Pay, Spar and Food Lover's Market stores concentrate on high income customers. Shoprite and the OK Franchise stores focus on the mass of middle-income customers whilst USave, Cambridge Foods and Boxer stores focus on low income customers [19]. Supermarkets servicing lower income customers tend to stock little to no fresh produce, a limited supply of dairy and meat and an abundance of dry cereals, canned goods, oils, rice, and other non-perishable goods. As the average income of a customer base increases, supermarkets stock more dairy, meat and fresh produce [20].

Food retailers in Cape Town

A study on food insecurity in Cape Town demonstrated that residents in the city utilised three main food sources: supermarkets, small formal retail outlets (butchers, grocers, fast food chains) and informal retailers (street-side grocers and "spaza" shops) [7]. Spaza shops

(informal convenience stores) are a key component of food access in low income suburbs as they are located close to poorer households than supermarkets [20].

These three major food retailer types are not evenly distributed across the city and not equally frequented by all income groups. In 2014, the richest quintile of Cape Town suburbs had eight times the number of supermarkets per 1 000 households as the poorest quintile of suburbs. Indigent households in Cape Town only visited supermarkets once a month on average, but visited informal retailers on a weekly or daily basis [2]. The advantages and disadvantages of these different food sources are outlined in the Table 1 [7].

Table 1: Food source types their advantages and disadvantages

Food source	Advantages	Disadvantages
Supermarkets	• Large range of foods (in medium/high income stores) • Low price per unit goods • High safety standards	• Unit sizes unaffordable for poor households • Inconvenient location and hours • No credit offered
Spaza shops/ informal retailers	• Small unit sizes are more affordable • Often sell food on credit with low to no interest • Convenient hours and location	• Cost per unit is high • Perceived low quality of food • Limited variety of fresh foods (preference given to canned and dry food with a long shelf life)
Street-side grocer	• Convenient location near transport hubs and on residential streets • Restocked daily from farm supplier • Cheaper than supermarkets	• Short shelf life (no cold chain storage)
Street-side meat vendor	• Cultural meat preferences (e.g. offal) • Large variety of cuts • Perceived better taste from freshly slaughtered meat	• Low food safety standard

It has been argued that supermarket expansion in the city could negatively impact food security as it can drive out some smaller businesses by absorbing their demand [21]. The retail food sales of 1 700 supermarkets equalled that of 350 000 spaza shops in 2010 [22]. The

informal sector is still very important in servicing poorer households' demand, making up 30% of national food retail sales [23].

Geography as a factor of food security

The proximity of food sources to a household is not the only way in which the geography of a city influences food security. The location of a household will influence what livelihood strategies a household can employ (for example, how far they are from workplaces) [7]. Time and transport costs also factor in when visiting different food sources. If a household member works in a more affluent and developed area, they can visit nearby food retail outlets as part of their daily commute cost. For unemployed households, accessing supermarkets includes a large transport cost [24]. This is of importance in Cape Town, where 25% of working age people are not in education, employment, or training (NEET) [25].

Food security policy

Within urban areas, including Cape Town, food insecurity is complex as residents follow the nutrition transition typically found in developing countries. The nutrition transition represents a shift in dietary consumption and energy expenditure coinciding with economic growth. Diets traditionally high in cereal, fibre and vegetables are replaced with a more Western diet high in sugars, fats, and animal-source foods. The transition of diet often corresponds with epidemiological changes including a higher prevalence of chronic and degenerative diseases [26]. Current South African policy does not address the systemic issues that inform the food choices people make, but rather focuses on increasing food production. There is still a belief within the global community that African food insecurity is as a result of scarcity of food and people being simply too poor to access adequate foods [27].

Over half of South Africans are overweight or obese and it is often assumed that this is attributable to the personal failings of people to choose healthier diets. The response to this phenomenon has therefore been to provide nutrition education to help people choose better diets [8]. However, this reaction does not address the irregularities in food availability and variety in different areas. There has been a dramatic shift in the South African diet, with snack bars, ready meals and noodle sales volumes increasing by 40% from 2005 to 2010. The number of Coca-Cola products consumed per South African per year has increased from 130 products in 1992 to 254 products in 2010 [28] and the price of fresh foods has increased faster than that of processed foods [29].

As diet-related degenerative diseases are directly linked to urban food deserts and these will require state support and care [30], it is in the best interests of policy makers and the government to address food insecurity. It has been contended that addressing food deserts is not a problem that can or should be solved by large retailers, but rather through the agency of communities alongside policymakers [31].

Description of data

The City of Cape Town municipality was divided into 111 voting wards in 2011 with an average of 34 000 people and 9 600 households per ward [1]. In 2016, 4 new wards were added by sub-dividing larger wards. The 2011 ward classifications will be used as the census data on household income was collected the same year. The GeoJSON file for plotting these wards was retrieved from the City of Cape Town [32]. The centre of each ward was manually determined and the latitude and longitude thereof recorded. This was done as the wards were not of equal size.

The number of people, number of households and percentage of households classified as indigent were retrieved from the 2011 census [1]. The Foursquare Places API was used search for all venues within 2 500 m of a ward centre with a limit of 1 000 venues per ward.

Methodology

The GeoJSON file of ward data (2016) was downloaded from the City of Cape Town municipality website (source) and read into the notebook. This method was used as directly downloading into the notebook from the website was rate limited. The GeoJSON file was read in as a geodataframe and contained the polygons and locations that represent the 116 voting wards of Cape Town. The ward polygons were then merged into the 2011 ward allocations to 111 wards. The demographics and statistics of each ward were then correctly geographically attributed.

The 2011 census data was collected from an online database and compiled in a Microsoft Excel file. This data includes the location of the centre of the ward, population size, number of households, demographics, and other socioeconomic indicators for each ward. These socioeconomic indicators include the percentage of residents aged 20 years or older than have completed high school, the percentage of households with a monthly income of less than R3 200, the percentage of households living in a formal dwelling, the percentage of households with access to piped water in their dwelling or yard, the percentage of households with access to a flush toilet, the percentage of households that have their refuse removed at least once a week, and the percentage of households with an electricity connection.

A choropleth map of the wards of Cape Town and the percentage of households living below the poverty line per ward was generated. This map, shown in Figure 3, demonstrates that the distribution of poverty across the city is not evenly spread and is focused in the Cape Flats.

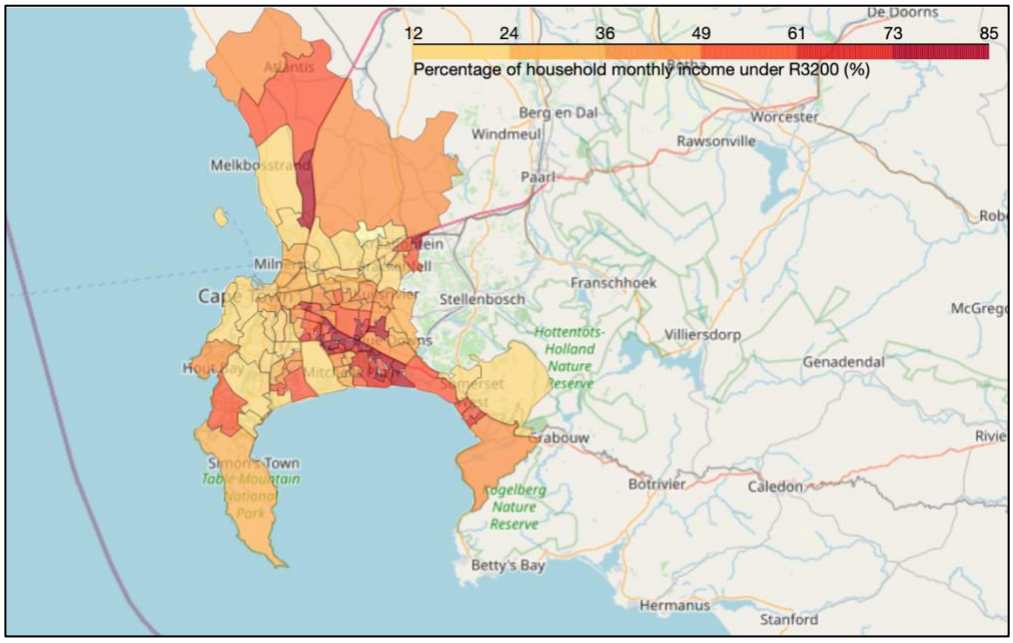

Figure 3: Choropleth of percentage of households with a monthly income under R3200 per ward of Cape Town (2011)

The Foursquare API was used to search for all venues within 2 500m of each ward centre with a limit of 1 000 venues per ward. The radius of 2 500m was chosen as this encompasses the area of most wards and a limit of 1000 venues per ward was chosen so that the program did not take too long to run. The name of the venue, its location, the ward it is in and the venue category is stored. This was performed over 111 wards and returned a dataframe of 12 960 venues. This number is very low for a metropolitan of 3.7 million people.

The venue categories from the retrieved venues was studied and a list of food related categories was generated. This list was used to filter all the venues retrieved to just food venues. This reduced the total number of venues from 12 960 to 1 868, incredibly low for such a large city.

The food venues were then further categorised into three major categories, namely fresh foods, fringe foods and restaurants. These categories represent different types of food sources for residents. Fresh food venues supply fresh vegetables, meats, and dairies for a healthy and balanced diet. This includes venues such as bakeries, supermarkets, and butcheries. Fringe food venues supply processed or junk food that is cheap, but lacking in nutrients for a balanced diet. Examples include fast food restaurants, convenience stores and tuck shops. Restaurants are much more expensive per meal than either fresh foods or fringe foods and often cater to the upper middle class, upper class, and tourists. As these are not daily food sources for most residents, they form their own category. There are 301 fresh food venues, 1 142 fringe food venues and 424 restaurant venues. The food venue categories were one-hot encoded for K-means clustering and grouped by ward. The fraction of a food venue category as a portion of total food venues per ward was calculated.

The percentage of indigent households per ward was classified into quartiles and one-hot encoded for K-means clustering. The minimum percentage of indigent households per ward

was 13% (ward 70, Welgemoed in the Northern Suburbs) and the maximum was 84% (ward 89, Nonqubela in Khayelitsha).

The wards were K-means clustered based on the fraction of the food venue categories as a portion of total food venues in each ward and each wards' quartile of indigent households. K-means clustering seeks to group similar data points into k groups to discover underlying patterns, whilst minimising within-cluster variances. A sample of input data for clustering was ward 1, which had fresh food venues making up 11.5% of total food venues, fringe food venues making up 61.5% of total food venues and restaurants making up 27% of total food venues. The percentage of indigent households in the ward (15%) placed it in the first quartile.

The data was clustered into 2 – 7 clusters, with all clusters homogeneously grouping by quartile indigent households. It was then decided to cluster the data into 5 groups to see if any differences between quartiles would emerge. The clustered wards were then displayed using coloured markers over a choropleth of Cape Town wards and percentage of poor households per ward.

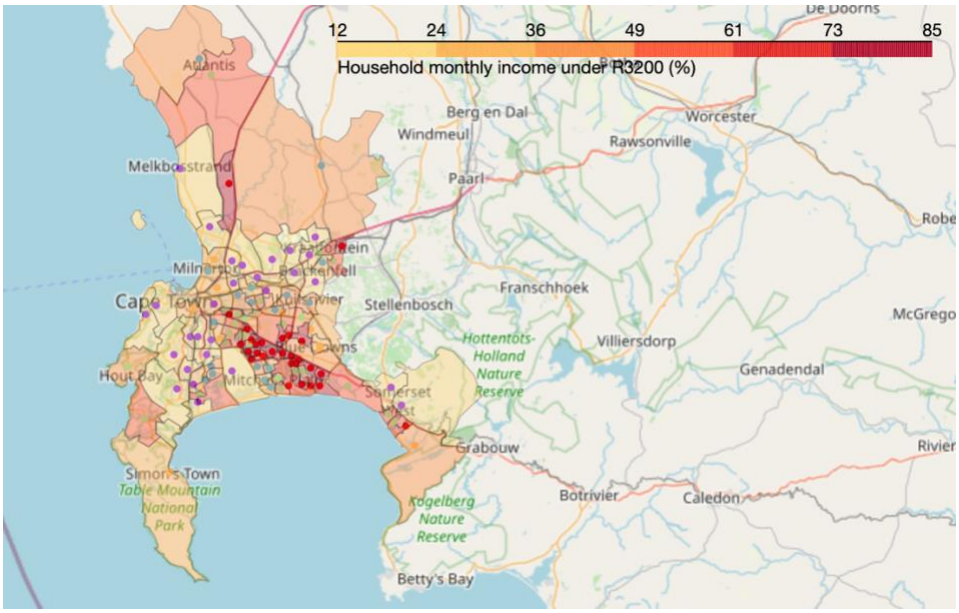

Figure 4: Wards of Cape Town K-means clustered on prevalence of fresh food, fringe food and restaurants as well as quartile of indigent households

The clusters were examined in a dataframe to see if any pattern in prevalence of food categories per ward or percentage of indigent households per ward emerged. As all clusters were homogenous for the quartile of indigent households that they represented, further analysis was required. Only quartile 2 wards were split into two clusters, with both being homogenous for quartile.

Further statistical analysis

Scatterplots

The relationship between percentage of indigent households per ward and the prevalence of food categories per ward was further investigated using scatterplots. For each food venue

category, the number of food venues per 1 000 ward residents was calculated. This was then plotted against the percentage of indigent households per ward. This calculation was used to control for the difference in population sizes between wards.

The ratio of fresh food to fringe food venue prevalence across the percentage of households classified as indigent was generated on a scatterplot. This was calculated as the number of fresh food venues per 1 000 ward residents divided by the number of fringe food venues per 1 000 ward residents. This is worth investigating as this impacts the food options for ward residents. It is ideal that a lower number of fringe food venues be available compared to fresh food venues, so that it is easier for citizens to access healthier options for their diets. This must not come at the sacrifice of overall food access, however.

The total number of food venues per 1 000 ward residents is plotted against the percentage of households classified as indigent. This was worth investigating as overall food access also impacts the food security of a community. An analysis of these scatterplots can be found in the results section of this report.

Simple linear regression plot and analysis

The variables outlined in Table 2 were plotted in a simple linear regression and an ordinary least squares regression analysis was performed on each pair. This was done to determine if there were any basic relationships or associations between these variables. The regression analysis was specifically used to confirm the strength of any relationship using the R^2 value and the probability of the F-statistic.

- The R^2 and adjusted R^2 value represent the coefficient of determination and the percentage of variation in y that is accounted for by x. The larger this percentage, the stronger the relationship between these two variables.
- The probability of the F-statistic shows the overall significance of the regression. The null hypothesis is that all regression coefficients are equal to zero. The probability of the F-statistic is the probability of the null hypothesis being true.

Table 2: x and y variable pairs analysed using simple linear regression plots and ordinary least squares regression analysis

$\boldsymbol{x\ variable}$	$\boldsymbol{y\ variable}$
$percentage\ of\ households\ classified\ indigent$	$\frac{Number\ of\ fresh\ food\ venues}{1000\ ward\ residents}$
$percentage\ of\ households\ classified\ indigent$	$\frac{Number\ of\ fringe\ food\ venues}{1000\ ward\ residents}$
$percentage\ of\ households\ classified\ indigent$	$\frac{Number\ of\ restuarant\ venues}{1000\ ward\ residents}$

$percentage\ of\ households\ classified\ indigent$	$\frac{Number\ of\ fresh\ food\ venues}{Number\ of\ fringe\ food\ venues}$
$percentage\ of\ households\ classified\ indigent$	$\frac{Number\ of\ food\ venues}{1000\ ward\ residents}$

Results

Scatterplots

Food venue prevalence vs percentage of households classified indigent

The scatterplot in Figure 5 shows the number of fresh food, fringe food and restaurant venues per 1 000 ward residents plotted against the percentage of households classified as indigent per ward.

- For fresh food venues, shown in red, there appears to be no correlation between prevalence and poverty across wards.
- For fringe food venues, shown in blue, there appears to be no correlation between prevalence and poverty across wards. There appears to be a consistently larger prevalence of fringe food venues than fresh food venues across all wards and may be worth further investigation.
- For restaurant venues, shown in green, there appears to be no strong correlation between prevalence and poverty across wards. The prevalence of restaurants per 1 000 ward residents is similar to fresh food venue prevalence.

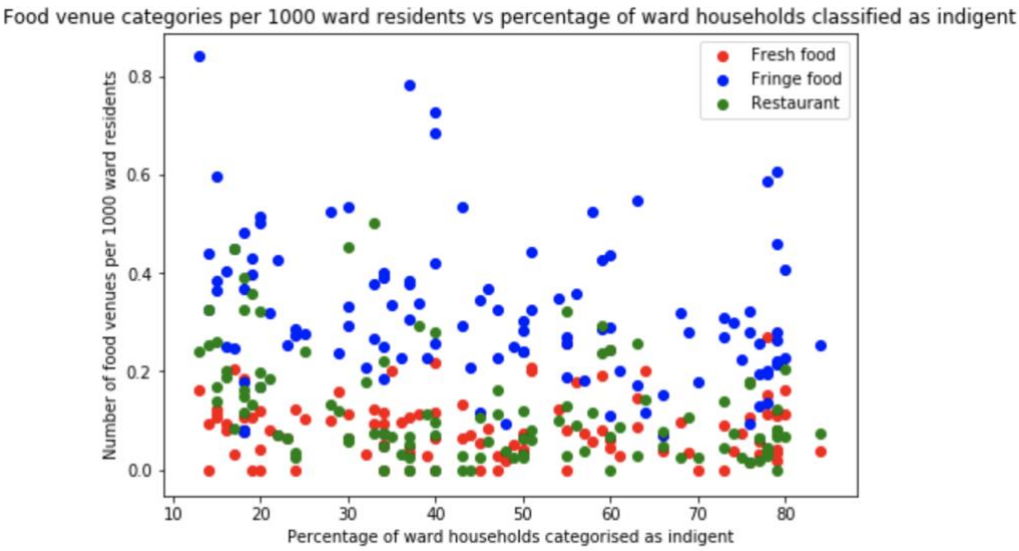

Figure 5: The number of fresh food, fringe food, and restaurant venues per 1000 ward residents per ward vs the percentage of households classified as indigent per ward

Ratio of prevalence of fresh food to fringe food vs percentage of households classified indigent

The scatterplot in Figure 6 shows the ratio of fresh food venues per 1 000 ward residents to fringe food venues per 1 000 ward residents plotted against the percentage of households classified as indigent per ward.

- There appears to be no correlation between the fresh to fringe food prevalence ratio and poverty across wards.
- There is, however, a larger number of fringe food venues than fresh food venues for all but three wards. This shows that it would be much easier for residents in almost all wards to access unhealthier fringe food options than fresh foods ones. This would have a negative impact on public health across all wards and income groups.
- This ratio does not control for overall food access in a ward.

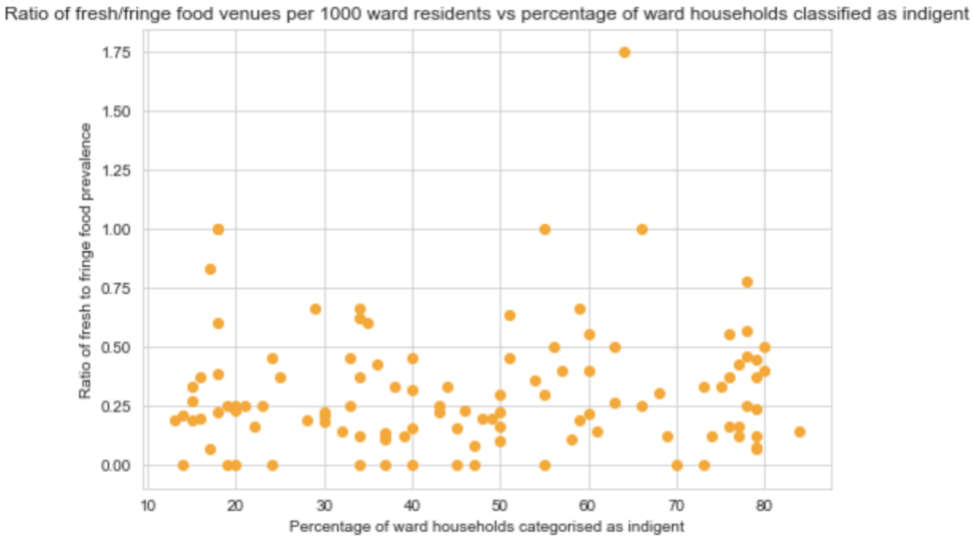

Figure 6: Ratio of fresh food to fringe food venues per 1000 ward residents vs percentage of households classified as indigent per ward

Total food venue prevalence vs percentage of households classified as indigent

The scatterplot in Figure 7 shows the total number of food venues per 1 000 ward residents plotted against the percentage of households classified as indigent per ward.

- There appears to be no correlation between prevalence of food venues and poverty across wards.

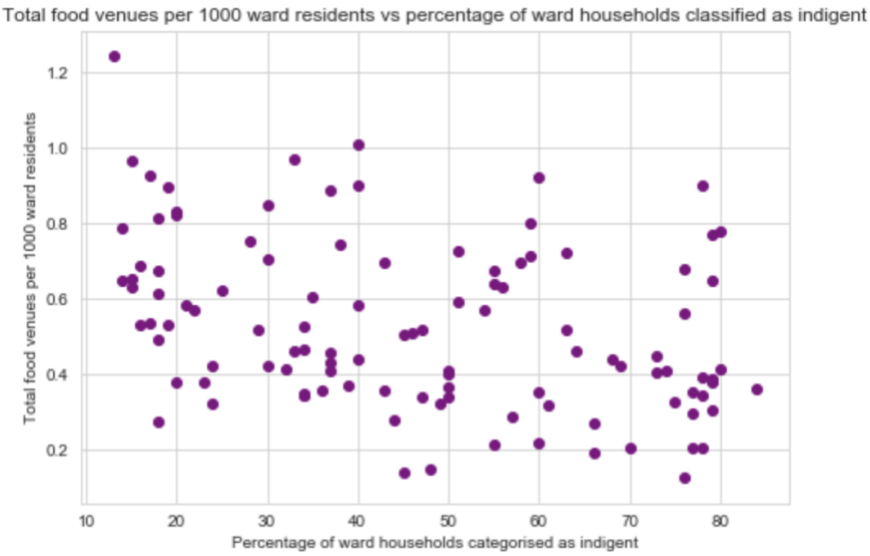

Figure 7: Total food venues per 1000 ward residents vs percentage of households classified as indigent

Simple linear regression plot and analysis

Number of fresh food venues per 1 000 ward residents vs percentage of households classified as indigent

The least squares regression shows no correlation between the number of fresh food venues per 1000 ward residents and the percentage of households classified as indigent in a ward.

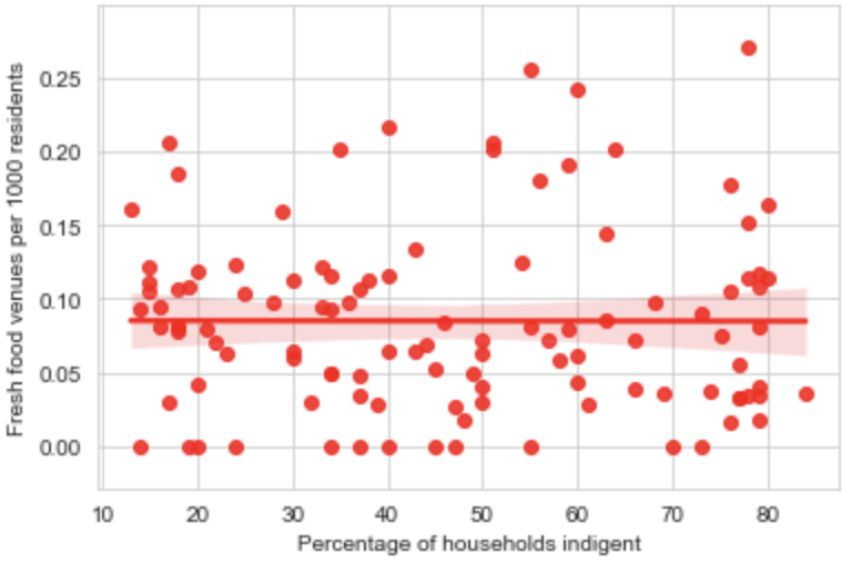

Figure 8: Fresh food venues per 1000 ward residents vs percentage of households classified as indigent

From the ordinary least squares regression analysis results:

- R^2 = 0.000 and adjusted R^2 = -0.009. This shows no correlation between these two variables.
- Prob(F-statistic) = 0.987. This shows that the null hypothesis of the regression coefficients being equal to zero is likely true.

OLS Regression Results

Dep. Variable:	y	R-squared:	0.000
Model:	OLS	Adj. R-squared:	-0.009
Method:	Least Squares	F-statistic:	0.0002788
Date:	Sat, 30 May 2020	Prob (F-statistic):	0.987
Time:	16:20:28	Log-Likelihood:	151.88
No. Observations:	111	AIC:	-299.8
Df Residuals:	109	BIC:	-294.3
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.0851	0.014	6.069	0.000	0.057	0.113
x1	-4.561e-06	0.000	-0.017	0.987	-0.001	0.001

Omnibus:	11.840	Durbin-Watson:	1.261
Prob(Omnibus):	0.003	Jarque-Bera (JB):	12.539
Skew:	0.808	Prob(JB):	0.00189
Kurtosis:	3.310	Cond. No.	122.

Figure 9: Ordinary least squares regression analysis of fresh food venues per 1000 ward residents versus percentage of households classified as indigent per ward

A possible reason for this observation is that supermarkets have expanded further into all suburbs of Cape Town. The number of supermarkets per ward does appear to be low, suggesting that the Foursquare Places data source undercounts this. This number does not consider any informal meat or vegetable traders, either.

Number of fringe food venues per 1 000 ward residents vs percentage of households classified as indigent

The least squares regression shows a very weak negative correlation between the number of fresh food venues per 1000 ward residents and the percentage of households classified as indigent in a ward.

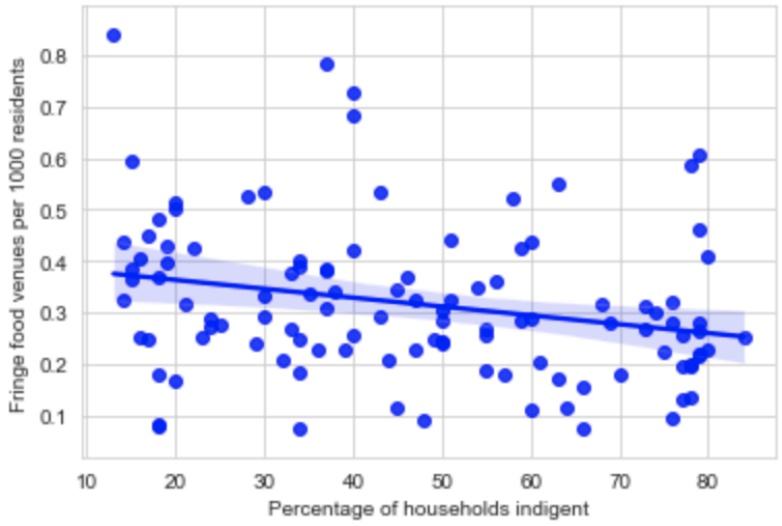

Figure 10: Fringe food venues per 1000 ward residents vs percentage of households classified as indigent

From the ordinary least squares regression analysis results:

- R^2 = 0.062 and adjusted R^2 = 0.054. This shows no significant correlation between these two variables.

- Prob(F-statistic) = 0.008. This shows that the null hypothesis of the regression coefficients being equal to zero is not true.

OLS Regression Results

Dep. Variable:	y	R-squared:	0.062
Model:	OLS	Adj. R-squared:	0.054
Method:	Least Squares	F-statistic:	7.267
Date:	Sat, 30 May 2020	Prob (F-statistic):	0.00814
Time:	16:20:29	Log-Likelihood:	57.418
No. Observations:	111	AIC:	-110.8
Df Residuals:	109	BIC:	-105.4
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.3974	0.033	12.098	0.000	0.332	0.463
x1	-0.0017	0.001	-2.696	0.008	-0.003	-0.000

Omnibus:	18.884	Durbin-Watson:	1.992
Prob(Omnibus):	0.000	Jarque-Bera (JB):	23.699
Skew:	0.921	Prob(JB):	7.14e-06
Kurtosis:	4.317	Cond. No.	122.

Figure 11: Ordinary least squares regression analysis of fringe food venues per 1000 ward residents versus percentage of households classified as indigent per ward

A possible reason for this observation is that fringe food venues have expanded across all areas of Cape Town as they are popular with all income groups. The fringe food venue type may differ across these areas, with cheaper fast food brands choosing poorer suburbs over wealthier ones. Informal spaza shops and tuckshops may not be accounted for in the Foursquare data and the overall number of fringe food venues still appears to be very low, suggesting undercounting by the source.

Number of restaurant venues per 1 000 ward residents vs percentage of households classified as indigent

The least squares regression shows a very weak negative correlation between the number of restaurant venues per 1000 ward residents and the percentage of households classified as indigent in a ward.

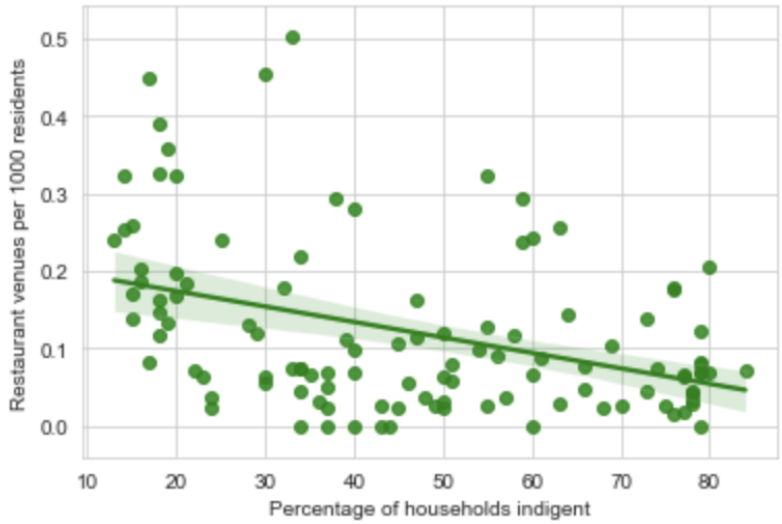

Figure 12: Restaurant venues per 1000 ward residents vs percentage of households classified as indigent

From the ordinary least squares regression analysis results:

- R^2 = 0.159 and adjusted R^2 = 0.151. This shows no significant correlation between these two variables.
- Prob(F-statistic) = 1.5×10^{-5}. This shows that the null hypothesis of the regression coefficients being equal to zero is not true.

Dep. Variable:	y	R-squared:	0.159
Model:	OLS	Adj. R-squared:	0.151
Method:	Least Squares	F-statistic:	20.60
Date:	Sat, 30 May 2020	Prob (F-statistic):	1.47e-05
Time:	16:20:29	Log-Likelihood:	99.036
No. Observations:	111	AIC:	-194.1
Df Residuals:	109	BIC:	-188.7
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.2141	0.023	9.480	0.000	0.169	0.259
x1	-0.0020	0.000	-4.538	0.000	-0.003	-0.001

Omnibus:	23.366	Durbin-Watson:	1.780
Prob(Omnibus):	0.000	Jarque-Bera (JB):	30.315
Skew:	1.132	Prob(JB):	2.61e-07
Kurtosis:	4.197	Cond. No.	122.

Figure 13: Ordinary least squares regression analysis of restaurant venues per 1000 ward residents versus percentage of households classified as indigent per ward

A possible reason for this observation would be that restaurants cater for richer customers so it would make sense for them to be in tourist areas or wealthier suburbs. The number of restaurants per ward seems quite low, suggesting that the Foursquare Places source undercounted these.

Ratio of fresh food venues/fringe food venues per ward and percentage of households classified as indigent

The least squares regression shows no correlation between the ratio of fresh food venues/fringe food venues per ward and the percentage of households classified as indigent.

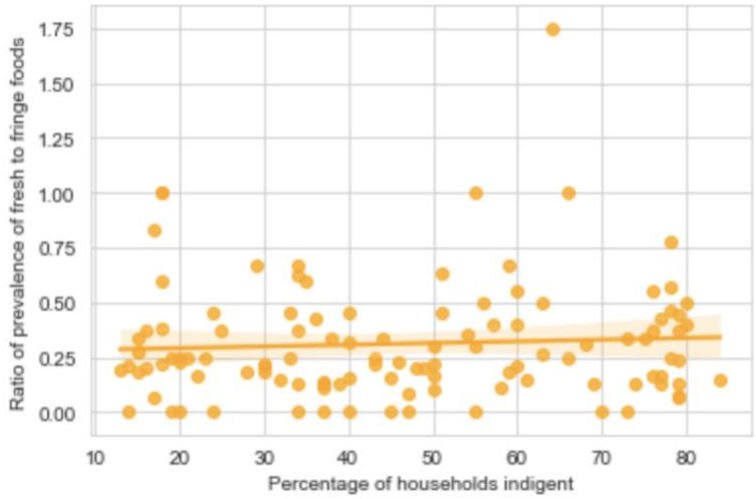

Figure 14: Ratio of fresh food venues/fringe food venues per ward vs percentage of households classified as indigent

From the ordinary least squares regression analysis results:

- R^2 = 0.004 and adjusted R^2 = -0.005. This shows no significant correlation between these two variables.
- Prob(F-statistic) = 0.517. The probability of the null hypothesis being true is inconclusive.

OLS Regression Results

Dep. Variable:	y	R-squared:	0.004
Model:	OLS	Adj. R-squared:	-0.005
Method:	Least Squares	F-statistic:	0.4230
Date:	Sat, 30 May 2020	Prob (F-statistic):	0.517
Time:	16:20:30	Log-Likelihood:	-10.895
No. Observations:	111	AIC:	25.79
Df Residuals:	109	BIC:	31.21
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.2760	0.061	4.540	0.000	0.155	0.396
x1	0.0008	0.001	0.650	0.517	-0.002	0.003

Omnibus:	64.763	Durbin-Watson:	1.900
Prob(Omnibus):	0.000	Jarque-Bera (JB):	278.885
Skew:	2.020	Prob(JB):	2.76e-61
Kurtosis:	9.632	Cond. No.	122.

Figure 15: Ordinary least squares regression analysis of ratio of fresh food venues/fringe food venues per ward versus percentage of households classified as indigent per ward

What is notable is that the number of fringe food venues per ward is almost consistently larger than the number of fresh food venues, barring three wards. (This is shown with a ratio less than 1.) This phenomenon is not linked to wealth and shows that this facet of food security may be a problem across the entire Cape Town area.

Total number of food venues per 1 000 ward residents and percentage of households classified as indigent

The least squares regression shows a weak negative correlation between the number of food venues per 1000 ward residents and the percentage of households classified as indigent in a ward.

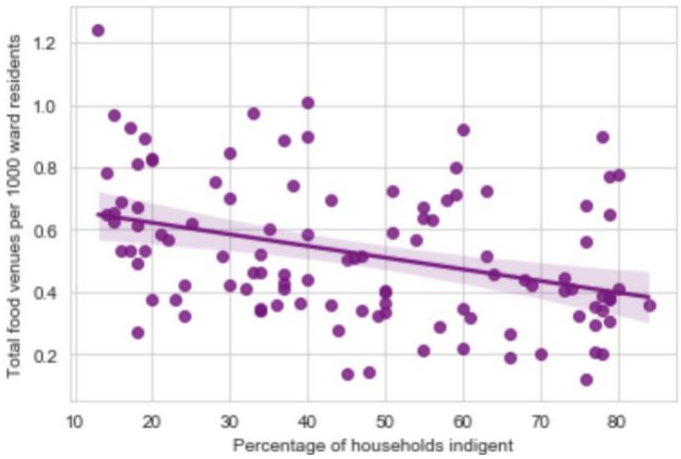

Figure 16: Food venues per 1000 ward residents vs percentage of households classified as indigent

From the ordinary least squares regression analysis results:

- R^2 = 0.132 and adjusted R^2 = 0.124. This shows no significant correlation between these two variables.
- Prob(F-statistic) = 8.9×10^{-5}. This shows that the null hypothesis of the regression coefficients being equal to zero is not true.

OLS Regression Results

Dep. Variable:	y	R-squared:	0.132
Model:	OLS	Adj. R-squared:	0.124
Method:	Least Squares	F-statistic:	16.58
Date:	Sat, 30 May 2020	Prob (F-statistic):	8.87e-05
Time:	16:44:50	Log-Likelihood:	17.720
No. Observations:	111	AIC:	-31.44
Df Residuals:	109	BIC:	-26.02
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.6966	0.047	14.829	0.000	0.604	0.790
x1	-0.0037	0.001	-4.072	0.000	-0.006	-0.002

Omnibus:	6.447	Durbin-Watson:	1.612
Prob(Omnibus):	0.040	Jarque-Bera (JB):	6.678
Skew:	0.591	Prob(JB):	0.0355
Kurtosis:	2.786	Cond. No.	122.

Figure 17: Ordinary least squares regression analysis of food venues per 1000 ward residents versus percentage of households classified as indigent per ward

This observation is notable as simple access to food sources is the backbone of basic food security. As the Foursquare data did not collect many venues or food venues for Cape Town, it would be interesting to see what a data source like Google Places would yield for this. (Google Places is much more popular than Foursquare Places in South Africa.)

The food venues counted in the current data source do not take informal traders into account. If the raw number of food venues per 1 000 ward residents did differ over the wealth of different suburbs with further analysis, this would be a major public health concern for policy

makers to address. This would also create an opportunity to promote the expansion of fresh food venues in poorer areas over franchised fast food and fringe food sources.

Discussion

This report sought to describe the relationship between the geography of Cape Town, the location of poor households and their access to different types of food sources. The number of fresh food venues, fringe food venues, restaurant venues, and total food venues per 1 000 ward residents was analysed against the percentage of households in a ward classified as indigent. There was also an attempt to cluster the wards by the prevalence of these three food venue categories and percentage of households classified as indigent.

Overall results

From the statistical analysis, there appeared to be no significant correlation between the prevalence of any food venue category and the percentage of households in that ward classified as indigent. This was used as a metric for gauging food security and access against poverty across areas in Cape Town. No conclusion can therefore be made on poorer suburbs having a lower prevalence of fresh food venues or total number of food venues. Therefore, no significant difference in food security across areas of different wealth can be concluded. This result should be interpreted with caution because the number of food venues returned per ward was sparse.

The clustering of wards by prevalence of different food venues and percentage of households classified as indigent was inconclusive, as the clustering was heavily skewed towards the quartile bin for household poverty classification. No recommendations can therefore be made to policy makers on classifications of areas around the city based on food access.

Critique of study

The largest shortcoming of this research project was the meagre number of venues returned by the Foursquare Places API call. This could be attributed to Google Maps being far more popular in South Africa than Foursquare. The next largest shortcoming was that any informal vendors were not accounted for in the venue data (and will probably not be accounted for when using Google Places, either). This excludes many food sources that make up a large portion of the food retail sector in poorer areas.

Recommendations

As the number of venues (including food venues) retrieved for each ward was much lower than anticipated, it is recommended that the same analysis be carried out using the Google Places API instead of the Foursquare Places API. It is also recommended that a method for estimating the location and number of informal food vendors per ward be considered if further analysis is performed. This could be done with a basic field survey per ward or using trader permit application data from the City of Cape Town. It would be prudent to make use of the upcoming 2021 census data for any follow up investigation, as the 2011 is currently 9 years old.

For further analyses, the burden of degenerative diseases per ward of Cape Town should be estimated using public and private hospital data to determine if there is any relationship

between food access and actual degenerative disease outcome. As this burden will mostly be carried by the state, effective planning of public health resources will be required to prepare for this.

Conclusion

In this report, the relationship between the geography of Cape Town, the location of poor households and their access to different types of food sources was analysed. This was done by using features of Foursquare data and census data such as the number of food venues, fresh food venues, fringe food venues, restaurants venues, and the percentage of households classified as indigent per 111 wards of Cape Town. These features were analysed using k-means clustering and linear regression analysis to determine if any relationship between features existed and the strength thereof. As food security is intrinsically linked to the prevalence of degenerative diseases and impacts public health, it would be in the best interests of policy makers and communities to determine where to focus their efforts.

No conclusion could be drawn on any relationships between food access, location, and poverty in the city as no statistically significant correlation was found. This could partly be attributed to the sparse number of food venues returned by the data source per ward. It is recommended that this research question be reanalysed using a larger food venue data source such as Google Places. It would also be prudent to determine the location and number of informal food vendors per ward that would not be included in this online data. No recommendations can therefore be made to policy makers or communities on the relationship between geography and food security in Cape Town.

Bibliography

[1] Statistics South Africa, "Census 2011 Statistical Release," October 2011. [Online]. Available: https://www.statssa.gov.za/publications/P03014/P030142011.pdf. [Accessed 22 May 2020].

[2] J. Crush, M. Caesar and G. Haysom, "The State of Household Food Security in Cape Town, South Africa," Hungry Cities Partnership, Waterloo, 2018.

[3] The World Bank, "GDP growth (annual %) - South Africa," The World Bank Group, 22 May 2020. [Online]. Available: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2018&locations=ZA&start=1994&view=chart. [Accessed 22 May 2020].

[4] Statistics South Africa, "Poverty Mapping in South Africa," Statistics South Africa, Pretoria, 2018.

[5] United Nations, "Sustainable Development Goal 2," United Nations, 2019. [Online]. Available: https://sustainabledevelopment.un.org/sdg2. [Accessed 23 May 2020].

[6] International Food Policy Research Institute, "Food Security," International Food Policy Research Institute, 2020. [Online]. Available: https://www.ifpri.org/topic/food-security. [Accessed 22 May 2020].

[7] J. Battersby, "The State of Urban Food Insecurity in Cape Town," *AFSUN Food Security Series (11),* vol. 1, no. 11, 2011.

[8] L. Joubert, "Food security: The optimal diet for people and the planet," *South African Medical Journal,* vol. 103, no. 11, pp. 809-810, 2013.

[9] T. O. Lloyd, The British Empire, 1558-1995, Oxford: Oxford University Press, 1997.

[10] J. Western, "A divided city: Cape Town," *Political Geography,* vol. 21, no. 5, pp. 711-716, 2002.

[11] Editors of Encyclopaedia Britannica, "Cape Coloured," Encyclopaedia Britannica, 2016. [Online]. Available: https://www.britannica.com/topic/Coloured. [Accessed 22 May 2020].

[12] Cape Town Tourism, "Cape Town City Map," A&C Maps, 2012. [Online]. Available: https://mapmyway.co.za/wp-content/uploads/2012/12/13-CapeTownCityRegional-LowRes.pdf. [Accessed 22 May 2020].

[13] C. da Cruz, "Map Customizer," Map Customizer, 22 May 2020. [Online]. Available: https://www.mapcustomizer.com/map/Forced%20removals%20Cape%20Town. [Accessed 23 May 2020].

[14] Statistics South Africa, "National Poverty Lines," Statistics South Africa, Pretoria, 2019.

[15] J. Battersby and J. Crush, "Africa's Urban Food Deserts," *Urban Forum,* vol. 25, pp. 143-151, 2014.

[16] J. Shannon, "Food deserts: Governing obesity in the neoliberal city," *Progress in Human Geography,* vol. 38, no. 2, 2014.

[17] D. Weatherspoon and T. Reardon, "The Rise of Supermarkets in Africa: Implications for Agrifood Systems and the Rural Poor," *Development Policy Review,* vol. 21, no. 3, pp. 333-355, 2003.

[18] T. Reardon, C. Timmer, C. Barrett and J. Berdegue, "The rise of supermarkets in Africa, Asia and Latin America," *American Journal of Agricultural Economics,* vol. 85, pp. 1140-1146, 2001.

[19] Veneto Promozione S.C.P.A, "Overview of the South African Retail Market," October 2013. [Online]. Available: https://www.tb.camcom.gov.it/uploads/CCIAA/Corsi/Atti/2013_11_07/OverviewOFTHESOUTHAfrica.pdfhttps://www.tb.camcom.gov.it/uploads/CCIAA/Corsi/Atti/2013_11_07/OverviewOFTHESOUTHAfrica.pdf. [Accessed 23 May 2020].

[20] J. Battersby and S. Peyton, "The Geography of Supermarkets in Cape Town: Supermarket Expansion and Food Access," *Urban Forum,* vol. 25, pp. 153-164, 2014.

[21] C. Abrahams, "Transforming the region: supermarkets and the local food economy," *African Affairs,* vol. 109, pp. 115-134, 2010.

[22] S. Planting, "Into the trolley," Financial Mail, 2010. [Online]. [Accessed 23 May 2020].

[23] M. Rogan and C. Skinner, "“Employment in the South African Informal Sector: Interrogating Trends, Identifying Opportunities," in *Tackling Unemployment and Poverty in South Africa: The Contribution of the Informal Sector.*, Pretoria, 2017.

[24] J. Strydom, "Retailing in disadvantaged communities: the outshopping phenomenon revisited," *Journal of Contemporary Management,* vol. 8, pp. 150-172, 2011.

[25] Statistics South Africa, "Quarterly Labour Force Survey Quarter 3: 2019," Statistics South Africa, October 2019. [Online]. Available: http://www.statssa.gov.za/publications/P0211/P02113rdQuarter2019.pdf. [Accessed 22 May 2020].

[26] B. M. Popkin, "Nutrition Patterns and Transitions," *Population and Development Review,* vol. 19, no. 1, pp. 138-157, 1993.

[27] J. Battersby and M. Marshak, Mapping the Invisible: The Informal Food Economy of South Africa, Cape Town: African Books Collective, 2016.

[28] E. Igumbor, D. Sanders, T. Puoane, L. Tsolekile, C. Schwarz and C. Purdy, ""Big Food" the consumer food environment, health and policy response in South Africa," *Public Library of Science Medicine,* vol. 9, pp. 1-7, 2012.

[29] S. Wiggins and S. Keats, "The Rising Cost of a Healthy Diet," Overseas Development Institute, London, 2015.

[30] B. Ghosh-Dastidar, D. Cohen, G. Hunter, S. N. Zenk, C. Huang, R. Beckman and T. Dubowitz, "Distance to Store, Food Prices, and Obesity in Urban Food Deserts," *American Journal of Preventive Medicine,* vol. 47, no. 5, pp. 587-595, 2014.

[31] J. Battersby, "The Food Desert as a Concept and Policy Tool in African Cities: An Opportunity and a Risk," *Sustainability,* vol. 11, no. 2, pp. 1-15, 2019.

[32] City of Cape Town, "City of Cape Town Official Suburbs," City of Cape Town, 2018. [Online]. Available: https://odp-cctegis.opendata.arcgis.com/datasets/official-suburbs. [Accessed 19 May 2020].