RETROSPECTIVE ANALYSIS OF ASSOCIATION OF LIVING IN USDA CLASSFIED FOOD DESERTS WITH INCIDENCE AND MORTALITY OF CANCER CASES AMONG PATIENTS IDENTIFIED IN THE FORT WORTH ADOLESCENT AND YOUNG ADULT ONCOLOGY COALITION DATABASE

INTERNSHIP PRACTICUM REPORT

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CHAPTER I

INTRODUCTION

This practicum project utilized the Fort Worth Adolescent and Young Adult (AYA) Oncology Coalition Database to assess for possible disparities in mortality rates and disease status among patients identified as living within USDA classified food deserts compared to those not. The AYA registry is built in collaboration with University of North Texas Health Science Center (UNTHSC) and local partners including Cook Children's Medical Center, JPS Health Network, Baylor Scott and White, and Texas Health Resources.

The adolescent and young adult oncology population is comprised of individuals aged 15-39 diagnosed with cancer. About 15,000 cases of AYA cancer are diagnosed annually in the United States, but these patients are often overlooked in a healthcare system that puts primary focus on pediatric and adult cancer cases. [1] While the incidence in AYAs diagnosed with cancer has been growing over the past years, the population still proves to be greatly understudied. In an effort to identify possible disparities affecting this population of patients, this practicum project divided the Fort Worth Adolescent and Young Adult (AYA) Oncology Coalition Database into two groups for comparative analysis – those living within USDA classified food deserts, and those not.

Food deserts are defined as areas where access to affordable and healthy food products is highly restricted or even completely non-existent. [2] The USDA classifies food deserts as areas which are deemed to be both low income and low access, and utilizes three main indicators of access:

(1) Accessibility to healthy food, measured by store distance or store volume in the area

(2) Individual-level resources such as family income or vehicle availability

(3) Neighborhood-level resources such as average income or public transportation. [3]

Residency in such areas has been linked to several conditions including obesity, diabetes, cardiovascular complications and even cancer. In addition, a defining characteristic of food deserts is that they are most commonly found in minority communities and low-income areas. [2] By analyzing the Fort Worth Adolescent and Young Adult Oncology Coalition Database by patient residency in food deserts, there is potential to find variations in disease status caused not only by differences in nutritional status, but also the socioeconomic factors affecting these areas.

CHAPTER II

BACKGROUND AND LITERATURE REVIEW

In 2009, an estimated 23.5 million United States Citizens were classified as living in a food desert, half of which were considered low income. [4] Food deserts are often utilized to highlight socioeconomic disparities, but they are also a major concern in terms of public health. Food desert residents who have minimal access to healthy food products exhibit much higher rates of chronic illnesses across their populations. [5] Families residing in these areas who are unable to afford or have transportation to grocery stores must rely on cheaper and easily available alternatives such as fast-food restaurants. Life expectancy in these communities is noted to be far shorter as spikes in these chronic illnesses frequently lead to diet related cancers and even premature death. [5]

It has been found that AYA cancer patients are at risk for late effects following cancer therapy that could be improved by a healthy diet alone. [6] The American Cancer Society emphasizes the importance of nutrition in the AYA cancer population; having poor nutritional status, as one likely would living in a food desert, is a major factor influencing cancer survival outcomes. [7] Dietary interventions in adult cancer cases have proven to improve both metabolic markers and quality of life, however such evidence of AYA dietary interventions is very limited. It is estimated that 80% of AYA-aged cancer survivors have fruit, vegetable and fiber intake below what is recommended. [8] Residency in a food desert creates a huge obstacle to obtaining adequate food sources, which in turn can affect comorbidities and even mortality rates amongst their AYA populations.

A study published in Advances in Radiation Oncology highlights the association between cancer and nutritional status through a literature review focusing on their molecular and clinical relationship. [9] Diet likely affects carcinogenesis through metabolic mechanisms and inflammatory processes, and many tumors are associated with obesity and metabolic syndrome, which suggests a nutritional relationship. [9] Poor nutrition is highly implicated in the pathogenesis of cancer and affects the survival of patients during and after completion of their therapies. The researchers in this case estimate that almost 80,000 cancer cases per year could be prevented with adequate diet alone. [9]

A population-based study published in the Health Services and Global Oncology Journal evaluates the relationship between food desert residency and survival of patients with stage II/III breast or colorectal cancer. The patients were identified in the 2000-2012 California Cancer registry and their residence at time of diagnosis was checked with USDA data to determine food desert grouping. It was found that living within a food desert was associated with diabetes, tobacco use, poor insurance coverage and low socioeconomic status, as well as higher mortality rates. [10] This internship practicum project aims to find differences caused by food desert residency within the Fort Worth Adolescent and Young Adult Oncology Coalition database through similar methodology.

SPECIFIC AIMS

The specific aims of this internship practicum project were to analyze the Fort Worth Adolescent and Young Adult Oncology Coalition Database for differences in disease status and mortality rates that could potentially be linked to disparities found within food desert communities. To achieve this, the Fort Worth AYA Oncology Coalition Database was divided into food desert and non-food desert residency groups using food desert location data from the USDA. Once divided, the groups were compared in terms of demographics, mortality and survival rate estimates, and differences in disease status. Food desert residency encompasses poor nutritional status, as well as many variations in socioeconomic status. Differences in the data were used to conclude if these factors have any impact on AYA disease and survivorship.

SIGNIFICANCE

In the year 2020, there were approximately 89,500 new cancer cases in the AYA population. In the past, this group has been grouped in with younger or older cancer populations leading to oversight in the distinct cancers and disparities this group tends to endure. [11] Recently, more effort has been made to study this unique group of patients and better understand their prognosis.

As previously stated, residency in a food desert is highly linked with poor nutritional status and thus higher disease frequencies including cancer. A major component leading to the creation of the Fort Worth AYA Oncology Coalition Database was the desire to extract information from the data registry in order to assess for disparities in incidence, treatment strategy and outcomes for the patients. This internship practicum project represents an effort to identify a disparity potentially affecting this population through analysis of food desert residency.

The American Cancer Society stresses the importance of providing both education and support to AYA patients to help them better their own health status through nutrition and physical well-being. Ensuring this group of patients have adequate resources on nutrition is highly important as AYAs are noted to be less engaged in health surveillance after their treatments. [7] Identifying such disparities can lead to improvement in quality of life through initiatives such as patient advocacy and development of appropriate resources. If there is a correlation between food desert residency and disease outcomes, future efforts can be made to better patient access to healthy food products and overall improve health in this population of AYA patients.

MATERIALS AND METHODS

The research design utilized in this practicum project is a retrospective analysis of data collected in the Fort Worth AYA Oncology Coalition (FWAYAOC) Database from the years 2016-2020. The creation of this database was approved by the North Texas Regional Institutional Review Board (Fort Worth, Texas). The registry data was compiled into a master file using six different spreadsheets of hospital data – two from Cook Children's Medical Center, two from JPS Health Network, and two from Baylor Scott and White. After analyzing the compiled data for any repeats and excluding patient entries who did not reside in a United States zip code at time of diagnosis, there were a total of 1035 individuals to evaluate for this project.

The FWAYAOC Database includes patients aged 15-39 diagnosed with cancer that were treated in the greater Fort Worth area. This project focuses on the data collected from Cook Children's Medical Center, JPS Health Network and Baylor Scott and White. The database contains patient address, diagnosis date, demographic, clinical and treatment information. This information was used to evaluate food desert residency in association with disease status and outcomes.

Through the USDA Food Access Research Atlas, the USDA identifies food deserts in the United States for varying years based on census tracts. Food desert status has the potential to change over time, so patients were categorized based on zip code at their time of diagnosis. The USDA Food Access Research Atlas provides data files for the years 2006, 2010, 2015 and 2019. The data file year to use for patient sorting into food desert and non-food desert residents was determined based on a range of diagnosis years. If diagnosed in 2005-2007, the patient zip code was categorized using the 2006 USDA data file, for 2008-2012 the 2010 file was used, for 2013-2016 the 2015 file was used, and for 2017-2020 the 2019 file was used (Table 1).

USDA Food Access Research Atlas File Year	**Date of Diagnosis**
2006	2005-2007
2010	2008-2012
2015	2013-2016
2019	2017-2020

Table 1. Categorization of USDA data files used to determine patient food desert residency. Patient zip code at time of diagnosis was cross referenced with appropriate USDA Food Access Research Atlas data file to determine grouping.

Once grouped, the zip codes found within the FWAYAOC database were matched to their appropriate counties to determine distribution of patients found within each area. Because it represented the highest density of patient residency in the database, the percentages of food desert and non-food desert residents were compared to the general Tarrant County food desert distribution via a Chi-Square goodness of fit test. This test was used to determine if frequencies found within the FWAYAOC database followed the same pattern as those in the Tarrant County population where most of the residents reside. Chi-Square and *p* values are reported to determine statistical significance at $p<0.05$.

Patient demographics and aspects of disease status were investigated using Microsoft Excel for comparative analysis. Multiple patient demographics, including race, origin, sex, tobacco use and insurance status, were evaluated utilizing a Chi-Square test of independence. This test was used to determine a possible relationship with food desert residency and each factor. Chi-Square and *p* values are reported to determine statistical significance at $p<0.05$.

Mortality and survival rates were calculated utilizing mortality counts from each group of patients. Mortality rate was calculated for food desert and non-food desert residents independently utilizing the formula $Mortality\ rate = \frac{Number\ of\ deaths\ in\ population\ (desert\ or\ non-desert)}{Total\ population\ in\ FWAYAOC\ database\ (desert\ or\ non-desert)}$. Significance testing on mortality rate was conducted through a Chi-Square test of independence to determine a relationship with residency at a statistical significance of $p<0.05$. Finally, aspects of disease status, including diagnosis coding, morphology and staging, were also tested using a Chi-Square test of independence at significance level $p<0.05$.

ArcGIS ArcMap was utilized to map out the food desert zip codes individuals in the FWAYAOC database resided in at time of diagnosis. ArcGIS provides base maps of United States zip codes, individual states and counties which were used with the data to identify desired regions on the map. Most patients in the FWAYAOC database live in the state of Texas at time of diagnosis, so an overall map of these regions was created to visualize this distribution.

The majority of patients in the FWAYAOC database lived in or around Tarrant County at time of diagnosis. Using ArcGIS ArcMap, these food desert zip codes in North Texas were mapped according to patient density. Patient density was determined by summation of zip codes found within the food desert residency group.

RESULTS AND DISCUSSIONS

Overview of Food Desert Residency

There are a total of 1035 patient entries in the Fort Worth AYA Oncology Coalition Database meeting inclusion criteria for analysis in this project. Cross checking patient zip code at diagnosis with the USDA Food Access Research Atlas yields 418 patients classified as food desert residents, and 617 as non-residents (Figure 1).

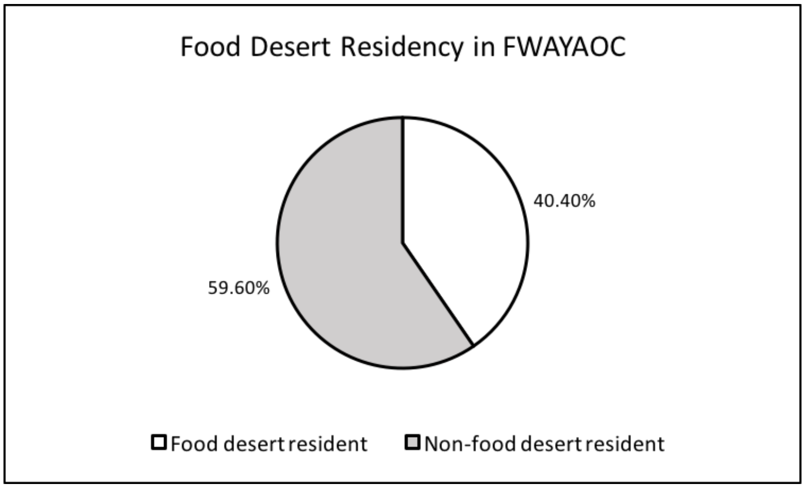

Figure 1. Food desert residency. Breakdown of food desert residency in the FWAYAOC database after sorting by USDA data. 40.4% of patients were identified as food desert residents, and the remaining 59.6% as non-residents.

A majority of 74.59% of patients in the FWAYAOC database reside in Tarrant County at time of diagnosis (Figure 2). An estimated 37.8% of all Tarrant County residents live within low income, low access food desert census tracts. [12]

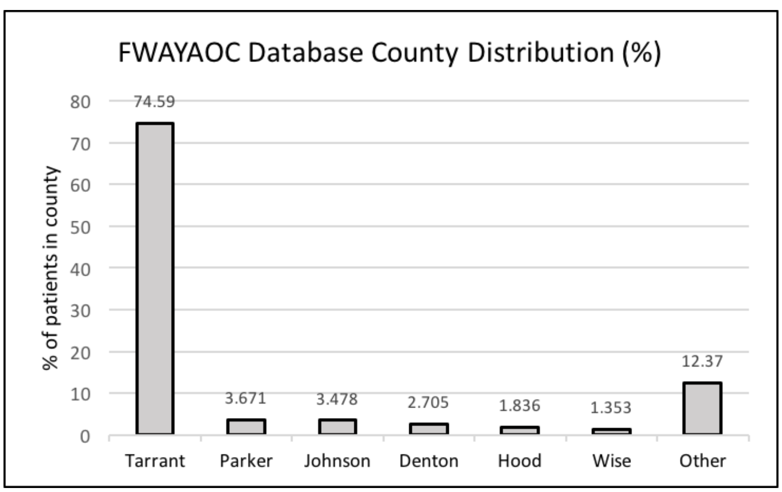

Figure 2. FWAYAOC Database Country Distribution. Frequency of patients diagnosed in each county.

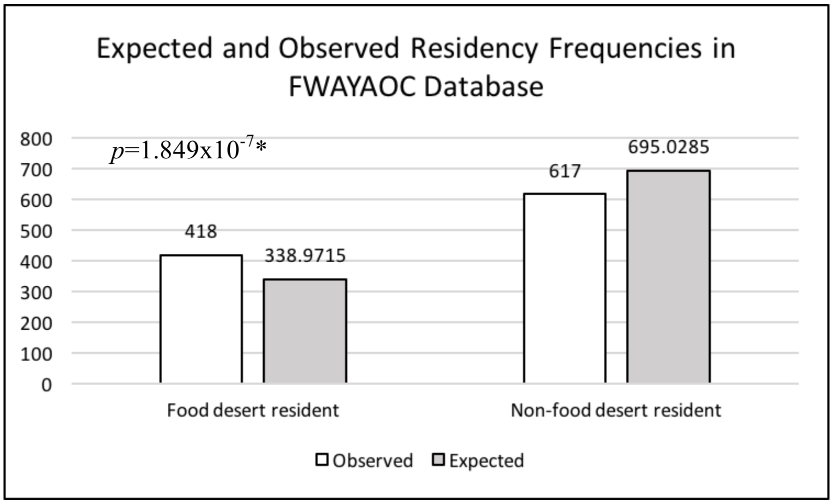

Figure 3. Expected and observed residency frequencies in the FWAYAOC database. Chi-Square goodness of fit utilized to determine statistical significance between population frequencies found within the FWAYAOC database and general Tarrant County Population. * Indicates statistical significance between the two groups at $p<0.05$.

A Chi-Square goodness of fit test was applied to the FWAYAOC database data to determine if it followed this hypothesized distribution found within Tarrant County. The data was found to have a higher proportion of food desert residents than theorized by the Tarrant County model (Figure 2). There was a significant difference between the two variables, $X^2(1, N=1035) = 27.1$, $p=1.849\text{x}10^{-7}$, indicating a possible relationship between food desert residency and incidence of AYA cancer cases.

The 40.4% of patients identified as food desert residents reside in the mapped zip codes throughout the state of Texas (Figure 4).

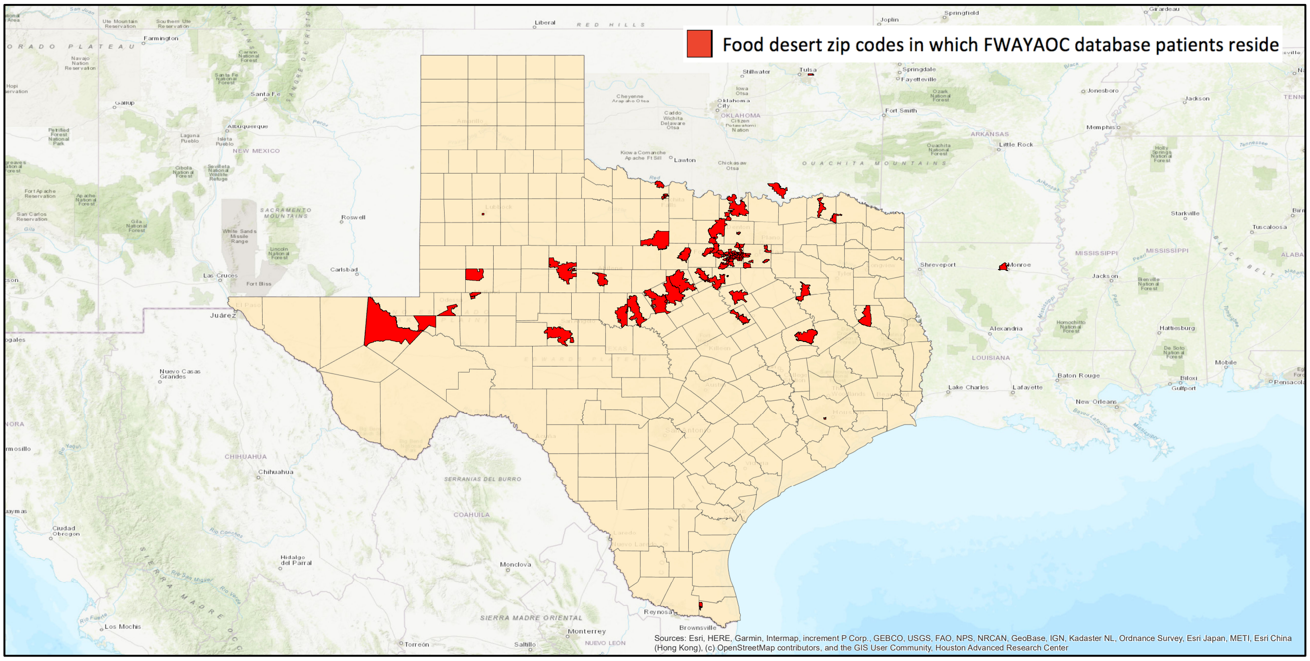

Figure 4. Overall food desert zip codes in which FWAYAOC database patients reside. Map created using ArcGIS ArcMap and zip code data from the FWAYAOC database.

79.9% of individuals in the FWAYAOC database identified as living in a food desert reside in Tarrant County.

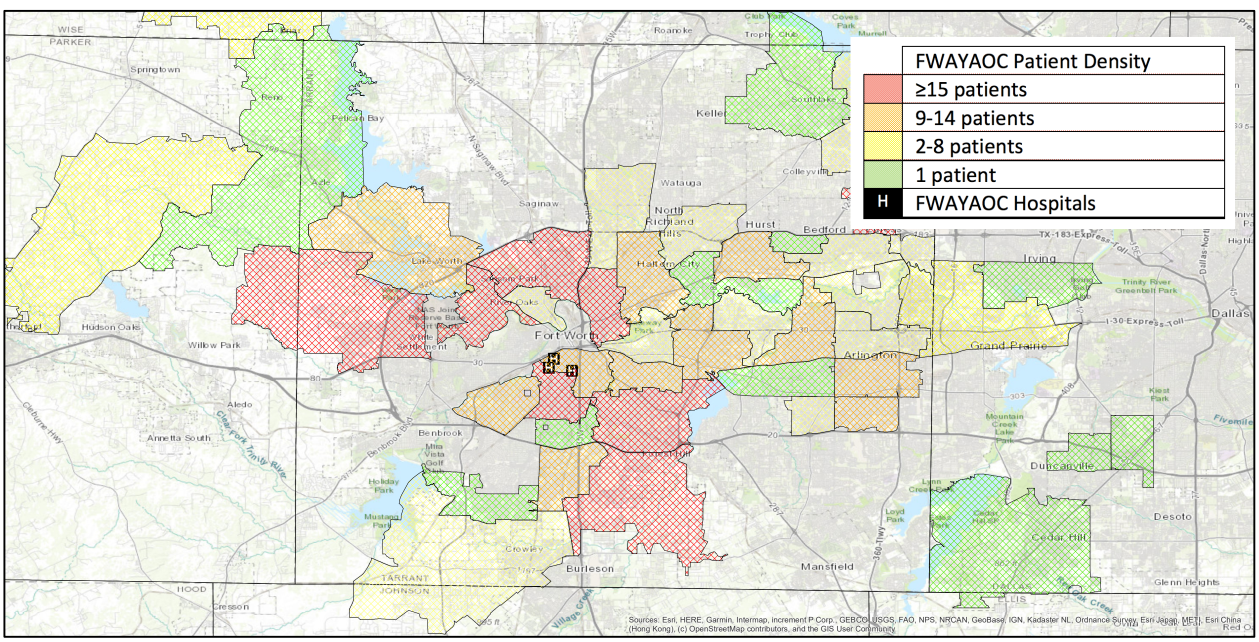

Figure 5. Tarrant County food desert patient density. Map created using ArcGIS ArcMap and zip code data from the FWAYAOC database.

The zip codes in which these patients reside are categorized based off of patient density (Figure 5). The greater Tarrant County area is greatly impacted by food deserts, and it is beneficial to evaluate if this obstacle to optimal nutritional status has any effect on disease incidence or outcome for AYA cancer patients.

Patient Demographics

Food desert residents represent a higher population of minority individuals than non-desert residents. For race, residents are significantly more likely to represent black or other non-white groups than non-desert residents, $X^2(2, N=1020) = 6.8$, $p=.034$. The United States Department of Agriculture states that the percent of the "population that is non-Hispanic black is over twice as large in urban food deserts than in other urban areas." [5] The data found within the FWAYAOC database is reflective of this statement, with 18.34% of food desert residents representing Black individuals compared to only 12.60% of non-food desert residents (Table 2).

Food deserts are also significantly associated with higher proportions of individuals of Spanish/Hispanic origin, $X^2(1, N=1006) = 30.5$, $p=3.388\times10^{-8}$. Within these areas, individuals of Spanish/Hispanic origin represent 34.64% of the population compared to only 19.20% in non-food desert zip codes (Table 2).

Parameter		**Food Desert**	**Non-Food Desert**	**Significance (*p*)**
Race	White	76.04%	82.32%	0.034*
	Black	18.34%	12.60%	
	Other including Chinese, Hawaiian, Korean, Vietnamese, Asian Indian, Asian and Pacific Islander	5.62%	5.07%	
Spanish/ Hispanic Origin	Non-Hispanic including Portuguese and Brazilian	65.36%	80.80%	3.388×10^{-8}*
	Hispanic including Mexican, Cuban, NOS	34.64%	19.20%	
Sex	Male	34.13%	36.79%	0.382
	Female	65.87%	63.21%	
Age at diagnosis	Average (Years)	31	30	
	Range	15-45	10-45	

Table 2. Overview of patient demographics. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert residents. * Indicates statistical significance between the two groups at $p<0.05$.

Racial disparities are prevalent in food desert communities across the United States. Of the millions of citizens living in these areas, African American and Hispanic individuals are noted to have as small as a third of access to chain supermarkets as their white counterparts. The markets in which they do have access are found to have less variety of products at higher prices. [13]

There is no significant association between sex and food desert residency, $X^2(1, N=1033) = 0.8$, $p=.392$. Both groups are comprised of a majority female population, and age at diagnosis represents only a one-year difference between groups (Table 2).

Tobacco Use	**Food Desert**	**Non-Food Desert**	**Significance (*p*)**
None	72.96%	74.37%	0.123
Current user at date of diagnosis	15.05%	11.01%	
Former user	11.99%	14.62%	

Table 3. Tobacco use. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert residents. * Indicates statistical significance between the two groups at $p<0.05$.

Food desert residents are more likely to current users of tobacco (including cigarettes, smokeless tobacco, and other smoke) at their time of diagnosis than non-desert residents (Table 3). However, there is overall no significant relationship between tobacco use at any point in time and food desert residency, $X^2(2, N=946) = 4.2$, $p=.123$. Both smoking and poor nutrition are leading causes of preventable death, and food desert residency has been traditionally associated with higher rates of tobacco use. [14] Because tobacco use can be a contributing factor to various cancers found throughout the body, it is important to rule out any confounding effects use has on differences in disease outcomes. The distribution of use found within the FWAYAOC database does not greatly differ between food desert and non-desert groups, indicating tobacco use itself is not driving many differences in prognosis.

There is a significant relationship between food desert residency and insurance status, $X^2(1, N=1009) = 12.9$, $p=.0003$. In total, 26.03% of patients living within food deserts did not have insurance during the course of their treatment, compared to only 16.86% of non-food desert residents (Table 4).

Insurance Status		Food Desert	Non-Food Desert	Significance *(p)*
No	Not insured	15.57%	8.76%	0.0003*
	Not insured, self-pay	10.46%	8.10%	
Yes	Insurance NOS	14.11%	17.52%	
	Private insurance	36.98%	49.26%	
	Medicaid	15.82%	13.22%	
	Medicare	4.38%	1.82%	
	Tricare	0.49%	0.50%	
	Military	0.49%	0.17%	
	Indian/Public Health service	0.73%	0.17%	
	Insurance status unknown	0.97%	0.50%	

Table 4. Insurance status. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert residents. * Indicates statistical significance between the two groups at $p<0.05$.

Historically, young adults are the least likely to have health insurance in the United States, and this has been identified as a major disparity affecting AYA cancer outcome. [15] In a study published in Cancer Medicine, researchers found that AYA insurance status was a statistically significant predictor of death for a variety of cancer types. [16]

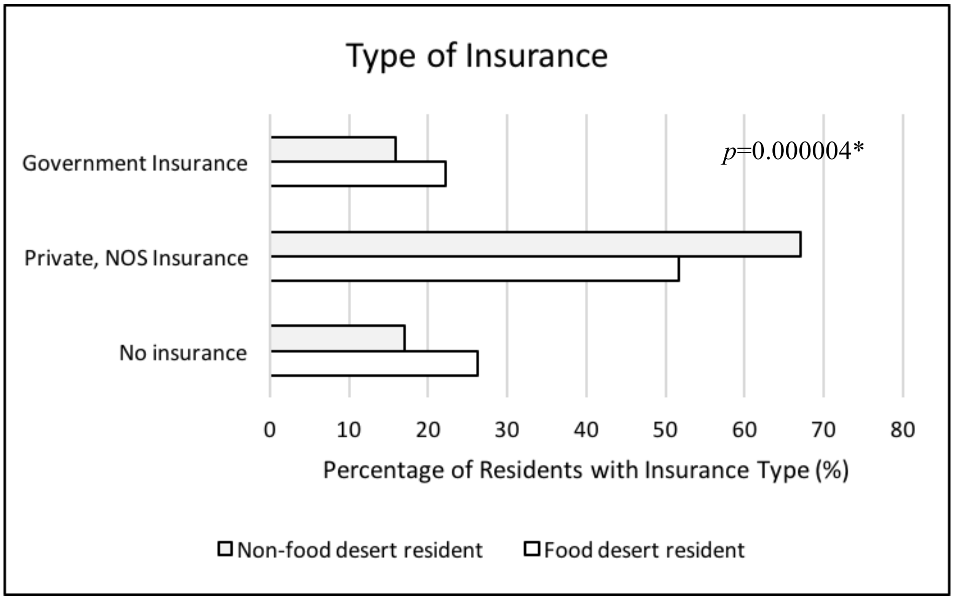

Figure 6. Types of insurance. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert residents. * Indicates statistical significance between the two groups at $p<0.05$.

Food desert residents who do have insurance are more likely to have a government plan than non-desert peers whom are more likely to hold private insurance plans (Figure 6). The differences in specific categories of insurance found within the FWAYAOC database is statistically significant between residency groups, $X^2(2, N=1009) = 24.9$, $p=.000004$. Oncology patients with government insurance have increased mortality risk than patients with private plans. [17] This contrast in insurance status is a potentially confounding aspect leading to differences in disease outcome.

Mortality and Survival Rate Estimates

There are a total of 54 deaths recorded among patients in the Fort Worth AYA Oncology Coalition Database. 23 of these deaths are within the food desert population, while the other 31 are among non-food desert residents.

Figure 7. Mortality rate. Mortality rate was calculated dividing number of deaths by population at risk in each group. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert groups. *Indicates statistical significance between the groups at $p<0.05$.

Morality rate was calculated by number of deaths in each population. Food desert residents present with a higher mortality rate of 5.5 deaths per 100 residents, compared to only 5.0 deaths per 100 residents in the non-desert group (Figure 7). This difference is not significant to conclude a relationship between residency and mortality rate outcomes, $X^2(1, N=1035) = 0.1$, p =.734. A survival estimate of this data yields a survival rate of 94.5% among food desert residents and 95.0% among non-residents. The five-year survival rate for all AYA cancer cases in the United States is estimated to be much lower than for patients in the FWAYAOC database, measuring between 83-86% for all cancer types. [18]

Differences in Disease Status

Topography codes indicate the origin of a neoplasm identified in a cancer diagnosis. [19] For analysis of the FWAYAOC database, topography codes are grouped by similar organ systems and body region for analysis of differences among the food desert and non-food desert groupings (Table 5). When grouped, there is no significant relationship between food desert residency and topography coding, $X^2(13, N=1035) = 16.4$, p =.231.

Topography/ Diagnosis Code		Food Desert	Non-Food Desert	Significance (p)
C00-C14	Malignant neoplasms of lip, oral cavity and pharynx	2.15%	4.21%	0.231
C15-C26	Malignant neoplasms of digestive organs	9.81%	8.43%	
C30-C39	Malignant neoplasms of respiratory and intrathoracic organs	2.63%	1.94%	
C40-C41	Malignant neoplasms of bone and articular cartilage	10.29%	9.73%	
C43-C44	Melanoma and other malignant neoplasms of skin	2.63%	3.08%	
C45-C49	Malignant neoplasms of mesothelial and soft tissue	2.87%	1.78%	
C50	Malignant neoplasms of breast	20.33%	22.04 %	
C51-C58	Malignant neoplasms of female genital organs	9.09%	6.32%	
C60-C63	Malignant neoplasms of male genital organs	5.50%	4.86%	
C64-C68	Malignant neoplasms of urinary tract	2.15%	1.94%	
C69-C72	Malignant neoplasms of eye, brain and other parts of the central nervous system	8.13%	7.13%	
C73-C75	Malignant neoplasms of thyroid and other endocrine glands	19.14%	18.48 %	
C76-C80	Malignant neoplasms of ill-defined, other secondary and unspecified sites	5.26%	10.05 %	

Table 5. Topography/diagnosis coding. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert groups for each range of codes. *Indicates statistical significance between the groups at $p<0.05$.

Food desert residents account for a higher percentage of diagnoses of malignant neoplasms of digestive organs, respiratory and intrathoracic organs, bone and articular cartilage, mesothelial and soft tissue, female and male genital organs, urinary tract, central nervous system, and endocrine glands. Subcategories of these codes are broken down for comparison of more specific cancer types between groups (Figure 8). The largest differences are found between digestive and uterine cancers.

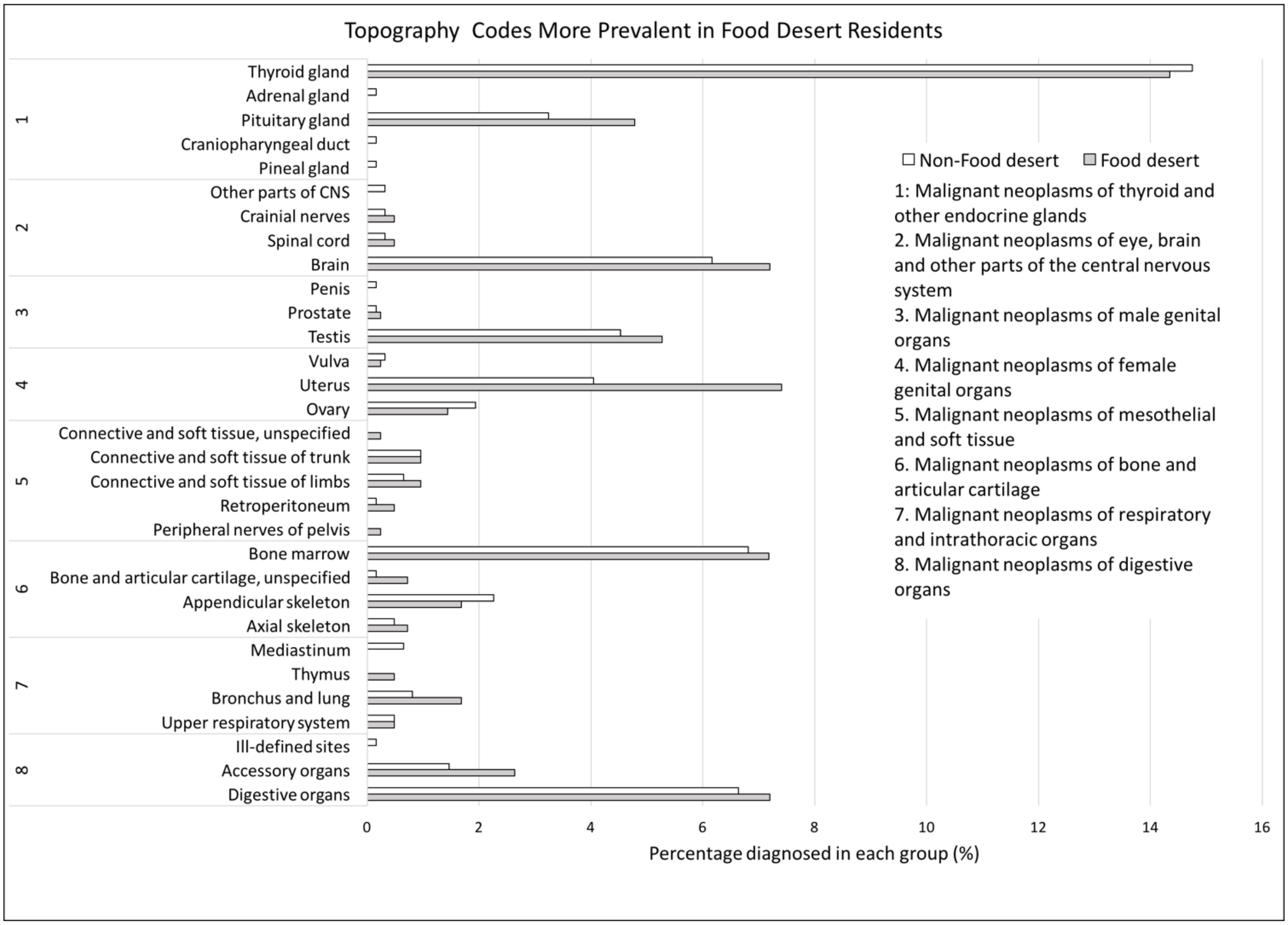

Figure 8. Breakdown of topography code groupings more prevalent in food deserts. Displays subcategories of topography codes for comparison between the two groups. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert groups for each range of codes. *Indicates statistical significance between the groups at $p<0.05$.

7.2% of food desert residents are diagnosed with malignant neoplasms of digestive organs (including the esophagus, stomach, small intestine, colon, rectum and anus) compared to 6.64% of non-food desert residents. Residents also represented 2.64% of malignant neoplasms of accessory digestive organs (including the liver and pancreas), while non-desert residents comprised only 1.46% (Figure 8). Nutrition is considered to be a modifiable risk for development of digestive cancers. Inadequate diets consisting of low quantities of fresh food and high quantities of processed foods are a major risk factor for colorectal and stomach cancers, and low-socioeconomic status is also associated with increased risk. [20, 21]

7.4% of food desert residents are diagnosed with malignant neoplasms of the uterus (including unspecified part of uterus, endometrium, cervix uteri, and endocervix), compared to only 4.05% of non-desert residents. Poor diet is a large risk factor for development of endometrial cancers, and has been linked to differences in quality of life after diagnosis and treatment. It is noted that only about 1% of survivors meet recommendations for fruit and vegetable intake. [22]

Morphology codes are markers of tumor development and behavior. [23] Codes in the FWAYAOC database are summed to compare rates of morphologic diagnosis between food desert and non-food desert groups (Table 6).

Morphology	Food Desert	Non-Food Desert	Significance (*p*)
Infiltrating duct carcinoma, NOS	17.27%	14.60%	0.280
Adult granulosa cell tumor of ovary	8.46%	10.89%	
Hodgkin lymphoma, nodular sclerosis, NOS	2.94%	1.73%	
Pituitary adenoma, NOS	2.76%	4.21%	
B lymphoblastic leukemia/lymphoma, NOS	2.42%	3.96%	
Adenocarcinoma, NOS	3.97%	5.94%	
Mixed germ cell tumor	1.90%	2.23%	
Malignant melanoma, NOS	2.59%	0.50%	
Squamous cell carcinoma, keratinizing, NOS	1.72%	0.50%	
Squamous cell carcinoma, NOS	2.93%	3.96%	
Seminoma, NOS	1.55%	1.24%	
Intraductal carcinoma, noninfiltrating, NOS	1.55%	2.48%	
Neoplasms, malignant	1.38%	0.99%	
Neuroendocrine tumor, NOS	2.07%	1.73%	
Clear cell adenocarcinoma, NOS	1.21%	0.74%	
Squamous intraepithelial neoplasia, high grade	1.21%	2.23%	
Hodgkin lymphoma, NOS	1.73%	0.99%	
Meningioma, NOS	1.21%	0.74%	
Papillary carcinoma, encapsulated of thyroid	1.04%	0.99%	
Carcinoma, NOS	0.86%	0.99%	
Cavernous hemangioma	0.69%	0.74%	
Other	38.51%	37.62%	

Table 6. Morphology. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert groups. *Indicates statistical significance between the groups at $p<0.05$.

There is no significant association between morphology and food desert residency, with percentages of each code being quite equal, $X^2(31, N=983) = 24.3$, $p = .28$. Food desert residents do slightly surpass non-desert counterparts in diagnosis of infiltrating duct carcinomas, malignant melanomas, keratinizing squamous cell carcinomas, squamous cell carcinomas, neuroendocrine tumors, clear cell adenocarcinomas, Hodgkin lymphomas, meningiomas, and encapsulated papillary carcinomas of the thyroid.

The largest differences are found between infiltrating duct carcinomas and malignant melanomas, with food desert residents representing 2.67% and 2.10% more diagnoses respectively (Table 6). An infiltrating duct carcinoma is the most common form of breast cancer, and obesity related to high caloric intake is a known risk factor of invasive breast cancers occurring post menopause; it is unknown if the same applies to cases found in the younger AYA community. [24 ,25] Malignant melanoma is cancer of the melanocytes in the skin. [26] An increase in the intake of carotenoids and vitamins C, E, D and A is thought to reduce melanoma risk due to photoprotective and antioxidant properties which protect against solar radiation. [27]

Morphology	Food Desert		Non-Food Desert	
	# deaths	% death rate by diagnosis	# deaths	% death rate by diagnosis
Squamous cell carcinoma, NOS	2	12.50%	3	17.65%
Squamous cell carcinoma, keratinizing, NOS	0	0.00%	2	20.00%
Adenocarcinoma, NOS	4	16.67%	2	8.70%
Neuroendocrine tumor, NOS	1	14.29%	1	8.33%
Infiltrating duct carcinoma, NOS	0	0.00%	1	1.00%
Alveolar rhabdomyosarcoma	1	100.00%	0	0.00%
Synovial sarcoma, NOS	0	0.00%	1	100.00%
Yolk sac tumor, NOS	0	0.00%	1	20.00%
Hemangiosarcoma	1	100.00%	0	0.00%
Central osteosarcoma, NOS	1	100.00%	1	50.00%
Ewing sarcoma	1	20.00%	2	16.67%
Glioma, malignant	0	0.00%	3	50.00%
Astrocytoma, anaplastic	1	100.00%	0	0.00%
Glioblastoma, NOS	1	50.00%	0	0.00%
B lymphoblastic leukemia/lymphoma, NOS	4	25.00%	3	21.43%
Acute myeloid leukemia, NOS	2	50.00%	1	50.00%
Therapy-related myeloid neoplasm	1	100.00%	0	0.00%
Juvenile myelomonocytic leukemia, NOS	1	100.00%	0	0.00%
Post-transplant lymphoproliferative disorder (PTLD), polymorphic	0	0.00%	1	100.00%
Neoplasm, malignant	0	0.00%	1	12.50%
Mucinous adenocarcinoma	0	0.00%	1	100.00%
Malignant melanoma, NOS	1	33.33%	4	26.67%
Sarcoma, NOS	1	50.00%	0	0.00%
Choriocarcinoma, NOS	0	0.00%	1	50.00%
Hodgkin lymphoma, NOS	0	0.00%	1	10.00%

Table 7. Morphology codes by mortality counts. Morphologic codes diagnosed in FWAYAOC database patients who have been identified as deceased are compared between groups. The percentage death rate is obtained by dividing number of deaths by the total number of specific morphologic diagnoses in each group.

The morphology codes in the FWAYAOC database are also evaluated by deceased patients only (Table 7). Individuals in the food desert group are significantly more likely to not survive when diagnosed with adenocarcinomas, neuroendocrine tumors, central osteosarcomas, Ewing sarcomas, B lymphoblastic leukemia/lymphoma, and malignant melanomas than non-food desert residents. It is difficult to confidently determine if these differences are truly related to food desert residency, however, as there are so few diagnoses in each category.

Staging of a disease refers to the extent in which a cancer has spread at diagnosis, regardless of future changes. [28] There is no significant relationship between food desert residency and stage of disease, $X^2(6, N=725) = 5.9$, $p = .425$.

Stage of Disease	Food Desert	Non-Food Desert	Significance (p)
In Situ	9.15%	6.51%	0.425
Localized	38.98%	40.70%	
Regional by direct extension only	12.54%	9.78%	
Regional to regional lymph nodes only	9.83%	13.95%	
Regional (direct extension and regional lymph nodes)	8.14%	6.74%	
Regional, NOS	1.36%	1.63%	
Distant metastasis or systemic disease (leukemia, multiple myeloma)	20.00%	20.70%	

Table 8. Stage of disease. Chi-Square test of independence utilized to determine statistical significance between food desert and non-food desert groups.
*Indicates statistical significance between the groups at $p<0.05$.

No significant patterns are found to differentiate disease stage between food desert and non-food desert residents (Table 8). Individuals in the FWAYAOC database living within a food desert are more likely to be staged as in situ, regional by direct extension only, or regional by direct extension and regional lymph nodes, but there is likely no true connection leading to this distribution.

SUMMARY AND CONCLUSIONS

1035 patient entries in the Fort Worth AYA Oncology Coalition Database were analyzed for difference in incidence, mortality and disease status based on food desert residency as determined by the USDA Food Access Research Atlas. 40.4% of individuals were identified as food desert residents. As most patients (74.59%) lived within Tarrant County zip codes, the distribution of food desert residents in the FWAYAOC database was compared to the distribution found in Tarrant County. There was a significant difference (p =1.839 x 10^{-7}) between the two distributions, indicating that the FWAYAOC database distribution of food desert residents do not follow that of the theorized model in Tarrant County. A greater percentage of food desert residents were observed in the FWAYAOC database than expected, indicating a possible relationship between residency and incidence of AYA cancer cases.

Food desert residents were significantly more likely to represent black or other non-white groups (p =.034), and individuals of Hispanic/Origin (p =3.388 x 10^{-8}) than non-desert residents. This is consistent with the demographic distribution found nationally within food deserts. There was no significant association between sex (p =0.8) or age at diagnosis and food-desert residency. FWAYAOC patients did not differ between groups in terms of tobacco use (p =.123), allowing this factor to be ruled out as cause for any major differences found in terms of disease status.

There was a significant relationship between food desert residency and insurance status, in terms of both generally having insurance (p =0.0003) and insurance type (p =0.000004). Food desert residents were more likely to not have insurance at all (26.03%), and if they did, more likely to hold a government insurance plan (22.11%). Because insurance status has potential to cause variation in disease outcome, it must be considered a possible confounding factor leading to differences in the two residency groups.

A total of 54 deaths were recorded among patients in the FWAYAOC database, 23 of which found in the food desert residency group. A mortality rate calculated from this count yielded 5.5 deaths per 100 food desert residents, and 5.0 deaths per 100 non-desert residents. This difference was not statistically significant to conclude a relationship between residency and mortality rate outcome (p =.734). The survival rate estimates for food desert and non-food desert residents were 94.5% and 95.0% respectively, which are both much higher than the 5-year survival rate for all United States AYA cancer patients at 83-86%.

Distribution of topography codes, morphology and stage of disease all did not have a statistically significant relationship with food desert residency. Food desert residents accounted for a higher percentage of diagnoses of malignant neoplasms of digestive organs, respiratory and intrathoracic organs, bone and articular cartilage, mesothelial and soft tissue, female and male genital organs, urinary tract, central nervous system, and endocrine glands (p =.231). For morphology, food desert residents have a higher percentage of in diagnosis of infiltrating duct carcinomas, malignant melanomas, keratinizing squamous cell carcinomas, squamous cell carcinomas, neuroendocrine tumors, clear cell adenocarcinomas, Hodgkin lymphomas, meningiomas, and encapsulated papillary carcinomas of the thyroid (p =.280). The most prevalent topography and morphology markers found in the FWAYAOC database do have a proved relationship with poor nutritional status. Overall, it seems food desert residency has more impact on disease incidence than disease outcome for patients within the FWAYAOC database.

Limitations

A limitation facing this study is patient change of residence from time of diagnosis. Because sorting via the USDA Food Access Research atlas was completed utilizing patient zip code at time of diagnosis, it does not account for any changes in residency thereafter. Changes in home residence following diagnosis could account for differences in survival rate and disease outcome if one is going from food-desert area to non-desert, or vice versa.

Another limitation arises with the markedly higher survival rates AYA cancer patients have compared to any other age group. The 5-year relative survival for AYA cancer patients is estimated to be around 85%, while those aged 40-65 fall at 73%, and 65+ at 60%. [29] Mortality is likely to be low, and therefore hard to evaluate, based on age alone. Because the FWAYAOC database has only collected data from the years 2016-2020, mortality and survival rates are possibly skewed based on duration only, despite any underlying disparities.

The database size is also relatively small (N=1035), and is limited to Fort Worth area hospitals. The results, therefore, are not widely applicable to AYA cancer cases throughout the United States. Due to the little number of deaths amongst patients in the database, it is difficult to establish a definitive relationship between mortality and food desert residency.

Differences in reporting across Cook Children's Medical Center, JPS Health Network and Baylor Scott and White patient files did not allow for calculation of specific demographics and disease status markers which would prove helpful in establishing a relationship with food desert residency. Comorbidity and BMI calculations would have been helpful in establishing patterns of obesity and various disease typically found within food desert areas, but lack of entries among hospital files did not allow this calculation. Additional markers of disease status and progression, such as disease grade and need for surgery and radiation also could not be calculated due to differences in data reporting.

Future Research

Previous research on food desert impact has focused on the socioeconomic and racial disparities found within their borders. While residency in these areas has been linked to a variety of conditions, there has been little work to establish a firm relationship between occupants and development of specific disease such as cancer.

Oncology research among the adolescent and young adult age group itself is also lacking in comparison to pediatric and adult cases. It is highly important to identify disparities and causes leading to development of disease in this demographic, as backgrounds greatly differ between patient age groups.

Because nutrition is highly implicated in the development of many cancers, it would be beneficial to evaluate food desert residency and disease status among AYA cancer patients on a larger scale. The FWAYAOC database was limited in its scale in terms of database size, duration and residential areas covered. A similar study conducted on state-wide or even national data, with a longer period of time covered in patient diagnoses, would yield more applicable results to establish a relationship between incidence, mortality and food desert residency.

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